

ANNEXURE III

CABLE SCHEDULE FORMAT

[illegible]

218999/2021/PS-PEM-MAX

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

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

218999/2021/PS-PEM-MAX

FORM NO. PEM-666-0



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



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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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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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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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)

218999/2021/PS-PEM-MAX

	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.)

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.

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.

	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

	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.

	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

	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

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.

PROJECT MANAGEMENT AND SITE SERVICES

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 packagewise 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.

(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.

ENGINEERING SERVICES

CONTENT

CLAUSE NO.	DESCRIPTION
1.00.00	GENERAL
2.00.00	DESIGN COORDINATION MEETING
3.00.00	CO-OPERATION WITH OTHER CONTRACTORS AND CONSULTING ENGINEERS
4.00.00	GUIDELINES FOR ENGINEERING SERVICES
5.00.00	OPERATING MANUALS AND MAINTENANCE INSTRUCTIONS
6.00.00	PLANT HANDBOOK
7.00.00	CONTRACT STAGE DOCUMENT SUBMISSION AND APPROVAL PROCEDURE
8.00.00	TENDER STAGE DOCUMENT SUBMISSION

ATTACHMENTS

ANNEXURE-1	DISTRIBUTION SCHEDULE
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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.

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- 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

	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.

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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V.IIA/S-6 Anx-1: 1

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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V.IIA/S-6 Anx-1: 2

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

QUALITY ASSURANCE REQUIREMENTS

CONTENT

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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				
		ITEM : -				REV NO :		0	1	2	3	4
						DATE :						
CLIENT :						LOCATION :						
PROJECT :						REFERENCE PURCHASE ORDER NO. & DT :						
VENDOR :						REFERENCE APPROVED DATA SHEET :						
SUB VENDOR :						REFERENCE APPROVED DRAWING. NO. :						
ABBREVIATIONS :						AGENCY :						
QAP - QUALITY ASSURANCE PLAN,		MATL - MATERIAL,		1 - DCPL/PROJECT AUTHORITY		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.						
CR - CRITICAL,		APP - APPROVED,		2 - SUPPLIER								
MA - MAJOR,		DWG - DRAWING,		3 - SUB-SUPPLIER								
MI - MINOR		SUPL - SUPPLIER,		4 - MANUFACTURER								
SPEC - SPECIFICATION,		PROC - PROCEDURE		5 - THIRD PARTY INSPECTION AGENCY								
TC - TEST CERTIFICATES												
P - PERFORM												
w - WITNESS												
V - VERIFY												
CHP - CUSTOMER HOLD POINT												
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			
DATE												

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Notes:

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

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

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.

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- 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.

CONDENSATE POLISHING SYSTEM

- 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.

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

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.

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

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

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.

- 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.

- 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.

- 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

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~~

**TECHNICAL SPECIFICATION
FOR
PRESSURE AND STORAGE VESSELS**

**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).

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. |

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

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

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.

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.

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)

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)

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.

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.

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#).

- 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

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- 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.

- 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 conforming 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

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:

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:

- 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).
- For only acid services Non- Return valves shall be of lined construction & Flap type.
- 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.

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.

**TECHNICAL SPECIFICATION
FOR
HORIZONTAL CENTRIFUGAL PUMPS**

**TECHNICAL SPECIFICATION
FOR
HORIZONTAL CENTRIFUGAL PUMPS**

C O N T E N T S

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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.

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.

**TECHNICAL SPECIFICATION
FOR
VERTICAL CENTRIFUGAL PUMPS**

TECHNICAL SPECIFICATION
FOR
VERTICAL CENTRIFUGAL PUMPS

C O N T E N T S

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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

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

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, along with 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.

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 ϕ , 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

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

**TECHNICAL SPECIFICATION
FOR
POSITIVE DISPLACEMENT PUMPS**

**TECHNICAL SPECIFICATION
FOR
POSITIVE DISPLACEMENT PUMPS**

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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.

	◆ Worm ◆ Shafts (worm) ◆ Diaphragm ◆ Base plate ◆ Foundation bolts	- AISI 4142. - En 19. - Chemically inert teflon. - MS. - MS.
2.07.00	Suitable gland seal should be provided to prevent leakage.	
2.08.00	Electric drive motor particulars should follow Electrical Specification, enclosed herewith.	
3.00.00	TESTING	
3.01.00	Testing and Inspection at Manufacturer's Works	
3.01.01	The Manufacturer shall conduct all tests required 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.	
3.01.02	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 representatives can witness the test.	
3.01.03	All materials and castings used for the equipment shall be of tested quality. The test certificates shall be made available to Purchaser.	
3.01.04	The pump casing shall be hydraulically tested at 200% of pump operating pressure or 15 Kg/Sq.Cm(g) whichever is higher. The test pressure shall be maintained for at least half an hour.	
3.01.05	The rotating parts of pump drive shall be subjected to static balancing.	
3.01.06	All pumps shall be tested at the shop for capacity volumetric accuracy, repeatative accuracy, power and volumetric efficiency. The tests are to be done according to the requirements of the "Hydraulic Institute" of U.S.A. ASME Power Test Code and Indian Standards or as per API.- 675.	
3.01.07	The pump accessories e.g. gear box, speed reduction unit etc. will be subjected to tests as per Manufacturer's standards.	
3.01.08	The combined vibration of pump and motor should be restricted within limits specified by Hydraulic Institute Standards, USA, when the pump is in operation singly or in parallel.	

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- 3.01.09 Test reports and certificates of all the above mentioned tests to ensure satisfactory operation of the system shall be submitted to the Purchaser before despatch.
- 3.01.10 Performance test shall be carried out for the setting of pressure relief valve.
- 3.02.00 Test 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.

**TECHNICAL SPECIFICATIONS
FOR
SCREW PUMPS**

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TECHNICAL SPECIFICATIONS FOR SCREW PUMPS

01.00.00 GENERAL

This section covers general requirement of design, construction features, manufacture, inspection and performance testing of screw / gear pump for water, oily water, fuel oil and sludge applications.

2.00.00 CODES AND STANDARDS

The equipment supplied shall comply with the latest applicable Indian Standards listed below. Other national standards are acceptable provided they are established to be equal or superior to the Indian Standards mentioned herewith.

IS : 5120. 1977	Technical requirements of rotodynamic purpose pumps
BS : 599. 1966	Method of testing for pumps
HIS	Hydraulic Institute Standards, USA
API: 676. 1980	Positive Displacement Pumps - Rotary
VDMA 24284. 1970	Positive Displacement Pumps - Code for Acceptance
	Test
IS: 210.1993	Grey Iron Castings
IS : 2062, 1992	Steel for general structural purposes
ANSI B16.5	Pipe flanges and flanged fittings
ASME Sec II	Engineering
	Materials

03.00.00 TECHNICAL REQUIREMENTS

03.01.00 Design & Performance Requirements

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- 03.01.01 The pump shall be horizontal, rotary, positive displacement type with gear or screw as rotary element.
 - 03.01.02 The pump shall be capable of developing the required total head at rated flow under continuous operation. The maximum efficiency of the pump shall be within $\pm 10\%$ of rated flow.
 - 03.01.03 Pumps of a particular category shall be identical and shall be suitable for parallel operation with equal load sharing. Components of identical pumps shall be Interchangeable.
 - 03.01.04 Pumps shall run smoothly without undue noise and vibration. The noise level at a distance of 1 m from the equipment shall not exceed 85 dBA.
 - 03.01.05 The pumps shall be suitable to handle fluid of characteristics as indicated in technical data sheet.
 - 03.01.06 The pumps shall be suitable to handle the specified fluid for the complete range of operating conditions. The pump capacity shall be selected based on lowest possible viscosity and driving motor power shall be selected based on highest possible viscosity.
 - 03.01.07 Each pump shall be connected to its drive motor directly and shall be mounted on a common base plate. The pump set along with drives shall be designed to permit rapid and economical maintenance.
 - 03.01.08 All pumps shall be provided with suitable mechanical seals of proven design and material.
 - 03.01.09 The supplier shall assume full responsibility in the operation of pump and motor as a unit.
 - 03.02.00 Construction Requirements
 - 03.02.01 Pump Casing
Casing and supports shall be designed to have sufficient strength and rigidity to prevent any adverse effect on internal clearances and to limit change of alignment to 50 micrometers at the coupling

flange caused by the worst combination of pressure, torque or allowable piping stress.

Pump casing shall be provided with a vent connection along with piping, fittings & valves unless pump is self-venting by the arrangement of nozzles. Casing drain, as required, shall be provided complete with drain valves, piping and plugs. It shall be provided with a connection for suction and discharge pressure gauge as standard feature.

Jacket for cooling or heating shall be provided, if specified in technical particulars. Passages shall not open into casing joints.

Inlet and outlet connections shall be flanged. Flanges shall be raised face and shall conform to ANSI B 16.5. Counter flanges with necessary bolts. nuts. gasket etc. shall be supplied along with the pump.

03.02.02 Rotating Elements

Rotating parts shall be properly aligned. Rotor and shaft shall be stiff enough to prevent contact between the rotor bodies and the casing. It shall be of material that have wear, corrosion and erosion resistance compatible with the application.

03.02.03 Mechanical Seals

The Pumps shall generally be employed with mechanical seals, which shall be arranged that replacement of seal should be possible with minimum downtime. T sealing faces should be highly lapped surfaces of materials known for their frictional coefficient and resistance to corrosion against the liquid being pumped

The seal end plate or rotating cover and bolting shall be designed to retain the SI with sufficient rigidity to prevent distortion that might impair seal operation. T stationary seal member shall be positively retained to prevent its rotation. For 1 seals under vacuum service, the seal design must ensure sealing against atmospheric pressure even when the pumps are not operating.

If seal flushing and cooling is provided by the pumped fluid, the pump supplier \$hall ensure that sufficient flow reaches the primary seal faces to provide for cooling and maintenance of a stable film at

the seal faces.

03.02.04 Stuffing Box

Stuffing box, if provided, should permit replacement of packing without removing any part other than the gland. Asbestos shall not be used as a packing material.

Stuffing Boxes of packed ring construction type preferably to accommodate five rings of packing (minimum four rings of packing) plus a lantern ring shall be provided wherever specified. Packed ring stuffing boxes shall be properly lubricated and sealed as per service requirements and manufacturer's standards. If external gland sealing is required, it shall be done from the pump discharge. The Bidder shall provide the necessary piping valves, fittings etc. or the gland sealing connection.

03.02.05 Bearing

Heavy duty antifriction bearings, adequately designed for the type of service specified in the technical data sheet and for long, trouble free operation shall be furnished.

The bearings offered shall be capable of taking both the radial and axial thrust coming into play during operation. Antifriction bearings shall be designed for a rated life of either 25000 hours with continuous operation at rated conditions or 16000 hours at maximum axial and radial loads and rated speed.

Proper lubricating arrangement for the bearings shall be provided. The design shall be such that the bearing lubricating element does not contaminate the liquid pumped. Where there is a possibility of liquid entering the bearings suitable arrangement in the form of deflectors or any other suitable arrangement must be provided ahead of bearing assembly.

Bearings shall be easily accessible without disturbing the pump assembly. A drain plug shall be provided at the bottom of each bearing housing.

03.02.06 Pump & Motor shaft Coupling

The pump and motor shafts shall be connected with an adequately sized flexible coupling of proven design with a spacer to facilitate dismantling of the pump without disturbing the motor. Necessary coupling guards shall also be provided.

03.02.07 Base plate

A common base plate for the pump and motor shall be provided. The base plate shall be of fabricated steel (minimum 6 mm thickness) and of rigid construction suitably ribbed and reinforced. Base plate and pump supports shall be constructed and the piping unit so mounted as to minimize misalignment caused by mechanical forces such as normal piping strain, internal differential thermal expansion and hydraulic piping thrust. The base plate shall be suitably drilled for the anchor bolts. The base plate shall have drip pan and suitable draining arrangement.

03.02.08 Relief Valve

To protect against damage due to accidental closure of discharge valve, each pump shall be provided with a relief valve of adequate capacity,

Relief valve shall be able to handle the pump rated capacity when fully open, at a pressure not more than 10 percent above the set pressure.

03.02.09 Material of Construction

The material of construction of various components shall be as indicated in technical particulars. These are to be considered as minimum requirement and it is the responsibility of supplier to select and offer proper material of construction for the required service,

03.02.10 Assembly and Dismantling

Assembly and dismantling of each pump with drive motor shall be possible without disturbing the grouted base plate or alignment.

03.02.11 Drive Motor

The motor shall be sized to meet the maximum specified operating conditions. including external gear and/or coupling losses. Continuous Motor rating (at 50 ° C ambient) shall be atleast ten percent (10%) above the maximum load demand of the pump in the entire operating range including the run out condition to take care of the system frequency & voltage variation.

The enclosure of motor shall comply various requirements of flame proof construction as per IS-2148 and degree of protection shall be as per IP-55.

Other design and construction features of the drive motor shall be as specified, elsewhere, under Standard Electrical Specifications.

4.00.00 TESTS

Material test certificates from recognized laboratories shall be furnished for review\for various components.

Following are the minimum shop and site tests to be conducted by the supplier:

4.01.00 Shop Tests

4.01.01 Hydrostatic Test

Pressure containing parts, including cooling and heating jackets, shall be test hydrostatically with liquid at a minimum of 1.5 times the maximum allowable working pressure but at not less than 1.38 bar gauge.

Tests shall be maintained for a sufficient period of time to permit complete examination of parts under pressure. The hydrostatic test shall be considered satisfactorily when no leaks are observed for a minimum of 30 minutes.

4.01.02 Mechanical Balancing

All rotating components of the pumps shall be subjected to static and dynamic balancing at shop as per ISO 1940. The dynamic balancing shall be done at or near the operating speed and the supplier shall furnish its acceptance norms for approval before conducting the test.

4.01.03 Non-destructive Testing

Non-destructive testing of the pump components shall be conducted in accordance with relevant standards. Prior to testing, the test procedure and repair procedure shall be submitted for approval. All components subjected to testing shall be identified and only those which are tested successfully shall be used for the manufacture of final product. All test results shall be submitted by the supplier for approval

All cast iron parts shall be tested in accordance with IS - 210. Test bars shall be cast or physical tests from the same ladle of metal as the casting they represent.

Steel forgings used in pump shall be tested for both physical properties and chemical composition. steel forgings shall be ultrasonically tested.

4.01.04 Performance Testing

All pumps shall be performance tested at the Manufacturer's Works as per testing code. The test shall be conducted to determine the following characteristics:

- a) Speed
- b) Discharge Pressure
- c) Suction Pressure
- d) Capacity
- e) Power

The test shall be conducted preferably with the tested job motor.

04.02.02 Noise and vibration shall be measured during the performance testing, for reference purposes.
For pumps operating in parallel, the load sharing should not vary by more than 5%.

The pumps showing any abnormal behaviour during the performance testing or the pumps as required shall be stripped down for a thorough examination after the performance test. The performance test report shall be prepared by the supplier and submitted for approval, before despatch of the pumps.

04.02.00 Site Tests

04.02.01 After installation, the pumps supplied shall be operated to prove satisfactory performance as individual equipment as well as a system. The noise and vibration level of the pumps shall be measured and it should be within the design values. For pumps operating in parallel, the load sharing should not vary by more than 5%. If performance at site is found to be unsatisfactory, then the supplier shall rectify or replace the equipment.

04.02.03 Test Procedure Instruments

The test procedures to be followed and instruments to be used for testing shall be subject to the approval. All instruments to be used for stage and performance testing shall be calibrated at reputed third party laboratories.

LOW PRESSURE PIPING, VALVES AND SPECIALITIES

CONTENT

CLAUSE NO.	DESCRIPTION
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2.00.00	CODES AND STANDARDS
3.00.00	SCOPE OF WORK
4.00.00	GENERAL DESIGN AND CONSTRUCTION
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6.00.00	BROAD GUIDELINES FOR ERECTION AND INSTALLATION OF L.P. PIPING

ATTACHMENTS

ANNEXURE-I	SPECIFICATION OF PIPES FOR DIFFERENT SERVICES
ANNEXURE-II	SERVICE OF VARIOUS CATEGORIES OF VALVES
ANNEXURE-III	SPECIFICATION OF VALVES

LOW PRESSURE PIPING, VALVES AND SPECIALTIES

1.00.00 GENERAL INFORMATION

This section covers all the low-pressure piping up to 400mm NB size, associated valves and specialties that include but is not limited to the following systems.

- 1.01.00 Service Air System - shall consist of distributions service air to different buildings.
- 1.02.00 Instrument Air System - shall comprise of distribution of instrument quality air to pneumatically operated instruments/ valves/dampers.
- 1.03.00 Demineralised Water Supply system including hot well make-up water piping from condensate storage tank.
- 1.04.00 Demineralised Water closed cycle cooling system.
- 1.05.00 Service water system.
- 1.06.00 Potable water system.
- 1.07.00 Any other low pressure piping as found necessary during detail engineering shall also be included.

2.00.00 CODES AND STANDARDS

2.01.00 In addition to the requirements spelt out in Volume IIA, the design, manufacture, inspection and testing of the piping, fittings, valves and specialties covered under this specification shall conform, in general, to the standards and codes (latest edition) mentioned below:

- 2.01.01 IS-1239 : Mild steel tubes, tubular and other wrought steel fittings
[Part-I & II]
- 2.01.02 IS-3589 : Electrically welded steel pipes for water, gas and sewage (150 to 2000 mm nominal diameter)
- 2.01.03 IS-554 : Dimensions for pipe threads where pressure tight joints are required on the threads.
- 2.01.04 IS-1363 : Hexagonal head bolts, screws and nuts (size range M5 M36)
[Part-I & II]

2.01.05	IS-1364	:	Precision and Semi-precision hexagon bolts, screws, nuts and lock nuts (diameter range 6 to 39 mm)
2.01.06	IS-3138	:	Hexagon bolts & nuts (M42 to M150)
2.01.07	IS-5312	:	Swing check type reflux (non-return) valves.
2.01.08	IS-2379	:	Colour code for the identification of pipelines.
2.01.09	IS-2016	:	Plain washers
2.01.10	IS-2712	:	Compressed asbestos fibre jointing
2.01.11	ANSI B-16.5	:	Steel pipe flanges and flanged fittings
2.01.12	ANSI B-16.9	:	Wrought steel Butt welding flanged
2.01.13	ANSI B-16.11 : ANSI B-36.10 :		Forged steel fittings, Socket-welding and Threaded. Steel pipes thickness
2.01.14	API-600	:	Steel gate valves
2.01.15	BS-2633	:	Class I Arc welding of ferrite steel pipe work for carrying fluids.
2.01.16	BS-534	:	Specification for steel pipes and specials for water and sewage.
2.01.17	BS-5351	:	Specification for Ball valves.
2.01.18	AWWA-C-504	:	Specification for Butterfly valves.
2.01.19	AWWA-C-208	:	Dimension for fabricated steel water pipe fittings.
2.02.00	Other international codes and standards may also be offered by bidder. However, same may be subject to acceptance by the Purchaser.		
3.00.00	SCOPE OF WORK		
3.01.00	The equipment and materials to be supplied shall include but not be limited to the following:		
	a)	Supply of all low pressure piping including bends, elbows, tees, branches, laterals, crosses, reducing union, couplings, caps, saddles, shoes, flanges, blank flanges, Y-pieces etc. as required for the piping system under the scope of this section.	
	b)	Matching pipes, matching pieces like reducers/enlargers etc., counter flanges with bolts, nuts, washers, temporary and permanent gaskets, threaded union etc.	
	c)	Supply and machining work of flanges, pipe spools and matching pipes to connect flow measuring orifices/nozzles with the main pipe work.	

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- d) All isolating and regulating valves, non-return valves, steam/air traps, relief/safety valves (wherever applicable), strainers, pressure reducing orifices etc. complete with the counter flanges and matching connecting pieces as required within the entire low pressure piping system.
 - e) Anchors, hangers and supports, etc. as required. Any platform necessary for maintenance and operation of valve and equipment located 1.5 m above any permanent floor or platform including access ladders, supporting structures etc.
 - f) All secondary structural steel members required for pipe supports from building steel structures and from embedded steel wherever provided including pipe supports in trenches. However, trench piping should be avoided to the extent possible.
 - g) Funnels, tundishes for drips and drains including all miscellaneous drain piping and drain piping from tundish outlet up to drain points. All drain and vent lines shall be conveniently terminated to floor drain points/permanent drain trenches.
 - h) Flanges, counter flanges, blank flanges, bolts, nuts, washers, temporary and permanent gaskets, fasteners caps etc. as required for interconnecting piping, valves & fittings.
 - i) Cleaning and Painting of all piping, valves & specialties at manufacturer's shop.

3.02.00 Following general requirements shall however be provided

- a) Instrument Connections including instruments, root valves, sensing lines etc.
- b) Pipe stubs and blanking plates etc. required for chemical cleaning and hydro testing.

For conducting acceptance test, the required pressure, temperature, flow measurement points shall be provided.

3.03.00 All miscellaneous instruments

4.00.00 **GENERAL DESIGN AND CONSTRUCTION**

4.01.00 **General Considerations**

4.01.01 The piping systems included in this section shall be designed to operate continuously without replacement during the plant service life of 30 years.

4.01.02 The piping system shall be complete in every detail and in accordance with the highest standard of workmanship.

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- 4.01.03 All design and fabrication shall be in accordance with codes/standards specified.
- 4.01.04 No pipe work shall be run in trenches carrying electrical cables.
- 4.01.05 Pipe size above 50 NB shall be shop fabricated and of size 50 NB and below shall be field run.
- 4.01.06 All piping shall be identified by means of colour strips and by adequate lettering, conveniently spaced and located. Identification colours and lettering shall be as approved.
- 4.01.07 Air release and drain branches shall be provided wherever necessary depending upon the layout and arrangement so that the drains and air release valves are located for easy operation.
- 4.01.08 Unless otherwise specified, all pipe work shall be suitable for a minimum pressure of 10.0 kg/sq. cm(g) at 80 deg. C or as required by the design of the different piping system, if higher.
- 4.01.09 **Drain Pipe Work**
- a) Low pressure drains shall have an isolating valve at the point of take-off from the pipe or vessel to be drained, or as near as possible for conventional operation.
 - b) Unless otherwise stated, all drain piping shall be of 25 mm NB minimum and all vent pipings shall be of 15 mm NB size minimum. For pipes up to 50mm NB, pipe wall thickness shall be as per schedule 80 of ANSI B36.10.
 - c) Unless otherwise stated, wherever a main or branch of any pipeline is terminated with a valve, such terminal valve shall be provided with a blank flange/blanking cap at the free end.
- 4.01.10 Specification of pipes used in different services included in the L.P piping section has been detailed in Annexure-I.
- 4.02.00 **Material Specification**
- 4.02.01 Materials for pipes and fittings shall be as stipulated in Annexure-I. In case bidder wants to offer alternative piping material, same may be accepted by the Purchaser depending on the merits of alternative material.
- 4.02.02 Pipe attachments for supports, anchors and restraints, which are coming in direct contact with pipes, shall have similar materials as the piping concerned. All other materials of supports, anchors and restraints shall be of tested quality and as per manufacturer's standards.

4.03.00 Fabrication

Except where otherwise specified all piping shall have butt-welded connections with a minimum of flanged joints necessary for maintenance. Where flanges are adjacent to welded fittings, weld neck flanges shall be used.

Branches shall, in general, be formed by welding. Standard fittings may be used in positions and for sizes where approval has been given in detail drawings. Pipe bends and tees shall be truly cylindrical and of uniform section. all welded branches shall be reinforced where needed as per the applicable codes/regulations.

4.03.01 Piping shall be fabricated in the shop in the largest transportable sections to minimize the number of field weld joints. The choice of field weld joints locations shall be based on the traverse of the pipe through walls, floors, sleeves or other restrictive areas. Support attachments for major piping shall be done at shop.

4.03.02 All pipes bends shall be made true to angle with no negative tolerance and shall have a smooth surface free of flat spots, crease and corrugations. A cross section through any bent portion of the pipe shall be true in diameter, within plus or minus 3% of the pipe diameter. Pipe bends shall be made from straight pipe pieces of sufficiently higher thickness so that after thinning, the minimum thickness of bends shall not be less than the minimum thickness required for the straight pipe. Thinning allowance shall be considered as per the relevant code.

4.03.03 For bends in pipes straight piece of pipes shall be bent by the contractor to required bend radius. However, forged bends (Bend radius = $1.5 \times$ pipe diameter) wherever required shall be provided.

4.03.04 The ends of Pipe and welded fittings shall be bevelled according to details shown in the relevant piping code. All welding shall be made in such a manner that complete fusion and penetration are obtained without an excessive amount of filler metal beyond root area. The reinforcement shall be applied in such a manner that it shall have a smooth contour merging gradually with the surface of adjacent pipe and welded fittings. Backing rings shall not be used on any pipe welds, unless otherwise approved by the Engineer.

4.03.05 Cutting and Bevelling

- a) Carbon steel piping - End preparation for butt welding shall be done by machining/flame cutting.
- b) Socket welding - Socket weld and preparation shall be done by saw or machine cutting.

4.04.00 **Hangers, Supports, Anchors**

Normally pipe supports and anchors shall be selected at those points in the buildings where provision has been made for the loads imposed. The cutting of floor/roof beams or the reinforcement in slabs will not be permitted. Piping attached to a plant item shall be supported in such a way that the weight of the piping is not taken by the plant item.

4.04.01 Support spacing shall be as per good engineering practice. However in no case it shall be less than support spacing stipulated in ANSI B31.1.

4.04.02 Accurate weight balance calculations shall be made to determine the required supporting force at each hanger location and the pipe weight load at each equipment connection.

4.04.03 All large pipes and all long pipes shall have at least two supports each arranged so that any length of pipe or valve may be removed without any additional supports being required.

4.04.04 Support steel shall be of structural quality. Perforated strap, wire or chain shall not be used. Support components shall be connected to support steel by welding, by bolting or by beam clamps. Bolt holes shall be drilled not burned. Support components may be bolted to concrete using approved concrete anchors.

4.05.00 **Valves and Accessories**

4.05.01 General Requirements

- a) All valves shall be of approved make and type and shall have cast/forged bodies with covers and glands of approved construction and materials as specified in Annexure-II & III. ~~In general all pumps (other than sump pumps), discharge valves shall be motor operated only. Tank inlet valves shall be motor operated only.~~
- b) Valves and specialties to be supplied under this specification will be used for various air and water services and will be located indoor/outdoor and on horizontal/vertical runs of the pipelines. However, mounting of valves in vertical pipe runs should be avoided as far as possible.
- c) All valves shall, unless otherwise stated, have the internal diameter same/as the internal diameter of the pipes to be joined.
- d) All valves shall receive tests at manufacturer's or contractor's works in accordance with the specific requirements of the approved Codes of Practice. Valves shall be rising stem or otherwise as approved by the Purchaser.
- e) Gate valve and Ball valve have been specified with the intention of achieving isolation and tight shut-off. In full open condition, these valves should offer minimum of resistance to fluid flow.

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- f) Globe valves have been specified with the intention of achieving good control of fluid passing. The plug and seat will have therefore suitable profiles for obtaining such controlling action.
 - g) Check valves have been specified in order to prevent reverse flow through them.
 - h) All valves shall function smoothly without sticking, rubbing or vibration on opening or closing and shall be suitable for most stringent service conditions i.e. flow, temperature and pressure under which they may be required to operate.
 - i) Material, design, manufacture, testing etc. for all valves and specialties along with the accessories shall conform to the latest editions of codes.
 - j) By pass valves shall be provided for larger size valves as per standards followed and as felt necessary for smooth and easy operation, even though not specifically mentioned in the specification.
 - k) All flanged valves and specialties to be supplied under this section shall be provided with two (2) counter flanges, bolts, nuts, washers, gaskets etc.
 - l) All valves shall be of approved design and manufacture. Where valves are of similar size and type they shall be interchangeable with one another. Valves shall have welded or flanged connections subject to the Purchaser's approval.
 - m) All valves shall have outside screwed spindles and screwed thread of spindle shall not pass through or into the stuffing box. Where valves are exposed to the weather, protective covers shall be provided for the spindles, which shall be subject to approval.
 - n) Gate, Globe and Ball valves shall be provided with the following accessories in addition to other standard items:
 - i) Hand wheel with embossed open and shut directions.
 - ii) Local position indicator.
 - iii) Motorised operation as specified by Engineer.
 - o) Gate valves, in addition shall be provided with following extra features
 - i) Bypass valve for larger valves
 - ii) Draining arrangement
 - iii) Enclosed Gear operators for valves 300 mm size and above for ease in operation.
 - iv) Motorised operation as specified by Engineer.
 - p) All gate and globe valves shall be rising stem type.

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- q) All valves shall be provided with hand-wheels, chain, operator, extended spindle and floor stand wherever required so that they can be operated manually by a single operator from the nearest operating floor either at a lower or higher elevation as the case may be. If such a valve is provided with integral bypass then similar arrangement shall be done for the bypass valve also.
 - r) All valves and specialties shall be provided with brass Tag Discs indicating Tag numbers and nomenclature of the valve including duty or service intended and the function of the valves specialties.
 - s) Stems shall preferably be arranged vertically with gland at the top, however, in no circumstances must the stem be inclined downward from horizontal or gland be at the bottom. Globe valves shall be installed with the pressure under the disc. Valves shall not be fitted in inverted position.
 - t) Where necessary, for accessibility, grease nipples shall be fitted at the end of extension piping and where possible these shall be grouped together and mounted on a common panel situated at a convenient position. A separate nipple shall be provided to lubricate each point. The Bidder shall supply the first fill of oil or grease for these parts. The Bidder shall supply a suitable manually operated grease gun for the standard type of nipple provided.
 - u) The spindles for all valves for use outside the building shall have weatherproof protection covers of approved construction.
 - v) All valves shall be fitted with indicators so that it may be readily seen whether the valves are open or shut. In the case of those valves fitted with extended spindles, indicators shall be fitted both to the extended spindles and to the valve spindles.
 - w) Plastic or bakelite valve hand wheels will not be accepted.
 - x) All valves shall be closed by rotating the hand wheel in a clockwise direction when looking at the faces of the hand wheel. The face of each hand wheel shall be clearly marked with the words 'Open' and 'Shut' with arrows adjacent to indicate the direction of rotation to which each refers.
 - y) Wherever practicable heavy valves of total weight including actuator, drive motor, integral by-pass etc., equal to or greater than 500 kg. shall be provided with suitable lugs to permit direct suspension by hanger rod or direct resting on bottom support, as applicable.
 - z) Special attention shall be given to the operating mechanism for large size valves in order that quick and easy operation is obtained and maintenance is kept to a minimum.
 - aa) Eyebolts shall be provided where necessary to facilitate handling heavy valves or parts of valves.

bb) The Bidder shall supply with his bid and in addition during the course of the Contract, comprehensive drawings showing the design of valves, test pressure and working pressure/temperatures. They should include a parts list referring to the various materials used in the valve construction.

cc) All sampling and root valves shall be of integral body bonnet type.

4.05.02 For Design Requirements for different valves refer Annexure-II & III.

4.06.00 **Safety/Relief Valves**

Safety/Relief valves shall be of direct spring loaded type and shall have a tight, positive and precision closing.

All safety valves shall be provided with manual lifting lever.

Valves used for air and any other compressive fluid shall be of pop type.

Safety/Relief valves shall be constructed and adjusted to permit the fluid to escape without increasing the pressure beyond 10% above the set blow off pressure. Valve shall reset at a pressure not less than 2.5% and more than 5% of the set pressure.

Releasing capacity of the safety/relief valves shall be as per the applicable codes and standards and shall be subject to the approval of the Engineer.

The seat and disk of safety valves shall be of suitable material to resist erosion. The seat of valve shall be fastened to the body of the valve in such a way that there is no possibility of the seat lifting.

4.07.00 **Hosepipe and Accessories**

4.07.01 Hose valves for service water system shall be Gate valves and service air system shall be Globe valves.

4.07.02 Hose pipes with fittings for Service Water System:

- a) The water hose shall be as per IS-444 (Type-3).
- b) Length of each hose shall be 15 metres.
- c) For each hose, one end shall be fitted with M.S. female coupling with swiveling nuts and soft seating ring suitable for connection to male end of hose valve and other end shall be made threaded for joining with the swiveling nut of a second hose whereby two hose lengths may be joined.

4.07.03 Hose pipes with fittings for Compressed air System

- a) The compressed air hose shall be as per IS-911 (Type 2).

	b) The length and type of each end shall be similar to as specified in above clause no. (4.07.02) above.
5.00.00	DRAWINGS, DATA, INFORMATION & MANUALS
5.01.00	Drawings, data, Information to be furnished by the Bidder besides those already mentioned in volume : IIA with the offer.
5.01.01	A complete list of all piping and fittings of various sizes with their quantities and details e.g. nominal size, O.D., I.D. (as applicable) thickness, design pressure, design temperature, material of construction/code/standards etc.
5.01.02	A complete list of all valves with their type, quantities & ratings.
5.01.03	Manufacturer's catalogue indicating complete range of available size and rating of pipes & fittings.
5.01.04	Descriptive literature on the manufacturing process and quality control procedures highlighting the manufacturing, fabricating and testing facilities available in the shop.
5.02.00	After Award of Contract Detail drawings including fabrication drawings of all shop fabricated piping system indicating design parameters and complete bill of material (Relevant Standards and grades to be indicated) and information/data pertaining to the hydrostatic and non-destructive test requirements to be submitted progressively.
5.02.01	Detail dimensioned drawing of each valve, specialties, indicating tag no., pressure rating, manufacturing standard, the bill of materials and hydrostatic test pressures. The drawing shall include the end preparation details and shall indicate the position of the hand wheel/operator. Technical particulars of motor operators wherever applicable shall also be indicated.
5.02.02	General arrangement drawing for each hanger/support/anchor etc. indicating identification number, auxiliary supporting structural details, other details & information as required in the specification.
5.02.03	Wiring diagram for all limit switches of motor operated valves.
5.02.04	The loading data required for design of structures shall be furnished well in advance to suit Purchaser's time schedule.
6.00.00	BROAD GUIDELINES FOR ERECTION AND INSTALLATION OF LP PIPING
6.01.00	All fittings like "T" pieces, flanges, reducers etc. shall be suitably matched with pipes for welding. The valves will have to be checked, cleaned or overhauled in full or in part before erection, after chemical cleaning and during commissioning.
6.02.00	Adjustments like removal of oval ties in pipes and opening or closing the fabricated bends of high pressure piping to suit the layout shall be considered
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	part of work and is required to carry out such work as per instruction of Owner, which shall include specified heat-treatment procedures, etc. also wherever required.
6.03.00	Certain adjustments in length may be necessary while erecting high pressure pipelines and the contractor should remove the extra lengths to suit the final layout after preparing edges afresh and adopting specified heat treatment procedures.
6.04.00	Suspension for piping, pressure parts, etc., will be supplied in running lengths, which shall be cut to suitable sizes and adjusted as required.
6.05.00	All the valves, lifting equipments, actuators, power cylinders, etc., shall be serviced and lubricated to the satisfaction of Engineer before erecting the same and also during pre-commissioning. Even after commissioning, the equipments, if there are problems in the operation, they have to be attended to by the Bidder during the tenure of the contract. Welding or jointing of extension spindle for valves to suit the site conditions and operational facility shall be part of erection work.
6.06.00	All tubes and pipes shall be cleaned and blown with compressed air and shown to the engineer before lifting. Bigger size pipes should be cleaned with flexible wire brush, wherever necessary. After cleaning is over the end caps shall be put back in tube openings till such time they are welded to other tubes.
6.07.00	Fine fittings, drain piping, oil systems & other small bore piping have to be routed according to site conditions and hence shall be done only in position. As such, layout of small-bore piping shall be done as per site requirement. There is a possibility of slight change in routing the above pipelines even after completion of erection, which shall be carried out by the Bidder without any extra cost to the Purchaser. Work shall also include fabrication of small bends at site from straight lengths to suit the site conditions.
6.08.00	No temporary supports shall be welded on the pressure parts. Welding of temporary supports, cleats, etc., on the building columns shall also be avoided. In case of absolute necessity, Contractor shall take prior approval from Engineer. Further, any cutting or alteration of member of the structure or platform or other equipments shall not be done without specific prior approval of Engineer.
6.9.00	a) All piping shall be grouped wherever practicable and shall be routed to present a neat appearance. b) The piping shall be arranged to provide clearance for the removal of equipment for maintenance and for easy access to valves, instruments and other piping accessories required for operational maintenance. c) Piping shall be routed above ground unless otherwise specifically indicated/ approved by the Engineer. In such special case, the piping may be arranged in trenches, or buried and properly protected as per AWWA Standards.

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- d) Overhead piping shall have a minimum overhead clearance of 4 meters above walkways and working areas and 7 meters above roadways unless otherwise approved by the Engineer.
 - e) Drains shall be provided at all low points and vents at high points as per actual layout regardless of whether some have been shown in respective drawings or not. The pipelines shall be sloped towards the drain points.

6.10.00 All drips and drains for piping and equipment whether shown in the drawings or not shall terminate on the ground floor up to station drain unless otherwise specified. Leading such drains up to station drainage is also the responsibility of the Contractor.

ANNEXURE-I
SPECIFICATION OF PIPES FOR DIFFERENT SERVICES

	A		B		C	D
Services	1. Clarified Water piping 2. DMCW piping		1. Drinking/ Potable Water Supply, piping (Clarified water, chlorinated)		1. Demineralised Water, Service and Instrument Air Piping less than and equal to 50 mm NB	1. Demineralised Water, Service and Instrument air piping for sizes equal to greater than 65 mm NB
1.00.00 Material of Pipe	Carbon Steel IS-1239 Heavy Grade upto 150 mm NB and IS-3589 for sizes above 150 mm with minimum pipe thickness of 6 mm.		Carbon Steel as per IS-1239 Heavy Grade for sizes upto 150 mm NB and IS-3589 for sizes above 150 mm NB with minimum pipe thickness of 6 mm. The pipes shall be galvanized as per IS-4736		Stainless Steel as per ASTM A-312 Gr. 304. Size- as per schedule 40 ANSI B36.10	Stainless steel as per ASTM A-312 Gr. 304. Size-upto 150 mm NB as per schedule 10S, ANSI B-36.10.
2.00.00 Construction	ERW / Seamless		ERW / Seamless		ERW	ERW
3.00.00 Joints	Slip-on Flange and butt weld for size 65 mm NB and above and Socket weld joint for size 50 mm NB and below.		Screwed flange for sizes 65 mm NB and above and screwed socket for size 50 mm NB and below.		Socket welded for size 50 NB and below	Slip-on flange and butt weld joint.
4.00.00 Fittings	Pipe Sizes > = 65 mm NB	Pipe Sizes < = 50 mm NB	Pipe Sizes > = 65 mm NB	Pipe Sizes < = 50 mm NB		

	A		B		C	D
Services	1. Clarified Water piping 2. DMCW piping		1. Drinking/ Potable Water Supply, piping (Clarified water, chlorinated)		1. Demineralised Water, Service and Instrument Air Piping less than and equal to 50 mm NB	1. Demineralised Water, Service and Instrument air piping for sizes equal to greater than 65 mm NB
4.01.00 Materials	ASTM-A-234 Gr. WPB	ASTM-A-105	ASTM-A-234 Gr. WPB galvanized as per IS-4736	ASTM-A-105 galvanised as per IS- 4736	ASTM-A-182 F304	ASTM-A-351-CF8
4.02.00 Construct ion	Welded/ Seamless	Forged	Welded/ Seamless	Forged	Forged	Welded/Seamless
4.03.00 Standard	ANSI-B-16.9 for fabricated fitting AWWA- C-208	ANSI-B- 16.11	ANSI-B-16.9	ANSI-B-16.11	ANSI-B-16.11	MSS-SP-43
4.04.00 End details	Pipe size >=65mm NB Butt welded as per ANSI-B- 16.25	Pipe size <=50 mm NB Socket welded as per ANSI-B- 16.11	Pipe size >=65 mm NB Screwed Flanged	Sizes <=50 mm Screwed socketed as per ANSI-B- 16.11All fittings shall be galvanized.	Socket welded	Slip - on flanges

	A	B	C	D
Services	1. Clarified Water piping 2. DMCW piping	1. Drinking/ Potable Water Supply, piping (Clarified water, chlorinated)	1. Demineralised Water, Service and Instrument Air Piping less than and equal to 50 mm NB	1. Demineralised Water, Service and Instrument air piping for sizes equal to greater than 65 mm NB
5.00.00 Flanges	150 lb class as per ANSI-B-16.5 complete with nuts, bolts and gaskets	As per ANSI-B-16.5 pressure class 150lbs - galvanised-complete with nuts, bolts and gaskets.	As per ANSI-B-16.5 pressure class 150lb complete with nuts, bolts and gaskets. Material as per class 4.01.00.	150lb class, flat face, as per ANSI-B-16.5 complete with nuts, bolts and gaskets.
Pipes which fall under IS:1239 shall be hydrostatically tested according to the said code, for others refer Section-V, Vol.: II-A.				

ANNEXURE-II
SERVICES OF VARIOUS CATEGORIES OF VALVES

Valve Classification		Service		
A.	Cast iron body Gate/Globe/Check Valve	i)	Service Water	For sizes 65mm NB and above.
		ii)	Clarified Water	
		iii)	Drinking/ Potable Water	
		iv)	Inhibited Demineralised Water	
B.	Stainless steel body/ Gate/Globe /Check/Ball Valve	i)	For Demineralised water	For all sizes
		ii)	Potable/ Drinking Water	For sizes less than and equal to 50 mm NB
		iii)	Service and Instrument Air	For all sizes. Ball valves to be used in air line.
C.	Steel Body valves	i)	Clarified Water	For sizes less than and equal to 50 mm NB
		ii)	Inhibited Demineralised Water for DMCW system	
D.	Cast Iron body butterfly valve	i)	For Demineralised Water	For butterfly valve specification refer Annexure II, Sec.IV of Vol. III E. For DM water line rubber lining/ EPDM/equivalent protection to be provided
		ii)	Raw water	
		iii)	Clarified Water	
		iv)	Filtered Water	
		v)	Inhibited Demineralised Water for DMCW system	

ANNEXURE-III

SPECIFICATION OF VALVES

		A. Cast Iron Body Gate/ Globe/Check Valve	B. Stainless steel Body Gate/Globe/Check/Ball Valve	C. Steel Body Gate/ Globe/Check Valve/ Ball Valve
1.00.00	Valve Classification Code	CIGC	SSGC	STGC
2.00.00	Basic Design Code			
	a) Gate	a) i) IS 780 for 50 mm - 300 mm NB ii) IS2906 for 350 mm NB and above or as per MSS-SP-70	a, b, c) ANSI-B-16.34	i) API 600 for 50mm ii) API 602 for size
	b) Globe	b) MSS - SP - 85		b) BS-1873/ANSI-B-16.34
	c) Check	c) IS-5312/MSS - SP -71		c) BS-1868/ANSI B16.34
	d) Ball		d) BS-5351	
3.00.00	Pressure Class	To be suitably chosen considering the pressure requirement. Refer Clause No. 4.01.08 in this regard.		
4.00.00	Construction	Cast body and bonnet / cover	Forged body up to 50mm NB and Cast body above that	Same as Group-B
5.00.00	Material			
5.01.00	Body & Bonnet/ cover	IS 210 Gr. FG 260	ASTM-A-182 F304 for Ball Valves: A351 CF8M for cast body, A 182 F304 for forged body.	ASTM-A-216 Gr. WCB for cast body & ASTM-A-105 for forged body

		A. Cast Iron Body Gate/ Globe/Check Valve	B. Stainless steel Body Gate/Globe/Check/Ball Valve	C. Steel Body Gate/ Globe/Check Valve/ Ball Valve
5.02.00	Trim / Disc.	IS-210 Gr. FG 260	ASTM-A-182 F304 for Gate, Globe, Check valves and 351CF 8M for Ball valves. For DKW system : ASTM-A-182 F6A (min. 250 HB)	13% Cr Steel as per ASTM-A- 182 Gr. F6 heat treated and hardened(min 250 NB) for cast body and ASTM-A-105 Hard faced with Stellite (min 350 HB) for forged body
5.03.00	Seating surface	13% Cr steel as per IS 1570	For Ball valves PTFE seats and seals.	13% Cr. Steel as per ASTM-A- 182 Gr. F6
6.00.00	End Preparation	Socket welded for size equal to and below 50mm NB and flanged with counter flanges for 65mm NB and above.		
7.00.00	Testing			
	a) Gate	i) As per IS - 780 for 50 mm - 300 mm NB ii) IS-2906 for sizes equal to and above 350 mm NB	As per ANSI B-16.34	API-598
	b) Globe	Hydrostatic Test as per MSS-SP-85		BS-1873
	c) Check	IS-5312/MSS-SP-71		BS--1868

POWER CYCLE PIPING VALVES AND SPECIALTIES

CONTENT

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POWER CYCLE PIPING VALVES AND SPECIALTIES

1.00.00 GENERAL INFORMATION

1.01.00 This section covers all the piping, valves and specialties which connects the different equipment like the boiler, turbine, condenser, pumps, heaters etc. to make the power cycle complete.

2.00.00 PERFORMANCE REQUIREMENT

The piping system acts as the pressure boundary for the fluid in circulation; water and steam in this case, which is subject to high pressure, temperature, change of phase and various types of transient and steady state operation. The piping system shall be designed and constructed for integrity, long life, high reliability acceptable pressure drop, smooth and good operation and control from start-up to the maximum sustained load.

3.00.00 CODES & STANDARDS

3.01.00 The design, manufacture, inspection and testing of the equipment covered under this specification shall conform, in general, to the standards and codes (latest edition) mentioned below :

3.01.01 ANSI B-31.1 : Code for Pressure Piping - "Power Piping".

3.01.02 Indian Boiler Regulations : (IBR), with latest amendment.

3.01.03 ANSI B-16.5 : "Steel pipe flanges and flanged fittings".

3.01.04 ANSI B-16.9 : Wrought steel Butt welding fittings.

3.01.05 ANSI B-16.11 : "Socket Welding Ends".

3.01.06 ANSI B-16.25 : "Butt Welding Ends".

3.01.07 ANSI B-16.34 : "Steel Valves - Flanged and Butt Welding Ends".

3.01.08 Design fabrication, assembly and testing of pipes, fittings shall generally conform to the requirements of ANSI B-31.1. But the portions, which come under the purview of Indian Boiler Regulations (IBR), shall completely comply the requirements of IBR as a minimum.

3.01.09 Any other internationally accepted codes and standards are also acceptable. However, the compliance of ANSI codes and IBR will be considered as

minimum for acceptance of the piping and all appurtenances.

4.00.00 **SCOPE OF WORK**

4.01.00 **Scope of Supply**

Scope shall include complete piping, valves & specialties as required for all systems, units and auxiliaries.

Items not mentioned but deemed necessary by the Bidder for making the system complete, reliable and efficient shall also be included.

4.01.01 The equipment and materials to be supplied under this specification shall include but not be limited to the following :

- a) Supply of all power cycle piping including bends, elbows, tees, branches, laterals, crosses, reducing union, couplings, caps, saddles, shoes, flanges, blank flanges, Y-pieces etc. as required for the piping system under the scope of this specification.
- b) Matching pipes, matching pieces like reducers/enlargers etc., counter flanges with bolts, nuts, washers, temporary and permanent gaskets, threaded union etc. for all terminals as required.
- c) Supply and machining work of flanges, pipe spools and matching pipes to connect flow measuring orifices/nozzles with the main pipe work. The pipe spools shall be supplied along with necessary test certificates of the pipes, after necessary machining to the required bore, for assembly of flow nozzle element. The assembled flow nozzle shall be installed in the piping system. Additional length of pipes equal to length of all fully assembled flow nozzle & orifice plates pipe piece shall be supplied and the same shall also be erected prior to cleaning of the pipes by flushing or steam blowing or chemical cleaning or both. After completion of cleaning of piping the assembled flow nozzles shall be erected replacing the temporary pipe spools.
- d) All motorised valves, manually operated isolating and regulating valves, non-return valves, steam traps, relief/safety valves, strainers, pressure reducing orifices, expansion joints and other flexible connections, complete with the counter flanges and matching connecting pieces as required within the terminal points of entire power cycle piping system.
- e) Anchors, hangers & supports, vibration dampeners, restraints, shock absorbers etc. as required. Any platform necessary for maintenance and operation of valve and equipment located 1.5m above any permanent floor including access ladders, supporting structures etc.
- f) All secondary structural steel members required for pipe supports from building steel structures and from embedded steel including pipe supports in trenches.

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- g) Funnels, tundishes for drips & drains including all miscellaneous drain piping and drain piping from tundish outlet up to drain points. All drain and vent lines shall be conveniently terminated either in flash tanks or permanent drain trenches of the Power Station.

All steam and saturated water open drains shall be drained through a water seal in drain funnels/tundish with a water connection in funnels/tundish for maintaining water seal level in them.

All oily effluent drains should be separately routed and connected to separate pit.

- h) For the isolation and check valves located on the main steam (MS), hot reheat (HR), cold reheat (CR), L.P. bypass and extraction lines, suitable line drains shall be provided just upstream and downstream of each of these valves. No drain is needed at the downstream of L.P. bypass isolation valve. Each of these drains shall be independently led to the condenser with branching off to atmosphere.

Line drains from MS, HR, CR, L.P. bypass & high pressure (above 40 Kg/Sq.Cm.) extraction lines shall be provided with double isolation valves in series for each branch - each located at the two extreme ties of the line drain route. The valve near the condenser should be motorised one. The balance line drains shall be provided with only one isolation valve for each branch.

- i) Bolts, nuts, washers, temporary and permanent gaskets, fasteners as required for interconnecting piping, valves & fittings as well as for terminal points.
- j) Complete insulation material for piping, valves, specialties & auxiliary equipment specified in this specification and as called for in the specification for thermal insulation.
- k) Painting of all piping, valves & specialties at site.

4.01.02 Bidder shall furnish his own layout and technical details of piping, valves, specialties and accessories along with his offer.

Following general requirements shall however be provided :

- a) Instrument Connections

The following instrument tappings shall be provided :

- i) Pressure Tappings

The Contractor shall furnish stubs and root valves for all gauge, transmitter and pressure test connections as required. The number of root valve for each connection shall be two (2) for system design pressure equal to or greater than 40 KG/Sq.cm.g.

	ii) Temperature Tappings The Contractor shall supply all stubs and mount the thermowells. iii) Flow Measurement Tappings The Contractor shall provide stubs and root valves similar to the above for all differential pressure taps at flow nozzle and orifice plate installations. b) Pipe stubs and blanking plates required for chemical cleaning and hydro testing. c) Flanges, spool pieces, gaskets, ring joints, jointing materials, aluminium and stainless steel forged marking plate and temporary piping for steam blowing. d) Drain/drip pockets on steam piping as per stipulation of ASME, TDP Vol.-I and general requirement. e) Expansion marker for high temperature steam lines. f) Fine threaded Radiography holes with stubs and suitable matching plugs, which shall be finally seal welded for piping, more than 25 mm nominal thickness. For conducting performance test of Turbo-Generator and Boiler, the required pressure, temperature, flow measurement points shall be provided. g) Provision for creep measurement on the piping operating in creep region viz. main steam and hot reheat.
4.01.03	Electrodes and filler wires required for stainless steel and alloy steel welding during shop fabrication at works and erection/installation at site.
4.01.04	All temporary pipes and accessories, supporting arrangement for cleaning, flushing and steam blowing of the main steam, cold reheat and hot reheat piping including HP/LP by pass piping and auxiliary steam piping.
4.02.00	Scope of Services
4.02.01	The Contractor shall design the piping system and perform necessary stress analysis of all piping and dynamic analysis as necessary.
4.02.02	For stress analysis purpose, individual piping systems shall be considered. All anchors are to be designed, supplied and erected by the Contractor.
4.02.03	Stress analysis and hanger selection for all piping including piping attachment for hangers/supports, all auxiliary supporting structures are included in the scope of the Contractor.

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- 4.02.04 The Contractor shall submit the design calculations for pipe sizing, thickness with specified diameters of pipes and stress analysis data to Owner/Engineer for review/reference/records. Pressure drop calculation for main steam, cold reheat and hot reheat piping to be submitted by the Contractor to show the adequacy of pipe sizes.
- 4.02.05 Preparation of detailed fabrication drawings (isometric) of shop fabricated piping which are of size 50 mm NB and above should be based on the "Released for Construction" drawings.
- "As built" drawings of the power cycle piping layout shall also be prepared by the Contractor based on any layout modifications made at site over "Released For Construction Drawings".
- 4.02.06 The Contractor shall design and detail all piping supports including restraints, guides, stops, snubbers, dampers etc. based on the final stress analysis and hanger load data. The Contractor's design of all supports shall be submitted to the Engineer for review.
- 4.02.07 The Contractor shall furnish separate sketches for each support, restraint, anchor, snubber, dampers etc. These sketches shall include the location with reference to column co-ordinates, identification number, bill of material, design loads, operating load, spring stiffness, amount of spring pre-compression, etc. and method of attachment to the pipe and steel structure.
- 4.02.08 In order to ensure that all piping, supporting elements, anchors and restraints have been installed and adjusted in accordance with the drawings and other written instructions of the Contractor, the hangers associated with the main steam, hot reheat, cold reheat, HP & LP by-pass, feed water, auxiliary steam piping etc. shall be inspected as follows :
- a) After hydro test, with the piping in the cold position, with all travel stops removed, with the pipe completely insulated and in all respects ready for start-up.
 - b) Piping in the hot position, with the unit operating at maximum load.
 - c) Piping in the hot position after 6 months of operation.
 - d) Piping in the cold position during first complete shutdown after at least 6 months of operation.
- The contractor shall depute his personnel for this purpose to site if the plant is officially handed over to the owner before such inspection after 6 months of operation.
- 4.02.09 At the time of each inspection, the Contractor shall determine the necessity for revision, adjustment or replacement of pipe supporting elements, restraints and anchors. Any changes proposed shall be incorporated by the Contractor after Owner/Engineer's concurrence.
- 4.02.10 All shop tests satisfying the requirements of Indian Boiler Regulations (IBR), ANSI standards, the standards enumerated herein and/or as specified.
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- 4.02.11 Furnishing drawings, data, design calculations, stress analysis results.
- 4.02.12 Furnishing certified copies of test results for all tests and examinations specified in the specification and for the mandatory tests and analysis required by the ASTM material specification, for the materials used for piping and the pressure parts of the valves.
- 4.02.13 Obtaining approval from Chief Inspector of Boilers as per Indian Boiler Act, including the following :
- a) For all pipelines coming under the purview of Indian Boiler Regulations (IBR) necessary approval of the design and layout drawings shall be obtained from the Chief Inspector of Boilers, and furnished to the Purchaser/Engineer. Necessary certificates of design, manufacture and tests in specified Form of IBR, for each fabricated pipe with proper identification shall be submitted.
 - b) For fittings & specialties, viz. valves, flanges, traps & other specialties, etc. of all pipelines coming under the purview of IBR, Certificate of design, manufacture and tests in specified Form of IBR with appropriate identification shall be furnished to the Owner/ Engineer.
 - c) Erection & testing of the pipe lines coming under the purview of IBR shall meet all the requirements of IBR and certificate of manufacture & tests in specified Form of IBR, for each of the erected pipe lines shall be submitted to the Purchaser/ Engineer prior to the application of insulation and/or flushing the line before commissioning
- 4.02.14 Steam blowing or chemical cleaning of piping systems, as specified elsewhere in the specification, after complete erection is to be carried out, which also includes supply, erection and dismantling of temporary piping, valves and fittings.
- 4.03.00 Omission of specific reference to any item or material or work which is necessary for completion of the piping systems, shall not relieve the bidder of the responsibility of furnishing all material and services for a complete installation satisfying the operational and other requirements stated in the specifications.
- 4.04.00 Drawing indicating the layout of pipe work shall be prepared in line with the flow diagrams and shall be provided as part of the Contract. These drawings shall indicate the position of all supports, guides, restraints and anchors; all drain and vent connections and the position of all pipes. All piping systems shall be arranged to allow adequate falls in the direction of flow, except where otherwise approved by the Engineer. At the points of drainage, drain pockets of ample size and approved construction shall be fitted as per details indicated in the enclosed drawings.

5.00.00 SPECIFIC DESIGN CRITERIA

Sl. No.	Item	Criteria
1.00	Design, fabrication & Erection	
1.01	Design, fabrication, testing & erection of Power Cycle Piping, valves & specialties for critical piping system under purview of IBR, as specified.	To satisfy IBR, ANSI/ ASME B31.1 latest code.
1.02	Design, fabrication, testing & erection of Power cycle piping, valves & specialties for non-critical piping system, which are not purview of IBR, as specified.	To satisfy ANSI/ASME B31.1 latest code.
1.03	Design of safety valve installation.	To conform with the Non-mandatory rules for the design of safety valve installation of ANSI/ASME B31.1. Open discharge installation preferred.
2.00	Piping Flexibility Analysis	
2.01	Piping to be analysed	All piping having sizes equal to or above 50 mm NB & design temperature 100 Deg.C and more.
2.02	Code to be followed	ANSI/ASME B31.1 latest & also satisfying IBR latest.
2.03	Loading conditions to be considered Note: Contractor shall justify with reasoning in case any one of the specified loads is not considered in analysis.	a) Internal pressure b) Thermal loads due : i) Piping thermal expansion ii) Anchor displacement due to thermal movements of piping anchors.
		c) Piping weight consisting of weight of piping, valves, bends, fittings, insulation etc. as well as weight of support components like clamps, shoes, suspension rods, trapeze etc. & weight of contained fluid.
		d) Test or cleaning fluid load.
		e) Equivalent static loads due to discharge of safety valve (SV), Electromatic relief valve (ERV), simultaneous discharge of SV & ERV where applicable.
		f) Dynamic load due to steam hammer (if applicable).
		g) Seismic loads due : i) Equivalent static load due to seismic inertia effect. ii) Equivalent static load due to seismic anchor displacement.

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Sl. No.	Item	Criteria
		h) Wind load where applicable.
2.04	Loading Combinations Note: Contractor shall clearly indicate the basis of his judicious selection or loading combination for support, restraints and anchor design.	Design load for supports, restraints, anchors & supporting structures shall be obtained by proper selection of one or combination of two or more of the loads as per item 2.03 above based on the possibility of independent or simultaneous occurrence. Component of thermal expansion reaction range expected to appear at cold condition, as per Equation 9 & 10 of ANSI/ ASME B31.1 shall be considered in loading combinations. An overload factor of 1.30 shall be considered over the computed loads except occasional loads before combining them.
2.05	Combination of Stresses	The computed stress under different loading conditions shall be combined as per Equation 11, 12 & 13 of ANSI/ASME B31.1 & the stress shall be within allowable limits.
2.06	Allowable Stress Values	For piping materials other than ASME/ ASTM materials, values shall be derived as per the criteria defined in Appendix-P of ASME Boiler & Pressure Vessel Code, Section-VIII, Division 1 while computing pipe wall thickness, and flexibility analysis shall be conducted as per ANSI/ASME B31.1. However higher pipe wall thickness derived between IBR regulation & ANSI/ASME B31.1 code shall be considered.
2.07	Factor to be considered in flexibility analysis	a) Contractor shall consider value of stress range reduction factor "f" for cyclic conditions due to temperature reversals equal to ONE.
		b) Stress intensification factors at all transitions, fittings & all branches as per ANSI/ASME B31.1.
		c) Variation in supporting effort by variable spring due to pipe movements.
2.08	Piping layout	Flexibility analysis of Piping is to be conducted as per the offered piping layout. In case any modification of piping layout is felt essential to maintain stresses & terminal reactions within allowable ranges, same are to be carried out by the Contractor after discussion with Owner.
3.00	Design Pressure & Temperature	As per IBR. Wherever not clearly stipulated in IBR, criteria stipulated in ASME/ ANSI 31.1 for selecting design pressure & temperature shall be followed.

Sl. No.	Item	Criteria
4.00	Material of construction of piping, valves & specialties	ASME/ASTM materials
5.00	Hangers, supports etc.	
5.01	Type	a) Variable spring : i) Where the variation in supporting effort between hot and cold condition does not exceed 20% of the load. ii) The resulting effect of load take-up/release by a group of hangers in a span does not overstress the piping span or cause overloading at equipment terminals. iii) Thermal deflection between hot & cold conditions does not exceed 40 mm.
		b) Constant load - For thermal deflection between hot and cold conditions exceeding 40 mm. and or, for load variation beyond 20%
		c) Spring hangers should not be loaded more than 80% of the spring travel range.
		d) Rigid hangers & restraints - To be judiciously selected, without exceeding the stipulated limits of terminal forces & moments & stress level. Struts shall be considered where compressive load is expected.
		e) Snubbers, dampers etc. - To take seismic/dynamic loads, thrust due to safety valve discharge. Effort shall be made to limit its use by judicious placement of rigid hangers.
		f) Bottom support spring hangers to be avoided as far as possible.
5.02	Design, materials, fabrication testing and erection of hangers, supports, anchors, guides etc.	a) As per ANSI/ASME B31.1 latest code.
		b) Hanger suspension rods, tie-rods/struts should have proper arrangement & adequate length, so that thermal movements in direction which are free are not constrained and should not make an angle more than 4 degrees with vertical due to horizontal pipe movements.

Note : In case turbine steam stop valve is not anchored, steam hammer analysis of the main steam & HP/LP By-pass pipe line on stop valve closing shall be carried out.

6.00.00 DESIGN AND CONSTRUCTION
6.01.00 General Considerations

6.01.01 Pipe sizing and piping system design shall conform to the requirements of power piping code ANSI B31.1. Statutory requirements as laid down in Indian Boiler Regulations (latest edition) will also be taken care in pipe system designs. Pipe wall thickness as calculated by ANSI Code formula will also be checked for IBR requirements for piping systems falling under IBR purview.

6.01.02 Inside diameters of piping shall first be calculated for the flow requirement of various systems. The velocity limits for calculating the inside diameters are listed below :

- | | | |
|-----|--|--|
| a) | Main Steam hot and cold reheat pipes | 75 m/sec. |
| b) | Auxiliary steam (Aux. steam to take care of various design flows). | 40 m/sec. |
| c) | Feed Water | |
| i) | Suction | 2.0 m/sec. |
| ii) | Discharge | 6.0 m/sec. |
| d) | HP bypass | |
| i) | Upstream | 75 m/sec. |
| ii) | Downstream | 150 m/sec. |
| e) | LP bypass | |
| i) | Upstream | 75 m/sec. |
| ii) | Downstream | 150 m/sec. |
| f) | Extraction steam | |
| i) | Superheated steam | 60 m/sec. |
| ii) | Saturated steam | 30 m/sec. |
| g) | Condensate | |
| i) | Discharge | 5.0 m/sec. |
| ii) | Suction | 1.5 m/sec. |
| h) | Heater Drains: | 1.5 m/sec |
| i) | Heater Vents: | 25 m/sec |
| j) | Other piping | As per good proven engineering practice. |

Note: This standard sets the maximum limits of the flow velocity.

Lower velocities may be selected if found necessary.

Inside diameters thus calculated shall be checked for allowable pressure drop for various systems. Pressure drop in main steam line shall not be more than 90% of the pressure differential between superheater outlet header and HP turbine inlet valves at BMCR. Similarly, combined pressure drop in cold and hot reheat piping will not exceed 90% of the available pressure differential between HP turbine exhaust and LP turbine inlet valves minus the reheater drop. The available pressure differential in the complete reheat line from HPT exhaust to IPT inlet shall not be more than 10% of the pressure at HPT exhaust. Wherever possible 5D/6D radius bends will be used to minimise the pressure drop in the main steam, cold & hot reheat piping systems.

Pipes shall be sized for the worst (i.e. maximum flow, temperature and pressure values) operating condition. In case of BFP suction pipe sizing "transient analysis" shall be carried out for optimum sizing of the system in order to establish the pipe inside diameter for minimum pressure drop in system to match with the pump NPSH requirements under worst operating conditions. The Boiler Feed Discharge pipe-work shall be designed for the maximum final feed water temperature down-stream of H.P. heaters and the maximum closed valve pressure of the boiler feed pump upto and including downstream valve at FRS in the following two cases, whichever gives a higher pressure.

- a) Temperature of water from deaerator
- b) Deaerator storage tank working at its maximum possible pressure with saturated water.

Feed regulating station (FRS) located at upstream of HP heaters and no isolating valve provided at economizer inlet, the design pressure of boiler feed discharge piping at downstream of FRS shall be worked out corresponding to design pressure of the boiler. This shall be for HP heaters provided with spring loaded relief valve(s) or having provision of media operated three way valves at inlet/ outlet of HP heater(s) as per approval of IBR so as to prevent BFP shut off pressure being communicated to downstream piping system and HP heaters.

In addition to this the rest of the design basis shall be same as for other water services described above.

- 6.01.03 Thickness calculation shall be made on the basis of procedure and formula given in ANSI/ASME B 31.1. Stress values of piping material for calculation shall be selected from tables given in ANSI B31.1. Thickness thus calculated shall then be checked based on the procedure and formula given in IBR and based on higher of the two calculations (after adding manufacturing tolerance), the next heavier commercial wall thickness shall then be selected from thickness schedules (e.g. sch.40, sch 80, etc) in ASME B36.10 for OD controlled pipes and from manufactures' schedules for ID controlled pipes.

However, in cases where the calculated thickness for OD controlled pipe falls beyond the thickness corresponding to the listed schedule nos. as given in

ANSI B36.10 for the pipe size, both ID and OD controlled pipes to manufactures' schedules are acceptable.

OD controlled pipes shall be to the dimensional standards ANSI B36.10 for carbon & alloy steels pipes and ANSI B36.19 for stainless steel pipes.

To account for losses due to corrosion, erosion etc. during the plant service life, an allowance of 1.6 mm/0.75 mm shall be considered in the minimum wall thickness calculation of pipes as per ASME B31.1/IBR respectively.

The design pressure and temperature, down-stream of any pressure reducing valve upto and including the first block valve shall be the same as that at up-stream of pressure reducing valve. The piping at down stream of de-superheater shall be designed for spray failure condition. The length of piping system considered for spray failure condition shall not be less than the length required for proper spray mixing as recommended by de-superheater supplier.

However, in no case, the selected pipe thickness shall be less than Sch.80 for alloy steel & carbon steel pipes of sizes 50 Nb & below. The selected thickness for SS pipes shall not be less than Sch.40S of ANSI B36.19.

Further, for the piping systems likely to be subjected to two phase flow, i.e. down stream of control valves on heater drain lines etc. and for the length of piping which is required for the proper mixing of spray water at downstream of de-superheater, the selected thickness shall not be less than :

(a.) Sch.40 for pipe sizes above 50 NB, but below 300 NB and

(b.) Sch. STD for pipe sizes 300 NB and above.

- 6.01.04 No pipe work shall be run in trenches carrying electrical cables.
- 6.01.05 Pipes shall not be less than 20 mm bore unless authorised by the Engineer.
- 6.01.06 Site fabricated pipes shall be installed only where they do not exceed 50 mm. bore and where their use has been approved in writing and shown on a scale drawing.
- 6.01.07 All piping shall be identified by means of colour strips and by adequate lettering, conveniently spaced and located. Identification colours and lettering shall be as approved.
- 6.01.08 Air release and drain branches shall be provided wherever necessary depending upon the layout and arranged so that the drains and air release valves are located for easy operation.
- 6.01.09 All valved drains in vacuum services shall be provided with screwed cap.
- 6.02.00 **Stress and Flexibility Analysis**
- 6.02.01 Overall procedure of stress & flexibility analysis shall be as per latest revision of ANSI B31.1/IBR and according to material used.

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- 6.02.02 Complete and comprehensive stress and flexibility analysis of the piping shall be done by computer using an approved standard program.
- 6.02.03 All piping of design temperature exceeding 100°C and nominal size equal to or above 50 mm except otherwise mentioned in Specific Design Criteria shall be stress analysed considering the effects stipulated therein.
- 6.02.04 The method of analysis due to seismic effects on static equivalent basis shall be submitted to Owner for approval prior to start of the analysis.
- 6.02.05 Stresses in pipes and fittings due to the above effects shall be limited to level prescribed by IBR wherever applicable. Other stress criteria not prescribed by IBR shall be guided by ANSI B31.1. Suitable stress intensification factors shall be assumed. Allowable stresses shall be computed by methods prescribed by IBR wherever applicable. However, such allowable stresses shall not be more than those prescribed by the relevant codes/standards.
- 6.02.06 The results of stress analysis shall be submitted for approval by Engineer before start of Fabrication or Erection clearly confirming the following :
- a) The terminal forces and moments are within permissible limit.
 - b) Forces and moments on supports, anchors and restraints attached to building/supporting structures are within permissible limit.
 - c) Stresses on piping are within acceptable limit stipulated in the applicable codes.
 - d) Pipe movements are acceptable for the spacing in between adjacent pipes and between pipes and adjacent structures/ equipment etc.
 - e) Stress checking for occasional loading.
 - f) All other stress/flexibility checking as stipulated in IBR/ American codes whichever is stringent.
- Above stress analysis results shall be used for checking the piping design.
- 6.02.07 The finalised flexibility analysis in the form of a report indicating procedure of analysis, pipe sizing based on specified diameter, spring hanger summary, design load charts for Anchors. Restraints and hanger supporting structures delineating different loading conditions, stress charts, loading on terminal anchors, along with isometric drawings of piping for flexibility analysis shall be submitted to Purchaser for review.
- 6.02.08 All high temperature lines shall be provided with expansion markers with scales at certain hanger locations, as decided by the Engineer. The Contractor shall guarantee and prove during trial run, after a few cycles of operation that the range of thermal movements in three directions from cold to hot condition at the expansion marker locations are within $\pm 20\%$ of the calculated values.

	If the error exceeds the above limit, necessary adjustments and rectifications shall be carried out by him at no extra cost, till the above requirement is fulfilled.
6.03.00	Material Specification
6.03.01	Material for pipes and fittings shall be as stipulated in Annexure-I enclosed. Bidder may note that ASTM materials have been considered for Main Steam, Hot reheat, Cold reheat, HP & LP bypass pipings and all the tendering information in the specification for such pipes have been given based on this material of piping. In case bidder wants to offer alternative piping material, same may be accepted by the Purchaser depending on the merits of alternative material. In that case pipe stress analysis, hanger selection etc. for such pipings are to be carried out by the Contractor accordingly.
6.03.02	Pipe attachments for supports, anchors and restraints, which are coming in direct contact with pipes and are inside the insulation of high temperature pipes shall have similar materials as the piping concerned. All other materials of supports, anchors and restraints shall be of tested quality and as per manufacturer's standards.
6.03.03	For rubber lined pipe, lining should be applied in three (3) layers, giving a total thickness not less than 4.5 mm.
6.04.00	Fabrication
	Except where otherwise specified all piping shall have butt-welded connections with a minimum of flanged joints necessary for maintenance. All high pressure steam valves and accessories shall have welded connections. Where flanges are adjacent to welded fittings, weld neck flanges shall be used.
	Branches shall, in general, be formed by welding. Standard fittings may be used in positions and for sizes where approval have been given in detail drawings. Pipe bends and tees shall be truly cylindrical and of uniform section. All welded branches shall be reinforced where needed as per the applicable codes/ regulations.
	Unless otherwise specified, for all welded lines with pressure above 7 kg./sq. cmg. and/or temperature above 200 Deg.C branch connections for branch sizes up to 25% of welded mains shall be made with special forged steel welded fittings.
6.04.01	The piping systems shall be constructed in accordance with the requirements of ANSI B31.1. The requirements of IBR 1950 (with latest amendments) shall be complied with for the piping systems, which are under the purview of IBR.
6.04.02	Piping shall be fabricated in the shop in the largest transportable sections to minimise the number of field weld joints. The choice of field weld joints locations shall be based on the traverse of the pipe through walls, floors, sleeves or other restrictive areas. Support attachments for major piping shall be done at shop.
6.04.03	All workmanship shall be carried out using methods and procedures of best
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	recognised pipe fabrication practice and must be done in a good and workman like manner in accordance with latest revisions. ANSI standards, ASME Codes, PFI standards and IBR as applicable.
6.04.04	All high-pressure steam valves and accessories shall have welded connections.
6.04.05	Mitred bends and elbows will not be accepted unless otherwise specified. Only forged tees, 90° elbows and 45° elbows are acceptable. In case the Bidder wants to deviate from this requirement on the ground of non-availability of such forged items, the bidder may submit alternative offer for Owner's consideration with sufficient documents to justify the same. In such a case the concerned fittings shall be manufactured with necessary reinforcing pads, bend thinning allowance etc. to satisfy code requirements.
6.04.06	All pipes bends shall be made true to angle with no negative tolerance and shall have a smooth surface free of flat spots, crease and corrugations. A cross section through any bend portion of the pipe shall be true in diameter. All pipe bends shall have a radius of not less than 3 times the nominal pipe size unless otherwise mentioned. Pipe bends shall be made from straight pipe pieces of sufficiently higher thickness so that after thinning, the minimum thickness of bends shall not be less than the minimum thickness required for the straight pipe. Thinning allowance shall be considered as per ANSI B 31.1. The ends of pipe and welded fittings shall be bevelled according to details shown in the relevant piping codes.
6.04.07	Pipes of size 65 mm NB and above shall be shop fabricated and of size 50 mm NB and below shall be field run.
6.04.08	All welding shall be made in such a manner that complete fusion and penetration are obtained without any excessive amount of filler metal beyond root area. The reinforcement shall be applied in such a manner that it shall have a smooth contour merging gradually with the surface of adjacent pipe and welded fittings. Backing rings shall not be used on any pipe welds, unless otherwise approved by the Engineer. Pipe and attachments shall be properly aligned prior to welding. If tack welds are used the tacks shall be either fused into the first layer of weld or else chipped out. All welding for steam and feed pipe work shall be electrical welding using the shielded arc process and electrodes in accordance with the relevant code. For pipes up to and including 100 mm. bore, provided the pipe does not exceed 12.7 mm. in thickness, gas welded butt joints will be accepted without backing rings. Welded joints in pipe work shall be pre-heated to a temperature as required by the agreed standard or code or to the approval of the Engineer. The temperature shall be maintained during the welding operation and a record of metal temperature shall be obtained by means of a recording thermometer throughout the welding operation.

	All welds shall be built-up by the application of multiple layers or passes. The thickness of metal applied for each layer or pass shall not exceed 3 mm. Each layer shall be cleaned and lightly peened before the next layer is applied. Before being assigned to welding work, each operator shall have passed a qualification test as prescribed in the applicable Code/ Regulations. Each approved welder shall have an identification number which shall be indicated on all welds.
6.04.09	Welded joints shall be stress relieved as per ANSI B31.1./IBR. Stress relieving temperature shall be measured by thermocouple pyrometers or other suitable equipment. Readings of temperature against time shall be recorded.
6.05.00	Welding
6.05.01	General
	Full scale joints preparation sketches (to be included with the welding procedure) shall show all dimensions including tolerances for bevel angle, land size and off-set and root gap. Adequate copies of detailed welding procedure for approval of IBR shall be furnished.
6.05.02	Cutting and Bevelling
	a) Carbon steel piping : End preparation for butt welding shall be done by machining/flame cutting. b) Chrom-Moly steel : End preparation for butt welding shall be done by machining. c) Socket welding : Socket weld end preparation shall be done by saw or machine cutting.
6.05.03	Welding Electrodes and Rods
	All special welding electrodes and filler wires to be supplied and used for the work under this specification shall be of reputed make, approved/tested quality with valid test certificate and shall have proven performance record for similar application. Approval of the Owner as well as IBR should be sought in selection of the electrodes for specific uses. The certificate of electrode shall incorporate all the chemical and physical test data and tests witnessed by a representative of the Inspecting Authority recognised under IBR.
6.06.00	Hangers, Supports, Anchors and Restraints
6.06.01	Hangers and supports shall be capable of carrying the sum of all concurrently acting loads.
6.06.02	All the hangers/supports shall be of reputed make, approved/tested quality
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and shall have proven performance record for similar application. They shall be designed to provide the required supporting efforts and allow pipeline movement with thermal changes without causing overstress. The design shall also prevent complete release of the piping load in the event of spring failure or misalignment and all parts of supporting equipment shall be fabricated and assembled so that they will not be disengaged due to movement of the supported piping. Necessary guides, anchors, braces and structural steel to be attached to building/boiler structure as well as any braces and/or dampeners required to eliminate piping vibration and seismic loading shall be provided.

- 6.06.03 In general piping shall be supported in such a manner to maintain drainage slopes, prevent interference with structure and piping and keep flexible supports in proper adjustment so that they will move within their design operating ranges. Normally pipe supports and anchors shall be selected at those points in the building where provision has been made for the loads imposed. The cutting of floor/roof beams or the reinforcement in slabs will not be permitted. Piping attached to a plant item shall be supported in such a way that the weight of the piping is not taken by the plant item.

Support spacing shall be as per good engineering practice. However, in no case it shall be less than support spacing stipulated in ANSI B31.1.

- 6.06.04 The design of the pipe supports and hangers and their locations shall be guided by the following general principles:

- a) Criteria of loading shall be as per "Specific Design Criteria" enclosed.
- b) Design loads for anchors, restraints, hanger supporting structures shall be as per the criteria stipulated in "Specific Design Criteria".
- c) Supports shall be adequate for extra loading due to hydrostatic tests and when piping system is full of water during chemical cleaning.
- d) Supports for relief valve stacks shall be adequate for both the pipe weight and the thrust developed when the valve is open.
- e) There should not be any interference of the hangers with other piping, pipe supports, cable trays structure, equipment etc.
- f) Besides vibration elimination, hangers shall ensure that the amplitude of oscillations in the pipe work owing to shock and vibration due to variation of fluid flow from zero to full capacity remains within approved limits.

- 6.06.05 Attempts shall be made to use variable spring and rigid hangers as much as possible. Rigid hangers shall preferably be used where vertical movement of the pipe is negligible.

Variable spring supports/hangers may be used provided the following conditions are met.

- a) The variation in supporting effort between hot and cold condition does

not exceed 20% of the load, which is higher of the operating condition, and cold setting load.

- b) The resulting effect of load take-up/release by a group of hangers in a span does not overstress the piping span or cause overloading at equipment terminals.
- c) Thermal deflection between hot and cold conditions does not exceed 40 mm.

Otherwise, constant load type support/hangers must be used. On the other hand rigid hangers can be used where possible without exceeding the stipulated limits of terminal forces and moments and the stress subject to the Purchaser/Consultant's approval.

An exception may be made in the instance where the piping movement occurs at a hanger supporting a portion of a piping riser on which rigid support is also located. In this case, variable spring hangers may be used for any amount of expansion up to the full recommended working range of the spring, provided the change in the supporting effect of the variable spring is added to the design load of the rigid support assembly. However, the acceptance of such a system will be at Purchaser's/Consultant's discretion.

- 6.06.06 All design and fabrication including loading and allowable stresses shall be in accordance with ANSI B31.1. Note shall be taken of the requirements against earthquake at site. Hangers and supports for systems shall be completely engineered and prefabricated for all piping 50 mm. and above. Sufficient random materials shall be furnished for field support of all lines of smaller diameter.
- 6.06.07 For pipes of design temperature 100°C. and more, bottom supports shall be avoided as far as possible and hanger type supports shall only be used. However, where bottom support cannot be avoided, the same shall be provided with suitable shoes along with balls/rollers/rockers to minimise frictional resistance against thermal movements. The material of shoe as well as the ball/rockers/rollers shall be suitable for the design temperature of the supported pipe and shall be of sufficient hardness so as to permit a reasonably long life keeping its roundness and maintaining a low friction factor. Where a constant load type support is required, the bottom support shall also be of constant load type.
- 6.06.08 Where stress analysis calculations are performed, the location of anchors, guides and restraints shall be based on the results of the final stress analysis. Such anchors, guides and restraints shall be designed for the maximum forces and moments encountered. Spring hangers shall be selected to allow the movements determined by the stress analysis.
- 6.06.09 The Contractor shall design and provide all supplementary steel required to properly secure and support all pipe supports, guided restraints, anchors, shock absorbers, etc. furnished. Purchaser shall provide only the main steel work or, embedded plates in the concrete.
- 6.06.10 Accurate weight balance calculations shall be made to determine the required

	supporting force at each hanger location and the pipe weight load at each equipment connection.
6.06.11	Provision shall be made for support of piping, which may be disconnected during maintenance work.
6.06.12	Supports shall be designed to prevent transfer of excessive loads from support to support or to equipment as the line expands or contracts. Support components shall be attached in places where they will not damage other construction either during or after installation. Cantilever type support shall not be taken from brick wall. Brackets may be used where piping is adjacent to vertical surfaces, suitable for support use, these shall be supported from columns/RCC structures.
6.06.13	All large pipes and all long pipes shall have at least two supports each arranged so that any length of pipe or valve may be removed without any additional supports being required.
6.06.14	Support steel shall be of structural quality. Perforated strap, wire or chain shall not be used. Support components shall be connected to support steel by welding, by bolting or by beam clamps. Boltholes shall be drilled, not burned. Support components may be bolted to concrete using approved concrete anchors.
6.06.15	Double nuts or lock-nuts shall be used on hanger rods and bolts in all cases.
6.06.16	Variable springs shall be furnished with travel stops. The travel stops shall be factory installed at the "cold" position.
6.06.17	Spring hangers should not be loaded more than 80% of the spring travel range.
6.06.18	Both constant load and variable spring support/hanger shall be provided with outside indicators for deflection and load. Provision for the site adjustment of load at least $\pm 10\%$ shall be incorporated. Also spring locking arrangement and turnbuckles of load/position adjustment shall be provided for all hangers.
6.06.19	Constant load type spring support/hangers shall be so selected as to permit, for the specific load, an over-travel of at least 25 mm or 20% (whichever is greater) of the specified range of vertical travel. The initial setting of the hangers/supports shall be such that half of the "over-travel" is allowed in either direction. Constant support hangers shall have a support variation of no more than 6% throughout the total travel range.
6.06.20	Rigid support shall be designed with adequate margins of safety so that variations in load distribution on them are of little consequence. All rigid hangers shall be provided with means for vertical adjustment after erection.
6.06.21	Where the piping system is subject to shock loads, such as thrust imposed by the actuation of safety valves (SV), hanger design shall include provision for shock absorbing devices of approved design.
	Vertical restraints near safety valves shall be preferred for taking SV discharge thrust, provided equipment terminal reactions remains within

	allowable limit.
	Attempts shall be made to avoid use of shock absorbers, dampers etc. as far as possible to take care of occasional loading like seismic effect etc. by proper engineering of the piping design and effective use of restraints. However, shock absorbers, VISCO- dampers, wherever felt necessary are to be supplied and erected by the bidder.
6.06.22	Layout of piping shall be properly designed to avoid excessive vibration by effective use of restraints. However, wherever felt necessary, shock absorbers, VISCO-dampers shall be supplied and erected by the bidder.
6.06.23	Hanger rods (except Rigid hangers where both tension and compression may occur) shall be subjected to tensile loading only. At hanger locations where lateral movement is anticipated, suitable linkage and rocking washers shall be provided to permit swing.
6.06.24	For all hangers, the length of suspension shall be so selected that the hanger rod may never make an angle of more than 4° with vertical due to horizontal pipe movements. If this cannot be avoided by erecting the hanger vertically for cold condition, it shall be suitably off set so that the above requirement is fulfilled in cold as well as hot conditions. Hangers shall be designed so that they cannot become disengaged by movements of the supported pipe.
6.06.25	Supports, guides and anchors shall be so designed that excess heat will not be transmitted to the building steel.
6.06.26	Tie rods/struts shall preferably be used for restraints to achieve low friction restraining. The Tie-rods/struts shall have proper arrangement and adequate length, so that, thermal movements in other directions, which are intended to be free are not constrained and there is no appreciable shift in centreline of pipe or the elevation of the supporting point on pipe due to sway. The design shall have provisions for adjusting the length to take up any slack and securely locking in position permanently once adjustment is done.
6.06.27	All relevant hangers shall be designed to take the dynamic movements for dynamic loading in addition to the thermal movements.
6.07.00	Valves and Accessories
6.07.01	General Requirements a) All valves shall be of approved make and type and shall have cast/ forged steel bodies with covers and glands of approved construction. The valves shall be provided with electric motors/solenoids and actuators as required. b) Valves and specialties to be supplied shall be used for various steam and water services of the power cycle system and shall be located indoor/ outdoor and on horizontal/vertical runs of the pipe lines. However, locating the valves on vertical runs should be avoided as far

as possible.

- c) All valves shall, unless otherwise approved, have ends prepared for butt-welding and the internal diameter shall be the same as the internal diameter of the pipes to be joined. Where valves are accepted with flanges, they shall comply with the requirements of the approved Code of Practice for the respective pressure and temperature conditions of the piping system.
- d) All valves shall receive tests at Manufacturer's or Contractor's works in accordance with the specific requirements of the approved Codes of Practice so that the same is acceptable to IBR where applicable. Valves shall be rising stem or otherwise as approved by the Purchaser.
- e) Gate valves have been specified with the intention of achieving isolation and tight shut-off. In full open condition, these valves should offer minimum of resistance to fluid flow.
- f) Globe valves have been specified with the intention of achieving good control of fluid passing. The plug and seat will have therefore suitable profiles for obtaining such controlling action.
- g) Check valves have been specified in order to prevent reverse flow through them.
- h) Steam traps with strainers will be used in the drain lines from various steam pipes such that only condensed steam can be drained.
- i) All valves shall function smoothly without sticking, rubbing or vibration on opening or closing.
- j) Material, design, manufacture, testing etc. for all valves and specialties along with the accessories shall conform to the latest editions of codes as specified or approved equivalent and acceptable to IBR.
- k) By-pass valves shall be provided for high pressure and larger size valves as per standards followed and as felt necessary for smooth and easy operation, even though not specifically mentioned in the specification.
- l) Motor operated valves shall be designed as specified hereinafter.
- m) Valves subjected to vacuum shall have sufficient long deep-seated packing. Valves in general shall preferably be of such design as to permit repacking while in service by providing back seating arrangement duly tested during manufacture.
- n) All flanged valves and specialties shall be provided with two (2) counter flanges, bolts, nuts, washers, gaskets etc.
- o) Valves and specialties along with counter flanges coming under the

purview of IBR shall meet all the requirements of IBR duly approved by the Purchaser.

- p) For pneumatically actuated valve, if any, the Bidder shall provide necessary instrument air connection near the valve. All accessories including solenoid valves etc. as necessary for the actuation of this valve shall be supplied.
- q) For all sizes below 50 mm, socket welded end valves may be used.
- r) All valves shall have outside screwed spindles and screwed thread of spindle shall not pass through or into the stuffing box. Where valves are exposed to the weather, protective covers shall be provided for the spindles, which shall be subject to approval.
- s) Valves requiring sealing water shall be adequately deep and shall be equipped with lantern ring to admit pressurised water for gland-sealing. Gland sealing water shall be tapped from one tapping point on the condensate extraction pumps discharge header and shall be reduced in pressure as per the requirement.
- t) The stops which limit the travel of any valve in the "Open" or "Shut" position shall be arranged exterior to the valve body.
- u) All regulating valves shall be designed to prevent erosion of the valve plugs and seats when the valves are operated partially opened. The valves shall have contoured plug.
- v) Approved access arrangements shall be provided for all valves and particular attention shall be given to those valves fitted with gearing, which require lubrication of the valve itself.
- w) Valves which cannot be operated from the floor or walkways shall be provided with suitable extension rods and linkages. If such a valve is provided with integral bypass then similar arrangement shall be done for the bypass valve also. The extension shall be such that the hand wheel is at a height of approximately one metre above the level of the floor or platform from which the valve is to be operated. Where required they shall be provided with head-stocks and pedestals of rigid construction and where gears or level wheels are used these shall be of cast steel or suitable quality cast iron with machine cut teeth. Where extension spindles are fitted, all thrust when opening or closing the valves shall be taken directly on the valve body. The extension linkage shall be so designed to take care of the thermal movements of the valve body with the pipe on which the valve is installed. The connection of the extension spindle to the valve stem shall be through a flexible coupling.

The extension spindle shall be of the same materials as that of the valve stem. The floor stands shall have column, not less than Group-B of ASTM-126. Necessary nuts and bolts for mounting the floor stands on foundation shall have to be provided. Adequate means of easy lubrication shall have to be provided for valves and operating

extension components.

- x) Stems shall preferably be arranged vertically with gland at the top, however, in no circumstances must the stem be inclined downward from horizontal or gland be at the bottom. Globe valves shall be installed with the pressure under the disc. Valves shall not be fitted in inverted position.
- y) Where necessary, for accessibility, grease nipples shall be fitted at the end of extension piping and where possible these shall be grouped together and mounted on a common panel situated at a convenient position. A separate nipple shall be provided to lubricate each point. The Contractor shall supply the first fill of oil or grease for these parts. The Contractor shall supply a suitable manually operated grease gun for the standard type of nipple provided.
- z) The spindles for all valves for use outside the building shall have weatherproof protection covers of approved construction.
- aa) All valves shall be fitted with indicators so that it may be readily seen whether the valves are open or shut. In the case of those valves fitted with extended spindles, indicators shall be fitted both to the extended spindles and to the valve spindles.
- bb) Plastic or bakelite valve hand wheels will not be accepted.
- cc) All valves shall be closed by rotating the hand wheel in a clockwise direction when looking at the faces of the hand wheel. The face of each hand wheel shall be clearly marked with the words 'Open' and 'Shut' with arrows adjacent to indicate the direction of rotation to which each refers.
- dd) Each valve hand wheel shall be fitted with a circular nameplate of a approved material indicating the valve tag number, duty or service intended and the function of the valve. The nameplates shall incorporate the colour code corresponding to the service of the piping.
- ee) Wherever practicable, heavy valves of total weight including actuator, drive motor, integral by-pass etc., equal to or greater than 500 kg. shall be provided with suitable lugs to permit direct suspension by hanger rods or direct resting on bottom support, as applicable.
- ff) Special attention shall be given to the operating mechanism for large size valves in order that quick and easy operation is obtained and maintenance is kept to a minimum.
- gg) Eyebolts shall be provided where necessary to facilitate handling heavy valves or parts of valves.
- hh) The Bidder shall supply with his bid and in addition during the course of the Contract, comprehensive drawings showing the design of valves, test pressure and working pressure/temperatures. They should include a parts list referring to the various materials used in the valve

construction.

ii) For high temperature application above 600°F (315°C), all gate valves shall preferably be of wedge type construction.

jj) All sampling and root valves shall be of integral body bonnet type.

6.07.02 Design Requirements

a) Design working pressure and temperature as well as pressure rating of all valves and specialties has been listed in Annexure-II of this Section. Valves and Specialties are to be supplied conforming to specified pressure rating.

b) Steel body gate valves shall preferably be in accordance with American Petroleum Institute, U.S.A., Standard No.API-600 or other approved international standards.

Carbon steel gate valves in size 50 mm and below shall be in accordance with API-602 or any other approved international standards.

c) Globe valves shall generally conform to BS-1873 or approved international standards, subject to other requirement specified in the specification.

d) Check valves shall conform to BS-1868 or approved international standards and shall be of swing check type.

The body seat for swing check valves shall be inclined at such an angle as to minimise chatter.

To enable the internal parts to be examined or renewed without removing the valves from the pipeline, the flanged cover should be used. The body shall be stamped with an arrow to indicate the correct flow direction.

e) Safety Valve

The safety relief valves shall be direct spring loaded type and shall be provided with casing levers. The valves shall be of rugged construction suitable for long periods of uninterrupted service. The safety relief valves shall conform to the requirements of ASME Boiler and pressure vessel code, Section-VIII and IBR as applicable and shall be installed as per recommended rules for the design of safety valve installations in ANSI B31.1.

f) Motor Operated Valves

i) Motor operated valves shall be fitted with both hand and motor operating gears and where a by-pass valve is provided this also shall be provided with both hand and motor operated gear and interlocks to ensure that the by-pass valve is opened

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- before the main valve. Each valve shall be complete with a device for automatically stopping the motor when the valve gate has reached the "full open" or "full close" position (with a minimum increase in the torque). The motor shall be placed in such a position relative to the valve that there is no possibility of leakage of liquid, steam or corrosive gas from valve joints on the motor or control equipment.
- ii) The hand operating and motor operating mechanism shall be so interlocked that the hand operating mechanism is disconnected before the motor is started. Valves shall be provided with seating control and except where specifically approved by the engineer for small valves, a slipping clutch or other torque-limiting device shall be incorporated in the motor drive. The opening or closing the valve shall be controlled by means of push buttons labelled respectively "open" and "stop". The control shall be so arranged that the motor can be stopped with the valve in any position by means of "stop" push button and after having been stopped, can be re-started in either direction by the "open" or "close" push buttons hand operating mechanism shall be placed in an accessible position from the floor.
 - iii) Necessary output signal (4-20 mA) shall be given for provision of positioning indicator in U.C.B.
- g) For reheater isolation, for hydraulic testing as well as wet lay up reheater isolating devices shall be provided on cold reheat and hot reheat lines, at boiler outlet. Isolating device shall consist of a robust cast steel body with carbon steel (ASTM A216 GR WCB) material for cold reheat application and alloy steel (ASTM A 217 GR WC 9) for hot reheat application suitable for pressure and temperature condition which they will be subjected. These shall be of welded type construction and shall form part of the pipeline during normal operation without any leakage. Before hydrostatic test top cover and bonnets are removed and a separate test closure assembly with sealing rings are inserted to close the flow patch. The test closure assembly shall be of disc type construction with appropriate seal and a preloading lever to form a complete tight assembly for effective closure during hydraulic testing. Drains shall be provided on both side of the device to detect leakage.
- h) Drain Valves, Steam traps and Strainers
- i) Drain Valves
- All drain valves shall be of approved type and shall have cast or forged steel bodies with covers and glands of approved construction. Spindles shall be of stainless steel and the materials of internal parts shall be suitable for operation at the maximum working pressure and temperature of the piping to which they are connected. Valves should be full-way type, unless otherwise specified and in full open position the bore of

the valve should not be obstructed by any part of the gate. The internal diameter of all valves at the bore and at the ends adjacent to the pipe work shall be similar to the internal diameter of the connecting pipe work. Valves shall be designed for continuous operation in partially open condition without erosion of the valve seats or faces. Where valve seats are shrouded the design of the shroud shall be such as to prevent foreign matter lodging in the valve seat.

All drain traps shall be of approved make, size and type and shall be complete with air cock and casing mechanism. All internal parts shall be constructed from approved material and shall be renewable. Trap bodies and covers shall be of cast or forged steel and shall be suitable for operation at the maximum working pressure and temperature of the steam piping to which they are connected.

ii) Steam Traps and Strainers

- The steam traps shall be inverted bucket or thermodynamic type complete with integral or separate strainers.
- The internal components of traps shall be of AISI-316 stainless steel construction. Material of construction of the body shall be selected by the Bidder based on the service conditions stipulated.
- All Y-type strainers, wherever provided with steam traps or otherwise, shall have AISI-316 stainless steel screen of not more than 20 mesh size. Screen open area shall be at least three (3) times the pipe internal cross-sectional area. The strainer shall have a screwed blow-off connection with a removable plug. Material of construction of the body shall be selected by the bidder based on the duty conditions specified.
- All traps and strainers shall have socket weld ends as per ANSI B16.11 for size NB 50 mm and smaller and butt weld ends as per B 16.25 for size NB 65 mm and above.
- Steam drain traps shall be provided with strainers, inlet and discharge valves and by-passes and test cocks as schematically indicated in the enclosed drawing. Materials and other details of these valves shall meet the specified requirement.

i) Pump Suction Strainer

The strainer at condensate Transfer pump should be removable type conical strainer assembly. The spool pipe shall have flanged ends suitable for direct mounting on condensate Transfer pump suction

flange. The material of construction of spool pipe shall be the same as that of pumps suction piping. The strainer element shall be of perforated sheet with aperture size of 6 mm and wrapped with AISI-316 stainless steel wire mesh of 500 micron nominal aperture. The clear opening area of the strainer shall be at least 5 times the pipe area.

j) Non-return Valves

- i) All non-return valves shall be of approved type and make and the pressure drop shall be subject to approval. Non-return valves for steam services and on pump discharge sides shall be provided with approved dash pots, where required, and with prior approval.
- ii) The body seat for swing check valves shall be inclined at such an angle as to minimise chatter.
- iii) To enable the internal parts to be examined or removed without removing the valves from the pipeline, the flanged cover should be used. The bodies shall be stamped with an arrow to indicate the correct flow direction.
- iv) Provision shall be made to drain both sides of a horizontal non-return valve where such a valve adjoins an isolating valve for non-return valves mounted on vertical pipe integral by-pass shall be used to facilitate draining as stated earlier.

k) De-super heaters

De-super heaters along with spray water supply and control system shall be provided on the auxiliary steam lines, etc. as required. A de-superheater shall be designed for the design conditions of the piping on its upstream side and shall also take care of its severe condition of working. As far as possible, the de-super heaters shall be mounted on a vertical line to avoid the problem of water accumulation in it. However, if installed horizontally, the inside diameter of the de-superheater shall be the same as that of the pipe on which it is mounted and the pipe shall be provided with drain pocket and trap station.

7.00.00 **INSPECTION, TESTING AND INSTALLATION**

7.01.00 **Testing of Piping at Works**

7.01.01 Material Test and Analysis

All materials shall be furnished in strict accordance with the codes specified and in accordance with the detailed specification. All sources of material shall be disclosed and relevant test certificates for the physical and chemical properties of the material shall be made available to the Owner/Engineer before the final shop inspection.

7.01.02	Hydrostatic Test All piping shall be subjected to the hydrostatic test pressure at shop as required by the IBR or any other applicable standards. Test pressure shall however be not less than the following : Test Pressure = $1.5 \times \frac{\text{Allowable Stress at Room Temp.}}{\text{Allowable Stress at Design Temp.}} \times \text{Design Pressure}$ The Contractor shall guarantee his work as capable of withstanding such hydrostatic tests and consent to repair or replace at his expense any item, which fails to pass such tests at site. Hydrostatic test of all pipes coming under IBR shall be offered for witnessing by the representative of the Inspecting Authority recognised by IBR.
7.01.03	Wall Thickness Tests Wall thickness tests shall be made on a length of pipe of each type to determine the actual wall thickness at outer wall of bend on such piping. The tests shall be done before fabrication on the piping system and results submitted to Owner/Engineer for approval.
7.02.00	Capacity Tests for Pipe Supports Each constant load and spring support shall be tested before delivery to ensure that the variation in support capacity provided through the specified ranges (i.e. the difference in load between hot conditions and cold condition) does not exceed 6 percent for constant load supports and 20 percent for variable spring supports. All materials shall be of tested quality. Hanger springs shall be properly calibrated.
7.03.00	Testing of Valves & Specialties at Works
7.03.01	All materials shall be of tested quality and the contractor shall submit the relevant material test certificate for the approval of Owner/Consultant.
7.03.02	All Valves and Specialties as well as counter flanges to be used in steam service shall have IBR certification marked on them and IBR certificates in appropriate proforma, shall be submitted.
7.03.03	Gate valves shall be subjected to shop tests in accordance with API-598 including the high-pressure closure test. Globe valves shall be tested in accordance with BS-1873 and check valves in accordance with BS-1868.
7.03.04	All gaskets used for test shall be of the same material and design as specified for the finished product.

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- 7.03.05 Each relief valve shall be subjected to hydrostatic test, seat pressure test, seat leakage test and test for relieving capacity.
- The valve body test pressure shall be at least twice the set pressure.
- The seat test pressure should be at least equal to the set pressure. During this test, the valve seat shall be demonstrated to be watertight for a period of at least two (2) minutes.
- 7.03.06 Functional tests : The fully assembled or completed valves including the operators and accessories shall be functionally tested to demonstrate the operability of the valve and the operator. This may be done by cycling typical valves 3 or 4 times from open to close position. The manual operation of the motor operated valves using the manual override to demonstrate freedom from friction shall also be conducted.
- 7.04.00 **Tests on Strainers and Traps at Works**
- 7.04.01 All strainers shall be subjected to hydrostatic test. The test pressure shall be twice the design pressure.
- 7.04.02 All steam traps shall be subjected to hydrostatic test at twice the design pressure. IBR certification shall be furnished for all steam traps.
- 7.05.00 Test reports and certificates of the mentioned tests and other tests as required to ensure satisfactory operation shall be submitted to Owner/Consultant before despatch of equipment IBR certification as required shall be furnished.
- 7.06.00 All rubber lining should be subjected to tests as per IS:4682 (Part-I).
- 7.07.00 **Tests at Site**
- Contractor shall carry out tests at site to prove to the Owner that the equipment of the plant complies with requirements stipulated and is erected in accordance with requirements. Before the plant is put on trial run the Contractor will be required to conduct tests to demonstrate to the Owner that each item of the plant is capable of correctly performing the functions for which it was specified. These test may be conducted concurrently with those required under commissioning sequence. Tests required shall in general be as follows :
- a) All piping, valves and specialties after installation, will be tested hydraulically at a pressure, one half times that of the maximum attainable pressure in the system or 2 times the design pressure whichever is higher, to check against leak tightness.
 - b) All manually operated valves/gates shall be operated throughout 100% of the travel and these should function without any trouble whatsoever.
 - c) Visual check on all structural components, welding, painting etc. and if doubt arises these will be tested again.
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- d) All test instruments and equipment shall be furnished by the Bidder to the satisfaction of the Owner.
 - e) Checks on electrical items as mentioned in relevant electrical specification.

7.08.00 **Pre-Commissioning Testing**

7.08.01 Alignment Test

After completion of erection and before start-up, alignment test shall be carried out by the Contractor to check levelling, clearance, eccentricity etc. Measurement will be witnessed and acceptance will be certified by the Engineer.

7.08.02 Heat Treatment

All necessary preheating, post heating and stress relieving operation of welds/fabricated, items are part of the erection work and shall be supervised by the Contractor in accordance with relevant regulations and standard.

The Bidder shall arrange all required supervising staff for heat treatment and stress relieving works.

Heat treatment may be required to be carried out at any time during day and night to ensure the continuity of the progress. The Contractor shall provide supervising staff accordingly.

All data such as heating temperature, heating rate, sparking time, maximum temperature during heat treatment shall be properly recorded. All the data recorded during heat treatment shall be the property of the Owner.

7.08.03 Radiography Test

The Contractor shall carryout radiography tests of all field-welded joints coming under IBR the acceptability standard of which shall be as per IBR (latest revision). For other field welded joints radiography or other ND testing methods shall be employed as per ASME or equivalent. All radiography shall be carried out in presence of a competent supervisor of the contractor and his certificate of identification of the films of the radiographs shall be given invariably in all cases.

The repair work shall be suggested by the Contractor immediately after detection of the defective zone to the complete satisfaction of the Engineer. Regarding acceptance of the joints, decision of the Engineer shall be final.

All X-ray films of joints radiographed at site shall become the property of the Owner.

Contractor shall carryout the following optional non-destructive tests after completion of erection of all piping and equipment.

Ultrasonic test per weld joint.

Hardness test for 10% weld joints for each system of piping and/or as specified in the approved Field Quality Plan (FQP).

7.08.04 Hydrotest

Hydrotesting shall be conducted for all pressure parts after installation at required pressure irrespective of carrying out 100% radiography of field welded joints. All necessary blanking arrangement required for such hydrotesting shall be furnished by the Contractor. The hydro testing of piping coming under the I.B.R. shall meet the requirements of I.B.R. and all necessary test pump, temporary piping etc. shall be supplied by the Erection Contractor, irrespective of carrying out radiography on 100% basis of the field welded joints.

After the hydrostatic test, the Erection Contractor shall carry out thorough flushing of all lines with water to ensure removal of foreign materials like welding rods, metal chips etc. to the satisfaction of Engineer. After the flushing of the lines, all the water shall be drained and the piping shall be blown with air for drying the cleaned surface and the lines shall be air blasted to ensure proper cleaning of line to the satisfaction of engineer.

As a rule, hydro test shall be performed after all eventual pipe branching have been completed and valves installed. Should it be required to hasten erection work, hydrotest may be performed in sections.

All safety valves coming under purview of Indian Boiler Regulation shall be set and other tests shall be conducted to the satisfaction of concerned Boiler Inspector. All other safety valves shall also be set and sealed to the satisfaction of the Engineer.

All instruments necessary for the tests shall be supplied by the Contractor and calibrated before test as per relevant code.

The Contractor shall make necessary changes and corrections without any extra cost as may be felt by the Owner/Engineer to meet the guarantee and other technical particulars.

7.09.00 **Installation**

7.09.01 For all steam blown lines temporary strainers shall be installed at the equipment terminals so as to prevent any inflow of particles where that may cause any damage or harmful effect. For example, such strainers shall be placed on main steam and hot reheat line terminals at turbine end unless the turbine stop valves/interceptor valves have integral strainers suitable for the purpose. The temporary strainers shall be kept on line for sometime after the plant starts normal operation, as per the discretion of the Engineer. So, the design of strainers shall be based on the design conditions of the pipes on which they are installed. Where flow meters are to be installed in pipes requiring steam blowing, initially the pipes shall be erected with the flow meter branch pipes replaced by temporary spool pieces. After the end of steam blowing operation the temporary spool pieces shall be removed and the flow

meter branch pieces shall be erected in position. In case such a pipe has also to be subject to cold pull-up, temporary anchoring of the main pipe on either ends of the temporary spool piece shall be done before replacing it by the flow-meter branch pipe.

All piping shall be installed in a manner such that expansion will take place in the direction desired and so that vibrations will be minimised. The contractor shall be responsible for the expansion provisions and flexibility of all field run piping. No piping shall be cold-sprung or cold-pulled unless there remains absolutely no other means to bring down the hot stress or terminal forces/moments within acceptable limit. All such cold pull up shall be shown in the piping drawings, along with a write-up describing clearly the method adopted for cold-pulling. All necessary attachments for cold-pulling, along with temporary anchors, as and wherever required, shall be provided.

The forces and moments on the temporary anchors and attachments shall be submitted. The cold pull-ups and all the above-mentioned documents shall be subject to the approval of the Owner.

- 7.09.02 All expansion bellows shall be installed with a minimum of two tie rods or bolts across each bellows to prevent the bellows from opening under pressure. The connection of the tie rods or bolts to the pipe shall make adequate provision for angular movement of the pipe and bellows.

Pump suction pipes shall be installed in such a manner that no air can be trapped in the suction piping. Suction pipes shall be supported in such a manner that there will be no high spots where air can be trapped. The in trades of suction branch lines shall be in no place lower than the in trades of the manifold at the point where the branch line connects to the manifold.

Standard "Factory Made" fittings shall be used in all piping. Shop or site fabricated mitred fittings shall not be used unless accepted by the Owner.

- 7.09.03 During erection no weights must be lifted by means of tackle fastened to the beams or slabs of the floor or roof except where provision has been specifically made for this purpose.

Supporting straps around flanges of pipes or valves or around welded joints will not be accepted. Anchors shall be attached to pipe by approved means. All supports should be shop fabricated and should be positioned before erection of the piping takes place and near to joints & valves wherever possible.

- 7.09.04 The Contractor shall provide all the necessary wall boxes and collars where pipes pass through walls, floors and roofs, also the necessary supports for any trenched pipes. Roof collars shall be fitted with a high sealing to prevent water falling through the holes.

The wall boxes and floor collars shall be constructed so that they can if necessary be erected after the pipes are in position. Pipes passing through roof collars shall be provided with an approved pipe sleeves, weather hood and cowl which shall be fixed by the Bidder. Floor collars shall extend to an approved height above the floor level and the pipes shall be fitted with hoods where required.

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- 7.09.05 Drainpipe work shall be designed as per ANSI B31.1.
- High pressure drains (above 40 kg/sq.cm) shall have two valves in series and that near the condenser or flash box shall be motor operated arranged to open and close to ensure minimum wear on one valve.
- High-pressure drains shall have a screw-down non-return valve at the point of discharge near the manifold of the Flash tank to prevent backflow of flashed steam.
- Low-pressure drains shall have steam traps of an approved design complete with strainers, isolating valves and by-pass valves.
- Low-pressure drains shall have an isolating valve at the point of take-off from the pipe or vessel to be drained or as near as possible for convenient operation.
- Pipe wall thickness shall be as per international standard approved by Owner/Engineer during detailed engineering.
- Drain pockets of an approved size and construction shall be provided for all steam lines.
- Arrangement of valves in the drain line shall be as shown in the Bidder's P & I Diagram.
- 7.09.06 All electrical actuators and pneumatic/hydraulic actuator shall be erected, aligned, adjusted and finally set to the satisfaction of the Owner. This includes adjustment and setting of torque and limit switches.
- 8.00.00 **DRAWINGS, DATA, INFORMATION & MANUALS**
- 8.01.00 **Drawings, data, Information to be furnished by the Bidder along with the Bid**
- 8.01.01 A complete list of all piping systems and corresponding materials included in the scope of work.
- 8.01.02 A complete list of all valves with their quantities and ratings.
- 8.01.03 Manufacturer's catalogue indicating design and construction of spring hangers, valves, specialties offered.
- 8.01.04 Manufacturer's catalogue indicating complete range of available size and rating of pipes and fittings.
- 8.02.00 **After Award of Contract**
- 8.02.01 Layout drawings as well as Isometric drawings (for line sizes NB 50 mm and larger) showing the routing of various piping and location of hangers, restraints, anchors, valves etc.

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- 8.02.02 Detail fabrication drawings of all shop fabricated piping system indicating design parameters and complete bill of material (Relevant Standards and grades to be indicated) and information/ data pertaining to the hydrostatic and non-destructive test requirements.
- 8.02.03 Detail dimensioned drawing of each valve, specialties, indicating tag no., pressure rating, manufacturing standard, bill of material and hydrostatic test pressures. The drawing shall include the end preparation details and shall indicate the position of the hand wheel/operator. Technical particulars of motor operators wherever applicable shall also be indicated.
- 8.02.04 Detail dimensioned drawing of each type of hangers and supports including guides, anchors, snubbers etc. with bill of materials (relevant standards and grades to be indicated).
- 8.02.05 General arrangement drawing for each hanger/support/anchor etc. indicating identification number, auxiliary supporting structural details, other details and information as required in the specification and typical details of Hangers & supports drawing enclosed with the specification.
- 8.02.06 Wiring diagram for all limit switches of motor operated valves.
- 8.02.07 Detail drawing with design calculation for the special Y-fittings on pipes, if any.
- 8.02.08 The loading data required for design of structures.
- 8.02.09 Miscellaneous Data/Documents
- a) Complete schedule of pipe lines in a format as approved by the Engineer indicating at least the line number, line description, pipe class (as per specification designation) design pressure and temperature, hydrostatic test pressure, insulation thickness, valve specification code, pipe material indicating standard and grade, number of BW/SW/Flanged joints and whether IBR certification needed.
 - b) Complete schedule of valves in format as approved by the Engineer indicating at least tag no, location, size, pressure class, design parameters, operation, make, quantity, special requirement if any etc.
 - c) Bill of material of hangers and supports in a format approved by the Engineer indicating at least the hanger/support number, type, operating load, cold setting load, Hydrostatic test load, movement of attachment point in X, Y and Z direction, line no. on which the hanger/support is located, insulation thickness of the pipe line, hanger rod length, angular deflection of hanger rod from vertical under hot and cold conditions etc.
 - d) Approval certificates from IBR in relevant forms regarding design, fabrication and testing of piping and valves for the piping system which are under the purview of IBR.
 - e) Design calculation for pipe wall thickness finally adopted.
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- f) Reinforcement calculations as per ANSI B 31.1 for all set on type branch connections.
 - g) A document containing the flexibility analysis procedure and results showing the forces and moments at various support points, anchors, equipment terminals etc. as elaborated before in this specification.
 - h) Procedure of shop and site tests, test reports and test certificates for all tests conducted at shop.
 - i) Quality assurance schedule, including report containing all pertinent details of the heat-treating cycle for all pipes, fittings, valves, specialties etc.
 - j) Detailed erection procedure for piping, valves, specialties and auxiliary equipment including complete details of welding of joints to be done at site. All necessary instructions/recommendation shall be given for satisfactory erection of piping, valves specialties and auxiliary equipment.
 - k) Erection, operation and maintenance manuals.

ANNEXURE-I

MATERIALS OF CONSTRUCTION FOR PIPING & FITTINGS

Materials used in piping, fittings & specialties shall be as stipulated in the IBR and various codes as specified. However, the following basic guidelines shall in any case be followed for pipe materials :

Service	Material, Equivalent/Superior to
i) Temp. Up to 410 Deg.C	Carbon Steel, ASTM A-106, Gr. B or C Seamless. ASTM A-105/ A-234 WPB/WPC
ii) Temp. Above 410 Deg.C to 510 Deg.C	Alloy Steel, ASTM A-335, P11 ASTM A-182 F11; A-234 WP11
iii) Temp. Above 510 Deg.C to 540 Deg.C	Alloy Steel, ASTM A-335, P22/P91 ASTM A-182 F22/F91; A-234 WP22/91
iv) Temp. Above 540 Deg.C to 600 Deg.C	Alloy Steel, ASTM A-335, P91 ASTM A-182 F91; A-234 WP91
v) Corrosive	Stainless Steel.

ANNEXURE-II
MATERIALS OF CONSTRUCTION FOR VALVES

Materials for Valves shall be equivalent/superior to the following, for non-corrosive services:

Working Class	Valves Size	Material	
		Body Bonnet Cover	Stem Hinge Pin
i) Temp. Up to 410°C	65 mm & above	ASTM A-216, Gr. WCBWCC	13% Cr. Steel (ASTM A-182, Gr. F6a)- min. hardness 200 HB
	50 mm & below	ASTM A-105	
ii) Temp. Above 410°C to 510°C	65 mm & above	ASTM A-217, Gr. WC6	ASTM A-182, Gr. F6a - min. hardness 200 HB
	50 mm & below	ASTM A-182, Gr. F11	
iii) Temp. Above 510°C to 540°C	65 mm & above	ASTM A-217, Gr. WC9	ASTM A-182, Gr. F6a - min. hardness 200 HB
	50 mm & below	ASTM A-182, Gr. F22	
iv) Temp. above 540°C to 600°C	65 mm & above	ASTM A-217, Gr. WC/C12	ASTM A-182, Gr. F6a - min. hardness 200 HB
	50 mm & below	ASTM A-182, Gr. F91	

Note : Non-return valves in corrosion service shall be swing check type, suitably lined.

218999/2021/PS-PFM-MAX

	TITLE: 5X800 MW YADADRI THERMAL POWER STATION	SPECIFICATION NO. PE-TS-417-155A-A001
		SECTION - II
		SUB-SECTION - II A
		REV.NO. 0 DATE:
	TECHNICAL SPECIFICATION FOR CONDENSATE POLISHING UNIT	

TECHNICAL SPECIFICATION FOR PRESSURE & STORAGE VESSEL

1.00.00 GENERAL

The following principal pressure and atmospheric vessels for the system has been covered in this part of specification.

1. Condensate Polisher Service vessels.
2. Condensate Polisher Resin Separation and Cation Regeneration vessel.
3. Condensate Polisher anion regeneration vessel.
4. Condensate Polisher mixed resin storage Vessel.
5. Alkali diluent Heating cum Storage Vessel.(hot water tank)
6. Activated carbon filter
7. Alkali Preparation Tank
8. Alkali Day Tank
9. Resin Injection Hopper
10. Acid Measuring Tank.
11. Acid Storage Tank
12. DM storage tank.
13. Alkali storage tank

1.01.00 Of these, the items specified from Sr. no. 1 to 6 shall be designed as pressure vessels and the rest shall be atmospheric vessels.

1.01.01 All other vessels, not specifically listed here, but required for the Bidder's system shall also meet the general requirements of this specification.

1.01.02 Process requirements of these vessels shall be governed by the requirements of the Condensate Polishing System, which will determine their design conditions. Following sections only indicate some of the minimum requirements which must be met, and the actual design of these vessels shall be better than these, if that is required from process considerations.

2.00.00 GENERAL DESIGN FEATURES**2.01.00 Design**

2.01.01 Design of all pressure vessels shall conform to ASME Section VIII or acceptable equivalent international standard. 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. Design pressure of condensate service vessels is indicated elsewhere in this specification. For all other pressure vessels, design pressure shall be at least 10 Kg/cm² (g) minimum or as per system design whichever is higher.

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- 2.01.02 Design of all vertical cylindrical atmospheric storage tanks containing water, acid, alkali and other chemicals shall conform to IS: 803.
- 2.01.03 Design of all horizontal cylindrical atmospheric storage tank containing water, acid, alkali and other chemicals shall conform to BS EN12285-2:2005.
- 2.01.04 Design temperature of all pressure vessels and 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.
- 2.01.05 In case, tank is subjected to vacuum; the same shall be taken care in designing the tank.
- 2.01.06 The design of Demineralised water storage tanks (Vertical type) shall conform to IS: 803. Supporting frame where required shall be in accordance with IS: 800. The tank shall be "Non-pressure" fixed roof type with atmospheric vents.
- 2.02.00 All vessels / tanks without inside rubber lining shall have a corrosion allowance of minimum 2 mm and mill allowance (minimum 0.3 mm) for shell and dished ends. Thinning allowance of 2 mm (minimum) shall be considered for dished end. Vessel / tanks ends shall be of dished design and constructed by forging, pressing or spinning process. Conical or flat ends shall not be accepted. All dished ends shall be stress relieved.
- 2.03.00 All the atmospheric tanks shall have sufficient free board above the "Level High"/"Normal Level" as the case may be. The overflow level shall be kept at least 30 cm or 10% of vessel height above the "Level High"/"Normal Level" for all the tanks except for the DM tanks for which a minimum height of 300 mm shall be provided over the "High Level". Further, a minimum 300 mm free board shall be provided above the top of overflow level to the top of the tank. Wall thickness of atmospheric tanks shall not be less than 6 mm.
- 2.04.00 Vessels coming under preview of IBR shall be designed accordingly.
- 2.05.00 Interior surfaces of all tanks shall be clear of stiffeners and other structural supports. Tanks shall be reinforced and stiffened externally as required.
- 2.06.00 All welds on inner tank surface 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. Inside weld seams shall be ground flush and smooth applicable for corrosion resistant coating or lining.
- 2.07.00 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, craters, high spots, sharp edges, and undercutting. Sharp edges shall be ground to a 3 mm minimum radius.
- 2.08.00 Weld splatter shall be removed.
- 2.09.00 All welding shall be performed by ASME qualified welders under Section-IX of ASME Boiler and Pressure Vessel code and welding electrodes shall be as per relevant Codes/Standards viz. AISC Section 1.17 etc.
- 2.10.00 The plates for cylindrical tanks shall be accurately formed in bending rolls to the diameters called for, and the completed shells be concentric and plump. Plates shall be cold-rolled by plate bending machine in a number of passes to true curvature and joined by welding.
- 2.11.00 Vessels seam shall be so positioned that they do not pass through vessel connections.

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3.00.00 MATERIAL OF CONSTRUCTION

3.01.00 All pressure vessels shall be fabricated from carbon steel plates as specified in datasheet A of this specification and lined internally. All atmospheric tanks shall be fabricated of material as specified in datasheet A and lined internally.

4.00.00 APPURTENANCES

4.01.00 Manholes

4.01.01 All the pressure vessels and horizontal type storage tanks shall be provided with manhole of 500 mm diameter minimum size, preferably at the top head, complete with cover plate, lifting handle, davit cap, nuts, bolts, gaskets etc. to ensure leak tightness at the test pressure.

4.01.02 The vertical type storage tanks shall be provided with a manhole of 500 mm dia on the top cover, if the diameter of the tank is 1200 mm or more. For the DM water storage tanks, manholes shall be provided as per IS:803.

4.01.03 All the vessels and tanks shall be normally provided with a six inch gasketed handhole located near the bottom of the straight side.

4.01.04 The required lining/coating for the inside surface of the manhole/handhole, nozzle and cover plate of the manhole/handhole shall be same as that of the respective vessel/tank.

4.01.05 Sight Glasses

All the vessels mentioned shall be provided with pad type sight glasses on their vertical sides. Locations of these sight glasses shall be as follows:

4.01.06 One with the centre line at the normal level of the bed top, and one near the bottom of the straight side, for each of these vessels.

4.01.07 In addition, item no. 1.00.00 shall be provided with sight glasses, with their center lines at each of the normal separated resin interfaces.

4.02.00 Lifting Lugs

All vessels of diameter 1200mm or greater shall be provided with a minimum of 4 lifting lugs. Smaller vessels shall be provided with at least 2 lifting lugs.

4.03.00 Vessels Supports

Adequate supporting arrangements like straps, saddles, skirt rings, or legs of steel shall be provided to transfer all loads to the respective skid structures.

4.04.00 Vessel Internals

The internals for pressure Vessels shall be designed for a low pressure drop to promote uniform distribution and flow through the vessels and to withstand the full design pressure of the vessel in both directions.

Specification requirements for vessel internals are as follows:

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4.05.00 Inlet water and Regenerant Distributors

Hub and laterals with diffuser splash plates or header and perforated laterals. Material of construction shall be type 316 stainless steel, except for acid service which shall be of Hastelloy B.

4.06.00 Underdrains

Same as above with screened laterals with internal perforated pipes, and rubber-lined false bottom. For resin separation/regeneration/mixed resin vessels, it may have fully screened bottom (NEVA – clog type with para Septanurse screen, fully supported by subway grid, or equal).

4.07.00 For lined vessels, they shall also be lined in the same manner as the internal surfaces of these vessels. For the caustic diluent heating/storage tank, they shall be of type 304 stainless steel construction.

4.08.00 Internal Fasteners

All internal fasteners shall be of type 316 stainless steel and heavy duty locknuts shall be used throughout.

4.09.00 Piping Connections

All lined vessel connections and connections in unlined vessels 25 NB and larger shall be to ANSI 300 lb class. Flat face flanges shall be used throughout. Nozzle material shall be ASTM-A-106. Grade B. schedule 80 pipe. All flanged connections shall be supplied complete with matching counter flanges, nuts, bolts and full-face gaskets.

4.10.00 All vessel connections in unlined tanks smaller than 25 NB shall be screwed to ANSI 2.1 for schedule 80 pipe.

4.11.00 Resin Traps

Outlets of each of the condensate polisher service vessel and the waste effluent header of the common external regeneration facility, shall be provided with a resin trap. These resin traps shall be a minimum, conform to the following:

4.11.01 The resin trap shells shall be of steel construction and lined internally with saran or Polypropylene. The internals for all traps shall be johnson well screen type, of 316 stainless steel in both directions, resin traps located in processes effluent lines shall have a screen opening that does not exceed 120 percent of the associated process vessel under drain screen opening. Resin traps located in waste effluent headers shall have a screen opening of approximately 60 mesh.

4.11.02 Each resin trap shall be fully piped and valved for inplace manual back flushing.

5.00.00 SPECIFIC DETAILS

5.01.00 Alkali Diluent Heating – Storage Tank (Hot water tank)

hot water tank for heating of alkali diluent water with (2X60%) electric heating coil, of MOC as specified in sub section –IA of this specification shall be provided by bidder. The capacity of tank shall be minimum 20% higher than the maximum water demand. This tank shall be provided with burn out protection, pressure relief valve, level switches, temperature indicator etc. The heaters shall be sized for heating the water from a temperature of 15 to

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50 deg. C in 5 hours at the outlet of ejector.

All tank internals, including the inlet water tail pipe, shall be fabricated of type 304 stainless steel.

5.02.00 **Atmospheric Tanks**

Wall thickness of these tanks shall not be less than 6mm.

5.03.00 **Resin Injection Hopper**

The supplier shall provide a hopper type tank for resin make-up, using water slurry, to the condensate polishing systems. This make-up system will constitute a portion of the condensate polishing external regeneration system. The resin hopper shall have a conical bottom and a flat top. The top shall have a piano type hinged port, having a lifting handle, of sufficient size for easy resin loading. The resin shall discharge through a bottom connection to a water ejector for transport. Water shall be added to the hopper to assist in the resin transfer. The ejector discharge shall be to the resin separation-cation regeneration vessel. Demineralized water shall be used throughout for the resin transfer. Piping of the resin make-up system shall be the responsibility of the Bidder as a part of the external resin regeneration system.

a) **Capacity**

The resin make-up hopper tank shall be sized to handle up to 150 liters of as received new resin per single injection.

b) **Material**

The resin make-up hopper tank shall be fabricated of mild carbon steel having a minimum thickness of 6mm and lined.

5.04.00 **Chemical preparation and day tanks**

These shall be vertical cylindrical tanks. They shall be of carbon steel fabrication, lined and provided with full height level gauges right up to the overflow levels.

The alkali preparation tank shall be provided with a dissolving basket of type 316 stainless steel constructions, and a motorized slow speed stirrer mounted eccentrically to the tank by a bracket fixed to the side wall. The stirrer shall have impellers of type 316 stainless steel.

The alkali day tank shall be provided with an airtight cover complete with a breather arrangement, to prevent absorption of carbon dioxide from the atmosphere by the alkali solution contained in it. The overflow connection shall also be provided with a suitable seal for this purpose.

The tanks for ammonia solution (if applicable) shall also be provided with similar arrangements to prevent escape of ammonia vapour to outside.

5.05.00 **LINING**

All internal lining of vessels provided under this specification shall be of natural rubber, meeting the following minimum requirements.

5.05.01 **Hardness**

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Lining used may be soft rubber having a shore durometer reading or 65 on the A scale, or semi-hard rubber having a durometer reading of 65 on the A scale. Variations in hardness of the rubber lining between the different areas of a specific tank shall be within +/-5 durometer reading.

5.05.02 Chemical Resistance

The lining material shall be suitable for prolonged service in the chemical environment described below:

- Hydrochloric acid, 2 to 8% concentration, at temperature from 10 deg C to 50 deg C.
- Sodium hydroxide, 1 to 4% concentration, at temperature from 30 deg C to 50 deg C.
- 100 to 500 mg /l of sulphuric and hydrochloric acid combined. Ratio of concentration of these two acid 1 : 5 to 5 : 1 and temperatures from 10 deg C to 40 deg C.
- 1 to 10mg/l of sodium hydroxide at temperature from 10 deg C to 40 deg C.

The linings will be subjected to the condition (a) or (b) for intermittent periods of approximately one hour out of eight hours, and to conditions (c) or (d) remainder of the time.

5.05.03 Thickness

The lining shall be applied in three layers, resulting in a total thickness of not less than 4.5 mm anywhere on the internal surfaces of the vessels. The lining shall extend over the full face of all flanged connections and shall have a minimum thickness of 3 mm in all such external areas.

5.05.04 Surface Preparation

Prior to rubber lining all surfaces must be prepared in the following manner.

- Degrease surface prior to blasting.
- The surface is to be blasted with steel grit or sharp silica sand to a white and bright metal surface.
- All traces of grit and dust should be removed with a vacuum cleaner or by brushing. Care must be taken to avoid contaminating the surface.
- Immediately after blasting and removal of grit, the first coat of primer or cement shall be applied and allowed to dry.

5.05.05 Protection

After the lining is completed the vessels shall not be subjected to any prolonged exposure to direct sunlight in course of its transportation erection, etc. They shall not also be stored in direct sunlight. No further welding or burning shall be carried out on the vessel, after application of the lining.

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All lining projecting outside of the vessel, shall be protected adequately from mechanical damages during shipment, handling, storage etc.

Suitable warning, indicating the special care that must be taken with respect to these lined vessels, shall be stenciled on their outside surfaces with the letter at least 12mm high.

Example:

“Warning – Tank is lined”

“Do not weld or Burn”

“Do not Store in Direct Sunlight” etc.

6.00.00

CODES AND STANDARDS

The design, manufacture, shop testing, site fabrication and erection, testing and commissioning of the pressure and storage vessels shall conform to the latest revisions of the following standards, in addition to other standards mentioned elsewhere in the tender document subject to any modification and requirement, as specified here in after.

- | | | | |
|----|---------|---|--|
| a) | IS: 803 | - | Code of practice for design, fabrication and erection of Vertical Mild Steel cylindrical welded oil storage tanks. |
| b) | IS: 816 | - | Code of practice for use of metal arc welding for general construction in mild steel. |
| c) | IS: 817 | - | Code of practice for training and testing of metal arc welders. |
| d) | IS: 822 | - | Code of procedure for inspection of welds. |
| e) | IS:1363 | - | Black hexagonal bolts, nuts and locknuts (dia 6 to 39 mm) and black hexagon screws (dia to 24 mm). |
| f) | IS:1367 | - | Technical supply conditions for threaded fasteners. |
| g) | IS:2062 | - | Specification for weld able structural steel. |
| h) | IS:2002 | - | Steel plates for pressure vessels for intermediate and High temperature service including boilers. |
| i) | IS:2825 | - | Code of unfired pressure vessels. |
| j) | IS:3133 | - | Manhole and inspection opening for chemical equipment. |
| k) | IS:4049 | - | Specification for formed ends for tanks and pressure vessels. |
| l) | IS:4682 | - | Code of practice for lining of vessels and equipment for chemical processes Rubber Lining. |
| m) | BS:2594 | - | Specification for carbon steel welded horizontal cylindrical storage tanks. |
| n) | ASME | - | Boiler and pressure vessel Section VIII code. |

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o) ASTM - American Society for Testing and Materials.

7.00.00 FABRICATION

7.01.00 The vessel ends for storage tanks of vertical type shall have flat bottom. However, the ends of horizontal storage tanks, and all the pressure vessels shall be dished design of Tori-spherical type designed.

7.02.00 The plates to be used for fabrication shall preferably have a minimum width of 1500 mm.

7.03.00 All the joints (circumferential / longitudinal) shall be continuous butt welded, inside and outside. Connection shall be flush with inner surface of tanks and welded continuously on both sides of shell. Sharp inside edges shall be rounded to a minimum 3 mm radius.

7.04.00 Welding sequence shall be adopted in such a way so as to minimize the distortion due to welding shrinkage. Contractor shall indicate in his drawing the sequence of welding proposed by him which should meet prior approval of the engineers. 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.

7.05.00 All pressure vessels and storage tanks except Demineralised water (D.M.) shall be fabricated complete and tested at manufacturer's works to ensure better workmanship.

7.06.00 Tank Connections

7.06.01 Bidder shall furnish all pipe material required for tank connection for the process requirement. In addition to these, additional connections, if required by the Owner for the inter-connection of their piping, instrumentation etc. shall also be provided. Such additional requirement will be intimated to the successful Bidder later and Contractor shall provide these fittings to match with the Owner's items. Adequate pipe support attachments in the external surface of the tank/vessel shall be provided for Owners pipes for all the vessels/tanks. All lined vessels connections shall be conforms to ANSI 300 lb class. Nozzle material shall be ASTM-106 Grade B, Schedule 80.

7.06.02 All flanged connections should be supplied complete with matching counter flanges, nuts bolts and gasket materials. The flange design, (thickness and drilling etc.) shall match with the interconnected piping flanges.

7.06.03 Bolts and nuts to be used externally to the vessels shall be of hexagonal head conforming to IS:1367. However, internal fasteners if any, shall be of IS:316 /SS-304 or Hastalloy-B as per the duty conditions.

7.06.04 Gaskets shall be of full face type.

7.06.05 Sight glasses shall be provided for the tanks/vessels as specified in the standard 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.

7.07.00 Vessels Supporting Lifting Lugs

7.07.01 Adequate supporting arrangements like straps, saddles, skirt boards, pillars etc. shall be provided to transfer all loads to civil foundation. All foundation bolts, inserts etc. shall also be provided.

7.07.02 All vessels of internal, diameter of 1200 mm or greater shall be provided with minimum four

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(4) lifting lugs for safe and effective handling during erection. Smaller vessels shall be provided with at least two (2) lifting lugs.

- 7.07.03 Material of construction for these vessel supports, saddles, lugs shall conform to IS:2062 of tested quality.
- 7.08.00 **Special Accessories Storage Tanks**
- 7.08.01 Vessel internals wherever required shall be provided as detailed out elsewhere in the specification.
- 7.08.02 All the pressure vessels and tanks shall be provided with drain connections along with drain valves of suitable size. Further all the atmospheric storage tanks shall be provided with over flow connection designed for the filling rate of the respective tank.
- 7.08.03 All the pressure and 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 in the tank during maximum filling/drain-off rate. The maximum draw off rate for the DM storage tanks shall be intimated later to the successful bidder.
- 7.08.04 Various instrumentation and the fittings required for the same shall be supplied as elaborated in data sheets.
- 7.08.05 Water seal shall be provided for the overflow line of DM and degassed water storage tanks. The vent and overflow lines of alkali preparation /measuring / day tanks and vent line of DM storage tanks shall be provided with Carbon dioxide absorber of proven design to prevent contamination from atmospheric air. Carbon dioxide absorber shall preferably be located at ground level. The vent and overflow lines of Acid measuring tanks shall be provided with fume absorber using suitable packing material, such as pall rings/raschig rings.
- 7.08.06 Conservation vent valves shall be provided in the vent line of DM storage tanks so that, at a vacuum to the extent of 65 mm water column, the valve shall open to relieve the vacuum. Body and trim of the valve shall be Die Cast Aluminum.

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**TECHNICAL SPECIFICATION FOR
HORIZONTAL CENTRIFUGAL PUMPS**

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1.00.0 SCOPE

- 1.01.0 This specification covers the design, material, construction features, manufacture, inspection, testing the performance at the Vendor's/Sub-Vendor's Works and delivery to site of Horizontal Centrifugal Pumps.

2.00.00 CODES AND STANDARDS

- 2.01.0 The design, material, construction, manufacture inspection and performance testing of Horizontal Centrifugal Pumps shall comply with all currently applicable statutes, regulations and safety codes in the locality where the Equipment will be installed. Nothing in these specifications shall be construed to relieve the Vendor of this responsibility. The Equipment supplied shall comply with the latest applicable Indian Standards listed below. Other National Standards are acceptable, if they are established to be equal or superior to the Indian Standards.

2.02.0 List of Applicable Standards.

1	IS : 1520	Horizontal Centrifugal Pumps for clear cold fresh water.
2	IS : 5120	Technical requirements of roto dynamic special purpose pumps.
3	API : 610	Centrifugal pumps for general refinery service.
4	IS : 5639	Pumps Handling Chemicals & corrosion liquids.
5	IS : 5659	Pumps for process water.
6	HIS	Hydraulic Institute Standards, USA
7	ASTM-1-165-65	Standards Methods for Liquid Penetration Inspection.

- 2.03.03 In case of any contradiction with aforesaid standards and the stipulations as per the technical specifications as specified hereinafter the stipulations of the technical specifications shall prevail.

3.00.00 DESIGN REQUIREMENTS

- 3.01.00 The Pump shall be capable of developing the required total head at rated capacity for continuous operation. Also the pumps shall be capable of being operated to give satisfactory performance at any point on the HQ characteristics curve over the operating range of 40% to 120% of the duty point. The maximum efficiency of pump shall be preferably be within +/- 10% of the rated design flow as indicated in the data sheets.

- 3.02.00 The total head capacity curve shall be continuously rising from the operating point towards shut-off without any zone of instability and with a minimum shut-off head of 15% more than the design head.

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3.03.00 Pumps of a particular category shall be identical and shall be suitable for parallel operation with equal load division. The head Vs capacity and BHP Vs capacity characteristics should match to ensure even load sharing and trouble free operation throughout the range. Components of identical pumps shall be interchangeable.

3.04.00 Pumps shall run smoothly without undue noise and vibration. Peak to peak vibration limits shall be restricted to the following values during operation:

SPEED	Antifriction Bearing	Sleeve Bearing
1500 rpm and below	75.0 micron	75.0 micron

3.05.00 The noise level shall not exceed 85 dBA. Overall sound pressure level reference 0.0002 microbar (the standard pressure reference for air sound measurement) at a distance of 1 M from the equipment.

3.06.00 The pumps shall be capable of starting with discharge valve fully open and close condition. Motors shall be selected to suit to the above requirements. Continuous Motor rating (at 50 deg.C ambient) shall be atleast ten percent (10%) above the maximum load demand of the pump in the entire operating range to take care of the system frequency variation and no case less than the maximum power requirement at any condition of the entire characteristic curve of the pump.

3.07.00 The kW rating of the drive unit shall be based on continuously driving the connected equipment for the conditions specified. However, in cases where parallel operation of the pumps are specified, the actual motor rating is to be selected by the Bidder considering overloading of the pumps in the event of tripping of operating pump(s).

3.08.00 Pumps shall be so designed that pump impellers and other accessories of the pumps are not damaged due to flow reversal.

3.09.00 The Contractor under this specification shall assume full responsibility in the operation of pump and motor as a unit.

4.00.0 DESIGN CONSTRUCTION

4.01.00 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 shall be referred to.

4.02.0 Pump Casing

4.02.01 Pump casing shall have axially or radially split type construction. The casing shall be designed to withstand the maximum shut-off pressure developed by the pump at the pumping temperature.

4.02.02 Pump casing shall be provided with a vent connection and piping with fittings & valves. Casing drain as required shall be provided complete with drain valves, piping and plugs. It shall be provided with a connection for suction and discharge pressure gauge as standard feature. It shall be structurally sound to provide housing for the pump assembly and shall be designed hydraulically to minimum radial load at part load operation.

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4.03.00 Impeller

4.03.01 Impeller shall be closed, semi-closed or open type, and it shall be designed in conformance with the detailed analysis of the liquid being handled.

4.03.01 The impeller shall be secured to the shaft, and shall be retained against circumferential movement by keying, pinning or lock rings. On pumps with overhung shaft, impellers shall be secured to the shaft by a lockout or cap screw which tightness in the direction of normal rotation.

4.04.00 Impeller/Casing Wearing Rings

4.04.01 Replaceable type wearing rings shall be provided at suitable locations of pumps. Suitable method of locking the wearing ring shall be used. Wearing rings shall be provided in pump casing and/or impeller as per manufacturer's standard practice.

4.05.00 Shaft

4.05.01 The critical speed shall be well away from the operating speed and in no case less than 130% of the rated speed.

4.05.02 The shaft shall be ground and polished to final dimensions and shall be adequately sized to withstand all stresses from rotor weight, hydraulic loads, vibration and torques coming in during operation.

4.06.00 Shaft Sleeves

4.06.01 Renewable type fine finished shaft sleeves shall be provided at the stuffing boxes/mechanical seals. Length of the shaft sleeves must extend beyond the outer faces of gland packing of seal end plates so as to distinguish between the leakage between shaft and shaft sleeve and that past the seals/gland.

4.06.02 Shaft sleeve shall be fastened to the shaft to prevent any leakage or loosening. Shaft and shaft sleeve assembly should ensure concentric rotation.

4.07.00 Bearings

4.07.01 Heavy duty bearings, adequately designed for the type of service specified in the enclosed pump data sheet and for long, trouble free operation shall be furnished

4.07.02 The bearings offered shall be capable of taking both the radial and axial thrust coming into play during operation. In case, sleeve bearings are offered additional thrust bearings shall be provided. Antifriction bearings of standard type, if provided, shall be selected for a minimum life 16,000 hrs. of continuous operation at maximum axial and radial loads and rated speed.

4.07.03 Proper lubricating arrangement for the bearings shall be provided. The design shall be such that the bearing lubricating element does not contaminate the liquid pumped. Where there is a possibility of liquid entering the bearings suitable arrangement in the form of deflectors or any other suitable arrangement must be provided ahead of bearings assembly.

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4.07.04 Bearings shall be easily accessible without disturbing the pump assembly. A drain plug shall be provided at the bottom of each bearings housing.

4.08.00 Stuffing Boxes

4.08.01 Stuffing box design should permit replacement of packing without removing any part other than the gland.

4.08.02 Stuffing boxes of packed ring construction type shall be provided wherever specified. Packed ring stuffing boxes shall be properly lubricated and sealed as per service requirements and manufacturer's standards. If external gland sealing is required, it shall be done from the pump discharge. The Bidder shall provide the necessary piping valves, fittings etc. for the gland sealing connection.

4.09.00 Mechanical Seals

4.09.01 Wherever specified in pump data sheet, mechanical seals shall be provided. Unless otherwise recommended by the tenderer, mechanical seals shall be of single type with either sliding gasket or bellows between the axially moving face and shaft sleeves or any other suitable type. The sealing faces should be highly lapped surfaces of materials known for their low frictional coefficient and resistance to corrosion against the liquid being pumped.

4.09.02 The pump supplier shall coordinate with the seal maker in establishing the seal chamber of circulation rate for maintaining a stable film at the seal face. The seal piping system shall form an integral part of the pump assembly. For the seals under vacuum service, the seal design must ensure sealing against atmospheric pressure even when the pumps are not operating. Necessary provision for seal water supply along with complete piping fittings and valves as required shall form integral part of pump supply.

4.10.00 Pump Shaft Motor Shaft Coupling

4.10.01 The pump and motor shafts shall be connected with an adequately sized flexible coupling of proven design with a spacer to facilitate dismantling of the pump without disturbing the motor. Necessary coupling guards shall also be provided.

4.11.00 Base Plate

4.11.01 A common base plate mounting both for the pump and motor shall be provided. The base plate shall be fabricated steel and of rigid construction, suitably ribbed and reinforced. Base plate and pump supports shall be so constructed and the piping unit so mounted as to minimize misalignment caused by mechanical forces such as normal piping strain, internal differential thermal expansion and hydraulic piping thrust. Suitable drain troughs and drip lip shall be provided.

4.12.00 Assembly and Dismantling

4.12.01 Assembly and dismantling of each pump with drive motor shall be possible without disturbing the grouting base plate or alignment.

4.13.00 Drive Motor (Prime Mover)

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- 4.13.01 The kW rating of the drive shall be based on continuously driving the connected equipment for the conditions specified. In case, where parallel operation of the pumps are specified, the actual motor rating is to be selected by the tenderer considering overloading of the pumps in the event of tripping of operating pumps.

5.00.00 TESTING FOR HORIZONTAL CENTRIFUGAL PUMPS

The manufacturer shall conduct all tests required to ensure that the equipment furnished shall conform to the requirements of this specification and in compliance with the requirement of applicable Codes and Standards. The particulars of the proposed tests shall be submitted to the Owner for approval before conducting the tests.

5.01.00 Hydrostatic Tests

All pressure parts shall be hydraulically tested at 200% of pump rated head or at 150% shut off head whichever is higher. The test pressure shall be maintained for 1/2 hr. and no leakage shall be permitted. While arriving at the above pressure, the maximum suction head specified in Data Sheet shall be taken into account.

5.02.00 Performance Tests

- 5.02.01 All the pumps shall be tested in the Manufacture's Works at rated speed for capacity, efficiency and brake horse power. Pumps shall be given running test over the entire operating range covering from the shut off head to the maximum flow. The duration of test shall be minimum one (1) hour. A minimum of seven readings approximately equidistant shall be taken for plotting the curves with one point at design flow. Testing of pumps shall be in accordance with stipulations of Hydraulic Institute Standards or as applicable equivalent
- 5.02.02 The test shall be preferably conducted with the actual motor being furnished.
- 5.02.03 Only those pumps shall be subjected to strip down examination visually to check for mechanical damages after testing at shop in case abnormal noise level and excessive vibration is observed during the performance test. Otherwise strip down examination is limited to bearing inspection only.
- 5.02.04 The pump accessories e.g. the thrust bearing, couplings etc. shall be subjected to tests as per manufacturer's standards.

5.03.00 Mechanical Balancing

All rotating components of the pumps shall be statically balanced. In addition to static balancing, rotating components of the pumps shall be balanced dynamically at or near the operating speed. Tenderer shall furnish acceptance norm for this test.

5.04.00 Visual Inspection

Pumps shall be offered for visual inspection by the bidder before shipment. The components of the pumps shall not be painted before inspection.

5.05.00 NPSH Test

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NPSH test shall be conducted with water as medium if required. NPSH shall not be mandatory in case type test certificates are furnished for the similar rating of pumps.

5.06.00 Noise and Vibration Measurement

Noise and vibration shall be measured during the performance testing at shop as well as during the site test.

- 5.06.01 The noise level shall not exceed 85 dBA. Noise level measurement will be made as per applicable internationally acceptable standard. The measurement shall be carried out with calibrated integrating sound level meter meeting the requirement of IEC:651 or BS:5969 or IS:9779. Sound pressure level will be measured all round the pump and motor set at a distance of one meter from the nearest surface of the machine and at a height of 1.5 m from the floor level. A minimum of six (6) points should be covered for measurement. The measurement shall be done with a slow response on the A-weighted scale. The average of the A-Weighted sound pressure measurements expressed in decibels to a reference 0.0002 microbars shall not exceed the specified value.

The tests shall be carried out on the machine operating at rated speed and as near as possible to the rated power. Corrections for background noise and correction on account of test environment will be considered in line with applicable standard. For this purpose all the additional data required should necessarily be collected during the test.

- 5.06.2 Vibration check will also be done as per HIS. Vibration would be checked at thrust bearing locations on horizontal, radial and vertical direction. The acceptance limits would be as per HIS. The instrument used would be IRD 308 or equivalent with velocity pick-up. Vibration limits to be specified as per the speed of the pump.

5.07.00 Material Test Certificate

- 5.07.01 Material of the various pump components shall be tested in accordance with the relevant standards. Test certificates for these shall be furnished for the Owner's approval.
- 5.07.02 Where stage inspection is desired by BHEL/customer all material test certificates shall be correlated and verified with the actual material used for construction before starting fabrication by BHEL/customer's inspector who will stamp the material. In case mill test certificate for the material are not available, the supplier shall carry out physical and chemical tests at his own cost from a testing agency, approved by BHEL/Customer, as per the requirement of specified material standard. The sample for physical and chemical testing shall be drawn up in presence of BHEL/Customer's inspector who shall also witness the testing.

5.08.00 Non Destructive Testing

- (a) UT shall be carried out on shafts of diameter more than 50 mm.
- (b) DP tests shall be carried out on shaft and impeller.
- (c) No weld repair shall be allowed on cast iron.

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5.09.00 Field Testing

- 5.09.01 After installation, the pumps offered shall be operated to prove satisfactory performance as individual equipment as well as a system run. If the performance at site is found not to the requirements then the equipment shall be rectified or replaced by the Vendor, at no extra cost to the Owner. The procedure of the above testing will be mutually agreed between the Owner and the contractor. Noise and vibration tests shall also be repeated at site.
- 5.09.02 Based on observation of the trial operation, if modifications and repairs are necessary, the same shall be carried out by the contractor to the full satisfaction of the engineer and then the performance and guarantee tests to be repeated at site as per relevant clauses of the specification.

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TECHNICAL SPECIFICATION FOR METERING PUMPS

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		SUB-SECTION - II A
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1.00.0 GENERAL

- 1.01.01 Specification cover the design, material, construction features, manufacture, inspection, testing the performance at the vendor's/sub-vendor's works, delivery to site, erection, commissioning and testing of metering pumps.

2.00.0 GENERAL DESIGN FEATURES

- 2.00.01 Pumps shall be simplex positive displacement hydraulically operated diaphragm design, driven by squirrel cage induction motor through suitable speed reduction unit. Maximum pump stroke speed shall not exceed 100 per minute.
- 2.00.02 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 by manual control facility (micrometric adjusting type) to be provided locally for each of the pump.
- 2.00.03 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 by manual control facility (micrometric adjusting type) to be provided locally for each of the pump.
- 2.00.04 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.
- 2.00.05 Pumps shall be provided with an integral relief valve, spring operated to release pressure when delivery line blockage occurs.
- 2.00.06 Crankcase shall be constructed of high quality cast iron, which will also house the gearbox and guides of cross head.
- 2.00.07 Guided, controlled travel, double-ball check valves or equivalent, shall be provided both on the suction and discharge side.
- 2.00.08 Material of construction of the various parts shall be as per the details furnished elsewhere in the specification. However all parts coming in contact with acid shall be of Haste alloy 'B' and for alkali it should be of SS-316 only.
- 2.00.09 Suitable gland seal shall be provided to prevent leakage.
- 2.00.10 Electric drive motor particulars should follow enclosed electrical chapters.

3.00.00 TESTING

3.01.00 Testing and Inspection at Manufacturer's Works

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- 3.01.01 The manufacturer shall conduct all tests required 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 Owner for approval before conducting the tests.
- 3.01.02 The Owner's representatives shall be given full access to all tests for which the Manufacturer shall inform the Owner allowing adequate time so that if the Owner so desires, his representatives can witness the test.
- 3.01.03 All materials and castings used for the equipment shall be of tested quality. The test certificates shall be made available to Owner.
- 3.01.04 The pump casing shall be hydraulically tested at 200% pump operating pressure or 150% of design pressure whichever is higher. The test pressure shall be maintained at least for ½ an hour.
- 3.01.05 The rotating parts of pump drive shall be subjected to static balancing.
- 3.01.06 All pumps shall be tested at the shop for capacity, volumetric accuracy, repetitive accuracy, power and volumetric efficiency. The tests are to be done according to the requirements of the "Hydraulic Institute" of U.S.A. and Indian Standards as applicable.
- 3.01.07 The pump accessories e.g. gear box, speed reduction unit etc. will be subjected to tests as per manufacturer's standards. The test results shall be furnished to the Owner.
- 3.01.08 The combined variation of the pump and motor should be restricted within limits specified by Hydraulic Institute Standard, USA when the pump operated singly or in parallel.
- 3.01.09 All pumps shall be subject to strip down examination visually to check for mechanical damages after performance testing at shop.
- 3.01.10 Diaphragm of the metering pump shall be type tested as per applicable code/standard.
- 3.01.11 Performance test shall be carried out for the setting of pressure relief valve.
- 3.01.12 Test reports and certificates of all the above-mentioned tests to ensure satisfactory operation of the system shall be submitted to the Owner for approval before dispatch.

3.02.00 Test at Site

After erection at site pumps as detailed under different groups shall be operated to prove satisfactory performance as individual equipment as well as a system. If the performance at site is found to be not to the requirements, then the equipment shall be rectified or replaced by the Vendor at no extra cost to the Owner.

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**TECHNICAL SPECIFICATION
FOR
VERTICAL CENTRIFUGAL PUMPS**

	TITLE:	SPECIFICATION NO. PE-TS-417-155A-A001
	5X800 MW YADADRI THERMAL POWER STATION	SECTION - II
		SUB-SECTION - II A
		REV.NO. 0 DATE :
	TECHNICAL SPECIFICATION FOR CONDENSATE POLISHING UNIT	

1.00.00 GENERAL INFORMATION

1.01.00 The general guidelines as illustrated in the subsequent clauses of this section shall be applicable for vertical pumps to be procured under the scope of this package.

2.00.00 CODES AND STANDARDS

2.01.00 In addition to the requirements spelt out elsewhere in the specification, the equipment to be provided under this section shall specifically conform to the following codes, standards, specifications and regulations, as applicable, including all the latest amendments subsequent to the year of publication as mentioned below.

2.01.01 IS 1710/1989: Vertical Turbine Pumps for Clear, Cold and Fresh Water.

2.01.02 IS 5120/1977: Technical requirements - Rotodynamic special purpose pumps.

2.01.03 IS 5639/1970: Pumps for handling chemical and corrosive liquids.

2.01.04 IS 5659/1970: Pumps for process water.

2.01.05 IS 6536/1972: Pumps handling volatile liquids.

2.01.06 IS 9137/1978: Code for acceptance for centrifugal, mixed flow and axial
Flow pumps - Class 'C'

2.01.07 BS 5316: Acceptance tests for Centrifugal, mixed flow Part-I/1976 And axial flow pumps - Class 'C' Tests (ISO 2548/1973)

2.01.08 BS 5316: Acceptance tests for Centrifugal, mixed flow Part- II/1977 And axial flow pumps - Class 'B' Tests (ISO 3555/1977)

2.01.09 ANSI B 73.2M : Vertical inline centrifugal pumps for chemical process 1984

2.01.10 API 610/1989: Centrifugal pumps general refinery services.

2.01.11 Hydraulic Institute Standards of USA (1983).

2.01.12 PTC 8.2/1965: Power Test Codes - Centrifugal pumps.

3.00.00 Accessories:

All the pumps under this specification shall be complete with following standard/special accessories.

3.01.00 Standard accessories:

- a) Pump motor coupling along with coupling guard
- b) Common base plates for pump and motor.
- c) Lubrication system along with all internal piping, valves, fittings, specialties etc. as required.
- d) Counter flanges for suction/ discharge nozzles along with fixing nuts, bolts and gaskets.
- e) Anchor bolts, nuts, seating steel works, etc. as necessary for mounting the pump-motor unit on Civil foundations.
- f) Suitable vent (with valves)/ lifting/ handling attachments for the pump/ motor/ Accessories.
- g) Suitable drain connections with isolating valves as applicable.

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- h) Set of "Special" Tools & Tackles for Pumps and motors, if any.
- i) Erection and commissioning spares, "on as required" basis.
- j) Bidder shall provide various drawings, data, calculations, test reports/ certificates, Operation and maintenance manuals, As-built drawings, etc. as specified and as necessary.

3.02.00 Services included in Bidder's Scope:

3.02.01 The pumps shall be guaranteed to meet the performance requirements as specified vide datasheet – A and also for trouble free operation after commissioning.

4.00.00 TECHNICAL REQUIREMENTS:

4.01.00 The pumps shall be Electric motor driven.

4.02.00 The Pumps shall conform to HIS

4.03.00 Vertical type pumps with 1500rpm.

4.04.00 Minimum efficiency of vertical pump will be 40%.

4.05.00 No negative tolerance shall be permitted in rated capacity & TDH.

4.06.00 No negative tolerance shall be permitted in efficiency at rated capacity.

4.07.00 The shut off head of pumps shall be at least 115% of pump rated TDH.

4.08.00 The pumps shall be capable of developing the required total head at rated capacity for Continuous operation. The pumps shall operate satisfactorily at any point on the Q-H Characteristic curve over a range of 0% to 130% capacity and shall be suitable for Continuous operation between 30% to 130% capacity.

4.09.00 Selection of the pumps shall be such that the design point shall be met even with negative manufacturing tolerance.

4.10.00 The total head capacity curve shall be continuously rising towards the shut off, the pumps shall preferably be non-overloading type and stable.

4.11.00 The pumps shall be capable of running over the entire range of NPSH conditions required without any noise, vibration or cavitations.

4.12.00 The pumps shall be of stiff shaft design. The minimum internal clearances should be sufficiently more than the max. Static deflection of the shaft. Shaft size selected must take into consideration the critical speed as specified in API-610.

4.13.00 Pumps and motors shall run smooth without undue noise and vibration. The vibration shall be within 75 microns for pump - motor set. The noise level shall be limited to 85 dB at distance of 1.0M.

4.14.00 High reliability of the pumps is an essential requirement and therefore it gets weight age over its efficiency. It is therefore essential that the bidder choose a standard proven model from the range of pumps manufactured.

4.15.00 If water handled by pump is dirty/ not suitable for lubrication/ cooling, the bidder shall provide requisite strainer/ filters, tanks, motorized valves, etc. after the tap off for the required service, the arrangement provided shall be subject to Purchaser's approval.

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5.00.00 OTHER REQUIREMENTS:

5.01.00 The materials of construction for various components specified are the minimum Requirements indicated in datasheet – A section C and materials of construction for other components not specified shall be similarly selected by the bidder for the intended duty.

6.00.00 PAINTING FOR PUMPS:

- a) The surface of SS, Gun metal, brass, bronze and non metallic component shall not be applied with any painting.
- b) The Steel surface to be applied with painting shall be thoroughly cleaned before applying painting by brushing, shop blasting etc. as per the agreed procedure.

For all the steel surfaces inside the (indoor installation) building, a coat of red oxide primes of min. thickness of 50 microns followed up with under coat of Synthetic Enamel paint of min. thickness of 50 microns shall be applied. the top coat shall consist of two coats each of min. thickness of 50 microns of synthetic enamel paint and thus total thickness shall be min. 200 microns.

7.00.00 PERFORMANCE REQUIREMENTS

7.01.00 Pump (s) shall preferably be designed to have the best efficiency at the specified duty point. Further, the pumps (s) shall be suitable for continuous operation at any point within its 'range of operation'.

7.02.00 Under all circumstances, the 'range of operation' of the pump (s) shall exclude any Unstable operating zone of the head-capacity curve.

8.00.00 DESIGN AND CONSTRUCTION

Pumps shall be of vertical shaft, complete with bowl, column pipe, discharge head and base plate with all accessories. General design and constructional features of the pumps shall be as follows:

8.01.00 BOWL ASSEMBLY

8.01.01 This will be either a single, mixed flow or axial flow type with discharge co-axial with shaft. Type of impeller shall be chosen on the basis of the pump specific speed and the characteristics of handling fluid.

8.02.00 IMPELLER SHAFT, LINE SHAFT AND HEAD SHAFT

8.02.01 Shaft size shall be selected on the basis of maximum torque to be applied on the pump shaft. Critical speed of the shaft shall be sufficiently away from the pump operating speed and in no case shall lie between 90% and 110% of the rated speed.

8.02.02 Impeller shaft shall be guided by bearings provided in each bowl or above and below the impeller shaft assembly. The butting faces of the shaft shall be machined square to the assembly and the shaft shall chamfer at the edges.

8.02.03 Line shaft may be single or multiple pieces as required. In case of multiple pieces, line shaft shall be coupled as per the standard practice of the manufacture. For screwed coupling, directions shall permit tightening of the joint during pump operation.

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8.02.04 Replaceable shaft sleeves shall be furnished at applicable location, particularly under stuffing box and at other locations, as considered necessary.

8.03.00 BEARINGS

8.03.01 SHAFT BEARINGS

Adequate number of properly designed bearings shall be provided for smooth and trouble free operation of the pump. Number of bearings shall consider the number of shaft pieces used and the critical speed of the shaft. Bearings shall be either lubricated by external clear water/oil/grease or self-lubricated. In case of external water/oil lubrication, complete lubrication arrangement shall be furnished with the pump.

8.03.02 THRUST BEARING

Thrust bearing of adequate size and capacity shall be provided to take the vertical thrust of the impeller arising out of the pump operation and dead weight of the rotating Components. Life of the thrust bearing shall be guided by the design standard of the pump. Thrust bearing shall be capable of running continuously at maximum load. Thrust bearing shall be either grease or oil lubricated. Lubrication arrangement shall be such that the lubricant does not contaminate the handling fluid. The arrangement shall also be adequate to protect the bearing, while the pump coast down to stop in case of power failure of the station. Pre-lubrication of the thrust bearing, if recommended by the pump manufacturer, shall be taken care of in designing the lubrication system. Cooling of the thrust bearing, if necessary, shall be done by the handling fluid/external Water, depending on the fluid handled. Location of the thrust bearing may be at the pump body or at the driver, or at both depending on the requirement.

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SECTION – II

GENERAL TECHNICAL REQUIREMENTS

SUB-SECTION IIB - GENERAL TECHNICAL REQUIREMENTS (ELECTRICAL)

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	TITLE	MOTOR DATA SHEET - C	SPECIFICATION NO.
			VOLUME II B
			SECTION D
			REV NO. 00 DATE
			SHEET 19 OF 33

S. No.	Description		Data to be filled by successful bidder
A.	General		
1	Manufacturer & country of origin		
2	Motor type		
3	Type of starting		
4	Name of the equipment driven by motor & Quantity		
5	Maximum Power requirement of driven equipment		
6	Rated speed of Driven Equipment		
7	Design ambient temperature		
B.	Design and Performance Data		
1	Frame size & type designation		
2	Type of duty		
3	Rated Voltage		
4	Permissible variation for		
5	a	Voltage	
6	b	Frequency	
7	c)	Combined voltage & frequency	
8	Rated output at design ambient temp (by resistance method)		
9	Synchronous speed & Rated slip		
10	Minimum permissible starting voltage		
11	Starting time in sec with mechanism coupled		
12	a) At rated voltage		
13	b) At min starting voltage		
14	Locked rotor current as percentage of FLC (including IS tolerance)		
15	Torque		
	a) Starting		
	b) Maximum		
16	Permissible temp rise at rated output over ambient temp & method		
17	Noise level at 1.0 m (dB		
18	Amplitude of vibration		
19	Efficiency & P.F. at rated voltage & frequency		
	a) At 100% load		
	c) At 75% load		

NAME OF VENDOR			SEAL	REV.	
NAME	SIGNATURE	DATE			

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	TITLE	MOTOR DATA SHEET - C	SPECIFICATION NO.
			VOLUME II B
			SECTION D
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S. No.	Description	Data to be filled by successful bidder
	c) At starting	
C.	Constructional Features	
1	Method of connection of motor driven equipment	
2	Applicable Standard	
3	DOP of Enclosure	
4	Method of cooling	
5	Class of insulation	
6	Main terminal box	
	a) Type	
	b) Power Cable details (Conductor, size, armour/unarmour)	
	c) Cable Gland & lugs details (Size, type & material)	
	d) Permissible Fault level (kArms & duration in sec)	
7	Space heater details (Voltage & watts)	
8	Flame proof motor details (if applicable)	
	a) Enclosure	
	b) suitability for hazardous area	
	i Zone	O / I / II
	ii Group	IIA / IIB / IIC
9	No. of Stator winding	
10	Winding connection	
11	Kind of rotor winding	
12	Kind of bearings	
13	Direction of rotation when viewed from NDE	
14	Paint Shade & type	
15	Net weight of motor	
16	Outline mounting drawing No (To be enclosed as annexure)	
D.	Characteristic curves/ drawings (To be enclosed for motors of rating $\geq 55\text{KW}$)	
	a) Torque speed characteristic	
	b) Thermal withstand characteristic	
	c) Current vs time	
	d) Speed vs time	

NAME OF VENDOR			SEAL	REV.	
NAME	SIGNATURE	DATE			

Explanatory notes for filling up cable list for routing through WinPath, the cable routing program (developed by Corporate R&D) being used in PEM.

1. For the purpose of clarity, it may please be noted that the information given in regard to the cables to be routed through WinPath as per the system elaborated below is called "Cable List", while the term "Cable Schedule" applies to the cable list with routing information added after routing has been carried out.
2. The cable list shall be entered as an MS Excel file in the format as per enclosed template EXT_CAB_SCH_FORMAT.XLS. No blank lines, special characters, header, footer, lines, etc. shall be introduced in the file. No changes shall be made in the title line (first line) of the template.
3. The field properties shall be as under:
 - a. UNITCABLENO: A/N, up to sixteen (16) characters; each cable shall have its own unique, unduplicated cable number. In case this rule is violated, the cable cannot be taken up for routing.
 - b. FROM: A/N, up to sixty (60) characters; the "From" end equipment/ device description and location to be specified here. Information in excess of 60 characters will be truncated after 60 characters.
 - c. TO: A/N, up to sixty (60) characters; the "To" end equipment/ device description and location to be specified here. Information in excess of 60 characters will be truncated after 60 characters.
 - d. PURPOSE: A/N, up to sixty (60) characters; the purpose (i.e. power cable/ indication/ measurement, etc.) to be specified here. Information in excess of 60 characters will be truncated after 60 characters.
 - e. REMARKS: A/N, up to forty (40) characters; Any information pertinent to routing to be specified here (e.g., cable number of the cable redundant to the cable number being entered). Information in excess of 40 characters will be truncated after 40 characters.
 - f. CABLESIZE: A/N, 7 characters exactly as per the codes indicated below shall be specified here. The program cannot route cables described in any other way/ format.
 - g. PATHCABLENO: Field reserved for utilization by the program. User shall not enter any information here.
4. One list shall be prepared for each system/ equipment (i.e., separate and unique cable lists shall be prepared for each system).
5. The cables shall be described as per the scheme listed below:

A	NN	A	NNN
Cable	No. of cores	Cable code	Cable size
Voltage	(e.g. 01,03,3H, 07)	(See C below)	(e.g. 035,185,2.5, 0.5)
Code (see B below)			

(A) SYSTEM VOLTAGE CODES:

(ac) A = 11KV, B = 6.6KV, C = 3.3KV, D = 415V, E = 240V, F = 110V
 (dc) G = 220V, H = 110V, J = 48V, K = +24V, L = -24V

(B) CABLE VOLTAGE CODES:

A = 11KV (Power cables)

Explanatory notes for filling up cable list for routing through WinPath, the cable routing program (developed by Corporate R&D) being used in PEM.

B = 6.6KV (Power cables)
 C = 3.3KV (Power cables)
 D = 1.1KV (LV & DC system power & control cables)
 E = 0.6KV (0.5 sq. mm. Control cables)

(C) CABLE CODES

PVC Copper

A = Armoured FRLS	B = Armoured Non-FRLS
C = unarmoured FRLS	D = Unarmoured Non-FRLS

PVC Aluminium

E = Armoured FRLS	F = Armoured Non-FRLS
G = unarmoured FRLS	H = Unarmoured Non-FRLS

XLPE Copper

J = Armoured FRLS	K = Armoured Non-FRLS
L = unarmoured FRLS	M = Unarmoured Non-FRLS

XLPE Aluminium

N = Armoured FRLS	P = Armoured Non-FRLS
Q = unarmoured FRLS	R = Unarmoured Non-FRLS

S = FIRE SURVIVAL CABLES
 T = TOUGH RUBBER SHEATH
 U = OVERALL SCREENED
 V = PAIRED OVERALL SCREENED
 W = PAIRED INDIVIDUAL SCREENED
 Y = COMPENSATING CABLES
 I = PRE-FABRICATED CABLES
 Z = JELLY FILLED CABLES

6. Once a cable list has been given to PEM for routing, any subsequent changes required in the cable list (which may be in the form of addition of cables, deletion of cables, change of type or size of cable, etc.) must be informed as specific changes (as a separate file MS Excel of the same format as the original file) to the cable list given earlier if the cable list has been routed and cable schedule generated. The routing status of the cable list shall be got confirmed from PEM by the agency that has prepared the cable list before the changes are intimated. In case PEM confirms that the cable list in question has not been taken up for routing, and the revised cable list is acceptable, the same may be sent. Since cable routing through the program involves adding each cable list to the project cable schedule database, the original cable schedule shall not be furnished to PEM with revisions incorporated within.

218999/2021/PS-PEM-MAX

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

SECTION – II

GENERAL TECHNICAL REQUIREMENTS

SUB-SECTION IIC - GENERAL TECHNICAL REQUIREMENTS (C&I)

218999/2021/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

C&I SPECIFICATION FOR CONDENSATE POLISHING SYSTEM

218999/2021/PS-PEM-MAX

FORM NO. PEM-6686-0



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

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

VOLUME

SECTION

REV. NO.

00

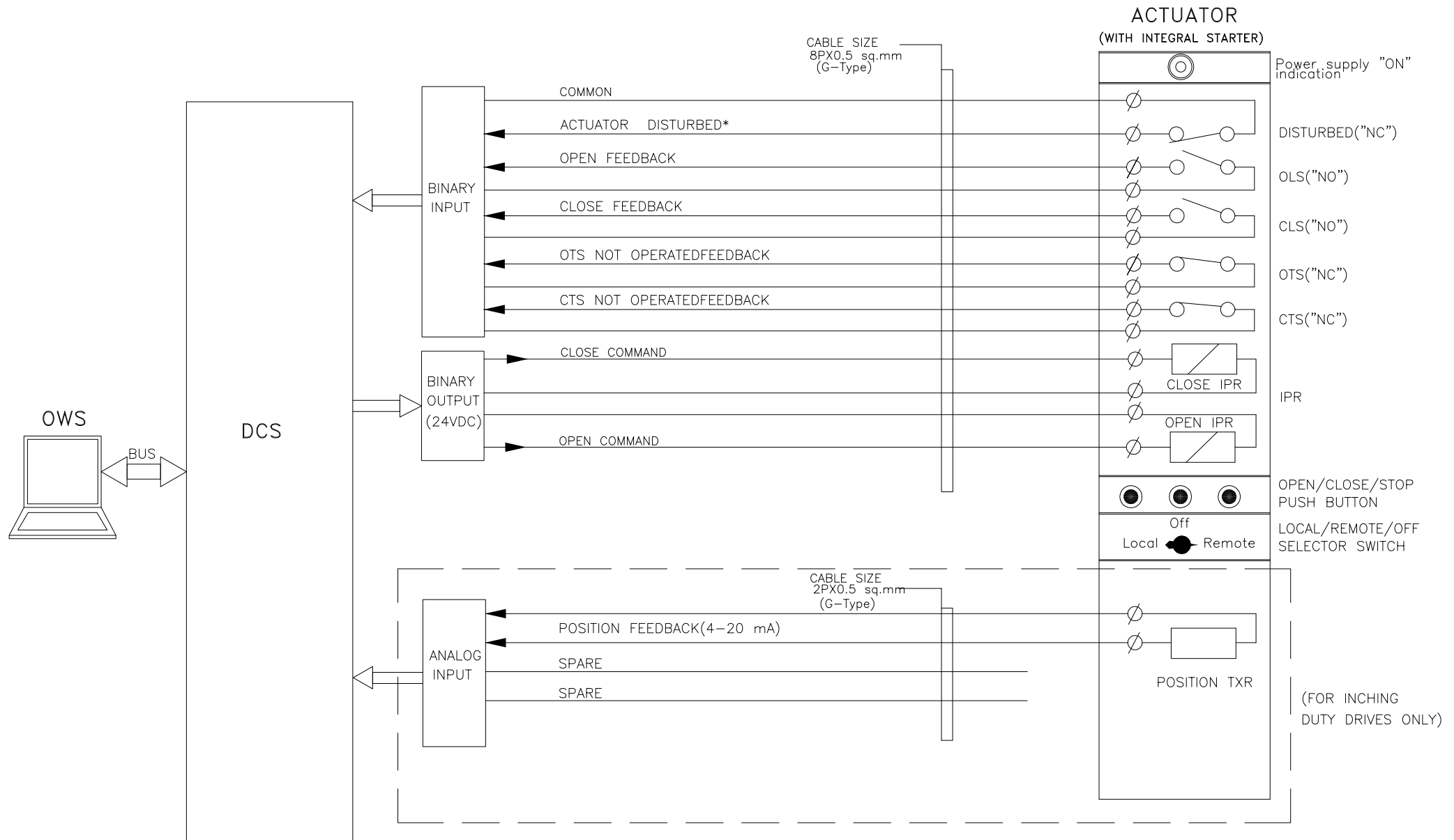
DATE : 03.04.2018

SHEET

OF

Drive Control Philosophy

DCS INTERFACE FOR BIDIRECTIONAL DRIVE (WITH INTEGRAL STARTER)



NOTE:

- * DISTURBED= Loss of Power supply (1 Phase/3 Phase)/
Loss of control supply/ Motor thermostat trip/
Thermal over load/Torque open/close cutoff
Local/Off/Remote Sel. switch
Stop PB optd.



PROJECT:

**5X800 YADADRI THERMAL POWER STATION
UNIT # 1 TO 5**

TITLE:

**DDCMS INTERFACE FOR
BIDIRECTIONAL DRIVE**

DRG.NO.

PE-DM-417-145-I002

DATE

06.12.2019

REV.NO.

03

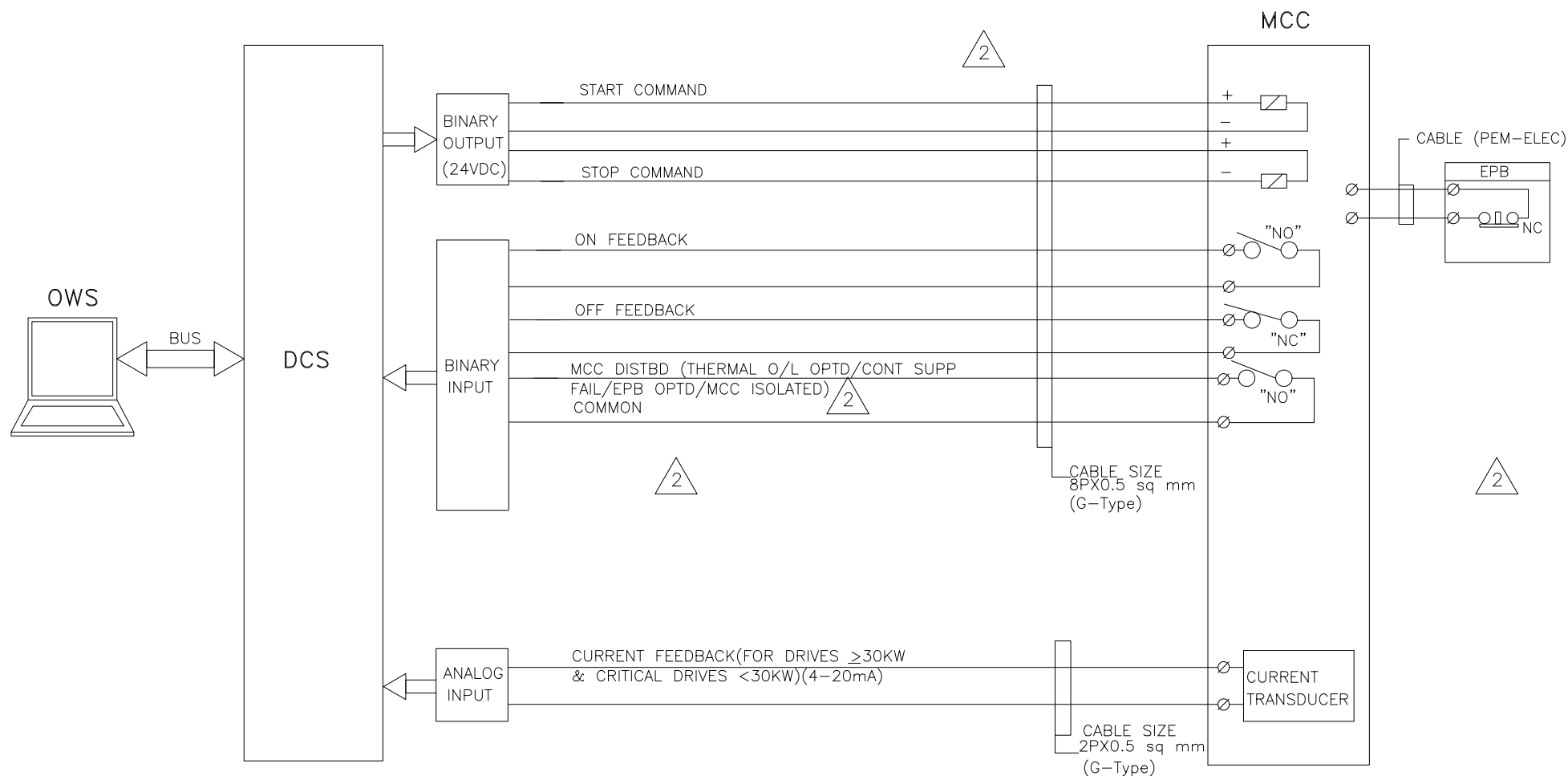
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OF 11

DCS INTERFACE FOR UNIDIRECTIONAL LT DRIVE



NOTE:-

1) EPB OF RESPECTIVE DRIVE WILL BE MOUNTED NEAR TO DRIVE ONLY.

2) 4-20mA CURRENT TRANSDUCER SHALL BE CONSIDERED. FOR LTUDs >30 KW AND IMPORTANT DRIVES, LUBE OIL PUMPS (REFER CLAUSE D, SHEET 6 OF 11)



PROJECT:

5X800 YADADRI THERMAL POWER STATION
UNIT # 1 TO 5

TITLE:

DDCMIS INTERFACE FOR
UNIDIRECTIONAL LT DRIVE

DRG.NO.

PE-DM-417-145-I002

DATE

06.12.2019

REV.NO.

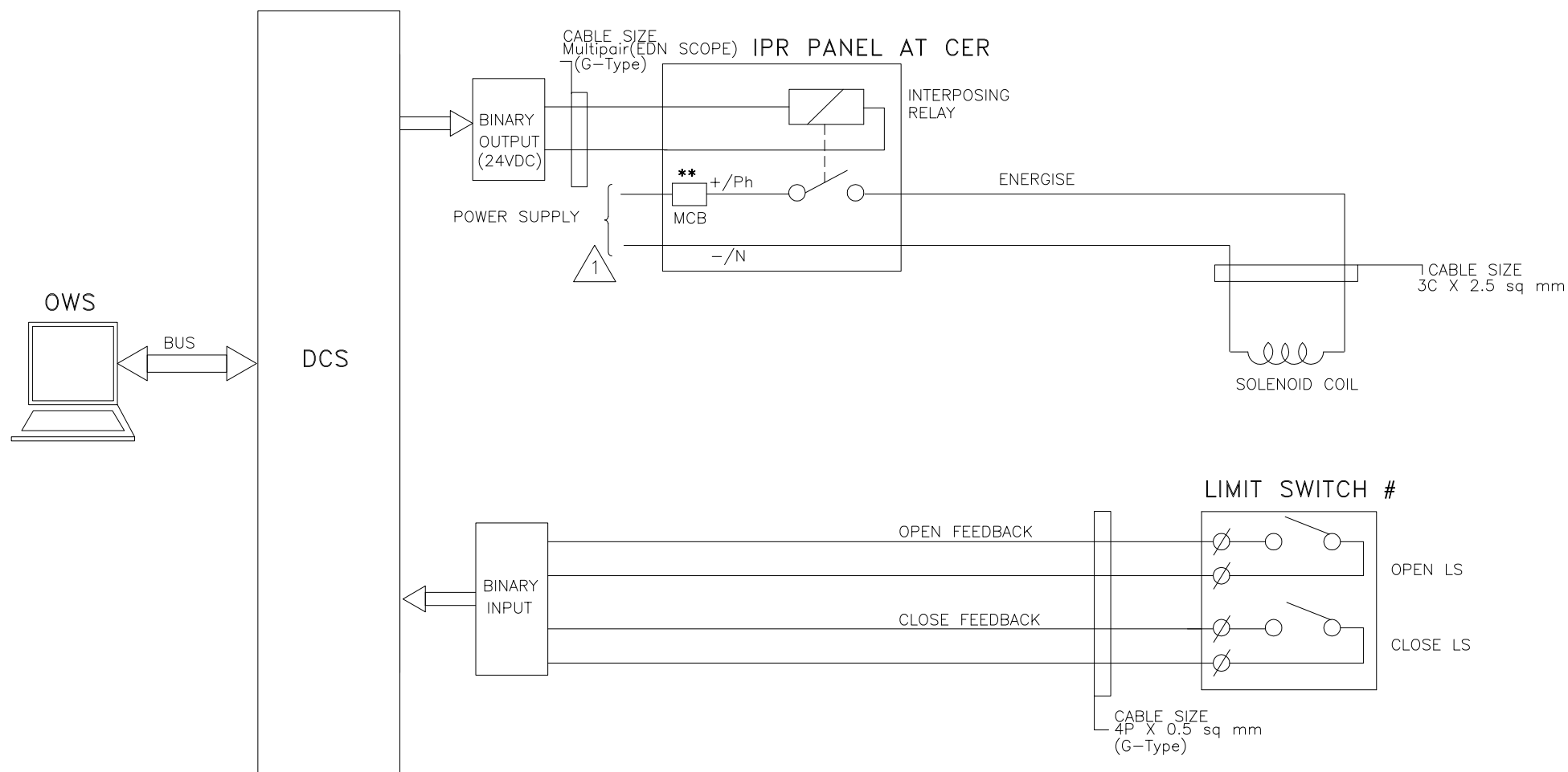
03

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DCS INTERFACE FOR SOLENOID DRIVE (24V DC / 240V AC UPS)



NOTES:

** MCB SHALL BE PROVIDED FOR EACH SOLENOID

FOR ON/OFF TYPE, SOLENOID ACTUATED CONTROL VALVE.



PROJECT:

5X800 YADADRI THERMAL POWER STATION
UNIT # 1 TO 5

TITLE:

DDCMIS INTERFACE FOR
SOLENOID DRIVE (SINGLE COIL)

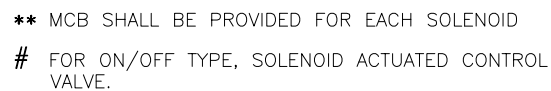
DRG.NO. PE-DM-417-145-I002

DATE 06.12.2019

REV.NO. 03

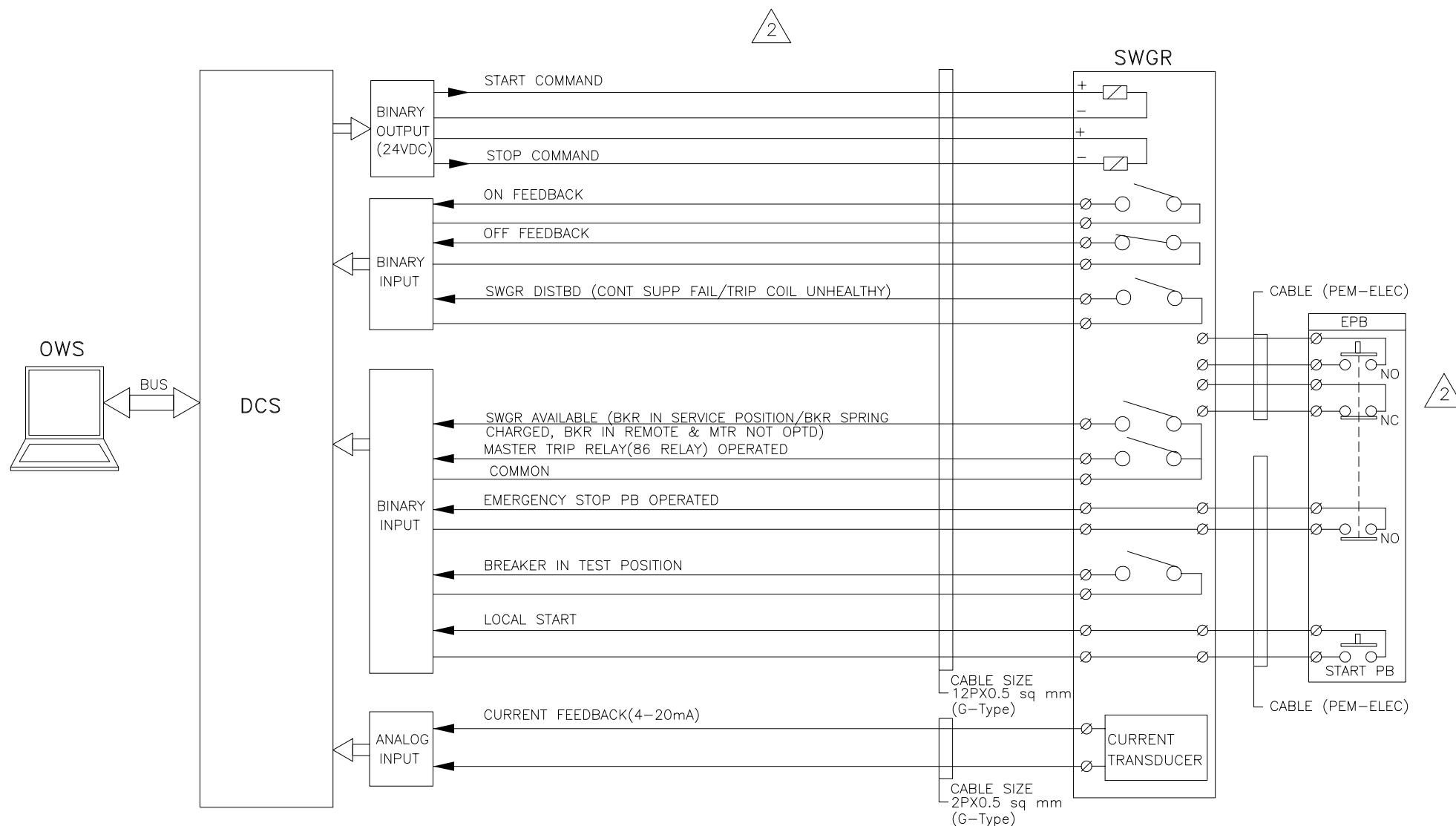
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CABLE SIZE
Multipair(EDN SCOPE) IPR PANEL AT CER
7(G-Type)



	PROJECT:	5X800 YADADRI THERMAL POWER STATION UNIT # 1 TO 5	DRG.NO.	PE-DM-417-145-I002
	TITLE:	DDCMS INTERFACE FOR SOLENOID DRIVE (DOUBLE COIL)	DATE	06.12.2019
			REV.NO.	03
			SHT	9a 561 of 669

DCS INTERFACE FOR HT/LT UNIDIRECTIONAL DRIVES(BREAKER OPERATED)



NOTE:-
EPB OF RESPECTIVE DRIVE WILL BE MOUNTED NEAR TO DRIVE ONLY.

1



PROJECT:

5X800 YADADRI THERMAL POWER STATION
UNIT # 1 TO 5

TITLE:

DDCMIS INTERFACE FOR
UNIDIRECTIONAL HT DRIVE

DRG.NO.

PE-DM-417-145-I002

DATE

06.12.2019

REV.NO.

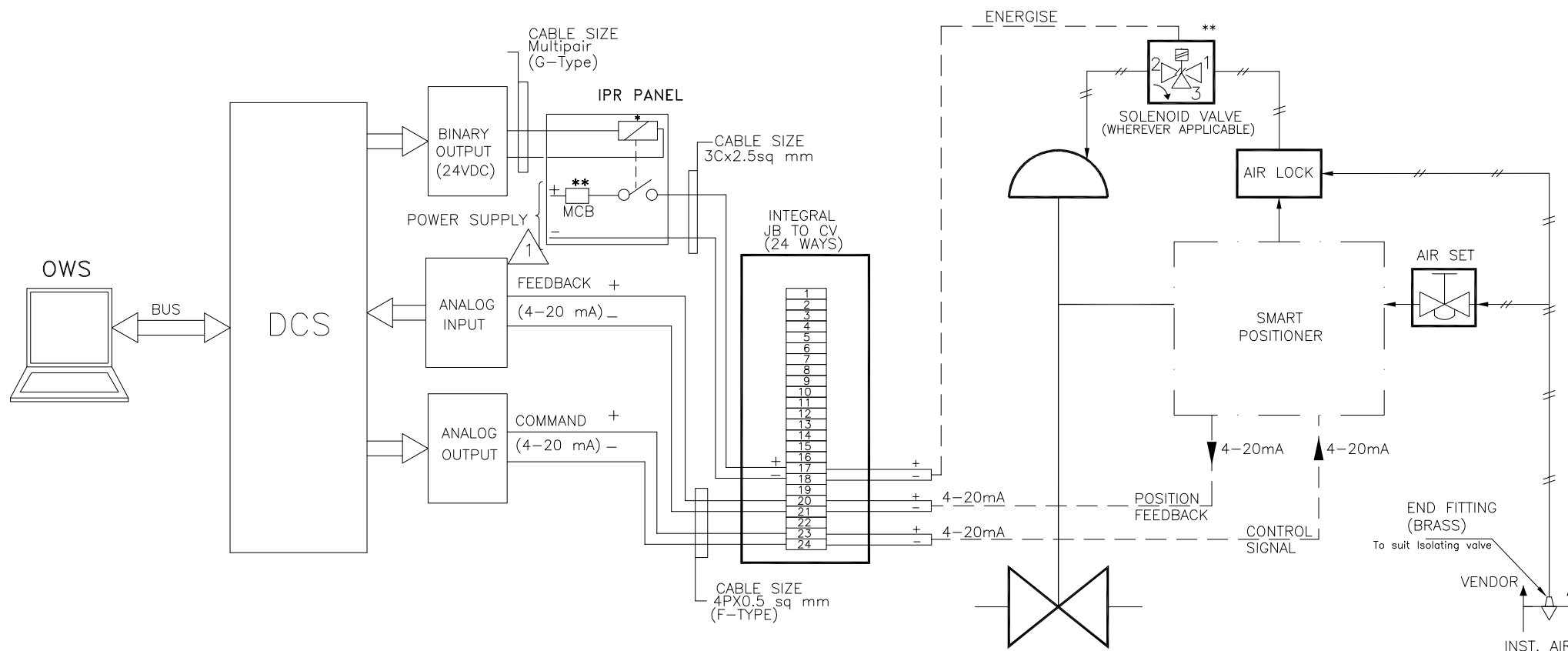
03

SHT

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DCS INTERFACE FOR ANALOG DRIVE (WITH SMART POSITIONER)



NOTES:

** APPLICABLE TO VALVES WHERE PROTECTION OPEN/CLOSE ACTION FOR CONTROL DEMAND OVERRIDING IS REQUIRED.



PROJECT:

5X800 YADADRI THERMAL POWER STATION
UNIT # 1 TO 5

TITLE:

TYPICAL HOOK-UP DIAGRAM
ANALOG DRIVE (WITH SMART POSITIONER)

DRG.NO. PE-DM-417-145-I002

DATE 06.12.2019

REV.NO. 03

SHT 11 OF 11

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218999/2021/PS-PEM-MAX

FORM NO. PEM-6686-0



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

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

VOLUME

SECTION

REV. NO.

00

DATE : 03.04.2018

SHEET

OF

ACTUATOR SPECIFICATION

VOLUME: V-A**SECTION-III****TECHNICAL SPECIFICATION
FOR
ELECTRIC MOTOR ACTUATORS****1.00.00 SCOPE**

1.01.00 This Section covers the general requirements of Electric Motor Actuators for valves/dampers.

1.02.00 All electric motor actuators shall be furnished in accordance with this general specification and the accompanying driven equipment specification. All the electrical actuators shall be INTEGRAL type only.

2.00.00 STANDARDS

2.01.00 All electrical equipment shall conform to the latest applicable IS, ANSI and NEMA Standards, except when stated otherwise herein or in driven equipment specification.

2.02.00 Major standards, which shall be followed, are listed below. Other applicable Indian Standards for any component part even if not covered in the listed standards shall also be followed

i) IS -9334

ii) IS-325

3.00.00 SERVICE CONDITIONS

3.01.00 The actuator shall be suitable for operation in hot, humid and tropical atmosphere, highly polluted at places with coal dust and/or fly ash.

3.02.00 Unless otherwise noted, electrical equipment/system design shall be based on the service conditions and auxiliary power supply given in the general specification.

3.03.00 For actuator motor installed outdoor and exposed to direct sun rays, the effect of solar heat shall be considered in the determination of the design ambient temperature.

4.00.00 RATING

4.01.00 For isolating service, the actuator shall be rated for three successive open-close operation of the valve/damper or 15 minutes, whichever is longer.

4.02.00 For regulating service, the actuator shall be suitably time-rated for the duty cycle involved with necessary number of starts per hour, but in no case less than 150 starts per hour.

5.00.00 PERFORMANCE

The actuator shall meet the following performance requirements:

- 5.01.00 Open and close the valve completely and make leak-tight valve closure without jamming.
- 5.02.00 Attain full speed operation before valve load is encountered and imparts an unseating blow to start the valve in motion (hammer blow effect).
- 5.03.00 Operate the valve stem at standard stem speed and shall function against design differential pressure across the valve seat.
- 5.04.00 The motor reduction gearing shall be sufficient to lock the shaft when the motor is de-energised and prevent drift from torque switch spring pressure.
- 5.05.00 The entire mechanism shall withstand shock resulting from closing with improper setting of limit switches or from lodging of foreign matter under the valve seat.

6.00.00 SPECIFIC REQUIREMENT**6.01.00 Construction**

- 6.01.01 The actuator shall essentially comprise the drive motor, torque/ limit switches, gear train, clutch, hand wheel, position indicator/ transmitter, in-built thermostat for over load protection, space heater and internal wiring.
- 6.01.02 The actuator enclosure shall be totally enclosed, dust tight, weather-proof suitable for outdoor use without necessity of any canopy. Degree of protection of enclosure for motor actuator shall be IP-65.
- 6.01.03 All electrical equipment, accessories and wiring shall be provided with tropical finish to prevent fungus growth.
- 6.01.04 The actuator shall be designed for mounting in any position without any lubricant leakage or operating difficulty.

6.02.00 Motor

- 6.02.01 The drive motor shall be three phase, squirrel cage, induction machine with minimum class B insulation and IPW-55 enclosure, designed for high torque and reversing service. Canopy shall be provided for outdoor service.
- 6.02.02 The motor shall be designed for full voltage direct on-line start, with starting current limited to 6 times full-load current.
- 6.02.03 The motor shall be capable of starting at 85 percent of rated voltage and running at 80 percent of rated voltage at rated torque and 85 percent rated voltage at 33 percent excess rated torque for a period of 5 minutes each.
- 6.02.04 Motor leads shall be terminated in the limit switch compartment.
- 6.02.05 Motor actuators for valves/dampers shall be with integral starter with 3phase/3wire, 415V AC and operable from remote.

- 6.02.06 Earthing terminals shall be provided on either side of the motor.
- 6.03.00 **Limit Switches**
- Each actuator shall be provided with following limit switches: -
- 6.03.01 2 torque limit switches, one for each direction of travel, self-locking, adjustable torque type.
- 6.03.02 4 end-of-travel limit switches, two for each direction of travel.
- 6.03.03 2 position limit switches, one for each direction of travel, each adjustable at any position from fully open to fully closed positions of the valve/damper.
- 6.03.04 Each limit switch shall have 2 NO + 2 NC potential free contacts. Contact rating shall be 5A at 240V A.C. or 0.5A at 220V D.C.
- 6.04.00 **Hand Wheel**
- Each actuator shall be provided with a hand wheel for emergency manual operation. The hand wheel shall de-energize automatically when the motor is energized.
- 6.05.00 **Position Indicator/Transmitter**
- The actuator shall have:
- 6.05.01 One (1) built-in local position indicator for 0-100% travel.
- 6.05.02 One (1) position transmitter, 4-20 mA current signal as position feedback, for remote indicator.
- 6.06.00 **Space Heater**
- A space heater shall be included in the limit switch compartment suitable for 240V, 1 phase, 50 Hz supply.
- 6.07.00 **Wiring**
- All electrical devices shall be wired up to and terminated in a terminal box. All wiring shall be done with 1100 V grade fire resistance PVC insulated stranded copper conductor of not less than 2.5 Sq.mm cross section. All wiring shall be identified at both ends with ferrules. All the electrical actuators shall have uniform wiring.
- 6.08.00 **Terminal Box**
- The terminal box shall be weather proof, with removable front cover and cable glands for cable connection. The terminal shall be suitable for connection of 2.5 Sq.mm copper conductor.
- 7.00.00 **ACCESSORIES**

As required for the driven equipment, the actuator shall be furnished with starting equipment mounted on the actuator. This shall include:

- 7.01.00 One (1) triple pole MCCB
- 7.02.00 One (1) reversing starter with mechanically interlocked contactors, 3 thermal overload relays, 2 NO + 2 NC auxiliary contacts for each contactor.
- 7.03.00 One (1) remote-local selector switch.
- 7.04.00 CLOSE-STOP-OPEN oil tight push buttons with indication lights.
- 7.05.00 415/240 V control transformer with primary & secondary fuses.

8.00.00 **TEST**

The actuator and all components thereof shall be subject to tests as per relevant Standards. In addition, if any special test is called for in the equipment specification, the same shall be performed.

9.00.00 **DRAWINGS, DATA & MANUALS**

- 9.01.00 Drawings, Data & Manuals shall be submitted in triplicate with the bid and in quantities and procedures as specified in General Conditions of Contract and/or elsewhere in the specification for approval and subsequent distribution after the issue of 'Letter of Intent'.

9.02.00 **To be submitted with Bid**

Data sheet for each type of actuator shall be furnished along with internal wiring diagram, suggested control schematic and torque limit switch contact development and manufacturer's catalogues. Drawings, Data & Manuals shall be submitted in triplicate with the bid and in quantities and procedures as specified in General Conditions of Contract and/or elsewhere in the specification for approval and subsequent distribution after the issue of 'Letter of Intent'.

9.03.00 **To be submitted for Owner / Purchaser's Approval and Distribution**

All relevant drawings and data pertaining to the equipment like GTP, GA drawing, foundation plan, BOM, control & schematics, QAP, etc. shall be submitted by the Bidder for approval of Owner/Owner's consultant. Also refer clause no. 1.19.02(u) of Section-I of Volume – V-A : Technical Specifications for Electrical Equipment & Accessories.

ANNEXURE-A**DESIGN DATA****1.0 AUXILIARY POWER SUPPLY**

S	upply	Description	Consumer
	L.V. Supply (i)	415V, 3Ø, 3W, 50 Hz Effectively earthed	u Motors above 0.2kW pto less than 175kW.
		Fault level 50 kA symm. for 1 sec.	
	(ii)	240V AC/415V AC	Motors upto 0.2kW.
		240V, 1Ø, 2W, 50 Hz effectively earthed	o Lighting, Space heat- ing , A.C supply for Contr- l & protective devices.
	D.C. Supply	220V, 2W, unearthed	& D.C. alarm, control protective devices
		Fault level 25* kA. for 1 sec.	

* Indicative only, the actual value will be decided by the Bidder, after substantiating the same by calculation.

2.0 RANGE OF VARIATION

A.C. Supply :

V	oltage	:	± 10%
	Frequency	:	+3% to -5%.
	Combined Volt + frequency	:	10% (absolute sum)

During starting of large motor, the voltage may drop to 80% of the rated voltage for a period of 60 seconds. All electrical equipment while running shall successfully ride over such period without affecting system performance.

D.C. Supply :

Voltage	:	187 to 242
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	Technical specification for CONTROL & INSTRUMENTATION 5x800 MW YADADRI TPS, NALGONDA	SPEC NO.: PE-TS-417-145-I		
		VOLUME		
		SECTION		
		REV. NO.	00	DATE : 03.04.2018
		SHEET	OF	
Actuator Data Sheet				

218999/2021/PS-PEM-MAX

	SPECIFICATION FOR MOTORISED VALVE ACTUATOR		DOCUMENT NO. : PE-ID-417-145-I902	
			VOLUME II B	
			SECTION D	
			REV. NO. 00	DATE:15/05/2019
			SHEET 1	OF 4
Data Sheet A & B				
DATA SHEET-A (TO BE FILLED BY PURCHASER)			DATA SHEET-B (TO BE FILLED-UP BY BIDDER)	
GENERAL *	* PROJECT	5 X 800 MW YADADRI TPS, NALGONDA		
	OFFER REFERENCE			
	* TAG NO. SERVICE			
	* DUTY	☐ ON / OFF ** ☐ INCHING		
	* LINE SIZE (inlet/outlet): MATERIAL			
	* VALVE TYPE	☐ GLOBE ☐ GATE ☐ REG. GLOBE ☐ BUTTERFLY		
	* OPENING / CLOSING TIME			
	* WORKING PRESSURE			
	AMBIENT CONDITION	SHALL BE SUITABLE FOR CONTINUOUS OPERATION UNDER AN AMBIENT TEMP. OF 0-55 DEG C AND RELATIVE HUMIDITY OF 0-95%		
	VALVE SEAT TEST PRESS	BIDDER TO SPECIFY		
	REQUIRED VALVE TORQUE	BIDDER TO SPECIFY		
	ACTUATOR RATED TORQUE	BIDDER TO SPECIFY		
	CONSTRUCTION AND SIZING	CONSTRUCTION	TOTALLY ENCLOSED, WEATHER PROOF, IP:68	
MECHANICAL POSITION INDICATOR		TO BE PROVIDED FOR 0-100% TRAVEL		
BEARINGS		DOUBLE SHIELDED, GREASE LUBRICATED ANTI-FRICTION.		
GEAR TRAIN FOR LIMIT SWITCH/TORQUE SWITCH OPERATION		METAL (NOT FIBRE GEARS). SELF-LOCKING TO PREVENT DRIFT UNDER TORQUE SWITCH SPRING PRESSURE WHEN MOTOR IS DE-ENERGIZED.		
SIZING		OPEN/CLOSE AT RATED SPEED AGAINST DESIGNED DIFFERENTIAL PRESSURE AT 85% OF RATED VOLTAGE. FOR ISOLATING SERVICE THREE SUCCESSIVE OPEN-CLOSE OPERATIONS OR 15 MINS. WHICHEVER IS HIGHER. FOR INCHING SERVICE - 150 STARTS/HR MINIMUM & FOR REGULATING SERVICE - 600 STARTS/HR MINIMUM.		
HANDWHEEL as per standard EN 12570:2000	* REQUIRED	☒ YES ☐ NO		
	* ORIENTATION	☐ TOP MOUNTED ☐ SIDE MOUNTED		
	*TO DISENGAGE AUTOMATICALLY DURING MOTOR OPERATION.			
ELECTRIC ACTUATOR	ACTUATOR MAKE/MODEL	BIDDER TO SPECIFY		
	MOTOR MAKE / MODEL / TYPE / RATING (KW) (REFER NOTE NO. 6 & 7)	BIDDER TO SPECIFY		
	@ MOTOR TYPE	SQUIRREL CAGE INDUCTION MOTOR, STARTING CURRENT LIMITED TO SIX TIMES THE RATED CURRENT-INCLUSIVE OF I.S. TOLERANCE		
	ACTUATOR APPLICABLE WIRING DIAGRAM	☒ ENCLOSED (BIDDER TO CONFIRM) DRG. NO. 3-V-MISC-24227 R00		
	COLOUR SHADE	☐ BLUE (RAL 5012) ☐		
	PAINT TYPE (## Refer Notes)	☐ ENAMEL ☐ EPOXY CONFIRMING TO CORROSION CATEGORY C5-I		
	SHAFT RPM	BIDDER TO SPECIFY		
	OLR SET VALUE	BIDDER TO SPECIFY		
	@ STARTING / FULL LOAD CURRENT	BIDDER TO SPECIFY		
	NO. OF REV FOR FULL TRAVEL	BIDDER TO SPECIFY		
	@ PWR SUPP TO MTR / STARTER	415V, 3PH, AC		
	@ CONTROL VOLTAGE REQUIREMENT	TO BE DERIVED FROM THE POWER SUPPLY TO THE STARTER ☐ 230 V ☐ 110 V		
	@ ENCLOSURE CLASS OF MOTOR	☐ IP 67 ☐ IP 68 ☐ FLAME PROOF		
	@ INSULATION CLASS	CLASS-F TEMP. RISE LIMITED TO CLASS-B		

	SPECIFICATION FOR MOTORISED VALVE ACTUATOR		DOCUMENT NO. : PE-ID-417-145-I902		
			VOLUME II B		
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			SHEET 2	OF	4
Data Sheet A & B					
DATA SHEET-A (TO BE FILLED BY PURCHASER)				DATA SHEET-B (TO BE FILLED-UP BY BIDDER)	
	@ WINDING TEMP PROTECTION	☒ THERMOSTAT (3 Nos.,1 IN EACH PHASE) ☐ -----			
	SINGLE PHASE / WRONG PHASE SEQUENCE PROTECTION	REQUIRED (THERMISTOR PTC)			
INTEGRAL STARTER	INTEGRAL STARTER	☒ REQUIRED ☐ NOT REQUIRED			
	TYPE OF SWITCHING DEVICE	☐ CONTACTORS ☐ THYRISTORS			
	TYPE	☐ CONVENTIONAL ☐ SMART (NON-INTRUSIVE)			
	IF SMART (REFER BELOW POINT a – h)				
	a) SERIAL LINK INTERFACE	☐ INTEGRAL ☐ FIELD MOUNTED			
	b) SERIAL LINK PROTOCOL	☐ FOUNDATION FIELD-BUS ☐ PROFI-BUS ☐ DEVICE NET ☐			
	c) SERIAL LINK MEDIA	☐ TWISTED PAIR Cu-CBL ☐ CO-AXIAL Cu-CBL ☐ OFC			
	d) HAND HELD PROGRAMMER	☐ REQUIRED ☐ NOT REQUIRED			
	e) TYPE OF HAND HELD PROGRAMMER	☐ BLUETOOTH ☐ INFRARED ☐			
	f) MASTER STATION	☐ REQUIRED ☐ NOT REQUIRED			
	g) MASTER STN INTRFACE WITH DCS	☐ MODBUS ☐ TCP/IP			
	h) DETAILS OF SPECIAL CABLE	☐ ENCLOSED ☐ NOT REQUIRED			
	STEP DOWN CONT. TRANSFORMER	☒ REQUIRED			
	OPEN / CLOSE PB	☒ REQUIRED ☐ NOT REQUIRED			
	STOP PB	☒ REQUIRED ☐ NOT REQUIRED			
	INDICATING LAMPS	☒ REQUIRED ☐ NOT REQUIRED			
	LOCAL REMOTE S/S	☒ REQUIRED ☐ NOT REQUIRED			
	STATUS CONTACTS FOR MONITORING	☒ REQUIRED ☐ NOT REQUIRED			
	INTEGRAL STARTER DISTURBED SIGNAL(Refer Note 14)	REQUIRED (O/L RELAY OPERATED, CONT./POWER SUPPLY FAILED, S/S IN LOCAL, TORQUE SWITCH OPTD. MID WAY,)			
	ACTION ON LOSS OF EXTERNAL ELECTRIC POWER	☐ STAYPUT ☐ FAIL SAFE			
INTERPOSING RELAY/OPTO COUPLER (Applicable for integral Starter) DATASHEET & WIRING DIAGRAM OF ISOLATION DEVICE TO BE PROVIDED	TYPE OF ISOLATING DEVICE	☒ INTERPOSING RELAY ☐ OPTO COUPLER TO BE DECIDED DURING DETAILED ENGINEERING			
	QUANTITY	☐ 2 NOs. ☐ 3 NOs.			
	DRIVING VOLTAGE	☒ 20.5 – 24V DC ☐ _____ V DC			
	DRIVING CURRENT	☒ 125mA MAX ☐ _____ mA MAX			
	LOAD RESISTANCE	☒ > 192 ohms - <25 k ohms ☐ > _____ ohms - < _____ ohms			
TORQUE SWITCH (Not Applicable for Smart Actuator) (\$\$ Refer Notes)	MFR & MODEL NO.	BIDDER TO SPECIFY			
	OPEN / CLOSE	☒ 1 No. ☐ 2Nos. / ☒ 1 No. ☐ 2Nos			
	CONTACT TYPE	2 NO + 2 NC			
	RATING	5A 240V AC AND 0.5A 220V DC			
	CALIBRATED KNOBS(OPEN&CLOSE TS)	REQUIRED FOR SETTING DESIRED TORQUE			
	ACCURACY	+3% OF SET VALUE			
LIMIT SWITCH (Not Applicable for Smart	MFR & MODEL NO.	BIDDER TO SPECIFY			
	OPEN : INT : CLOSE	☐ 1 No. ☒ 2 Nos.	2 Nos. (ADJ.)	☐ 1 No. ☒ 2Nos.	

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	SPECIFICATION FOR MOTORISED VALVE ACTUATOR		DOCUMENT NO. : PE-ID-417-145-I902	
			VOLUME II B	
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			REV. NO. 00	DATE:15/05/2019
			SHEET 3	OF 4
Data Sheet A & B				
DATA SHEET-A (TO BE FILLED BY PURCHASER)			DATA SHEET-B (TO BE FILLED-UP BY BIDDER)	
Actuator) (\$\$ Refer Notes)	CONTACT TYPE	2 NO + 2 NC		
	RATING (AC / DC)	5A 240V AC AND 0.5A 220V DC		
	ACCURACY	2% OF SET VALUE		
POSITION TRANSMITTER	POSITION TRANSMITTER (For inching duty & other specific applications)	☒ REQUIRED ☐ NOT REQUIRED		
	MFR & MODEL NO.	BIDDER TO SPECIFY		
	TYPE	☐ ELECTRONIC (2 WIRE) R/I CONVERTER ☒ ELECTRONIC (2 WIRE) CONTACTLESS		
	SUPPLY	☒ 24V DC ☐		
	OUTPUT	☒ 4-20mA		
	ACCURACY	± 1% FS		
SPACE HEATER	@SPACE HEATER	REQUIRED		
	@ POWER SUPPLY (NON INTEGRAL)	230V AC,1 PH.,50 Hz		
	@ POWER SUPPLY (INTEGRAL)	BIDDER TO SPECIFY		
	@ RATING			
TERMINAL BOX	ACTUATOR/MOTOR TERMINAL BOX	REQUIRED		
	ENCL CLASS ACTUATOR/MOTOR T.B.	@ ☐ IP 68 @ ☐		
	@ EARTHING TERMINAL	REQUIRED		
	PLUG & SOCKET	☐ REQUIRED ☐ NOT REQUIRED		
	NO. OF PINS REQUIRED(TO BE CHECKED AS PER SIGNALS IN DRIVE CONTROL PHILOSOPHY)			
	NOS. OF PLUG & SOCKET	☐ 1 Nos. for ON/OFF ☐ 2 NOS.(for inching duty) ☐ OTHER (TO BE SPECIFIED INLINE WITH DRIVE CONTROL PHILOSOPHY)		
CABLE GLANDS	@ POWER CABLE GLAND	SIZE:-----		
	@ SPACE HEATER CABLE GLAND	SIZE:-----		
	CONTROL CABLE GLANDS-1	INSTRUMENT CABLE SIZE FOR ON/OFF DUTY VALVES SHALL BE 8PX0.5 SQMM. ONE CABLE GLAND OF OD SIZE 20 MM. INSTRUMENT CABLE SIZE FOR INCHING DUTY TYPE VALVES SHALL HAVE TWO NO. CABLES (ONE NO. 8PX0.5 SQMM AND 2ND 2PX0.5 SQMM) - TWO NO. GLANDS OF OD SIZES 20 MM & 15 MM.		
	CONTROL CABLE GLANDS-2			
WEIGHT	TOTAL WEIGHT (ACTUATOR + ACCESSORIES)	BIDDER TO SPECIFY		_____ Kg.

218999/2021/PS-PEM-MAX

	SPECIFICATION FOR MOTORISED VALVE ACTUATOR	DOCUMENT NO. : PE-ID-417-145-I902		
		VOLUME	II B	
		SECTION	D	
		REV. NO.	00	DATE:15/05/2019
		SHEET	4	OF 4
Data Sheet A & B				
DATA SHEET-A (TO BE FILLED BY PURCHASER)			DATA SHEET-B (TO BE FILLED-UP BY BIDDER)	

NOTES:

- SCOPE:** DESIGN, MANUFACTURE, INSPECTION, TESTING AND DELIVERY TO SITE OF ELECTRIC ACTUATOR FOR INCHING OR OPEN / CLOSE DUTY.
 - CODES & STANDARDS:** DESIGN AND MATERIALS USED SHALL COMPLY WITH THE RELEVANT LATEST NATIONAL AND INTERNATIONAL STANDARD. AS A MINIMUM, THE FOLLOWING STANDARDS SHALL BE COMPLIED WITH:
IS-9334, IS-2147, IS-2148, IS-325, IS-2959, IS-4691, IS-4722, IEC 60947-5-1 AND EN 15714-3 :2010 OR LATEST VERSION.
 - TEMPERATURE RISE SHALL BE RESTRICTED TO 70 DEG. C FOR AMBIENT TEMPERATURE OF 50 DEG C.
 - CABLE GLANDS OF DOUBLE COMPRESSION TYPE, BRASS MATERIAL SHALL BE PROVIDED.
 - THE TORQUE SWITCHES SHALL BE PROVIDED WITH MECHANICAL LATCHING DEVICE TO PREVENT OPERATION WHEN UNSEATING FROM THE END POSITIONS. THE LATCHING DEVICE SHALL UNLATCH AS SOON AS THE VALVE LEAVES THE END POSITION. IF SUCH PROVISION IS NOT POSSIBLE, THE TORQUE SWITCHES SHALL BE BYPASSED BY END-POSITION LIMIT SWITCHES WHICH OPENS ON VALVE LEAVING END POSITION. THESE LIMIT SWITCHES ARE ADDITIONAL TO THE NUMBER OF LIMIT SWITCHES SPECIFIED ELSEWHERE.
 - THE MOTOR SHALL BE SUITABLE FOR DIRECT ON LINE STARTING.
 - THE MOTOR SHALL BE CAPABLE OF STARTING AT 85 PERCENT OF RATED VOLTAGE RUNNING AT 80 PERCENT OF RATED VOLTAGE AT RATED TORQUE AND 85 PERCENT RATED VOLTAGE AT 33 PERCENT EXCESS RATED TORQUE FOR A PERIOD OF 5 MINUTES EACH.
 - IN ADDITION TO ABOVE REQUIREMENTS FOR LIMIT/TORQUE SWITCH, **MECHANICAL END STOP** WITH ACCURACY OF 2% SHALL BE SUPPLIED.
 - IT SHOULD BE POSSIBLE TO OPERATE THE ACTUATOR LOCALLY. LOCKABLE LOCAL/REMOTE SELECTION SHALL BE PROVIDED ON THE ACTUATOR.
 - LOCAL POSITION INDICATOR SHALL BE PROVIDED FOR 0 TO 100 % TRAVEL.
 - CONTROL WIRING SHALL BE SUITABLE VOLTAGE GRADE COPPER WIRE 1.5 SQ. MM.
 - ENDURANCE: RATED TORQUE RANGE SHOULD BE BASED ON ISO 5211, ISO5210.
 - TAG PLATE SHALL BE CONFIRMING TO STANDARD BS-15714.
 - INTEGRAL STARTER/ACTUATOR DISTURBED SIGNAL SHALL BE CHECKED AND INCLUDE AS PER DRIVE CONTROL PHILOSOPHY.
 - ** VALVES WITH 10 DEGREE/20DEGREE FEEDBACK REQUIREMENT FOR APPLICATIONS SUCH AS CW/ACW/PLANT WATER SYSTEM ETC SHALL BE CONSIDERED AS INCHING DUTY VALVES. ACCORDINGLY, POSITION FEED BACK TRANSMITTER, PLUG & SOCKET REQUIREMENT SHALL BE CONSIDERED.**
- \$\$ TORQUE SWITCH & LIMIT SWITCH SHALL ACT INDEPENDENT OF EACH OTHER. TANDEM OPERATION IS NOT ACCEPTABLE.**
- ## EPOXY PAINT IS RECOMMENDED FOR COASTAL AREAS.**

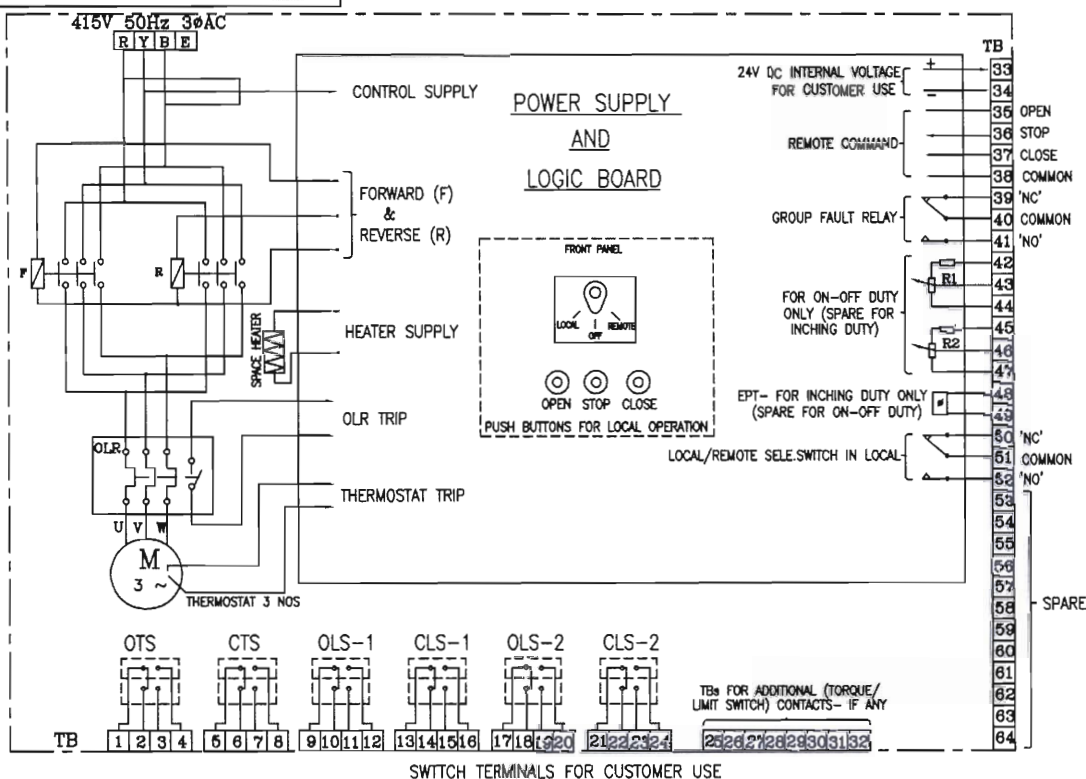
NAME SIGNATURE DATE	PREPARED BY	CHECKED BY	APPROVED BY	VENDOR COMPANY SEAL
	RINKY	RAVINDER K RAINA	SHIVRAJ SINGH BANSALA	NAME
				SIGNATURE
	15.05.2019	15.05.2019	15.05.2019	DATE

NOTES* = TO BE FILLED BY MPL (LEAD AGENCY).

@ BE FILLED BY ES

ALL DIMENSIONS ARE IN MILLIMETRES. FOR TOLERANCES OF UNTOLERANCED DIMENSIONS DURING MANUFACTURE REFER RELEVANT QCP / QP.

DRAWING NO. 3-V-MISC-24227



CONTACT DEVELOPMENT DIAGRAM

OTS	1-2	OPEN AT OVER TORQUE DURING OPENING TRAVEL
	3-4	CLOSE AT OVER TORQUE DURING OPENING TRAVEL
CTS	5-6	OPEN AT OVER TORQUE DURING CLOSING TRAVEL
	7-8	CLOSE AT OVER TORQUE DURING CLOSING TRAVEL
OLS-1	9-10	
	11-12	
CLS-1	13-14	
	15-16	
OLS-2	17-18	
	19-20	
CLS-2	21-22	
	23-24	
SWITCH	TERMINAL NO.	VALVE POSITION
		FULL OPEN
		INTERMEDIATE
		FULL CLOSE

INDICATES CONTACT CLOSED
 ----- INDICATES CONTACT OPEN
 CONTACT RATING: 5A AT 250V AC & 0.5A AT 220V DC

SETTING PROCEDURE OF POSITION LIMIT AND TORQUE SWITCH

VALVES	OPEN		CLOSE	
	MAIN	BACK UP	MAIN	BACK UP
GATE VALVE OF 100 mm AND ABOVE IN 1500 CL AND ABOVE RATINGS	OLS	OTS *	CLS	CTS
ALL OTHER GATE & GLOBE VALVES	OLS	OTS *	CTS	#

- CLS NOT TO BE CONNECTED IN TRIP CIRCUIT
 * - BYPASS OTS FOR INITIAL 5% OF TRAVEL (FOR GATE VALVES ONLY)

NOTE:-

- ALL TORQUE AND LIMIT SWITCHES (OTS, CTS, OLS1&2, CLS1&2) ARE WITH 2NO+2NC CONTACTS
 '1NO+1NC' IS TERMINATED IN TBS 1-24, REMAINING CONTACTS ARE FOR INTERNAL USE.
 ANY SPARE CONTACTS WHICH ARE NOT USED INTERNALLY ARE TO BE TERMINATED IN TBS 25-32
- CTS - TORQUE SWITCHES FOR CW ROTATION (CLOSE)
- OTS - TORQUE SWITCHES FOR CCW ROTATION (OPEN)
- OLS-1, OLS-2 - LIMITSWITCHES FOR POSITION OPEN
- CLS-1, CLS-2 - LIMITSWITCHES FOR POSITION CLOSE
- EPT - ELECTRONIC POSITION TRANSMITTER
 (CONTACTLESS TYPE, FOR INCHING DUTY)
- R1-R2-POTENTIOMETER 2 x 100 OHMS (FOR ON-OFF DUTY)
- FOR COMMANDS & EPT EITHER INTERNALLY GENERATED 24 VDC OR EXTERNAL SUPPLY OF 24VDC CAN BE USED
- M - MOTOR 3Φ 415V 50 Hz AC SUPPLY

REV	DATE	ALTERED
		CHD & APPD

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TYPE OF PRODUCT ELECTRICAL VALVE ACTUATORS (AC) WITH INTEGRAL STARTERS
 OR NAME OF
 CUSTOMER/PROJECT (DRAWN FOR INTERMEDIATE POSITION OF VALVES)

Bharat Heavy Electricals Ltd.		DESIGN	N.P.ESWAR	SIGN	N.P.	DATE	07.10.04	NO. OF	VAR.
UNIT: HIGH PRESSURE BOILER PLANT, TIRUCHENPAI-600014.		CHD	D. DRAKARAN	D.D		DATE	07.10.04		
365-121		APPD	KARUNACHALAM	K.A		DATE	07.10.04		
DEPT	VL	SCALE	WEIGHT (KG)	REFERENCE INFORMATION				NO. OF SHEETS	
CODE									
TITLE				CARD CODE		DRAWING NO.		REV	
WIRING DIAGRAM (TERMINAL PLAN)				U 01		3-V-MISC-24227		0	
FOR ACTUATOR WITH INTEGRAL STARTER									

Size A3

218999/2021/PS-PEM-MAX

FORM NO. PEM-6686-0



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

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

VOLUME

SECTION

REV. NO. 00

DATE : 03.04.2018

SHEET OF

INSTRUMENTATION DATA SHEET

VOLUME : VI
SECTION-VII
SUB SECTION - B
CONTROL VALVES

- 1.00.00 **GENERAL**
- 1.01.00 Control valves for regulating service shall normally be globe body, preferably cage guided, metal-to-metal seated, pneumatically operated and shall be provided with characterized plugs
- 1.02.00 Where high stroking speed , high actuation forces and accurate positioning is critical for the operation of the plant, as in case of HP or LP bypass valves, Separator Drain Valves , hydraulic actuators with electro-hydraulic interface shall be offered.
- 2.00.00 **GENERAL TECHNICAL REQUIREMENTS**
- 2.01.00 Bidder shall exercise caution in selecting severe service control valves like BFP recirculation, HP & LP bypass, superheater & reheater attemperator, PRDS for Boiler & Turbine, Feed control station ,Soot blower steam pressure, Fuel oil heating and pressurizing ,minimum economizer flow control ,DM make up (emergency / normal), control valves whose down stream are connected to vacuum such as HP/LP heater emergency level control, condenser make up water, separator level control , CEP minimum flow control etc. For such critical applications, Bidder shall offer valves which are proven for similar application. Above valves shall have leakage class equal or better than class-VI with metal-to-metal seating.
- 2.02.00 Valve with ANSI leakage class-V shall be provided for all applications except for the control valves indicated above.
- 2.03.00 Bidder shall provide redundant control valves for some services such as Main condensate flow control, Superheat attemperation control and Reheat attemperation control as a minimum for high availability. For other application, if the availability criteria for the plant cannot be met even with the best established product, redundant control valves shall be provided.
- 2.04.00 Control valves shall be located near floor or platform for ease of access and with adequate clearances for maintenance and lay-down and shall be placed as station with upstream motorized isolating valve, down-stream motorized isolating valve, inching duty motorized bypass valve and manual drain valves. Each redundant control valve shall have its upstream motorized and down-stream motorised isolating valves. Where quick shut off requirement is foreseen such as in case of SH & RH attemperation valves, upstream isolation valve shall be pneumatic type.
- 2.05.00 Wherever, steam conditioning calls for , Pressure reducing & desuperheating, combined PRDS type valves shall be offered.
- 2.06.00 Control Valve shall be furnished with IBR certification wherever required .
- 2.07.00 Valve Body / End Connections
- 2.07.01 Valve end to end dimension and connection shall be according to ANSI standard, straight through pattern. However, Bidder may offer angle body valve for high pressure drop applications. For high pressure drop applications, construction of the valve shall be such that the gland is not exposed to inlet pressure.
- 2.07.02 Control valves of 40 mm. size and above with line pressure up to 50 Kg / Sq. cm may have flanged or welded end connections.

- 2.07.03 Control valves, used in high pressure services shall have butt welded end connections for size 65mm and above and socket weld end connection for size 50 mm or below.
- 2.07.04 Control valve body shall be selected as per the ISA GUIDeline. Generally control valve body shall be cast and machined for pressure rating up to 1500 lbs. Above 1500 lbs, valve body shall be of forged steel. For Demineralized Water application, valve body shall be Stainless Steel.
- 2.07.05 Bonnet joints for all control valves shall be of flanged and bolted type.
- 2.07.06 Flanged valve shall be rated at no less than class 300 lbs
- 2.07.07 The direction of flow shall be clearly engraved on the body . Valve tag no, , description or purpose, stroke time shall be painted on all control valve body with black letters on white background in Bold letters.
- 2.07.08 Valve Body Material shall match the process condition requirement as per ANSI. . General guideline shall be as follows

SR. No.	SERVICE	MATERIAL
1.	Non corrosive, non-flashing and non cavitating service for fluid temperature up to 275°C	Cast carbon steel ASTM A216 Gr. WCB , Trim material - 316 SS stellited faced GUIDe posts and bushings.
2.	Non corrosive, non-flashing and non cavitating service for fluid temperature above 275°C	Cast alloy steel ASTM A217 Gr. WC9 Trim material - 316 SS stellited faced GUIDe posts and bushings.
3.	Severe flashing / cavitating services	Alloy steel ASTM A217 Gr. WC9 , Trim material - 440C
4.	Low flashing / cavitating services	Alloy steel ASTM A217 Gr. WC6 , Trim material - 17-4 PH SS
5.	DM water application (condenser hotwell normal, emergency make up etc.)	316 stainless steel

- 2.07.09 Bidder may supply valves with body and trim materials with superior quality than specified material and in such cases Bidder shall furnish the comparison of offered material properties ,such as cavitation resistance , , hardness , tensile strength , strain energy , corrosion and erosion resistance etc. , with specified material for Owner's approval.

2.08.00 Valve Size

The control valve sizing (Cv / Kv) shall be based on following guidelines :

- a) The valves shall pass normal flow (MCR condition) with 60 to 70 percent opening for linear characterised valves and between 70 to 80 percent opening for equal percentage characterised valves.

- b) The valves shall have adequate rangeability to pass the minimum and maximum flows at 10% and 85% of the valve opening respectively. Valve stem travel range from minimum to maximum flow condition shall not be less than 50% of the total valve stem travel.
 - c) Valve Cv shall be selected in such a way that the valve shall be capable of handling at least 120% of required maximum flow.
 - d) The valve selection shall be based on the highest size dictated by the above considerations unless noise, flashing or other factors dictate the final selection.
 - e) Trim exit outlet velocity as defined in ISA handbook does not exceed 8 m / sec for liquid services , 150 m/sec for steam services and 50% of sonic velocity for flashing services The sizing procedure followed shall be as per latest edition of ANSI/ISA or equivalent standard.
- 2.09.00 Valve Top work
- 2.09.01 Top work shall be sized so that the valve shall operate properly when upstream pressure is 10 percent above maximum inlet pressure and downstream pressure is atmospheric.
- 2.09.02 Extended bonnet/ bonnet when maximum temperature fluid is greater than 280° C shall be provided and high temperature packing shall also be used for high temperature application.
- 2.09.03 The gland material shall be chosen to suit the operating temperature. PTFE may be chosen for lower temperature application (232°C maximum) and for high temperature application graphited asbestos glands are to be provided. For vacuum services,. All valves connected to vacuum on downstream side shall be provided with packing suitable for vacuum applications eg. double vee type chevron packing.
- 2.10.00 Valve Trim
- 2.10.01 Valve trim for applications up to leakage class-V shall be stainless steel 316 SS for pressure drop up to 7 Kg/ Sq. cm. For pressure drops above 7 Kg/Sq. cm hard trim (stelliting or equivalent) shall be used. Other alloys or treatment such as nitride shall be used if severe erosion is expected.
- 2.10.02 Balanced trim valves shall be offered for high shut-off pressure or high pressure drop condition to reduce the size of the actuators.
- 2.10.03 For flashing services and two stage mixtures, the trim material shall be 17-4 PH SS or equivalent.
- 2.10.04 If cavitating condition is foreseen, Bidder shall offer multistage or labyrinth trims valves. Trim of severe service valves shall be of multistage and multipath design with number of discrete pressure drop stages to eliminate the chances of erosion, cavitation, noise and vibration throughout the control range of the valve.
- 2.10.05 Quick replacement type trim shall be considered for easy maintenance.
- 2.10.06 Plug shall be one-piece construction cast , forged or machined from solid bar stock .Plug shall be screwed or pinned to valve stems or shall be integral with the valve stems.

- 2.11.00 Noise Level
- The equivalent sound level measured at 1.5M above nearest floor level in elevation and 1 M horizontally from the control valve expressed in decibels to a reference of 0.0002 microbar shall not exceed 85 dBA. The noise abatement shall be achieved by valve body & trim design and not by use of silencers. Valve Actuators
- 2.12.00 Actuator
- 2.12.01 Spring-diaphragm type actuators shall generally be used. Piston type actuators shall be offered in case of high shut-off pressure & quick response requirement. Hydraulic actuation system shall be provided for Critical valves as described elsewhere in the specification.
- 2.12.02 The actuator shall be designed for 150% thrust required for the valve (at shut-off pressure) at an air line supply pressure of 5.5 Kg/Sq. cm.
- 2.12.03 Diaphragms shall be designed for 200% maximum operating pressure.
- 2.12.04 Nylon reinforced neoprene is preferred as diaphragm material.
- 2.12.05 Valve actuators shall be capable of operating at 80⁰ C ambient, continuously.
- 2.12.06 Entire actuator assembly shall be painted with corrosion inhibiting paint.
- 2.12.07 Air connection size shall be 1/4" NPT (F) unless otherwise dictated by process response time. Integral tubing shall be stainless steel.
- 2.12.08 Bidder shall indicate the stroking time of the valve assemblies with positioned and ensure that the stroke time shall meet the process and equipment dynamics and shall be better than 10 seconds.
- 2.12.09 All actuators shall be of fail safe design signifying that the spring direction will tend to move the valve (open or close) in a direction safe for the process. "Failure to Open" or "Failure to Close" shall be marked on the actuator.
- 2.12.10 Hydraulic actuation system
- The system shall consist of , but not limited to , Hydraulic cylinder , proportional valve with blocking unit , SMART positioner with position transmitter , SOVs , safety bypass unit , safety control unit , Hydraulic supply unit and local controller cubicle with controller unit
- 2.13.00 Valve Positioners
- 2.13.01 All regulating service valves shall be offered with HART protocol based Smart Electro Pneumatic Positioners to ensure accuracy and repeatability of response.
- 2.13.02 Positioners shall have integral non contact type position transmitter, input and output gauges, local keypad & display and 4-20 mA DC output to DDCMIS in CCR.
- 2.13.03 Positioners shall be capable of functioning under hot, humid and vibrating conditions.
- 2.13.04 Positioner casings shall be dust tight, corrosion resistant and weatherproof to IP 65 .and explosion proof in hazardous areas.

- 2.13.05 In general, positioner shall operate at signal range 4 – 20 mA DC for the full travel of the valve. Split range operation in few cases may be required.
- 2.13.06 Remote calibration from control room shall be possible through HART management station.
- 2.14.00 Performance
- 2.14.01 Performance of the complete assembly of the control valves shall be better than +/- 1% of FS for linearity , +/- 0.5 % of FS for hysteresis , 1% for accuracy.
- 2.15.00 Valve Accessories
- 2.15.01 Accessories shall include side mounted hand wheels, open & close , intermediate (as applicable) limit switches for both regulating and On off valves ,, junction boxes with 20 % spare terminals , Air filter regulators , airlock relays , volume chambers etc. Solenoid valve (SOV) wherever required shall be furnished. Each limit switch shall have not less than 2 NO & 2 NC contacts with contact rating 5A , 240 V AC / 0.5 A , 220 V DC . SOV shall have SS bar stock body , SS316 Trim , SS coil enclosure , Class H insulation Air filter regulator shall have sintered bronze filter element with maximum 5 microns filter size & 2 inch dial size pressure gauges. .Protection class of all Limit switches , junction boxes , SOV etc. shall have protection class IP 65 and explosion proof for hazardous areas.
- 2.15.02 Air distribution line to all final control elements like control valves, pneumatic dampers (both regulating / on-off type) , SOV operated valves shall be through SS manifolds and SS isolating valves only. These valves shall be properly tagged also with KKS tag no. and description of final control element / instrument for which they are intended.
- 2.16.00 Test and Examination
- All valves shall be tested in accordance with the Quality Assurance programme agreed between the Owner and Bidder , which shall meet the requirements of IBR and other applicable codes mentioned elsewhere in the specification . The test shall include but not be limited to Non destructive test , Hydrostatic shell test prior to seat leakage test , Seat leakage test , Valve closure test , Functional test of fully assembled valves including actuators and accessories. CV test etc. For all control valves Cv test shall be witnessed by Owner.

1.00.00 **SPECIFICATION FOR ELECTRONIC TRANSMITTERS**

1.01.00 PRESSURE TRANSMITTER

- | | | | |
|-----|---------------------|---|---|
| 1. | Working Principle | : | Smart (HART Compatible) |
| 2. | Type | : | Microprocessor based, 2 – Wire |
| 3. | Output Signal | : | 4-20 mA DC along with superimposed digital signal |
| 4. | Measuring Element | : | Capsule / Diaphragm |
| 5. | Element material | : | SS-316 (Stainless Steel) or better |
| 6. | Static Pressure | : | 150 % of maximum span continuously, without affecting the calibration |
| 7. | Turn-down ratio | : | 100: 1 |
| 8. | Span and Zero | : | Continuous, tamper proof, remote as well locally adjustable with zero elevation and suppression by 100% of span |
| 9. | Enclosure Class | : | IP-65 (Explosion proof for NEC Class-1, Division 1 area) |
| 10. | Output Indicator | : | LCD (Integral indicator of 5 digit display) |
| 11. | Nameplate | : | Tag number, service engraved in SS tag plate |
| 12. | Body | : | SS |
| 13. | Operating Voltage | : | 24V DC |
| 14. | Load | : | 600 Ohms (min.) at 24 Volts D.C. |
| 15. | Ambient Temperature | : | 0 - 50 °C |
| 16. | Performance: | : | |
| | i. Accuracy | | ± 0.075% of Span or better |

-
- | | | |
|-----|-------------------------------------|--|
| ii. | Repeatability | ± 0.05% of Span or better |
| 17. | Sealing/Isolation | : Extended diaphragm (Silicon oil/ Fluorolub filled) with 5 meters SS armoured capillary for corrosive/viscous/solid bearing or slurry type fluid applications |
| 18. | Accessories | : <ul style="list-style-type: none"> a. Universal mounting bracket suitable for 2" pipe mounting b. High tensile carbon steel U-bolts c. Siphon for steam and hot water services d. ½" NPT 2-valve stainless steel manifold, constructed from SS316 bar stock e. Companion flange with nuts, bolts and gaskets f. ½" NPT cable gland g. Handheld calibrator |
| 19. | Adjustment/Calibration/ Maintenance | : From handheld calibrator/ HART management system |

Notes: For primary air/ secondary air/ flue gas applications, DP type transmitters shall be provided for pressure measurement.
LVDT type is not acceptable.

1.02.00 DIFFERENTIAL PRESSURE TRANSMITTER / FLOW TRANSMITTER

- | | | |
|----|-------------------|---|
| 1. | Working Principle | : Smart (HART Compatible) |
| 2. | Type | : Microprocessor based, 2 – Wire |
| 3. | Output Signal | : 4-20 mA DC along with superimposed digital signal |
| 4. | Measuring Element | : Capsule / Diaphragm |

-
- | | | | |
|-----|---------------------|---|---|
| 5. | Element material | : | SS-316 (Stainless Steel) or better |
| 6. | Static Pressure | : | 150 % of maximum span continuously, without affecting the calibration |
| 7. | Turn-down ratio | : | 100: 1 |
| 8. | Span and Zero | : | Continuous, tamper proof, remote as well locally adjustable with zero elevation and suppression by 100% of span |
| 9. | Enclosure Class | : | IP-65 (Explosion proof for NEC Class-1, Division 1 area) |
| 10. | Output Indicator | : | LCD (Integral indicator of 5 digit display) |
| 11. | Nameplate | : | Tag number, service engraved in SS tag plate |
| 12. | Body | : | SS |
| 13. | Operating Voltage | : | 24V DC |
| 14. | Load | : | 600 Ohms (min.) at 24 Volts D.C. |
| 15. | Ambient Temperature | : | 0 - 50 °C |
| 16. | Performance: | | |
| | i. Accuracy | : | ± 0.075% of Span or better |
| | ii. Repeatability | : | ± 0.05% of Span or better |
| 17. | Sealing/Isolation | : | Extended diaphragm (Silicon oil/ Fluorolub filled) with 5 meters SS armoured capillary for corrosive/viscous/solid bearing or slurry type fluid applications |
| 18. | Accessories | : | a. Universal mounting bracket suitable for 2" pipe mounting

b. High tensile carbon steel U-bolts |

- c. Siphon for steam and hot water services
- d. ½" NPT 5-valve stainless steel manifold, constructed from SS316 bar stock
- e. Companion flange with nuts, bolts and gaskets
- f. ½" NPT cable gland
- g. Handheld calibrator

19. Adjustment/Calibration/ Maintenance : From handheld calibrator/ HART management system

1.03.00 Displacer Type Level Transmitters

- 1. Type : Smart (HART Compatible)
- 2. Stages of operation : Continuous
- 3. Material :
- 4. i. Displacer SS-316
- 5. ii. Suspension wire SS-316
- 6. iii. Torque tube housing SS
- 7. iv. Torque tube Inconel
- 8. v. Displacer chamber SS
- 9. vi. Transmitter Housing SS
- 10. Operating Voltage : 24 V DC
- 11. Transmission : Microprocessor based, 2-wire
- 12. Output Signal : 4-20 mA DC along with superimposed digital signal
- 13. Static / overload : Maximum static pressure without

	pressure		permanent deformation or loss of accuracy
14.	Turn-down ratio	:	10 : 1 or better
15.	Zero & Span	:	Continuous, tamper proof, remote as well locally adjustable with zero elevation and suppression by 100% of span
16.	Enclosure Class	:	IP-65
17.	Output Indicator	:	LCD type (Integral indicator of 5 digit display)
18.	Nameplate	:	Tag number and Service engraved in stainless steel tag plate
19.	Ambient Temperature	:	0 - 50 °C
20.	Load Impedance	:	600 Ohms at 24 Volts (minimum)
21.	Process Connection	:	2" Flanged
22.	Performance - Accuracy	:	± 0.075 % of span or better
23.	Accessories	:	a) Counter Flange, nuts, bolts, gaskets etc b) Weights for 5 point calibration of instruments c) Vent and drain plugs d) ½" NPT Glands e) Handheld calibrator
24.	Preferred Features	:	a) Test plug connection and cutout terminals physically separated from other electronics b) Electronic Damping facility (adjustable)
25.	Adjustment/Calibration/ Maintenance	:	From handheld calibrator/ HART management system

- | | | | |
|---------|----------------------------|---|--|
| | 26. Applications | : | During detail engineering on Owner's approval |
| 1.04.00 | MASS FLOW METER | | |
| 1.04.01 | SENSOR | | |
| | 1. Measuring Principle | : | Coriolis Mass flow |
| | 2. Primary Element | : | Flow Tube of 316SS or better |
| | 3. Heating Arrangement | : | Integral |
| | 4. Temperature Control | : | For heavy fuel oil application |
| | 5. Process Connection | : | Flanged of rating as per process requirement |
| | 6. Drain | : | Self-draining facility |
| | 7. Enclosure | : | Stainless steel |
| | 8. Accessories | : | Counter flanges, Mounting nuts, bolts, gaskets etc. |
| 1.04.02 | TRANSMITTER | | |
| | 1. Measured quantities | : | Mass Flow rate, Total Mass Flow, Density |
| | 2. Input Signal Processing | : | Smart (HART compatible) |
| | 3. Display | : | LCD |
| | 4. Output | : | 2 nos. isolated output of 4-20mA DC selectable from four measured quantities |
| | 5. Load | : | < 750 ohms |
| | 6. Power supply | : | 240V AC, 50 Hz |

-
- | | | | |
|-----|---|---|---|
| 7. | Turn Down | : | 100:1 |
| 8. | Accuracy | : | ± 0.2 % of measured value |
| 9. | Housing | : | IP 65 (Explosion proof) |
| 10. | Nameplate | : | Tag number, service engraved in stainless steel tag plate |
| 11. | Accessories | : | a) Handheld calibrator
b) Mounting U-bolts, nuts, bolts, prefab cable etc
c) $\frac{1}{2}$ "NPT cable gland |
| 12. | Adjustment/Calibration/
/Maintenance | : | From handheld calibrator/ HART management system |
| 13. | Applications | : | Fuel Oil service |

1.05.00 RADAR TYPE LEVEL MEASUREMENT

- | | | | |
|----|---------------------------|---|---|
| 1. | Type | : | Smart (HART Compatible) |
| 2. | Antenna | : | Co axial / guided wave radar / Overspill protection |
| 3. | Principle | : | TDR (Time Domain Reflectometry) |
| 4. | Communication | : | Two wire 4-20mA DC with HART |
| 5. | Environmental temperature | : | 0 – 50 °C |
| 6. | Enclosure | : | IP-65 (Explosion proof for NEC Class-1, Division 1 area) |
| 7. | Calibration | : | a) Self calibration with internal reference
b) Zero & Span calibration |
| 8. | Process Connection | : | External cage mounting
Flanged /screwed |
| 9. | Electronic Housing | : | Epoxy painted Die-Cast aluminium |

		alloy	
10.	Antenna / Flange assembly	:	316 SS or Hest alloy (as required)
11.	Power supply	:	24 V DC
12.	Output Indicator	:	LCD
13.	Accuracy	:	5 mm or 0.1% of probe length
14.	Accessories	:	a) Handheld calibrator
		:	b) Counter Flange, nuts, bolts, gaskets etc
		:	c) ½"NPT cable gland
		:	d) SS Nameplate
15.	Adjustment/Calibration/ /Maintenance	:	From handheld calibrator/ HART management system
16.	Applications	:	Vessels under vacuum or low pressure applications, solid levels

1.06.00 ULTRASONIC LEVEL TRANSMITTER

1.	Type	:	Microprocessor based, 2-wire, Smart (HART Compatible)
2.	Operating Principle	:	Detection of reflected ultrasonic pulse
3.	Output Signal	:	4-20 mA DC along with superimposed digital signal
4.	Operating frequency	:	10 KHz to 50 KHz (typical)
5.	Display	:	LCD
6.	Temperature Compensation	:	Built in –Programmable
7.	Power supply	:	24 V DC
8.	Enclosure	:	SS, IP-65 (Explosion proof for NEC Class-1, Division 1 area)

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|--|---|---|
| 9. Zero & Span | : | Continuous, tamper proof, remote as well locally adjustable. It shall be possible to calibrate the instrument without any level in the sump/ tank |
| 10. Accuracy & Repeatability | : | 0.15 % of span or better |
| 11. Resolution | : | 0.1 % of span |
| 12. Operating temp. | : | Transmitter- 500 C and Sensor - 800 C |
| 13. MOC Sensor | : | SS-316/Body- PVC and Face – Polyurethane |
| 14. Mounting | : | 4" Flanged/ 2" NPT for sensor and Transmitter on panel |
| 15. Accessories | : | a) Handheld calibrator

b) Weather canopy for protection from direct sunlight and direct rain

c) ½"NPT cable gland

d) All mounting hardware (SS-316), Prefab cable

e) SS Nameplate |
| 16. Diagnosis | : | On-line |
| 17. Status Indication | : | Power On, HI, HI-HI, Lo, LO-LO, Fault |
| 18. Output Contacts | : | 2 SPDT, 230V, 5A |
| 19. Adjustment/Calibration/ /Maintenance | : | From handheld calibrator/ HART management system |
| 20. Applications | : | Coal Bunker, Water Service etc. |

1.07.00 ULTRASONIC FLOW TRANSMITTER

1. Type : Ultrasonic – Clamp On
2. Accuracy : +/- 1 % of reading
3. Repeatability : +/- 0.3 % of reading
4. Rangeability : 400 : 1
5. Output Signal : 4-20 mA DC with HART
6. Measured Parameter : Volumetric flow, Totalized flow and flow Velocity
7. Display : LCD with internal Key Pad (Flow rate & Totalization)
8. Power Supply : 24 V DC (2 Wire)
9. Enclosure : SS (IP- 68 – Submersible)
10. Mounting : SS Chain or Strap
11. Accessories
 1. Handheld calibrator
 2. ½"NPT cable gland
 3. Transducer cable
 4. All mounting hardware (SS-316)
 5. SS Nameplate
12. Adjustment/Calibration/ /Maintenance : From handheld calibrator/ HART management system
13. Applications : Plant water service

Note: Multi-path insertion type (minimum 4 path) Ultrasonic Flow meter shall be provided for Raw water/ Cooling Water flow measurements.

2.00.00 HART HAND HELD CALIBRATOR

Hand held calibrators (5 nos. for each type) shall be provided for adjustment/ calibration/maintenance of the HART compatible

transmitters. The hand held calibrator shall be suitable for all types of transmitters supplied in the package. If one type of hand held type calibrator is not suitable for communicating with all types of transmitters then separate hand held calibrator will be provided.

3.00.00 PROCESS ACTUATED SWITCHES

3.01.00 PRESSURE SWITCH

1. Type :
 - i. Piston for high pressure application
 - ii. Bellow / Diaphragm for low pressure application
2. Sensing element : SS-316.
material All other wetted part SS316
3. Case Material : SS $\frac{1}{2}$
4. Setter Scale : Black graduation on white linear scale.
Graduation 0-100% with red pointer for set points
5. Over range : 150 % of maximum pressure
6. Adjustments :
 - a) Internal Set Point
 - b) Differential adjustment
7. End Connection : 1/2" NPT bottom connected
8. Switch configuration : Two SPDT (240V, 5A AC/220V, 0.5A DC)
9. Switch Type : Snap acting, shock & vibration proof
10. Terminal Block : Suitable for full ring lugs
11. Enclosure Class : IP-65 (Explosion proof for NEC Class-1, Division 1 area)
12. Performance :
 - a) Repeat accuracy $\pm 1.0\%$
 - b) Accuracy of Setting Indication of $\pm 1.5\%$
13. Ambient temperature : 0 – 50 Deg.C

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|------------------|---|---|
| 14. Nameplate | : | Tag number, service engraved in SS tag plate |
| 15. Accessories | : | <ul style="list-style-type: none"> a) Silicon oil/ Fluorolub filled Remote diaphragm seal with SS-316 capillary for corrosive/ viscous/ solid bearing or slurry type fluid applications b) Snubbers for pulsating fluid applications c) Siphons for steam and hot water services d) Retention ring and screws for surface mounting e) 1/2" NPT 2 Valve SS-316 barstock manifold f) 1/2" NPT cable gland |
| 16. Applications | : | During Detail Engineering on Owner's approval |

3.02.00 DIFFERENTIAL PRESSURE SWITCH

- | | | |
|-----------------------------|---|--|
| 1. Type | : | <ul style="list-style-type: none"> i. Piston for high pressure application ii. Bellow / Diaphragm for low pressure application |
| 2. Sensing element material | : | SS-316.
All other wetted part SS316 |
| 3. Case Material | : | SS |
| 4. Setter Scale | : | Black graduation on white linear scale. Graduation 0-100% with red pointer for set points |
| 5. Over range | : | 150 % of maximum pressure |

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|-----|----------------------|---|---|
| 6. | Adjustments | : | a) Internal Set Point |
| | | : | b) Differential adjustment |
| 7. | End Connection | : | 1/2" NPT bottom/ back connected |
| 8. | Switch configuration | : | Two SPDT (240V, 5A AC/220V, 0.5A DC) |
| 9. | Switch Type | : | Snap acting, shock & vibration proof |
| 10. | Terminal Block | : | Suitable for full ring lugs |
| 11. | Enclosure Class | : | IP-65 (Explosion proof for NEC Class-1, Division 1 area) |
| 12. | Performance | : | a) Repeat accuracy $\pm 1.0\%$
b) Accuracy of Setting Indication of $\pm 1.5\%$ |
| 13. | Ambient temperature | : | 0 – 50 Deg.C |
| 14. | Nameplate | : | Tag number, service engraved in SS tag plate |
| 15. | Accessories | : | a) Silicon oil/ Fluorolub filled Remote diaphragm seal with SS-316 capillary Diaphragm seals for corrosive/ viscous/ solid bearing or slurry type fluid applications
b) Snubbers for pulsating fluid applications
c) Siphons for steam and hot water services
d) Retention ring and screws for surface mounting
e) 1/2" NPT 5 Valve SS-316 barstock manifold
f) 1/2" NPT cable gland |
| 16. | Applications | : | During Detail Engineering on Owner's |

approval

3.03.00 LEVEL SWITCH

3.03.01 FLOAT OPERATED

1. Float material : SS-316
2. Wetted parts : SS-316
3. Float chamber : Stainless steel/Carbon steel,
construction welded
4. Float chamber : Side mounted
mounting
5. Fluid connection : Side – Side
6. Fluid connection size : 1" ANSI RF Flange (rubber line, if
required)
7. Drain : ½ inch NPT with Plug
8. Pressure rating of
chamber : Minimum 1.5 times of design pressure
9. Repeatability : +/- 1.5 mm or better
10. Switch housing : Stainless Steel
11. Switch housing type : IP- 65
12. Type of switch : Snap acting magnetically operated
hermetically sealed
13. Switch configuration : 2 SPDT (5A, 240 V AC, 0.5A, 220V DC)
14. Accessories :
 - a) Counter flange, nuts
& bolts, suitable
gasket etc.
 - b) Steel globe type
drain valve
 - c) ½"NPT cable gland

d) Stainless steel nameplate with alpha-numeric engraved for service and tag

15. Application : During Detail Engineering on Owner's approval

3.04.00 FLOW SWITCH

1. Type : Paddle /Piston/Disk
2. Wetted part material : Stainless steel or Hastelloy for acidic application
3. End connection :
 - a) Threaded upto 1" line size with integral Tee
 - b) Flanged for line size > 1 ½"
4. Enclosure material : Stainless Steel
5. Enclosure class : IP 65
6. Switch configuration : 2 SPDT (5A, 240 V AC, 0.5A, 220V DC)
7. Repeatability : 2%
8. Cable connection : ½"NPTF
9. Accessories :
 - a) Tee, Counter flange, nuts & bolts, suitable gasket etc
 - b) ½"NPT cable gland
 - c) Stainless steel nameplate with alpha-numeric engraved for service and tag

3.05.00 RF LEVEL SWITCH

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- | | | |
|-----------------------------|---|---|
| 1. Type | : | RADIO FREQUENCY |
| Sensing probe | | |
| 2. Material | : | SS-316 |
| 3. Mounting | : | Threaded |
| Application | | |
| 4. Temperature | : | 250°C (Max.) |
| Electronic Controller | | |
| 5. Input Supply Voltage | : | 240V AC ±10%, 50 Hz. |
| 6. Relay Output | : | 2 SPDT (240V AC, 5A) |
| 7. Ambient Temperature | : | 50 °C |
| 8. Enclosure Protection | : | IP-66 |
| 9. Enclosure Housing | : | SS |
| | | Normal Level |
| | | Power On |
| 10. Local LED Indication | : | Alarm Level |
| | | Probe Healthy |
| 11. Switching Repeatability | : | ±0.5% |
| | | Co-axial cable for probe connection to controller |
| 12. Accessories | : | SS Tag plate |
| | | ½" NPT Cable Glands |
| 13. Application | : | Solid level |

3.06.00 CONDUCTIVITY TYPE LEVEL SWITCH

- | | | |
|------------------|---|-----------------------------|
| 1. Type | : | Conductivity discrimination |
| 2. Probe MOC | : | SS-316 |
| 3. Mounting | : | Flanged on external cage |
| Application | | |
| 4. Temperature | : | 250°C (Max.) |
| 5. Test Pressure | : | Two times rated pressure |

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|-----|----------------------|---|--|
| 6. | Input Supply Voltage | : | 240V AC $\pm$ 10%, 50 Hz.
Four independent channel with |
| 7. | Input | : | selectable switching threshold for water conductivity |
| 8. | Relay Output | : | 2 SPDT (240V AC, 5A) |
| 9. | Ambient Temperature | : | 50 °C |
| 10. | Enclosure Protection | : | IP-65 (Explosion proof for NEC Class-1, Division-1 area) |
| 11. | Enclosure Housing | : | SS
HI,LO, HIGH-HIGH, LOW-LOW |
| 12. | Local LED Indication | : | Power
Fault |
| 13. | Accessories | : | a) Interconnecting cable from probe to electronics

b) Mounting accessories

c) External cage

d) Washer & Gasket

e) ½" NPT Cable Glands

f) SS Tag Plate |
| 14. | Application | : | During Detail Engineering on Owner's approval |

3.07.00 TEMPERATURE SWITCH

- | | | | |
|----|--------------------------|---|--------------------------|
| 1. | Type | : | Bimetallic or gas filled |
| 2. | Sensing Element Material | : | SS-316 |
| 3. | Bulb Material | : | SS-316 |
| 4. | Capillary | : | Stainless Steel armored |

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- | | | | |
|-----|-----------------------|---|--|
| 5. | Movement Material | : | Stainless Steel |
| 6. | Case material | : | Stainless Steel with neoprene gasket and clear glass where applicable cover conforming to IP-65. (Explosion proof for NEC Class-1, Division 1 area). |
| 7.. | Scale | : | Black graduation on white linear scale. Graduation 0-100% with red pointer for set points |
| 8. | Over range Protection | : | 120 % |
| 9. | Instrument connection | : | Bottom |
| 10. | Switch configuration | : | Two SPDT (240V, 5A AC/220V, 0.5A DC) |
| 11. | Switch type | : | Snap acting, shock and vibration-proof |
| 12. | Adjustability | : | Internal Set point adjustable over span range |
| 13. | Compensation | : | a) Capillary compensation with invar wire throughout the capillary length
b) Case compensation |
| 14. | Performance | | |
| | a) Scale Accuracy | : | ± 1.0 % of full scale |
| | b) Repeatability | : | < 0.5 % of full range |
| | c) Response time | : | Less than 40 seconds with thermowell |
| 15. | Capillary length | : | 5 meters (minimum) for local mounting/15 meters for local panel mounting |
| 16. | Nameplate | : | Tag number, service engraved in stainless steel tag plate |
| 17. | Accessories | : | Mounting accessories, 1/2" NPT cable gland |
| 18. | Applications | : | During Detail Engineering on Owner's |

approval

4.00.00 **LOCAL INSTRUMENTS**

4.01.00 PRESSURE GAUGE AND DIFFERENTIAL PRESSURE GAUGE

- | | | |
|--------------------------|---|--|
| 1. Type | : | Bourdon/Bellows/Diaphragm |
| 2. Sensing & Socket | : | SS-316 |
| 3. Movement Material | : | SS-316 |
| 4. Case Material | : | Stainless steel. IP-65 (Explosion proof for NEC Class-1, Division 1 area) |
| 5. Dial Size | : | Generally 150 mm |
| 6. Scale | : | Black lettering on white in 270 O arc. |
| 7. Window | : | Shatterproof glass |
| 8. Range Selection | : | Normal process pressure: 50~70 % of range |
| 9. Over-range Protection | : | 125% of maximum range by internal stop. External stop at zero
For Zero adjustment (Micrometer screw external) |
| 10. Adjustment | : | For Range adjustment (Micrometer screw internal). |
| 11. Element Connection | : | Argon welding |
| 12. Process Connection | : | 1/2" NPT (M) Bottom for local, back for panel mounting |
| 13. Performance | : | Accuracy of ± 1.0 % of span or better |
| 14. Operating ambient | : | 0 - 50 °C |
| 15. Safety Feature | : | Blow out disc /diaphragm at the back |
| 16. Accessories | : | a) Snubbers for pulsating fluid application.discharge
b) Stainless steel Diaphragm seals |

for corrosive/ viscous/ solid bearing or slurry type fluid applications

c) 3-Way SS316 Gauge cock for pressure gauges

5-valve SS316 manifold from

d) barstock for differential pressure gauge

e) Siphons for steam and hot water services

17. Nameplate : Tag number, service engraved in stainless steel tag plate

4.02.00 LEVEL INDICATOR (FLOAT & BOARD TYPE)

1. Type : Float and Board

2. Float Material : SS-316

3. Float Cable : SS-316

4. Indicator Assembly : Epoxy painted Aluminium

5. Guide wire spring assembly : SS-316 (2 Nos.)

6. Guide Wire Anchor : SS-316

Anodized Aluminium with engraved marking (Minimum graduation 10mm),

7. Scale Board :

mounting brackets and suitable hardware required as per tank height

8. Elbow Assembly : Anodized Aluminium

9. Flanges : RF , ANSI 150 , SS (3 Nos.)

10. Accuracy : ± 10 mm or better

11. Accessories : All mounting accessories including counter flange, nuts & bolts, suitable

gasket etc. as applicable, SS Tag plate

4.03.00 GAUGE GLASS

1. Type : Reflex /Transparent
2. Material : Toughened borosilicate resistant to thermal shock
- Body Material : ~~Carbon Steel~~ Stainless Steel
- Enclosure : IP-65 (Explosion proof for NEC Class-1, Division 1 area)
3. Integral cocks & valves/Fittings : i. SS 316
4. : ii. Rubber lined corrosion resistant stainless steel (for DM/RO service)
5. Vessel Connection : ANSI Flanged SS316
6. Accessories : i. Integral cocks
- ii. Drain Valves
- iii. Companion Flanges, Bolts, nuts, gaskets, SS Tag plate
- iv. Illuminating lamps, Mica shield as required
- v. Calibrated scale
7. Pressure rating : Twice the maximum working pressure
8. Temperature : 300 ° C
9. Other details : For larger lengths (greater than 1200mm), additional gauge glasses shall be provided with minimum of 50 mm overlap.

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- 4.04.00 SLIGHT GLASS
1. Type : Flap-type.
 2. End connection : Screwed / Flanged
 3. Material
 - a) Body : SS- 304
 - b) Cover plate : SS- 304
 - c) Indicator : SS- 316
 4. Sight Glass : Toughened Borosilicate
 5. Gasket : Neoprene
 6. Bolts & Nuts : High tensile steel.
 7. Hydraulic Test Pressure : 1.5 times maximum working pressure
 8. Accessories : Companion Flanges, Bolts, nuts, gaskets as required, SS Tag plate.
- 4.05.00 ROTAMETER
1. Type : ON-LINE for line upto and including 50 mm NB.
: Borosilicate BY-PASS for line size above 50 NB
 2. Metering tube : Toughened Borosilicate
 3. Float : SS-316
 4. End fittings : SS-316
 5. Packing material : Teflon / PTFE
 6. Casing : Stainless Steel
 7. Gland Rings : Stainless Steel
/Followers/ Other wetted parts
 8. Orifice Plate : Stainless Steel (for bypass type)
 9. Operating Temperature : 0-50 Deg. c

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|------------------------|---|--|
| 10. Test Pressure | : | 200% of maximum operating pressure |
| 11. Scale | : | 250 mm nominal length |
| 12. Graduation | : | Direct reading |
| 13. Process Connection | : | Flanged (RF) to line size as per ANSI standards (150#) |
| 14. Tapping | : | D & D/2 |
| 15. Accuracy | : | +/- 2% of full scale reading |
| 16. Reproducibility | : | Within 0.5% of instantaneous reading |
| 17. Accessories | : | SS Tag Plate, orifice plate |

5.00.00 TEMPERATURE ELEMENTS & ACCESSORIES

5.01.00 RESISTANCE TEMPERATURE DETECTOR

- | | | |
|----------------------------------|---|--|
| 1. Type | : | Platinum (Duplex), Ungrounded |
| 2. Platinum (Duplex), Ungrounded | : | 100 ohm at 0 °C |
| 3. Base | : | Wound on ceramic (anti-inductive) |
| 4. Wiring | : | 3 Wire |
| 5. Protecting Tube | | |
| a) O.D. | : | 6 mm |
| b) Material | : | SS-316, Seamless |
| c) Filling | : | Magnesium oxide (Purity above 99.4%). |
| 6. Response time | : | a) 15 sec. (bare).
b) 30 sec. (with thermowell) |
| 7. Calibration | : | DIN 43760 |
| 8. Accuracy | : | ± 0.5% |
| 9. Head | | |
| a) Type | : | IP-65 universal screwed type |

-
- b) Material : Stainless Steel
- c) Terminal blocks : Nickel plated Brass-screw type / silver plated
- d) Cable connection : ½" NPT gland and grommet
- e) Others : Terminal head cover with SS chain and suitable gasket.
- Head of TE to be provided with sufficient space and arrangement to mount head mounted temperature transmitter (as applicable).
- Adjustable nipple-union-nipple [1/2" Sch 80 X ½" NPT] with thermowell connection
10. Accessories : a)
- b) Compression fittings/unions
- Flanges etc. (for flanged
- c) connections only)
- Thermowell (As specified
- d) below)
11. Thermowell connection : ½" NPT (M) or 150 RF Flanged
- Tag number, service engraved in
12. Nameplate : stainless steel tag plate

Note: The specifications for RTDs of winding/ bearing of motor/pump, can be as per their manufacturer standards. The manufacturer shall submit the adequate supporting documents for establishing their standard practice. However, the type of RTD shall be Pt-100.

5.02.00 THERMOCOUPLES

1. Type :
 - a) 16 SWG wire of Chromel AlumeI) (Type-K)
 - b) Duplex
 - c) Ungrounded
2. Protecting Tube
 - a) O.D. : 6 mm
 - b) Material : SS-316, Seamless
 - c) Filling : Magnesium oxide (Purity above 99.4%).
3. Response time :
 - a) < 20 seconds for measurement
 - b) < 10 seconds for control
4. Accuracy : $\pm 1.1^{\circ}\text{C}$ up to 300°C & 0.4% of measured temperature range above 300°C
5. Head
 - a) Type : IP-65 universal screwed type
 - b) Material : Stainless Steel
 - c) Terminal blocks : Nickel plated Brass-screw type / silver plated
 - d) Cable connection : $\frac{1}{2}$ " NPT gland and grommet
6.
 - e) Others : Terminal head cover with SS chain and suitable gasket.

Head of TE to be provided with sufficient space and arrangement to mount head mounted temperature transmitter (as applicable).

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|----|-----------------------|---|---|
| 7. | Accessories | : | a) Adjustable nipple-union-nipple
[1/2" Sch 80 X 1/2" NPT] with
thermowell connection

b) Compression fittings/unions

c) Flanges etc. (for flanged
connections only)

d) Thermowell (As specified
below) |
| 8. | Thermowell connection | : | 1/2" NPT (M) or 150 RF Flanged |
| 9. | Nameplate | : | Tag number, service engraved in
stainless steel tag plate |

5.03.00 TEMPERATURE GAUGE

- | | | | |
|----|--------------------------------|---|---|
| 1. | Type | : | Expansion type (Liquid filled system) |
| 2. | Sensing Element
Material | : | Bourdon – SS-316 |
| 3. | Bulb and Capillary
Material | : | SS-316 |
| 4. | Capillary Tubing | : | Inner sheath - solid drawn Material
copper tube
Outer sheath - PVC tube |
| 5. | Movement Materials | : | Stainless Steel / Direct Bourdon tip
connection to pointer spindle |
| 6. | Case Material | : | Stainless Steel stove enameled, black
finish, threaded bezel ring, clear glass |

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|---------------------------|---|---|
| | | cover conforming to IP 65. |
| 7. Dial size | : | 150 mm |
| 8. Scale | : | Black lettering on white background in
270 Deg.C arc |
| 9. Over range protection | : | 125 percent of FSD |
| 10. Capillary Glanding | : | 1/2" NPT(M) x compression fitting (SS)
to suit capillary |
| 11. Instrument Connection | : | Bottom connection for local mounting,
back connection for panel mounting |
| 12. Process Connection | : | 1/2" NPT (M) or 150 RF Flanged |
| 13. Extension Neck Length | : | 50 mm |
| 14. Compensation | : | a) Capillary compensation |
| 15. | : | b) Case compensation |
| 16. Performance | : | a) Accuracy : + /- 1.0 percent of
full scale Deflection |
| | : | b) Repeatability : Less than 0.5
percent of full range |
| | : | c) Response time: 15 seconds
(max.). |
| 17. Capillary length | : | 3.0 meters (local) / 15.0 metres (local
panel) |
| 18. Other features | : | Shatter proof glass |
| 19. Nameplate | : | Tag number, service engraved in
stainless steel tag plate |
| 20. Accessories | : | SS316 Thermowell |

5.04.00 THERMOWELL

- | | | |
|----------------|---|---|
| 1. Material | : | SS-316 |
| 2. Manufacture | : | Drilled from bar stock, Hex Head,
Tapered design (As per ASME PTC
19.3) |

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- | | | | |
|-----|------------------------|---|---|
| 3. | Process connection | : | M33x2 |
| 4. | Certification | : | Not applicable |
| 5. | Bore concentricity | : | +5% of wall thickness |
| 6. | Identification mark | : | Tag number punched on head |
| 7. | Surface treatment | : | Polish after machining |
| 8. | Element connection | : | ½" NPT (M) or 150 RF Flanged |
| 9. | Head | : | Hex |
| 10. | Length of the hex head | : | 31.75 mm (min.) |
| 11. | Accessories | : | SS Plug and chain for test thermo wells
SS Nameplate, Flange with companion
flange & all required accessories for
flanged connections. |

Note: Wake frequency calculations shall be furnished for all thermowells for approval.

Thermowells shall be designed such that the resonant frequency is above the exciting frequencies generated by vortex shedding in the process fluid.

5.05.00 METAL TEMPERATURE THERMOCOUPLE

- | | | | |
|----|----------------------------|---|---|
| 1. | Measuring medium | : | Metal temperature |
| 2. | Type | : | Chromel Alumel (Type-K)
Duplex, Ungrounded |
| 3. | Insulation | : | Mineral Insulation Magnesium Oxide |
| 4. | Wire gauge | : | 16 AWG |
| 5. | Protective sheath | : | SS |
| 6. | Protective sheath diameter | : | 8 mm O.D. |
| 7. | Characteristics | : | Special limits of error as in ANSI thermocouple MC 96.01 |
| 8. | Accessories | : | ½" BSP SS sliding end connector, weld pad, clamps of heat resistant steel |

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|----|----------------|---|-----------------------------|
| 1. | Type | : | Hydrometer Type |
| 2. | Mounting | : | On line |
| 3. | Accuracy | : | +/- 2% of range |
| 4. | Scale | : | Black letter on white scale |
| 5. | End connection | : | PVC flange |

9.06.00 DENSITY/ CONCENTRATION METER

- | | | | |
|----|--------------------|---|---|
| 1. | Wetted Part | | Stainless Steel |
| 2. | Enclosure | | Stainless Steel (IP-65) |
| 3. | Power Supply | | 24 V DC |
| 4. | Output signal | : | 4-20 mA DC (isolated) into 600 ohms |
| 5. | Accuracy | | ±0.001 g/cc |
| 6. | Indication | : | LCD display |
| 7. | Temp. Compensation | : | Integral |
| 8. | Accessories | | Mounting hardware, integral amplifier
(if required), cable glands, tag plate
etc. |

10.00.00 SOLENOID VALVES

- | | | | |
|----|---------------------|---|--------------------------------------|
| 1. | Operating Principle | : | Electromagnetic (noiseless) |
| 2. | Coil voltage rating | : | 240 V AC /24 V DC (as required) |
| 3. | Ways | : | 2/3/4 way |
| 4. | Port size | : | 1/4" NPT all ports |
| 5. | Body | : | SS bar stock |
| | Trim | : | SS-316 |
| 6. | Duty | : | Suitable for continuous energization |
| 7. | Sealing | : | Airtight and leak proof |
| 8. | Ambient Temperature | : | 0 - 50 ° C |

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- | | | | |
|-----|-------------------|---|--|
| 9. | Fluid Temperature | : | 0-150 ° C (approx.) |
| 10. | Coil Enclosure | : | Stainless Steel |
| 11. | Insulation | : | Class-H |
| 12. | Coil Casing | : | IP-65 (Explosion proof for NEC Class-1, Division-1 area) |
| 13. | Mounting | : | On pipe or on panel |
| 14. | Cable Connection | : | ½" NPT |
| 15. | Accessories | : | Cable glands, SS Tag plate |

Note : 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.

TEMPERATURE TRANSMITTER (TT)

Following specifications are applicable for Dual input/ Single input temperature transmitter.

Temperature transmitter shall be 2-wire (loop powered) directly powered from 4-20mA input cards of DDCMIS. TT shall be fully compatible with thermocouples and RTDs being

provided by the contractor. Temperature compensation for thermocouples shall be performed in the temperature transmitter itself.

S No.	Features	Essential/Minimum Requirements
1.	Output	2-wire (power supply from input card of control system) with 4-20mA output with superimposed HART protocol signal
2.	Input	Same transmitter shall be capable to handle Pt-100 RTD, Thermocouples –K, R & ,S types (Selectable through HART terminal/calibrator)
	Isolation	Min 500 VAC
	EMC compatibility	As per EN 61326
	Power supply	24 V C +/- 10%
3.	Housing	Weather proof as per IP-67, metallic housing with durable corrosion resistant coating
4.	Electrical connection	Plug and Socket connector except hazardous area
5.	Diagnostics display	& Self-Indicating feature and digital display on transmitter
6.	Operating Ambient temperature	85 deg C without display. 70 deg C with display.
7.	Mounting	2 inch pipe mounting with Canopy.
8.	Accessories	As required by service and operating condition.
9.	Composite Accuracy	(Refer note 2) RTD =<0.25% of 0-250 deg C span T/C-K type =<0.2% of 0-600 deg C span CJC accuracy (for thermocouples) shall be =< 1 deg C

Notes:

1. In case of failure (open or burn-out) of RTD/thermocouple, transmitter shall provide low temperature output.
2. Dual input temperature transmitter shall have bump less changeover facility to second sensor in case first sensor fails. This changeover is to be alarmed in control system.
3. Composite accuracy is to be calculated as summation of all applicable accuracies of temperature transmitter for converting sensor input to output (e.g., A/D accuracy, basic accuracy, digital accuracy, etc.) and temperature effect on these



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

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accuracies at ambient temperature of 50 deg C, based on the figure/ formula given in the standard product catalogue for span as specified above for various types of temperature elements specified. All such accuracy/ temperature effect figures in catalogue shall be first converted to deg C, and then percentage of this converted accuracy in specified span shall be calculated to compare with the specified composite accuracy figures. All temperature transmitters shall be interchangeable (i.e. can be used for either RTD or thermocouple) and composite accuracy shall be met for each type of input as specified above.

4. Above mentioned parameters/features of offered models shall be strictly as defined in standard published catalogue of the manufacturer only.
5. Dual input temperature transmitters can also be accepted in place of single input TT.

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6.00.00 ANALYZERS

All Analyzers shall be of microprocessor based design. The general technical specification of the analyzers is provided in this section. Bidder in his offer shall indicate the sample flow requirement of each analyzer and the total quantity of cooling water required for the system.

6.01.00 CONDUCTIVITY ANALYZER

A. Sensor

1. Type of Cell : Flow thru'
2. Conductivity Range : As per process
3. Cell Constant : 0.01 / 0.1 / 1.0 depeding upon range
4. Temp. Compensation : Manual and Automatic (Integral) 0-100°C
5. Process Connection : Screwed
6. Wetted Parts : Electrodes-SS 316L/ Insulators KYNAR/ Viton
7. Pressure Rating : 10 kg/cm²
8. Accessories : Vessel (SS 316) with ½" NPT connection
9. Cable : Upto transmitter in flexible conduct

B. Transmitter

1. Type : Microprocessor based, Single stream
2. Mounting : 2" pipe
3. Protection Class : IP-65 or better
4. Output : 4-20 mA DC (isolated)
5. Display : Digital Display in Engineering Unit, Alarm Status.
6. Zero/Span Adjustment : Front Panel Membrane type Keyboard

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- | | | | |
|-----|--------------------|---|---|
| 7. | Temp. Compensation | : | Automatic |
| 8. | Diagnostic | : | Self diagnostic for electronics, electrode etc |
| 9. | Alarm | : | Dual set point, hysteresis and time delay adjustable |
| 10. | Enclosure | : | Die cast aluminum, epoxy coated |
| 11. | Cable Termination | : | Internal (cable entry through conduit) |
| 12. | Accuracy | : | ± 1.0 % of measured range |
| 13. | Response time | : | Less than 5 sec |
| 14. | Stability | : | ± 1.0 % of output range / month non-cumulative |
| 15. | Accessories | : | <p>a. 2" pipe mounting bracket, Sensor cable with flexible conduit (as required), 1/2" NPT Cable Gland, SS Tag plate, For cation conductivity- Dual Ion-Exchange column, resin, etc. (minimum 12 months' requirements).</p> <p>b. Retractable type conductivity sensor along with flow chamber and other accessories shall be provided for vacuum application. Transmitter (local) along with 4-20 Ma output to SWAS room & DDCMIS shall also be provided.</p> |

For cation conductivity analyser bidder to follow conductivity analyser specification and provide cation column additionally.

6.02.00

pH ANALYSER

A. Sensor

- | | | | |
|----|---------------------|---|---|
| 1. | Type of Cell | : | Flow thru' |
| 2. | Range | : | 0-14 pH |
| 3. | Type of measurement | : | Combination electrode |
| 4. | Temp. Compensation | : | Manual and Automatic (Integral) 0-100°C |
| 5. | Process Connection | : | Screwed |

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- | | | |
|-----|---------------------|---|
| 6. | Measuring Electrode | : Glass, high independence, thin electrode in one housing |
| 7. | Pressure Rating | : 10 kg/cm ² |
| 8. | Accessories | : Vessel (SS 316) with ½" NPT connection |
| 9. | Cable | : Upto transmitter in flexible conduct |
| 10. | Preamplifier | : Integral or separate |
| 11. | Liquid Junction | : Ceramic / Kyner or equivalent |

B. Transmitter

- | | | |
|-----|--------------------|---|
| 1. | Type | : Microprocessor based, Single stream |
| 2. | Mounting | : 2" pipe |
| 3. | Protection Class | : IP-65 or better |
| 4. | Output | : 4-20 mA DC (isolated) |
| 5. | Display | : Digital Display in Engineering Unit, Alarm Status. |
| 6. | Accuracy | : ± 0.2% of FSD or better |
| 7. | Response time | : Less than 5 sec |
| 8. | Stability | : ± 0.001 pH /week |
| 9. | Repeatability | : ± 1% or better |
| 10. | Temp. Compensation | : Automatic (Pt-100 sensor) |
| 11. | Diagnostic | : Self diagnostic for "Calibration required"/ "Calibration O.K.", electrode checking etc. |
| 12. | Alarm | : Dual set point, hysteresis and time delay adjustable |
| 13. | Enclosure | : Die cast aluminum, epoxy coated |
| 14. | Cable Termination | : Internal (cable entry through conduit) |
| 15. | Accessories | : 2" pipe mounting bracket, Sensor cable |
-

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with flexible conduit (as required), ½”
NPT Cable Gland, SS Tag plate, ,
Ultrasonic Electrode Cleaner, Buffer
solution tablets

6.03.00

SILICA ANALYZER

1. Type : Colorimetric monitor, gravity / pumped feed Microprocessor based
2. No. of Streams : Multi-stream with atleast one stream as spare
3. Output : 4-20 mA DC (isolated) into 600 ohms
4. Readout : Digital Indicating meter for direct readout
5. Accuracy : ± 1% of F.S.D or better
6. Reproducibility : ± 2% of F.S.D. or better
7. Calibration : Manual & automatic
8. Cycle time : Less than 10 min or better
9. Operating temperature : 0-50 ° C
10. Temperature Compensation : (Pt-100 Sensor)
11. Mounting : 2” pipe
12. Life of light source : 10,000 hours (approx.)
13. Alarm Facility : 2 HI & 2 LO independently adj. over span.
14. Enclosure Protection : IP-65
15. Accessories : Reagent cabinet , Sample strainer, Reagent Reservoir etc., Phenolic name plate, Reagents & consumables, Special cables.

6.04.00

SODIUM ANALYZER ASSEMBLY

1. Type of Cell : Flow Through ion-selection electrode
2. Flow Chamber : Plexi Glass Body or equivalent

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- | | | | |
|-----|----------------------|---|--|
| 3. | Measuring Electrode | : | Sodium Selective Glass Electrode |
| 4. | Output | : | 4-20 mA DC (isolated) into 600 ohms |
| 5. | Temp. Compensation | : | Automatic upto 45 deg.C |
| 6. | Read Out | : | Digital Indicating meter |
| 7. | Accuracy | : | < 5% of reading |
| 8. | Response Time | : | 2 minutes or better |
| 9. | Mounting | : | Flush Panel |
| 10. | Calibration | : | Automatic |
| 11. | Alarm Facility | : | 2 HI and 2 LO independently adj. over span. |
| 12. | Enclosure Protection | : | IP-65 or better |
| 13. | Accessories | : | Phenolic tag plate, Sample filter, Pressure regulator & flow meter, Automatic calibration kit, Reagents and consumables, Special cables, ½" NPT cable gland. |

6.05.00

HYDRAZINE ANALYZER

- | | | | |
|-----|--------------------|---|--|
| 1. | Type | : | Electrochemical |
| 2. | Output | : | 4-20 mA DC linear |
| 3. | Readout | : | Digital Indicating Meter, linear read-out |
| 4. | Accuracy | : | ± 2% of FSD or better |
| 5. | Reproducibility | : | 2% of FSD or better |
| 6. | Drift | : | 2 ppb/month or better |
| 7. | Temp. Compensation | : | Automatic up to 45 ° C |
| 8. | Response Time | : | 1 minutes or better |
| 9. | Mounting | : | Flush Panel |
| 10. | Alarm Facility | : | 2 HI and 2 LO independently adj. over span |

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11. Preferred Feature : 2 Hi and LO alarm LED visible from front , Power supply on/failure LED
12. Enclosure Protection : IP-65/ NEMA 4 or better
13. Accessories : Sample Conditioning kit, Phenolic nameplate, Special cable upto transmitter with flexible conduit Chemical reagents for 12 months, ½" NPT Cable Glands

6.06.00 DISSOLVED OXYGEN ANALYZER

1. Type : Electro-chemical, Microprocessor based.
2. Range : As per process.
3. Type of Cell : Flow through sampling type (continuous)
4. Enclosure : IP-65 or better
5. Output : 4-20 mA DC isolated to a load of 600 Ohms (minimum)
6. Temp.Compensation : Automatic up to 45°C
7. Readout : Digital Indicating meter
8. Accuracy : Better than $\pm 2\%$ of full scale for Transmitter
9. Sensor Response Time : 90% in 30 seconds or better
10. Mounting : Flush panel
11. Alarm Facility : 2 HI & 2 LO independently adj. over span.
12. Preferred Feature : HI & LO Alarm LED visible from front, Power supply on/failure LED, In-built calibration facility.
13. Accessories : Phenolic nameplate, Special cable upto transmitter with flexible conduit, ½" NPT Cable Glands

6.07.00 CHLORIDE ANALYZER

1. Type : Electro-chemical, Microprocessor based.

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2. Type of cell : Chloride ion selective electrode
3. Enclosure : IP-65 or better
4. Output : 4-20 mA DC isolated to a load of 600 Ohms (minimum)
5. Temp. Compensation : Automatic with Pt 100
6. Ambient temperature : 45°C
7. Readout : Digital Indicating meter
8. Accuracy : Better than $\pm 2\%$
9. Reproducibility : $<3\%$
10. Detection limit : 0.5 mg/ L or better
11. Analysis time : 5 minutes (max).
12. Cycle time : Adjustable
13. Calibration : Manual or automatic
14. Mounting : Flush panel
15. Alarm : 1 HI, 1 LO & 1 system alarm
16. Control accessories : Sample level detector, Reagent level detector, Calibration solution level detector, Automatic sample, rinse and drain valve, Pump for calibration solution, Pump for reagent solution.
17. Accessories : Reagent solution tank, Calibration solution tank

6.08.00 **TURBIDITY ANALYZER**

1. Type : Nephelometric (Light reflection principle)
2. Range : 0.001-100 NTU
3. Body : Corrosion resistant polystyrene
4. Enclosure : IP-65 or better

5.

Output

:

4-20 mA DC isolated to a load of 600 Ohms (minimum)
6.

Readout

:

LCD Display
7.

Accuracy

:

Better than $\pm 2\%$ of full scale
8.

Repeatability

:

$\pm 1\%$ of reading or ± 0.002 NTU (which ever is greater)
9.

Accessories

:

Phenolic nameplate, Special cable upto transmitter with flexible conduit, $\frac{1}{2}$ " NPT Cable Glands, 2" pipe mounting bracket, Calibration kit & standard solution etc.

6.09.00

IRON ANALYZER

1.

Type

:

Colorimetric
2.

Range

:

0-100 ppb, 0-2 ppm
3.

Material

:

Kynar (Probe), Hastelloy C (Reflector)
4.

Enclosure

:

IP-65 or better
5.

Output

:

4-20 mA DC isolated to a load of 600 Ohms (minimum), 2NO+NC Contacts
6.

Readout

:

LCD Display
7.

Operating Temperature

:

45 Deg. C
8.

Accessories

:

As required.

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- 1.00.00 **GENERAL REQUIREMENT**
- 1.01.00 ENCLOSURES FOR INSTRUMENTS AND OTHER EQUIPMENT
- 1.01.01 All panels, cabinets, distribution boxes, junction boxes, terminal boxes and all other field mounted equipment / enclosures shall have suitable environmental protection as detailed in Section-I of this volume of the specification.
- 1.02.00 SURFACE PREPARATION & PAINTING
- 1.02.01 All sheet metal panel/ desk exterior steel surfaces shall be sand blasted, ground smooth and painted as specified below.
- 1.02.02 Suitable filler shall be applied to all pits, blemishes and voids in the surface. The filler shall be sanded so that surfaces are level and flat; corners are smooth and even. Exposed raw metal edges shall be ground burr-free. The entire surface shall be blast clean to remove rust and scale and all other residue due to the fabrication operation. Oil, grease and salts etc. shall be removed from the panels by one or more solvent cleaning methods prior to blasting.
- 1.02.03 Two spray coats of inhibitive epoxy primer surfacer shall be applied to all exterior and interior surfaces, each coat of primer surfacer shall be of dry film thickness of 1.5 mil. A minimum of two spray coats of final finish color (Catalyzed epoxy or polyurethane) shall be applied to all surface of dry film thickness 2.0 Mil. The finish colors for exterior and interior surfaces shall conform to the following shades:
- Exterior – Opaline green shade 275 of IS: 5 or equivalent international code..
 - Interior - Brilliant White.
- 1.02.04 Paint films, which show sags, cheeks, blisters, teardrops, fat edges or other painting imperfections, shall not be acceptable.
- 1.03.00 WIRING
- 1.03.01 All spare contacts of relays, switches and push buttons shall be wired up to the terminal blocks. All intercommunications between sections of panels/desks shall be furnished.
- 1.03.02 Each wire shall be identified at both ends with wire designation as per approved wiring diagram. Heat shrinkable type ferrules with indelible computerized ink print shall be used with cross- identification.
- 1.03.03 All wire termination shall be made with insulated sleeve and crimping type lugs. Wire shall not be spliced or tapped between terminals. Open-ended terminal lugs will not be accepted. Wires shall not be looped around the terminal screws or studs.

- 1.03.04 Internal wiring should be terminated uniformly on one side of the terminal block leaving the other side available for termination of outgoing cables. Internal wiring shall be grouped so that all outgoing wiring to each particular remote location is terminated on adjacent terminal blocks. Interior wiring and jumperings shall be arranged so that external connections can be made from internal side of terminal blocks. Common connections shall be limited to two (2) wires per terminal.
- 1.03.05 Wiring shall be arranged to ensure free access to all instrument or devices for maintenance. No wire shall be routed across the face or rear of any device in a manner, which will impede the opening of covers or obstruct access to leads, terminals or devices
- 1.03.06 Wires shall be dressed and run in trays or troughs with clamp-on type covers. Wirings may be neatly bunched in groups by non-metallic cleats or bands. Each group shall be adequately supported along its run to prevent sagging or strain on termination.
- 1.03.07 Shield wires shall be terminated on separate terminal blocks. Common connections shall be limited to two wires per terminal. Signal circuit shields shall be grounded at the power supply end only or as recommended by manufacturer.
- 1.03.08 All low level signal cables shall be separately bundled to from control cable and maintained at 300 mm minimum spacing from control bundles.
- 1.03.09 Panel internal wiring shall follow distinct color-coding to segregate different voltage levels viz. 24V DC, 48V, 110V AC, 240V AC, 220V DC etc.
- 1.03.10 Thermocouple lead wires, analyzer measuring lead wires, or any other lead wires carrying measuring signal of the order of low milli volt or micro volt shall be electrically and physically isolated from other AC and DC wiring. Shielded wires used in such cases for panel internal wiring shall be continuous and ungrounded with the shield terminated individually and separately in panel terminal block.
- 1.03.11 Wiring to door mounted devices shall be provided with multi-strand wires of (49 strands minimum) adequate loop lengths of hinge-wire so that multiple door openings will not cause fatigue failure of the conductor.
- 1.03.12 Internal wiring in factory pre-wired electronic systems cabinets may be installed according to the Contractor's standard wire size, insulation, and method of termination on internal equipment. Insulation for all wiring, including circuit board wiring, back panel wiring, power supply wiring and interconnecting cables between devices shall pass the vertical flame test per IPCEAS-1981. Identification of conductors may be done by insulation color-coding identified on drawings or by printed wiring lists.

- 1.04.00 TERMINAL BLOCKS
- 1.04.01 All terminal blocks shall be rail mounted/ post mounted type, cage clamp type with high quality non-flammable insulating material of melamine suitable for working temperature of 105 Deg C. The terminal blocks in field mounted junction boxes, instrument enclosures racks etc. shall be suitable for cage clamp connections. The terminal blocks in Control Equipment Room termination/ marshalling cubicles shall be suitable for post mounted cage clamp connection at the field input end. The exact type of terminal blocks to be provided by Bidder shall be subject to Owner.
- 1.04.02 All terminal blocks shall be provided complete with all required accessories including assembly rail, locking pin and section, end brackets, small partitions, transparent covers, support brackets, distance sleeves, warning level, marking etc. For RTDs ring - tong type lugs shall be used at Junction Boxes.
- 1.04.03 The characteristics of the terminal blocks shall be as follows.
- i) High contact force, independent of conductor cross-section and large contact surface area.
 - ii) Integrated self-loosening protection to avoid shifting of contact surface that may allow contamination of connection point.
 - iii) Inspection and maintenance free (resistant to thermal aging and vibration)
 - iv) Low and constant voltage drop
- 1.04.04 The insulation of the terminal blocks shall be of suitable thermoplastic material.
- 1.04.05 The spacing between Terminal blocks channels in panels and cubicles shall be adequate for routing the cable troughs and to allow adequate free workspace for termination and removal of wires. The terminal blocks shall be arranged with atleast 100 mm clearance between two sets of terminal blocks and junction box walls.
- 1.04.06 Signals of different voltage levels shall be clearly segregated by providing separate rows to each type of signal and by using terminal blocks of different color for each type of signal and by providing barrier strips between them.
- 1.04.07 Terminal blocks shall be provided with white marking strips / self-adhesive marker cards and where permitted by the safety codes and standards, shall be without covers. Power terminals and high voltage (above 48 volts) terminals shall have protection covers. All terminals shall be provided with permanent terminal identification numbers on both sides.
- 1.04.08 At least 20% spare unused terminals shall be provided on each terminal block for circuit modifications and for termination of all conductors in a multi-conductor control cable.

- 1.04.09 The bottom of the terminal block shall be at least 200 mm above the cable gland for bottom entry type panels.
- 1.04.10 For extending 24 V DC supply to panels, the size of the terminals shall be decided based on voltage drop and not based on current.
- 1.04.11 Other requirements of the terminal blocks are as follows:
- i) The last terminal in a rail-mounted assembly shall be closed with an end plate and end bracket.
 - ii) For visual and electrical separation of terminal groups, partition plates shall be provided, which can be push fitted after forming an assembly.
 - iii) Design shall permit testing of incoming and outgoing signals by using suitable test plug and socket without disconnecting the cable connections.
 - iv) It shall be possible to use jumper plugs through the above test plug socket to connect adjacent terminals. Adequate number of short circuit jumper plugs shall be provided for the purpose.
 - v) Where more than one connection to a terminal block is required, two tier terminals shall be used.
- 1.05.00 **GROUNDING**
- 1.05.01 Separate Protective and Electronic system ground as required shall be provided.
- 1.05.02 All panels, desks, cabinets shall be provided with a continuous bare copper ground bus (Frame ground), bolted to the panel structure at bottom on both sides and effectively ground the entire structure. The bolts shall face inside of panels.
- 1.05.03 For electronic system cabinets the electronic system ground bus (Electronic ground) shall be similar but insulated from the cabinet and shall be separately connected to the system ground. The same ground may be used to earth the shield of shielded signal cables, otherwise a separate ground bus shall be provided for connecting the signal cable shields. Cable shields shall be grounded at the panel end only and shall never be left open. The electronic ground between panels of a shipping section shall be firmly looped.
- 2.00.00 **CONTROL DESKS & PANELS**
- 2.01.00 **GENERAL**
- 2.01.01 All control desk, panels etc. shall be furnished fully wired with necessary provision for convenience outlets, internal lighting, utility receptacles, grounding, ventilation, space heating, anti-vibration pads, internal piping &

- accessories as required for completeness of the system.
- 2.01.02 The design shall conform to the EN ISO 11064 (Ergonomical design of Control Room), Part 1, 2 and 3.
- 2.01.03 The exact dimensions, material, construction details, grounding, general arrangement etc. shall be as per actual requirement and shall be finalized during detail engineering and subjected to Owner's approval.
- 2.01.04 Incoming power supply feeders shall be duplicated. Alarm shall be provided for failure of a power supply feed.
- 2.01.05 For Control desk/ panel mounted instruments/ devices etc. which are to be powered from UPS, all required conversion of interface equipments/ accessories to make such devices compatible with UPS supply shall be provided. All necessary hardware like input switches/ fuse unit for each feeder as well as switch fuse unit for each instrument/ device on the power supply line shall be provided. From UPS redundant feeders shall be provided with suitably rated MCB and provision of fast auto changeover of UPS feeders.
- 2.01.06 Crating of the panels and desks shall be suitable for protection against shock, vibration, inappropriate handling and inclement weather conditions during transportation and warehousing. Mounted equipment shall have adequate protection against damage during handling, transit and storage. Suitable desiccant shall be used inside the packing case.
- 2.01.07 Nameplate
- a) Nameplate shall be provided for instrument or device mounted on the panel.
 - b) Nameplates for panels shall be provided both in front and rear.
- 2.02.00 CONTROL DESK
- 2.02.01 Control desk shall be free standing, floor mounting, table top type with doors at back and shall be constructed of 3 mm thick (minimum) CRCA steel or Aluminium extrusion. Aluminium structure shall be anodized or powder coated paint finish. The top surface of control desk shall be 30 mm (minimum) thick with the top 12 mm (minimum) of acrylic solid surface and the remaining 18 mm of laminated medium density fibre (MDF) board.
- 2.02.02 Monitors with retractable keyboard shall be provided on the desk. Desk shall be arranged in arc-like shape without any sharp edges. Edges shall be extruded PVC or rounded post-formed laminate.
- 2.02.03 Desks shall be of modular, scalable and industrially ruggedized design and shall have connections for PA system handsets & telephone sets.
- 2.02.04 Desks shall have concealed cable trays for wire dressing. Both Horizontal & Side Managers (2 separate horizontal cable routing wire baskets for power & data cables) shall be provided.

Each User station will be provided with 2 separate power distribution units (1 for Main line & 1 for UPS line). Each power distribution unit will have 6 points of 5/13 Amp sockets, Mains MCB On/Off Switch & Indicator.

Adequate heat management provision for Exhaust of heat from within the Console Desk Assembly shall be provided. There will be multiple fans provided in the Main Control Desk. Each Fan will be of 230 VAC 250 CFM Ball Bearing based. Ventilation louvers will be provided on both Front & Rear Modesty with special Air Filters. Adequate space for CPU & Other equipments placed with in the desk.

- 2.02.05 Design shall include Earthing bolts.
- 2.02.06 Back installed items shall be suitably concealed from front view.
- 2.02.07 All operator workstations for SG, TG, Auxiliaries & Off-site Plants shall be mounted on this Control Desk. The cabling / wiring between OWS & CPUs, power supply cables etc. shall be aesthetically routed and concealed from view.
- 2.02.08 HARDWIRED DEVICES ON CONTROL DESK (DRAW OUT SECTION)
- Release and Lamp Test push buttons shall be provided for a set of push buttons (decided during detail engineering stage). Depending on the type of control/ function, required number of push buttons/ indicating LEDs & their color, push button stations shall be selected. The size of push button stations shall be 24 x 48 mm or 25 x 50 mm and shall have service inscription details at the front. Emergency push buttons (with cover) shall be mounted on top of Control Desk.
- 2.03.00 BACK UP PANEL
- 2.03.01 Construction shall be from CRCA steel of thickness not less than 3mm.
- 2.03.02 Upright back-up panel shall be provided where hardwired devices shall be mounted on a mosaic grid type console. The mosaic grid tiles shall be of 24 mm x 48 mm (or 25 mm x 50 mm) size, made of heat & flame retardant, self extinguishing and non-hygroscopic material with flat matt finish without glare and non reflecting type.
- 2.03.03 DDCMIS Back-up Panel (referred as Unit Control Panel-UCP) shall also mount annunciation fascia (minimum 500 nos.) and the flame monitoring cameras along with other hardwired devices as decided during detail engineering stage by Owner. Color coding shall also subject to Owner's approval.
- 2.03.04 Colored Mimic for different Off-site plant control systems (as enumerated elsewhere in this specification) and hardwired annunciation system shall also

be mounted on the back up panels.

2.04.00 PANELS/CABINETS

2.04.01 All DDCMIS system modules, power supply components and other Local Control panels (PLC/Relay based) shall be housed in cabinets as specified below.

2.04.02 The cabinet mounted equipments shall be fully assembled, installed in mounting racks, wired and fully tested as per specification requirements and Owner approved drawings prior to shipment to the project site.

2.04.03 The Bidder shall ensure that the cabinets are complete & ready for installation before dispatch from manufacturing works. The installation work at project site for these cabinets shall only involve connections through multi-pair cables from marshalling cabinets (wherever provided) to system cabinets and inter-cabinet/cabinet to Control Desk/ Back up Panel.

2.04.04 All electronic cards, network components, power supply modules etc. located shall be suitably housed in cabinets and shall be neatly arranged in sub-racks. Network components shall be visible in door closed condition (e.g. Glass doors etc.) as approved by Owner.

2.04.05 Bidder shall design the cabinet internal arrangement, floor cutout and cable gland plate such that all the cables entering or leaving the cabinet can be properly glanded in the gland plate.

2.04.06 The packaging density of panels shall be such that the temperature rise within the panels shall never exceed 10°C above ambient even under worst operating conditions. Cooling Fans shall be provided wherever required and this shall be of industrial grade.

2.04.07 TECHNICAL PARTICULARS

- | | | | |
|----|--------------------------|---|--|
| 1. | Material of Construction | : | Cold Rolled Coal Annealed (CRCA) steel sheet |
| 2. | Thickness of Sheet | : | a) 2.0 mm for faces supporting instruments / terminals |
| | | : | b) 1.6 mm for other sides and top |
| 3. | Construction | : | Welded throughout as per approved National Standards |
| 4. | Post welding operation | : | a) Grounding of all welds to smoothness |
| | | : | b) Rounding of corners |

- : c) Cleaning of weld spatters
- 5. Panel height : 2300 mm (approx)
- 6. Corners : 7 mm inner radius
- 7. Dimensional Tolerances :
 - a) In height & length - 3 mm
 - b) In height between adjacent sections - 2 mm
 - c) Total for a group - 6 mm
- 8. Doors : Double, recessed, turned back edges, full height front & rear
 - i) Thickness of Sheet : 2 mm
 - ii) Hinges : Stainless steel
 - iii) Door latches : Three point type
 - iv) Door gaskets : Neoprene rubber on fixed frame to result dust proof/weatherproof enclosure
 - v) Opening of the doors : Outward
 - vi) Louvers : With removable wire mesh to ensure dust and vermin proof
- 9. Gland plates : Removable in sections
4 mm thick (bottom)
- 10. Cable entry : Bottom
- 11. Hardware :
 - a) Anti vibration pad- 15 mm
 - b) Predrilled base channel ISMC – 100 or equivalent for all sides
 - c) Stainless steel buff- finished 2 mm thick kick plate for all sides
 - d) Stainless steel scratch strips along desk edges fixed with pan-head recessed screws
 - e) Rubber strips to ensure air

tightness between kick plate and finished floor

f) Lifting hook / Eye bolt

g) Drawing pocket

h) Door switch, lamps, thermostat, heaters and industrial grade cooling fans,, illumination fixtures

12. Name Plate : Both at front and back surface of the panel

13. Fixing of name plate : Stainless steel pan head screws

14. Name plate material : Laminated phenolic (3 layers)

15. Lettering : Black with white engraved

16. Mounting of terminal blocks : Vertical angle support bracket tack welded on sheet steel plate, screwed on internal wall of enclosure

2.05.00 FURNITURE

All the furnitures in the Central / Local control Room (s), Engineers' rooms, Instrument laboratory , SWAS Room & any other rooms with C&I equipments located in different plant buildings under Bidder's scope shall be included in Bidder's scope of supply. Bidder shall provide following industrial grade furniture items as a minimum from reputed manufacturers/suppliers meeting International Standards. The furniture shall be modular and latest with ease of operational features. The furniture shall be modern, aesthetically designed, modular, flexible, space saving and future safe.

2.05.01 WORK STATION FURNITURE

Modular work station furniture, suitable for mounting servers & historians, programmer stations, PC based systems, printers (A4/A3 color laserjet) etc. shall be provided.

2.05.02 PC RACK

PC Racks shall be provided to mount CPUs of workstations/PCs of OWS/LVS etc. in control room. For each PC / workstation / monitor at least one chair shall be included.

2.05.03 CHAIRS

Industry standard revolving chairs with wheels and with provision for adjustment of height (hydraulically/gas lift) shall be provided for the operators, unit-in-charge & other personnel in control room area. These shall be designed for sitting for long duration such that these are comfortable for the back.

2.05.04 TABLES

Industry standard computer tables shall be provided & shall be as approved by Owner during detailed Engineering. Glass top teak wood horse shoe shaped table with vertical file mounting arrangement (two layers to house approx. 40 Nos of files and lockable drawers at both ends) for Engineering Room shall be provided.

2.05.05 ALMIRAHs

Steel Almirahs shall be provided for keeping documents in the documentation room. Glass doors for each rack shall be provided such that the documents are visible from outside. Size of the rack shall be sufficient to easily fit technical manuals. The exact details shall be approved by Owner during detailed Engineering.

2.05.06 KEYPAD

One keypad per unit shall be provided for the storing of keys of relevant areas of the unit in the control room.

2.05.07 LOCKERS

Suitable lockers shall be provided in the room adjacent to the control room for storing of personal articles of control room personnel. Also, lockers of bigger size shall be provided in documentation Room for storing of personal documents. Details shall be finalized and approved by Employer during detailed engineering.

~~3.00.00 LVS PANEL~~

~~3.01.00 An arc shaped Large Video Screen (LVS) panel shall be supplied for mounting large video screens in number of tiers in various Control rooms as specified elsewhere in this specification.~~

~~Bidder shall provide and fix ACP cladding around the LVS screen including covering the LVS back side and LVS stand. The cladding will be from floor finish to 600 mm above LVS screen like a self-standing partition with necessary openings for system requirement. ACP paneling shall be with 304 grade & approx. 0.5 mm mirror finish SS strip.~~

~~3.02.00 The profile, dimensions and the general arrangement shall be finalized & approved by Owner during detailed engineering. Recommendations, if any, for the control room lighting in order to ensure continuous proper viewing of the LVS screen by the operator & shift incharge (without any fatigue) shall be~~

- ~~clearly brought out by the Contractor in his offer, alongwith all relevant details/basis.~~
- 3.03.00 ~~Any other requirement for proper LVS mounting & functioning & viewing shall also be specifically brought out by the Contractor in his offer, along with all relevant details.~~
- 4.00.00 **LOCAL INSTRUMENT RACK (LIR) & LOCAL INSTRUMENT ENCLOSURE (LIE)**
- 4.01.00 GENERAL
- 4.01.01 Devices (Transmitters/ Switches) located in the field shall be suitably grouped together to the extent possible and installed in the LIE (Closed Rack) and LIR (Open Rack) in Boiler/TG Building and Off-site plant areas.
- 4.01.02 Racks and enclosure shall be factory prefabricated & painted and shall complete with internal piping, tubing, manifold, isolation valves, blowdown valves, integral junction box, illumination etc.
- 4.01.03 No more than six instruments shall be grouped in a single rack / enclosure.
- 4.01.04 Racks shall be installed above the tapping points for air, flue gas and coal air mixture application whereas for applications such as for water and steam, racks to be installed below the source point.
- 4.01.05 Attention shall be paid in the layout to avoid air traps in liquid piping and water accumulation in air /gas piping.
- 4.01.06 Racks used for furnace, flue gas and air application shall be provided with intermittent & continuous air purging
- 4.01.07 Welding of impulse lines shall comply with the provisions of the latest applicable ANSI Code for Pressure Piping.
- 4.01.08 Earth stud shall be furnished at rack for safety grounding.
- 4.02.00 LOCAL INSTRUMENT ENCLOSURE (LIE)
- 4.02.01 Enclosure shall be free standing type. Racks shall be adequately reinforced to ensure true surfaces and to provide support. Major load - bearing posts shall be suitably supported by gusset plates or moment members.
- 4.02.02 Enclosure outer shall be constructed from at least 3 mm thick steel plate and epoxy painted to shade gray. Base frame shall be made of ISMC 100 and black colour finish.
- 4.02.03 2" NB galvanized pipes shall be laid horizontally and supported at two end channels to mount transmitters at accessible height. Center posts or any

member, which would reduce access, shall be avoided.

- 4.02.04 Double leaf interlocking front opening doors with three point locking shall be provided and shall be arranged for maximum possible access to the interior. Key shall be of identical for all enclosures.
- 4.02.05 Doors shall have concealed quick removal type pinned stainless steel hinges and locking handles. Gaskets shall be used between all mating sections to achieve dust and weather proof enclosure rated for IP-65 including the internal junction box. All enclosures shall have access doors on front side.
- 4.02.06 Removable type bulkhead plates of thickness not less than 6 mm shall be mounted at the racks with suitable high temperature gasket. Impulse lines within the enclosures shall be properly clamped.
- 4.02.07 All internal wirings between the instruments and junction box shall run through flexible conduits. No exposed wirings within transmitter racks both open and closed type, is admissible.
- 4.02.08 Racks shall have a common blowdown drain header, which will connect individual instrument blowdown line after suitable pressure breaking through regulating globe type blowdown valves. Covered funnels shall be used for saturated liquid and steam service, whereas, open funnels may be used for cold liquid services. Header (2" NB ASTM A 106, Sch-80 Gr. C) shall be suitably sloped and shall have one end flanged and extending beyond the rack for connection to plant drain header..
- 4.02.09 Each rack shall be provided with one receptacle, light fixtures with wire guard and one lighting switch each at instrument & Junction box compartments with wire guard. Lighting switches may be door actuated & mounted inside the panel. Outlet box, switch box and device covers shall be of galvanized stamped steel. Light switches and receptacles shall be installed inside the enclosure on the wall near the latch side of the enclosure door. Light fixtures shall be installed on the ceilings of the enclosures.
- 4.02.10 Power supplies for miscellaneous devices shall be provided with MCB located within the enclosures. MCB shall be mounted in fuse blocks. Nameplates shall be furnished above the MCB blocks, identifying the devices being served.
- 4.02.11 Vibration dampeners shall be installed for supporting each enclosure. The loading at each corner of the enclosure shall be determined by actual test weighting when construction is complete to determine the correct length of each dampener for proper loading of the dampener in accordance with manufacturer's recommendations
- 4.03.00 LOCAL INSTRUMENT RACK (LIR)
- 4.03.01 Rack shall be free standing type constructed from 6 mm thick steel channel frame provided with a canopy to protect the instrument from dripping water or

falling objects and shall be epoxy painted. Canopy shall be of CRCA steel sheet of at least 3 mm thickness.

4.03.02 Rack Major load-bearing posts shall be suitably supported by gusset plates or moment members. Suitable fenders grill shall be welded to the end-posts of the rack to outline a boundary beyond which no mounted equipment shall project to protect instrument from accidental contact during personnel movement. Center posts or any member, which would reduce access, shall be avoided.

4.03.03 2" NB galvanized pipes laid horizontally and supported at two end channels shall be employed at working accessible height for mounting of instruments.

4.03.04 All internal wirings between the instruments and junction box shall run through flexible conduits. No exposed wirings are admissible.

4.03.05 Racks shall have a common blowdown drain header, which will connect individual instrument blowdown line after suitable pressure breaking through regulating globe type blowdown valves. Covered funnels shall be used for saturated liquid and steam service, whereas, open funnels may be used for cold liquid services. Header (2" NB ASTM A 106, Sch-80 Gr. C) shall be suitably sloped and shall have one end flanged and extending beyond the rack for connection to plant drain header..

Each rack shall be provided with one receptacle, one light fixture with wire guard and one lighting switch. Outlet box, switch box and device covers shall be galvanized stamped steel. Light fixtures shall be installed on the canopy of the rack

4.03.06 Power supplies for miscellaneous devices shall be provided with MCB located within the enclosures. MCB shall be mounted in fuse blocks. Nameplates shall be furnished above the MCB blocks, identifying the devices being served.

4.04.00 JUNCTION BOX

- | | | |
|----------------------|---|--|
| 1. Type of Enclosure | : | Dust tight & weatherproof conforming to IP 65 |
| 2. Material | : | 3 mm sheet steel / fiberglass reinforced polyester(UV stabilized) |
| 3. Type of Cover | : | Solid unhinged with retention chain / Screwed at all four corners |
| 4. Paint | : | i) Exterior : Opaline green shade 275 of IS: 5
ii) Interior - Brilliant Glossy White. |

- Surface / Two (2) inch Pipe stanchion
5. Mounting : (At a dry compartment at one side of the enclosure / rack with front opening type door)
6. Cable Entry : 3 mm (min) Bottom / side Gland plate
7. Gasket : Neoprene
8. Grounding : Brass earth lug with green screw head
External-2 nos , Internal-1no. (M6)
9. Number of Drain Holes : Two at bottom capped
10. Identification : Label for JB and Tags for cable
11. Accessories : Rail mounted cage clamp type screwless terminals (suitable for conductor size up to 2.5sq.mm of suitable voltage grade) with markers and 20% spare terminals
- b) Cable gland (Brass) & raceways
- c) Ferrules & lugs (Brass)
- d) Aluminum back panel
- e) Canopy at top
- f) Mounting brackets
- g) bolts and nuts made of brass etc.

218999/2021/PS-PEM-MAX

FORM NO. PEM-669-0



DATA SHEET FOR LOCAL PANELS

SPECIFICATION NO.: PE-SS-999-145-054A

VOLUME

SECTION

REV. NO.

02

DATE: 16.09.2013

SHEET

1

OF

3

TAG No. Qty.....

Data Sheet No.: PES-145A-DS1-0

Data Sheet A & B

DATA SHEET-A FOR LOCAL PANEL
(TO BE FILLED BY PURCHASER)DATA SHEET-B
(TO BE FILLED-UP BY
BIDDER)

GENERAL	MANUFACTURER		
	CONSTRUCTION		☒ FOLDED ☐ WELDED
	ENCLOSURE SHEET THICKNESS (As per Section 8.13, Volume V of contract specification)	FRONT	☐ 2.0 mm
		OTHER	☐ 2.0 mm
		DOOR	☐ 1.6 mm
		HEIGHT	☐ 2365 mm for stand alone panels. ☐ Other
	OTHER	☐ Load bearing sheet front shall have 3mm thickness	
TECHNICAL	INPUT POWER SUPPLY * (As per Electrical specification) (ANY OTHER POWER REQUIREMENT TO BE DERIVED FROM THIS SUPPLY ONLY)		☐ 240V 50 Hz AC ☐ 220V DC ☒ 415V 3 PHASE 3W ☐ 400V 3 PHASE 4W
	NO. OF FEEDERS (As per Electrical specification)		☐ ONE ☐ TWO
	STARTER WITH MCC		☐ REQUIRED ☒ NOT REQUIRED
	IPR POSITION		☒ MCC ☐ RELAY PANEL
	CONTACT RATING OF RELAY		☒ 5 Amp, 230 V AC ☒ 0.25 Amp, 220V DC
	CONTROL SUPPLY		☐ 110V AC ☐ 220V AC ☐ 220V DC ☐ Other. (As per requirement)
	ALARM ANNUNCIATOR WINDOW (EXCLUDING SPARES)		_____ NOS. (AS REQUIRED)
	TEMP SCANNER (IF REQUIRED –NO. OF CHANNELS TO BE SPECIFIED UNDER SEC-C)		☐ REQUIRED ☒ NOT REQUIRED
	PAINT TYPE (As per Annex-1, Section 7.6, Volume IV of contract specification)		☐ EPOXY ENAMEL ☐ EPOXY POWDER COATED
	MIMIC (TYPE OF MIMIC- MATERAIL, THICKNESS TO BE SPECIFIED DURING DETAILED ENGG.)		☒ REQUIRED ☐ NOT REQUIRED
	PANEL COLOUR (EXTERNAL) (As per Annex-1, Section 7.6, Volume IV of contract specification)		☐ LIGHT GREY ☐ OPALINE GREEN
	FINISH (EXTERNAL) (As per Annex-1, Section 7.6, Volume IV of contract specification)		☐ MATT ☐ GLOSSY ☐ SEMI GLOSSY
	PANEL COLOUR (INTERNAL) (As per Annex-1, Section 7.6, Volume IV of contract specification)		☐ WHITE ☐ CREAM ☐ OFF WHITE
	FINISH (INTERNAL) (As per Annex-1, Section 7.6, Volume IV of contract specification)		☐ MATT ☐ GLOSSY ☐ SEMI GLOSSY
	CLASS OF PROTECTION		☒ IP-55 (FOR INDOOR SERVICE) ☒ IP-67 (FOR OUTDOOR SERVICE) ☐ ANY OTHER
	CONTROL HARDWARE		☒ RELAY BASED
	FOUNDATION ARRANGEMENT		☐ FOUNDATION BOLTS ☐ ANCHOR FASTENERS
	WEIGHT OF PANEL (Kg.)		(Vendor to specify)

218999/2021/PS-PEM-MAX

FORM NO. PEM-669-0



DATA SHEET FOR LOCAL PANELS

SPECIFICATION NO.: PE-SS-999-145-054A

VOLUME

SECTION

REV. NO.

02

DATE: 16.09.2013

SHEET

2

OF

3

TAG No. Qty.....

Data Sheet No.: PES-145A-DS1-0

Data Sheet A & B

DATA SHEET-A FOR LOCAL PANEL
(TO BE FILLED BY PURCHASER)DATA SHEET-B
(TO BE FILLED-UP BY
BIDDER)

	PANEL TYPE	☐ PRESSURISED ☐ UNPRESSURISED As per Requirement		
	CABLE GLAND	☒ DOUBLE COMPRESSION		
	AMMETER (TYPE OF INPUT) *	☐ 1 Amp CT ☐ 4-20 mA		
	SCOPE OF SUPERVISION FOR ERECTION & COMMISSIONING	☐ APPLICABLE ☒ NA		
	* TO BE CO-ORDINATED WITH PEM ELECTRICAL			
NAME DESIGNATION SIGNATURE DATE	PREPARED BY	CHECKED BY	APPROVED BY	COMPANY SEAL NAME: SIGNATURE: DATE:
	AANCHAL CHOUDHARY	SACHIN SRIVASTAVA	MA MANSOORI	
	SR.ENGR	DY.MNGR	D. GM	
	16.09.2013	16.09.2013	16.09.2013	

FORM NO. PEM-666-0

	DATA SHEET FOR LOCAL PANELS		SPECIFICATION NO.: PE-SS-999-145-054A		
			VOLUME		
			SECTION		
			REV. NO. 02	DATE: 16.09.2013	
			SHEET 3 OF 3		
TAG No. Qty.....			Data Sheet No.: PES-145A-DS1-0		
Data Sheet C					
DATA SHEET-C FOR LOCAL PANEL (TO BE FILLED BY CONTRACTOR AFTER AWARD OF CONTRACT)					
GENERAL	MANUFACTURER				
	CONSTRUCTION				☐ FOLDED ☐ WELDED (As per requirement EDN)
	ENCLOSURE SHEET THICKNESS	FRONT			
		OTHER			
		DOOR			
		HEIGHT			
OTHER					
TECHNICAL	INPUT POWER SUPPLY				
	NO. OF FEEDERS				
	CONTACT RATING OF RELAY				
	TEMP SCANNER				
	CONTROL SUPPLY				
	ALARM ANNUNCIATOR WINDOW (EXCLUDING SPARES)				
	PAINT TYPE				
	PANEL COLOUR (EXTERNAL)				
	FINISH (EXTERNAL)				
	TYPE OF MIMIC MATERIAL OF MIMIC THICKNESS OF MIMIC				
	PANEL COLOUR (INTERNAL)				
	FINISH (INTERNAL)				
	CLASS OF PROTECTION				
	CONTROL HARDWARE				
	FOUNDATION ARRANGEMENT				
	WEIGHT OF PANEL (Kg.)				

FORM NO. PEM-666-0

	DATA SHEET FOR LOCAL PANELS			SPECIFICATION NO.: PE-SS-999-145-054A	
				VOLUME	
				SECTION	
				REV. NO. 02	DATE: 16.09.2013
				SHEET 3	OF 3
TAG No. Qty.....				Data Sheet No.: PES-145A-DS1-0	
Data Sheet C					
DATA SHEET-C FOR LOCAL PANEL (TO BE FILLED BY CONTRACTOR AFTER AWARD OF CONTRACT)					
	PANEL TYPE				
	CABLE GLAND				
	AMMETER (TYPE OF INPUT)				
	SCOPE OF SUPERVISION				
NAME SIGNATURE DATE	PREPARED BY	CHECKED BY	APPROVED BY		COMPANY SEAL NAME: SIGNATURE: DATE:
	AANCHAL CHOUDHARY	SACHIN SRIVASTYAVA	MA MANSOORI		
	16.09.2013	16.09.2013	16.09.2013		

FORM NO. PEM-6686-0



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

SPEC NO.: PE-TS-417-145-I		
VOLUME		
SECTION		
REV. NO.	00	DATE : 03.04.2018
SHEET	OF	

CABLE BOQ

218999/2021/PS-PEM-MAX

CABLE SIZES FOR 5X800 MW YADADRI TPS	
Sl no.	Cable Type
	G-TYPE
1	2P X 0.5 sqmm
2	4P X 0.5 sq mm
3	8P X 0.5 sqmm
4	12P X 0.5 sqmm
5	2P X 1.5 sqmm
	F-TYPE
1	4P X 0.5 sqmm
2	8P X 0.5 sqmm
3	12P X 0.5 sqmm
4	20P X 0.5 sqmm
	CONTROL CABLE
1	3C X 2.5 sqmm
2	5C x 2.5 sq mm
3	12C x 2.5 sqmm

ERECTION HARDWARES

1.00.00 GENERAL TECHNICAL REQUIREMENTS

This section provides the general technical guidelines for the erection materials for instruments. All erection materials shall be of good quality and conform to the operating environment of the corresponding instrument.

However, any item required for erection of Bidder supplied system but not categorically indicated in this section, shall be supplied by the Bidder and all these items shall conform to International / National standards / codes.

1.01.00 Electrical Accessories

Electrical conduit and associated materials shall conform to the requirements of the articles which follow :

- a) Rigid Steel Conduit
 - i) Conduits up to and including 25 mm shall be of 16 SWG and conduits above 25 mm shall be of 14 SWG. Minimum size of conduits shall be 19 mm.
 - ii) Each piece of conduit shall be straight, free from blister and other defects and covered with capped bushing at both ends.
 - iii) All rigid conduit couplings and elbows shall be hot dip galvanized rigid mild steel in accordance with IS:9537 Part-I (1980) and Part-II(1981).. The conduit interior and exterior surfaces shall have a continuous zinc coating with an over coat of transparent enamel lacker or zinc chromate. Conduits shall be furnished in standard length of 3 meters, threaded at both ends.
 - iv) All rigid conduit fittings shall conform to requirements of IS:2667,1976. Galvanised steel fittings shall be used with steel conduit. All flexible conduit fittings shall be liquid tight, galvanized steel. The end fitting shall be compatible with the flexible conduit supplied.
- b) Flexible Conduit
 - i) Flexible conduit shall be of three layer construction of very high quality of lead coated steel. Outside and inside layer shall be reinforced with heat resistant material.
 - ii) Lead coating outside and inside of the conduit steel surface shall provide a non-corrosive characteristic particularly in acidic atmosphere. Besides flexibility, this shall be strong enough to stay at the desired profile without support and shall be durable and strong so as to offer sufficient mechanical protection. It shall also be fully liquid dust and air tight and shall withstand a continuous hydraulic pressure up to 2 Kg/Sq. cm and temperature up to 200 °C.
- c) Special Fittings
 - i) Conduit sealing and fittings shall be provided as required and shall be consistent with the area and equipment with which they are installed.
 - ii) Double locknuts shall be provided on all conduit terminations not provided with threaded lugs and couplings. Locknuts shall be designed to securely bond the conduit to the enclosure when tightened. Locknuts shall not loosen due to vibration.

- 1.02.00 Electrical Junction Box:
Please refer to Section VII , Subsection – D of this volume of the Specification.
- 1.03.00 Cable Gland
1. Type : Double compression
 2. Entry Thread : NPT / ET
 3. Material : Brass
 4. Finish : Cadmium Plated.
 5. Protection : IP 54 or better
 6. Accessories : Neoprene gasket, locknuts, reducers etc
- 1.04.00 Cable Tray
1. Material : Mild steel, slotted
 2. Thickness : not less than 2.0 mm
 3. Finish : Hot dip galvanized
 4. Perforation : As per MFR standard
 5. Cover : Suitable for tray
- 1.05.00 Process Hook Up Accessories & specification
Material and rating of the hook up items shall suit the piping and fluid condition. Hook up materials shall be IBR certified for applicable cases. Bidder shall furnish hook up drawings and the drawings for open racks & closed racks for owner's approval.
- 1.05.01 Seamless Stainless Steel Pipe
1. Reference : ASTM A-312 TP 316
 2. Material Grade : TP 316
 3. Type : Seamless /Plain end
 4. Size : As applicable (e.g. ½" NB etc)
 5. Schedule : 40
 6. Standard Length : 5 meter
- 1.05.02 Stainless Steel Pipe Fittings

1. Reference : ASTM A-182 F 316 / ANSI B16.11
2. Type : Forged
3. Rating : 3000 lbs / 6000 lbs / 9000 lbs
4. Size : To suit related SS pipe.
5. End connection : Generally socket weld
6. Type of Fittings : Reducing coupling, male-female reducer, straight coupling, equal tee, three piece union, elbow, cap etc.

1.05.03 Seamless Stainless Steel Tube

1. Reference : ASTM A-213 , ASTM A-249 or ASTM A-269
2. Material Grade : TP 316
3. Size : As applicable (e.g. ½" OD X 0.083" wall thickness / ¼" OD X 0.049" wall thickness etc.)
4. Type : Cold drawn annealed, pickled, passivated, de-scaled, hydraulically cleaned seamless tube.
5. Properties : The tube shall be free from scratches and suitable for bending and capable of being flared by hardened and tapered steel pin. The expanded tube shall show no crack or rupture. Hardness shall be RB 80.
6. Test Pressure : 400 Kg/Sq. cm (minimum)
7. Tolerance : ± 0.13 mm for outside diameter
: ± 15 % for wall thickness
8. Standard Length : 5 meter
9. Test : Flare, Hardness, Ball and Bubble Test

1.05.04 Stainless Steel Tube Fittings

1. Reference : ASTM-A-182
2. Type : Double ferrule double compression
3. Material : 316 Stainless steel forged
4. Ferrule : 316 Stainless Steel

- | | | | |
|---------|----|--------------------|--|
| | 5. | Type of Fittings | : Male / female connector, elbow, cross /equal tee, straight connector, bulkhead union, ferrule etc. as required to suit installation. |
| | 6. | Size | : To suit SS tubing and NPT end connection |
| 1.05.05 | | C.S. Pipe | |
| | 1. | Reference | : ASTM-A 106 Gr. C |
| | 2. | Material | : Cold drawn seamless black C.S. |
| | 3. | Type | : Seamless / Plain ends |
| | 4. | Size | : As applicable (e.g. 1/2" NB etc) |
| | 5. | Schedule | : 80, 160, XXS as required |
| | 6. | Standard Length | : 5 meter |
| 1.05.06 | | C.S. Pipe Fittings | |
| | 1. | Reference | : ASTM-A 105 / ANSI B16.11 |
| | 2. | Type | : Forged |
| | 3. | Rating | : 3000 lbs / 6000 lbs / 9000 lbs |
| | 4. | Size | : Suitable to related C.S.Pipe |
| | 5. | End connection | : Generally socket weld |
| | 6. | Type of Fittings | : Reducing coupling, male-female reducer, straight coupling, equal tee, three piece union, elbow, cap etc. |
| 1.05.07 | | A.S. Pipe | |
| | 1. | Reference | : ASTM-A 335 P22 AS PER ANSI B 36.10 |
| | 2. | Material | : Cold drawn seamless A.S. |
| | 3. | Type | : Seamless / Plain ends |
| | 4. | Size | : As applicable (e.g. 1/2" NB etc) |
| | 5. | Schedule | : XXS |
| | 6. | Standard Length | : 5 meter |
| 1.05.08 | | A.S. Pipe Fittings | |

- | | | | |
|---------|----|--------------------------|--|
| | 1. | Reference | : ASTM-A 182 F22 AS PER ANSI B 16.11 |
| | 2. | Type | : Forged |
| | 3. | Rating | : 9000 lbs |
| | 4. | Size | : Suitable to related A.S.Pipe |
| | 5. | End connection | : Generally socket weld |
| | 6. | Type of Fittings | : Reducing coupling, male-female reducer, straight coupling, equal tee, three piece union, elbow, cap etc. |
| 1.05.09 | | G.I.Pipe | |
| | 1. | Reference | : IS-1239, Part-I |
| | 2. | Type | : Medium grade, threaded at both ends protected with end caps |
| | 3. | Material | : Continuous ERW galvanized MS pipe |
| | 4. | General | : Pipe shall be galvanized both inside and outside |
| | 5. | Size | : As applicable (e.g 1/2"/3/4"/1" etc.) |
| 1.05.10 | | G.I.Pipe Fittings | |
| | 1. | Reference | : IS-1239, Part-II for material, dimension, thread etc. |
| | 2. | Style | : Threaded |
| | 3. | Type of Fittings | : Equal tee, three piece union, unequal tee, straight socket, 90 Deg. elbow, reducing socket cap. etc. to suit installation. |
| | 4. | Size | : Suitable to related G.I.Pipe |
| 1.05.11 | | Carbon Steel Globe Valve | |
| | 1. | Reference | : ASTM A-105 |
| | 2. | Type | : Globe |
| | 3. | Construction | : Forged Body Cadmium Plated |
| | 4. | End Connection | : As applicable (eg. 1/2" Socket Weld etc.) |
| | 5. | Rating | : Cl. 800 / CL. 2500 |

- | | | |
|-----|-----------------|-----------------------------------|
| 6. | Material | : Body - Carbon steel |
| | | : Stem - Hardened Steel |
| | | : Plug - AISI 316 SS |
| | | : Seat- Stainless steel stellited |
| 7. | Packing | : Teflon / Grafoil as required |
| 8. | Yoke | : ASTM A105 |
| 9. | Hand wheel | : Carbon steel |
| 10. | Design standard | : As per ANSI B 16.34 |

1.05.12 Stainless Steel Globe Valve

- | | | |
|-----|-----------------|--|
| 1. | Reference | : ASTM A-182 F316 |
| 2. | Type | : Globe |
| 3. | Construction | : Forged Body |
| 4. | End Connection | : As applicable (eg. ½" Socket Weld etc.) |
| 5. | Proof Pressure | : 400 Kg/Cm2 |
| 6. | Material | : Body - Stainless steel |
| | | : Stem - Hardened Steel |
| | | : Plug - AISI 316 SS |
| | | : Seat- Stainless steel stellited |
| 7. | Packing | : Teflon as required |
| 8. | Yoke | : ASTM A182 F316 |
| 9. | Handwheel | : Carbon steel |
| 10. | Design standard | : As per ANSI B 16.34 |

1.05.13 Alloy Steel Globe Valve

- | | | |
|----|--------------|------------------|
| 1. | Reference | : ASTM A-182 F22 |
| 2. | Type | : Globe |
| 3. | Construction | : Forged Body |

- | | | |
|-----|-----------------|--|
| 4. | End Connection | : As applicable (eg. ½" Socket Weld etc.) |
| 5. | Rating | : CL. 2500 |
| 6. | Material | : Body - Alloy steel |
| | | : Stem - Hardened Steel |
| | | : Plug - AISI 316 SS |
| | | : Seat- Stainless steel stellited |
| 7. | Packing | : Grafoil as required |
| 8. | Yoke | : ASTM A182 F22 |
| 9. | Handwheel | : Carbon steel |
| 10. | Design standard | : As per ANSI B 16.34 |

1.05.14 Structural Steel

Steel supports for JB's, trays; tubes and related equipments shall not be limited to the following:

- | | |
|----|---------------------------------------|
| a) | MS Angle |
| b) | MS Channel |
| c) | I-Beam |
| d) | Hexagonal head Bolt & Nut with washer |
| e) | Foundation Bolt & Nut |
| f) | Expansion Bolt |
| g) | Steel Plates / Flats |
| h) | CRCA sheet |
| i) | 50 NB Pipe |
| j) | Pipe clamps, U Bolts & Nuts |
| k) | Checker plate |

1.05.15 Condensate Pot

- | | | |
|----|----------------|--|
| 1. | Reference | : ASTM A182 F22 /ASTM A105 |
| 2. | Material | : Alloy steel / carbon steel as per application |
| 3. | Construction | : Drilled from barstock |
| 4. | End connection | : As applicable (e.g 3 nos. ½" socket weld end etc.) |

	5. Accessories	: Vent valves
1.05.16	Instrument Valve Manifold	
	1. Type	: Two valve manifold : Five valve manifold
	2. Mounting	: Remote 2" Pipe Mounting / Transmitter Rack mounting
	3. Construction	: Single block (bar stock)
	4. Material	: Forged body and bonnet AISI 316 stainless steel
	5. Ports	: Mfg std. (e.g 1/2 " NPT (F) etc.)
	6. Rating	: 420 Kg/Sq. cm at ambient
	7. Operating Temperature	: (-)30 to (+)170 Deg C
	8. Packing	: PTFE Wafer
	9. Seat & Stem	: AISI 316 SS
	10. Plug	: AISI 316 SS free to turn on stem / 17-4 PH
	11. Handle Bar	: AISI 316 SS
	12. Connection	: Straight
	13. Accessories	: Plugs for all ports, Mounting Bracket , bolts , nuts
1.06.00	Pneumatic Hook Up Accessories	
1.07.00	Air Header	

Technical Particulars	For Panel	For Field
Material of Construction	: Stainless steel	: Stainless steel
Inlet Connection	: 2" NPT (M)	: 1" NPT (M)
Header Take-off Material	: Stainless steel	: Stainless steel
Take off connection	: 1 / 2" NPT (M)	: 1/ 2" NPT (M)
Take-off Valves Material	: stainless steel	: stainless steel

Tube Take-off	: Tube adapter on valve	: Tube adapter on valve
Drain	: SS drain valve at lowest point	: SS drain valves at lowest point

218999/2021/PS-PEM-MAX

FORM NO. PEM-6686-0



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

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

VOLUME

SECTION

REV. NO.

00

DATE : 03.04.2018

SHEET

OF

KKS PHILOSOPHY



KKS NUMBERING PHILOSOPHY

1X800MW KOTHAGUDEM

KKS NUMBERING PHILOSOPHY

For identifying (tagging) an instrument / equipment in Power plant KKS numbering scheme is used. The purpose is to assign a unique number to every equipment in the power plant. For C&I equipment unique number are to be provided up to the signal level so that a unique number Input / Output exist in DCS for every signal.

Normally KKS number is a 10 digit alpha-numeric code and is typically split into the following:

X	X	X	A A Y			Y B B	B		
---	---	---	-------	--	--	-------	---	--	--

First three digits indicate the Sub-System. The Code for the major system are given as per **Annexure-1**.

Fourth and Fifth digits are the **Numerical Keys at System Code Level** and used to distinguish between main systems having same Alpha Codes.

Sixth and Seventh digits are the **Equipment / Apparatus / Measuring Circuit Code**. The code of various Equipment / Apparatus / Measuring Circuit is shown in **Annexure-2**

Eight, Nine and tenth digits are the **Numerical Keys at Equipment / Apparatus / Measuring Circuit Code** and used to distinguish between various instruments in the same sub-group. Numerical keys at System / Equipment / Apparatus / Measuring Circuit is shown in **Annexure-3**.

**ANNEXURE-1****List of System / Sub-System Codes used in Power Plant:**

- 1) Compressed air system : QEA, QEC
- 2) Ventilation System : SAA TO SAZ
- 3) Fire Detection & Protection System + Fire Water pumps : SGM, SGN, SGO, SGP
- 4) Sewage Treatment : SJA TO SJZ
- 5) Pre-treatment Plant : GBI, GBM, GBV
- 6) RO DM Plant : GCI, GCM, GBV

ANNEXURE-2**Standard Equipment Codes:**

AA	Valves including drives, also hand operated
AB	Seclusions, Lock, Gates, Doors
AC	Heat Exchanger
AE	Turning, Driving, Lifting equipment
AF	Continuous conveyors, Feeders
AG	Generator Units
AH	Heating and Cooling Units
AK	Pressing and Packaging equipment
AM	Mixer, Stirrer
AN	Blower, Air Pumps / Fans, Compressor Units
AP	Pump Units
AT	Purification, Drying, Filter
AV	Combustion Equipment e.g. grates

Standard Apparatus Codes:

BB	Vessels and Tank
BF	Foundation
BG	Boiler Heating Surfaces
BN	Injector, Ejector
BP	Flow and throughput limitation equipment (Orifice)
BQ	Holdings, Carrying Equipment, Support
BR	Piping, Ducts, Chutes, Compensator
BS	Sound Absorber
BU	Insulations, Sheatings



Standard Measuring Circuits Codes:

CD	Density
CE	Electrical Quantities
CF	Flow, throughput
CG	Distance, Length, Position
CK	Time
CL	Level
CM	Humidity
CQ	Analysis (SWAS)
CS	Speed, Velocity, Frequency
CT	Temperature
CY	Vibration, Expansion

ANNEXURE-3

Numerical Keys

A) Numerical Keys at System Code Level

- i) Use 10, 20, 30, To distinguish between main systems having same Alpha Codes. Examples:
 - a) Main Steam (Left) and Main Steam (Right)
 - b) BFP – A/B/C
 - c) ID Fan – A/B, FD Fan A/B, AH – A/B
- ii) For branch off from main system path having code say 10, keep the same alpha code and use 11, 12, 13 etc. Similarly for other branch off from main system path having code say 20, keep the same alpha code and use 21, 22, 23 etc and shall carry on further in the same way.
- iii) If the branch off from main system / sub system path is used for some other system, where different alpha codes can be applied, then in that case the said branch line will be designated by the alpha codes of the system to which it is providing the input.

B) Numerical keys at Equipment Code level:

There are three numerical keys available for each type of equipment code. Following has been agreed upon considering present practice, better flexibility and ease in sorting.

- i) Valves and Dampers --- *Equipment Code – AA*

N1

N2 N3



KKS NUMBERING PHILOSOPHY

1X800 MW KOTHAGUDEM

Motorised (<i>on/off duty</i>)	-	0	01 to 50
Motorised (<i>inching duty</i>)	-	0	51 to 99
Pneumatic (Control)	-	1	01 to 50
Motorised (<i>thyrestor Control</i>)	-	1	51 to 99
Sol. Operated	-	2	01 to 99
(Open / Close duty (Valves, NRVs, Gate)			
Hydraulic	-	3	01 to 99
NRV (Without actuation)	-	4	01 to 99
Manual	-	5	01 to 99
Manual	-	6	01 to 99
Relief & Safety Valves	-	7	01 to 99
Reserve	-	8	01 to 99
Reserve	-	9	01 to 99

ii) Field Instruments

Field Transmitters & Analog Signals	-	0	01 to 99
Field Switches & Binary Signals	-	1	00 to 99
PG Test Point	-	4	00 to 99
Gauges	-	5	00 to 99
Automatic Turbine Tester (ATT)-HWR	-	2	00 to 99

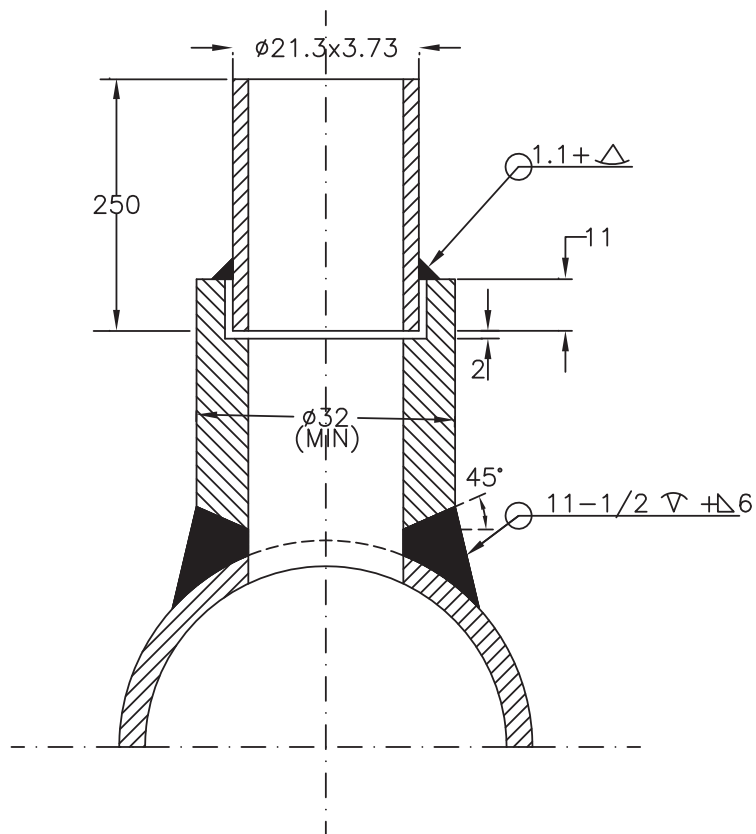
(Reserved for protection Signals used by Hardwar)

Example of Numerical Key Usage:

In line with the philosophy adopted for Valves / Dampers /instruments etc. pumps and fans in the main systems (having different system code) can be numbered as AP/N100 and as AP/N101, 102, Where system code is same.

INSTRUMENT STUB DETAILS

					CUSTOMER:  TELANGANA STATE POWER GENERATION CORPORATION LTD TELANGANA, INDIA 5 x 800 MW YADADRI TPS, UNIT # 1 TO 5				
					CONSULTANT:  TATA CONSULTING ENGINEERS LIMITED BANGALORE, INDIA				
JOB NO. 417 STATUS CONTRACT DISTRIBUTION					 BHARAT HEAVY ELECTRICALS LTD POWER SECTOR PROJECT ENGINEERING MANAGEMENT NOIDA				
REV. DATE ALTD CHD APPD REV. DATE ALTD CHD APPD					COPY RIGHT AND CONFIDENTIAL The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED it must not be used directly or indirectly in any way detrimental to the interest of the company.				
					DEPT CODE NAME SIGN DATE DRN AKS 20.01.18 DESN AKS 20.01.18 CHD RKR 20.01.18 APPD SSB 20.01.18				
					TITLE INSTRUMENT STUB DETAILS				
					DEPT. SCALE SIGN 				
					DRAWING NO. PE-DG-417-145-I101 SHEET 1 OF 6 659 of 669				



NOTE :

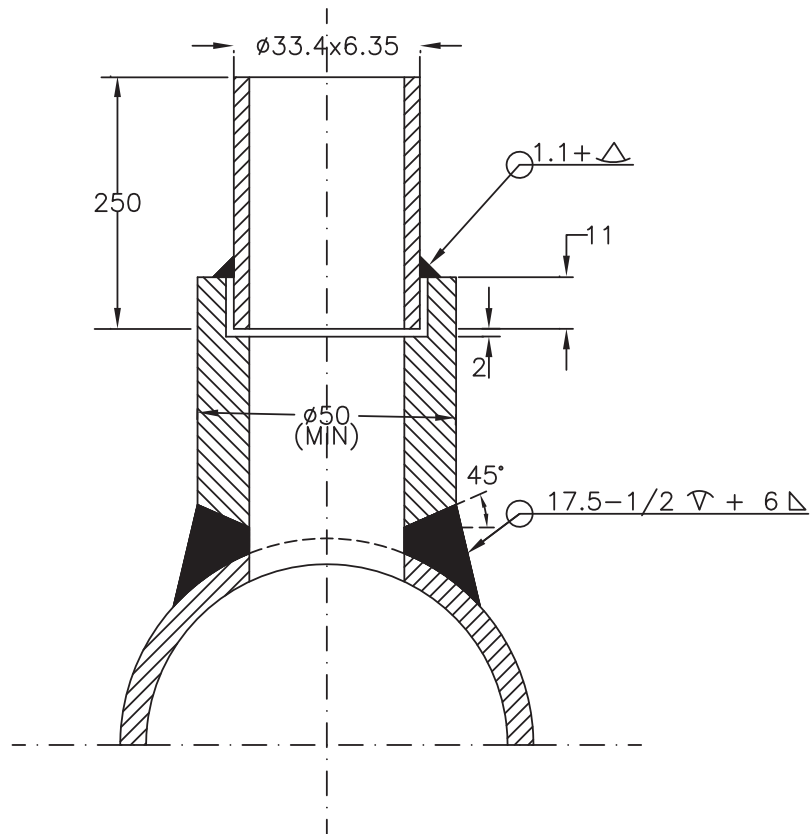
1. MATERIAL OF THE BOSS AND NIPPLE SHALL BE THE SAME AS THE PIPE INTO WHICH IT IS WELDED AND CONFORM TO ANSI B16.11.
2. THE LENGTH OF NIPPLE SHALL BE 250 MM.
3. THE OTHER END OF THE NIPPLE SHALL BE SOCKET WELDED WITH 1/2" GLOBE VALVE OF MATERIAL AS PER ANSI B 31.1.
4. TWO ISOLATION VALVES ARE TO BE USED FOR PRESSURE EXCEEDING 40 Kg/Cm².
5. ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE STATED.
6. EDGE HOLE MUST BE CLEAN AND SQUARE OR ROUNDED SLIGHTLY (1/64" RADIUS) FREE FROM BURRS, WIRE EDGES OR OTHER IRREGULARITIES.



TITLE : 5 x 800 MW YADADRI TPS
 STD INSTRUMENT STUB
 DETAILS
 PRESSURE STUB

SYSTEM PRESS < 60Kg/Cm² & SYSTEM TEMP < 425 Deg C, Nb15 , CL3000

DRG. NO.
 PE-DG-417-145-1101
 REV. 00
 SH. 02 OF 06



NOTE :

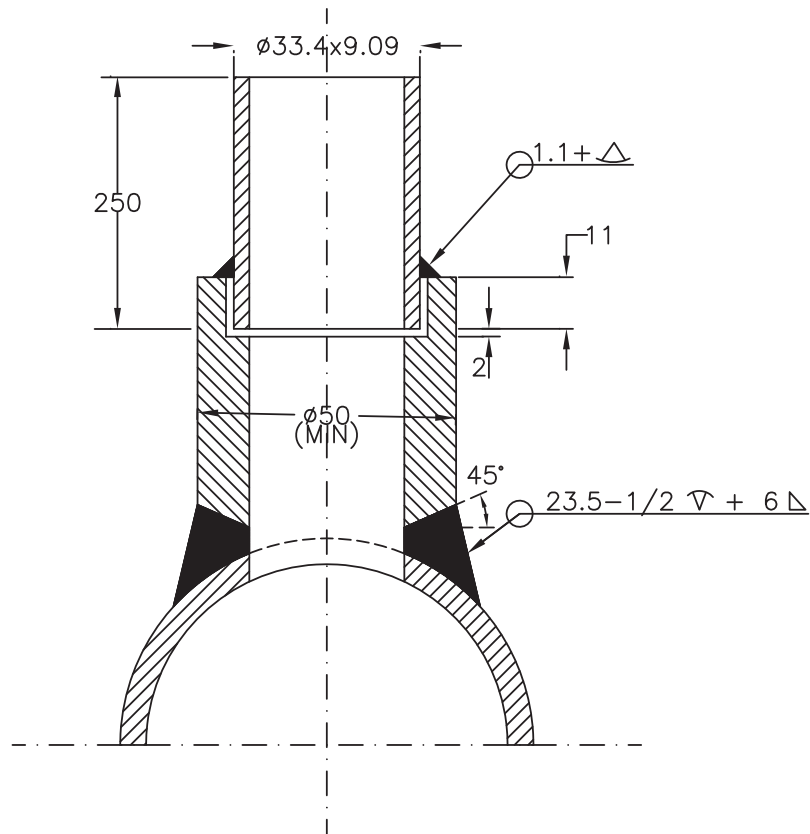
1. MATERIAL OF THE BOSS AND NIPPLE SHALL BE THE SAME AS THE PIPE INTO WHICH IT IS WELDED AND CONFORM TO ANSI B16.11.
2. THE LENGTH OF NIPPLE SHALL BE 250 MM.
3. THE OTHER END OF THE NIPPLE SHALL BE SOCKET WELDED WITH 1" GLOBE VALVE OF MATERIAL AS PER ANSI B 31.1.
4. TWO ISOLATED VALVES ARE TO BE USED.
5. ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE STATED.
6. EDGE HOLE MUST BE CLEAN AND SQUARE OR ROUNDED SLIGHTLY(1/64" RADIUS) FREE FROM BURRS, WIRE EDGES OR OTHER IRREGULARITIES.



TITLE : 5 x 800 MW YADADRI TPS
STD INSTRUMENT STUB
DETAILS
PRESSURE STUB

DRG. NO.
PE-DG-417-145-I101
REV. 00
SH. 03 OF 06

SYSTEM PRESS > 60Kg/Cm² & 425 Deg C < SYSTEM TEMP <= 500 Deg C , Nb25 , CL3000/6000



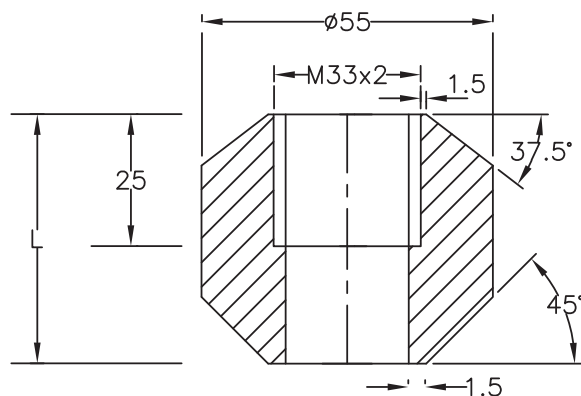
NOTE :

1. MATERIAL OF THE BOSS AND NIPPLE SHALL BE THE SAME AS THE PIPE INTO WHICH IT IS WELDED AND CONFORM TO ANSI B16.11.
2. THE LENGTH OF NIPPLE SHALL BE 250 MM.
3. THE OTHER END OF THE NIPPLE SHALL BE SOCKET WELDED WITH 1" GLOBE VALVE OF MATERIAL AS PER ANSI B 31.1.
4. TWO ISOLATED VALVES ARE TO BE USED.
5. ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE STATED.
6. EDGE HOLE MUST BE CLEAN AND SQUARE OR ROUNDED SLIGHTLY (1/64" RADIUS) FREE FROM BURRS, WIRE EDGES OR OTHER IRREGULARITIES.

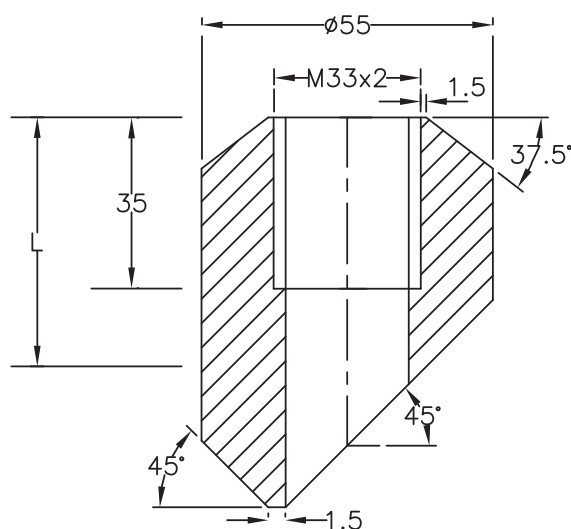


TITLE : 5 x 800 MW YADADRI TPS
 STD INSTRUMENT STUB
 DETAILS
 PRESSURE STUB
 SYSTEM TEMP > 500 Deg C , Nb25 , CL9000

DRG. NO.
 PE-DG-417-145-1101
 REV. 00
 SH. 04 OF 06



TEMPERATURE STUB FOR STRAIGHT IMMERSION



TEMPERATURE STUB FOR SLANT IMMERSION

NOTE :

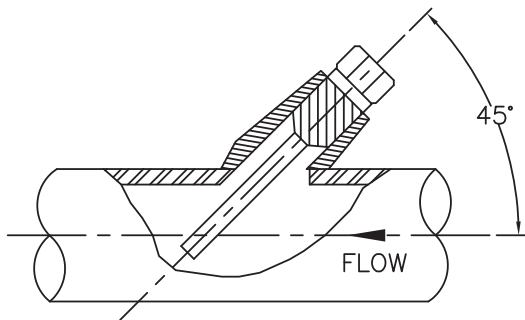
1. MATERIAL OF THE BOSS SHALL BE THE SAME AS THE PIPE INTO WHICH IT IS WELDED.
2. LENGTH OF THE STUB (L) SHALL BE 64/45 mm DEPENDING UPON PIPE SIZE, AS PER CORPORATE STD. AA 7326102.(FOR PIPE OD 88.9 mm TO 159 mm STUB HEIGHT SHALL BE=64mm & FOR PIPE OD ≥ 219.1 mm STUB HEIGHT SHALL BE=45mm)
3. STRAIGHT IMMERSION STUBS SHALL BE USED FOR PIPE OD'S 168.3 mm & ABOVE. THE STUB HEIGHT FOR PIPE OD 168.3 mm TO <219.1 mm SHALL BE 64 mm.
4. SLANT IMMERSION STUBS SHALL BE USED FOR PIPE OD'S 88.9 mm TO 159 mm.
5. FOR MAIN PIPE OD'S 88.9 mm & BELOW SUITABLE EXPANDER SHALL BE USED.
6. PLEASE REFER SHEET-6 FOR THERMOWELL INSTALLATION.



TITLE : 5 x 800 MW YADADRI TPS
STD INSTRUMENT STUB
DETAILS

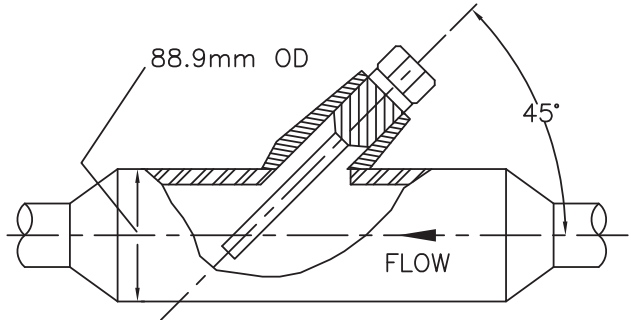
TEMPERATURE STUB

DRG. NO.
PE-DG-417-145-I101
REV. 00
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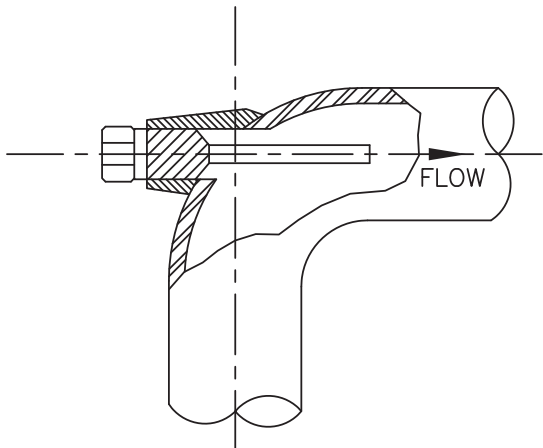
INSTALLATION TYPE-1

FOR MAIN PIPE OD 88.9mm to 159mm



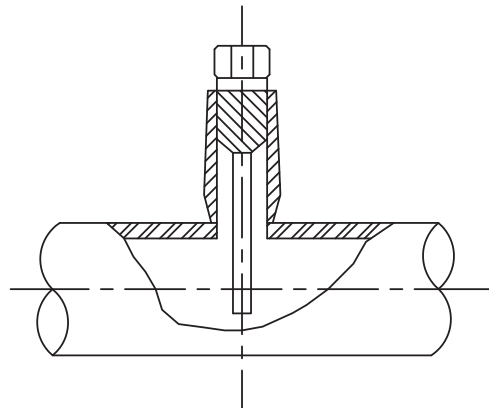
INSTALLATION TYPE-2

FOR MAIN PIPE OD BELOW 88.9mm



INSTALLATION TYPE-3

FOR MAIN PIPE OD 88.9mm & BELOW



INSTALLATION TYPE-4

FOR MAIN PIPE OD 168.3mm & ABOVE



TITLE : 5 x 800 MW YADADRI TPS

STD INSTRUMENT STUB
DETAILS

THERMOWELL INSTALLATION

DRG. NO.
PE-DG-417-145-I101

REV. 00
SH. 06 OF 06

218999/2021/PS-PFM-MAX

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

SECTION III



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

SCHEDULE OF PRE-BID CLARIFICATION

All clarification from the Technical Specification shall be filled in by the BIDDER clause by clause in this format only.

VOLUME	SECTION	CLAUSE NO.	PAGE NO.	SPECIFICATION REQUIREMENT	CLARIFICATION	REASONS FOR CLARIFICATION

Note: Bidder to furnish all the pre bid in the above indicated pre bid clarification format only. General Pre bid clarification will not be considered.

218999/2021/PS-PFM-MAX

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

COMPLIANCE CUM CONFIRMATION SCHEDULE

The bidder shall confirm compliance with following by signing/ stamping this compliance certificate and furnishing same with the offer:

- a.) The scope of supply, technical details, construction features, design parameters etc. shall be as per technical specification & there are no exclusions/ deviations with regard to same.
- b.) QP/ test procedures shall be submitted in the event of order based on the guidelines given in the specification & QP enclosed therein. QP will be subject to BHEL/Customer approval in the event of order & customer hold points for inspection/ testing shall be marked in the QP at the contract stage. Inspection/ testing shall be witnessed as per same apart from review of various test certificates/ Inspection records etc. The charges for 3rd party inspection (Lloyds, TUV or equivalent) for imported components shall be included in the base price of the equipment by the bidder.
- c.) All drawings/data – sheets etc. to be submitted during contract shall be subject to BHEL/Customer review/ approval. GA drawings, as submitted with offer at tender stage are for reference purpose only and shall be subject to approval during contract stage.
- d.) There are no other deviations with respect to specification other than those furnished in the 'Schedule of Deviations'.
- e.) The offered materials shall be either equivalent or superior to those specified. Also for components where material is not specified it shall be suitable for intended duty, materials shall be subject to approval in the event of order.
- f.) The commissioning spares (if any) are supplied on 'As Required Basis' & prices for same included in the base price (If bidders reply to this is "No commissioning spares are required" and if some spares are actually required during commissioning same shall be supplied by bidder without any cost to BHEL).
- g.) All sub vendors shall be subject to BHEL/CUSTOMER approval.
- h.) Any special tools & tackles, if required, shall be in bidder's scope.
- i.) Demonstration parameters shall stand valid till the satisfactory completion of demonstration test and its acceptance by BHEL/Customer.

218999/2021/PS-PFM-MAX

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

DECLARATIONS

Icertify that all the technical data and information pertaining to this specification are correct and are true representation of the equipment/system covered by our format proposal number Dated and there is no deviation to the specification.

I hereby certify that I am duly authorized representative of the Bidder's company whose name appears above my signature.

Bidders Company Name

Authorized representative's
Signature

Name

Bidder's Name

The bidder hereby agrees to fully comply with the requirements and intent of this specification for the price indicated

THIS IS A PART OF TENDER TECHNICAL SPECIFICATION PE-TS-417-155A-A001

SCHEDULE OF DEVIATIONS WITH COST OF WITHDRAWAL**PROJECT:- 5X800 MW YADADRI THERMAL POWER STATION****CONDENSATE POLISHING UNIT****TENDER ENQUIRY REFERENCE:-****NAME OF VENDOR:-**

SL NO	VOLUME/ SECTION	PAGE NO.	CLAU SE NO.	TECHNICAL SPECIFICATION/ TENDER DOCUMENT	COMPLETE DESCRIPTION OF DEVIATION	COST OF withdrawal OF DEVIATION	REFERENCE OF PRICE SCHEDULE ON WHICH COST OF withdrawal OF DEVIATION IS APPLICABLE	NATURE OF COST OF withdrawal OF DEVIATION (POSITIVE/ NEGATIVE)	REASON FOR QUOTING DEVIATION
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TECHNICAL DEVIATIONS

COMMERCIAL DEVIATIONS

PARTICULARS OF BIDDERS/ AUTHORISED REPRESENTATIVE

NAME	DESIGNATIONS	SIGN & DATE	

NOTES:

- For self manufactured items of bidder, cost of withdrawal of deviation will be applicable on the basic price (i.e. excluding taxes, duties & freight) only.
- For directly dispatchable items, cost of withdrawal of deviation will be applicable on the basic price including taxes, duties & freight.
- All the bidders have to list out all their Technical & Commercial Deviations (if any) in detail in the above format.
- Any deviation not mentioned above and shown separately or found hidden in offer, will not be taken cognizance of.
- Bidder shall submit duly filled unpriced copy of above format indicating "quoted" in "cost of withdrawal of deviation" column of the schedule above along with their Techno-commercial offer, wherever applicable.
- Bidder shall furnish price copy of above format along with price bid.
- The final decision of acceptance/ rejection of the deviations quoted by the bidder shall be at discretion of the Purchaser.
- Bidders to note that any deviation (technical/commercial) not listed in above and asked after Part-I opening shall not be considered.
- For deviations w.r.t. Payment terms, Liquidated damages, Firm prices and submission of E1/ E2 forms before claiming 10% payment, if a bidder chooses not to give any cost of withdrawal of deviation loading as per Annexure-VIII of GCC, Rev-06 will apply. For any other deviation mentioned in un-priced copy of this format submitted with Part-I bid but not mentioned in priced copy of this format submitted with Priced bid, the cost of withdrawal of deviation shall be taken as NIL.
- Any deviation mentioned in priced copy of this format, but not mentioned in the un-priced copy, shall not be accepted.
- All techno-commercial terms and conditions of NIT shall be deemed to have been accepted by the bidder, other than those listed in unpriced copy of this format.
- Cost of withdrawal is to be given separately for each deviation. In no event bidder should club cost of withdrawal of more than one deviation else cost of withdrawal of such deviations which have been clubbed together shall be considered as NIL.
- In case nature of cost of withdrawal (positive/negative) is not specified it shall be assumed as positive.
- In case of discrepancy in the nature of impact (positive/ negative), positive will be considered for evaluation and negative for ordering.