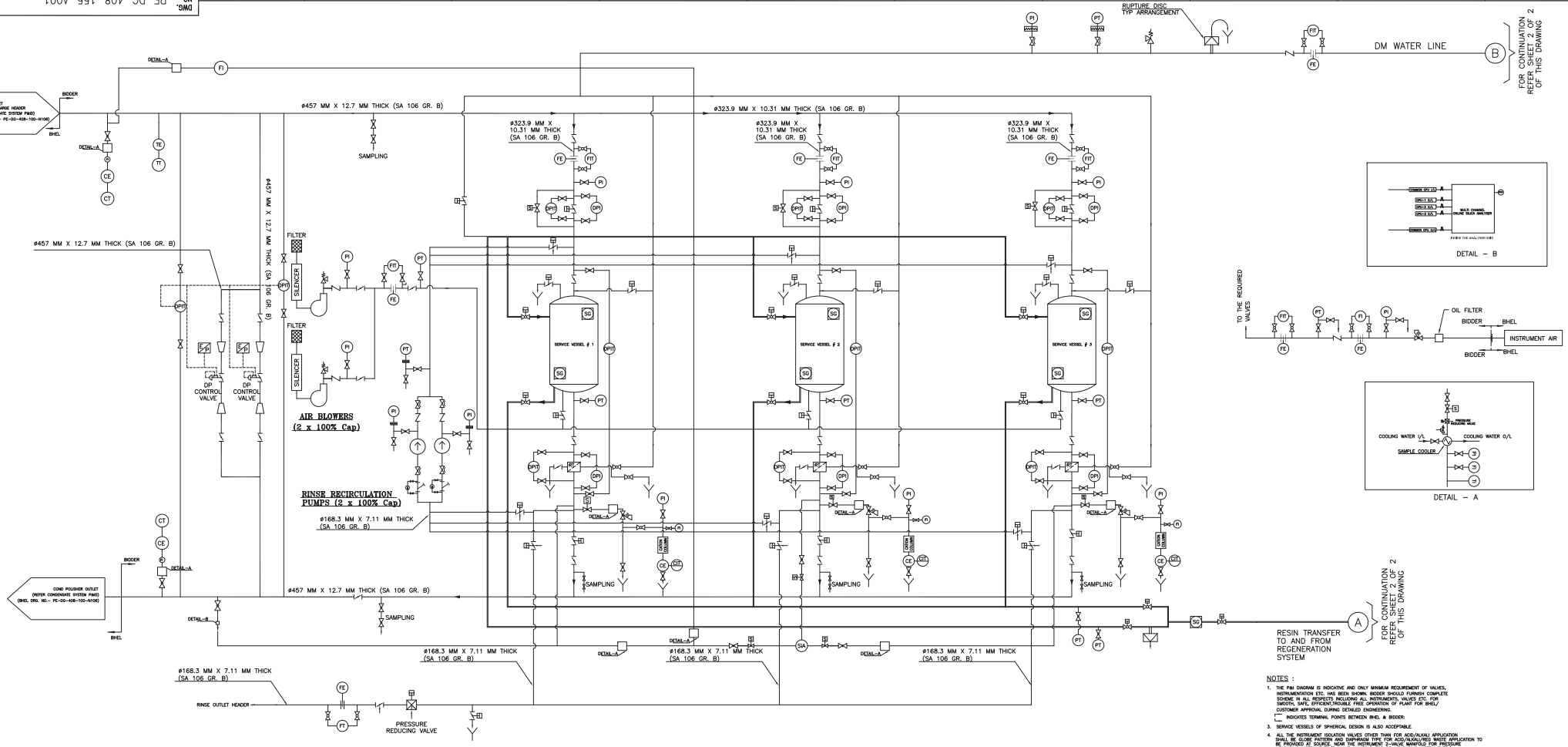
P&ID OF CONDENSATE POLISHING UNIT



CONDENSATE POLISHING FOR UNIT # 8 (TYPICAL)

LEGEND

SYMBOL	DESCRIPTION	SYMBOL	DESCRIPTION
	PRIMING CHAMBER		BLOWER
	PUMP		ISOLATION GATE
	BALL VALVE / PLUG VALVE		DRAIN
	BUTTERFLY VALVE		OVERFLOW SEAL POT/CO_2 ABSORBER
	GLOBE VALVE		RUPTURE DISC
	DIAPHRAGM VALVE		PRESSURE REDUCING VALVE
	MOTORISED VALVE		CONDENSATE LINE
	PRESSURE RELIEF VALVE		D.M.WATER/DRAIN LINE
	NON RETURN VALVE		RINSE WATER LINE
	BUTTERFLY VALVE WITH GLAND SEALING		ACID SOLUTION LINE
	SOLENOID VALVE		ALKALI SOLUTION LINE
	RESIN TRAP		RESIN TRANSFER LINE
	SIGHT GLASS		FIELD MOUNTED INSTRUMENT
	DOUBLE ACTING PNU.CYLINDER OPERATOR		PANEL MOUNTED INSTRUMENT
	PNEUMATICALLY OPERATED VALVE		PULSATION DAMPER
	'Y' TYPE STRAINER		DIAPHRAGM SEAL
	ORIFICE PLATE	OC LS	OPEN CLOSED LIMIT SWITCH

LEGEND

SYMBOL	DESCRIPTION	SYMBOL	DESCRIPTION
CS	CONTROL SYSTEM	FE	FLOW ELEMENT
LS	LEVEL SWITCH	CE	CONDUCTIVITY ELEMENT
LI	LEVEL INDICATOR	CT	CONDUCTIVITY TRANSMITTER(SP)
LT	LEVEL TRANSMITTER	DI	DENSITY INDICATOR
PS	PRESSURE SWITCH	FI	ORIFICE (Pressure Breakdown)
PI	PRESSURE INDICATOR(LOCAL)		SAMPLE COOLER
PT	PRESSURE TRANSMITTER	CRUD	ONLINE MAGNETIC CRUD PARTICLE MONITOR
DPS	DIFF. PRESSURE SWITCH	SA	ONLINE SODIUM ANALYSER
DPI	DIFF. PRESSURE INDICATOR	SiA	ONLINE SILICA ANALYSER
DPT	DIFF. PRESSURE TRANSMITTER	SP	SMART POSITIONER
TI	TEMPERATURE INDICATOR (LOCAL)	PHM	pH TRANSMITTER
TT	TEMPERATURE TRANSMITTER		
TS	TEMPERATURE SWITCH		
TE	TEMPERATURE ELEMENT (METAL)		
FI	FLOW INDICATOR		
FIT	FLOW INDICATOR TRANSMITTER		
FS	FLOW SWITCH		

NOTES :

1. THE P&I DIAGRAM IS INDICATIVE AND ONLY MINIMUM REQUIREMENT OF VALVES, INSTRUMENTATION ETC. HAS BEEN SHOWN. BIDDER SHOULD FURNISH COMPLETE SCHEME IN ALL RESPECTS INCLUDING ALL INSTRUMENTS, VALVES ETC. FOR SMOOTH, SAFE, EFFICIENT,TROUBLE FREE OPERATION OF PLANT FOR BHEL/ CUSTOMER APPROVAL DURING DETAILED ENGINEERING.
   INDICATES TERMINAL POINTS BETWEEN BHEL & BIDDER.
3. SERVICE VESSELS OF SPHERICAL DESIGN IS ALSO ACCEPTABLE.
4. ALL THE INSTRUMENT ISOLATION VALVES OTHER THAN FOR ACID/ALKALI APPLICATION SHALL BE GLOBE TYPE(NON RISING AND DIAPHRAGM TYPE FOR ACID/ALKALI) VENT APPLICATION TO BE PROVIDED AT SUITABLE LOCATIONS. FOR DP MEASURING 2-VALVE MANIFOLD FOR PRESSURE MEASURING INSTRUMENTS/3-VALVE MANIFOLD FOR DP MEASURING INSTRUMENTS/ 5-VALVE MANIFOLD FOR DPTS, BALL VALVE FOR FLOW INDICATORS/ANALYTICAL INSTRUMENT SHALL BE PROVIDED BY BIDDER.
5. WHERE EVER PROVIDING 2 VALVE MANIFOLD IS NOT FEASIBLE TWO NUMBERS OF GLOBE VALVES SHALL BE PROVIDED TO MEET THE FUNCTION OF 2-VALVE MANIFOLD.
6. ACID,ALKALI,LOW LINE, DM WATER LINE, RECI WASTE, RESIN LINES, REGENERATION VESSEL AND MIXED RESIN STORAGE VESSELS PR. INSTRUMENTS SHALL BE PROVIDED WITH DIAPHRAGM SEAL.
7. FLOW TOTALISATION SHALL BE DONE IN SOFTWARE.
8. ALL SOLENOID OPERATED VALVES SHALL BE PROVIDED WITH SOLENOID VALVE, AIR LOCK RELAY ETC. AS REQUIRED BY PROCESS.
9. BLIND FLANGES, COUNTER FLANGES & ISOLATION VALVES SHALL BE PROVIDED BY THE BIDDER AT THE TERMINAL POINTS WHEREVER APPLICABLE
10. ALL THE ANALYSERS SHALL BE PANEL MOUNTED.
11. ALL THE ISOLATION VALVES OF ALL THE INSTRUMENTS SHALL BE OF SS316 CONFORM TO ANSI 300# CLASS (MINIMUM).
12. REFER SHEET 2 OF 2 OF THIS DRAWING FOR ADDITIONAL NOTES.
13. FOR DESIGN PRESSURE BETWEEN 40 BAR TO 60 BAR, DESIGN TEMPERATURE LESS THAN 425 DEG C, 2 NOS. ROUTE VALVES OF 15 NB SIZE OF 800 CLASS HAVE TO BE PROVIDED BY THE BIDDER. FOR PRESSURE, FLOW, LEVEL MEASUREMENT.
14. ALL THE CONTROL LOOPS SHALL BE INDICATED IN VENDOR DOCUMENT.
15. ALL THE INDIVIDUAL 'Y' TYPE STRAINERS SHALL BE PROVIDED WITH DPIT
16. ALL SOLENOID VALVE SHALL BE PROVIDED BY BIDDER WITH LOCAL LED STATUS DISPLAY AND LIMIT SWITCHES SHALL BE PROVIDED BY BIDDER FOR CRITICAL APPLICATIONS TO FACILITATE REMOTE INDICATION ON OWS.
17. LOCATION OF SILICA ANALYZER SHALL BE INSIDE THE CONTROL ROOM. ALL REQUIRED TUBING AND RACK ALONG WITH DRAIN DISPOSAL PIPES SHALL BE IN BIDDER'S SCOPE.
18. PRESSURE TRANSMITTER SHALL BE PROVIDED BY THE BIDDER FOR ALL THE PUMPS FOR AUTO OPERATION.
19. FOR DETAIL A AND ALL ANALYZERS, ALL REQUIRED ACCESSORIES & VALVES SUCH AS ISOLATION VALVES, PRESSURE REDUCING VALVES, BACK PRESSURE REDUCING VALVES ETC SHALL BE PROVIDED FOR IMPLEMENTING SAMPLE MEASUREMENT AS PER BIDDER'S STANDARD PRACTICE.
20. PIPE LINE SIZE & THICKNESS, WHEREVER MENTIONED ARE IN MM & INDICATE MINIMUM REQUIREMENT.
21. BIDDER TO INDICATE RECOMMENDED ALARM LIST ALONGWITH CONTROL PHILOSOPHY AND INTERLOCK/PROTECTION WRITE UP IN LINE WITH TECHNICAL SPECIFICATION/ PROCESS ADOPTED.
22. DRAWING WITH KKS TAGGING FOR ALL THE INTRUMENTS, VALVES ETC. SHALL BE SUBMITTED BY THE SUCCESSFUL BIDDER.

REV.	STATUS	TYPE	REASONS FOR REVISION	DRAWN	CHECKED	APPROVED	DATE

GUJARAT STATE ELECTRICITY CORPORATION LIMITED
VADODARA, GUJARAT
1x800 MW Wanakbori Thermal Power Station Extn. Unit-8

DEVELOPMENT CONSULTANTS PVT. LTD.
CONSULTING ENGINEERS
KOLKATA · MUMBAI · CHENNAI · NEW DELHI

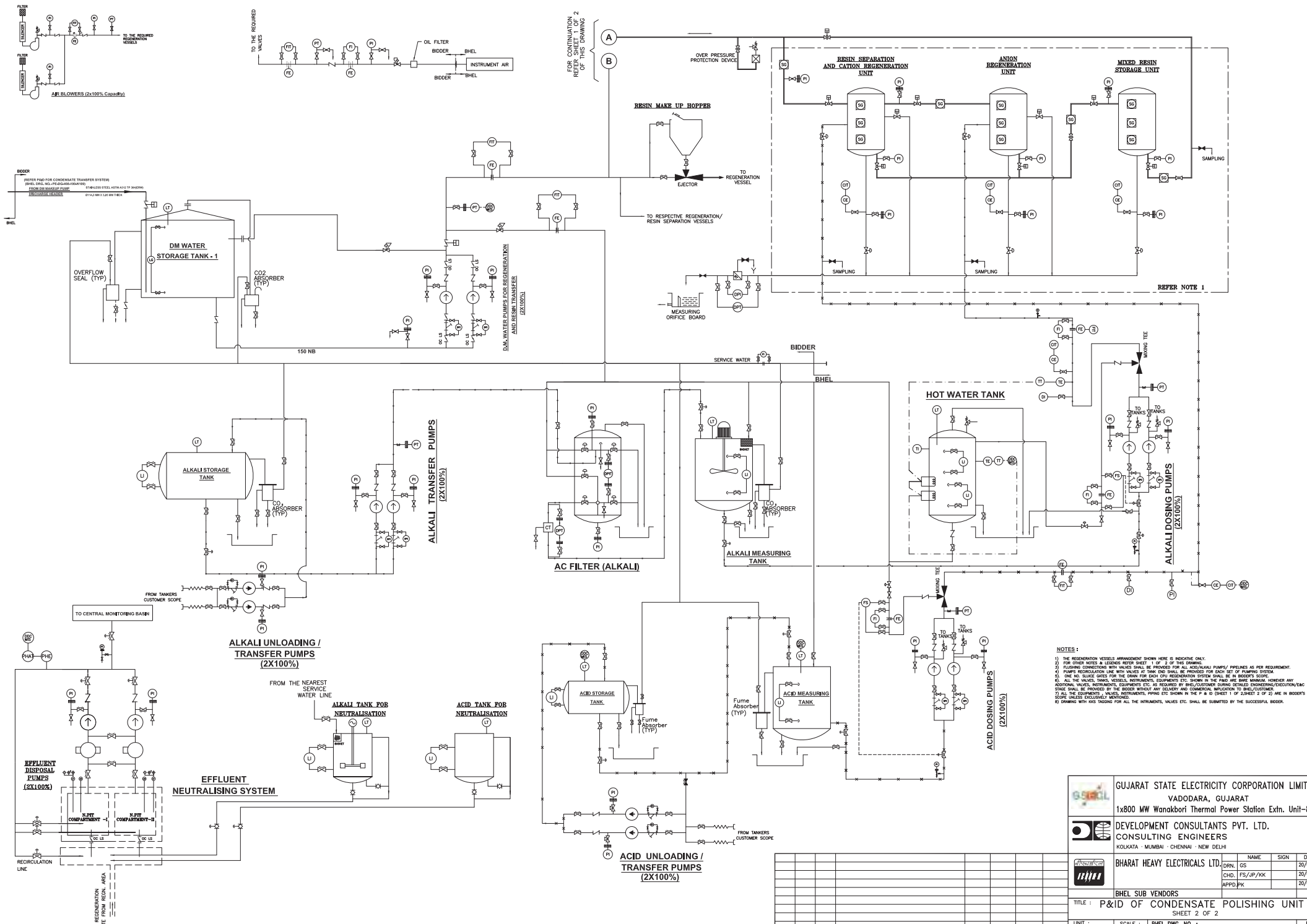
BHARAT HEAVY ELECTRICALS LTD.

	NAME	SIGN	DATE
DRN.	GS		20/05/15
CHD.	FS/JP/KK		20/05/15
APPD.	PK		20/05/15

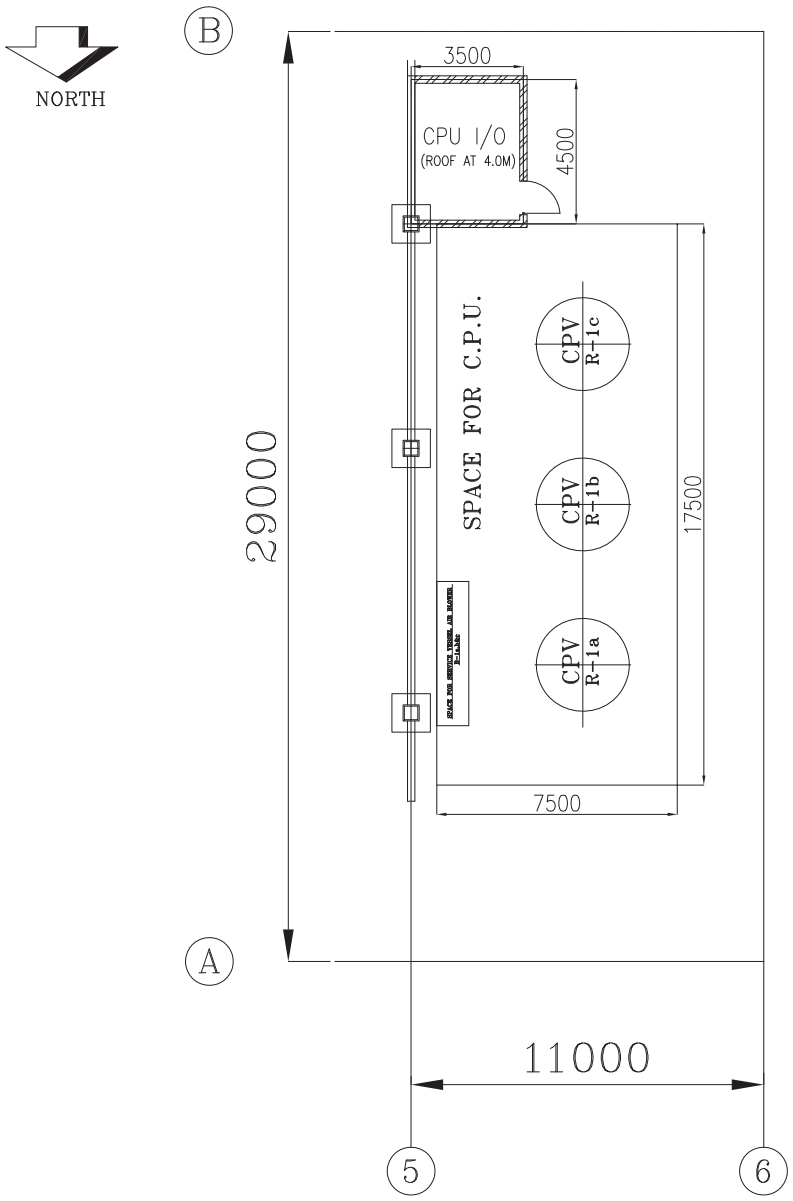
BHEL SUB VENDORS

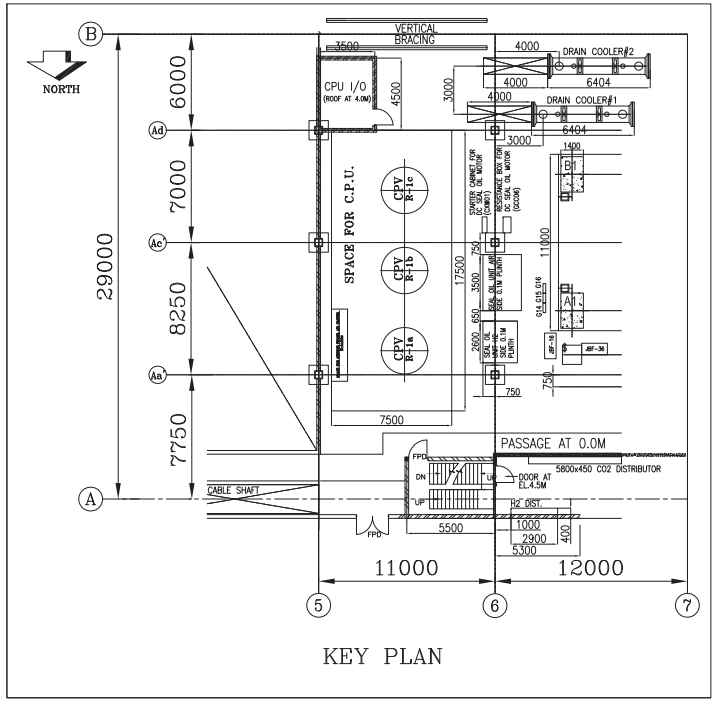
TITLE : P&ID OF CONDENSATE POLISHING UNIT
SHEET 1 OF 2

UNIT : XXXXX | SCALE : NIL | BHEL DWG. NO. : PE-DG-408-155-A001 | REV. 00


DM WATER STORAGE TANK - 1
OVERFLOW SEAL (TYP)
CO2 ABSORBER (TYP)
150 NB
D.M. WATER PUMPS FOR REGENERATION AND RESIN TRANSFER (2X100%)
RESIN MAKE UP HOPPER
EJECTOR
TO REGENERATION VESSEL
TO RESPECTIVE REGENERATION/ RESIN SEPARATION VESSELS
OVER PRESSURE PROTECTION DEVICE
RESIN SEPARATION AND CATION REGENERATION UNIT
ANION REGENERATION UNIT
MIXED RESIN STORAGE UNIT
SAMPLING
REFER NOTE 1
MEASURING ORIFICE BOARD
FOR CONTINUATION REFER SHEET 1 OF 2 OF THIS DRAWING
TO THE REQUIRED VALVES
OIL FILTER
BIDDER
BHEL
INSTRUMENT AIR
AIR BLOWERS (2x100% Capacity)
TO THE REQUIRED REGENERATION VESSELS
SERVICE WATER
HOT WATER TANK
MIXING TEE
TO TANKS
ALKALI DOSING PUMPS (2X100%)
ALKALI STORAGE TANK
ALKALI TRANSFER PUMPS (2X100%)
ALKALI UNLOADING / TRANSFER PUMPS (2X100%)
FROM TANKERS CUSTOMER SCOPE
AC FILTER (ALKALI)
ALKALI MEASURING TANK
TO CENTRAL MONITORING BASIN
FROM THE NEAREST SERVICE WATER LINE
ALKALI TANK FOR NEUTRALISATION
ACID TANK FOR NEUTRALISATION
EFFLUENT NEUTRALISING SYSTEM
EFFLUENT DISPOSAL PUMPS (2X100%)
N.PIT COMPARTMENT -I
N.PIT COMPARTMENT-II
RECIRCULATION LINE
CPU REGENERATION WASTE FROM RESIN AREA
ACID STORAGE TANK
Fume Absorber (TYP)
ACID MEASURING TANK
ACID DOSING PUMPS (2X100%)
ACID UNLOADING / TRANSFER PUMPS (2X100%)
NOTES :
1) THE REGENERATION VESSELS ARRANGEMENT SHOWN HERE IS INDICATIVE ONLY.
2) FOR OTHER NOTES & LEGENDS REFER SHEET 1 OF 2 OF THIS DRAWING.
3) FLUSHING CONNECTIONS WITH VALVES SHALL BE PROVIDED FOR ALL ACID/ALKALI PUMPS/ PIPELINES AS PER REQUIREMENT.
4) PUMPS RECIRCULATION LINE WITH VALVES AT TANK END SHALL BE PROVIDED FOR EACH SET OF PUMPING SYSTEM.
5) ONE NO. SLUICE GATES FOR THE DRAIN FOR EACH CPU REGENERATION SYSTEM SHALL BE IN BIDDER'S SCOPE.
6) ALL THE VALVES, VESSELS, INSTRUMENTS, EQUIPMENTS ETC. SHOWN IN THE P&ID ARE BARE MINIMUM. HOWEVER ANY ADDITIONAL VALVES, INSTRUMENTS, EQUIPMENTS ETC. AS REQUIRED BY BHEL/CUSTOMER DURING DETAILED ENGINEERING/EXECUTION/E&C STAGE SHALL BE PROVIDED BY THE BIDDER WITHOUT ANY DELIVERY AND COMMERCIAL IMPLICATION TO BHEL/CUSTOMER.
7) ALL THE EQUIPMENTS, VALVES, INSTRUMENTS, PIPING ETC. SHOWN IN THE P & ID (SHEET 1 OF 2,SHEET 2 OF 2) ARE IN BIDDER'S SCOPE UNLESS EXCLUSIVELY MENTIONED.
8) DRAWING WITH KKS TAGGING FOR ALL THE INSTRUMENTS, VALVES ETC. SHALL BE SUBMITTED BY THE SUCCESSFUL BIDDER.
GUJARAT STATE ELECTRICITY CORPORATION LIMITED
VADODARA, GUJARAT
1x800 MW Wanakbori Thermal Power Station Extn. Unit-8
DEVELOPMENT CONSULTANTS PVT. LTD.
CONSULTING ENGINEERS
KOLKATA · MUMBAI · CHENNAI · NEW DELHI
BHARAT HEAVY ELECTRICALS LTD.
BHEL SUB VENDORS
TITLE : P&ID OF CONDENSATE POLISHING UNIT
SHEET 2 OF 2
UNIT : XXXXX
SCALE : NIL
BHEL DWG. NO. : PE-DG-408-155-A001
REV. 00
DWG. NO. PE-DG-408-155-A001
REV.

SPACE AVAILABLE AND KEY PLAN OF CONDENSATE POLISHING UNIT SERVICE VESSEL AREA





KEY PLAN

LEGEND:

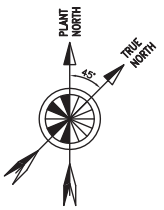
	BRICK WALL
CPV	CONDENSATE POLISHER VESSEL

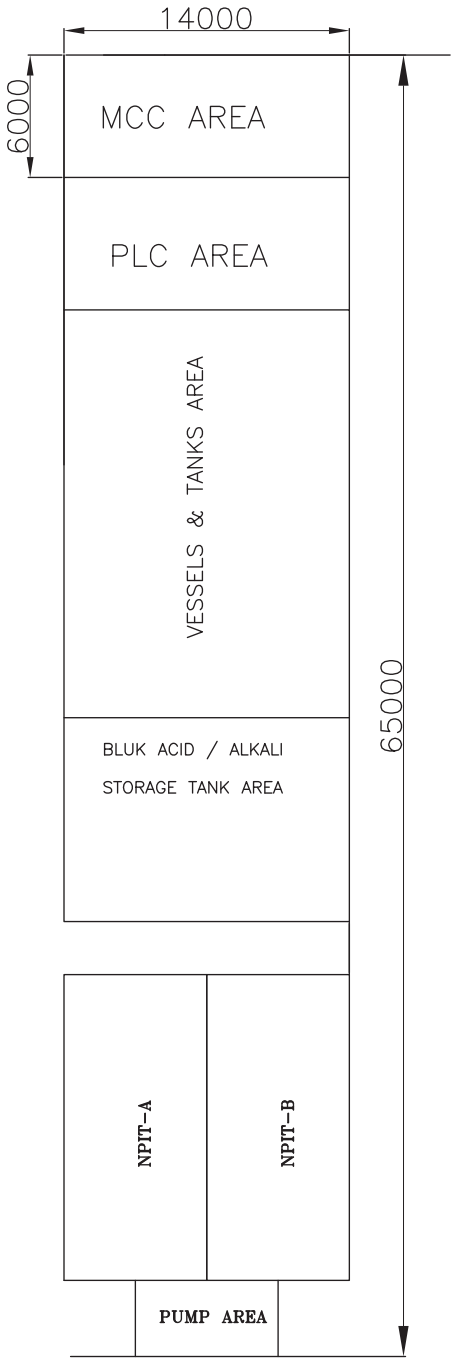
NOTES:
1) ALL DIMENSIONS ARE IN "mm".
2) BIDDER TO ACCOMODATE ALL THEIR EQUIPMENTS WITHIN THE SPACE AS SHOWN HERE.

CPU SERVICE VESSEL AREA (TG BUILDING)

CUSTOMER:	GUJARAT STATE ELECTRICITY CORPORATION LTD VADODARA, GUJARAT 1x800 MW Wanakbori Thermal Power Station Extn. Unit-8
CONSULTANT:	DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS KOLKATA MUMBAI CHENNAI NEW DELHI
	BHARAT HEAVY ELECTRICALS LTD POWER SECTOR PROJECT ENGINEERING MANAGEMENT NOIDA
JOB NO. 408	
STATUS CONTRACT	
DISTRIBUTION	
TITLE	SPACE AVAILABLE FOR CPU SERVICE VESSEL AREA
DRAWING NO.	PE-DG-408-155-A002
SHEET 1 OF 1	REV. 00

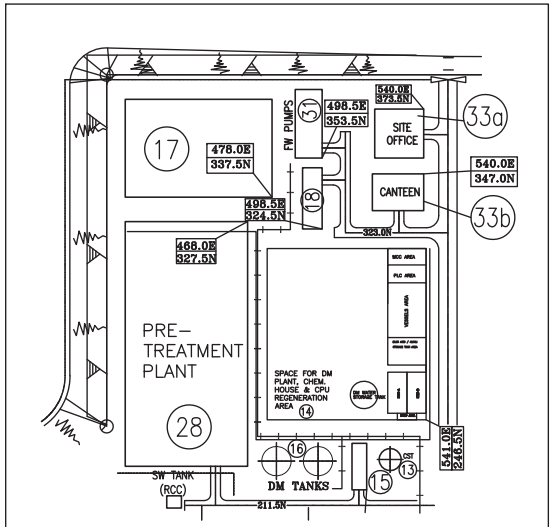
SPACE AVAILABLE AND KEY PLAN OF CONDENSATE POLISHING UNIT REGENERATION AREA





DM WATER
STORAGE TANK

CPU REGENERATION AREA



KEY PLAN

NOTES:
1) ALL DIMENSIONS ARE IN "mm".
2) BIDDER TO ACCOMODATE ALL THEIR EQUIPMENTS WITHIN THE SPACE AS SHOWN HERE.

CUSTOMER:	GUJARAT STATE ELECTRICITY CORPORATION LTD VADODARA, GUJARAT 1x800 MW Wanakbori Thermal Power Station Extn. Unit-8
CONSULTANT:	DEVELOPMENT CONSULTANTS PVT. LTD. CONSULTING ENGINEERS KOLKATA MUMBAI CHENNAI NEW DELHI
	BHARAT HEAVY ELECTRICALS LTD POWER SECTOR PROJECT ENGINEERING MANAGEMENT NOIDA

JOB NO. 408
STATUS CONTRACT
DISTRIBUTION

REV.	DATE	ALTD	CHD	APPD

REV.	DATE	ALTD	CHD	APPD

DEPT CODE	NAME	SIGN	DATE
M	DRN		
	DSGN		
	CHD		
	APPD		

TITLE
SPACE AVAILABLE FOR CPU REGENERATION AREA

DEPT. SCALE SIGN

DRAWING NO. PE-DG-408-155-A003
SHEET 1 OF 1 REV. 00
SIZE-A0

SECTION-C2-A
CUSTOMER SPECIFICATION
(TECHNICAL REQUIREMENT)

SECTION-C2-A
CUSTOMER SPECIFICATION
(TECHNICAL REQUIREMENT)
CONDENSATE POLISHING UNIT

VOLUME : IIC

SECTION-VI

CONDENSATE POLISHING SYSTEM

1.00.00 GENERAL INFORMATION

1.01.00 On line Condensate Polishing System (CP System) is envisaged to achieve high order of availability of various power cycle equipment as well as to ensure quick start up of the unit & continue the unit operation without any restriction by maintaining desired quality of condensate water as recommended by Boiler manufacturer. The CP System should also be capable of maintaining specified condensate quality with condenser tube leakage (clarified water).

1.02.00 The proposed CP System shall comprise of 3 X 50% Condensate Polisher Mixed Beds and One (1) no. common External Regeneration System for 800 MW Unit. Common external regeneration system shall include DM Water Storage Tank as specified hereinafter for regeneration of condensate polishing resin.

1.03.00 The Condensate Polisher Mixed Beds and associated pipe works, valves, instruments, control panels etc. shall be located at ground floor of Power House.

1.04.00 The regeneration facilities comprising of Regeneration Vessels, Measuring Tanks and Pumps shall be located in a separate place near and outside the Power House. The resins will be transferred to the Regeneration Area from the Condensate Polisher Mixed Beds and vice versa through a pipeline.

2.00.00 EQUIPMENT AND ACCESSORIES

It is not the intent to completely specify all the details of design, construction and installation herein. Nevertheless, the equipment along with accessories and installation shall conform to a high standard of engineering design and workmanship and capable of performing continuous and satisfactorily. Details not furnished here shall be subject to approval.

The Bidder shall be responsible for providing all material, equipment and services, specified or otherwise which are required to fulfill the intent of ensuring operability, maintainability and the reliability of the complete work covered under this specification.

The equipment and accessories of CP System shall be complete to ensure the recommended condensate water quality both in terms of physical & chemical properties.

The CP System should consist of but not limited to the equipment and accessories as follows:

2.01.00 Three (3) nos. Condensate Polisher Mixed Beds (3x50%), each complete with condensate inlet and outlet connections, connections for resin transfer to and from vessels, bed support-cum-under drain system, inlet water distributors, all accessories and appurtenances etc. as required.

2.02.00 External resin traps at the outlet of each of the Condensate Polisher Mixed Beds each designed for in-place manual back wash facility.

2.03.00 Condensate inlet and outlet headers for Condensate Polisher Mixed Beds within the boundary limits.

2.04.00 Resin transfer lines of stainless steel construction between the External Regeneration Vessels and the Condensate Polisher Mixed Beds along with all necessary supports, anchors etc.

2.05.00 Rinse water outlet header from Condensate Polisher Mixed Beds to the boundary limit.

2.06.00 All necessary valves and fittings along with the actuators necessary for operation from CP System Control Panel. These shall include suitable arrangement to prevent accidental over pressurization of the resin transfer pipeline and regeneration facilities connected to it, which are designed for pressure much lower than that of the Condensate Polisher Mixed Beds.

2.07.00 A common drain header for the Condensate Polisher Mixed Beds.

2.08.00 All necessary drains, vents and sampling points along with isolation valves as required.

2.09.00 Two (2) x 100% capacity blowers for Condensate Polisher Mixed Beds (if required), each complete with electrical drive motor and all other accessories as required.

2.10.00 Two (2) nos. Rinse Recirculation Pumps, each complete with electrical drive motor and all other accessories as required.

2.11.00 All instrumentation and controls as required for operation of the CP System.

2.12.00 Emergency bypass system between the condensate inlet and outlet headers with its automatic valve, isolation valves on both sides and controls for each of Condensate Polisher Mixed Beds.

2.13.00 Instrument racks for mounting pressure and flow transmitters, pressure switches, conductivity analyzers, etc. for each of Condensate Polisher Mixed Beds.

2.14.00 Local Control Panel with Instruments, Push Buttons, Selector Switches, Annunciation Facility, etc. along with PLC for the control and safe operation of the CP System shall be provided. The PLC for CP System shall have all necessary interfaces for interlocking / control and signal exchange with the PLC for Regeneration.

2.15.00 External Regeneration Vessels

The equipment and accessories for external regeneration as described below is tentative and for 800 MW Unit. Based on specific regeneration technology, the Bidder may adopt deviations with reference to Regeneration Vessels to make the system suitable in all respects for satisfactory operation.

2.15.01 One (1) no. Resin Separation & Anion Resin Regeneration Vessel complete with all accessories.

2.15.02 One (1) no. Cation Resin Regeneration Vessel complete with all accessories.

2.15.03 One (1) no. Resin Isolation Vessel complete with all accessories.

2.15.04 One (1) no. Mixed Resin Storage Vessel complete with all accessories.

2.15.05 One (1) no. Resin Injection Hopper, complete with a water ejector system for resin make-up complete with all accessories.

2.15.06 One (1) nos. Hose Station for Transfer of Hydrochloric Acid. The hose station shall have two (2) nos. each 80 mm NB rubber hose connections.

2.15.07 Two (2) nos. Hydrochloric Acid Transfer Pumps each complete with electrical drive motor and all other accessories as required.

2.15.08 One (1) no. Hydrochloric Acid Storage Tank complete with integral pipe works, valves and all other accessories as required.

2.15.09 One (1) no. Hydrochloric Acid Measuring Tank for Polishers, complete with integral pipe works, valves and all other accessories as required.

2.15.10 One (1) no. Hose Station for Transfer of Alkali. The hose station shall have two (2) nos. each 80 mm NB rubber hose connections.

2.15.11 Two (2) nos. Alkali Transfer Pumps, each complete with electrical drive motor and all other accessories as required.

2.15.12 One (1) no. Activated Carbon Filter for Alkali, complete with internals, integral pipe works, valves and all other accessories as required.

2.15.13 One (1) no. Alkali Storage Tank, each complete with integral pipe works, valves and all other accessories as required.

2.15.14 One (1) no. Alkali Measuring Tank for Polishers, complete with integral pipe works, valves and all other accessories as required.

2.15.15 Two (2) nos. (2 x 100%) air blowers, each with electric motor drives, V-belt drive with belt guard, air filters, silencers, discharge snubbers, for supply of process air required for regeneration of the resins.

2.15.16 One (1) no. Dematerialized Water Storage Tank complete with all accessories.

2.15.17 Two (2) nos. DM Water Regeneration / Resin Transfer Pumps each with electric drive motor, one normally operating and the other standby, for water supply for chemical preparation / dosing and transfer of resin from Condensate Polisher Mixed Beds to Regeneration vessels and vice-versa, backwash etc.

2.15.18 One (1) no. Water Heater for regeneration of Anion Resins, complete with integral pipe works, valves and all other accessories as required.

2.15.19 Diluent DM Water Supply System, separately for acid and alkali, each provided with an automatic on-off valve, a throttling valve for setting of flow, a local flow indicator and a mixing tee where the chemicals get injected into the water stream.

2.15.20 Common Waste Effluent Header with one resin trap designed for in-place manual backwash.

2.15.21 One (1) no. Neutralization Pit with two (2) compartments, ~~each complete with all accessories.~~

2.15.22 One (1) no. Acid Measuring Tank for neutralization, complete with integral pipe works, valves and all other accessories as required.

2.15.23 One (1) no. Alkali Measuring Tank for neutralization, complete with integral pipe works, valves and all other accessories as required.

2.15.24 Two (2) nos. Neutralized Waste Transfer Pumps, each complete with electrical drive motor and all other accessories as required.

2.15.25 DM water piping for dilution, resin transfer, backwashing, flushing, rinsing etc. including the DM water piping along with all supports and hangers between the Regeneration Facility and the CP System.

2.15.26 All necessary valves and fittings along with the actuators necessary for their remote automatic operation. These shall include all drains, vents, sampling points with isolation valves as required.

2.15.27 All other integral and interconnected pipe works, valves, sump, gates, all types of pipe supports, pipe and cable racks etc. for the entire Plant.

2.15.28 Operating platforms, ladders, supports and other structural works as required to facilitate accessibility for operation and maintenance for all the Condensate Polisher Mixed Beds, Regeneration Vessels, Storage Tanks and other equipment.

2.15.29 Programmable Logic Controller and CRT/Keyboard based operator console & engineering console for the interlock, control and safe operation of regeneration of CP System.

2.16.00 All drive motors / actuators associated with the system / equipment.

2.17.00 First fill of resins for all Condensate Polisher Mixed Beds, mixed storage vessel and makeup resin hopper and also first fill of lubricants and grease.

2.18.00 All instruments, process switches, analysers, control valves, solenoid valves, etc. as required.

2.19.00 All junction and solenoid Boxes.

2.20.00 Supply of all screened, instrument and special cables.

2.21.00 All cable glands and lugs as required shall be provided by the Bidder.

2.22.00 Pneumatic & Process hook up tubing / piping.

2.23.00 All anchor bolts, foundation plates sleeves, nuts, inserts, etc. to be embedded in concrete for entire CP System.

3.00.00 **SALIENT DESIGN FEATURES**

3.01.00 The system shall be designed for 100% condensate polishing for 800 MW Unit corresponding to the maximum mass flow rate established with VWO condition of turbine with suitable bypass arrangement plus maximum heat cycle make-up.

3.02.00 Each of the Condensate Polisher Mixed Beds shall be designed to handle maximum fifty percent (50%) of the system design flow rate for 800 MW Unit as addressed above and to suit the system design pressure as well as temperature.

3.03.00 Condensate Polisher Mixed Beds will be connected to the condensate cycle and will treat the entire flow. The Condensate Polisher Mixed Beds should be capable of operating without any prior filtration of the condensate.

3.04.00 When condensate temperature exceeds 50°C or bypass pressure difference reaches 0.35 Mpa, the bypass valve shall be 100 % opened automatically and the inlet/outlet of the Condensate Polisher Mixed Beds shall be closed to protect elements and resins inside the polisher.

3.05.00 After the bypass valve is 100 % opened, the bypass valve shall be closed manually. Before closing the bypass valve, one needs to ensure that two Condensate Polisher Mixed Beds have been put into operation.

3.06.00 Pressure differential across a Condensate Polisher Mixed Bed may also be judged by the flow value. When the flow of one Condensate Polisher Mixed Bed under service is less than that of the other, it indicates that pressure differential inside the Condensate Polisher Mixed Bed with small flow is high and the resin inside it shall be regenerated.

3.07.00 The Bidder shall provide all instrumentations and controls to analyze the condensate as per the requirements for safe and satisfactory operation of boiler. The system should be capable of producing the output characteristics which will be better than or equal to the specified conditions as prescribed by the Boiler Manufacturer or as specified elsewhere in this document whichever is more stringent. The system should be also capable of monitoring and maintaining the characteristics during unit start up, load variations and condenser tube leakage.

3.08.00 The minimum design concentrations of various contaminants envisaged to be present in the condensate at inlet of CP System, shall be considered as per Annexure–I.

3.09.00 The CP System shall be designed to deliver the treated condensate as per the requirements of Annexure – II or as recommended by the Boiler manufacturer whichever are more stringent.

3.10.00 Under condenser tube leakage condition, the CP System shall be designed for ingress of TDS (2000 ppb minimum) in addition to the influent contaminants under Normal Condition as stated above. The cation and anion load distribution for 2000 ppb TDS shall be based on circulating cooling water composition.

3.11.00 Under the Normal Condition, each Condensate Polisher Mixed Bed shall be designed to operate in hydrogen cycle for not less than 168 hours of continuous operation, while maintaining the above treated condensate quality.

Useful service run between regenerations during the above conditions of start-up and condenser tube leakage, shall not be less than 50 hours.

3.12.00 The bed cross section shall be such that the average velocity of condensate through it does not exceed 120 m/hour at the design flow rate.

3.13.00 At the design flow rate, the pressure drop between inlet and outlet flanges of the polisher Condensate Polisher Mixed Beds with clean resin bed shall not exceed 2.0 bar. This pressure drop shall include losses due to entrance and exit nozzles, distributors, underdrains, resins and the effluent resin traps. Maximum pressure drop under dirty conditions will be restricted to about 3.5 bar including the pressure drop across effluent resin traps.

3.14.00 **Exchange Resins**

The Bidder shall provide suitable resins for the Condensate Polisher Mixed Beds, Mixed Resin Storage Vessel and Resin Makeup Hopper.

The cation resin shall be strong acid, with sulfonic acid functional group to the regenerated with Hydrochloric Acid.

The anion resin shall be strong base, with quaternary ammonium (Type-I) functional group to be regenerated with Sodium Hydroxide.

Insert resin, if used, shall be non-ionic compatible with the above resins.

A minimum resin ratio of 1.5 to 1 (Cation : Anion) will be provided.

After seperation, anion resin in the cation resin shall be less than 0.1 % and cation resin in the anion resin shall be less than 0.1 %.

Deration factor of 10% for all resins shall be considered while calculating the quantity of resin to be supplied.

The resins furnished shall be of Rohm and Hass/ Dowex/ Duolite make. The effective depth of the mixed resin bed in the condensate polisher Condensate Polisher Mixed Beds shall not be less than 1100 mm.

The resin strength and other physical properties shall be suitable to withstand the design pressures in the system.

The resins selected must have been in use in Condensate Polishing plants capable of producing water as specified or better, for a period of not less than three (3) years.

The resin charge shall consist of material properly selected, washed, processed and graded to provide the guaranteed capacity and life. The resin shall have adequate abrasion resistance during its guaranteed life.

3.15.00 Cation resins shall be regenerated by dilution of technical grade hydrochloric acid to IS:265 (concentration 30-33% by volume) and anion resins by dilution of sodium hydroxide, rayon grade to IS:252 available as 48% lye. For calculations regeneration temperature should be taken as 25°C.

3.16.00 The regeneration process offered by the Bidder, shall be of proven design and shall essentially be the same process for which the Bidder have experience and shall give proper resin separation method compatible with the desired treated water quality. The Bidder shall include inert resin in the system if it is felt that it helps in better resin separation.

In case, after separation of resins, if there are undesired contaminant resins, the Bidder shall provide a system either to eliminate this cross contamination of resins or to nullify the detrimental effect of entrapped resins to the effluent quality.

The guaranteed chemical consumption figures must be supported by relevant published data such as performance of the resin system, statistical data on resin losses and actual field performances of plants using a similar technique, indicating the quantity of chemicals required for regeneration, in particular, besides other parameters. The data on the chemical consumption figures and the calculations furnished by the Bidder shall be the primary basis of checking the guaranteed parameters during evaluation. The operating exchange capacity and regeneration levels shall be vetted by resin manufacturer and the Bidder must furnish the resin performance curves especially applicable for this project.

3.17.00 The free board in various vessels shall be as indicated below :

Vessel		Percentage
Mixed Bed Polisher	:	100 %
Resin Separation & Anion Resin Regeneration Vessel	:	100 %
Cation regeneration vessel	:	100 %
Mixed Resin Storage Vessel	:	80 %
Resin Make Up Hopper	:	80 %

3.18.00 The common influent and effluent header of Condensate Polisher Mixed Beds will be connected to an automatic bypass line to be provided. This bypass line shall include a differential pressure device which on a high signal will cause an automatic valve to open, bypassing the Condensate Polisher Mixed Beds. Automatic bypass line shall be provided with a butterfly type control valve and wafer type butterfly isolation valves (resilient material seated, to ensure bubble-tight shut off) on the upstream and downstream sides of the control valve. In the event of excessive pressure differential between the condensate inlet and outlet headers, this control valve will open automatically to bypass requisite quantity of condensate to prevent this pressure differential from exceeding a preset limit when both Beds/one Bed/no Bed are/is in operation.

3.19.00 The control system shall be so designed that the Control valve is able to bypass 50% of rated flow when any of the Condensate Polisher Mixed Beds is out of service and 100% of flow when both the Condensate Polisher Mixed Beds are out of service.

3.20.00 Under normal conditions, Condensate Polisher Mixed Bed will hold a complete charge of freshly regenerated and mixed resin, ready for use. For regeneration, resin from the exhausted Condensate Polisher Mixed Bed will be transferred hydraulically. The empty Condensate Polisher Mixed Bed will then be filled up with already regenerated resin available in the regeneration facility. This Condensate Polisher Mixed Bed shall come into service soon after prerequisite condition is satisfied or as and when desired by the operator. In the meantime, the exhausted resin charge will be cleaned, separated, regenerated, mixed and rinsed before being stored for the next use.

3.21.00 The Bidder 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 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 led to the resin regeneration vessels. Demineralized water shall be used throughout for the resin transfer. Piping of the resin make-up system shall be under the scope of the Bidder as a part of the external resin regeneration system.

3.22.00 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.

3.23.00 DM water, acid/alkali piping shall be of CSRL (Carbon steel rubber lined) for sizes 40 mm NB and above. The Carbon steel piping shall conform to IS 1239 Part I (heavy)/IS 3589 or equivalent. The fittings provided shall be as per ASME SA 234 Gr. WPB/IS 1239 Part II or equivalent. Inside surface of fittings to be rubber lined. The dimensions of the fittings shall be as per ANSI B 16.9 Flange ends to ANSI B 16.5.

3.24.00 The resin transfer piping shall be of Stainless Steel material to ASTM A 312 TP 304.

3.25.00 For sizes below 40 mm NB SS piping to ASTM A 312 TP 304 Sch 40 S shall be provided. The fittings shall be of forged stainless steel to ASME SA 182 F 304 with SW ends to ANSI B 16.11

4.00.00 OPERATION AND CONTROL PHILOSOPHY

The control / operation for the Condensate Polisher Mixed Beds shall be from local programmable logic controller. The CP system PLC for 800 MW Unit shall be located in the ground floor of Power House. 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 this PLC. This PLC 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. A mimic diagram shall be provided on the front of the control panel. Status of various valves shall be indicated by LED's on the mimic diagram.

Facility to control the CP System from the Main Control Room shall also be provided.

The control for the external regeneration system shall be from the Control Desk with PLC located in a separate Control Room at Regeneration Area. This shall clearly show the status of each concerned Condensate Polisher Mixed Bed. This PLC shall be interconnected with the local PLC of Condensate Polisher Mixed Beds. This Desk 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 Desk shall also contain all controls and accessories for the acid and alkali solution preparation and dosing system. The regeneration control Desk 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.

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 switch installed between the influent and effluent headers will on a high signal cause an annunciator alarm. By observing the individual vessel flow indicators, or conductivity at vessel outlet the operator can determine which vessel is contributing most to the pressure drop and is in need of resin cleaning/regeneration.

Panel mounted conductivity indicators shall monitor the polishing system influent and effluent streams as well as the discharge of each Condensate Polisher Mixed Bed. A high influent conductivity annunciator alarm will alert the plant operator that a problem condition such as air or condenser cooling water leakage has occurred. This conductivity analyzer shall also provide contacts for an alarm at the power station main control room. A high conductivity annunciator 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 rate of 0.4 to 0.6 cu.m / min / sq.m 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. A panel mounted conductivity indicator 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 control panel.

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 sample system for a Condensate Polisher Mixed Bed shall be taken out of service when the Condensate Polisher Mixed Bed is not in service or pre-service rinse.

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

The sequence for resin Transfer from Condensate Polisher Mixed Bed to Regeneration Vessel and Resin Transfer from Regeneration Vessel to Condensate Polisher Mixed Bed shall be initiated from the condensate polishing unit control panel but shall be controlled by the programmable logic controller in the Regeneration control panel.

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 external regeneration.

The return of fresh resin to the empty Condensate Polisher Mixed Bed shall include the hydraulic transfer from the resin storage 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.

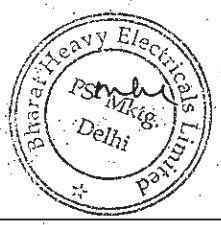
Resin transfer from a Condensate Polisher Mixed Bed to the regeneration vessel shall be automatic following manual pushbutton initiation from the control panel.

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.



ANNEXURE – I

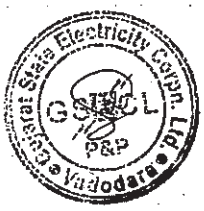
DESIGN ANALYSIS OF CRUDE CONDENSATE

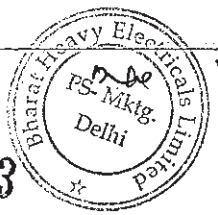
Contaminants	Unit	Normal Condition	Start Up Condition
Ammonia	Ppb	500	1500
Total Dissolved Solids (TDS, ammonia and Silica excluded)	Ppb	125 approx	2000 approx
Copper	Ppb	5	-
Total Ferric Iron	Ppb	50	1000
pH value (polisher runs at 25^{0}C with H / OH mode)	Ppb	8.8-9.5	9.5
Chloride (as Cl)	Ppb	10	100
Sodium (as Na)	Ppb	10	20
Silica (as SiO_2)	Ppb	30	150
Crud (mostly black oxide of iron)	Ppb	100	1000
Conductivity (at 25^{0}C)	µS/cm	0.5	2.0

ANNEXURE – II

ANALYSIS OF TREATED CONDENSATE

Contaminants	Unit	Normal Condition	Start Up Condition	Tube Leakage Condition
Total Dissolved Solids	Ppb	< 20	< 50	< 50
Silica (as SiO_2)	Ppb	< 5	< 50	< 50
Total Ferric Iron	Ppb	< 5	< 100	< 100
Total Copper	Ppb	Less than 1.0	-	-
pH value (runs in H/OH mode)	Ppb	6.5 - 7.5	6.5 - 7.5	6.5 - 7.5
Electric Conductivity after hydrogen column (25^0C)	µS/cm	< 0.1	< 0.2	< 0.2
Chloride (as Cl)	Ppb	<1	< 10	< 10
Sodium (as Na)	Ppb	< 2	<5	<5
Crud (mostly black oxide of iron)	Ppb	< 5	< 150	< 10





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SECTION-C2-A
CUSTOMER SPECIFICATION
(TECHNICAL REQUIREMENT)
HORIZONTAL CENTRIFUGAL PUMPS

VOLUME : II-H

SECTION-II

HORIZONTAL CENTRIFUGAL PUMPS

1.00.00 GENERAL INFORMATION

1.01.00 This section presents the general guidelines and details of horizontal centrifugal pumps to be procured under the scope of this section and shall not be limited to the pumps specified under clause no. 3.00.00 below. For other horizontal centrifugal pumps in the scope of this specification, these general guidelines as specified hereinafter shall be followed.

2.00.00 CODES AND STANDARDS

2.01.00 The design, manufacture and performance of the horizontal centrifugal pumps as specified hereinafter, shall comply with the requirements of the following codes and standards and shall include all the latest amendments subsequent to the year of publication as mentioned below.

2.01.01	IS-6595 Part-2/ 1993	:	Horizontal Centrifugal pumps for clear, cold and fresh water.
2.01.02	IS-5120/1977	:	Technical requirements for Rotodynamic special Purpose pumps.
2.01.03	IS-5639/1970	:	Pumps for handling chemicals & corrosive liquids.
2.01.04	IS-5659/1970	:	Pumps for process water.
2.01.05	IS-6536/1972	:	Pumps for handling volatile liquids.
2.01.06	IS-9137/1978	:	Code for acceptance tests for centrifugal, mixed flow and axial flow pumps - Class 'C'.
2.01.07	ISO 3555/1977 BS 5316/1977 Part 2	:	Acceptance tests for centrifugal, mixed flow and axial flow pumps - Class 'B' tests.
2.01.08	ISO 2548/1973 BS 5316/1976 Part 1	:	- Do - Class 'C' tests.
2.01.09	API-610/1989	:	Centrifugal pumps for general refinery services.

2.01.10 Standards of the Hydraulic Institute of USA (1983).

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

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2.02.00 In case of any contradiction with the above standards and annexures, the stipulations in the annexures shall prevail and shall be binding to the Contractor.

3.00.00 SCOPE OF WORKS

3.01.00 Scope of Supply

3.01.01 The scope of supply under this section shall be as below. Items specifically not mentioned but deemed necessary by the Tenderer for making the system completely reliable and efficient shall also be included.

a) Equipment

i) DMCW Pumps	Two (2) nos. Horizontal Centrifugal Pumps and drives. (If Bidder adopts separate DMCW systems for Boiler and TG auxiliaries, then Clause no. 3.01.07 of Section-1 of this Volume shall be referred to)
ii) Cycle make-up Pumps	Two (2) nos. Horizontal Centrifugal Pumps and drives complete with all accessories as specified in this section and in the annexures attached to this section.
iii) Boiler Fill Pumps	Two (2) nos. Horizontal Centrifugal Pumps and drives complete with all accessories as specified in this section and in the annexures attached to this section.

iv) Any other horizontal centrifugal pump included by the Bidder within the scope of this section.

b) Equipment Accessories

Each pump set for all the above groups shall be supplied with the following accessories:

i) Couplings of approved design to connect pump shaft directly with the motor shaft.

ii) Sets of base plates, support plates, grounding pads, lifting lugs, eye bolts, nuts etc for each pump and motor set.

iii) Slip-on type drilled steel flanges of proper rating for both suction and discharge connections of each pump set. All the counter-flanges shall be complete with requisite number of bolts, nuts, gaskets etc.

iv) Air release cocks and drain plugs for each pump set.

v) Discharge line pressure gauge and suction line pressure/vacuum gauges complete with isolating cocks for each pump set.

vi) All internal/integral piping with valves, fittings, and pressure gauges for lubrication, cooling and sealing, wherever applicable, shall be tapped of directly from respective pump discharge.

3.02.00 For details regarding scope of services and works Volume IIA of this specification shall be referred to.

4.00.00 PERFORMANCE REQUIREMENTS

4.01.00 Performance requirements for the pumps shall be as guided in Section-I of this volume and by the Annexures enclosed with this section.

4.02.00 Pumps shall preferably be designed to have the best efficiency at the specified duty point. The pumps shall be suitable for continuous operation at any point within the "Range of Operation" as stipulated in the annexures attached with this section.

4.03.00 Pumps shall preferably have a continuously rising head-capacity characteristics from the specified duty point towards shut-off point, the maximum being at shut-off to enable parallel operation.

Under all circumstances, the 'range of operation' of the pumps shall exclude any unstable operating zone of the head - capacity curve.

4.04.00 Wherever specified in the annexures attached to this section, pumps of each category shall be suitable for parallel operation. The head vs. capacity, the BHP vs. capacity characteristics etc. shall be identical to ensure equal load sharing and trouble-free operation of any pump when the other pumps working in parallel with it trip.

4.05.00 The pump set along with the drive motor shall run smooth without undue noise and vibration. Acceptable peak to peak vibration limits shall be generally guided by the Hydraulic Institute Standards of USA.

5.00.00 DESIGN AND CONSTRUCTION

5.01.00 Pump Casing

5.01.01 Pump casing shall be provided with adequate number of vents and priming connections with valves unless the pump is made self- venting and priming. Casing drain, as required, shall be provided complete with drain valves.

5.01.02 Pump design must ensure that the nozzles are capable of withstanding external reactions not less than those specified in API-610.

5.01.03 In cases where an expansion joint is located at pump discharge, the pump assembly will be subjected to an additional thrust which will be transmitted to the foundation. This additional thrust shall be taken into the consideration of pump design.

5.02.00 **Impeller**

5.02.01 The rotor assembly shall be dynamically balanced and designed with critical speed substantially above the operating speed.

5.03.00 **Wearing Rings**

5.03.01 Replaceable type wearing rings shall be furnished to prevent damage to impeller and casing.

5.04.00 **Shaft**

5.04.01 Shaft size shall be selected considering that the critical speed shall be away from the operating speed as recommended in applicable Code/Standard. The critical speed shall also be at least 10% away from runaway speed.

5.05.00 **Shaft Sleeves**

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

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

5.06.00 **Bearings**

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

5.06.02 Heavy duty sleeve/ball/roller type bearings shall be provided to take care of the radial loads.

5.06.03 In case of sleeve type radial bearings, axial thrust shall be absorbed in suitable hydraulic devices and/or thrust bearings.

5.06.04 Bearings and hydraulic devices (if provided for balancing axial thrust) shall be of adequate design for taking the entire pump load arising from all probable conditions of continuous operation, as specified in the annexures. Life of the bearings shall be guided by the design standard of the pump or as specified in annexures. Thrust bearing shall be capable of running continuously at maximum load.

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5.06.05 The bearings shall be oil/grease lubricated. Suitable lubricating arrangement for the bearings shall be furnished with the pump complete all accessories like pump, filters, piping, fittings, valves, interlocking and supervising instruments etc. as necessary and specified in the Annexures. The design shall be such that the bearing lubricant does not contaminate the liquid being pumped.

5.07.00 **Stuffing Boxes**

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

5.07.02 Stuffing boxes shall be sealed/cooled by the fluid being pumped/external clear water, as specified in the Annexures. All necessary pumps, piping, fittings, valves, instruments etc. as required for safe and trouble-free operation of the pumps and as specified in the Annexures shall be included in the scope of supply.

5.08.00 **Mechanical Seals**

5.08.01 Mechanical seals shall be provided if specified in the Annexures. The pump supplier shall co-ordinate with the seal maker in establishing the circulation rate for maintaining a stable film at the seal face in the chamber. The seal piping system shall form an integral part of the pump assembly.

5.08.02 When handling liquids near their boiling point, suitable arrangement for external cooling shall be provided so as to prevent flashing at the seal faces.

5.08.03 For the seals under vacuum service, the seal design must ensure sealing against atmospheric pressure, even when the pumps are not operating.

5.09.00 **Drive Unit**

5.09.01 The pumps shall be driven by electric motor or other driving equipment like diesel engine etc. directly coupled or through a gear box/belt drives, as specified in the Annexures. A heavy duty coupling along with coupling guard shall be provided between the pump and drive unit (except for belt drives).

5.09.02 Unless otherwise specified in Annexures, drive unit power rating shall be the maximum of the following requirements.

a) 15% margin over the pump shaft input power at the rated duty point.

b) 5% margin over the maximum pump shaft input power required within the 'Range of Operation'.

c) Pump shaft input power required considering the overloading of the pump assuming single pump operation in the event of tripping of one or more of the pumps operating in parallel.

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6.00.00 **INSPECTION AND TESTING**

6.01.00 The Contractor shall carry out the following specific tests and inspections to ensure that the equipment furnished lies in strict conformance with the specification and also in accordance with applicable codes/standards and good engineering practice.

a) Identification and Testing

i) All materials used for pump construction shall be of tested quality. Material shall be tested as per the relevant standards and test certificates shall be made available to the Owner.

ii) Tests for each pump included under this section shall include but not be limited to the following :

- The entire surface of the impeller castings shall be subjected to Dye Penetration Test as per ASTM Specification no.: E165-65.
- Shaft shall be subjected to Dye Penetration and Ultrasonic Tests.
- Wearing rings shall be subjected to Dye Penetration Test.
- Verification of material, witnessing of pouring, casting and inspection of finalized fabricated/cast castings.
- Inspection of finished castings for impeller and verification of materials.
- Inspection of pump shaft and verification of material.
- Witnessing of NDT/review of NDT reports.
- Static balancing test for impeller and dynamic balancing of complete rotating parts as per ISO- 1940.
- Complete Inspection of assembled pump.

b) Hydrostatic Testing

The pump casing shall be hydrostatically tested at 150% of the shut-off pressure. Pressure shall be maintained for a period of not less than one (1) hour. While arriving at the above values maximum suction pressure shall be taken into account.

c) Performance Test at Shop

i) Each pump shall have to be tested to determine the performance curves of the pumps. These tests are to be conducted in presence of Owner's representative as per the requirements of the Standards of Hydraulic Institute of USA (ASME-Power Test Code PTC 8.2/BS-599) or any other equivalent standard but the tolerances on head discharge and power shall be as specified in HIS, USA.

ii) Performance tests are to be conducted to cover the entire range of operation of the pumps. These shall be carried out to span 130%

of rated capacity up to pump shut-off condition. A minimum of five combinations of head and capacity are to be achieved during testing to establish the performance curves, including the design capacity point, shut-off point and the two extremities of the range of operation as specified in the annexures. After completion of performance test, all pumps shall be stripped down for inspection of internals.

iii) Tests shall be conducted with actual drive motors being furnished.

iv) NPSH tests are to be conducted on one pump of each type at 3% head drop conditions, if specified in the pump Annexures.

v) Mechanical run test shall be carried out on all pumps to determine the vibration levels, noise levels etc. This test shall be conducted at site also. However, test value at site shall be used for the acceptance of the equipment.

7.00.00 DRAWINGS, DATA, CURVES AND INFORMATION

7.01.00 The Bidder shall submit the following along with his formal proposal besides the different information plate required as indicated elsewhere in this section.

7.01.01 Drawings

a) General arrangement drawings showing the principal dimensions, weight and location of the suction and discharge connections of the pumps offered. Details of lubrication and sealing arrangement shall be included.

b) Typical cross-section drawing showing various components of the pumps offered materials of construction etc.

7.01.02 Data and Curves

a) Determination of pump total dynamic head and rated capacity as per guidelines specified in Section-I of this Volume. Detailed calculations shall be shown by the Bidder.

b) Anticipated performance curves showing the following characteristics :

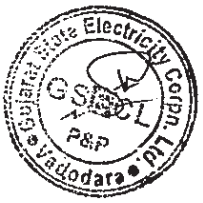
i) Capacity vs. head

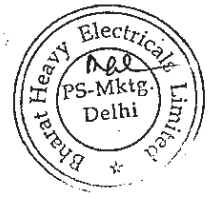
ii) Capacity vs. power

iii) Capacity vs. efficiency

iv) Capacity vs. NPSH required

v) System resistance curves





c) Speed vs. torque curve of the pump corresponding to recommended mode of pump starting superimposed on speed vs. torque curves of the drive unit corresponding to 80%, 90%, 100% of the rated voltage (applicable only in the cases of pumps with drive motor power rating of 100 KW and above).

d) Completely filled-in Technical particulars enclosed under Volume-III of this specification.

7.02.00 The successful Bidder shall furnish the following drawings/data for Purchaser/Engineer's approval after award of the contract.

7.02.01 Final versions of all the drawings, documents as specified in clause no. 7.01.00 above.

7.02.02 Pump foundation details along with all design loads, direction and points of application.

7.02.03 Test reports, test certificates and other particulars.

7.02.04 All other applicable drawings and documents as specified in Volume IIA of this specification.

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TECHNICAL SPECIFICATION FOR HORIZONTAL CENTRIFUGAL PUMPS(CONT.)

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. The minimum efficiency of pumps shall be 40%.

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.

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.

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.

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)

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

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.

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. Noice 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.

SECTION-C2-A
CUSTOMER SPECIFICATION
(TECHNICAL REQUIREMENT)
VERTICAL CENTRIFUGAL PUMPS
(IF APPLICABLE)

VOLUME : II-H

SECTION-IIIA

VERTICAL PUMPS FOR WATER SERVICE

1.00.00 **GENERAL INFORMATION**

1.01.00 This section presents the general guidelines and details of vertical pumps to be procured under the scope of this section and shall not be limited to the pumps specified under clause no. 3.00.00 below. For other vertical pumps in the scope of this specification, these general guidelines as specified hereinafter shall be followed.

2.00.00 **CODES AND STANDARDS**

2.01.00 In addition to the requirements spelt out in Volume-IIA of this 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/ 1984	:	Vertical inline centrifugal pumps for chemical process
2.01.10	API 610/1989	:	Centrifugal pumps for general refinery services.

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2.01.11 Hydraulic Institute Standards of USA (1983)

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

2.02.00 In case of any contradiction between the above standards and Annexure attached to this section, the stipulations in the Annexure shall prevail and shall be binding on the Contractor.

3.00.00 **SCOPE OF WORKS**

3.01.00 **Scope of Supply**

3.01.01 The scope of supply under this section and pertaining to 1 x 800 MW supercritical Unit shall be as below. Items not specifically mentioned but deemed necessary by the Bidder for making the system completely reliable and efficient shall also be included.

a) Equipment

i) ACW Pumps : Two (2) nos. (One working and one standby) Vertical Wet Pit type Auxiliary Cooling Water (ACW) Pumps complete with electric motor drives together with all other accessories as specified and corresponding to the ratings obtained in strict conformance with the guidelines specified in Section-I of this Volume.

ii) Any other vertical pump to be installed by the Contractor under this specification.

b) Equipment Accessories

Each pump set for all the above groups shall be supplied with the following accessories, as applicable.

i) Heavy duty couplings of approved design to connect the pump shaft directly with the motor shaft.

ii) Sets of base plates, support plates, grounding pads, thrust blocks, fitting lugs, eye bolts, nuts etc. for each pump and motor set.

iii) Slip on type drilled steel counter flanges of proper rating to suit the discharge flange of each pump set. All the counter flanges shall be complete with requisite number of bolts, gaskets etc.

iv) Thrust pads, if required, for pump discharge head complete with all necessary fixing and bolting arrangement, fasteners etc.

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v) One (1) pressure indicator with isolating cocks at the discharge side of each pump ; two (2) additional stubs with isolating root valves for pressure tappings and two (2) thermowells for temperature tappings at the discharge side of each pump for performance testing. Thrust bearing shall be furnished with dial type thermometer, temperature switch for high temperature annunciation and oil level gauge.

vi) All internal/integral piping with valves, fittings and instruments for lubrication, cooling and sealing, if applicable, shall be tapped off from respective pump discharge.

3.02.00 For detailed scope of services and works, Volume-IIA of this specification shall be referred to.

4.00.00 PERFORMANCE REQUIREMENTS

4.01.00 Performance requirements for the pumps shall be guided by the stipulations as specified in annexure enclosed with this section.

4.02.00 Pumps shall preferably be designed to have the best efficiency at the specified duty point. Further, the pumps shall be suitable for continuous operation at any point within its `range of operation' as specified in annexure enclosed with this section.

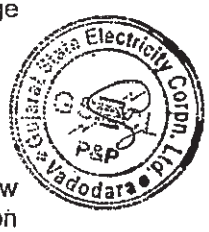
4.03.00 Pumps shall preferably have continuously rising Head-capacity characteristics, with maximum head at pump discharge shut-off, to enable parallel operation.

Under all circumstances, the 'range of operation' of the pumps shall exclude any unstable operating zone of the head-capacity curve.

4.04.00 For parallel operation of the pumps, pumps shall have identical characteristics to ensure equal load sharing and shall ensure trouble-free operation of any pump when the other pumps working in parallel with it trip.

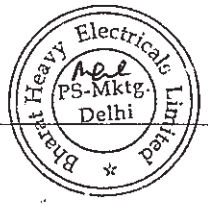
5.00.00 DESIGN AND CONSTRUCTION

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:



5.01.00 Bowl Assembly

5.01.01 This will be either a single or multi-stage centrifugal, 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.



5.01.02 Pumps shall have provision for adjustment of impellers in vertical direction from an accessible location, preferably at the housing (where separate thrust bearing for the pump is provided). The adjustment mechanism must take into consideration the extension of the line shaft due to hydraulic down thrust, weight of the shaft and impeller.

5.02.00 **Discharge Head**

5.02.01 Pumps shall be either above floor or below floor discharge type, as specified in the annexure, attached to this section.

5.02.02 In case, expansion joint is to be used at the pump discharge, pump base plate shall either be adequately designed to take the unbalanced forces and moments from the use of such expansion joint or a separate thrust block at the pump discharge head shall be provided to transmit these forces to the external supporting structure. Calculation of thrust load shall be done considering the highest pressure seen by the pump and internal diameter of the arch of the expansion bellow.

5.03.00 **Column Pipe**

5.03.01 Column pipe shall be flanged and have bolted connection. Column pipes shall be designed for full internal vacuum.

5.03.02 If below floor discharge and the water level is at or above the discharge valve level, the column pipe piece located at the intermediate floor level shall be provided with suitable floor sealing device.

5.03.03 In case of multi-piece column pipe and shaft assembly, the design shall permit raising/lowering of the pump assembly piece by piece without any difficulty. Any fixtures, clamps, etc. necessary for such purpose shall be supplied by the Contractor under this section. The Contractor shall also submit a write-up describing clearly the procedure of handling the pump.

5.04.00 **Impeller Shaft, Line Shaft and Head Shaft**

5.04.01 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.

5.04.02 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 be chamfered at the edges.

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

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

5.05.00 **Shaft enclosing Tube**

Shaft enclosing tube shall be required, unless self lubricated (and cooled) type of shaft bearings is asked for. Length of the shaft enclosing tube shall be in conformity with the shaft piece lengths.

5.06.00 **Seal Rings**

Replaceable seal/wear rings both on impeller and on casing shall be provided in case it is asked for in the annexures.

5.07.00 **Bearings**

5.07.01 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 as specified in the Annexure.

In case of external water/oil lubrication, complete lubrication arrangement shall be furnished with the pump. If the annexure calls for pre-lubrication of the shaft bearings, pre-lubrication tank and other accessories shall be within the scope of supply of the Bidder/Contractor.

5.07.02 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 bearings 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 of annexure or as per the recommendation of the pump manufacturer (and approved by Owner).

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5.07.03 Guaranteed life of bearing shall be minimum 25,000 years.

5.08.00 **Reverse Rotation**

5.08.01 The pump impeller and other rotating components shall be designed for reverse rotation, when subject to reverse flow at rated pump discharge head.

5.09.00 **Drive Unit**

5.09.01 The pump will be driven by electric motor as specified in annexure. A heavy duty coupling shall be provided between the drive unit and the driven equipment (except for belt drive).

5.09.02 Unless otherwise specified in annexure, drive element power rating shall be the maximum of the following requirements.

a) 15% margin over the pump shaft input power at the rated working condition.

b) 5% margin over the maximum pump shaft input power required within its operating range including the shut off point.

c) Pump shaft input power required considering overloading of the pump assuming single pump operation in the event of tripping of the other pump(s) operating in parallel.

5.09.03 The drive equipment shall preferably be air cooled. In case the pumping fluid is water, free of abrasive and corrosive matter, the same can be used for cooling purpose. The arrangement shall be within the scope of the supplier.

6.00.00 **INSPECTION AND TESTING**

6.01.00 The Contractor shall carry out the following specific tests and inspections to ensure that the equipment furnished lies in strict conformance with the specification and in accordance with codes/standards and good engineering practice.

a) Material identification and testing shall include, but shall not be limited to the following components:

i) Bowls and suction bells.

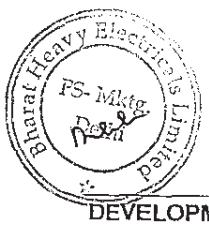
ii) Impeller and wearing rings.

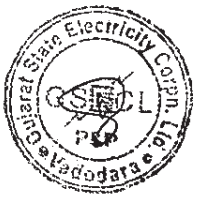
iii) Shafts and shaft sleeves.

iv) Couplings.

v) Bearings.

vi) Column pipes.





vii) Discharge heads.

viii) Bowl Assembly.

b) Test shall also include but shall not be limited to the following :

i) The entire surface of the impeller castings shall be subjected to Dye Penetration Test as per ASTM-E-165.

ii) Shaft shall be subject to dye penetration and ultrasonic test.

iii) Wearing rings shall be subjected to Dye Penetration Test.

iv) Witnessing of NDT/review of NDT reports.

v) Static balancing test for impeller and dynamic balancing of complete rotating parts as per ISO-1940.

vi) Complete inspection of assembled pump.

c) Hydrostatic test shall be done for the following components (as minimum) at 150% of the shut-off pressure. Pressure shall be maintained for a period of not less than one (1) hour. While arriving at the above values, maximum suction pressure shall be taken into account.

i) Bowls/Suction bells.

ii) Column pipe.

iii) Discharge head.

iv) Any other applicable pressure parts.

d) Performance Test at Shop

i) Each pump shall have to be tested to determine performance curves of the pumps. These tests are to be conducted in presence of Owner's representative as per the requirements of the Standards of Hydraulic Institute of USA (ASME-Power Test Code PTC 8.2/BS-599) or any other equivalent standard but the tolerances on head discharge and power shall be as specified in HIS, USA.

ii) Performance tests are to be conducted to cover the entire range of operation of the pumps. These shall be carried out to span 130% of rated capacity up to pump shut-off condition. A minimum of five combinations of head and capacity are to be achieved during testing to establish the performance curves, including the design capacity point, shut-off point and the two extremities of the range of operation specified. After completion of performance test, all pumps shall be stripped down for inspection of internals.

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iii) Tests shall be conducted with similar shop motors being furnished.

iv) The Bidder shall submit in his proposal the facilities available at his works to conduct performance testing.

v) NPSH tests are to be conducted on one pump of each type at 3% head drop conditions, if specified in the pump Annexure.

vi) All rotating components of the pumps shall be subjected to static and dynamic balancing tests. The assembled rotor will be subjected to dynamic balancing tests.

vii) Mechanical run test shall be carried out on all pumps to determine the vibration levels, noise levels etc. This test shall be conducted at site also. However, test value at site shall be used for the acceptance of the equipment.

viii) Reports and test certificates of above tests shall be submitted to the Owner for approval.

7.00.00 DRAWINGS, DATA, CURVES AND INFORMATION

7.01.00 Following drawings, data and information for the equipment are required to be submitted by the Bidder along with his formal proposal.

7.01.01 Drawings/Data

a) Determination of pump head and capacity as per guidelines of this specification. Detailed calculations shall be submitted by the Bidder.

b) Outline drawings of the pump showing the various dimensions, suction and discharge locations.

c) Typical cross section drawing of the pump to be supplied, showing various components, bearings, seal rings etc. and materials of construction for all items.

d) Lubrication arrangement drawings for external lubrication.

7.01.02 Anticipated performance curves and test curves for:

a) Capacity Vs Head

b) Capacity Vs. Power & Efficiency

c) Capacity Vs. NPSH requirement

d) System resistance curves.

e) Speed Vs. torque requirement of the pump considering reverse flow of the pump at rated head (for pump sets with drive motor rating of 100 KW or more) together the drive motor speed-torque characteristic.

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7.01.03 Completely filled up schedules enclosed under Volume-III of this specification.

7.01.04 A write-up describing clearly the procedure for installing the pump with its column pipe, piece by piece and also for overhauling the pump in a like manner. A diagram showing the required pump house crane hook lift above the pump operating floor has also to be furnished.

7.02.00 The drawings/data asked against the clause nos. 7.01.01 and 7.01.02 above shall also be furnished in a finalized form by the successful Bidder (after the contract is awarded to him), for the approval of the Owner/his Consultant. In addition, he will also submit the following for Owner's/ Consultant's approval

7.02.01 Principal dimensions of the pump sump indicating clearance dimensions for the suction bell from back wall and side walls, minimum submergence required for the pump etc.

7.02.02 Pump foundation details, with static and dynamic loads.

7.02.03 Pump and drive sealing, bearing lubrication and cooling arrangement drawing.

7.02.04 Drive data.

7.02.05 Reports on shop tests and test certificates.

7.02.06 All other drawings, data and documents specified in Volume-IIA of this specification.

SECTION-C2-A
CUSTOMER SPECIFICATION
(TECHNICAL REQUIREMENT)
POSITIVE DISPLACEMENT PUMPS

SECTION: XI

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	AISI 4142.
♦ Shafts (worm)	En 19.
♦ Diaphragm	Chemically inert teflon.
♦ Base plate	MS.
♦ Foundation bolts	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.

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.

SECTION-C2-A
CUSTOMER SPECIFICATION
(TECHNICAL REQUIREMENT)
LOW PRESSURE PIPING, VALVES AND SPECIALTIES

VOLUME : II-I

SECTION-VI

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 condensate storage tank.

1.04.00 Demineralised Water closed cycle cooling system.

1.05.00 Service water system.

1.06.00 Drinking 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 II, 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 [Part-I & II]	:	Mild steel tubes, tubular and other wrought steel fittings.
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 [Part-I & II]	:	Hexagonal head bolts, screws and nuts (size range M5 M36)
2.01.05	IS-1364	:	Precision and Semi-precision hexagon bolts, screws, nuts and lock nuts (diameter range 6 to 39 mm)

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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.

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.

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 x 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.

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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. The valves shall be provided with electric motors/solenoids and actuators as required.

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.

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.

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 of nominal size above 50 mm, 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.

For valves with nominal size upto 50 mm, indicator is not required for rising stem type valves.

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

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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 : II 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 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.

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.

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ANNEXURE-I

SPECIFICATION OF PIPES FOR DIFFERENT SERVICES

	A		B		C	D
Services	1. Clarified Water piping 2. DMCW piping 3. Service Air		1. Drinking Water Supply, piping (filtered water, chlorinated)		1. Demineralised Water and Instrument Air Piping less than and equal to 50 mm NB	1. Demineralised Water 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 40S (Min) ANSI B36.19	Stainless steel as per ASTM A-312 Gr. 304. Size-upto 150 mm NB as per schedule 10S (Min), ANSI B-36.19.
2.00.00 Construc-tion	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	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		
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

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	A		B		C	D
Services	1. Clarified Water piping 2. DMCW piping 3. Service Air		1. Drinking Water Supply, piping (filtered water, chlorinated)		1. Demineralised Water and Instrument Air Piping less than and equal to 50 mm NB	1. Demineralised Water and Instrument air piping for sizes equal to greater than 65 mm NB
4.02.00 Construc-tion	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	Butt Welded
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.	150 lb class, raised 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)	Filtered Water	
		iii)	Drinking Water	
		iv)	Inhibited Demineralised Water	
B.	Stainless steel body/ Gate/Globe /Check/Ball Valve	i)	For Demineralised water	For all sizes
		ii)	Drinking Water	For sizes less than and equal to 50 mm NB
		iii)	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	
		iii)	Service Air	For all sizes Ball valves to be used in air line
D.	Cast Iron body butterfly valve	i)	For Demineralised Water	For butterfly valve specification refer Annexure II, Sec.V of Vol. II-I. 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	

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Bharat Heavy Electricals Limited PS-Mktg. Delhi

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 602 for 50mm NB and below. ii) API 600 for sizes above 50mm NB
	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 & 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