

THIS IS A PART OF TECHNICAL SPECIFICATION NO. PE-TS-412-155A-A001

TANGEDCO				Total Ex-Works price	*Remarks
Sl no	Name of spares	Unit	Qty	in INR	
a)	Electronic Module/Mother Board	Nos.	10% of installed or at Least one number of each type of module for each analyser type.		
b)	Cooling and purging air blower unit	Nos.	One No. for each analyser type		
c)	Light source and detector unit for smoke density analyser.	Set	One set for each analyser type		
d)	Infrared source and detector unit for CO analyser	set	One set for each analyser type		
e)	Zirconia Cell, ceramic filters, heater & thermo couple assembly for flue gas oxygen analyzer.	Nos.	Two Nos. of each type		
f)	of chopper motor, two nos. protection window, one no. of heater cartridge for CO analyser	Nos.	Two No. of each type		
g)	Power supply module	Nos.	1 no. of each type for each analyser type.		
h)	UV Lamp with adopter with SO2 analyser	Nos.	2 no. of each type.		
i)	Light source and detector unit for SPM, and NOX/SOX analyser.	Nos.	1 no. of each type for each analyser type.		
j)	Set of filters	Nos.	1 No. of each type for each analyser type.		
k)	Analysers spares like transmitter lens and receiver lens, protection windows for transmitter & receiver, intergral pressure and temperature sensors, signal processing unit, electronic modules	Nos.	1 No. of each type for each type of flue gas analyser.		
1.00.02	DDCMIS/PLC system, Master slave clock system, Hart Management System, Vibration Monitoring system, CAAQMS, ERP/MIS/LAN/Simulator/ WAN, CCTV, Microprocessor based control system, and other Control System/Sub-systems/electronic system listed in NIT.				

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1.00.02.01	I/O cards				
a.	Analog Input module	Nos.	10% of qty Installed of each category/model or at least 2 No. of each type/model (Whichever is more)		
b.	Analog output module	Nos.	10% of qty Installed of each category/ model or at least 2 No. of each type/model (Whichever is more)		
c.	RTD/TC cards/modules	Nos.	10% of qty Installed of each category/model or at least 2 No. of each type/model (Whichever is more)		
d.	Digital input module	Nos.	10% of qty Installed of each category/model or at least 2 No. of each type/model (Whichever is more)		
e.	Digital output module	Nos.	10% of qty Installed of each category/model or at least 2 No. of each type/model (Whichever is more)		
1.00.02.02	All types of electronic modules, controllers, function modules, cards, terminal boards, relay boards, power supply cards etc for above mentioned system and other Control System/Sub- systems and any other type of PCB not covered above	Nos.	10% of qty Installed of each category/model or at least 2 No. of each type/model (Whichever is more)		

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1.00.02.03	Electronic Cards/modules	Nos.	10% of number for each type or minimum of 2 number for each type whichever is high.		
1.00.02.04	Auto/Manual stations, set-point/bias stations etc	Nos.	10% of the number of stations offered for the project from each type or a minimum of 2 number from each model, whichever is more.		
1.00.02.05	Control logic power supply fuses, MCB,MCCB, at each current rating required for the project.	Nos.	20% spare for each type/Model		
1.00.02.06	Electronic cards of each type used for each type of Servers supplied with any control system	Nos.	Ten (10) percent or 2 no. (Whichever is more)		
1.00.02.07	Electric to pneumatic converters of each type utilized with automatic control system using pneumatic drives	Nos.	Ten (10) percent of each type or a minimum of one of each type, whichever is more.		
1.00.02.08	Plug-in type keyboard	Nos.	5 nos. of each type/model		
1.00.02.09	OWS/OEWS with 24" LED monitor		1 no. of each type/model		
1.00.02.10					
1.00.02.11	DVD/CD	Nos.	10 boxes		
1.00.02.12	Data highway cable with adequate connectors of each type	set.	200 mts. each		
1.00.02.13	Hard disc drive unit	Nos.	2 nos. of each type/model		
1.00.02.14	Prefab cable connectors	Nos.	10% or 5 nos (whichever is more) of each type of Installed		
1.00.02.15	Cubicle power supply power supply modules	Nos.	Ten (10) percent or 5 nos (whichever is more) of Installed of each type and rating		
1.00.02.16	Interposing/coupling relays.	Nos.	Ten (10) percent Installed of each type and rating		

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1.00.02.17	Ethernet Switches, Routers & other communication hardware	Nos.	10% of qty Installed of each type or a minimum of 2 numbers from each model, whichever is more.		
1.00.02.18	Sensors with special cables, Power supply modules, Relay, Interface Module, and electronic modules used for vibration monitoring system.	Nos.	10% of qty installed or Five no. (Whichever is more) of each type)		
1.00.02.19	Printer toners for all printers	Nos.	1 no.		
1.00.02.20	DMP printer head of the total quantity	Nos.	Not applicable for this package		
1.00.02.21	Drum for A3 sized scanner cum copies, printer	Nos.	Not applicable for this package		
1.00.02.22	24" LED monitor,	Nos.	Not applicable for this package		
1.00.02.23	29" LED monitor	Nos.			
1.00.02.24	22" LED monitors.	Nos.			
1.00.02.25	RJ 45 connector with box of each type	Nos.	Twenty (20) percent or 2 no. (Whichever is more)		
1.00.02.26	Hooters, Buzzers, Cooling fans of each type.	Nos.	Ten (10) percent or 2 no. (Whichever is more)		
1.00.02.27	Interface cables	Set	2 sets of each type/model		
1.00.02.28	Power supply modules (AC to DC convertors)	Nos.	10% or Five no. (Whichever is more) of each type/model		
1.00.02.29	DVD/CD drive unit of each type	Nos.	2 nos.		

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SI no	Name of spares	Unit	Qty	in INR	
1.00.02.30	Mouse	Nos.	5 nos. of each type/model		
1.00.03	Steam and Water Analysis System (SWAS)				
1.00.03.01	High pressure reducing elements for sample flow.	Nos.	10% spare of qty installed.		
1.00.03.02	Ion exchange columns with resin as utilized with cation conductivity analysers	Nos.	Four No		
1.00.03.03	Conductivity cells as utilised with conductivity monitors	Nos.	Two nos of each type		
1.00.03.04	pH flow-through type cells used with pH monitors	Nos.	Two nos. of each type		
1.00.03.05	Chemical reagents for all analysers	Set	12 months continuous operation of all analysers from date of taking over.		
1.00.03.06	Chemical reagents for colorimetric silica analyzers	Set	12 months continuous operation of all analysers from date of taking over.		
1.00.03.07	Electronic Modules	Nos.	One (1) no. for each type of Analyser.		
1.00.03.08	Pressure gauge, solenoid valves, temperature gauge, Back Pressure regulating valves, 3 way grab valves, needle valves, isolation valves, PRV, flow switch, flow indicator and temperature switch, erection hardware s, valves in SWAS.	Nos.	Two (2) no. of each type		
1.00.03.09	Primary coolers/secondary coolers.	Nos.	Three (3) No of each type		
1.00.04	Relay based Control Panels				
1.00.04.01	LEDs for indicating lights	Nos.	10% of qty installed.		
1.00.04.02	Control circuit fuses/MCB/MCCB/ Semiconductor Fuses	Nos.	300% of installed of each type, current rating.		
1.00.04.03	Relays modules & contactors.	Nos.	20% spare of qty Installed of each type & rating.		

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SI no	Name of spares	Unit	Qty	in INR	
1.00.05	Alarm Annunciation System				
1.00.05.01	logic modules, group card modules, power supply modules, Hooters and any other electronic module.	Nos.	20% spares of each type installed		
1.00.05.02	un-engraved window boxes complete with LED etc.	Nos.	5% spares of each size installed		
1.00.05.03	LEDs for annunciation facia windows and LEDs box assemblies offered for the project	Nos.	20% of qty installed		
1.00.05.04	Annunciator hooter	Nos.	One (1) No. of each type		
1.00.06	Un-interrupted Power Supply System and DC Control Power Supply System				
1.00.06.01	As per Manufacturer's Recommendation for Three Years Continuous Operation or minimum quantities indicated as below (whichever is more)				
1.00.06.02	Fuses/Semiconductor Fuses	Nos.	300% of installed of each type, current rating with each panel /board		
1.00.06.03	Miscellaneous parts for the power supplies such as SCRS, transistors, resistors, diodes, light bulbs, static switches , blocking diodes etc	Nos.	Minimum of 10% or atleast two (which ever is more) of each type		
1.00.06.04	Battery cells complete with contactor,cover plates etc	Nos.	10% of qty installed		
1.00.06.05	Electronic Modules like Rectifier control card, inverter control card, Driver card, IGBT Module, DC-DC converter card or any other card as listed in approved BOM for UPS, AC supply & 24 V DC supply etc.	Set	1 Set of each type & rating		

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1.00.06.06	Miniature Circuit breakers for AC and DC supply.	Nos.	20 % of installed or 10 Nos of each type (which ever is more) for ACDB and DCDB.		
1.00.06.07	Digital/analog panel meters/indicators	Nos.	5% or 2 no. of each type (whichever is more)		
1.00.06.08	CT's, CVT's VT's chokes, AC/DC isolators, contactors, timers, relays.	Nos.	10% or 2 nos. of each type and rating, (whichever is more)		
1.00.06.09	Cooling Fans in UPS & 24 V DC charger panels	Nos.	10% or 2 nos. of each type and rating, (whichever is more)		
1.00.06.10	following accessory equipment for the battery shall be furnished : a) Cell lifting facilities b) Assembly wrenches c) Vent plug hydrometer d) Vent plug thermometer e) Supply of corrosion-preventive grease. f) 10% spare cells.	Set	Two sets		
1.00.06.11	Electronic modules of each type & rating for UPS and DC control power supply system.	Set	One set of with each set consisting of at least one number of each type of electronic module for inverters, chargers, static switch, stabiliser etc. as per approved BOM.		
1.00.06.12	MCCB for UPS & 24 V DC charger panels, ACDB, DCDB.	Nos.	20 % of installed or 5 Nos of each type (which ever is more)		
1.00.07	Erection hardware				
1.00.07.01	Instrument valves	Nos.	Ten (10) percent of each type & Size installed		

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1.00.07.02	Condensate pots of each type & Size installed	Nos.	Ten (10) percent of total number of Installed or four numbers whichever is higher.		
1.00.07.03	Manifold	Nos.	Ten (10) percent of each type & Size installed		
1.00.07.04	Fittings	Nos.	Ten (10) percent of each type & Size installed		
1.00.08	LVS				
1.00.08.01	LEDs	Nos.	20% (Installed) spares of each type & size.		
1.00.08.02	LVS Filters	Nos.	50% spare or min 6 nos.		
1.00.08.03	Electronic cards of each type for LVS	Nos.	3 nos. or 20% whichever is more		
1.00.08.04	Interfacing cables	Set	Two Set of each type & size.		
1.00.08.05	Power supply modules of each type for LVS	Nos.	3 nos. or 20% whichever is more		
1.00.08.06	Cooling modules of each type for LVS	Nos.	3 nos. or 20% whichever is more		
1.00.08.07	LVS Controller of each type for LVS	Nos.	2 nos.		
1.00.09	Master Slave Clock system				
(i)	As per Manufacturer's Recommendation for Three Years Continuous Operation or minimum quantities indicated as below (whichever is more)	Set			
(ii)	Electronic cards	Nos.	One No. of each type & model		
(iii)	Signal Conditioner cards	Nos.	One No. of each type & model		
(iv)	Slave clocks of each type used for Master slave clock system	Nos.	Two No. of each type & model		
(v)	Cubicle power supply power supply modules	Nos.	Ten (10) percent or 2 nos (whichever is more) of Installed of each type and rating		
1.00.10	Plant Security and surveillance system				

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1.00.10.01	As per Manufacturer's Recommendation for Three Years Continuous Operation or minimum quantities indicated as below (whichever is more)				
1.00.10.02	Electronic cards	Nos.	One No. of each type		
1.00.10.03	PTZ controller	Nos.	One No. of each type		
1.00.10.04	Electronic modules used for server system	Nos.	10% or Two No. of each type (whichever is more)		
1.00.10.05	Special cables & connector	Set	(5 sets) of each type		
1.00.10.06	Cartridges for air filter	Nos.	Two No. of each type		
1.00.10.07	Relay	Nos.	5 nos. of each type		
1.00.10.08	Power supply modules of each type	Nos.	5 nos. of each type		
1.00.10.09	Camera of each type used for Plant Security and surveillance system.	Nos.	Two no. of each type		
1.00.10.10	Automatic door sensors	Nos.	10% or 2 nos. min whichever is more		
1.00.10.11	Card reader.	Nos.	10% or 2 nos. min whichever is more		
1.00.11	AAQMS				
1.00.11.01	As per Manufacturer's Recommendation for Three Years Continuous Operation or minimum quantities indicated as below (whichever is more)				
1.00.11.02	Electronic cards/Module/Mother Board /Signal Processing Unit for each type of Analyzer	Nos.	One no. of each type		
1.00.11.03	Power supply module	Nos.	One no. of each type for each analyser		
1.00.11.04	UV Lamp with adopter with SO2 analyser.	Nos.	One no. of each type		
1.00.11.05	Light source and detector unit for SPM, and NOX/SOX analyser.	Nos.	One no. of each type for each analyser		
1.00.11.06	Pump for SPM Analyser	Nos.	One no. of each type		
1.00.11.07	Conference hall mic.	Nos.	Two no. of each type		
1.00.11.08	Conference hall speakers.	Nos.	Two no. of each type		
1.00.12	HMS				
1.00.12.01	As per Manufacturer's Recommendation for Three Years Continuous Operation	Set			
1.00.12.02	Electronic cards	Nos.	One no. of each type		

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1.00.13	Mandatory Spares for Control valves, Power Cylinder, Control Dampers, Actuators and Accessories				
(A)	Following spares shall be furnished for control valves, Power Cylinder, Control Dampers as applicable.				
	One set of spare control valve stem packing for each control valve.				
	Two moulded rubber diaphragms for each control valve.				
	One sets of each of O-rings and rubber gaskets for each control valve.				
d)	100 percent qty. of lubricants for gaskets for each control valve on one year consumption basis.				

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	2 sets of limit switches and 1 set of valve positioner for each control valve.				
f)	20 percent of position transmitter (4-20mA) for total qty. of control valve.				
g)	One (1) set of valve trims (such as plug, stem, seat ring /cage, guide bushing, stem lock pin, packing retaining ring, etc) for each control valve.				
h)	One completes actuator of each type or min 10% for each type and size whichever is more.				
i)	20 percent of Solenoid valves or min 2 no. of each type for total qty. of control valves.				
j)	20% of I to P converters, Pressure regulators.				
B)	Mandatory spares for each critical applications special control valves as specified in NIT				
C)					

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Sl no	Name of spares	Unit	Qty	in INR	
	a. Soft Goods Kit Valve	1 set			
	b. Metal seat	1 set			
	c. Seat Ring	1 set			
	d. Spindle	1 set			
	e. Actuator Soft Goods kit	1 set			
	i. Feed back transmitter unit	2 Nos.			
	ii. Electronic Position Transmitter	2 Nos.			
	iii. Solenoid valves	2 Nos.			
	iv. Air filter regulators	2 Nos.			
	v. Air Lock Relay	2 Nos.			
	vi. Complete Actuator for each type and model	1 set			
C)	Following spares shall be supplied for each of the HP/LP By Pass & Spray control valves				
i)	Stem	1 NO.			
ii)	Jet Cage	1 NO.			
iii)	Nozzle Body	1 NO.			
iv)	Seat	1 NO.			
v)	Guide bushing	1 NO.			
vi)	Valve Packing	1 Set			
vii)	Valve Gaskets	1Set			
viii)	Actuator seal set	1 Set			
D)	Common spares for HP/LP By Pass & Spray control valves:				

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i)	Feedback transmitter	2 NOS.			
ii)	Electronic positioner	2 NOS.			
iii)	Proportional Valve	2 NOS.			
iv)	Quick opening device	2 NOS.			
v)	Seal sets	4 Sets			
vi)	Solenoid Valves	2 NOS.			
vii)	Filters for Oil Units	1 set			
viii)	Supply manifold for oil units	1 No			
ix)	Hose for each service	1 each			
x)	Seal set for oil unit	1 Set			
	Complete actuator for each type and model	1 set			
E)	1 NO of Nozzle for each PRDS De Super heater & Spray water desuperheater and orifice plate for CEP flow.				
1.00.14	Mandatory Spares for Boiler Tube leak Detection System				
	Following mandatory spares along with their individual price required for maintaining boiler tube leak detection system to supply along with the package.				
1)	2nos. acoustic transducer with rear connector sealed to IP-65				
2)	2 nos. flexible high temperatures lead, 3metre long for acoustic transducer.				
3)	2 nos. acoustic s field amplifier / processor mounted in a die cast aluminum or polycarbonate box sealed to IP-65 with mounting brackets, pairs.				
4)	1 no. A/D Convertor cards/field signal interface module for 32 or more channels.				
5)	1 no. Alarm relay output card.				

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b)	Consumables like batteries, fuses etc. for two years operation of boiler tube leak detection system.				
1.00.15	Mandatory spares not covered above				
	Bidder to supply 10% or 1 no. (whichever is more) of each type of sensor/instrument, instrumentation/mechanical fittings etc for any other electronic system, feeder control cabinets, hydrastep (EWLI), Vibration Monitoring System, CCTV, C&I Lab Instruments, On line Carbon in Ash analyser system, On line Coal mass flow/speed measurement system, On line secondary air flow measurement system Mass Flow meter, Solid flow meter, 3 D Acoustic type level transmitters, Nucleonic & non nucleonic density transmitter etc.				
1.00.16	OTHER RELATED CONTROL AND INSTRUMENTATION SYSTEMS/EQUIPMENTS				
1.00.16.01	Other SG related sub-systems				
	1 Flame Monitoring System				
(i)	Complete Flame Scanner Assembly including scanner head assembly, scanner housing, and fibre optic cables.	20% or 4 nos. whichever is more.			
(ii)	Flame Scanner Lens.	100%			
(iii)	Electronic cards for scanners	10% or 2 nos. of each type whichever is more.			
(iv)	Power Supply Modules	10% or 2 nos. of each type whichever is more.			
	2 Coal Feeders				
(i)	Calibration Motor	10% or 2 nos. whichever is more.			
(ii)	Correction Motor	10% or 2 nos. whichever is more.			

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(iii)	Motion monitor	10% or 2 nos. whichever is more.			
(iv)	Speed pick-up	10% or 2 nos. whichever is more.			
(v)	Torque switch	10% or 2 nos. whichever is more.			
(vi)	Load Cell	10% or 2 nos. whichever is more.			
(vii)	Electronic cards & Power Supply cards	10% or 2 nos. whichever is more.			
(viii)	Clutch (if applicable)	10% or 2 nos. whichever is more.			
(ix)	Local indication lamps	200% .			
(x)	Panel meters	10% or 2 nos. whichever is more.			
(xi)	Limit switch assembly for coal-on-belt, no coal flow, shear pin failure, etc.	10% or 2 nos. whichever is more.			
(xii)	Coupling (eddy current type etc., if applicable)	10% or 2 nos. whichever is more.			
	3 Electromatic Safety Valves				
(a)	Pressure switches, local PB stations and solenoid Valves.	10% or 2 nos. of each type whichever is more.			
	4 Furnace Temperature Probes				
(a)	Thermocouple	2 Nos. of each type			
	5 Acoustic Pyrometers				
(a)	Signal Processor and interface modules	10% or 2 nos. of each type and model whichever is more			
(b)	Sensors and Transceivers	20% or 2 nos. of each type and model which is more.			
	6 Furnace and Flame Viewing System				
(a)	Flame Cameras	10% or 2 nos. of each type whichever is more.			
(b)	Electronic Modules	10% or 2 nos. of each type whichever is more.			
	7 Coal Bunker Level Indicating System				
(i)	Sensors of each type	20% or 2 nos. of each type whichever is more.			

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(ii)	Electronic Cards of each types, model	10% or 2 nos. of each type and model whichever is more.			
(iii)	Panel indicators/displaysfor Bunker Level	20% or 2 nos. of each type whichever is more.			
8 (i)	Solenoids for SG pneumatic drives/valves.	20% or 2 nos. of each type whichever is more.			
(ii)	Solenoid valves.	20% or 2 nos. of each type whichever is more.			
(iii)	Diaphragms	20% or 2 nos. of each type whichever is more.			
9 Conductivity type level monitoring system					
(i)	Electrodes	50% of population of each type and model.			
(ii)	Electronic Cards	20% or 2 nos. of each type and model whichever is more.			
(iii)	Lamps/LEDs of display units	100%			
10	Mill and Air heater Fire detection system.				
(a)	Thermocouple	10% or 2 nos. whichever is more			
(b)	Process actuated switches	10% or 1 no. whichever is more			
(c)	Electronic cards	20% or 2 nos. whichever is more			
1.00.16.02	Other TG Related Sub-Systems				
	Turbine Supervisory System/EHTC/TSC/ATT/ATRS/GSPC/TDBFP etc.				
(i)	Power Supply assemblies of all types	10% or 2 nos. of each type whichever is more			
	Temperature Sensing elements	10% or 2 nos. of each type whichever is more			
(iii)	CJC assemblies of all types	10% or 2 nos. of each type whichever is more			
(iv)	Local gauges/transmitters of all types, range, model no. etc. For Temperature, pressure, DP, differential expansion, axial shift etc.	5% or 1 no. of each type whichever is more			

1. C&I Mandatory spares are indicated in above list. These spares shall be considered as per the applicable items in main supply of CPU package.

2.The spares shall be considered as unit wise except for any item/equipment supplied as common for both units.

THIS IS A PART OF TECHNICAL SPECIFICATION NO. PE-TS-412-155A-A001

TANGEDCO				Total Ex-Works price	*Remarks
SI no	Name of spares	Unit	Qty	in INR	
(v)	Process Actuated Switch Devices of all types, range, model no. etc. for pressure, DP, temperature, flow, level, proximity/speed etc.	5% or 1 no. of each type whichever is more			
(vi)	Electronic Cards/PCB's/interface units/special cables etc. of each type of measurement used in TSI.	10% or 2 nos. of each type whichever is more.			
(vii)	Instrument valves of all types like isolating, 2/3/5 way valve manifolds, hi pressure reducing, safety relief, each type of solenoid valves etc.	5% or 2 nos. of each type, model etc.; whichever is more.			
(viii)	Sensors of all types, range, model etc. for vibration, eccentricity, proximity, differential expansion, axial shift, EHC position, Stop/Control valve position and any other measurements etc.	10% or 2 nos. of each type whichever is more.			
(ix)	Electro Hydraulic Converter.	1 complete unit of each type.			
			C& I TOTAL		

1. C&I Mandatory spares are indicated in above list. These spares shall be considered as per the applicable items in main supply of CPU package.

2. The spares shall be considered as unit wise except for any item/equipment supplied as common for both units.

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ANNEXURE III

RAW WATER ANALYSIS AND CLARIFIED WATER ANALYSIS

(Not applicable)

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ANNEXURE IV**LIST OF TOOLS AND TACKLES**

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Bidder to consider necessary tools and tackles for mechanical, electrical and control & instrument as per their system requirement. In addition bidder to adhere relevant clauses of tender specification also. List of tools and tackles to be furnish by bidder during bid submission.

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ANNEXURE -V

DRAWING DOCUMENT / SUBMISSION SCHEDULE



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Note:

- Quantity of prints may change during detailed engineering stage based on BHEL / Customer requirement. However the same will be adhered by the bidder without any delivery/commercial implication to BHEL.
- All the drawing documents along with the O&M manual (of all the revisions) are necessarily to be submitted in soft copies in addition to hard copies.
- Bidder to submit soft copies of all the drawing and document along with quality plans for BHEL review and approval.
- The date of submission of drawing documents shall be considered as the date of submission of hard and soft copies whichever is later.
- All the drawings shall be prepared on computer auto cad and other documents (like datasheet etc.) on MS office software. Bidder not complying to the requirement shall not be considered. For the execution of the contract regular meeting (generally once in 15 days or as per project requirement) is required.
- Bidder has to come for meeting with the concerned dealing persons as per BHEL or customer requirement in a short notice.
- Bidder to submit instrument schedule, cable schedule and valve schedule in MS- Excel format during detailed engineering.
- Bidder to also furnish the auto cad copy / MS-word (as applicable) of the following documents after award of contract. However any other auto cad copy/MS-Excel/MS-word of any other document as per the insistence of BHEL / customer will also be submitted by the bidder without any delivery/commercial implication to BHEL.
 - P&IDs.
 - Equipment lay out of the service vessel area and regeneration area.
 - Equipment Cable tray layout for service vessel area and regeneration area
 - Equipment earthing layout service vessel area and regeneration area
 - Civil scope drawings.
 - Piping lay out drawing for Service vessel area, regenerative area and yard piping layout.

ANNEXURE-I

S. NO.	DESCRIPTION OF MANUALS	NO OF PRINTS (sets)	NO. OF CD- ROMs (sets)
1.	PLANT DEFINITION MANUAL-	-	3 CD-ROMs
2.	Drawings "FOR APPROVAL"	10	Soft Copy
3.	Drawings "FOR INFORMATION"	10	Soft Copy
4.	Drawings "FINAL APPROVED DRAWING"	8	Soft Copy
5.	Drawings "AS BUILT "	8	3 CD-ROMs
6	DATASHEETS,DESIGNCALCULATIONS,PURCHASE SPECIFICATIONS, etc. and Other type of documents		
	i) For Approval	10	SOFT COPY
	ii) FINAL	8	3 CD-ROMs -
	iii) Analysis reports of equipment/ piping/ structures components/ systems employing software packages as detailed in the specifications		
	a) Input	10	SOFT COPY
	b) Output	10	SOFT COPY
	c) Drawings/ Sketches	10	SOFT COPY
7	Erection manual "FINAL"	8	3CD ROMS
8	Operation & Maintenance manual	10	3CD ROMS
9	Plant Hand Book "DRAFT"	6	SOFT COPY
10	Plant Hand Book "FINAL"	15	3CD ROMS
11	Commissioning and Performance Procedure manual	10	3CD ROMS
12	Performance and Functional Guarantees test report	6	3CD ROMS
13	Progress Reports	6	3CD ROMS
14	Project completion report	10	3CD ROMS
15	QA programme including	1	



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Anshul
Anshul

S A Khan
S A Khan

Praveen Kishore
Praveen Kishore



S. NO.	DESCRIPTION OF MANUALS	NO OF PRINTS (sets)	NO. OF CD- ROMs (sets)
	Organization for implementation and QA system manual (with revision-servicing)		
16	Vendor details in respect of proposed vendors including Bidder's evaluation report.	1	
17	Manufacturing QPs, Field QPs, Field welding schedules and their reference documents like test procedures, WPS, POR etc.		
	(i) For review/comment	3	
	(ii) For final approval	4	1 set CD ROMS
18	Welding Manual, Heat Treatment Manuals, Storage & preservation manuals	4	
	Final	4	2 CD ROMS
19	Monthly Vendor Approval and QP approval status	2	1 CD ROM
20	QA Documentation Package for items / equipment manufactured and dispatched to site	2	2 CD ROMS
21	QA Documentation Package for field activities on equipment/systems at site	2	2 CD ROMS



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S A Khan

Praveen Kishore



indigenous supplies. The cost towards this inspection shall be borne by the Contractor.

- b) In the case of imported supplies. - For imported materials or non- indigenous supplies, the inspection shall be carried out by a foreign agency of repute to be appointed by the contractor as approved by the Owner. The cost of such inspection shall be borne by the Contractor.

18.0 OPERATION AND MAINTENANCE MANUALS:

- 18.1 For all the equipments supplied by the Contractor, he shall submit to the Owner ten sets of the O&M manuals. The manual shall contain the operational features of the equipment, DOs & DON'Ts, trouble shooting, maintenance schedules for preventive maintenance, detail dimensional drawings, cross sectional drawings, method of assembly etc. to make the Owner's staff acquainted with the equipment as well as to enable them to operate and maintain the same in prescribed manner. Manuals shall contain all information for ordering of the spares, like part name, part no., Drawing/material Specifications, address of the supplier with phone no. & fax no. etc. Contractor shall ensure that these O&M manuals are made available to the Owner well before starting of initial trials of equipment.

18.2 ERECTION MANUALS:

- 18.2.1 In order to enable the engineers of the Owner to supervise the works properly, Contractor shall furnish five copies of erection manuals depicting therein the erection procedure, special precautions to be taken, various clearance to be maintained, erection checks and tests to be carried out before the equipment is put to initial trials.

19.0 SUBMISSION AND APPROVAL OF DRAWINGS:

- 19.1 The contractor shall submit the drawings in sequential order to match with completion of milestone activity. The contractor shall submit all the G.A. drawings, mechanical, electrical and

civil drawings, data sheets etc. for approval of the Owner along with the design calculations and general write up wherever involved. The drawings for all the systems shall be properly coordinated. While scrutinizing the drawings, the Owner shall indicate the corrections to be made in these drawings and documents, which the contractor shall incorporate or justify its correctness. The Contractor then shall submit the revised drawings for approval of the Owner. On approval of the same, Contractor shall furnish six copies and soft copy on CD of these approved drawings to the Owner as per the distribution to be intimated. Any delay in approval of drawings by Owner, due to submission of incorrect data, non-submission of data, non-updating the drawings in line with the corrections indicated shall be to the Contractor's account. During the currency of the contract, if any approved drawings are required to be modified, such details of the modifications required to be carried out shall be separately maintained. On completion of all the works, the Contractor shall incorporate all the changes necessitated in the drawings and submit 6(six) sets of all the "As built" drawing for the records of the Owner. As the drawings shall be approved based on the basic information furnished by the Contractor, approval by the Owner shall not absolve the Contractor of his responsibilities towards correctness of design & performance of the equipment.

20.0 TEST REPORTS:

- 20.1 On completion of tests of equipment at manufacturer's works, the Contractor shall furnish 4 copies of test certificates to the Owner for approval and subsequent despatch clearance. The test report shall invariably indicate identification data, including model no., sl. no. etc. of the equipment, method of application and duration of test along with test results. Only on approval of these test results by the Owner or Owner's representative, dispatch clearance will be issued for dispatch of material to site.

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ANNEXURE VI

MAIN DRAWING LIST WITH SCHEDULE OF SUBMISSION


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DRAWINGS AND DOCUMENTS TO BE FURNISHED AFTER AWARD OF CONTRACT

After award of LOI / PO, following drawing/documents shall be submitted by the bidder in soft as well as hard form for BHEL/Customer approval / information. However, any additional drawing/documents if found necessary for completion of the engineering, the same shall be submitted by bidder without any commercial and delivery implication to BHEL / customer.

S.NO.	BHEL DRAWING NUMBER	DRAWING TITLE	SCHEDULE OF SUBMISSION FROM LOI	SIZE
1	PE-V2-412-155-A001	P& I DIAGRAM OF CONDENSATE POLISHING UNIT	4	A1
2	PE-V2-412-155-A002	EQUIPMENT LAYOUT OF CONDENSATE POLISHING UNIT (SERVICE VESSEL AREA)	4	A1
3	PE-V2-412-155-A003	EQUIPMENT LAYOUT OF CONDENSATE POLISHING UNIT (REGENERATION AREA)	4	A1
4	PE-V2-412-155-A004	PROCESS DESIGN AND SIZING CALCULATIONS , DATA SHEET OF RESIN VESSEL THICKNESS AND PRESSURE DROP CALCULATIONS FOR CPU	4	A4
5	PE-V2-412-155-A005	SUB-VENDOR LIST AND INSPECTION CRITERIA	4	A4
6	PE-V2-412-155-A006	OPERATION & CONTROL PHILOSOPHY FOR CPU ALONG WITH CONTROL SYSTEM CONFIGURATION DIAGRAM	6	A4
7	PE-V2-412-155-A007	CIVIL ASSIGNMENT DRAWING OF CONDENSATE POLISHING UNIT (SERVICE VESSEL AREA)	8	A1
8	PE-V2-412-155-A008	CIVIL ASSIGNMENT DRAWING OF CONDENSATE POLISHING UNIT REGENERATION AREA)	8	A1
9	PE-V2-412-155-A009	PIPING LAYOUT (REGENERATION AREA)	8	A1
10	PE-V2-412-155-A010	ELECTRICAL LOAD DATA	8	A4
11	PE-V2-412-155-A011	PIPING LAYOUT (SERVICE VESSEL AREA)	10	A1
12	PE-V2-412-155-A012	GA DRAWING OF SERVICE VESSELS FOR CPU	10	A3
13	PE-V2-412-155-A013	QAP FOR SERVICE VESSEL	10	A4
14	PE-V2-412-155-A014	GA DRAWING OF PRESSURE VESSELS FOR CPU	10	A3
15	PE-V2-412-155-A015	QAP FOR PRESSURE VESSELS	10	A4
16	PE-V2-412-155-A016	GA DRAWING OF ATMOSPHERIC TANKS FOR CPU	10	A3
17	PE-V2-412-155-A017	QAP FOR ATMOSPHERIC TANKS	10	A4
18	PE-V2-412-155-A018	TECHNICAL DATA SHEET OF HORIZONTAL / VERTICAL CENTRIFUGALPUMPS	10	A4
19	PE-V2-412-155-A019	TECHNICAL DATA SHEET FOR METERING PUMPS	10	A4
20	PE-V2-412-155-A020	TECHNICAL DATA SHEET OF BLOWERS	10	A4
21	PE-V2-412-155-A021	TECHNICAL DATA SHEET FOR MOTOR	10	A4
22	PE-V2-412-155-A022	QAP FOR HORIZONTAL / VERTICAL CENTRIFUGALPUMPS WITH MOTOR	10	A4


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23	PE-V2-412-155-A023	QAP FOR METERING PUMPS WITH MOTOR	10	A4
24	PE-V2-412-155-A024	QAP FOR BLOWERS WITH MOTOR	10	A4
25	PE-V2-412-155-A025	TECHNICAL DATA SHEET FOR HIGH PRESSURE VALVES	10	A4
26	PE-V2-412-155-A026	TECHNICAL DATA SHEET FOR LOW PRESSURE VALVES	10	A4
27	PE-V2-412-155-A027	QAP FOR VALVES	10	A4
28	PE-V2-412-155-A028	TECHNICAL DATA SHEET FOR INSTRUMENTS	10	A4
29	PE-V2-412-155-A029	TECHNICAL DATA SHEET FOR ANALYSERS	10	A4
30	PE-V2-412-155-A030	TECHNICAL DATA SHEET FOR HEATER	10	A4
31	PE-V2-412-155-A031	VALVE SEQUENCE CHART	10	A4
32	PE-V2-412-155-A032	INSTRUMENT SCHEDULE	12	A3
33	PE-V2-412-155-A033	VALVE SHEDULE	12	A3
34	PE-V2-412-155-A034	PLC DOCUMENTS FOR SERVICE VESSEL AREA & REGENERATION AREA--GA & WIRING DETAILS OF PLC & RIO PANEL, I/O LIST, BOM, MIMIC DIAGRAM	12	A4
35	PE-V2-412-155-A035	QAP FOR PLC	12	A4
36	PE-V2-412-155-A036	CABLE TRAY/TRENCH & CONDUIT ROUTING AND EARTHING LAYOUT DIAGRAM FOR CONDENSATE POLISHING UNIT (REGENERATION AREA)	12	A1
37	PE-V2-412-155-A037	CABLE TRAY/TRENCH & CONDUIT ROUTING AND EARTHING LAYOUT DIAGRAM FOR CONDENSATE POLISHING UNIT (SERVICE VESSEL AREA)	12	A1
38	PE-V2-412-155-A038	DATASHET OF RESIN TRAP, CARBON TRAP, ACF, AGITATOR	12	A4
39	PE-V2-412-155-A039	GA OF BATTERY BANK AND CHARGER	12	A4
40	PE-V2-412-155-A040	QAP / ICL FOR CPU (FOR BALANCE OF ITEMS)	12	A4
41	PE-V2-412-155-A041	ERECTION PROCEDURE	16	A4
42	PE-V2-412-155-A042	YARD PIPING LAYOUT	16	A1
43	PE-V2-412-155-A043	CABLE SCHEDULE FOR CONDENSATE POLISHING UNIT	16	A3
44	PE-V2-412-155-A044	ERECTION PROCEDURE	16	A4
45	PE-V2-412-155-A045	PG test procedure for condensate polishing unit	20	A4
46	PE-V2-412-155-A047	O&M MANUAL FOR CONDENSATE POLISHING UNIT	24	A4

*High pressure valves are those valves which are subjected to the service vessel pressure. Bidder to refer list of documents required in section C3 of this specification also.



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Notes:

1. The above drawing list is tentative and shall be finalized with the successful bidder after placement of order. While some of the drawings indicated above may not be applicable, some additional drawings may also be required based on scope of work.
2. Drawings shall be prepared in Auto-Cad latest edition. Required no. of hard and soft copies (editable) of the drawings shall be furnished as per requirement specified elsewhere in the specification.
3. Only manual calculation with authentic supporting literature (e.g. extracts of hand Book/ standard/codes) shall be acceptable. All design calculations and drawings shall be in SI system only.
4. All the drawings and documents including general arrangement drawing, data sheet, calculation etc. to be furnished to the customer during detailed engineering stage shall include / indicate the following details for clarity w.r.t. Inspection, construction, erection and maintenance etc.:-
 - a) All drawings and documents shall indicate the list of all reference drawings including general arrangement.
 - b) All drawings shall include / show plan, elevation, side view, cross - section, skin section, blow - up view; all major self-manufactured and bought out items shall be labeled and included in BOQ / BOM in tabular form.
 - c) Painting schedule shall also be made as a part of general arrangement drawing of each equipment / items indicating at least 3 trade names.
 - d) All the drawings required to be furnished to customer during detailed engineering stage shall include technical parameters, details of paints and lubrication, hardness and BOQ / BOM in tabular form indicating all major components including bought out items and their quantity, material of construction indicating its applicable code / standard, weight, make etc.
 - e) Drawings/ documents to be submitted for purchasers review/ approval shall be under Revision A, B, C... etc. while drawings /documents to be submitted thereafter for customer's approval after purchaser's approval shall be under R-0, 1, 2, 3etc.
 - f) Drawings and documents not covered above but required to check safety of machines/ system, shall be submitted during detailed engineering stage without any commercial implication.
 - g) All drawings shall include "B.O.M" and indicate quantity, material of construction, make along with IS/BS No., Technical parameters, dimensions, hardness, machining symbol and tolerance, requirement of radiography and hydraulic tests, painting details, elevation, side view, plan, skin section and blow-up view for clarity.
 - h) All drawings shall be prepared as per BHEL's title block and shall bear BHEL's drawing Number.
 - i) Schedule of drawings submissions, comment incorporations & approval shall be as stipulated in the specifications. The successful bidder shall depute his design personnel to BHEL's/ Customer's/ Consultant's office for across the table resolution of issues and to get documents approved in the stipulated time.
 - j) Bidder to follow the following the drawing submission schedule:
 - k) 1st submission of drawings from date of LOI as per the submission schedule.
 - l) Every revised submission incorporating comments – within 7 days.
 - m) Bidder to submit revised drawings complete in all respects incorporating all comments. Any incomplete drawing submitted shall be treated as non-submission with delays attributable to bidder's account. For any clarification/ discussion required to complete the drawings, the bidder shall himself depute his personal to BHEL for across the table discussions/ finalizations/ submissions of drawings.
5. Bidder to note that the successful bidder, during detail engineering, will submit the drg/doc through web based Document Management System in addition to hard copies to be submitted as

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per the Annexure III of this specification. Bidder would be provided access to the DMS for drg/doc approval and adequate training for the same. Detailed methodology would be finalized during the kick-off meeting. Bidder to ensure following at their end:

- Internet explorer version – Minimum Internet Explorer 7.
- Internet speed – 2 mbps (Minimum preferred).
- Pop ups from our external DMS IP (124.124.36.198) should not be blocked.
- Vendor's Internal proxy setting should not block DMS application's link (<http://124.124.36.198/wrenchwebaccess/login.aspx>).
- DMS user manuals to be used by BHEL PEM vendors for uploading, viewing, revising, commenting and tracking documents on PEM's DMS have been uploaded on PEM internet website (www.bhelpem.com) under the Vendor session.
- For quick access bidder may refer the link <http://bhelpem.com/DMSManuals/DMSManuals.html> .

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ANNEXURE VII

FORMAT FOR OPERATION AND MAINTENANCE MANUAL



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Bidder to submit operation and Maintenance manual with minimum information as listed in below check list during contract stage.

Check List for Operation & Maintenance Manual

Project name :

Project number :

Package Name :

PO reference :

Document number :

Revision number :

Sl.no. & Sections	Description	Tick (√)if included in Manual			Remarks
		Yes	No	Not Applicable	
1.	Cover page				
1.1	Project Name				
1.2	Customer/consultant Name				
1.3	Name of Package				
1.4	Supplier details with phone, FAX ,email address , Emergency Contact number				
1.5	Name and sign of prepared by , checked by & approved by				
1.6	Revision history with approval Details				
2.0	Index				
2.1	showing the sections & related page nos All the pages should be numbered section wise				
3.0	Description of Plant/System				
3.1	Description /write up of operating principle of system equipment/ associated sub-systems & accessories/controls system , operating conditions, performance parameters under normal , start up and special cases				
3.2	Equipment list and basic parameter with Tag numbers				
3.3	Data sheets approved by Customer/for information and catalogues provided by original				


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	manufacturer				
3.4	Associated other packages and Interface /terminal points				
3.5	P&ID & Process Diagrams				
3.6	GA Layout drawings, As-built drawings , Actual photograph of items/system (Drawings of A2 & bigger sizes are to be attached in the last)				
3.7	Single line/wiring diagrams				
3.8	Control philosophy /control write-ups				
4.0	<i>Commissioning Activities (if not covered in separate document i.e. erection manual, commissioning manual)</i>				
4.1	Pre-Commissioning Checks				
4.2	handling of items at site				
4.3	Storage at site				
4.4	Unpacking & Installation procedure				
5.0	<i>Operation Guidelines for plant personal/user/operator</i>				
5.1	Interlock & Protection logic along with the limiting values of protection settings for the equipment along with brief philosophy behind the logic, drawings etc. to be provided.				
5.2	Start up, normal operation and shut down procedure for equipments along with the associated systems in step by step mode. Valve sequence chart, step list, interlocks etc. with Equipment isolating procedures to be mentioned.				
5.3	Do's & Don't of the equipments.				
5.4	Safety precautions to be taken during normal operation. Safety symbols, Emergency instructions on total power failure condition/lubrication failure/any other condition				
5.5	Parameters to be monitored with normal values and limiting values				
5.6	Trouble shooting with causes and remedial measures				
5.7	Routine operational checks, recommended logs & records				
5.8	Changeover schedule if more than one auxiliary for the same purpose is given				
5.9	Painting requirement and schedule				
5.10	Inspection, repair , Testing and calibration procedures				
6.0	<i>Maintenance guidelines for plant personal</i>				
6.1	List of Special Tools and Tackles required for Overhaul/Trouble shooting including special testing equipment required for calibration etc.				
6.2	Stepwise dismantling and re-assembly procedure clearly specifying the tools to be				



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	used, checks to be made, records to be maintained, clearances etc. to be mentioned. Tolerances for fitment of various components to be given.				
6.3	Preventive Maintenance & Overhauling schedules linked with running hours/calendar period along with checks to be given				
6.4	Long term maintenance schedules especially for structural, foundations etc.				
6.5	Consumable list along with the estimated quantity required during commissioning, normal running and during maintenance like Preventive Maintenances and Overhaul. Storage/handling requirement of consumables/self-life.				
6.6	List of lubricants with their Indian equivalent, Lubrication Schedule, Quantity required for each equipment for complete replacement is to be given				
6.7	List of vendors & Sub-vendors with their latest addresses, service centres ,Telephone Nos., Fax Nos., Mobile Nos., e-mail IDs etc.				
6.8	List of mandatory and recommended spare parts list				
6.9	Tentative Lead time required for ordering of spares from the equipment supplier				
6.10	Guarantee and warranty clauses				
7.0	Statutory and other specific requirements considerations.				
8.0	List of reference documents				
9.0	Binding as per requirement				

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ANNEXURE VIII

SITE STORAGE AND PRESERVATION

CONTENT

- 1 SCOPE OF THE DOCUMENT
- 2 PURPOSE OF STORAGE & PRESERVATION
- 3 MEASURES TO BE TAKEN FOR STORAGE AND PRESERVATION
 - a) GENERAL STORAGE REQUIREMENTS
 - b) GENERAL PRESERVATION REQUIREMENTS
 - c) GENERAL INSPECTION REQUIREMENTS
- 4 TYPE OF STORAGE FOR VARIOUS EQUIPMENT
5. CONCLUSION
6. STACKING ARRANGEMENT FOR PLATES AND STRUCTURAL STEEL

1. SCOPE OF THE DOCUMENT

This guideline is prepared in intent to provide proper site storage and preservation of the Mechanical, Electrical and C & I items / equipment supplied under various bought out packages/items. This storage procedure shall be followed at different power plant sites by concerned agency for storage and preservation from the date of equipment received at site until the same are erected and handed over to the customer.

2. PURPOSE OF STORAGE & PRESERVATION

Many of the items may be required to be kept in stores for long period. It shall therefore be essential that proper methods of storage and preservation be applied so that items do not deteriorate, loose some of their properties and become unusable due to atmospheric conditions and biological elements.

3. MEASURES TO BE TAKEN FOR STORAGE, HANDLING & PRESERVATION

a) GENERAL STORAGE REQUIREMENTS

1. To the extent feasible, materials should be stored near the point of erection. The storage areas should have adequate unloading and handling facilities with adequate passage space for movement of material handling equipment such as cranes, fork lift trucks, etc. The storage of materials shall be properly planned to minimise time loss during retrieval of items required for erection.
2. The outdoor storage areas as well as semi-closed stores shall be provided with adequate drainage facilities to prevent water logging. Adequacy of these facilities shall be checked prior to monsoon.
3. The storage sheds shall be built in conformity with fire safety requirements. The stores shall be provided with adequate lights and fire extinguishers. 'No smoking' signs shall be placed at strategic locations. Safety precautions shall be strictly enforced.
4. Adequate lighting facility shall be provided in storage areas and storage sheds and security personnel positioned to ensure enforcement of security measures to prevent theft and loss of materials.
5. Adequate number of competent stores personnel and security staff shall be deployed to efficiently store and maintain the equipment / material.
7. The equipment shall be stored in an orderly manner, preserving their identification slips, tags and instruction booklets, etc., required during erection. The storage of materials shall be equipment-wise. Loose parts shall be stored in sheds on racks,

preserving the identification marks and tags in good condition. The group codes shall be displayed on the racks

6. At no time shall any materials be stored directly on ground. All materials shall be stored minimum 200 mm above the ground preferably on wooden sleepers

b) GENERAL PRESERVATION REQUIREMENTS

1. All special measures to prevent corrosion shall be taken like keeping material in dry condition, avoiding the equipment coming in contact with corrosive fluid like water, acid etc.
2. Materials which carry protective coating shall not be wrapped in paper, cloth, etc., as these are liable to absorb and retain moisture. The material shall be inspected and in case of signs of wear or damages to protective coating, that portion shall be cleaned with approved solution and coated with an approved protective paint. Complete record of all such observations and protective measures taken shall be maintained.
3. Generally equipment supplied at site are properly greased or rust protective oil is applied on machined/ fabricated components. However periodic inspection shall be carried out to ensure that protection offered is intact.
4. While handling the equipment, no dragging on the ground is permitted. Avoid using wire rope for lifting coated components. Use polyester slings (if possible) otherwise protective material (e.g. clothes, wood block etc.) should be used while handling the components with rope / slings
5. For Equipment supplied with finished paint, touch paint shall be done in case any surface paint gets peeled off during handling. Otherwise such surfaces shall necessarily be wrapped with polythene to avoid any corrosion. Further for equipment wherein finish coat is to be applied at site, site to ensure that equipment is received with primer coat applied.
6. It shall be ensured by periodic inspection that plastic inserts are intact in tapped holes, wherever applicable.
7. Pipes shall be blown with air periodically and it shall be ensured that there is no obstruction.
8. Silica gel or approved equivalent moisture absorbing material in small cotton bags shall be placed and tied at various points on the equipment, wherever necessary.
9. Heavy rotating parts in assembled conditions shall be periodically rotated to prevent corrosion/jamming due to prolonged storage.

10. All the electrical equipment such as motors, generators, etc. shall be tested for insulation resistance at least once in three months and a record of such measured insulation values shall be maintained.
11. Following preservatives/preservation methods can be used depending upon type of equipment
 - a. Rust preventive fluid (RPF)
 - b. Rust protective paints
 - c. Tarpaulin covers, in case of outdoor storage
 - d. De-oxy aluminate for weld-ments

c) GENERAL INSPECTION REQUIREMENTS

1. Period inspection of materials with specific reference to –
 - Ingress of moisture and corrosion damages.
 - Damage to protective coating.
 - Open ends in pipes, vessels and equipment -
 - In case any open ends are noticed, same shall be capped.
2. Any damages to equipment / materials.
 - In case of any damages, these shall be promptly notified and in all cases, the repairs / rectification shall be carried out.
 - Any items found damaged or not suitable as per project requirements shall be removed from site. If required to store temporarily, they shall be clearly marked and stored separately to prevent any inadvertent use.

4. TYPE OF STORAGE FOR VARIOUS EQUIPMENT

The types of storage are broadly classified under the following heads:

i **Closed storage with dry and dust free atmosphere. (C)**

The closed shed can be constructed by using cold-rolled / tubular components for structure and corrugated asbestos sheets / galvanised iron sheets for roofing. Brick walls / asbestos sheets can be used to cover all the sides. The floor of the shed can be finished with plain cement concrete suitably glazed. The shed shall be provided with proper ventilation and illumination.



ii **Semi-closed storage. (S)**

The semi closed shed can be constructed by using cold-rolled / tubular components for structure and corrugated / asbestos sheets for roofing. The floor shall be brick paved. If required a small portion of sides can be covered to protect components from rainwater splashing onto the components.





iii Open storage (O)

The open yard shall be levelled, well consolidated to achieve raised ground with the provision of feeder roads for crane approach along with access roads running all sides. One part of the open yard shall be stone pitched, levelled and consolidated with raised ground suitable for storing / stacking heavier and critical components with due space to handle them by cranes etc . Adequate number of sleepers, concrete block etc. to be provided to make raised platforms to stack critical materials.

A separate yard to be identified as “scrap yard” slightly away from main open yard to store wooden/steel scraps, which are to be disposed off. This is required to avoid mix up with regular components as well as to avoid fire hazard.

Some of the components, which are having both machined & un-machined surfaces and are bulky, shall be stored in open storage area on a raised ground and suitably covered with water proof / fire retardant tarpaulin.



The equipment listed below shall be stored and inspected as per requirement mentioned in the table below.

Sl. No.	Description of the equipment	Type of Storage	Check for	Remarks
Raw material /mechanical items like pipes, plates, structure sections etc.)				
1.	Steel pipes (lined/unlined)	S	Damage , paint, corrosion, rubber lining peeling	Provide end cap
2.	MS Plates	S	Damage, paint, corrosion	
3.	SS Plates	S	Damage	
4.	Non-metallic pipes	S	Damage, cracks	Provide end cap
5.	Stainless steel pipes	S	Damage ,	Provide end cap
6.	MS sections, beams	S	Damage, paint, corrosion	
7.	Cable trays	S	Damage, condition of preservations	
8.	Insulation sheets	S	Damage	
9.	Insulation	C	Damage, packing	
10.	Hangers Rods	S	Damage, paint, packing	
11.	Tubes	S	Damage, paint , packing	Provide end cap
12.	Hume pipes	O	Damage	
13.	Castings	O	Damage, paint, corrosion	
Fabricated mechanical items (pressure vessels, tanks etc.)				
14.	Pressure vessels (unlined)	O	Damage, paint, corrosion,	Covered nozzles
15.	Atmospheric storage tanks (unlined)	O	Damage, paint, corrosion	Covered nozzles

Sl. No.	Description of the equipment	Type of Storage	Check for	Remarks
16.	Pressure vessels (lined)	S	Damage, paint, corrosion, rubber lining	
17.	Atmospheric storage tanks(lined)	S	Damage, paint, corrosion, rubber lining	
18.	Support structures	O	Damage , paint, corrosion	
19.	Flanges	C	Damage , paint, corrosion	
20.	Fabricated pipes	S	Damage , paint, corrosion	Provide end cap
21.	Vessels internals	C	Damage , paint, corrosion ,packing	
22.	Grills	S	Damage , paint, corrosion	
23.	Angles	S	Damage , paint, corrosion	
24.	Bridge mechanism/clarifier mechanism	O	Damage , paint, corrosion	
25.	Cranes, rails	S	Damage , paint, corrosion	
26.	Stair cases	O	Damage , paint, corrosion	
27.	Ladders/handrails	O	Damage , paint, corrosion	
28.	Fabricated ducts	S	Damage , paint, corrosion	
29.	Isolation Gates	O	Damage , paint, corrosion	
30.	Fabricated boxes/panels	S	Damage , paint, corrosion	
Mechanical components like valves, fittings, cables glands, spares etc.)				
31.	Valves	S	Damage , packing	

Sl. No.	Description of the equipment	Type of Storage	Check for	Remarks
32.	Fittings	S	Damage , packing	Provide end cap
33.	Cable glands	C	Damage , packing	
34.	Tools & tackles	C	Damage , packing	
35.	Nut , bolts, washers,	C	Damage , packing	
36.	Gasket & Packings	C	Damage , packing	
37.	Copper tubes	C	Damage , packing, corrosion	Provide end cap
38.	SS tubing	C	Damage , packing	Provide end cap
Rotating assemblies (pumps, blowers, stirrers, fans, compressors etc.)				
39.	Pumps	S	Damage , packing, corrosion	Shaft rotation
40.	Blowers/Compressors	S	Damage , packing, corrosion	Shaft rotation
41.	Agitators/stirrers/radial launders	C	Damage , packing, corrosion	Shaft rotation
42.	Rollers for chlorine tonner mounting	C	Damage , packing, corrosion	
43.	Centrifuge	S	Damage , packing,	
44.	Gear box	C	Damage , packing, corrosion	
45.	Bearings	C	Damage , packing, corrosion	
46.	Fans	S	Damage , packing, corrosion	
47.	Dosing skids	S	Damage , packing, corrosion	
48.	Pump assemblies	S	Damage , packing, corrosion	
49.	Air washers(INTERNALS)	S	Damage , packing	
50.	Air conditioners (split)	C	Damage , packing	

Sl. No.	Description of the equipment	Type of Storage	Check for	Remarks
51.	Elevators(CONTAINERIZED)	O	Damage , packing, corrosion	
52.	Chillers/VA machines	S	Damage , packing	
53.	Air handling Unit/Package unit	S	Damage , packing	
54.	Chlorinators & Evaporators	C	Damage , packing	
55.	Ejectors	C	Damage , packing	
56.	Electrolyser	C	Damage , packing	
Miscellaneous items like chain pulley blocks, hoists etc.				
57.	Chain pulley blocks	S	Damage, Packing	
58.	Electric hoists	S	Damage, Packing	
59.	Fire extinguishers	C	Damage, expiry date	
60.	Fork Lift Truck	S	Damage, Packing	
61.	Hydraulic Mobile Crane	O	Damage, Packing	
62.	Mobile Pick Up & Carry Crane	O	Damage, Packing	
63.	Motor boats	O	Damage, Packing	
64.	Safety showers	S	Damage, Packing	
65.	Diffusers/dampers	S	Damage, Packing	
Chemicals and consumables (acid, alkali, paints, oils, reagents and special chemicals)				
66.	Hydro Chloric Acid (HCl)	Store in canes/ storage tank in dyke area	Date of production/ leakage/fumes	hazardous chemical
67.	Sulphuric acid (H ₂ SO ₄)	Store in canes/ storage tank in dyke area	Date of production/ leakage/fumes	hazardous chemical

Sl. No.	Description of the equipment	Type of Storage	Check for	Remarks
68.	Sodium hydroxide (NaOH)	Store in canes/ storage tank in dyke area	Date of production/ leakage/ fumes/ breather	hazardous chemical ,breather to be checked for air ingress
69.	Sodium hypo chlorite	To be stored under shed	Date of production/ leakage/ fumes	hazardous chemical ,self-life normally 15-30 days after which strength of chemical decays
70.	Ammonia	S	Date of production/ leakage/ fumes	Store in closed storage tanks, hazardous chemical
71.	CW treatment chemicals	S	Date of production , Self-life	Store in closed canes
72.	RO/UF cleaning chemicals	S	Date of production , Self-life	Store in closed canes
73.	Lime	C	Damage to packing , seepage	Prevent moisture, rain
74.	Alum bricks	C	Damage to packing	Prevent moisture, rain
75.	Poly electrolyte	S		Store in closed storage tanks
76.	Laboratory chemicals(powder)	C	Damage, Packing self-life	
77.	Laboratory chemicals(liquid)	C	Damage, Packing self-life	
78.	Lubrication oils	C	Leakage	
79.	Paints	S	Leakage ,air tightness	
80.	Sand	O	Damage of packing	No hooks
81.	Salt (NaCl)	C	Damage of packing, water ingress	Prevent moisture, rain
82.	Anthracite	S	Damage of packing	
83.	Activated carbon	S	Damage of packing	

Sl. No.	Description of the equipment	Type of Storage	Check for	Remarks
84.	Thermal insulation	S	Damage of packing	
85.	Cement	C	Damage of packing	Prevent moisture, rain
86.	Gravels	O	Damage of packing	
87.	ION exchange resins	C	Damage , packing	Refer manufacturer guidelines
88.	RO membranes	C	Damage , packing	Refer manufacturer guidelines
89.	UF membranes	C	Damage , packing	Refer manufacturer guidelines
90.	Cleaning chemicals	C	Damage , packing	Refer manufacturer guidelines
91.	Chemicals for analysers/calibration	C	Damage , packing	Refer manufacturer guidelines
Electrical and C & I items (motors, cables etc.)				
92.	Motors	C	Damage , packing	
93.	Cable drums	O	Damage	
94.	Control Panel /control desk, UPS ,JB	S	Damage, Packing	
95.	Instruments(gauges/analysers)	C	Damage	
Special items		As per Manufacturer's item, like Hydrogen cylinders, Ozonator, Analyser, Chlorine dioxide generators etc.		

5. CONCLUSION

Concerned storage agency at site should make sure that loss in equipment performance and wear & tear are minimised through proper storage and preservation. The above are broad guidelines and cover major equipment / materials. However specific storage practices shall be followed as per manufacturer recommendation. All the necessary measures even in addition to the ones mentioned above, if found necessary, should be taken to achieve the objective.

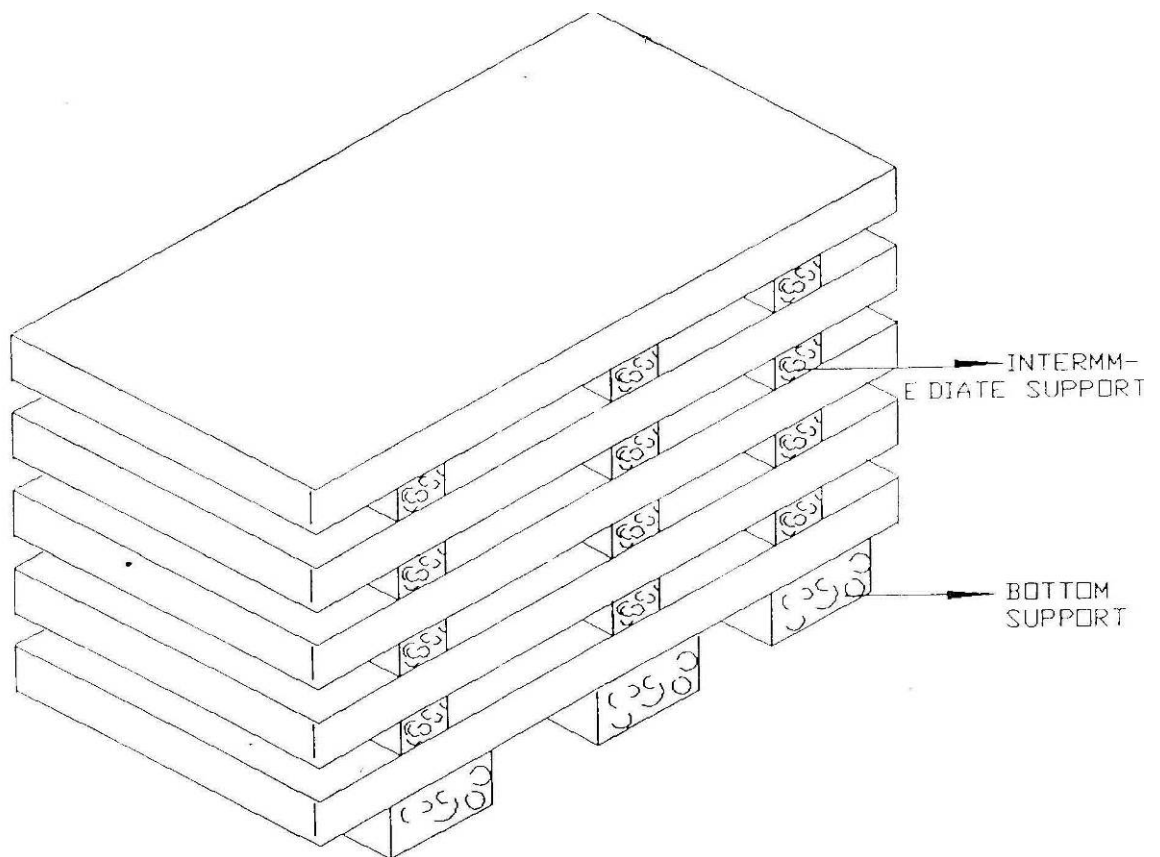


Figure – 1 – PLATE STACKING ARRANGEMENT

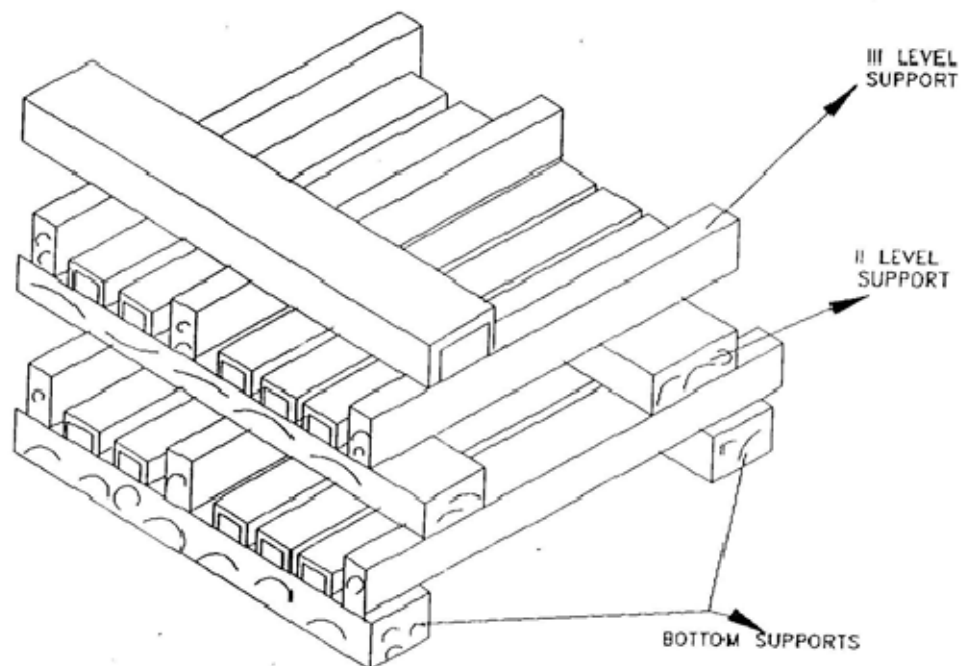


Figure – 2 – STRUCTURAL STEEL STACKING ARRANGEMENT

**TITLE**

2X 660 MW ENNORE SEZ STPP
TECHNICAL SPECIFICATION FOR
CONDENSATE POLISHING UNIT

SPECIFICATION NO : PE-TS-412-155A-A001

VOLUME: II B

REV 00

SHEET

ANNEXURE IX

INPUT DRAWINGS

**TITLE****2X 660 MW ENNORE SEZ STPP
TECHNICAL SPECIFICATION FOR
CONDENSATE POLISHING UNIT**

SPECIFICATION NO : PE-TS-412-155A-A001

VOLUME: II B

REV 00

SHEET

SL. NO.	DRAWING TITLE	DRAWING NO.
1.	P & ID OF CONDENSAT POLISHING UNIT	PE-DG-412-155A-A001 (2 SHEETS)
2.	T.G. EQUIPMENT LAYOUT PLAN AT EL. 0.0M	PE-DG-412-100-M003 R2
3.	PLOT PLAN	PE-DG-412-100-M001-R 1A

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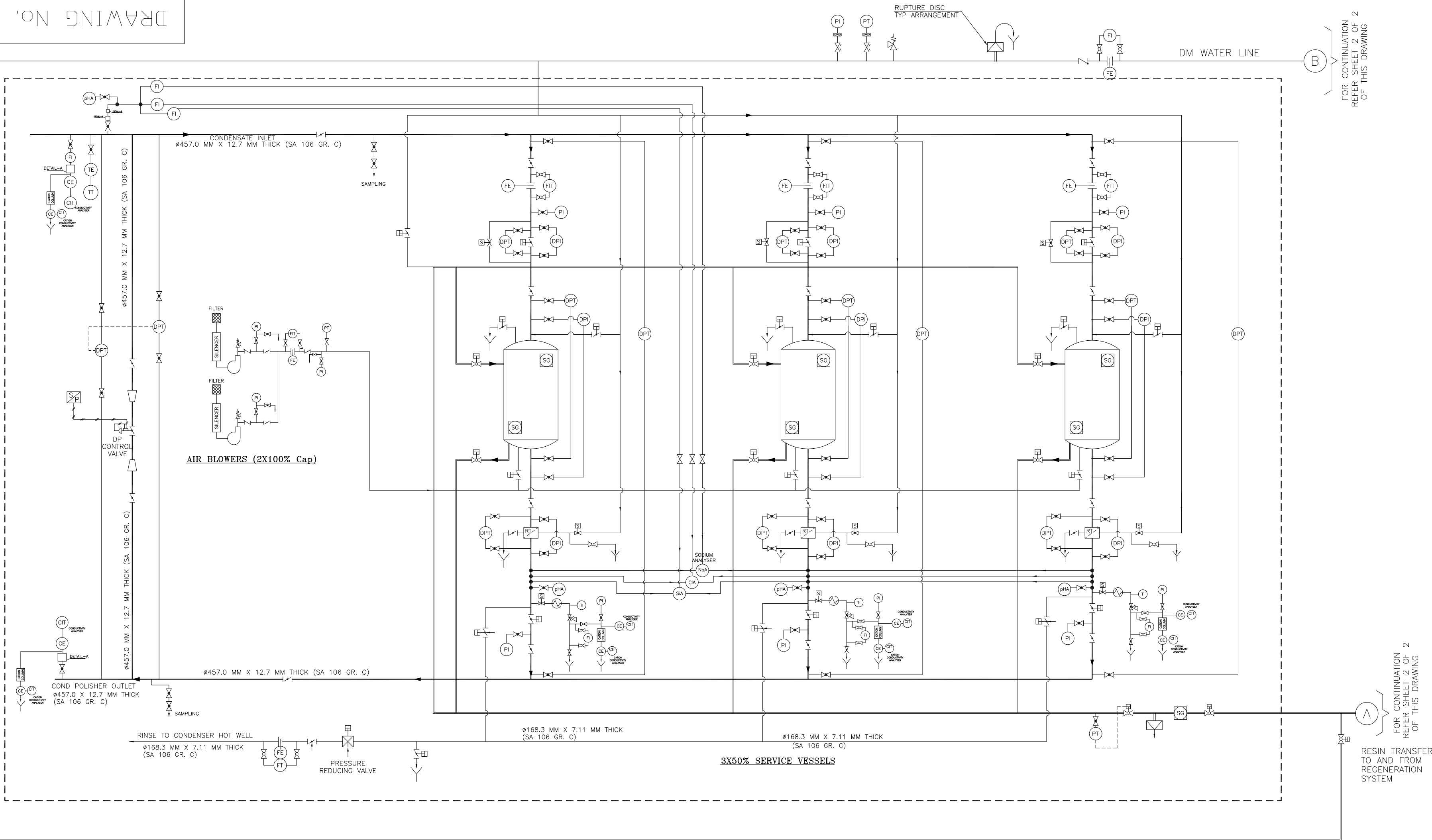
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FIRST ANGLE PROJECTION

ALL DIMENSIONS ARE IN MM

DRAWING No.

CONDENSATE
POLISHING
FOR UNIT# 2
(SIMILAR AS UNIT-1)



NOTES :

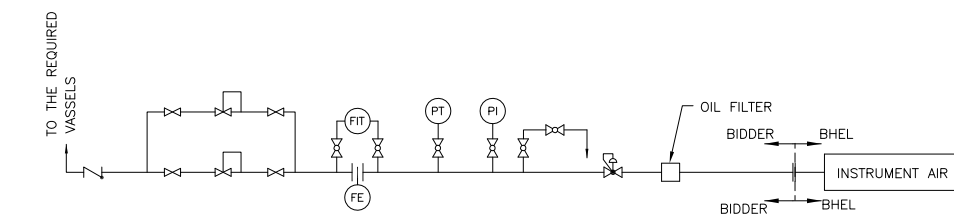
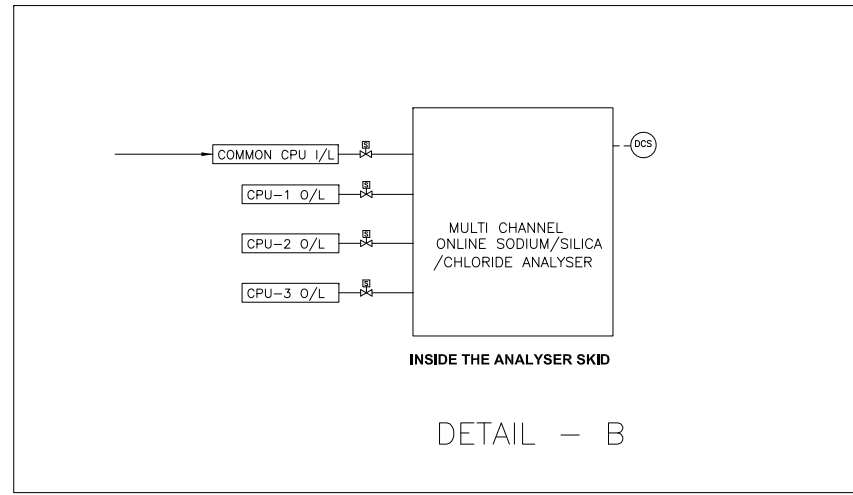
1. THE P&I DIAGRAM IS INDICATIVE AND ONLY MINIMUM REQUIREMENT OF VALVES, INSTRUMENTATION ETC. HAS BEEN SHOWN. BIDDER SHOULD FURNISH COMPLETE SCHEME IN ALL RESPECTS INCLUDING ALL INSTRUMENTS, VALVES ETC. FOR SMOOTH, SAFE, EFFICIENT, TROUBLE FREE OPERATION OF PLANT FOR BHEL/ CUSTOMER APPROVAL DURING DETAILED ENGINEERING.
2. [] INDICATES TERMINAL POINTS BETWEEN BHEL/SCCL & BIDDER:
[] BHEL - SCOPE OF EMPLOYER TP (TERMINAL POINT)
[] BIDDER - SCOPE OF 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 PATTERN AND DIAPHRAGM TYPE. FOR ACID/ALKALI/REG WASTE APPLICATION TO BE PROVIDED AT SOURCE. NEAR THE INSTRUMENT 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.
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/DM LINE, REG WASTE, RESIN LINES, CRU, ARU, IRU AND MIXED RESIN STORAGE VESSELS PR. INSTRUMENTS SHALL BE PROVIDED WITH DIAPHRAGM SEAL.
7. FLOW TOTALISATION SHALL BE DONE IN SOFTWARE.
8. DP CONTROL VALVE BETWEEN INLET/OUTLET OF CPU SHALL BE MODULATING TYPE DULY PROVIDED WITH PNEUMATIC ACTUATOR, MICRO-PROCESSOR BASED POSITIONER, POS. XMR, AIR LOCK DEVICE AND SOLENOID VALVE ETC.
9. ALL SOLENOID OPERATED VALVES SHALL BE PROVIDED WITH SOLENOID VALVE, AIR LOCK RELAY ETC. AS REQUIRED BY PROCESS.
10. ALL THE TRANSMITTERS PROCESS ACTIVATED SWITCHES ARE TO BE CONNECTED TO PLC.
11. BLANK FLANGES, COUNTER FLANGES & ISOLATION VALVES SHALL BE PROVIDED BY THE BIDDER AT THE TERMINAL POINTS WHEREVER APPLICABLE
12. ALL THE ANALYSERS SHALL BE PANEL MOUNTED.
13. ALL THE ISOLATION VALVES OF ALL THE INSTRUMENTS SHALL BE OF SS316 CONFORM TO ANSI 300# CLASS.
14. REFER SHEET 2 OF 2 OF THIS DRAWING FOR ADDITIONAL NOTES.
15. DOUBLE ROOT VALVE WILL BE PROVIDED BY BIDDER WHEN LINE PRESSURE IS MORE THAN 40 BAR.
16. LEVEL TRANSMITTERS FOR ACID/ ALKALI TANKS SHALL BE ULTRASONIC / RADAR TYPE.
17. BIDDER TO INDICATE RECOMMENDED ALARM LIST ALONGWITH CONTROL PHILOSOPHY AND INTERLOCK/PROTECTION WRITE UP INLINE REQUIREMENT.
18. WHERE EVER THE TERMINAL POINTS HAVE BEEN MARKED BETWEEN BHEL & BIDDER IF REDUCERS/EXPANDERS ARE REQUIRED DURING DETAIL ENGG. SHALL BE PROVIDED BY BIDDER.

CONDENSATE POLISHING FOR UNIT #1 (TYPICAL)

- | | |
|-------|--|
| CS | CONTROL SYSTEM |
| LS | LEVEL SWITCH |
| TT | TEMPERATURE TRANSMITTER |
| PI | PRESSURE INDICATOR |
| PT | PRESSURE TRANSMITTER |
| TI | TEMPERATURE INDICATOR |
| FI | FLOW INDICATOR |
| CE | CONDUCTIVITY ELEMENT |
| SiO2 | SILICA ANALYSER |
| FT | FLOW TOTALISER |
| DPI | DIFF. PRESSURE INDICATOR |
| DPS | DIFF. PRESSURE SWITCH |
| FIT | FLOW INDICATOR TRANSMITTER |
| FE | FLOW ELEMENT |
| CT | CONDUCTIVITY TRANSMITTER |
| DPT | DIFF. PRESSURE TRANSMITTER |
| FS | FLOW SWITCH |
| CIT | CONDUCTIVITY INDICATING TRANSMITTER |
| DT | DENSITY TRANSMITTER |
| TE | TEMPERATURE ELEMENT |
| LI/LG | LEVEL INDICATOR |
| PHE | pH ELECTRODE |
| PHAT | pH ANALYSER TRANSMITTER |
| ① | ORIFICE (Pressure Breakdown) |
| ② | SAMPLE COOLER |
| ③ | ONLINE MULTI CHANNEL SODIUM ANALYSER |
| ④ | ONLINE MULTI CHANNEL CHLORIDE ANALYSER |
| ⑤ | ONLINE MULTI CHANNEL SILICA ANALYSER |
| ⑥ | ONLINE MULTI CHANNEL PH ANALYSER |
| ⑦ | MAGNETIC FLOW TRANSMITTER |

LEGEND

SYMBOL	DESCRIPTION	SYMBOL	DESCRIPTION
	PRIMING CHAMBER		BLOWER
	PUMP		ISOLATION GATE
	BALL VALVE		PLUG VALVE
	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		OPEN CLOSED LIMIT SWITCH
	TEMPERATURE CONTROL VALVE		OVER PRESSURE PROTECTION DEVICE
			CONCENTRATION ANALYSER



2 X 660 MW ENNORE SEZ SUPER CRITICAL TPP



TAMILNADU GENERATION & DISTRIBUTION CORPORATION LTD.



CONSULTANT: DESEIN PVT LTD, NEW DELHI.



BHARAT HEAVY ELECTRICALS LTD
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT
NOIDA

TITLE

P&I DIAGRAM FOR
CONDENSATE POLISHING UNIT

DEPT CODE		NAME	SIGN	DATE
A	DRN	DK		3.3.2015
	DESN	MKG		3.3.2015
	CHD	JP		3.3.2015
	APPD	PK		3.3.2015

DRAWING No.
PE-DG-412-155-A001

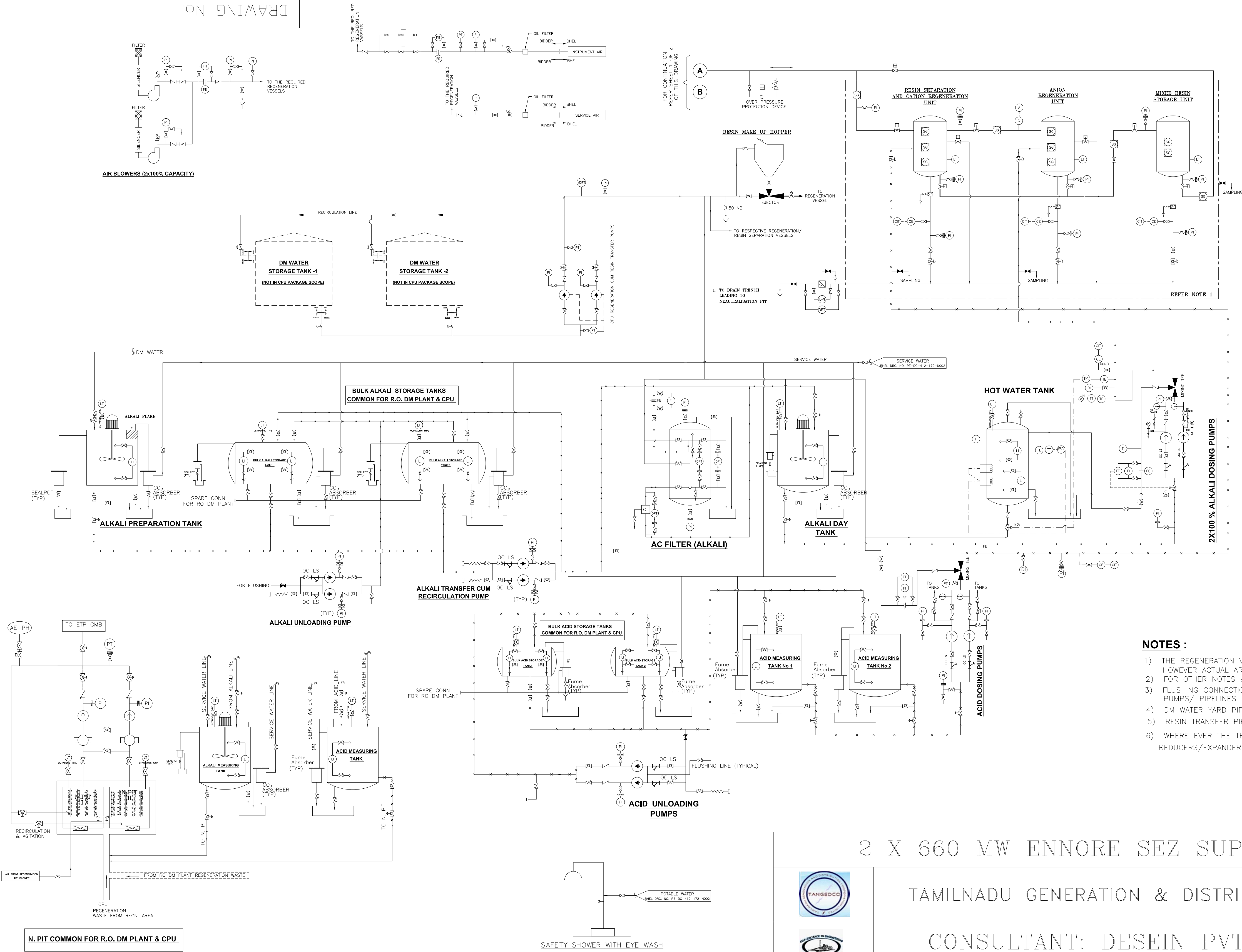
SHEET	01	OF	02	REV	1
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SIZE-A3

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DRAWING No.



- NOTES :
- 1) THE REGENERATION VESSELS ARRANGEMENT SHOWN HERE IS INDICATIVE ONLY. HOWEVER ACTUAL ARRANGEMENT SHALL BE AS PER SUPPLIER PROCESS REQUIREMENT.
 - 2) FOR OTHER NOTES & LEGENDS REFER SHEET 1 OF THIS DRAWING.
 - 3) FLUSHING CONNECTIONS WITH VALVES SHALL BE PROVIDED FOR ALL ACID/ALKALI PUMPS/ PIPELINES .
 - 4) DM WATER YARD PIPING SIZE WILL BE MIN. 100 NB.
 - 5) RESIN TRANSFER PIPING SIZE WILL BE MIN. 80 NB.
 - 6) WHERE EVER THE TERMINAL POINTS HAVE BEEN MARKED BETWEEN BHEL & BIDDER IF REDUCERS/EXPANDERS ARE REQUIRED DURING DETAIL ENGG. SHALL BE PROVIDED BY BIDDER.

2 X 660 MW ENNORE SEZ SUPER CRITICAL TPP



TAMILNADU GENERATION & DISTRIBUTION CORPORATION LTD.



CONSULTANT: DESEIN PVT LTD, NEW DELHI.



BHARAT HEAVY ELECTRICALS LTD
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT
NOIDA

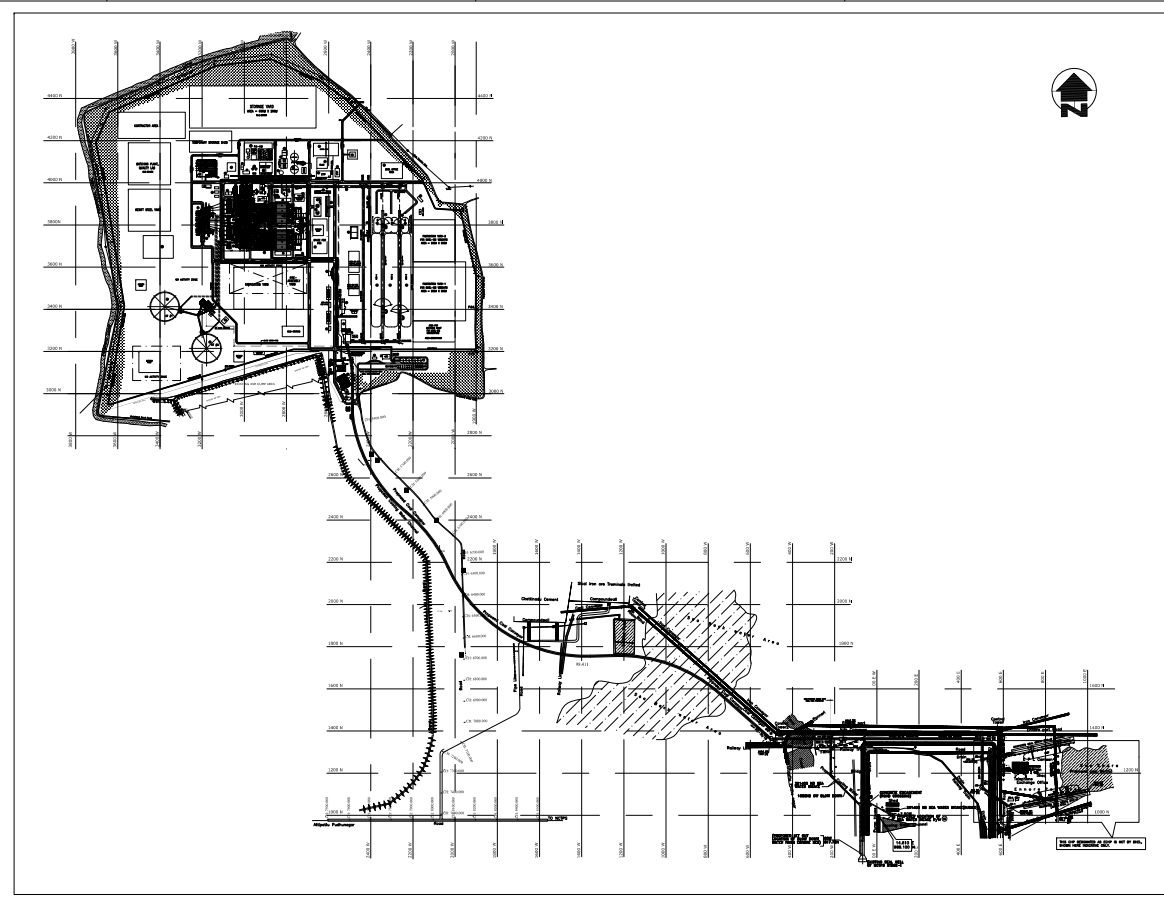
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	DESN	MKG		3.3.2015
	CHD	JP		3.3.2015
	APPD	PK		3.3.2015

TITLE
P&I DIAGRAM FOR
CONDENSATE POLISHING UNIT

DRAWING No.
PE-DG-412-155-A001

SHEET 02 OF 02 REV 1

SIZE-A3



PROJECT	2x660MW ENNORE SEZ SUPERCRITICAL THERMAL POWER PROJECT AT ASH OF NCTPS, CHENNAI
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OWNER	TAMILNADU GENERATION & DISTRIBUTION CORPORATION LIMITED
-------	---

	OWNER'S CONSULTANT:-	DESEIN PRIVATE LIMITED DESEIN HOUSE, NEW DELHI
---	---------------------------------	---

	EPC CONTRACTOR:-	BHARAT HEAVY ELECTRICALS LTD
---	-----------------------------	-------------------------------------

	BHARAT HEAVY ELECTRICALS LTD		DEPT	NAME	SK
	POWER SECTOR		CODE		sd
	PROJECT ENGINEERING MANAGEMENT		M	DRN	SD
	NOIDA			DESN	SD
				CHD	SK
				SD	sd

[illegible]

						SIGN		PE-DG-412-100	
						DATE		SHEET 1 OF 1	RE

Page 325 of 680

**TITLE**

**2X 660 MW ENNORE SEZ STPP
TECHNICAL SPECIFICATION FOR
CONDENSATE POLISHING UNIT**

SPECIFICATION NO: PE-TS-412-155A-A001

VOLUME: II B

REV 00

SHEET

SECTION – D

STANDARD TECHNICAL REQUIREMENTS

SECTION – D1: STANDARD TECHNICAL REQUIREMENTS FOR MECHANICAL

SECTION – D2: STANDARD TECHNICAL REQUIREMENTS FOR ELECTRICAL

**SECTION – D3: STANDARD TECHNICAL REQUIREMENTS FOR CONTROL AND
INSTRUMENTATION**

**TITLE**

2X 660 MW ENNORE SEZ STPP
TECHNICAL SPECIFICATION FOR
CONDENSATE POLISHING UNIT

SPECIFICATION NO:PE-TS-412-155A-A001

VOLUME: II B

REV 00

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SECTION – D1

STANDARD TECHNICAL SPECIFICATIONS (MECHANICAL)

**TITLE**

2X 660 MW ENNORE SEZ STPP
TECHNICAL SPECIFICATION FOR
CONDENSATE POLISHING UNIT

SPECIFICATION NO:PE-TS-412-155A-A001

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STANDARD TECHNICAL SPECIFICATION FOR CONDENSATE POLISHING PLANT

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1. INTRODUCTION

For maintaining the feed water purity condensate polishing plant will be provided in the feed water cycle at the downstream of condensate extraction pumps. The function of the CPU will be to purify the condensate effluent from the condenser by removing solids and dissolved salts with the intent of reducing corrosion and depositions in the steam-water cycle. The proposed Condensate Polishing Unit (CPU) shall treat the condensate of the Turbine-Generator (TG) Units of the power station, using deep Mixed Bed Ion exchange Polisher vessels and an external regeneration system. One (1) number of Condensate Polishing Plants (CPP), for each TG (Turbine-Generator) unit, along with one complete common external regeneration system shall be provided alongwith instrumentations, valves and pipings, controls etc.

2. SYSTEM DESCRIPTION (GENERAL)

- 2.1 The proposed Condensate Polishing Plant (CPP) shall treat the condensate of the respective Turbine-Generator (TG) Units of the power station. The system shall be as per tender drawing titled P&ID of Condensate polishing Plant.
- 2.2 The proposed schematic arrangement of the condensate polishing plant and its regeneration facilities shall be as per the enclosed P & ID. Arrangements of vessels, piping, and valves shown in regeneration area are for reference only. Actual regeneration process shall be supplier specific.
- 2.3 There shall be three service vessels (3X50%) for each 660 MW unit each polishing 50% of the condensate flow corresponding to VWO (valve wide open) condition at 1% make up (Flow through each service vessel indicated in the data sheet) & all HP heaters out of service condition.
- 2.4 A common external regeneration facility for both the units shall be provided. For regeneration, resin from the exhausted exchanger vessel will be transferred hydraulically to this facility. The exhausted resin charge will be cleaned, separated, regenerated, mixed and rinsed before being stored for the next use.
- 2.5 The common influent and effluent headers of each CPU, will be connected to an automatic bypass line (s) to be provided by Contractor. On high pressure signal across the service vessel, the automatic control valve(s) in the bypass line(s) shall open, bypassing the service vessel(s).
- 2.6 In the event of a tube failure in the condenser, circulating water will enter the condensate system and will contaminate it. Typical composition for the **"START-UP OR CONDENSER LEAK CONDITION"** is given in the technical specification and the condensate polishing plant shall be designed for such condition as mentioned.
- 2.7 Polisher mixed bed / service vessels of each 660 MW Unit shall be located in respective TG hall unit. However the regeneration system shall be common to polisher of both the units and shall be external and in building (except bulk acid & alkali storage facility & N-pit which is in open area). The CPU regeneration system will be located near DM plant area (kindly refer plot plan for the same).
- 2.8 The equipments kept in open area (Pumps, blowers, motors, tanks, instruments, analysers etc.) have localized shade provisions which is in bidder's scope. All the instruments associated with condensate polishing plant shall be provided with proper enclosures by Bidder. All vessels, pumps & blowers and their drives and other electrical and C&I equipments/accessories of regeneration system shall be suitable for outdoor duty and enclosures class of all the equipments shall be suitably selected by the bidder.

3. SALIENT DESIGN INPUTS/ CRITERIA

- 3.1 There shall be three service vessels (3X50%) for each 660 MW unit each polishing 50% of the condensate flow corresponding to VWO (valve wide open) condition at 1% make up & all HP heaters out of service condition (Flow through each service vessel indicated in the data sheet)

(a) NORMAL RUN :

The following dissolved solids concentration and conditions shall be used as a basis of design for the condensate polishing system.



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The inlet and outlet quality ionic concentrations for design of CPU exchanger shall be as mentioned below:

CONTAMINANT	UNIT	INFLUENT	EFFLUENT
Ammonia	ppb	100	---
Total dissolved solids (TDS, ammonia excluded)	ppb	100	< 25
Conductivity (at 25°C)	Micro-mhos/cm	---	< 0.1 (After Cation Column)
Silica – Dissolved (as SiO ₂)	ppb	30	5 (Refer note # 1)
Iron (Dissolved) -as Fe	ppb	50	5
Sodium(as Na)	ppb	10	2
Chloride (as Cl)	ppb	10	2
pH (polisher runs at 25°C with H/OH mode)		8.5	6.8-7.5
Crud (mostly black oxide of iron)	ppb	50	5

Note-1: For temperature 50°C and above the silica value in the effluent shall be based on the resin supplier's recommendations.

Under the Normal Condition, each Condensate Polisher Mixed Bed shall be designed to operate in hydrogen cycle for not less than 720 hours (30 days) of continuous operation, while maintaining the above treated condensate quality.

In addition to the dissolved solids, the influent condensate shall also contain some quantities of suspended solids (crud) derived from the corrosion of water and steam carrying pipelines, turbine condenser, and steam side of the feed water heater. Normally this concentration will not exceed about 50 ppb and the polisher beds shall provide sufficient filtering action to restrict the effluent crud content to less than 5 ppb & same shall be guaranteed.

Under the above operating and design flow through the polisher units, the un-ammoniated resins shall not reach "ammonia break-point" in less than 30 days (720 hrs.) of continuous operation while maintaining the above effluent quality. Whenever specific conductivity starts increasing from 0.1 micro mhos/cm in the effluent, it is deemed that "ammonia break point" is reached. The effluent values indicated above shall be the maximum values.

(b) START-UP OR CONDENSER LEAK CONDITION :

The inlet and outlet quality ionic concentrations for design of CPU exchanger for startup or condenser tube leakage conditions shall be as mentioned below:

CONTAMINANT	UNIT	INFLUENT	EFFLUENT
Ammonia	ppb	1000	---
Total dissolved solids (TDS, inclusive ammonia)	ppb	2000	---
Conductivity (at 25°C)	Micro-mhos/cm	---	---
Silica – Dissolved (as SiO ₂)	ppb	150	20
Iron (Dissolved) -as Fe	ppb	500	---
Sodium(as Na)	ppb	50	20
Chloride (as Cl)	ppb	300	--
Crud (mostly black oxide of iron)	ppb	500	150

Note-1: For temperature 50 ° C and above the silica value in the effluent shall be based on the resin supplier's recommendations.

Useful service run under this condition shall be 50 hours before regeneration.



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- 3.2 Influent water quality as indicated in the above clauses is minimum only. Bidder to check the same and higher values, if felt by them, shall be considered in the design so as to meet the specified effluent quality.
- 3.3 The bed cross section in the service vessels shall be such that the average velocity of condensate through it shall not exceed 2 meters/min (120 M3/hr/M2) at the design flow rate. The effective depth of mixed bed in condensate polisher service vessel shall be not less than 1100 mm.
- 3.4 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 (g). This pressure drop shall include losses due to entrance and exit nozzles, distributors, under drains, resins and the effluent resin traps. Maximum pressure drop under dirty conditions shall be restricted to about 3.5 bar (g) including the pressure drop across effluent resin traps.
- 3.5 Cation resins shall be regenerated by dilution of technical grade hydrochloric acid to IS: 265 (concentration 30-33% by volume) and anion resins by sodium hydroxide, rayon grade to IS: 252 available as 48% lye. For calculations regeneration temperature should be taken as 25° C.
In no case, the regeneration levels cannot be lower than the valves indicated below:
- Cation resin: 125 kg of 100% HCl per cubic meter of resin
 - Anion resin: 160 kg of 100% NaOH per cubic meter of resin.
- 3.6 Rinse water outlet headers from condensate-polisher vessels shall be provided with a pressure reducing valve and orifice plate, suitably designed to enable the water entry to the condenser hot well under all operating condition of condenser. The pressure reducing station shall consist of both a pressure reducing valve from design pressure of service vessel to condenser vacuum or a combination of orifice plates to reduce pressure from design pressure of service vessel to 2 kg/cm2 and a pressure reducing valve from 2 kg/cm2 to condenser vacuum.
- 3.7 While calculating pump head, 10% margin (minimum) shall be considered of the value of friction losses. Pipe friction loss shall be calculated as per William-Hazen formula and "C" value to be adopted shall be as below:-
- | | | |
|----------------------------|---|-----|
| 1. Carbon Steel pipe | : | 100 |
| 2. CI pipe/ductile Iron | : | 100 |
| 3. Rubber lined steel pipe | : | 120 |
| 4. Stainless steel pipe | : | 100 |

Pump recirculation with a regulating valve shall be provided for all the pumping system.

4. GUARANTEES

All the design parameters at clause no 3.0 of this chapter, i.e. the effluent quality, the design flow, design service length and Pressure drop across the resin bed in clean and dirty condition at rated design flow shall be guaranteed by the Bidder. In addition to that Bidder to refer detail chapter of guarantees as specified in Section C1-C of this specification for the same.

5. SYSTEM REQUIREMENT

- 5.1 The regeneration process offered by the bidder, shall be of proven design and shall essentially be the same process by virtue of which the bidder is qualified and shall give resin-separation compatible with the desired effluent quality. Documentary evidence shall be submitted by the bidder to the Customer/BHEL to establish this requirement during detailed engineering stage if required.
- 5.2 The bidder shall include inert resin in the system if they feel that it helps in better resin separation.
- 5.3 In case, after separation of resins, 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.



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5.4 EXCHANGE RESINS

- (a) The plant shall include resins for each condensate polisher service vessels along with one (1) spare charge of resin in the mixed resin storage tank. Two (2) spare charge of resins per unit during commissioning and one (1) spare charge of resins as mandatory spares. Total resin charges shall be supplied for the project is twelve (12) nos. One resin charge shall be considered as resin required for one service vessel i.e. cation resin, anion resin and inert resin (if any) used for the project.
- (b) The resins used for the Condensate Polishing Unit are of the spherical form. Base of the ion-exchange resins shall be copolymer of styrene and divinyl benzene forming a macro porous or macrorecticular structure. Other details are as follows:
 - Cation Resin : Strong acid, with sulfonic acid as functional group.
 - Anion Resin : Strong base, with quaternary ammonium (Type-I) functional group
 - Inert Resin (if required) : Non-ionic, compatible with the above resin types
- (c) The total wet volume Exchange Capacities shall be based on resin supplier recommendations.
- (d) Cation-anion resin ratio shall be 1.5 parts Cation to 1.0 part anion by volume. In case the process require any non-ionic resin the same shall represent at least 10% of the bed volume, but not less than 15 cm of the bed depth in the resin separation / cation regeneration tank of the external regeneration facility. The CPU Grade resin shall be of uniform particle size quality. Cation resins shall be supplied in hydrogen form and Anion resins shall be supplied in hydroxide form.
- (e) **Physical Properties:**

Particle size: The resins shall be in the form of spherical beads. All resins, when wet screened with U.S. standard sieves, shall pass through a No.14 sieve no more than 2 percent shall be retained on a no. 16 sieve, and more than 2 percent shall pass through a no. 40 sieve. The particle sizes and densities shall be carefully controlled to facilitate clear separation between the resins during regeneration process.

Bead Strength: The average force required to fracture individual beads of cation resins in hydrogen form, anion resins in hydroxide form, and the inert resins, shall exceed 350 grams. Not more than 5 percent of the beads tested in each batch shall get fractured by forces less than 200 grams.
- (f) **Chemical Properties:**
 - i. Total wet volume ion-exchange capacities in equivalents/liter shall not be less than the following:

Cation in hydrogen form: 1.7
Anion in hydroxide form: 0.8
 - ii. The resins shall contain a minimum of metallic and organic impurities consistent with good processing. The processing procedure will include rinsing the resins with demineralized water before packing, so that further rinsing will not be required before use. Foreign objects in the resins shall constitute a basis for its rejection.
- (g) The resins shall be of reputed manufacturer with adequate past record of successful service for not less than 3 years in similar application. Some of these possible resin systems shall be as follows:
 - 1.0 Duolite.
 - 2.0 Rohm and Hass
 - 3.0 Dowex
 - 4.0 Purolite.
- (h) The resin shall be suitable for the condensate temperature that may be achieved in all operating regimes of TG cycle. However, the anion resin shall be suitable for a minimum temperature of 60 deg.C.

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6. CONDENSATE POLISHING UNIT:

Condensate polisher vessel shall consist of following:

- 6.1 Condensate Polisher vessels complete with condensate inlet and outlet connections, connections for resin transfer to and from the vessels, bed support-cum-under drain system, inlet water distributors air distribution arrangement for resin mixing, all fittings and appurtenance as specified and as required.
- 6.2 External resin traps at the condensate & rinse outlet of each of the condensate polisher mixed beds each designed for in-place manual back flushing facility.
- 6.3 Condensate inlet and outlet headers with pipe connections to the condensate polisher vessels.
- 6.4 Resin transfer headers connecting the common external regeneration facilities to the condensate polisher vessels.
- 6.5 Rinse water outlet headers from condensate-polisher vessels shall be provided with a pressure reducing valve and orifice plate, suitably designed to enable the water entry to the condenser hot well under all operating condition of condenser.
- 6.6 All necessary valves, and fittings for the installations with actuators necessary for their remote operation from CP System Control Panel of each 660 MW Unit. These shall include suitable foolproof 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.
- 6.7 A drain header for the condensate polisher service vessels .All necessary drains, vents and sampling points, with valves as required.
- 6.8 Emergency bypass between the condensate inlet & outlet headers for each unit.
- 6.9 Service vessel design pressure shall be equal to shut off pressure of condensate extractions pump plus 5% margin or as specified in data sheet (A) of this technical specification, whichever is higher.
- 6.10 Design temperature of the service vessel shall take care of all operating regimes including HP-LP bypass operation.
- 6.11 Two (2) nos. (1W + 1S) per unit oil free type air blowers with electric motor drive for supplying air required for mixing the resins in service vessels.
- 6.12 The polisher units shall be provided at common inlet and each outlet unit with a minimum of following analytical online analysers i.e. PH analyzer, Conductivity analyzer, Sodium analyzer, Silica analyzer, Chloride analyzer and Cation Conductivity analyzer. However the Sodium analyzer, Silica analyzer & Chloride analyzer provided shall be of multichannel type which shall measure the values of common inlet and each service vessel outlet.

7. TECHNICAL REQUIREMENT OF EQUIPMENTS OF SERVICE VESSEL & REGENERATION AREA

- 7.1 All pressure vessels shall be designed and constructed in strictly in accordance with the ASME code Section VIII Div.-I Ed 2010 /IS-2825 or acceptable equivalent international standard.
- 7.2 All pressure vessels shall be fabricated from carbon steel plates as per SA-516 Gr. 60/ 70 and lined internally.
- 7.3 Lining used shall be natural rubber having a shore durometer reading of 65 ± 5 Shore 'A' as per IS 4682 Part I.

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

- 7.5 Vessel internal shall meet the following requirements:

Inlet water and regenerant distributor- Hub and internals diffuser splash plate or header and perforated laterals. Material of construction shall be SS-316.

Under Drains-

The under drain system shall be provided with screened laterals with internal perforated pipes and rubber lined flat bottom. For resin separation/ regeneration/ mixed resin vessels, it may have fully screened bottom (NEVA – clog type with pora-septanurese screen, fully supported by subway grid or equal) /Fasteners.

All internal fasteners shall be of SS-316 and heavy duty locknuts shall be used throughout.

7.6 Resin Traps-

Outlet of each condensate polisher vessel, activated carbon filter shall be provided with a resin trap. Pressure drop at design flow through a clean resin trap shall not exceed 0.35 kg/sq.cm. Resin trap shall be of steel construction and internals shall be of SS-316 construction. Resin traps of process effluent line shall have screen opening not exceeding 120 percent of associated process vessel under drain screen Opening. Other resin traps shall have screen opening of 60 mesh. Manual back flushing shall be provided for all resin traps.

Carbon Trap (for ACF): Outlet of each Activated Carbon filler on Carbon trap (media trap) shall be provided.

8. EMERGENCY BYPASS SYSTEM

- 8.1 Each Condensate polisher service unit shall be provided with an automatic bypass for the condensate polisher on the condensate inlet and outlet headers of the unit with a Butterfly control valve and Butterfly isolation valves (resilient material seated, to ensure bubble-tight shut off) on the upstream and downstream sides of the control valve.
- 8.2 In the event of excessive pressure differential (0.35 MPa) 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 two vessel/one vessel/no vessel is in operation.
- 8.3 Either 2X50% capacity valves or 1X100% capacity control valve shall be provided to achieve proper control under all operating conditions.
- 8.4 The control system shall be so designed that the control valve is able to bypass 50 % of rated flow when any of the service vessel is out of service & 100% when both the service vessels are out of service.
- 8.5 The isolation valves shall be provided with geared operators for manual operation. The entire system shall be designed for an internal pressure of at least the design pressure of service vessels and for a maximum condensate flow of not less than total design flow of all the working service vessels.
- 8.6 Complete instrumentation and controls for this system, including the differential pressure transmitters, panel mounted indicating type controller with provision for remote manual operation, actuator for the control valve with position indicator shall be furnished by the bidder as part of this package. All tubing, wiring, air sets, and other fittings, required to complete the system, shall also be installed by bidder.

9. EXTERNAL REGENERATION FACILITY

- 9.1 One common facility for regeneration of the resins from the condensate polishers for both the units shall be provided and consisting of following:



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- a. Resin Separation & Cation Regeneration Vessel.
- b. Anion resin regeneration vessel.
- c. Mixed resin storage vessel.

Note: The type of above vessels mentioned under sr. no. a, b, c shall be as per supplier process requirements.

- 9.2 One (1) no. Resin Injection Hopper, complete with a water ejector system for resin make-up. The tank shall be sized to handle up to 150 liters of as received new resins.
- 9.3 Common waste effluent header with one resin trap designed for in-place manual backwashing.
- 9.4 Two (2) (1W+1SB) nos. oil free type air blowers, each with electric motor drives for supplying all the process air required for cleaning of resins and their regeneration processes. Each blower shall be complete with motor, V-belt drive with belt guard, inlet filter / silencer, v-belts and discharge snubber, all mounted on a single base, along with Relief valves, Acoustic hood etc. as required.
- 9.5 Two (2) nos. CPU Regeneration cum Resin Transfer Pumps each with electric drive motor drives, one normally operating and the other standby, for water supply for chemical preparation / dosing and transfer of resin from service vessel to regeneration vessels & vice-versa, backwash & rinse activities shall be provided.

9.6 **BULK ACID & ALKALI STORAGE & ACID/LAKALI DOSING SYSTEM:**

The Acid and alkali dosing equipment for regeneration of condensate polishing resins shall preferably be mounted on skid. All the equipment, piping etc. shall be assembled on two structural steel skids one for acid and one alkali dosing equipment. This shall consist of at least the following:

- a. One (1) no. acid measuring tank of adequate capacity to hold 120% acid required for one regeneration.
- b. One (1) no. alkali preparation tank complete with electrically driven stirrer, and dissolving basket. The tank capacity shall be equal to 120% of regeneration requirement of one regeneration.
- c. One (1) no. alkali measuring tank complete with electrically driven stirrer, and dissolving basket. The tank capacity shall be equal to 120% of regeneration requirement of one regeneration.
- d. One (1) no. hot water tank for heating of alkali diluent water with (2X50%) electric heating coil, adequately insulated of stainless steel construction shall be provided. The capacity of tank shall be minimum 20% higher than the maximum water demand. This tank shall be provided with burn out protection, pressure relief valve, level switches, temperature indicator etc. The heaters shall be sized for heating the water from a temperature of 15 to 50 deg. C in 5 hours at the outlet of ejector.
- e. One (1) no. Activated Carbon Filter for alkali rated flow of the filter shall not be less than the design capacity of the alkali unloading pump, and the maximum velocity through the filter for this flow shall not exceed 12 meters/hour: Depth of the filter materials shall not be less than 1 meter.
- f. Two (02) numbers (1W+1S) simplex hydraulically operated diaphragm type acid dosing pumps with electric motor drive, pulsation dampener & safety relief valve at the outlet header of each pump along with all other required accessories for acid dosing.
- g. Two (02) numbers (1W+1S) simplex hydraulically operated diaphragm type alkali dosing pumps with electric motor drive, pulsation dampener & safety relief valve at the outlet header of each pump along with all other required accessories for alkali dosing.
- h. One (1) no. hose Station for Transfer of Hydrochloric Acid (30-33% HCl).The hose station shall consist of one (1) no. of hose pipe. Hose size shall be of 80 mm /NB @ 20 m, provided along with coupling & diaphragm type isolation valves.
- i. One (1) no. hose station for transfer of Alkali (48% NaOH). The hose station shall consist of one (1) no. of hose pipe. Hose size shall be of 80 mm /NB @ 20 m, provided along with coupling & diaphragm type isolation valves.

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- j. Two nos. (2X100%) Acid unloading pumps each complete with electrical drive motor and all other accessories as required.
- k. Two nos. (2X100%) Alkali unloading pumps each complete with electrical drive motor and all other accessories as required.
- l. Two nos. (2X100%) Alkali transfer cum recirculation pumps each complete with electrical drive motor and all other accessories as required.
- m. Two (2) nos. Bulk Acid storage tanks complete with integral pipe works, valves, level transmitter, level gauges, fume absorber cum overflow seal pot and all other accessories required.
- n. Two (2) nos. Bulk Alkali storage tanks complete with integral pipe works, valves, level transmitter, level gauges, CO₂ absorber, over flow seal pot and all other accessories required.
- o. Carbon trap shall be provided at the outlet line of Activated carbon filter. This carbon trap shall have screen opening of 60 mesh.
- p. One (1) no. Neutralization Pit of RCC construction with two (2) compartments with acid and alkali resistant lining along with isolation gates shall be provided in the CPU regeneration area. Each section shall have capacity to hold 150% of waste water generated from CPU in one regeneration + 120% of waste generated from RO –DM plant in one regeneration. Dosing of acid and alkali shall also be provided to neutralize effluents of CPU regeneration waste before disposal.
- q. One (1) no. Acid Measuring Tank for Neutralization- pit complete with integral pipe works, valves & instruments all other accessories.
- r. One (1) no. Alkali Measuring Tank for neutralization-pit along with slow speed agitator driven by motor complete with integral pipe works, valves & instruments all other accessories.
- s. Two (2 x 100%) capacity Waste Recirculation / Disposal pumps, each complete with electrical drive motor. These pumps shall be of horizontal centrifugal type with priming arrangement and shall be supplied for waste recirculation and disposal to CMB of ETP. The pump shall be designed to pump the total volume of one section of the neutralization pit in 2 hours. Proven agitation system like air agitation, venture mixing etc. shall be provided in addition to recirculation from pumps.
- t. Two (2) nos. Safety Shower with necessary accessories.
- u. All interconnecting piping, valves and fittings as required for the CPU regeneration system.

10. VESSEL FREEBOARD REQUIREMENTS

The pressure vessels in the external regeneration facility shall be provided with adequate freeboards over the top of the settled resins, to minimize resin loss during their use. Minimum permissible freeboards are as follows:

Mixed resin storage vessel - 50%
Resin separation vessel - 100%
Anion and cation regeneration vessels - 100%
Activated carbon filter - 75%

However if a vessel is used for more than one service, then the vessel design shall be based on the service which gives maximum free board.

Note: Mill tolerances 0.3 mm shall be considered for determining the thickness of the shells and dished ends of pressure vessels. A minimum thinning allowance of 2 mm shall be considered for the dished ends of pressure vessels.

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11. TECHNICAL REQUIREMENT OF REGENERATION EQUIPMENTS**11.1 Activated Carbon Filter (for alkali):**

Rated flow of the filter shall not be less than the design capacity of the alkali transfer-cum recirculation pump, and the maximum velocity through the filter for this flow shall not exceed 12 meters/hour. Depth of the filter material shall be as specified in DATASHEET –A of this specification.

The filtering medium shall be granulated activated carbon, meeting following minimum requirements. Total

Surface area : Not less than 850 sq.m/gm.

Bulk density : Not less than 400 kg/cu.m.

Iodine number : 850 minimum

Uniformity coefficient : 1.9 or less

Abrasion number : 70 minimum

Ash : 8% maximum

Mean particle diameter shall be about 1.5-1.7 mm with following size distribution:

On 20 mesh : Less than 3%

Through 40 mesh : Less than 10%

Through 50 mesh : Less than 1%

The filter shall be provided with all necessary valves and connections for manual backwashing and rinsing with demineralized water. Rate set valves shall be provided with adjustable limit stops for setting backwash and rinse rates.

11.2 DM Water storage tanks (Not in bidder' scope) for Condensate polishing Plant

DM water required for CPU regeneration as well as resin transfer operations shall be drawn from DM Water Storage Tanks (not in bidder's scope) .However provision of suction nozzle & recirculation nozzle for CPU plant DM water requirement, shall be there is BHEL provided each DM water storage tanks (2nos.). Bidder to consider the piping from these suction nozzles to CPU regeneration a cum resin transfer pumps and recirculation line piping from the outlet discharge line of these pumps to each DM water storage tanks recirculation nozzle with an automatic valve. Further Bidder to consider interlock (trip) of these pumps from the Level transmitter /level switch provided in both the DM water storage tanks.

11.3 Resin Injection Hopper

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 a piano type hinged port, having a lifting handle, of sufficient size for easy resin loading. The resin shall discharge through a bottom connection to a water ejector for transport. Water shall be added to the hopper to assist in the resin transfer. The ejector discharge shall be to the resin separation-cation regeneration vessel. Demineralized water shall be used throughout for the resin transfer. Piping of the resin make-up system shall be the responsibility of the Bidder as a part of the external resin regeneration system.

a) Capacity

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

b) Material

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

12. PIPING

- 12.1 Bidder shall design, supply and erect the piping between the service units and the common external regeneration facility, for transferring the exhausted and regenerated resins as required.
- 12.2 All piping shall be laid above ground and generally laid in pipe trestles including crossing of road/pipe/cable trenches if any. Piping of between chemical tanks area and regeneration area etc. may be laid on pedestals if layout permits.
- 12.3 Complete supporting system for the pipeline shall be designed, fabricated and supplied by the Bidder. Inside the building, the overhead portion of the pipeline may be supported from the building structures. In outdoors, the pipeline may run on steel posts. Crossing of the roads shall be on a pipe bridge with a clear height of at least 6.1 meters over the road surface. All the steel structures of the pipe bridge and the supporting posts along with all necessary hanger, clamps, connecting steel, fixing bolts, nuts, etc. shall be supplied and erected by the bidder.
- 12.4 Routing of this pipe line shall be developed by the bidder and shall be finalized in coordination with the BHEL/Customer, based on the space available and the final layout.
- 12.5 The resin transfer pipeline arrangement shall avoid any sharp bends which cause segregation of the mixed resins, and pockets where the resins can get trapped. Suitable observation ports shall be provided in all critical areas to enable the operator to monitor completeness of the resin transfer operations. All necessary arrangements for venting and draining of the pipeline shall be provided.
- 12.6 The resin transfer pipeline shall be sized for a flow velocity of between 2.3 and 3.0 meters/sec.
- 12.7 The condensate pipeline shall be sized for a flow velocity between 3 and 5 m/sec.
- 12.8 Remotely operated valves suitably interlocked with the plant operation, shall ensure that the resins get transferred to and from only the particular service vessel which has been selected by the operator.
- 12.9 All lined vessel connections and connections in unlined vessels (25 Nb and larger) shall be flanged to ANSI 150 lb class except the polisher service vessels which shall be ANSI 300 lb class: Flat face flanges shall be used throughout. All flanged connections shall be supplied complete with matching counter flanges, nuts, bolts and full face gaskets. All the pipeline in service vessels area where pressure may attain same as service vessel shall be designed for 300 lb class.
- 12.10 Bidder to also refer the detailed specification for low pressure piping for piping inside regeneration area & power cycle piping for piping inside service vessel area which is enclosed elsewhere in this specification.

13. PRESSURE VESSELS, ATMOSPHERIC TANKS & MISCELLANEOUS ITEMS

- 13.1 Design pressure of the condensate Polisher Service Vessels shall be as indicated in the data sheet. For all other pressure vessels, unless otherwise mentioned design pressure shall be at least 10 kg/cm²(g).
- 13.2 Design of all vertical cylindrical atmospheric storage tanks containing water, acid, alkali and other chemicals shall conform to IS: 803.
- 13.3 Design of all horizontal cylindrical storage tanks containing water, acid, alkali and other chemicals shall conform to BS 2594/ BS EN12285-2:2005.

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- 13.4 Unless otherwise mentioned design temperature of all pressure vessels and storage tanks shall be 10 deg.C higher than the maximum temperature that any part of the vessel/tank is likely to attain during operation.
- 13.5 In case, tank is subjected to vacuum, the same shall be taken care in designing the tank.
- 13.6 The design of Demineralized water storage tanks (Vertical type) shall conform to IS: 803. Supporting frame where required shall be in accordance with IS: 800. The tank shall be "Non-pressure" fixed roof type with atmospheric vents.
- 13.7 All vessels/tanks without inside rubber lining shall have a corrosion allowance of minimum 2 mm and mill allowance (minimum 0.3 mm) for shell and dished ends. Thinning allowance of 2 mm (minimum) shall be considered for dished end of torispherical type.
- 13.8 Spherical vessels for CPU service vessels are acceptable.
- 13.9 All the atmospheric tanks shall have sufficient free board above the "Level High /Normal Level" as the case may be. The overflow level shall be kept at least 20 cm or 10% of vessel height above the "Level High /Normal Level" for all the tank except for the DM tanks for which a minimum height of 300 mm shall be provided over the "High Level". Further, a minimum 300 mm free board shall be provided above the top of overflow level to the top of tank.
- 13.10 Material:
- i All pressure vessels shall be designed and constructed in strict accordance with the ASME code Section VIII or acceptable equivalent international standard. Suitable mill tolerances shall be considered for determining the thickness of the shells and dished ends. A minimum thinning allowance of 2 mm shall be considered for the dished ends of torispherical type.
 - ii Pressure vessel ends shall be of dished design and constructed by forging, pressing or spinning process. Spherical vessels for CPU service vessels are acceptable. Conical or flat ends shall not be accepted. All the atmospheric vessels shall be at least 6 mm thickness.
 - iii All pressure vessels shall be fabricated from carbon steel plates as specified in DATASHEET-A and lined internally. The lining shall be of rubber having a hardness of 65 plus/minus 5 shore -A meeting the requirements of IS: 4682, Part-I. The lining shall be applied in three layers, resulting in a total thickness of not less than 4.5 mm anywhere on the internal surfaces of the vessels. The lining shall extend over the full face of all flanged connections and shall have a minimum thickness of 3 mm in all such external areas.
 - iv Vessel internals shall meet the following requirements:
 - 1) Inlet water and regenerant distributor: - Hub and internals diffuser splash plate or header and perforated laterals. Material of construction shall be SS-316 except for acid service which will be of Hastelloy-B.
 - 2) Under drains: Same as above with screened laterals with internal perforated pipes and rubber lined flat bottom. For resin separation/regeneration/mixed resin vessels, it may have fully screened bottom (NEVA - clog type with pora septanurese screen, fully supported by subway grid or equal).
 - 3) All internal fasteners shall be of SS-316 and heavy duty locknuts shall be used throughout.
 - v Resin Traps: Outlet of each condensate polisher vessel, activated carbon filter and waste effluent header of the common regeneration shall be provided with a resin trap. Pressure drop at design flow through a clean resin trap shall not exceed 0.35 kg/sq.cm. Resin trap shall be of rubber lined steel

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construction and internals (cord & screen) shall be of JOHNSON SCREENS IRELAND or equivalent (SS-316) construction. Resin traps of process effluent line shall have screen opening not exceeding 120 percent of associated process vessel under drain screen opening. Other resin traps shall have screen opening of 60 mesh. In place manual back flushing shall be provided for all resin traps.

- vi Carbon Trap (for ACF): Outlet of each Activated Carbon filler on Carbon trap (media trap) shall be provided.

14. OPERATION & CONTROL PHILOSOPHY OF CPU PLANT

The regeneration system shall be external and common to the polisher of both the units. Under normal conditions, it will hold a complete charge of freshly regenerated and mixed resin, ready for use, in its storage tank. For regeneration, resin from the exhausted exchanger vessel shall be transferred hydraulically / hydro pneumatically to this facility.

The empty exchanger vessel will then be filled up with the already regenerated resin which was stored in the regeneration facility. This exchange vessel shall come into service soon after perquisite condition is satisfied or as and when desired by the operator. In the meantime, the exhausted resin shall be cleaned, separated, regenerated, mixed and rinsed before being stored for next use.

The control & operation of regeneration area shall be from OWS as well as OWES located in regeneration area. Operation of Service vessel shall be from 1 no. OWS located in each unit of service vessel area.

CONTROL & OPERATION OF CONDENSATE POLISHING PLANT**A) GENERAL**

- (i) It shall be possible to operate the regeneration plant in Auto / Semi auto / Manual mode. In 'Auto mode, once the sequence has been initiated, it shall proceed from step to step automatically. In 'Semi auto' mode each step shall be performed only after initiation by the operator. In 'manual' mode complete operation shall be by the operator.
- (ii) The control system shall link the various steps such as closing/ opening of different valves, starting / stopping of various pumps etc. which form a sequence. The logic system shall adhere to the correct sequence of operation and predetermined time intervals. The system shall have interlocks so that, criteria necessary for each step are complete prior to proceeding to the next step.
- (iii) It shall be possible to switch mode of operation from one to the other at any moment and the operation shall proceed on the newly selected mode from that time.
- (iv) For steps, which require frequent time adjustment and all other steps, it shall be possible to change the time setting from the OWS/OWES.
- (v) For all sequences, the current step number, time of the step, elapsed time of the step and the total elapsed time of the sequences shall be indicated in the OWS/OWES.
- (vi) The system shall incorporate the necessary safety features. During automatic sequential operation, if any pre-requisite criterion is not fulfilled or missing for a pre-determined time interval, the steps shall not proceed further, and alarm shall be provided. Missing criteria, sequence, which is under hold up etc. shall be displayed.
- (vii) The safety system for any sequence/step shall check the opening of the required valves and closure of the remaining valves of the plants to avoid mal operation.

B) CONDENSATE POLISHER CONTROL SYSTEM

- (i) Operation of the complete Condensate Polishing System shall be through Programmable Logic Controller

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(PLC). In addition to above, local control desk with colored Mimic, Indicators, Ammeters, H.W. Annunciator, P.B. and indication Lamps shall also be provided. The control and monitoring of condensate polishing plant is done at two places:

The condensate-polishing unit shall be controlled from the PLC system, located near the service vessel. This system shall be suitably interlocked with the regeneration system control panel.

- **Service vessel:** The control & operation of the CPU service vessels shall be done from the 1 no. OWS for Each TG unit provided & located in TG hall area near CPU Service vessels. RPU (Remote Processing unit) shall also be provided near service vessel area of each TG unit.
- **Regeneration system:** The operation of regeneration system shall be by means of PLC based control system located in regeneration area. In addition to the PLC based system, Backup Control desk with coloured Mimic, Indicators, Ammeters, H.W. Annunciator, P.B. and indication Lamps shall also be provided. Also operation shall be envisaged from 2 No. of OWS (1 OWS & 1 OEWS), in regeneration area.
- (ii) Facility to monitor the Condensate Polishing System from the Main control room is not envisaged. However the status of major parameter shall be sent to the control room for indication purpose only.
- (iii) This PLC shall have interface module for redundant and bi-directional OPC connectivity with DDCMIS. Taking the equipment into service and regeneration of mixed-bed units shall be initiated manually from the OWS of control system or local panel and balance operation shall be carried out sequentially by the control system. Manual override facility is also provided for all operations.
- (iv) The latest proven PLC system shall be provided. PLC should be sourced from original manufacturers; PLC from system house shall not be acceptable. PLC system shall be complete with hot standby redundant CPU of word length of 32bits minimum, Input / Output modules, dual serial link interface module for connecting Input / Output Modules, dual Communication Processors, dual Memory modules and redundant Power supply units. Power supply unit shall be redundant for each CPU & I/O rack. PLC system will be interfaced with DDCMIS through OPC dual redundant communication interfacing (to be provided at PLC & DDCMIS end) for important process parameters. PLC shall confirm to IEC – 61131.
- (v) PLC shall be provided with necessary redundant ports & complete hardwares for Auto time synchronization from Master clock time.
- (vi) Open and Close limit switch feed backs of valves are to be connected to PLC for remote viewing and for interlocks and protection.
- (vii) Remote and local indications of various important parameters to the process requirement shall be provided.
- (viii) The instruments shall be offered as per the process requirement for complete auto operation. All the instruments/equipment/electrical items shall be provided & designed with maximum star rating as available in line with energy conservation policies notified by BEE, GOI.
- (ix) Necessary instruments pressure gauges, Temperature gauges, DP instruments, Pressure transmitters, Radar Level transmitters, Differential pressure transmitters, Temperature Elements Various analysers, Magnetic type level indicators, shall be provided. The junction boxes and instruments / electronics housing used shall be Non – corrosive material.
- (x) Flow transmitters at each CPU service vessel inlet shall be provided for monitoring the performance and accountability.
- (xi) Annunciations for abnormal conditions (as per system requirement) shall be provided in the Control Panel.
- (xii) Pneumatic actuators with all accessories shall be controlled using solenoid valves, which shall be energized from OWS / Control Panel. The opening and closing of these valves is based on system requirement, which is programmed in the Control system. Feed backs to the control system regarding the valve open / close position are set through the limit switches.
- (xiii) Each of the solenoid valves in CPU plant shall be provided with 'close-Auto-open control switches. In 'Auto' position of the control switch the solenoid valve shall receive close/open command from the Automatic



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sequence logic

- (xiv) Time synchronization of PLC with master clock system is to be carried out. Necessary hardware/software for the same shall be provided.
- (xv) PLC shall be connected to DCS through OFC with Modbus/OPC protocol for monitoring.
- (xvi) 2 x 100% parallel redundant UPS, 1 x 100% Bypass stabilizer & 1 set of battery bank for minimum 60 minute back up at 100% load shall be provided.
- (xvii) Smart positioners shall be provided for pneumatically controlled valves.
- (xviii) Each condensate polishing system shall be provided with programmable logic control based local panel that will clearly show the status of each service vessel. It shall be possible to select each of the CPU vessel for any of the following operations or mode:
 - Service.
 - Isolation from service.
 - Exhausted Resin Transfer from CPU vessel to Regeneration plant.
 - Regenerated Resin Transfer from Regeneration Plant to CPU vessel.
 - Rinse recycle mode.
- (xix) A mimic diagram shall be provided for the CPU scheme on the OWS and as well as front of the CPU control panel. Status of various valves shall be indicated by LED's on the mimic diagram.

Each condensate polishing system shall be provided with a programmable logic control based local panel that will clearly show the status of each service vessel. From this panel it shall be possible to initiate any of the following operating modes. This panel shall be located near the respective condensate polishing vessels.

The following requirements of the control system shall be included:

➤ RINSE RECYCLE MODE

The rinse recycle shall be manually initiated in full automatic sequence. This sequence shall include the rinse down step using condensate at the desired flow rate until the unit effluent quality is acceptable for boiler feed water. The effluent quality shall be determined by conductivity monitoring of the rinse water outlet which is returned to the condenser hotwell for recycle. A panel mounted cation conductivity indicator shall be interlocked to prevent advancing of the automatic sequence until the rinse down is complete.

➤ SERVICE MODE

Service flow rate for each polishing vessel shall be monitored by panel mounted flow indicators. 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.

Panel mounted cation conductivity indicators shall monitor the polishing system influent and effluent streams as well as the discharge of each service vessel. 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 effluent header or service vessel conductivity annunciator alarm will alert the operator to the need for regeneration of a polishing vessel.

➤ ISOLATION FROM SERVICE

Normally "Service vessel" once exhausted shall be isolated from service till the "Resin Transfer" operation is complete.



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- The sequence 'Resin Transfer from CPU Vessel to Regeneration plant' and Resin Transfer from Regeneration plant to CPU Vessel' shall be initiated from the condensate polishing unit control panel but shall be controlled by the programmable logic controller in the Regeneration Control Panel.

C) EXTERNAL REGENERATION CONTROL SYSTEM

- (i) One external regeneration system shall be provided to serve the condensate polishing for the unit. This system shall be designed for physical cleaning and chemical regeneration of the resin system will consist of required number of resin separation and regeneration vessels, a mixed resin storage vessel, the tank for introducing the required regeneration solutions and means for adding make-up resin. It will have acid, alkali, and ammonia (if required) dosing system and alkali preparation facilities.
- (ii) Manually initiated automatic sequences shall be provided for transferring resin from a vessel to the remote common facility for physical cleaning and chemical regeneration and for returning fresh resin to that vessel. Control for chemical dosing system and alkali preparation facility shall also be provided in it.
- (iii) Regeneration shall include hydraulic reclassification of the resins and the transfer of the resins to the respective regeneration vessels shall be hydraulically/hydro pneumatically. The separated resins shall then be backwashed, cation and anion regenerated with hydrochloric acid and sodium hydroxide solutions respectively, rinsed and then followed air scrubbing and a good backwash. The resin is then transferred back to the resin separation vessel and the resins are air mixed. The mixed resins after regeneration are given a final rinse with the discharge conductivity being monitored. If the quality is satisfactory, the mixed resin shall be transferred to the resin storage vessel otherwise regeneration sequence shall be repeated.
- (iv) **Regeneration Control System**
 - a) A manually initiated automatic sequence for physical cleaning and chemical regeneration of the resin shall be provided. Control for chemical dosing system and alkali preparation facility shall also be provided in it.
 - b) Demineralized water shall be used throughout the regeneration process for backwashing, regenerant diluents, rinsing and resin transfer.
 - c) A conical bottom hopper having a water ejector will be used for resin make-up.
 - d) The complete detail of the regeneration system shall be supplier specific and the extent of automation offered, operation of the complete system, logic/flow diagrams, type and details of the presentation of information, the type of mimic, hardware details etc. along with detailed circuit descriptions shall be provided during detail engineering.
 - e) The complete control and operation of the regeneration plant shall be through programmable logic controller (PLC).
- (v) **Resin Transfer**

Manually initiated automatic sequences shall be provided for transferring resin from a Service vessel to the remote common facility for physical cleaning and chemical regeneration and for returning fresh resin to that Service vessel.

The sequence resin transfer from CPU vessel to regeneration plant and from regeneration plant to CPU vessel shall be initiated from the condensate polishing unit control panel but shall be controlled by the programmable logic controller in the regeneration control panel.

The transfer of resin from the service vessel shall include isolation of the service vessel, hydraulic/hydro-pneumatic transfer of the resin to the external regeneration system (resin separation vessel) and the complete drain down of the service vessel to the hot well.
- (vi) The complete control and operation of the Regeneration Plant shall be through Programmable Logic Controller.
- (vii) It shall be possible to operate the Regeneration Plant in Auto/Semi-Auto/Manual mode.

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(viii) Following operations shall be possible from the Regeneration Control Panel.

- a) Complete Regeneration.
- b) Resin Transfer from CPU vessel to Regeneration Plant.
- c) Resin Transfer from Regeneration Plant to CPU vessel.

Operation (a) shall be initiated from the Regeneration Control panel whereas operation (b) & (c) shall be initiated from the CPU service vessel Remote I/O panel.

- (ix) In 'Auto' mode, once the sequence has been initiated, it shall proceed from step to step automatically.
- (x) In 'Semi-auto' mode each step shall be performed only after initiation by the operator.
- (xi) In 'Manual' mode complete operation shall be by the operator by operation of the Control switches on the panel.
- (xii) 'Close-Auto-Open' control switches shall be provided on the panel for the various drives. In 'Auto' position, the drives shall receive stop/start command from the PLC.
- (xiii) 'Start-Auto-Start' Control switches shall be provided on the panel from the various drives. In 'Auto' position, the valves shall receive close/open command from the PLC.
- (xiv) On PLC failure, it shall be possible to operate the valves by means of manual operation of solenoid valves also.
- (xv) It shall be possible to switch mode of operation from one to the other at any moment and the operation shall proceed on the newly selected mode from that time.
- (xvi) For steps which require frequent time adjustment, it shall be possible to change the time setting from the front of the panel. For all other steps it shall be possible to adjust the time setting from inside the panel.
- (xvii) For all sequences, the current step number, set time of the step, elapsed time of the step and the total elapsed time of the sequence shall be indicated on the front of the panel.
- (xviii) A mimic diagram of the Regeneration system shall be provided on the front of the panel. The status of various drives and valves shall be indicated by LED on the mimic diagram.
- (xix) The system shall incorporate the necessary safety features. During automatic sequential operation, if any pre-requisite criteria is not fulfilled or missing for a pre-determined time interval, the steps should not proceed further, the Alarm shall be provided. Missing criteria, sequence which is under hold up etc. shall be displayed on the panel.
- (xx) The safety system for any sequence/step shall check the opening of the required valves and closure of the remaining valves of the plant to avoid mal-operation.
- (xxi) Wherever standby equipments are provided, it shall be possible to select each of the drive on 'standby' duty.
- (xxii) Start, progress and stop of each of the sequence shall be annunciated in all the control panels.
- (xxiii) At any time only one of the sequence shall be in progress.

D) SPECIFIC INTERLOCKS RELATED TO SERVICE & REGENERATION SYSTEM

All interlocks for safe operation of the plant shall be provided. The following interlocks as a bare minimum requirement of the system shall be provided:

- (i) Service vessels shall be taken back in service, only after they have been pressurized.
- (ii) Service vessels can be taken up for resin transfer only after they have been completely isolated from the condensate system and depressurized.

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- (iii) Resin can be transferred to and from only one service vessel at a time.
- (iv) Resin transfer between the service and the regeneration skids shall be permitted only when the receiving vessel is initially empty.
- (v) Regeneration sequence can commence, only when the level in the waste N-Pit is low enough to receive the entire waste water from the regeneration operation.
- (vi) Wherever possible, completion of all timed steps in the regeneration and resin transfer process shall be physically verified by effluent conductivity etc. as applicable. The automatic sequence shall be prevented from advancing to next step, till these required physical conditions are achieved, and at the same time this delay shall be annunciated in the control panel, to draw the attention of the operator. The automatic sequence of operations shall be interruptive at any time by the operator and he shall be able to take over the control to manual from that step onwards. Further operator should be able to override sequence, if required.
- (vii) It shall be possible for the operator to extend the timing of the particular step by isolating the timer for the duration. The timer will restart once the operator puts back the system on 'auto' and the other steps will then follow as programmed.
- (viii) The regeneration sequence shall be prevented from advancing further in the event of tripping of a running motor or other fault condition, which do not permit the various desired parameter of this step to be achieved. A manual over ride for this shall also be provided.
- (ix) Annunciation logic shall be carefully designed so that the alarms are activated only under abnormal conditions. As for example, low flow of diluent water is only relevant when the chemical dosing is in progress. All other times, when no diluent water flow is required, this annunciation should be blocked. In general, Normal and trouble free operation of the plant shall not activate any of these alarms.
- (x) Adequate diluent water flow shall be established before starting of the ejectors/dosing pumps for acid and alkali.
- (xi) The immersion heater in the hot water tank can be put on only when there is adequate water level in the tank.

Note: Bidder to note that for complete control & operation of the CPU plant bidder to also refer the respective Control & Instrumentation (Section C3, D3) & Electrical (section C2 & D2)

CHAPTER 32

32.00.00 LAYOUT REQUIREMENT

32.01.00 The general layout criteria to be adopted for this project are indicated below.

1. Minimum clear working space around equipment : 1200mm
2. Clear Head room within Main Plant Building for pipes, ducts structures & cable trays etc. : 2.5 m (Minimum)
3. No. of Fire Escape staircases in the main plant with fire doors at each landing : Min-4 Nos. per unit - However the number shall meet the requirement of insurance companies.
4. Adequate space for handling/removal of pumps, heaters, heat-exchanger, fans, Mills, during maintenance.
5. Independent floor drains with separate down comers shall be provided where sprinkler system are provided.
6. Valves in the Bidder's scope shall be located in accessible positions. All piping shall be routed at a clear height of 2500 mm (min.) from the nearest access level to clear man movement.
7. Provision of monorail beams with chain pulley blocks/HOT cranes along with hoists, as required shall be decided during detailed engineering stage and are in bidder scope.
8. Approach for removal of equipment for maintenance shall be provided.
9. A/C and Ventilation ducts, Bus ducts, and Critical Piping routes to be identified at conceptual stage.
10. Fuel oil (F.O) piping shall be routed over trestles. The headroom for F.O. Trestle in Boiler/ESP area shall be 8.0M till the road behind chimney as per the layout requirement. The headroom for F.O. trestle in outlying area shall be 3.0M except at rail/road crossing where the headroom shall be 8.0M. F.O. trestle legs or supports shall be located so as to clear the road spaces, approach to maintenance bays of different equipment buildings located in the route of F.O. trestle.
11. Routing of cable trays & piping
 - i) Trestle height in outlying area : 3 Meters(BOS/BOP)
 - ii) Trestle height from C-row to road Behind chimney /in front of XFMR Yard Boiler/ESP area : 8 Meters(BOS/BOP)
 - iii) Cable/ Pipe trestles height at rail/ road crossings shall be 8M. (BOS/BOP)
 - iv) Head room below cable / pipe rack in transformer yard area for movement of spare GT shall be 12.0 Meters.
 - v) A walkway with hand rails & toe guards of 600mm (minimum) width shall be provided all along length of the trestle for maintenance of cables & pipes. Ladders for

approach to these platforms shall be provided near roads, passage ways and turning points.

- vi) At the crossing of pipe/ cable trestles with the dry ash pipe rack/CHP cable rack trestle, pipe/ cable trestle shall be locally raised to provide a head room of 2.5 M over the walkways of dry ash pipe rack/CHP cable trestles.
- vii) Head room below cable/pipe rack along Mill bay shall be 12.0 Meters.
- viii) Head room for man movement shall be 2.5 m at ground floor, over all platforms etc.
- ix) Minimum clear hand space required for
 - a) The application of thermal insulation 100 mm
 - b) Welding work 150 mm
 - c) Bolt tightening 150 mm
- 12. Piping in main plant area (i.e. boiler/ESP/ID fan/chimney/transformer yard) shall be routed above ground on trestles with a height of minimum 8M. Further, piping in outlying area shall be routed over trestles with a height of 3M. However, height of trestles at approach roads to various buildings/ facilities shall be 8M.
- 13. Fire water piping within the Plant boundary shall be routed above ground on pedestals. However, fire water pipes in Main Plant Island shall be routed in trenches filled with sand and covered with pre cast RCC covers. Fire water pipes shall be protected in main plant area as per TAC requirement. Fire water piping at road crossing shall be encased/culvert. Fire water pipe at rail crossing shall be on trestle of BOS 8M height from rail top.
- 14. All other safety requirements as per the factories act, National Electricity code shall be observed while developing the layout.
- 15. Insulation of equipment/piping for personnel protection is to be provided if the temperature exceed 60 deg C.
- 16. Chequered plate edges should have continuous supports/ stiffeners.
- 17. Each equipment room shall be provided with alternate exits in case of fire /accidents as per requirements of factory act and TAC.
- 18. Each building shall have an identified vacant space for equipment unloading and maintenance and preferably a separate bay altogether in buildings housing heavy equipment. Provision for handling equipment by monorail hoist and/or overhead crane shall be made as specified.
- 19. Cubicle for operating personnel shall be located for all buildings at safe place near the equipment.
- 20. All buildings shall have provision for toilet and associated effluent discharge system together with facility for drinking water. The criteria for ventilation, fire protection and illumination of building spaces specified elsewhere in this specification shall be complied with.
- 21. All gratings shall be of electro forged type with adequate bearing & locking on the supporting structure.

22. Approach to all elevated structures like Fans, Pumps, etc shall be through steel stairs with gratings & hand rail.
23. All cranes shall be provided with approach rung ladders at least at two places. Where ever cranes can't be maintained in situ on the carriage, facility to draw them to maintenance platforms as well as provision of suitable platforms shall be considered.
24. All fresh air ventilation louvers shall be 1000 mm from floor level and directed downward at an angle.
25. The VFD control equipment and transformers for ID fan shall be located along with the ESP control equipment in the ESP/ VFD control room.
26. Three (3) nos. of staircases per ESP of each unit shall be provided. Two (2) nos. of the staircase shall be located on the inlet side and one (1) no. on the outlet side of ESP.
27. The grating platform shall be provided in oil equipment room, control fluid room and valve room.
28. Approach platform shall be provided from ESP outlet to ID fan suction gate.
29. Minimum access opening required 3.5M wide x 4M high or, (with rolling shutter) transportation wherever entry of truck, for material more depending upon this envisaged equipment size to be handled.
30. Toilet and drinking water facility required in all buildings and on all floors wherever operating personnel are to be deployed.
31. Local Pits/trenches in Main Plant building are to be avoided. However pits/sumps which are unavoidable such as CW (Circulating Water System) pits etc shall be provided with required dewatering arrangements by means of drainage pumps and piping upto the nearest drainage network. Bidder shall provide required sump pumps/drainage pumps/submersible pumps & Piping etc.
32. Pump shall be permanently fixed in the pits/sumps. If the pit depth is shallow, vertical top mounted sump pumps shall be provided and in deep pits self priming drainage pumps (horizontal type) at floor level or alternatively submersible type pumps may be provided.
33. Each pit/sump shall be provided with two numbers (2 x 100% Capacity) of respective type pumps so that the entire pit is evacuated within 15-20 minutes and the operation of the pumps shall be interlocked through level measurement devices to be installed in the pit/sump so that the pumps shall start automatically and empty the pit.

CHAPTER 13**13.0 LP PIPING, VALVES & SPECIALITIES****13.1 Equipment sizing Criteria**

- 13.1.1 All the piping systems and equipment supplied under this package shall be designed to operate without replacement and with normal maintenance for a plant service life of 30 years, and shall withstand the operating parameter fluctuations and cycling which can be normally expected during this period.
- 13.1.2 For all LP piping system covered under this specification, sizing and system design shall be to the requirements of relevant codes and standard indicated elsewhere. In addition to this, requirements of any statutory code as applicable shall also be taken into consideration.
- 13.1.3 Inside diameters of piping shall be calculated for the flow requirements of various systems. The velocities for calculating the inside diameters shall be limited to the following.

a) Water Application

		Water Velocity in m/sec		
	Pipe Size	Below 50 mm	50-150 mm	200 mm & above
a)	Pump suction	-----	1.2-1.5	1.2-1.8
b)	Pump discharge and recirculation	1.2-1.8	1.8-2.4	2.1-2.5
c)	Header	----	1.5-2.4	2.1-2.4

The pipes in CW, ACW & DMCW system shall be designed to maintain a maximum velocity of 2 m/s inside the pipelines at pump discharge.

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

WILLIAM & HAZEN formula shall be used for calculating the friction loss in piping systems with the following "C" value.

i)	Carbon steel pipe	100
ii)	CI Pipe/Ductile Iron	100
iii)	Rubber lined steel pipe	120
iv)	Stainless steel pipe	100

For calculating the required pump head for pump selection, at least 10% margin shall be taken over the pipe friction losses and static head shall be calculated from the minimum water level of the tank/sump/reservoir from which the pumps draw water.

b) Compressed Air Application

Compressed air – 15.0 m/sec. (under Average Pressure & Temp. conditions)

- 13.1.4 The pipes shall be sized for the worst (i.e. maximum flow, temp. and pressure values) operating conditions.
- 13.1.5 Based on the inside dia. so established, thickness calculation shall be made as per ANSI B 31.1 OD and thickness of pipes shall than be selected as per ANSI B 36.10/IS-1239 Heavy grade/IS-3589/ASTM-A-53/API-5L/ANSI B 36.19 as the case may be.
- 13.1.6 Corrosion allowance of 1.6 mm will be added to the calculated thickness being considered.
- 13.1.7 Bend thinning allowance/manufacturing allowance etc. shall be as per the requirement of the design code provision.
- 13.1.8 High points in piping system shall be provided with vents alongwith valves as per the system requirement. Low points shall be provided with drains alongwith drain valves as per the system requirement. Drain lines shall be adequately sized so as to clear condensate in the lines. Material for drain and vent lines shall be compatible with that of the parent pipe material.
- 13.1.9 Material of construction for pipes carrying various fluids shall be as specified elsewhere.
- 13.1.10 Compressed air pipe work shall be adequately drained to prevent internal moisture accumulation and moisture traps shall be provided at strategic locations in the piping systems.
- 13.1.11 Depending upon the size and system pressure, joints in compressed air pipe work shall be screwed or flanged. The flange shall be welded with the parent pipe at shop and shall be hot dip galvanized before dispatch to site. Alternatively, the flanges on GI pipes may be screwed-on flanges also.
- 13.1.12 Threaded joints shall be provided with Teflon sealant tapes.
- 13.1.13 Following types of valves shall be used for the system/service indicated.

System	Type of Valves					
	Butterfly	Gate	Globe	Check	Ball	Plug
Water	x	x	x	x	x	
Air		x	x	x	x	
Drains & Vents		x	x	x		
Fuel oil		x	x	x	x	x

In water service, valves above 200 NB size shal be butterfly valves.

- 13.1.14 Recirculation pipes alongwith valves, breakdown orifices etc. shall be provided for important pumping systems as indicated in respective process and instrumentation diagrams (P&IDs). The recirculation pipe shall be sized for minimum 30% design

flow of single pump operation or the recommended flow of the pump manufacturer whichever is higher.

13.1.15 All Piping 450 NB & Above shall be designated as Large dia Piping.

13.2.00 TECHNICAL SPECIFICATION

13.1.00 GENERAL

Specific technical requirements of low-pressure piping, fittings, supports, valves, specialties and tanks etc. have been covered under this Sub-section. It includes details pertaining to design and material of construction for piping, fittings, valves, equipment, etc. cleaning/surface preparation application of primer and painting on over ground piping. It also includes detailed technical requirement of laying underground/buried piping including water proofing/anti corrosive protection. It also covers design, engineering, manufacturing, fabrication, technical details of piping, valves, specialties, piping hangers/supports, tanks etc.

13.2.00 Pipes and fittings

13.2.1 All low pressure piping systems shall be capable of withstanding the maximum pressure in the corresponding lines at the relevant temperatures. However, the minimum thickness as adhered to. The bidder shall furnish the pipe sizing / thickness calculation as per the criteria mentioned above under LP piping equipment sizing criteria of this Technical Specification.

13.2.2 Piping and fittings coming under the purview of IBR shall be designed satisfying the requirements of IBR as a minimum.

13.2.3 Supporting arrangement of piping systems shall be properly designed for systems where hydraulic shocks and pressure surges may arise in the system during operation. Bidder should provide necessary protective arrangement like anchor blocks/anchor bolt etc. for the safeguard of the piping systems under above mentioned conditions. The requirement will be, however, worked out by the contractor and he will submit the detailed drawings for thrust/anchor block to the Employer. External, and internal, attachments to piping shall be designed so as not to cause flattening of pipes and excessive localized bending stresses.

13.2.4 Bends, loops, off sets, expansion or flexible joints shall be used as required in order to prevent overstressing the piping system and to provide adequate flexibility. Flexibility analysis (using software packages such as Caesar-II etc.) shall be carried out for sufficiently long piping (straight run more than 300M).

13.2.5 Wherever Bidder's piping coming under this specification, terminates at an equipments or terminal point not included in this specification, the reaction and the thermal movement imposed by bidder's piping on equipment terminal point shall be within limits to be approved by the Employer.

13.2.6 The hot lines shall be supported with flexible connections to permit axial and lateral movements. Flexibility analysis shall be carried out for pipelines which have considerable straight run as indicated above and necessary loops/expansion joint etc. shall be provided as may be necessary depending on layout.

13.2.7 Piping and fittings shall be manufactured by an approved manufacturer of repute. They should be truly cylindrical of clear internal diameter, of uniform thickness, smooth and strong, free from dents, cracks and holes and other defects.

- 13.2.8 For rubber lined ERW pipes, beads shall be removed.
- 13.2.9 Inspection holes shall be provided at suitable locations for pipes 800 NB and above as required for periodic observations and inspection purposes.
- 13.2.10 At all intersection joints, it is Contractor's responsibility to design and provide suitable reinforcements as per the applicable codes and standards.
- 13.2.11 For large size pipes/duct, at high point and bends/change of direction of flow, air release valves shall be provided as dictated by the system requirement and operation philosophy & tripping conditions of pumping system. Sizing criteria for air release valves shall be generally on the basis of valve size to pipe diameter ratio of 1:8. Requirement shall be decided as per relevant code.

Transient analysis / surge analysis wherever specified and required shall be conducted in order to determine the location, number and size of the Air-Release valve on certain long distance/high volume piping systems such as CW/ ACW/ Raw Water etc.

13.3.00 Material

- 13.3.1 Alternate materials offered by Bidder against those specified shall either be equal to or superior to those specified, the responsibility for establishing equality or superiority of the alternate materials offered rests entirely with the Bidder and any standard code required for establishing the same shall be in English language.
- 13.3.2 No extra credit would be given to offers containing materials superior to those specified. Likewise no extra credit would be given to offers containing pipe thickness more than specified.
- 13.3.4 All materials shall be new and procured directly from the manufacturers. Materials procured from traders or stockiest are not acceptable.
- 13.3.5 All materials shall be certified by proper material test certificates. All material test certificates shall carry proper heat number or other acceptable reference to enable identification of the certificate that certifies the material.
- 13.3.6 Material of construction for pipes carrying various fluids shall be as follows:

1.	Circulating Water (CW) – CW Pumphouse to Condenser & Condenser to Cooling Tower	RCC DUCT WITH INSIDE PROTECTIVE COATING AS INDICATED IN VOLUME VI
2.	Circulating Water (CW) – Pump Discharge, condenser risers including header near condenser and cooling tower riser.	IS 3589 FABRICATED FROM IS 2062 PLATES –INTERNALLY LINED WITH CORROCOAT OR POLYUREA COATING OF 1500 MICRONS DFT /GRP/ FRP
3.	ACW	UPTO 150 NB - ASTM A 312 TP 316 L (ERW)/ DUPLEX SS 200 NB & ABOVE - ERW IS 1978 (OR) API5L (OR) IS 3589 FABRICATED FROM IS 2062- Internally lined with Corrocoat or polyureA Coating inside of 1500 microns DFT
4.	RO Stage I reject, RO Stage II	UPTO 150 NB - ASTM A 312 TP 316

	Reject, Guard pond inlet & discharge, Piping from Reject sump,. Ash water piping using sea water and all other sea water applications.	L (ERW)/ DUPLEX SS 200 NB & ABOVE - ERW IS 1978 (OR) API5L (OR) IS 3589 FABRICATED FROM IS 2062- Internally lined with Corrocoat or polyureA Coating inside of 1500 microns DFT/ GRP/ FRP
5.	Sea Water Intake Pipe, CT Make up, Make up upto clarifier & CT Blowdown Pipe	GRP
6.	RO Stage I Permeate, Filtered Water, service water, AHP Seal Water, HVAC Make up, Air Pre-Heater Wash water, Passivated DM Water and clarifier sludge.	IS-2062 Gr. B/ASTM-A-36/ASTM A-53 type 'E' Gr. B/IS-3589 Gr. 410/IS-1239 Heavy. 150 NB & above pipes shall be spiral welded.
7.	RO Stage II Permeate, Dematerialized water, (condenser Make up water, Boiler fill and Deaerator Fill water) & DMCW overhead tank make-up water	Stainless steel to ASTM A-312, Gr. 304 welded for sizes above 50mm NB Stainless steel to ASTM A312, Gr. 304 sch. 40 Seamless for sizes 50 mm and below
8.	Drinking water	ASTM A-53 type E Gr. B galvanized /IS 1239 heavy galvanized/IS 3589 Gr 410 Galvanized to SI-4736 or equivalent.
9.	Instrument air & plant air.	ASTM A-53 type E Gr. B galvanized /IS 1239 heavy galvanized/IS 3589 Gr 410 Galvanized to SI-4736 or equivalent.
10.	Fuel Oil piping	API5L
11.	HOSES FOR HFO TANKER HEATING (STEAM/ CONDENSATE)	CARBON STEEL – ELECTRO ZINC PLATED
12.	FUEL OIL UNLOADING LINES	IS1239 / IS1978 / API5L Gr.B (ERW) / IS3589 FABRICATED FROM IS 2062 PLATES
13.	FUEL OIL PUMP DISCHARGE LINES	ASTM A 106 GR B
14.	UF Feed/ Chemical Backwash (Upto 150 NB) (Pipes & Fittings)	CPVC ON 10 Sch 40
15.	UF Feed/ Chemical Backwash (> 150 NB)	GRP
16.	Sodium Hypochlorite (pipes & Fittings)	CPVC Sch 80 ASTM
17.	RO High pressuer Discharge (Pipes & Fittings)	Dupless SS
18.	Cleaning Solution Line (Pipes & Fittings)	CPVC ON 10 Sch 40

13.3.7

In water lines, pipes upto 150 mm NB shall conform to ANSI B36.10/ASTM-A-53, Type-E Gr. B/IS:1239 Gr. Heavy and minimum selected thickness shall not be

less than IS: 1239 Grade heavy except for dematerialized water and condensate spill lines.

- 13.3.9 Pipes of above 150 mm NB shall be to AWWA-C200/ANSI B 36.10/ASTM A-53/IS 3589 Gr. 410. Pipe to be fabricated by the bidder shall be rolled and butt welded from plates conforming to ASTM A-53 type 'E' Gr. B/IS 2062 Gr. B/ASTM-A-36. However, larger pipes, i.e. 1000 mm NB and above shall be made from plates conforming to ASTM A 36/IS 2062 Gr. B and shall meet the requirements of AWWA-M-11(for deflection & buckling criteria considering water filled pipe as well as vacuum condition that may prevail during transient/ surge conditions, truck-load, rail-load and weight density for compacted soil or any other load as the case may be).
- 13.3.10 In dematerialized water service, the pipes upto 50 NB shall be of stainless steel ASTM A 312, Gr. 304 sch. 40 Seamless. The size for these pipes shall be to ANSI B 36.19. These shall be socket welded. The material for pipe from 65 mm NB upto and including 400 NB shall be to ASTM A 312, Gr. 304 (welded). In no case the thickness of fittings shall be less than parent pipe thickness.
- 13.3.11 Bidder/Contractor shall note that pipes offered as per a particular code shall conform to that code in all respects i.e. Dimension, tolerances, manufacturing methods, material, heat treatment, testing requirements, etc. unless otherwise mentioned elsewhere in the specification.
- 13.3.12 Instrument air, Plant (service) air lines and Drinking water lines shall be to ASTM A 53 type E grade B/ANSI B 36. 10/IS 3589, Gr. 410/IS: 1239 Heavy (in case thickness calculated is more than gr. Heavy, ANSI B 36.10 Schedule numbers shall be followed) and galvanized to IS 4736 or any equivalent internationally reputed standard. The material of the pipes shall be to ASTM A 53 type 'E' Gr. B/IS: 3589, Gr. 410/IS: 1239 Gr. Heavy. The fittings shall be of either same as parent material or malleable iron to IS-1879 (galvanized).
- 13.3.13 Spiral welded pipes as per API-5L/IS-3589 are also acceptable for pipe of size above 150 NB. However minimum thickness of the pipes shall be as elaborated in above clauses.
- 13.3.14 Condensate lines shall be to ASTM A 106 Gr. B and dimension to ANSI B 36.10 schedule "standard" as minimum to be maintained.
- 13.3.15 If carbon steel plates of thickness more than 12 mm are used for manufacture of pipes, fittings and other appurtenances, then the same shall be control-cooled or normalized as the case may be following the guidelines of the governing code.

13.4.0 Piping Wall Thickness

- 13.4.1 The calculation of wall thickness required for pipelines subject to internal and/or external pressure shall be based on the formulae and recommendations as given in the applicable codes. Adequate allowances shall be made towards thinning due to bending, weakening at branch connections, threading, commercial tolerances on pipe wall thickness, corrosion and erosion, etc., and the same shall be subject to approval by Purchaser. In any case a minimum corrosion allowance of 1.0 mm shall be considered while selecting the thickness.
- 13.4.2 In case of carbon steel materials, the nominal wall thickness of pipeline shall not be less than the minimum acceptable values given below:

NB mm (inch)	15 (1/2)	30 (3/4)	25 (1)	32 (1¼)	40 (1.5)	50 (2)	65 (2.5)	80 (3)	100 (4)	125 (5)
Min. thickness, mm	3.2	3.2	3.6	3.6	3.6	3.6	3.6	4.0	4.5	5.4
NB mm (inch)	150 (6)	200 (8)	250 (10)	300 (12)	350 (14)	400 (16)	450 (18)	500 (20)	600 (24)	
Min. thickness, mm	5.4	6.35	6.35	6.35	7.1	7.1	7.1	8.0	8.0	

> NB 600 mm to NB 900 mm	-	8.0 mm
> NB 900 mm to NB 1200 mm	-	10.0 mm
> NB 1200 mm to 1400 mm	-	12.0 mm
> NB 1400 mm to 1600 mm	-	14.0 mm
> NB 1600 mm to NB 2200 mm	-	16.0 mm
> NB 2200 mm	-	18.0 mm

13.5.00 Piping Layout

- 13.5.1 Piping shall be grouped together where practicable and routed to present a neat appearance.
- 13.5.2 Piping routing shall be such as to provide sufficient clearance for removal and maintenance of equipment, easy access to valves, instruments and other accessories. The piping shall not encroach on the withdrawal space of various equipments.
- 13.5.3 Over head piping shall have a normal minimum vertical clearance of 2.5 meters above walkways and working areas and 8 m above roadways/railways. When several pipelines are laid parallel, flanged joints must be staggered. Welded and flanged joints should as far as possible be located at one third span from supports. If the support is situated right under the welded joints this joint must be reinforced with a strap. Flanged and welded joints must be avoided in the middle of the span. Valves should be located in such a manner so as to ensure their convenient operation from the floor or the nearest platform.
- 13.5.4 Pipelines of NB 50 size and below are regarded as field run piping. It is Bidder's responsibility to plan suitable layouts for these system insitu. Bidder shall prepare drawings indicating the layout of field run pipe work. These drawings shall be approved by Project Manager to the installation of the field run pipe work. Based on these approved layouts the Bidder shall prepare the BOQ of field run-pipe and submit to Employer for approval.
- 13.5.5 All piping shall be routed so as to avoid interference with other pipes and their hangers and supports, electrical cable trays, ventilation ducting, structural members, equipment etc.
- 13.5.6 Adequate clearance shall be ensured with respect to the above to accommodate insulation and pipe movements, if any.
- 13.5.7 Piping shall generally be routed above ground but where specifically indicated / approved by the project Manager the pipes may be arranged in trenches or buried. Pipes at working temperature above the ambient shall however not be buried.

- 13.5.8 Sufficient up stream and down stream lengths shall be provided for flow measuring devices, control valves and other specialties.
- 13.5.9 All local instruments shall be located on pipelines as to render them observable from the nearest available platforms.
- 13.5.10 Openings provided in the wall for pipelines must be closed with bricks and mortar with 10-12 mm clearance between brick work and pipe after taking care of insulation and thermal movement, if any. The clear space must be filled with felt or asbestos or approved filling compound.

13.6.00 Slope/Drains and Vents

- 13.6.1 Suitable slope shall be provided for all pipelines towards drain points. It is Bidder responsibility to identify the requirements of drains and vents, and supply the necessary pipe work, valves, fittings, hangers and supports etc. As per the system requirement low points in the pipelines shall be provided with suitable draining arrangement and high points shall be provided with vent connections where air or gas pockets may occur. Vent shall not be less than 15 mm size. Drains shall be provided at low points and at pockets in piping such that complete drainage of all systems is possible. Drain shall not be less than 15 mm for line size up to 150 mm, not less than 20 mm up to 300 mm and not less than 25 mm for 350 mm to 600 mm pipes and not less than 50 mm for 600 mm and above pipes.
- 13.6.2 Air piping shall be sloped so that any part of the system can be drained through the shut-off drain valve or drain plugs.

13.7.0 Pipe Joints

In general all water lines 65 mm NB and above, are to be joined generally by butt welding except the locations where valves/fittings are to be installed with flanged connections and 50 mm and below by socket welding unless mentioned otherwise specifically. All air lines shall be of screwed connection and rubber lined pipes of flanged connections.

13.7.1 Screwed

- (a) Threading of pipes shall be carried out after bending, heat treatment etc. If not possible, threading may be done prior to these operations but proper care should be taken to protect them from damage. Threads shall be to ANSI B 2.1 (taper) NPT/IS:554 unless specified otherwise.
- (b) Galvanized pipe shall generally be joined by screwing into sockets. The exposed threaded portion on the outside of the pipes shall be given a zinc silicate coating. Galvanized pipes shall not be joined by welding. Screwed ends of GI pipes shall be thoroughly cleaned and painted with a mixture of red and white lead before jointing. For galvanized pipe sizes above 150 mm NB, screw & socket jointing as per ASTM-A-865 shall be employed for both pipe-to-pipe and pipe-to-fitting jointing. For pipe to fitting connection since no direct threading can be done on the fittings (supplied as per ASTM-A-234 Gr. WPB and ANSI B-16.9) necessary straight pipe lengths acting as match pieces shall be welded to the fitting at both ends and subsequently the free ends of the straight lengths shall be threaded as per ASTM A-865 for jointing with main pipe. Once welding of fittings with match pieces and threading of free ends of match pieces are over, the entire fabricated piece shall be galvanized, or in case match pipes and fittings are already galvanized before the above mentioned fabrication then

suitable application of Zinc-Silicate paste adequately at the welded surface (both in side & out side) after welding with zinc rich electrode, alongwith the nascent threaded metal portion at both free ends given the same application of Zinc Silicate paste. Alternatively flanged jointing may be employed for pipe sizes 100 NB and above. However, the bidder shall ensure the galvanized pipe joints do not fail during hydro test.

- (c) Teflon tapes shall be used to seal out screwed joints and shall be applied to the male threads only. Threaded parts shall be wiped clean of oil or grease with appropriate solvent if necessary and allowing proper time for drying before applying the sealant. Pipe ends shall be reamed and all chips shall be removed. Screwed flanges shall be attached by screwing the pipe through the flange and the pipe and flange shall be refaced accurately.
- (d) For pipe sizes from 350 mm NB to 550 mm NB (including 350 NB & 550 NB) the GI pipes shall be of flanged connection. However, the pipes after welding of flanges shall be completely galvanized. Any site welding done on galvanized pipes shall be done with zinc-rich special electrodes and the welded surfaces whether inside or outside shall be coated with zinc-silicate pasts. Seal welding of flanges with zinc-rich electrode will be permitted only when any flange is leak-prone during hydro testing.
- (e) For pipe sizes 600 mm NB and above, the GI pipes shall be of welded connection (with zinc-rich special electrodes) followed by application of zinc silicate coating at welded surfaces both inside and outside the pipe, except for the last blank/blind flange, or, equipment connection where application of zinc-silicate paste after welding cannot be done due to inaccessibility of the inside welded surface and where galvanic protection has been impaired due to welding of pipe-to-pipe joint. Thus the last erection joint shall be flanged joint.

13.7.2 Welded

- (a) For making up welded joints (butt weld or socket weld) the welding shall be performed by manual shielded metal arc process in accordance with the requirements specified elsewhere in the spec. Any welder employed for carrying butt welding shall be qualified as per ASME section IX for the type of joints he is going to weld. Jointing by butt weld, or socket weld shall depend upon the respective piping material specifications.

13.7.3 Flanged

- (a) Flanged connections for pipes are to be kept to the minimum and used only for connections to vessel, equipments, flanged valves and other fittings like strainer/traps/orifices etc. for ease of connection and maintenance etc. Rubber lined pipes shall be flange joined only.
- (b) All flanged valves intended for installation on steel piping system, shall have their flanges drilled to ANSI B 16.5 (or equivalent) and according to the pressure class stated in their respective piping material specification.
- (c) Drilling on flanges of flanged valves must correspond to the drilling of flanges on the piping system on which the valves are installed.

13.8.00 Bends/elbows/mitre bends/Tees/Reducers & other fittings

- 13.8.1 Unless otherwise specified elbows shall be of long radius type.
- 13.8.2 For pipe sizes up to 65 Nb, long radius forged elbows or seamless pipe bends shall be used. Pipe bends, if used, shall be cold bent to a radius measured to the centre line of pipe of 3 to 5 times the pipe diameter.
- 13.8.3 For steel pipes 80 Nb and above, seamless long radius forged elbows shall be used. For pipe size 250 Nb and above mitre bends may be used for all pipes except rubber lined pipes. The bend radius shall be 1½ times the nominal pipe diameter. 90 deg. Bends (mitre) shall be in 4 pieces (3 cuts) and 45 deg. mitre bends shall be in 3 pieces 22½ deg. Fabrication of mitre bends shall be as detailed in BS 2633/BS534.
- 13.8.4 Mitre bends are not acceptable in case of rubber lined mild steel pipes.
- 13.8.5 For pipe fittings such as reducers and tees, the material shall be to ASTM-A-234 gr. WPB up to 300 NB. For pipe reducers and tees above 300 NB, the fittings may be fabricated conforming to parent pipe material. Provision of compensation pads shall be kept as per ANSI B 31.1. The fittings shall conform to the dimensional standard of ANSI B-16.9.
- However, for pipes up to 150 NB, pipe fittings may be supplied with material and dimension conforming to IS 1239 in case parent pipes also conform to IS 1239.
- For pipes, above 1200 NB, reducer and tees shall be to dimensional standard of AWWA-C-208.
- 13.8.6 Stainless steel fittings shall conform to either ASTM-A-182, Gr. 304 (316 for Sea water application, if any) or ASTM-A-403, Gr. WP 304 (316 for Sea Water application, if any) Class-S, for sizes up to and including 50 mm NB, i.e. the fitting shall be of seamless construction.
- However, for stainless steel fittings above 50mm NB, the same shall conform to ASTM-A-403, Gr. WP 304 (316 for Sea water application, if any), Class W i.e. the fittings shall be of welded construction strictly in accordance with ASTM-A-403.
- 13.8.7 In no case, the thickness of fittings shall be less than the thickness of parent pipe, irrespective of material of construction.
- 13.9.00 Flanges**
- 13.9.1 Flanges shall be slip on type. Welding of flanges in tension is not permitted.
- 13.9.2 All flanges and flanged drilling shall be to ANSI B 16.5/BS EN-1092 of relevant pressure/temperature class. Flanges shall be fabricated from steel plates conforming to ASTM A 105/IS 2062 Gr. B. However stainless steel flanges shall be fabricated from SS plates to ASTM-A-240, Gr. 304 (316 for Sea water application, if any) or equivalent. For all Sea Water applications including guard pond, reject sump, CW, ACW, CT make Up, Sea Water Intake, RO Stage I Reject, RO Stage II Reject, Ash water (Sea water) etc flanges & bolts & nuts shall be SS 316 L construction.
- 13.10.00 Specific technical requirement of laying buried pipe with anti corrosive treatment**

The pipe in general shall be laid with the top of the pipe minimum 1.0 (one) meter below finished general ground level.

13.10.1 Trenching

- (a) The trench shall be cut true to the line and level and shall follow the gradient of the pipeline. The width of the trench shall be sufficient to give free working space on each side of the pipe. Trenches shall conform to IS 5822.
- (b) Free access shall be provided for the welding of the circumferential joints by increasing the width and depth of the trench at these points. There should be no obstruction to the welder from any side so that good welded joint is obtained.
- (c) The free working space shall conform to IS: 5822. The trench shall be excavated so as to provide minimum cover of 1000 mm between the top of the pipe and finished grade.
- (d) Prior to lowering and laying pipe in any trench, the bidder shall backfill and compact the bottom of the trench or excavation in accordance with IS: 5822 to provide an acceptable bed for placing the pipe.
- (e) Coating and Wrapping shall be done as under.

13.10.2 Preparation and cleaning of piping

- (a) The pipeline shall be thoroughly cleaned of all rust, grease, dirt, weld scales and weld burrs etc. moisture or other foreign matter by power cleaning method such as sand blasting, power tool cleaning, etc. Grease or heavy oil shall be removed by washing with a volatile solvent such as gasoline. Kerosene will not be permitted for cleaning. This cleaning operation shall be immediately followed by priming with the mechanical priming machine.
- (b) Certain inaccessible portions of the pipeline (which otherwise not possible to be cleaned by power cleaning methods) may be scrubbed manually with a stiff wire brush and scrapped where necessary with specific permission of the Project Manager.
- (c) The cleaning and priming operation shall be carried out at site. The entire pipe length shall be cleaned but the ends of the pipes shall be left without coating for a distance of 230 mm for joints, which shall be coating manually at site after laying, welding and testing the pipe.

13.10.4 Trench bed preparation and back filling

Prior to lowering and laying pipe in any excavated trench, the bottom of the trench may require to be back filled and compacted (or as the case may be) to provide an acceptable bed for placing the pipe. Bed preparation in general shall be as per IS: 5822.

13.10.5 Laying of galvanized steel (GI) pipes

All the joints shall be screwed with socket or flanged. Screwed ends of GI pipes shall be thoroughly cleaned and painted with a mixture of red and white lead before

jointing Threaded portion on either side of the socket joints shall be applied with Zinc silicate paste.

All the provisions for trenching' bed preparation' laying the pipe application of primer' coating' wrapping with tapes and back filling etc. as indicated for "laying of buried piping" and "anti corrosive protection for buried piping" are applicable for buried galvanized steel (GI) pipes also.

13.11.00 Cleaning and Flushing

13.11.1 All piping shall be cleaned by the Bidder before and after erection to remove grease, dirt, dust, scale and welding slag.

13.11.2 Before erection all pipe work, assemblies, sub-assemblies, fittings, and components, etc. shall be thoroughly cleaned internally and externally by blast cleaning or by power driven wire brushes and followed by air-blowing. The brushes shall be of the same or similar material as the metal being cleaned. Cleaning of Galvanized pipes shall be done in such a manner that the coating on MS pipe is not affected.

13.11.3 After erection, all water lines shall be 1.2-1.5 times the operating velocities in the pipelines.

13.11.4 All compressed air pipe work shall be cleaned by blowing compressed air.

13.12.00 Painting of Pipes

13.12.1 Buried Piping

Internal surfaces

- (i) Surface cleaning by sand blasting.
- (ii) Two (2) coats of epoxy primer coats. The minimum DFT of each coat shall be 35 microns.
- (iii) Finish coat-Two (2) coats of high build epoxy paint. The minimum DFT of each coat shall be 35 microns.

The total dry film thickness of 150 microns.

Tests to be carried out after application : Bond/ Adhesion test, Holiday test

External surfaces

- (i) Surface cleaning by Sand Blasting.
- (ii) Coal tar primer compatible with coal tar enamel grade. The number of coats shall be two with a DFT of 35 microns each.
- (iii) Coal tar enamel shall be applied. A single spiral inner wrap of glass fibre tissues shall be applied overlapping at least 25 mm ensuring impregnation of glass fibre tissues in the first coat. The second coat of enamel and second outer wrap of glass fibre felt, Type – I to IS: 7193-1974 will be applied in the same way confirming to Table – 10 of IS – 10221 – 1982.

The total thickness of the coating will not be less than 4.0 mm

- (iv) Alternatively Wrapping with coal tar based anticorrosion tape conforming to IS 15337: 2003 is also acceptable in lieu of s.no. (iii) above. Wrapping thickness shall be 4.0 mm.

Tests to be carried out after application : Bond/ Adhesion test, Holiday test

13.12.2 Overground Piping

Internal surfaces

- (i) Surface cleaning by sand blasting.
- (ii) Two (2) coats of epoxy primer coats. The minimum DFT of each coat shall be 35 microns.
- (iii) Finish coat-Two (2) coats of high build epoxy paint. The minimum DFT of each coat shall be 35 microns.

The total dry film thickness of 150 microns.

External surfaces

- (i) Surface cleaning by Sand Blasting.
- (ii) Two (2) coats of epoxy primer coats. The minimum DFT of each coat shall be 35 microns.
- (iii) Finish coat-Two (2) coats of high build epoxy paint. The minimum DFT of each coat shall be 35 microns.

13.12.3 Other requirements

- (a) Paint manufacturers instructions shall be followed in method of application, handling, drying time etc.
- (b) The color of the finish paint shall be as per approved color-coding.
- (c) If finish paint was applied in shop, one coat of finish paint shall be applied at site.
- (d) The dry film thickness of paint shall not be less than 0.15 mm.

13.12.4 Color code for identification

The pipes shall be color painted/banded for identification as per the approved color-coding scheme and shall be generally as per IS-9404.

13.13.00 Specification for hangers and supports

13.13.1 All supports and parts shall conform to the requirement of power piping code ANSI B 31.1 or approved equivalent.

13.13.2 While designing supports for rubber lined pipes special consideration should be given. Any kind of welding on these pipes is not allowed after rubber lining.

- 13.13.3 Hanger for piping 65 mm Nb and larger and all spring support assemblies regardless of size shall be completely engineered in conformance with the provisions of power piping code ANSI B 31.1.
- 13.13.4 Hangers, saddles, supports etc. shall be fabricated from plates/pipes sections conforming to ASTM A 53/IS: 2062/IS:226/ or equivalent. They shall be designed to provide the required supporting effects and allow pipeline movements as necessary. The structural steel work shall be as per IS: 800/BS:4360. Insulation protection saddles shall be used at support point of all insulated piping.
- 13.13.5 The support shall be so interspaced as to minimize sagging of the pipes and to keep them within permissible limits where pipes are full with the conveying media.
- 13.13.6 The maximum spans of the supports of straight length shall not exceed the recommended values indicated in ANSI B 31.1.
- 13.13.7 All pipe supports shall be designed to provide an absolute minimum head room of 2.5 m from floor in passages/walkways.
- 13.13.8 At all sliding surfaces of supports suitable arrangement is to be provided to minimize sliding friction.
- 13.13.9 All components of hangers/support shall be provided with two coats of primer (red oxide paint) at shop before dispatch to site. After erection they shall be given finish coat of Long Oil Synthetic enamel to IS: 2932 of total DFT 100 to 140 microns. CLH & VLH will be primed with Epoxy Zinc rich primer of 50 micron followed by finish painting of Aliphatic Acrylic Polyurethane or equivalent of DFT 65 microns.
- 13.14.00 Design/Construction/Material Particulars of Gate/Globe/Check Valves/Globe Stop Valve/Butterfly Valve**
- 13.14.1 GENERAL**
- (a) All valves shall be suitable for the service conditions i.e. flow, temperature and pressure, at which they are required to operate.
 - (b) The valves as well as all accessories shall be designed for easy disassembly and maintenance.
 - (c) Valves to be installed outside shall be required to have the stem properly protected against atmospheric corrosion.
 - (d) All rising stem valves shall be provided with back seat to permit repacking (of glands) with valves in operation. All valves shall preferably be of outside screw and yoke type.
 - (e) All valves shall be closed by rotating the hand wheel in the clockwise direction when looking at the face of the hand wheel. In case where the hand wheel is not directly attached to the valve spindle suitable gearing shall be introduced.
 - (f) All valves shall have indicators or direction clearly marked on the hand-wheel so that the valves opening/closing can be readily determined.
 - (g) Special attention shall be given to operating mechanism for large size valves with a view to obtaining quick and easy operation ensuring that a

- minimum of maintenance is required. For valves of size 350 mm and above either bevel or spur gearing shall be provided to facilitate manual operation.
- (h) The valves coming in vacuum lines shall be of extended gland type and / or water sealed.
 - (i) The actuator-operated valves shall be designed on the basis of the following:
 - (1) The internal parts shall be suitable to support the pressure caused by the actuators.
 - (2) The valve-actuator unit shall be suitably stiff so as not to cause vibrations, misalignments, etc.
 - (3) All actuator-operated valves shall be provided with hand operated gearing mechanism also.
 - (4) All actuators operated valves shall open/close fully within time required by the process.
 - (j) Valves coming under the purview of IBR shall meet IBR requirements.
 - (k) Gate/sluice valves shall be used for isolation of flow. Gate valves shall be provided with the following accessories in addition to other standard items:
 - (1) Hand wheel
 - (2) Position indicator (for above 50 mm NB valve size)
 - (3) Draining arrangement wherever required.
 - (l) Globe valves shall be used for regulation purposes. They shall be provided with hand wheel, position indicator, draining arrangement (wherever required) and arrow indicating flow direction.
 - (m) Check valves shall be used for non-return service. They shall be swing check type or double door (Dual plate) check type with a permanent arrow inscription on the valve body indicating the fluid flow direction. In long distance pipes lines with possibility of surge-occurrence, dual plate check valves are preferable for its spring controlled opening/closing of flaps/doors against flow reversals. However, dual plate check valves shall not be used for sizes more than 600 mm NB.
 - (n) All gate and globe valves shall be provided with back seating arrangement to enable on line changing of gland packing.
 - (o) All gate and globe valves shall be rising stem type and shall have limit switches for full OPEN and full CLOSED indication wherever required. This will include motor-operated valves also wherever required. In such cases the limit switches shall form an integral part of the valve. Stop-gap arrangement in this respect is not acceptable.
 - (p) All valves shall be provided with embossed name plate giving details such as tag number, type, size etc.

- (q) Wherever required valves shall be provided with chain operator, extension spindles and floor stands or any other arrangement approved by employer so that they can be operated with ease from the nearest operating floor. Wherever necessary for safety purpose locking device shall be provided. Further, necessary small platforms for facilitating easy valve operation shall be provided by the contractor wherever necessary in consultation with project manager within the bid price at no extra cost to employer.
- (r) All valves except those with rising stems shall be provided with continuous mechanical position indicator; rising stem valves shall have only visual indication through plastic/metallic stem cover for sizes above 50 mm nominal bore.
- (s) For CI gate, globe and check valves wherever thickness of body/bonnet is not mentioned in the valves standards, thickness mentioned in IS-1538 for fitting shall be applicable.

13.14.2 VALVE BODY MATERIAL

Valve body material for various services shall be as follows:

Valve body material for water application like DM Cooling Water (Passivated DM Water) (DMCW), RO Stage I Permeate, AHP Seal Water, APH/ ESP Wash, Service Water, Potable Water, HVAC Make UP shall be cast iron for sizes 65 NB and above; gun-metal/ Forged Carbon Steel for sizes 50 NB and below.

Valve body material for sea water application like Circulating Water. Auxiliary Cooling water, Blowdown, CT make up, sea water Intake, Guard pond inlet & Discharge, Ash Water using sea water, RO Stage II reject, RO Stage I reject, Reject Sump discharge and all other sea water applications shall be SS 316 L for all sizes.

For compressed air application, valve body material shall be cast carbon steel or forged carbon steel for sizes 65 mm NB & above and Gun metal for sizes 50 NB and below.

DM water: SS body and disc alongwith SS internals.

Condensate: Cast Carbon Steel/Forged Carbon Steel.

- 13.14.2.1 The design, material, construction, manufacture, inspection, testing and performance of valves shall comply with all currently applicable statutes, regulations and safety codes in the locality where the valves will be installed. The valves shall conform to the latest editions of applicable codes and standards as mentioned elsewhere. Nothing in this specification shall be construed to relieve the Bidder of his responsibility. Valves in general shall conform to the requirements of the following standards.

Standards and Codes

AWWA-C-504	Rubber seated butterfly valves
BS-5155/EN-593	Cast iron and steel body butterfly valves for general purpose.
IS-778	Gun-metal gate, globe and check valves for general purpose.

BS-5154	Copper alloy globe/globe stop and check and gate valves for general purpose.
IS-780	Sluice valves for water works purpose (50-300 mm size)
IS-2906	Sluice valves for water works purpose (350-1200 mm size)
IS-5150	Cast iron wedge and double disc gate for general purpose.
BS-5152	Specification for cast iron globe valves
BS-5153	Cast iron check valves for general purpose.
IS-5312	Swing check type reflux (non-return) valves
ANSI B 16.34	Standard for valves
API-594	Standard for Dual-check valves
API-600	Steel gate valves
ANSI-B-16.10	Valves face to face and other relevant dimension
API-598	Valves inspection test

13.14.2.2 End Connections

The end connections, shall comply with the following:

Socket welding (SW) – ANSI B 16.11

Butt Welding (BW) – ANSI B 16.25

Threaded (SC) – ANSI B 2.1

Flanged (FL) – ANSI B 16.5 & AWWA-C-207 (steel flanges), ANSI B 16.1 (Cast Iron flanges)

- 13.14.2.3 All cast iron body valves (gate, globe and non-return) shall have flanged end connections; (screwed ends for Ductile D.2NI body valves are not acceptable).
- 13.14.2.4 All steel and stainless steel body valves of sizes 65 mm and above shall have flanged or butt welding ends. Valves of sizes below 65mm shall have flanged or socket welded ends. Compatibility of welding between valve body material and connecting pipe material is a pre-requisite in case of butt-welded joints.
- 13.14.2.5 All gun metal body valves shall have screwed ends.
- 13.14.2.6 All flanged end valves/specialties shall be furnished alongwith matching counter flanges, fasteners, gaskets etc. as required to complete the joints

13.15.00 Check Valves

13.15.1 Check valves shall comply with the following characteristics:

- (a) For bore greater than 2" the valves must be swing check type or dual plate check type suitable for installation in all positions (vertical and horizontal);
- (b) For bore smaller than or equal to 2" the valves must be of the piston type to be installed, in horizontal position.
- (c) In the case of swing check valves, the body seat shall be inclined at such an angle from the vertical as will facilitate closing and prevent chatter.

13.15.2 Drilling on flanges of flanged valves must correspond to the drilling on flanges of the piping system on which the valves are to be installed.

13.15.3 All flanged valves intended for installation in steel piping systems shall have their flanges drilled to ANSI B 16.5 (or equivalent) and according to the pressure class.

13.15.4 Counter flanges to be installed on air pipes shall be screwed-on type irrespective of size.

13.16.00 Globe Valves

13.16.1 The globe valves shall have the following characteristics;

Straight conveyed flow

Right angle

Preferably, the valves shall be of the vertical stem type.

13.16.2 Globe valves shall preferably have radiused or spherical seating and discs shall be free to revolve on the spindle.

13.16.3 The pressure shall preferably be under the disc of the valve. However, globe valves, with pressure over the disc shall also be accepted provided (i) no possibility exists that flow from above the disc can remove either the disc from stem or component from disc (ii) manual globe valves can easily be operated by hand. If the fluid load on the top of the disc is higher than 40-60 KN, bypass valve shall be provided which permits the downstream system to be pressurized before the globe valve is opened.

13.16.4 For the regulating valves, valves with regulating plug & parabolic outline disc type is preferred.

13.16.5 All motorized globe valves with regulating plug for which indication of percentage (%) opening are required in the control room shall be provided with necessary position transmitter.

13.17.00 Gate valves

All gate valves shall be of the full-way type, and when in the full open position the bore of the valve shall not be constricted by any part of the gate.

Gate valves shall be of the solid/elastic or articulated wedge disc and rising stem type.

13.18.00 Air Release Valve

- (a) The air release valves shall be of automatic double air valve with two orifices and two floats. The float shall not close the valve at higher air velocities. The orifice contact joint with the float shall be leak tight joint.
- (b) The valve shall efficiently discharge the displaced air automatically from ducts/pipes while filling them and admit air automatically into the ducts/pipes while they are being emptied. The valve shall also automatically release trapped air from ducts/pipes during operation at the normal working pressure.
- (c) Body material of automatic air release valves shall comply generally with BS 1452 Gr. 14/IS:210 Gr. FG 260 and spindle shall conform to high tensile brass.
- (d) Air release valves shall not have any integral isolation device within them. Each Air release valve shall be mounted, preceded by a separate isolation gate/butterfly valve.

13.19.00 Butterfly Valves

13.19.1 Design/Construction

- (a) The valves shall be designed for the design pressure/temperature of the system on which it is installed and in accordance with AWWA-C-504, EN-593 or any other approved equivalent standard latest edition. Fabricated steel (IS: 2062 GR. B) butterfly valves instead of cast iron body valves are also acceptable for size above 300 mm nb diameter. In such a case, however, the bidder will have to necessarily submit thickness calculations, in order to establish the integrity of the fabricated valve body under the system operating pressure condition.
 - (1) The valves shall be suitable for installation in any position (horizontal/vertical etc.) and shall be generally of double-flanged construction. However for sizes 600 NB and below the valves of Wafer construction are also acceptable.
 - (2) The seals, both on the body (sleeve) and on the disc shall be of the material specified. Necessary shaft seal shall be provided and adequately designed to ensure no leakage across the seal. This seal shall be designed so that they will allow replacement without removal of the valve shaft. The sealing ring on the disk shall be continuous type and easily replaceable.
 - (3) For all types of valves, the design with shaft eccentric to the disc is preferred. The shaft shall be solid type and shall pivot on bushings. Bushings/sleeve type bearings shall be contained in the hub of valve body. The bearing shall be self-lubricated type with low coefficient of friction and should not have any harmful effect on water and on valve components.
 - (4) The design of the shaft shall be such that it will safely sustain maximum differential pressure across the closed valve. The shaft

and any key (taper pin etc.) for transmitting the torque between shaft and disc shall be capable of withstanding the maximum torque required to operate the valve. However, the shaft diameter shall not be less than the minimum shaft diameter specified in relevant code. Necessary Torque Calculation and the torque class selected on the basis of the same shall be furnished to the Employer for information.

- (5) The disc shall rotate from the full open to the tight shut position. The disc shall be contoured to ensure the least possible resistance to flow and shall be suitable for throttling operation. While the disc is in the throttled position, valve shall not create any noise or vibration.

- (6) The operating mechanism shall be mounted directly on or supported from the valve body.

- (7) All valves shall be complete with:

Position indicator (located in a visible place)

Arrow indicating the flow direction;

Adjustable mechanical stop limiting devices to prevent over

Travel of valve disc in open/close position.

All valves shall be "tight shut off"

- (8) Hand operated valves shall have the following

Local hand controls

The hand controls shall close the valve with clockwise rotation.

The hand controls shall be dimensioned to guarantee an easy maneuver under most severe conditions.

The hand controls shall be provided with locking systems suitable to avoid the disc assuming a non-desirable position during the operation.

Hand wheel shall be made of malleable iron with arms and rims of adequate strength. The hand wheel of diameters 300 mm or less shall be provided with handles for ease of operation. The pulling force required on the hand wheel rim shall not exceed 25 Kgf when operating the valve under full flow and operating pressure.

Valves-350 Nb and above shall have pressure equalizing bypass valves, wherever system parameters warrant the same.

Valves-350 Nb and above shall also be provided with gear operator arrangement suitable for manual operation. Manual operation of valve shall be through worm and gear arrangement having totally enclosed gearing with hand wheel diameter and gear ratio designed to meet the required operating torque. It shall be designed to hold the valve disc in intermediate position between full open and full closed position without creeping or fluttering.

Adjustable stops shall be provided to prevent over travel in either direction.

Limit and torque switches (if applicable) shall be enclosed in water tight enclosures alongwith suitable space heaters for motor actuated valves, which may be either for On-Off operation or inching operation with position transmitter.

13.19.2 Material of Construction (Butterfly Valves)

Materials and other design details shall be as indicated below:

(a) Cast Iron Butterfly valves

Body & Disc	ASTM A48, Gr. 40 with 2% Ni/ IS: 210. Gr. FG-260, with 2% Ni and epoxy coated
Shaft	BS 970 431 S: 291/EN 57, or AISI-410 or AWWA-permitted shaft material equivalent to EN-57/AISI-410 or better.
Seat ring	18-8 Stainless steel
Seal	Nitrile Rubber
Companion Flanges	IS 2062
External hardware	SS 316
Internal hardware	SS 316

(b) Duplex Stainless Steel Butterfly valves (All Sea Water applications including guard pond, reject sump, CW, ACW, CT make Up, Sea Water Intake, RO Stage I Reject, RO Stage II Reject, Ash water (Sea water) etc.)

Body & Disc	SS 316 L
Shaft	SS 316 L.
Seat ring	SS 316 L
Seal	Nitrile Rubber
Companion Flanges	SS 316 L
External hardware	SS 316 L
Internal hardware	SS 316 L

(c) Stainless Steel Butterfly Valves

Body & Disc	ASTM A 351, Gr. CF8M/ASTM-A-182-Gr. 304
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Shaft	ASTM A 182, Gr. 316/ASTM-A-479 Gr. 316/Equivalent
Disc & Seat Rings	EPT/BUNA-N/Neoprene
Companion Flanges	SS 304
External hardware	SS 316
Internal hardware	SS 316

(d) Carbon Steel Butterfly Valves

Body & Disc	ASTM A 216, Gr. WCB
Shaft	ASTM A 182, Gr. 304/ASTM-A-479 Gr. 304/Equivalent
Disc & Seat Rings	EPT/BUNA-N/Neoprene
Companion Flanges	IS 2062
External hardware	SS 316
Internal hardware	SS 316

13.19.3 Proof of Design Test (Type Test) for Butterfly Valves

Proof of Design (POD) test certificates shall be furnished by the bidder for all applicable size-ranges and classes of Butterfly valves supplied by him, in the absence of which actual POD test shall be conducted by the bidder in the presence of Employer's representative.

All valves that are designed and manufactured as per AWWA-C-504 shall be governed by the relevant clauses of POD test in AWWA-C-504. For Butterfly valves designed and manufactured to EN-593 or equivalent, the POD test methods and procedures shall generally follow the guidelines of AWWA-C-504 in all respect except that Body & seat hydro test and disc-strength test shall be conducted at the pressures specified in EN-593 or the applicable code. Actuators shall also meet requirements of POD test of AWWA-C-504.

13.20.00 MATERIAL OF CONSTRUCTION (GATE/GLOBE/CHECK VALVE)

(a) The materials shall generally comply with the following:

(1) Cast Steel Valves	
Body & bonnet	ASTM A 216 Gr. WCB/ ASTM A 105
Disc for non-return Valves	ASTM A 216 Gr. WCB/ ASTM A 105
Trim.	ASTM A 182 Gr. F6 or Equivalent
Companion Flanges	IS 2062
External hardware	SS 316

	Internal hardware	SS 316
(2)	Stainless Steel Valves	
	Body & Bonnet	ASTM A 351 Gr. CF 8M/ ASTM A 182 Gr. 304
	Disc	-do-
	Trim.	ASTM 182 Gr. F. 316 /ASTM-A-479 Gr. 316 or Integral with body
	Companion Flanges	SS 304
	External hardware	SS 316
	Internal hardware	SS 316
(3)	Cast Iron Valves	
	Body & bonnet 260	BS 1452 Gr. 14/IS-210 Gr. FG
	Seating surfaces and rings	13% chromium steel/13% Chrome overlay
	Disc for non-return valves	BS 1452 Gr. 14/IS-210 Gr FG 260
	Hinge pin for non-return valves	AISI 316
	Stem for gate globe valves	13% chromium steel or Equivalent
	Back Seat	13% chromium steel / 13% Chrome overlay
	Companion Flanges	IS 2062
	External hardware	SS 316
	Internal hardware	SS 316
(4)	Gun Metal Valves	
	Body and bonnet	IS 318 Gr. 2/Equivalent Standard
	Trim	-do-
	Companion Flanges	IS 2062
	External hardware	SS 316
	Internal hardware	SS 316
(5)	Duplex Stainless Steel (All Sea Water applications including guard pond, reject sump, CW, ACW, CT make Up, Sea Water Intake, RO Stage I Reject, RO Stage II Reject, Ash water etc)	

Body & bonnet	SS 316 L
Disc for non-return	SS 316 L
Stem	SS 316L
Trim.	SS 316 L
Companion Flanges	SS 316 L
External hardware	SS 316 L
Internal hardware	SS 316 L

- (b) Cast iron body valves shall have high alloy steel stem and seat.
- (c) Material for counter flanges shall be the same as for the piping except for sea water application.

13.21.00 Float Operated Valves

- (a) Valve shall automatically control the rate of filling and will shut off when a predetermined level is reached and close to prevent over flow on pre-set maximum water level. Valve shall also open and close in direct proportion to rise or fall of water level.

(b) DESIGN AND CONSTRUCTION FEATURES

The following design and construction feature of the valve shall be the minimum acceptable.

- (c) Valves shall be right-angled or globe pattern.
- (d) Valves shall be balance piston type with float ball.
- (e) Leather liner shall not be provided.
- (f) The body and cover material shall be cast iron conforming to ASTM-A 126 Grade 'B' or Is: 210 Grade 200 or equivalent, and float shall be of copper with epoxy painting of two (2) coats. For all sea water applications the complete valve shall be SS 316 L construction.
- (g) Valves shall be suitable for flow velocities of 2 to 2.5m/sec.
- (h) The valves shall have flanged connections.

13.22.00 PAINTING OF VALVES:

Two (2) coats of primer followed by three (3) coats of epoxy of approved color code/shade (usually same as that of connected piping) shall be applied to all exposed surfaces except stainless steel surface, Galvanized steel surface and gun metal surface at shop as required to prevent corrosion, before dispatch. The use of grease/oil other than light grade mineral oil, for corrosion protection is prohibited. The total DFT of painting shall be 150 micron (minimum). If during transport, unloading/unpacking or erection at site any part of the painted surface gets

damaged, the same shall be made good by the contractor by repainting with compatible painting primer and enamel to the satisfaction of the project manager.

13.23.00 RUBBER EXPANSION JOINTS

- 13.23.1 All parts of expansion joints shall be suitably designed for all stresses that may occur during continuous operation and for any additional stresses that may occur during installation and also during transient condition.
- 13.23.2 The expansion joints shall be single bellow rubber expansion joints. The arches of the expansion joints shall be filled with soft rubber.
- 13.23.3 The tube (i.e. inner cover) and the cover (outer) shall be made of natural or synthetic rubber of adequate hardness. The shore hardness shall not be less than 60 deg. A for outer and 50 deg. A for inner cover.
- 13.23.4 The carcass between the tube and the cover shall be made of high quality cotton duck, preferably, square woven to provide equal strength in both directions of the weave. The fabric plies shall be impregnated with age resistant rubber or synthetic compound and laminated into a unit.
- 13.23.5 Reinforcement, consisting of solid metal rings embedded in carcass shall be provided.
- 13.23.6 Expansion joints shall be complete with stretcher bolt assembly. The expansion joints shall be suitable to absorb piping movements and accommodate mismatch between pipelines.
- 13.23.7 The expansion joints shall be of heavy duty construction made of high grade abrasion-resistant natural or synthetic rubber compound. The basic fabric for the 'duck' shall be either a superior quality braided cotton or synthetic fibre having maximum flexibility and non-set characteristic.
- 13.23.8 The expansion joints shall be adequately reinforced, with solid steel rings, to meet the service conditions under which they are to operate.
- 13.23.9 All expansion joints shall be provided with stainless steel retaining rings for DM water application and IS 2062 Gr. B galvanized steel retaining rings for ordinary water for use on the inner face of the rubber flanges, to prevent any possibility of damage to the rubber when the bolts are tightened. These rings shall be split and beveled type for easy installation and replacement and shall be drilled to match the drilling on the end rubber flanges and shall be in two or more pieces.
- 13.23.10 The expansion joints shall have integral fabric reinforced full-face rubber flanges. The bolt on one flange shall have no eccentricity in relation to the corresponding bolt hole on the flange on the other face. The end rubber flanges shall be drilled to suit the companion pipe flanges.
- 13.23.11 All exposed surfaces of the expansion joint shall be given a 3 mm thick coating of neoprene. This surface shall be reasonably uniform and free from any blisters, porosity and other surface defects.
- 13.23.12 Each control unit shall consist of two (2) numbers of triangular stretcher bolt plates, a stretcher bolt with washers, nuts, and lock nuts. Each plate shall be drilled with three holes, two for fixing the plate on to the companion steel flange and the third for fixing the stretcher bolt.

13.23.13 Each joint shall have a permanently attached brass or stainless steel metal tag indicating the tag numbers and other salient design features.

13.23.14 Bidder to note that any metallic part which comes in contact with DM / Corrosive water shall be of stainless steel material.

13.23.15 For all Sea Water applications including guard pond, reject sump, CW, ACW, CT make Up, Sea Water Intake, RO Stage I Reject, RO Stage II Reject, Ash water etc the bolts & nuts, stretcher plates and companion flanges shall be SS 316 L.

13.24.00 STRAINERS

13.24.1 Simplex type

The strainers shall be basket type and of simplex construction. The strainer shall be provided with plugged drain/blow off and vent connections. The free area of the strainer element shall be at least four (4) times the internal area of the connecting pipe lines. The strainer element shall be 20 mesh. Pressure drop across the strainers in new condition fitted with a removable plug. The material of construction of various parts shall be as follows:

- | | | |
|-----|------------------|---|
| (a) | Body | IS: 318, Gr. 2 up to 50 mm Nb, and IS: 210 Gr. FG 260 above 50 mm Nb. (For DM water/ -Body: AISI 316 or equivalent)
SS 316 L (all Sea Water applications including guard pond, reject sump, CW, ACW, CT make Up, Sea Water Intake, RO Stage I Reject, RO Stage II Reject, Ash water etc) |
| (b) | Strainer Element | Stainless steel (AISI 316)

SS 316 L (all Sea Water applications including guard pond, reject sump, CW, ACW, CT make Up, Sea Water Intake, RO Stage I Reject, RO Stage II Reject, Ash water etc) |
| (c) | End connection | Screwed upto 50 mm Nb, and flanged above 50 mm Nb |

13.24.2 Duplex type

- (a) The strainers shall be basket type and of duplex construction. The strainer shall be provided with plugged drain/blow off and vent connections. The free area of the strainer element shall be at least four (4) times the internal area of the connecting pipe. The mesh of strainer element shall be commensurate with the actual service required. Pressure drop across the strainer in new condition shall not exceed 4.0 MWC at full flow.
- (b) Wire mesh (if applicable) of the strainers shall be suitably reinforced. The material of construction of various parts shall be as follows.

- | | |
|------|---|
| Body | IS: 318, Gr. 2
Up to 50 mm Nb, and IS:210,
Gr. FG 260 of ASTM-A-515 Gr. 75/IS-2062
Gr. B and internally epoxy-painted above 50 NB. |
|------|---|

SS 316 L (all Sea Water applications including guard pond, reject sump, CW, ACW, CT make Up, Sea Water Intake, RO Stage I Reject, RO Stage II Reject, Ash water etc)

Strainer element Stainless steel (AISI 316)/ SS 316 L (all Sea Water applications including guard pond, reject sump, CW, ACW, CT make Up, Sea Water Intake, RO Stage I Reject, RO Stage II Reject, Ash water etc)

End connection Screwed up to 50 mm NB, and Flanged above 50 NB. Gasket shall be of full face type

- (c) The strainer will have a permanent stainless steel tag fixed on the strainer body indicating the strainer tag number and service and other salient data.
- (d) The size of the strainer and the flow direction will be indicated on the strainer body casting.
- (e) Thickness of the strainer element should be designed to withstand the pressure developed within the strainer due to 100% clogged condition exerting shut-off pressure on the element.

13.24.3

Three shop coats of paint preceded by two coats of primer shall be applied to all exposed surfaces as required to prevent corrosion. All parts shall be adequately protected for rust prevention. The use of grease or oil other than light grade mineral oils for corrosion protection is prohibited.

CHAPTER – 33**POWER CYCLE PIPING, VALVES, FITTINGS & THERMAL INSULATION****33.0 POWER CYCLE PIPING, VALVES, FITTINGS & THERMAL INSULATION**

This section covers all the power cycle piping, valves and specialties which connect the different equipment like the boiler, turbine, condenser, pumps, heaters etc. to make the power cycle complete and thermal insulation to be provided for the power plant.

33.1 PERFORMANCE REQUIREMENT

The piping system acts as the pressure boundary for the fluid in circulation, water and steam in this case, which is subject to high pressure, temperature, change of phase and various types of transient and steady state operation. All the piping systems supplied shall be designed to operate without replacement and with normal maintenance for a plant service life of 30 years and shall withstand to the maximum sustained load.

33.2 Line Sizing

33.2.1 Pipelines shall be selected such that the velocity of fluid in pipes does not exceed the following limits under conditions of maximum possible volumetric flow:

Steam

(i)	Superheated Steam	:	60.0 m/s
(ii)	Saturated Steam	:	30 m/s
(iii)	Wet Steam/ Exhaust Steam	:	30 m/s
(iv)	Auxiliary Steam	:	50 m/s
(v)	Main Steam Hot & cold reheat piping	:	100 M/s
(vi)	HP Bypass Upstream	:	125 m/s
(vii)	HP Bypass Downstream	:	100 m/s
(viii)	LP Bypass Upstream	:	100 m/s
(ix)	LP Bypass Downstream	:	125 m/s

Water

(i)	Pump suction	:	1.0 m/s
(ii)	Pump delivery	:	2.5 m/s;
(iv)	Feed Water discharge	:	4 - 6 m/s
(v)	Feed Water Suction	:	2 - 3 m/s
(vi)	Condensate Discharge	:	3 – 5 m/s
(vii)	Condensate Suction	:	1.5 m/s

Oil

(i)	HFO, HSD	:	2 m/s
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WILLIAM & HAZEN formula shall be used for calculating the friction loss in piping systems with the following “C” value.

i)	Carbon steel pipe	100
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ii)	CI Pipe/Ductile Iron	100
iii)	Rubber lined steel pipe	120
iv)	Stainless steel pipe	100

For calculating the required pump head for pump selection, at least 10% margin shall be taken over the pipe friction losses and static head shall be calculated from the minimum water level of the tank/sump/reservoir from which the pumps draw water.

33.3

CODES & STANDARDS

The design, manufacture and performance of the LP Piping System specified hereinafter, shall comply with the requirements of the following codes and standards and shall include all the latest amendments

ASME-B31.1 : Code for Power Piping

ASME-B16.5 : Pipe Flanges & Flanged Fittings

ASME-B16.9 : Factory-Made Wrought Steel Butt-Welding Fittings ASME-

B16.10 : Face to Face and End to End Dimension of valves. ASME-

B16.11 : Forged Steel Fittings, Socket-Welding and threaded

ANSI B-16.25: Butt Welding Ends.

ASME-B16.34 : Valves – Flanged, Threaded and Welding End

ASME-B36.19 : Stainless Steel Pipe

IBR : Indian Boiler Regulations (Latest Revision)

IS-1239 : Carbon steel tubes, tubular and other wrought steel fittings.

IS-3589 : Seamless or Electrically welded steel pipes for water, gas and sewage.

IS-11428 : Specification for Wrought Carbon Steel butt welding pipe fittings.

IS- 4736 : Hot-dip Zinc coatings on Carbon steel tubes.

IS- 2062 : Steel for general structural Purposes - Specification.

IS- 4682 : Code of practice for lining of vessels and equipments for chemical processes: Part 1 Rubber lining.

ASTM A312 : Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.

ASTM A403 : Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings.

API-594 : Check valves: Flanged, Lug, Wafer and Butt-welding.

API-598 : Valve Inspection and Testing

API-600 : Bolted bonnet steel gate valves for Petroleum and natural gas industries.

API-602 : Compact Steel Gate Valve – Flanged, Threaded, Welding and Extended Body Valves.

BS- 1873 : Steel Globe and globe stop and check valves (flanged and butt-welding ends) for Petroleum, Petrochemical and allied industries.

BS- 1868 : Steel check valves (flanged and butt-welding ends) for Petroleum, Petrochemical and allied industries.

IS 12709 : GRP pipes, joints and fittings for use for potable water supply

IS 14402 : GRP pipes, joints, and fittings for use for sewerage, industrial waste and water.

ANSI/AWWA C950-07: AWWA Standard for Fiber Glass pipes.

AWWA M45 : AWWA manual of water Supply & Fiberglass Pipes Design.

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

Any other internationally accepted codes and standards are also acceptable. However, the compliance of ANSI codes and IBR will be considered as minimum for acceptance of the piping and all appurtenances.

33.4 **Scope of Supply**

Scope shall include all piping, valves & specialties as indicated in Annexure-I. of this chapter as a minimum. However all piping as required for the completeness of the system shall be supplied.

33.4.1 In general, the equipment and materials to be supplied under this specification shall include, as a minimum:

- a. Supply of all power cycle piping including bends, elbows, tees, branches, laterals, crosses, reducing union, couplings, caps, saddles, shoes, flanges, blank flanges, Y-pieces etc as required.

- b. Matching pipes, matching pieces like reducers/enlargers etc, counter flanges with bolts, nuts, washers, temporary and permanent gaskets, threaded union etc.
- c. The pipe spools shall be supplied along with necessary test certificates of the pipes, after necessary machining to the required bore, for assembly of flow nozzle element. The assembled flow nozzle shall be installed in the piping system. Additional length of pipes equal to length of all fully assembled flow nozzle & orifice plates pipe piece shall be supplied and the same shall also be erected prior to cleaning of the pipes by flushing or steam blowing or chemical cleaning or both. After completion of cleaning of piping, the assembled flow nozzles shall be erected replacing the temporary pipe spools.
- d. All motorised valves, manually operated isolating and regulating valves, non- return valves, steam traps, relief/safety valves, strainers, pressure reducing orifices, expansion joints and other flexible connections, complete with the counter flanges and matching connecting pieces as required within the entire power cycle piping system.
- e. Anchors, hangers and supports, vibration dampeners, restraints, shock absorbers etc as required.
- f. Any platform necessary for maintenance and operation of valve and equipment located 1.5 m above any permanent floor including access ladders, supporting structures etc.
- g. All secondary structural steel members required for pipe supports from building steel structures and from embedded steel including pipe supports in trenches.
- h. 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 either in Blowdown tank/flash tanks or permanent drain trenches of the Power Station. All steam and saturated water open drains shall be drained through a water seal in drain funnels/tundish with a water connection in funnels/tundish for maintaining water seal level in them. All oily effluent drains shall be separately routed and connected to separate pit.
- i. For the isolation and check valves located on the main steam, hot reheat, cold reheat, L.P. bypass and extraction lines, suitable line drains shall be provided just upstream and downstream of each of these valves. No drain is needed at the downstream of L.P. bypass isolation valve. Each of these drains shall be independently led to the condenser with branching off to atmosphere.

Line drains from Main Steam, Hot Reheat, Cold Reheat, L.P. bypass & high pressure (above 40 kg/cm²) extraction lines shall be provided with double isolation valves in series for each branch - each located at the two extreme ties of the line drain route. The valve near the condenser

shall be motorised one. The balance line drains shall be provided with only one isolation valve for each branch.

- j. Bolts, nuts, washers, temporary and permanent gaskets, fasteners as required for interconnecting piping, valves & fittings.
- k. Complete insulation material for piping, valves, specialties & auxiliary equipment specified in this specification and as called for in the specification for thermal insulation.
- l. Painting of all piping, valves & specialties at site. Coating and wrapping for buried pipes.

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

Following general requirements shall however be considered:

- (a) Instrument Connections
- (b) Pipe stubs and blanking plates required for chemical cleaning and hydro testing.
- (c) Flanges, spool pieces, gaskets, ring joints, jointing materials, aluminium and stainless steel forged marking plate and temporary piping for steam blowing.
- (d) Drain/drip pockets on steam piping as per stipulation of ASME TDP – Volume I and general requirement.
- (e) Expansion marker for high temperature steam lines.
- (f) Fine threaded Radiography holes with stubs and suitable matching plugs which shall be finally seal welded for piping, more than 25 mm nominal thickness.

For conducting performance test of Turbo-Generator and Boiler, the required pressure, temperature, flow measurement points shall be provided.

- (g) Provision for creep measurement on the piping operating in creep region.

33.4.3 Electrodes and filler wires required for stainless steel and alloy steel welding during shop fabrication at works and erection/installation at site.

33.4.4 All temporary pipes and accessories, supporting arrangement for cleaning, flushing and steam blowing of the main steam, cold reheat and hot reheat piping including HP/LP by pass piping and auxiliary steam piping.

33.5 **SCOPE OF SERVICES**

- a) The Contractor shall design the piping system and perform necessary stress analysis of all piping and dynamic analysis as necessary for the piping systems shown in Annexure-I of this chapter as a minimum.
- b) For stress analysis purpose, individual piping systems shall be considered up to the anchor points (location to be decided during detail engineering). All anchors coming within the piping are to be designed, supplied and erected by the Contractor.
- c) Stress analysis and hanger selection for all piping specified else where, including piping attachment for hangers/supports, all auxiliary supporting structures are included in the scope of the Contractor.
- d) The Contractor shall submit the design calculations for pipe sizing, thickness with specified diameters of pipes and stress analysis data to Owner/Engineer for review/ reference/records. Pressure drop calculation for main steam, cold reheat and hot reheat piping shall be submitted by the Contractor to show the adequacy of pipe sizes to meet steam parameter at turbine inlet.
- e) Preparation of detailed fabrication drawings (isometric) of shop fabricated piping which are of size 50 NB and above should be based on the "Released for Construction" drawings pertaining to power cycle piping layout prepared by the Contractor.

"As built" drawings of the power cycle piping layout shall also be prepared by the Contractor based on any layout modifications made at site over "Released for Construction Drawings".
- f) The Contractor shall design and detail all piping supports including restraints, guides, stops, snubbers, dampers etc based on the final stress analysis and hanger load data. The Contractor's design of all supports shall be submitted to the Owner/Engineer for review.
- g) The Contractor shall furnish separate sketches for each support, restraint, anchor, snubber, dampers, spring hangers etc. These sketches shall include the location with reference to column co-ordinates, identification number, bill of material, design loads, operating load, spring stiffness, amount of spring pre-compression etc and method of attachment to the pipe and steel structure.
- h) In order to ensure that all piping, supporting elements, anchors and restraints have been installed and adjusted in accordance with the drawings and other written instructions of the Contractor, the hangers associated with the main steam, hot reheat, cold reheat, HP & LP by-pass, feed water, auxiliary steam piping etc. shall be inspected as follows :
 - After hydro test, with the piping in the cold position, with all travel stops removed, with the pipe completely insulated and in all respects ready for start-up.

- Piping in the hot position, with the unit operating at maximum load.
- Piping in the hot position after 6 months of operation.
- Piping in the cold position during first complete shutdown after at least 6 months of operation.

The contractor shall depute his personnel for this purpose to site if the plant is officially handed over to the owner before such inspection after 6 months of operation.

- i) At the time of each inspection, the Contractor shall determine the necessity for revision, adjustment or replacement of pipe supporting elements, restraints and anchors. Any changes proposed shall be incorporated by the Contractor after Owner's/Engineer's concurrence.
- j) All shop tests satisfying the requirements of Indian Boiler Regulations (IBR), ANSI standards, the standards enumerated herein and/or as specified.
- k) Furnishing drawings, data, design calculations, stress analysis results.
- l) Furnishing certified copies of test results for all tests and examinations specified in the specification and for the mandatory tests and analysis required by the ASTM material specification, for the materials used for piping and the pressure parts of the valves.
- m) Obtaining approval from Chief Inspector of Boilers as per Indian Boiler Act, including the following:
 - For all pipelines coming under the purview of Indian Boiler Regulations (IBR), necessary approval of the design and layout drawings shall be obtained from the Chief Inspector of Boilers and furnished to the Owner/Engineer. Necessary certificates of design, manufacture and tests in specified Form of IBR, for each fabricated pipe with proper identification shall be submitted.
 - For fittings and specialties, viz. valves, flanges, traps and other specialties etc of all pipelines coming under the purview of IBR, Certificate of design, manufacture and tests in specified Form of IBR with appropriate identification shall be furnished to the Owner/Engineer.
 - Erection & testing of the pipe lines coming under the purview of IBR shall meet all the requirements of IBR and certificate of manufacture & tests in specified Form of IBR, for each of the erected pipe lines shall be submitted to the Owner/Engineer prior to the application of insulation and/or flushing the line before commissioning.
- n) Steam blowing or chemical cleaning of piping systems, as specified.

- o) Omission of specific reference to any item or material or work which is necessary for completion of the piping systems shall not relieve the bidder of the responsibility of furnishing all material and services for a complete installation satisfying the operational and other requirements stated in the specifications.

Drawing indicating the layout of pipe work shall be prepared in line with the flow diagrams and shall be provided as part of the Contract. These drawings shall indicate the position of all supports, guides, restraints and anchors; all drain and vent connections and the position of all pipes. All piping systems shall be arranged to allow adequate falls in the direction of flow, except where otherwise approved by the Engineer. At the points of drainage, drain pockets of ample size and approved construction shall be fitted as per details indicated in the enclosed drawings.

33.6 POWER CYCLE PIPING

33.6.1 EQUIPMENT SIZING CRITERIA

- (a) All the piping systems and equipment supplied shall be designed to operate without replacement and with normal maintenance for a plant service life of 30 years and shall withstand the operating parameters fluctuations and cycling normally expected during this period.
- (b) The design engineering erection testing etc. of the complete piping systems shall be to the requirements of power piping code ASME B 31.1. in addition to this, requirements as laid down in Indian Boiler Regulations (latest edition) shall also be met completely.

33.6.1.1 PIPE SIZING

- (a) Inside diameters of piping shall first be calculated for the flow requirement of various systems. The velocity limits for calculating the inside diameters are indicated in clause 33.2.1.
- (b) Inside diameters thus calculated for various piping systems shall be checked for the allowable pressure drop as per HBD's.
- (c) Pipes shall be sized for the worst (maximum flow temperature & pressure values) operating conditions for each system considering the maximum occasional pressure & temperature variations. In case of BFP suction sizing "transient analysis" shall be carried out for optimum sizing of the system in order to establish the pipe inside diameter for minimum pressure drop in system to match with pump NPSH requirement under worst operating conditions. The design pressure of MS piping system from superheater outlet header upto and including boiler stop valve shall not be less than the design pressure of superheater outlet header,
- (d) The design pressure for BFP discharge piping upto and including downstream valve at feed regulating station (FRS) shall be selected such that the minimum calculated thickness for various pipes at design temperature is sufficient for the following conditions, considering allowable stresses as per ASME B 31.1.

- Discharge pressure corresponding to turbine driven BFP trip speed at shut off head flow condition, if TDBFFP characteristics is governing for calculation of boiler feed discharge piping design pressure.
- Discharge pressure corresponding to motor driven BFP trip speed (frequency 51.5 Hz) at shut off head flow condition, if MDBFFP characteristics is governing for calculation of boiler feed discharge piping design pressure

However bidder may consider 20% higher stress as per the provision of ASME B 31.1 (for the piping upto downstream valve at feed regulating station only) for which the requirement of special provision as per stipulation of clause no. 520 of IBR shall be met as a must by the bidder. The valve rating in such case shall be arrived at based on design pressure calculated as per above.

- (e) The design pressure of boiler feed discharge piping at downstream of FRs shall be 105% of pressure corresponding to the emergency point of BFP operation. However pressure relief valve across the HP heaters shall be provided so that piping & valves beyond feed regulating station are not subjected to shut off head condition.

33.6.1.2 Inside diameters this calculated for various piping systems shall be checked for the allowable pressure drop. Pressure drop in the main steam line shall not be more than 90% of the allowable pressure differential between superheater outlet header and HP turbine inlet valves at BMCR. Similarly combined pressure drop in cold & reheat piping will not exceed 90% of the pressure differential between HP turbine exhaust and IP turbine inlet valves minus pressure drop in reheater. The pressure drop in the complete reheat line from HPT exhaust to IPT inlet shall not be more than 10% of the pressure at HPT. Wherever possible 5/6 dia radius bends will be used to minimize the pressure drop. Pressure drop in CRH NRV shall be considered as furnished by supplier for calculating the pressure drop in the reheat circuit.

33.6.2 MATERIAL SELECTION

Piping system shall be of carbon steel for design temperature upto 400 Deg C and alloy steel for design temperature beyond 400 Deg C.

33.6.3 PIPE WALL THICKNESS

Thickness calculation shall be made on the basis of procedure and formula given in ANSI/ ASME B 31.1. Thickness thus calculated shall be checked based on the procedure and formula given in IBR. Then, based on the higher value of the two calculations (after adding manufacturing tolerance), the next heavier commercial wall thickness shall be selected from the thickness schedules (eg Sch 40, sch 80 etc) as contained in ASME B 36.10 for OD controlled pipes and from manufacturers schedules for ID controlled pipes.

However, in such cases where the calculated thickness for OD controlled pipes falls beyond the thickness corresponding to the listed schedule nos. as given in ANSI B 36.10 for the pipe size, both ID & OD controlled pipes to manufacturers schedules are acceptable.

OD controlled pipes shall be to dimensional standards ANSI B 36.10 for carbon steel & alloy steel pipes and ANSI B 36.19 for stainless steel pipes.

To account for losses due to erosion, corrosion etc during the plant service life, an allowance of 1.6 mm/ 0.75 mm shall be considered in the minimum wall thickness calculation of pipes as per ASME B 31.1/ IBR respectively.

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

However in no case, the selected pipe thickness shall be less than Sch 80 for alloy steel & carbon steel pipes of sizes 50 NB & below. The selected thickness for SS pipes shall not be less than Sch 40S of ANSI B 36.19.

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

- a. Sch 40 pipe sizes above 50 NB but below 300 NB.
- b. Sch STD for pipe sizes 300 NB & above.

33.6.4

LAYOUT

- (a) All high points in piping system shall be provided with vents. All low points shall be provided with drains. Provision of drains on steam piping shall be as per ASME code TDP-1. Drain lines shall be adequately sized so as to clear condensate in the line and prevent water hammer and damage to turbine due to water induction. All piping shall be sloped towards the system low point such that slope is maintained in both hot and cold condition.
- (b) All drain and vent lines in piping system with design pressure 40 Kg/cm² (g) and above or with vacuum service shall be double valved.
- (c) The piping routing shall be such that clear headroom of not less than 2.5 meters above the walkways /working area is available. The contractor shall ensure correct orientation of and easy access to valves and instruments etc. and sufficient clearance for removal and maintenance of the same. The piping shall not encroach on withdrawal space of various equipment and walking space.
- (d) Wherever there is possibility of ingress of rain water through floor /ceiling opening at points where any pipe passes through floor /ceiling suitable weather protection hood shall be provided.

33.6.5

STRESS ANALYSIS

- (a) Flexibility and stress analysis for various piping system shall be carried out by the contractor as per the requirement of ASME B31.1 analysis results shall satisfy the following.
 - (1.) Calculating stresses in the piping shall be within the allowable limits stipulated in ASME B 31.1 as well as in IBR for piping under the purview of IBR.
 - (2.) Calculated forces and moments on equipment nozzles/TP are not more than the allowable loading provided by respective equipment manufacturer(s) / contractors. Flexibility analysis also calculates the deflections in all directions (translational and rotational) to enable design and selection of hanger/support system.
- (b) Cold pulling is not permitted. The contractor shall so design the piping system that there will be no requirement of cold pulls for meeting allowable reaction/stress values.

33.6.6

HANGERS AND SUPPORTS

All hangers and supports shall be erected such that they are vertical when piping is in hot condition (rated parameters). However in piping system connected to the rotating equipment nozzles, it may be required to design and erect the hangers/supports in the piping near the equipment nozzle as per the requirements/ recommendations, if any of rotating equipment manufacture(s).

All the hangers/supports shall be of reputed make, approved/tested quality and shall have proven performance record for similar application. They shall be designed to provide the required supporting efforts and allow pipeline movement with thermal changes without causing overstress. The design shall also prevent complete release of the piping load in the event of spring failure or misalignment and all parts of supporting equipment shall be fabricated and assembled so that they will not be disengaged due to movement of the supported piping. Necessary guides, anchors, braces and structural steel to be attached to building/boiler structure as well as any braces and/or dampeners required to eliminate piping vibration and seismic loading shall be provided.

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

- (a) Criteria of loading.
- (b) Design loads for anchors, restraints, hanger supporting structures.
- (c) Supports shall be adequate for extra loading due to hydrostatic tests and when piping system is full of water during chemical cleaning.
- (d) Supports for relief valve stacks shall be adequate for both the pipe weight and the thrust developed when the valve is open.

Besides vibration elimination, hangers shall ensure that the amplitude of oscillations in the pipe work owing to shock and vibration due to variation of fluid flow from zero to full capacity remains within approved limits.

33.6.7

THERMAL INSULATION

- (a) Thermal insulation shall be provided mainly for the following reasons.
 - (1) Conservation of heat and maintenance of temperature as per design cycle.
 - (2) Personal protection/
- (b) Design for personal protection

For the piping and the equipment with surface operating temperature of 60 °C and above the personal protection insulated shall be applied such that the temperature of protective cladding shall be below 60 °C
- (c) The contractor shall prepare an insulation thickness schedule covering both the cases of heat conservation and personnel protection based on the following design data.

Design ambient temperature	40°C for inside and 45°C for outside the main plant building.
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Maximum cladding temperature	60°C
Wind speed	0.5m/sec. for inside and 0.25m/sec. outside the main plant building.
Emissivity of cladding	0.2
Pipe/equipment wall temp.	maximum operating temperature.
Thickness calculation	as per ASTM C-680 or equivalent

33.6.8

FLASH TANKS

- (a) The flash tanks shall be adequately sized to take care of the total drains in the complete power cycle piping system. There shall be sufficient margin to accommodate the possible variation in drains quantities as well as flash steam. Flash tanks shall be designed as per the requirement of ASME boiler and Pressure vessels (B&PV) codes, & ANSI standard. The contractor shall selection for employer's review.
- (b) However the minimum design pressure and temperature for the flash tanks shall be 3.5 Kg/cm² (g) and 210°C respectively. Flash tanks shall also be designed for full vacuum condition.
- (c) Corrosion allowance of 3.0 mm shall be added to the design thickness of the shell and head of the vessels. The minimum thickness of the vessels including corrosion allowance shall not be less than 8 mm.
- (d) The flash tanks and manifolds shall be designed to take care of the impact forces due to incoming drains.
- (e) In case the spray is in manifold, the material for the flash tank manifold shall conform to ASTM A335 Gr. P22 or better and its thickness shall not be less than SCH 100 of ANSI B36.10 irrespective of temperature of the fluid handled
- (f) The temperature in the flash tanks shall be maintained by using condensate /feed water spray, as the case may be and in whichever case applicable. The spray shall be automatically controlled. However for flash tanks open to atmosphere continuous spray through an orifice shall also be acceptable.

33.6.9

SPECIFIC REQUIREMENTS – PIPES & FITTING

Manufacturing tolerances on pipe diameter (both ID & OD controlled pipes) and thickness shall be as per ASTM-A530/ A999M, as applicable.

Bend thinning allowance shall be provided for all bends as per the recommendations of ASME B 31.1. The finished bends wall thickness at any point of the bend shall not be less than the calculated minimum straight wall pipe thickness.

Steel pipes & fittings shall in general be provided with butt welding ends as per ANSI B 16.25. Pipe fittings of size 50 NB & below shall be socket welded as per ANSI B 16.11. However in certain cases the preparations of welding end for the pipe may be required to be done to match equipment terminals, valves etc.

All stubs welded to the pipe including welded thermo wells and instrument source shall be installed on the pipe prior to stress relieving.

Instrument tubing up to and including the root valves and all drains & vents shall be generally of the same pipe material as that of the main pipe which they are located unless & until specified otherwise elsewhere.

Wherever ASTM A 106 Gr B/ Gr C or A – 105 material are used the maximum carbon content shall be limited to 0.3% (max)

Wherever mitered bends are used the thickness of pipe from which they are fabricated shall conform to the requirements of regulations 361 (C) of IBR. The angle between axes of adjoining pipe sections shall not exceed 22.5 Deg C.

Non destructive examinations for butt weld of NPS over 50 mm and for welded branch connections of branch size over 100 mm NPS shall be specified elsewhere. For smaller sizes the mandatory minimum requirements shall be as per Table 136.4 of ANSI B 31.1 for non IBR piping as per regulation 360 of IBR or table 136.4 of ANSI B 31.1, whichever is more stringent, for piping under the purview of IBR.

33.6.10

SPECIFIC REQUIREMENTS – VALVES & SPECIALTIES

For all globe and check valves, the direction of flow shall be clearly stamped on the body of the valve.

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

Where globe valves have been specified for regulation purpose, the disc shall be tapered plug type and suitable for controlling throughout its lift.

All gate and globe valves shall have bonnet back seating arrangement.

Check valves shall have full floating and accurately guided discs.

All gate, globe & check valves shall be designed for reconditioning seating surfaces and replacement of stem and disc without removing the valve body from the line.

Hand wheels for all the valves shall close the valve in clockwise direction when viewing from the top. All hand wheels shall be clearly marked indicating the direction of opening/ closing.

Manual gear operators shall be provided to open/ close the valve against the maximum differential pressure across the valve such that the effort required to operate the valve does not exceed 25 Kgf.

Valves 65 NB & above with rising stem shall be provided with position indicator/ visual indication either through plastic stem covers or through metallic stem covers. All gate and globe valves of size 50 NB and below in vacuum service shall have extra deep gland packing without requiring water gland sealing. All gate & globe valves of size 65 NB & above in vacuum services shall have adequately deep gland packing and shall be equipped with lantern rings to admit pressurized water for gland sealing.

Where floors and extension spindle arrangement is required for valves, the height of floor stand shall be about one meter from the floor/ platform. The floor stand shall be sturdy condition with column, nut plate and hand wheel made of cast iron conforming to ASTM-A-126 Grade B. Suitable thrust bearing shall be provided/ between the hand wheel and floor stand. The connection of the extension spindle to the valve stem shall be through a flexible coupling and shall be designed to permit valve thermal movements. Necessary nuts, bolts etc. For mounting the floor stand platform shall be provided.

33.6.11

INTEGRAL BYPASS VALVES

The requirement of integral bypass valves shown in flow diagrams is the minimum required. The final requirement shall be worked out as per the process requirement during detailed engineering.

If integral bypass valve selected is of size 50 NB & below, then the gate or globe type of forged construction with socket weld end as per ANSI B 16.11 shall be provided. For integral bypass valves of size 65 mm and above only cast steel gate valves with butt weld ends as per ANSI B 16.25 shall be provided.

Bypass pipe shall be of seamless construction and thickness corresponding to minimum of schedule 80 and shall be of same material class as the main pipe.

Integral bypass shall be motor operated if main valve is motor operated.

33.6.12 **SPECIFIC REQUIREMENTS: FABRICATION**

- 33.6.12.1 Piping system fabrication shall be in accordance with the requirement of ANSI B 31.1 however for system under purview of IBR, the requirements of IBR, shall also be complied with. All dissimilar material piping connection shall be subjected to the acceptance and approval of the employer. Complete document shall be submitted by the contractor in addition to the fulfillment of IBR requirement.
- 33.6.12.2 Where welded pipes and fittings are used the longitudinal weld seams of adjoining sections shall be staggered by 90 deg.
- 33.6.12.3 Access holes for radiography at shop for piping requiring 100 % radiography shall be provided only if the area to be radio graphed is not accessible from pipe ends. Access holes for field radiography shall be provided.
- 33.6.12.4 Except where otherwise specified, all piping shall have butt-welded connections with a minimum of flanged joints, if necessary. All high pressure steam valves and accessories shall have welded connections. Where flanges are adjacent to welded fittings, weld neck flanges shall be used.
- 33.6.12.5 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.
- 33.6.12.6 Unless otherwise specified, for all welded lines with pressure above 7 kg/ cm²(g) and/or temperature above 2000C, branch connections for branch sizes upto 25% of welded mains shall be made with special forged steel welded fittings.

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

All workmanship shall be carried out using methods and procedures of best recognised pipe fabrication practice and must be done in a good and workman like manner in accordance with ANSI standards, ASME Codes, PFI standards and IBR as applicable.

All high-pressure steam valves and accessories shall have welded connections.

Mitred bends and elbows will not be accepted unless otherwise specified. Only forged tees, 90° elbows and 45° elbows are acceptable. In case the Bidder wants to deviate from this requirement on the ground of non-availability of such forged items, he may submit his alternative offer for Owner's consideration with sufficient documents to justify the same. In such a case, the concerned fittings shall be manufactured with necessary reinforcing pads, bend thinning allowance etc to satisfy code requirements.

All pipes bends shall be made true to angle with no negative tolerance and shall have a smooth surface free of flat spots, crease and corrugations.

A cross section through any bend portion of the pipe shall be true in diameter. All pipe bends shall have a radius of not less than 3 times the nominal pipe size unless otherwise mentioned. Pipe bends shall be made from straight pipe pieces of sufficiently higher thickness so that after thinning, the minimum thickness of bends shall not be less than the minimum thickness required for the straight pipe. Thinning allowance shall be considered as per ANSI B 31.1. The ends of pipe and welded fittings shall be bevelled according to details shown in the relevant piping codes.

For bends in pipes, straight piece of pipes shall be bent to required bend radius. However, forged bends (Bend radius = $1.5 \times$ pipe diameter) wherever required shall be provided at no extra cost.

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.

Pipes of size 50 NB and above shall be shop fabricated and of size 40 NB and below shall be field run.

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

Pipe and attachments shall be properly aligned prior to welding. If tack welds are used, the tacks shall be either fused into the first layer of weld or else chipped out.

All welding for steam and feed pipe work shall be electrical welding using the shielded arc process and electrodes in accordance with the relevant code.

For pipes up to and including 100 NB, provided the pipe does not exceed 12.7 mm in thickness, gas welded butt joints will be accepted without backing rings.

Welded joints in pipe work shall be pre-heated to a temperature as required by the agreed standard or code or to the approval of the Engineer. The temperature shall be maintained during the welding operation and a record of metal temperature shall be obtained by means of a recording thermometer throughout the welding operation.

All welds shall be built-up by the application of multiple layers or passes. The thickness of metal applied for each layer or pass shall not exceed 3 mm. Each layer shall be cleaned and lightly peeled before the next layer is applied. Before being assigned to welding work, each operator shall have passed a qualification test as prescribed in the applicable Code/ Regulations. Each approved welder shall have an identification number which shall be indicated on all welds.

Welded joints shall be stress relieved as per ANSI B31.1/IBR. Stress relieving temperature shall be measured by thermocouple pyrometers or other suitable equipment. Readings of temperature against time shall be recorded.

33.6.13

BENDS AND ELBOWS

- (a) Elbows shall be generally of long radius type.
- (b) Bends for piping 65mm NB and above shall be made hot and for piping 50mm NB and smaller may be made cold.
- (c) Bends shall be made in accordance with PFI-ES-24. Bends shall be supplied with the minimum tangents except where the piping layout necessitates shorter lengths in which case the tangents shall be suitably reduced after the bending operation to suit the requirements of the piping layout.
- (d) Heat treatment of bends shall be done as per material specification.
- (e) Where examinations of bends indicates that wall thinning has resulted in thickness less than the minimum specified, repair by weld deposition shall be allowed only where the length of the affected area is 150mm or less as measured along the outside arc of the bend. Repairs in excess of this amount shall not be allowed. All repairs shall be carried out only after approval of the employer.
- (f) Circumferential butt weld shall not be used in the area of the bend. Longitudinal welds, where bends are formed from welded pipe shall be located on the bend's neutral axis.
- (g) Bend thinning allowance on straight pipe prior to bending shall be applied as per ANSI B 31.1. For bends of 5D or higher radius, the difference between maximum and minimum diameters shall not exceed 8 percent of average measured outside diameter of the pipe before bending.
- (h) All bends in 50 NB and larger piping shall be made hot. Bends in 40 NB and smaller piping may be made cold only when commercially available bending

shoes are used. Finished bends shall be smooth in contour and free from buckles and distortion.

- (i) Pipe bends may be fabricated by the incremental induction heating process. Circumferential butt welds or longitudinal welds (where seamless piping has been specified) shall not be used in the arc of the pipe bends, without Engineer's permission. After bending, such welds, where permitted, shall be re-examined and re-inspected.
- (j) All piping bends are subject to heat treatment as required by the original material specification unless otherwise approved by the Engineer.
- (k) All pipe bends in 50 NB and larger piping shall be examined ultrasonically after fabrication for wall thickness conformance. Measurements shall be taken in accordance with PFI Standard ES-20 using the "Pulse Echo" method. Data reports containing information as recommended in PFI Standard ES-20 shall be forwarded to the Engineer for record purposes.
- (l) Where examination of pipe bends indicates that wall thinning has resulted in less than code required minimum wall thickness repair by weld deposit shall be allowed only where the affected area is 150 mm or less as measured along the outside arc and with Engineer's approval. Repairs in excess of this amount shall not be permitted.

33.6.14 **End Preparation, Cutting etc.**

- (a) For steel pipes, end preparation for butt-welding shall be done by machining/flame cutting.
- (b) Socket weld end preparation shall be saw/machine cut
- (c) For tees, laterals and other irregularities details, cutting template shall be used for accurate cutting and cutting shall follow the outline of the template.

Alignment Considerations

- The pipes joined by welding shall be aligned correctly within the existing tolerances on diameter, wall thickness and out of roundness, which shall be preserved during welding.
- All flange facings shall be true and perpendicular to the axis of the pipe with boltholes being off centre.

33.6.14.1 Branch connections shall conform to the requirements of ASME B 31.1. All branch connection welds shall be full penetration welds, except as permitted by ASME B 31.1/IBR. The branch connections shall generally conform to the following :

- Socket welding and threaded connections on pipelines shall be made by forged outlet fittings. The holes in pipe headers made for these connections shall be drilled to the same size as the fitting inside diameter. All burrs shall be removed and threaded fitting shall be repeated after welding.

- For branch connection, additional reinforcements shall be provided wherever necessary by the applicable codes including supply of necessary material by the contractor at his own cost.
- The design and fabrication details for the instrument stub connection are included in Tenderer's scope. Materials for instrument connection shall be the same as that of the pipe to which it is attached. Fittings ratings shall be in accordance with those specified for the main process pipe.

33.6.14.2 All materials that are bent, forged or informed shall be subjected to heat treatment after the forming operations as required by the original material specification. For ally steel materials the preferred heat treatment process is full annealing.

33.6.15 SPECIFIC REQUIREMENTS: WELDING

In addition to the requirements spelt out elsewhere, the followings shall be taken into consideration:

33.6.15.1 Welding Process

- (a) Welding under this specification shall be done by one of the following processes :
 - (i) Manual oxy-acetylene welding process
 - (ii) Manual shielded metal arc process (SMAW)
 - (iii) Manual inert gas tungsten arc process (TIG)
- (b) Automatic or semi-automatic welding shall be done only with the specific approval of the Owner/Consultant.
- (c) Socket weld joint shall be done with low hydrogen type covered electrodes with manual shielded metal arc process.
- (d) Welding at any joint should be completed uninterrupted. If this procedure cannot be followed for some reason, the weld shall be insulated for slow and uniform cooling.
- (e) As far as possible welding shall be carried out in flat position. If not possible, welding shall be done in a position as close to flat position as possible.
- (f) As a rule no backing ring shall be used for circumferential butt welds.

33.6.15.2 Alignment and Spacing

- (a) Components to be welded shall be aligned and spaced. Root opening shall be as under :

- (i) For wall thickness 2.5 mm or under and for all thickness in oxy-acetylene welding 1.0 mm - 2.0 mm
- (ii) For wall thickness over 2.4 mm 2.0 mm - 3.0 mm

Special care shall be taken for fitting and alignment in case of inert gas tungsten arc welding. Flame heating for adjustment of ends is not permitted without the approval of the Owner/Consultant.

- (b) A wire spacer of proper diameter may be used for the weld root opening but must be removed after tack welding and before application in root pass.
- (c) Tack welding for the alignment of pipe joints shall be executed carefully and shall be free from defects since tack welds form a part of final welding. Defective welds shall be removed prior to the welding of joints. Electrode size for tack welding shall be selected depending upon the root opening.
- (d) Tacks should be equally spaced as follows:
 - (i) For 65 NB pipe and smaller 2 tacks
 - (ii) For 80 NB to 300 NB pipe 4 tacks
 - (iii) For 350 NB and larger pipes 6 tacks

33.6.15.3 Welding Technique

- (a) Root pass shall be made with respective electrodes/filler wires. The size of the electrodes shall not be greater than 3.25 mm (10 SWG). Welding shall be done with direct current values recommended by the electrode manufacturers.
- (b) Upward technique shall be adopted for welding pipes in horizontally fixed position. For pipes with wall thickness less than 3 mm, oxy-acetylene welding is recommended.

33.6.17 **CLEANING AND PROTECTION**

- (a) All fabricated piping shall be cleaned as per relevant SSPC cleaning technique/practice such that both inside and outside surface of the piping are free of sand, loosely adhering scale, dirt and other foreign matters.
- (b) After cleaning outside surface shall be coated with enamel or other protective paint, the weld end preparation shall be coated with deoxyaluminate paint and protected adequately. Use of grease or oil. Other than light grade mineral oil is not allowed.

- (c) After desiccating and preservation, the fabricated sections shall be covered, boxed, capped, or others shielded from further contamination or corrosion.

33.6.18 MARKING

- 33.6.18.1 All piping shall be marked clearly and legibly at the shop with its identifying pipeline description and piece no. as per the appropriate component or spool piece fabrication drawing.
- 33.6.18.2 Marking shall be by any method which does not produce sharp discontinuities and the marking does not get erased until the piping is erected. Piping 6 mm and thicker may be marked by stamping using round nose or dot interrupted die stamps with minimum nose radius of 0.8mm.
- 33.6.18.3 Item too small to be marked shall have metal tags securely attached to each bundle or container of such items such that it does not get erased until the item has been erected.

33. 6.19 SPECIFIC REQUIREMENTS- ERECTION

- 33.6.19.1 Where control valves, flow nozzles, orifices and other piping appurtenances are to be installed, they shall be installed only after steam blowing and chemical cleaning operation. After the completion of the steam blowing / chemical cleaning the contractor shall cut spool pieces of required length and install the components.
- 33.6.19.2 Field run piping shall be erected only after completion of the erection of all other piping system structures and equipment unless otherwise approved/directed by the employer.
- 33.6.19.3 when C clamps are tack welded to the pipe for the purpose for the alignments of a joint, preheating for the lack welding shall be performed if the main joint adjacent to it to be preheated as per the requirement of this specification, otherwise preheating for the tack weld may be omitted after the joint is completed, all tack weld shall be removes, flushed with the adjacent of pipe by chipping and /or grinding. The areas where C clamps were attached shall be subjects to stress reliving as required.
- 33.6.19.4 The hydrostatic testing of the piping system shall be done after proper installation of all permanent hangers/supports. Springs hangers shall be locked during hydrostatic test. Prior to steam blowing all hangers which had been locked for the hydrostatic testing shall be unlocked.
- 33.6.19.5 The setting and logging of all supports, restraints/limit stop, spring hangers, etc, is the responsibility of the contractor. The initial setting on all hangers and supports and clearance on restrains and limit stops shall correspond to the design cold values. The contractor shall check all readings after completion of erection of piping system and application of insulation and carry out readjustment as necessary to be in line with the design cold values. After satisfactory setting of all hangers/restraints. Hangers reading / clearance shall be logged by the contractor in proper format and a joint protocol be made.
- 33.6.19.6 The contractor shall monitor the behavior of all hangers, supports, restrains etc. during the initial stage of plant operation. When the piping system(s) have attained their rated temperature the contractor shall log, hanger reading, snubber deflection, restrains/limits stop clearances as specified elsewhere.

33.6.19.7 **All gaskets shall be asbestos free material and suitable for the service application.**

33.6.20 **SPECIFICATION FOR POWER CYCLE PIPING & FITTINGS**

S. No.	Description	Alloy Steel	Carbon Steel
A	PIPES		
	Material	X20 Cr Mo V 121 to DIN 17175 or ASTM A335 Gr P91 (For all temp above 510 deg C) ASTM A 335 Gr P22	ASTM A 106 Gr B/ ASTM 106 Gr C (A 106 Gr C for BFD design parameters, CRH design parameters & above) ASTM A 672 Gr B 60 CLASS-12/ 22
	Construction	Seamless	Seamless
B	FITTINGS		
	Material for 65 NB & Above	X20 Cr Mo V 121 to DIN 17175 or ASTM A 234 Gr WP91 (for temp above 510 Deg C) ASTM A 234 Gr WP 22	ASTM A 234 Gr WPB with A 106 gr B piping
	Material for 50 NB & Below	ASTM A 182 Gr F 91 (For all temp above 510 deg C) ASTM A 182 Gr F 22	ASTM A 105
	Construction	Seamless (forged for 50 NB & below)	Seamless (forged for 50 NB & below)
	Basic Standards	ANSI B 16.9 ANSI B 16.11 ANSI B 16.25 ANSI B 16.28	ANSI B 16.9 ANSI B 16.11 ANSI B 16.25 ANSI B 16.28
	Rating/wall/thickness	To match with that of pipe	To match with that of pipe
C	WELDING		
	Backing rings	Not permitted	Not permitted
D	MATERIAL ANALYSIS		
	MANDATORY REQUIRMENTS	All tests, as given in respective material code (other than supplementary requirements). Shall be carried out as minimum. This includes the tests wherein it is specified in the respective material code that "the test is to carried out when specified by the purchaser" or any such indication, in the code.	

E. HYDROSTATIC TEST PRESSURE

(1) Piping system under IBR purview:

At shop

All piping including fabricated piping shall be hydro tested at 1.5 times the design pressure subjected to regulation 374 of IBR. However, non-destructive testing in lieu of hydro test is also acceptable subject to regulation 343 (3) of IBR

After erection

All piping system shall be hydro tested at 1.5 times the design pressure subjected to regulation 374 of IBR. However for such systems where it is practically not possible to do hydro tests. The test as called for in ANSI B 31.1 & IBR in lieu of hydro test

shall also be acceptable.

Hydro test of boiler feed piping: since isolating valve is not provided at economizer inlet, contractor to make all necessary arrangement of hydro testing of BFD piping beyond HP heater downstream heating isolating valve upto TP either by blanking or providing a temporary valve. NDT as per the provision of IBR & ASME B 31.1 can be carried out for the joint at TP between SG & TG contractor.

(2) Non- IBR piping system:-

At shop	All piping including fabricated piping shall be hydro tested at 1.5 times the design pressure subjected to regulation 374 of IBR. However, non-destructive testing in lieu of hydro test is also acceptable subject to regulation 343 (3) of IBR
After erection	All piping system shall be hydro tested at 1.5 times the design pressure subjected to regulation 374 of IBR. However for such systems where it is practically not possible to do hydro tests. The test as called for in ANSI B 31.1 & IBR in lieu of hydro test shall also be acceptable.

Note:

1. EFW pipes as per A 672 are acceptable if the design pressure and design temperature are such that it calls for ASME 300 class & below piping and size is 550NB and above. The fitting shall correspond to ASTM A 234 with grade corresponding to the pipe. Material. Welded construction fitting are also acceptable with A672 piping. However all requirements as per ASME B31.1 including the requirements given in mandatory appendix-D, IBR & respective material code shall be fully complied with, in respect of welded firings
2. In case the design temperature is above 545 deg C, then P91 material only shall be applicable for both pipes as well as fittings.

Materials for fittings, specialties and valves shall be corresponding to piping material.

33.6.21 **SPECIFICATION FOR POWER CYCLE VALVES**

33.6.21.1 General Requirements

33.6.21.1.1 All the control station configuration shall be as follows.

(a) For Continuous Service requirement:

- (i) One (1) pneumatically/hydraulically operated control valve.
- (ii) One (1) motor operated isolation valve at the upstream side of control valve.
- (iii) One (1) manual operated isolation valve at the downstream side of the control valve.

- (iv) One (1) pneumatically/hydraulically operated bypass control valve.
 - (v) One (1) motor operated isolation valve at the upstream side of the bypass control valve.
 - (vi) One (1) manual operated isolation valve at the downstream side of the bypass control valve.
 - (vii) Non return valve in the common downstream line, for spray piping.
 - (viii) Drain valves at upstream and downstream of the control valves.
- (b) For Intermittent Service requirement:
- (i) One (1) pneumatically/hydraulically operated control valve.
 - (ii) One (1) motor operated isolation valve at the upstream side of control valve.
 - (iii) One (1) manual operated isolation valve at the downstream side of the control valve.
 - (iv) One (1) motor operated inching type regulating bypass valve.
 - (v) One (1) motor operated isolation valve at the upstream side of the bypass valve.
 - (vi) One (1) manual operated isolation valve at the downstream side of the bypass valve.
 - (vii) Non return valve in the common downstream line, for spray piping.
 - (viii) Drain valves at upstream and downstream of the control valves.

All valves shall have cast/forged steel bodies with covers and glands of approved construction. The valves shall be provided with electric motors/solenoids and actuators as required.

Locating the valves on vertical runs shall be avoided as far as possible

All valves shall, unless otherwise approved, have ends prepared for butt-welding and the internal diameter shall be the same as the internal diameter of the pipes to be joined.

All valves shall receive tests at Manufacturer's or Contractor's works in accordance with the specific requirements of the approved Codes of Practice so that the same is acceptable to IBR where applicable. Valves shall be rising stem or otherwise as approved by the Owner.

All valves shall function smoothly without sticking, rubbing or vibration on opening or closing.

Material, design, manufacture, testing etc. for all valves and specialties along with the accessories shall conform to the codes as specified or approved equivalent and acceptable to IBR.

By-pass valves shall be provided for high pressure and larger size valves (including control valves) as per standards followed and as felt necessary for smooth and easy operation, even though not specifically mentioned in the specification.

Valves subjected to vacuum shall have sufficient long deep-seated packing. Valves in general shall preferably be of such design as to permit repacking while in service by providing back seating arrangement duly tested during manufacture.

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.

Valves requiring sealing water shall be adequately deep and shall be equipped with lantern ring to admit pressurised water for gland-sealing. Gland sealing water shall be tapped from one tapping point on the condensate extraction pumps discharge header and shall be reduced in pressure as per the requirement.

The stops which limit the travel of any valve in the "Open" or "Shut" position shall be arranged exterior to the valve body.

All regulating valves shall be designed to prevent erosion of the valve plugs and seats when the valves are operated partially opened. The valves shall have contoured plug.

Approved access arrangements shall be provided for all valves and particular attention shall be given to those valves fitted with gearing, which require lubrication of the valve itself.

Valves which cannot be operated from the floor or walkways shall be provided with suitable extension rods and linkages. If such a valve is provided with integral bypass then similar arrangement shall be done for the bypass valve also. The extension shall be such that the hand wheel is at a height of approximately one metre above the level of the floor or platform from which the valve is to be operated. Where required, valves shall be provided with head-stocks and pedestals of rigid construction and where gears or level wheels are used, these shall be of cast steel or suitable quality cast iron with

machine cut teeth. Where extension spindles are fitted, all thrust when opening or closing the valves shall be taken directly on the valve body. The extension linkage shall be so designed to take care of the thermal movements of the valve body with the pipe on which the valve is installed. The connection of the extension spindle to the valve stem shall be through a flexible coupling.

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

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.

Where necessary, for accessibility, grease nipples shall be fitted at the end of extension piping and where possible these shall be grouped together and mounted on a common panel situated at a convenient position. A separate nipple shall be provided to lubricate each point. The Contractor shall supply the first fill of oil or grease for these parts. The Contractor shall supply a suitable manually operated grease gun for the standard type of nipple provided.

The spindles for all valves for use outside the building shall have weatherproof protection covers of approved construction.

All valves shall be fitted with indicators so that it may be readily seen whether the valves are open or shut. In the case of those valves fitted with extended spindles, indicators shall be fitted both to the extended spindles and to the valve spindles.

Plastic or bakelite valve hand wheels are not permitted.

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.

Each valve hand wheel shall be fitted with a circular nameplate of approved material indicating the valve tag number, duty or service intended and the function of the valve. The nameplates shall incorporate the colour code corresponding to the service of the piping.

Wherever practicable, heavy valves of total weight including actuator, drive motor, integral by-pass etc equal to or greater than 500 kg shall be provided with suitable lugs to permit direct suspension by hanger rods or direct resting on bottom support, as applicable.

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.

Eyebolts shall be provided where necessary to facilitate handling heavy valves or parts of valves.

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

Gate valves below 100 NB shall be solid wedge/Flexible wedge type. Valves of 150/300 and size 100 NB and above shall be flexible wedge type. However, for sizes 100 NB and above for temperature 300oC above, parallel slide gate valves shall be used.

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

For butterfly valves, Contractor shall guarantee that in the closed position and with a disc differential pressure as specified, the valves shall be water tight.

Contractor shall guarantee that the operating mechanism shall open and close the valve under the specified maximum differential pressure within the time specified.

A. CAST STEEL VALVES (GATE/ GLOBE/ CHECK 65 NB & Above)

S. No.	Description	Alloy Steel		Carbon Steel		Stainless Steel
		600 lbs & below	600 lbs & above	600 lbs & below	600 lbs & above	400 lbs & below
1.0	Basic Standard	ANSI B 16.34				
2.0	Construction					
a	Bonnet/ cover	Bolted Type	Pressure Type	Bolted Type	Pressure Type	Bolted Type
b	Disc					
	Globe Valves	Throttling Type Plug				
	Check Valves	Twilting/ swing type				
	Gate Valves	Solid/ flexible wedge below 100 NB				
		Flexible Wedge for 100 NB & above				
c	Seat	Integral Type				
3.0	Material					
a	Body, Bonnet & Cover	ASTM 216 Gr WCB	ASTM 216 Gr WCC	ASTM A 217 WC9 ASTM A 217 Gr C 12A		ASTM A 351 CF 8
b	Stem	13% Chrome Steel ASTM A 182 Gr F6A				ASTM 182 F316/ F 304
c	Hinge Pin (for check valves)	13% Chrome Steel ASTM A 182 Gr F6A				ASTM 182 F316/ F 304
d	Disc & Seat ring (heat treated & hardened)	ASTM A 216 Gr WCB minimum	ASTM A 216 Gr WCC	ASTM A 217 Gr WC9 ASTM A 217 Gr C12A		ASTM 182 F316/ F 304
		Hardness 250 BHN	Seating surface hard faced with satellite 350 BHN			
e	Back seat/ stem guide bushing	ASTM A 182 gr F6a 13% Cr SS with stellite hard facing				ASTM 182 F316/ F 304

B. FORGED STEEL VALVES (GATE/ GLOBE/ CHECK 50 NB & Below)

S. No.	Description	Carbon Steel	Alloy Steel	Stainless Steel
1.0	Basic Standard	ANSI B 16.34		
2.0	Construction			
a	Bonnet/ cover	Bolted Type for 600/ 800 lbs Seal welded for 900 lbs & above		Seal Welded/ Bolted Type for 600/ 800 lbs Seal welded for above 800 lbs
b	Disc			
	Gate Valves	Solid Wedge Type		
	Globe Valves	As per mfg std		
	Check Valves	Piston Lift		
c	Seat	Integral Type		
3.0	Material			
a	Body, Bonnet & Cover	ASTM A 105	ASTM A 182 Gr F22 ASTM A 182 Gr F91	ASTM 182 F316/ 304
b	Stem	13% Chrome Steel ASTM A 182 Gr F6A		ASTM 182 F316/ F 304
c	Hinge Pin (for check valves)	13% Chrome Steel ASTM A 182 Gr F6A		ASTM 182 F316/ F 304
d	Disc & Seat ring	ASTM A 105 with stellite minimum Hardness 350 BHN	ASTM A 182 Gr F22/ F 91 hard faced with satellite minimum hardness 350 BHN	ASTM 182 F316/ F 304 hard faced with satellite minimum hardness 350 BHN

C. ANGLE GLOBE VALVE

S. No.	Description	Alloy Steel	Carbon Steel
1.0	Design Standard	ASME B 16.34	
2.0	Material		
a	Body & Bonnet	A 182 Gr F22/ F 91 or better	A 105 or better
b	Spindle/ disc	Stellited	
c	Body Seat & Back Seat	Stellited	
d.	Gland Packing	Graphite	
3.0	Construction		
a	Valve Type	Outside Screw & yoke Type	
b	Body & Bonnet	Forged body with integral/ welded bonnet connection	
c	Disc type	Taper plug or parabolic type to suit system requirement	
d	End connection	Socket weld (ANSI B 16.11) for sizes 50 Nb & below Butt weld (ANSI B 16.25) for sizes 65 NB & above	
e	Pressure rating	To suit the service condition. However minimum pressure rating shall be corresponding to ANSI Class 1500	

D OTHER VALVES (65 Nb & Above)

S. No	Description	Safety Valve		Relief Valve	BF Valve
		Alloy Steel	Carbon Steel		
1.0	Design Standard	ASME B 16.34			AWWA C 504
2.0	Pressure Class	400 lbs & below			75 B & above
3.0	Accumulation	10% (max)			
4.0	Blowdown	5% (max)		10% to 15%	
5.0	Construction				
a	General	Spring loaded with weld end inlet, pop up type		Spring loaded with flanged inlet & outlet	Long body butt welded
b	Bonnet	Bolted type			
c	Seat bushing	Renewable type screwed on and held in position type			
d	Shaft seat				O ring type
6.0	Material				
a	Body & Bonnet cover	ASTM A 217 WC 9/ C 12A	ASTM A 216 Gr WCB/ WCC		ASTM A 216 Gr WCB
b	Spindle/ Shaft	Stainless Steel			ASTM A 182 Gr 304
c	Disc, nozzle, seat ring	ASTM A 182 F 316			ASTM A 216 Gr WCB Seal & O Ring : EOT/ BUNA – N/ Neoprene for water service EOPT/ EPDM for steam service
d	Spindle Guide	17% Chrome steel or monel, heat treated and hardened to minimum hardness 250 BHN			
e	Spring	Stainless Steel or Tungsten Steel	Carbon Steel		
f	Retainer Rings and Internal Bolts				SS 304
g	Bearing				Sleeve type self lubricated

Note the material of body, bonnet/ cover & disc shall be corresponding to that of pipe material on which valve is installed.

33.6.22 SPECIFIC REQUIREMENTS

1. Valve of size 65 NB and above shall have butt welded ends as per ANSI B16.25 and valves 50 NB and below shall have socket weld ends as per ANSI B16.11
2. Locking arrangement, wherever specified shall be of non-detachable type.
3. Valve shall be tested in accordance to ANSI B 16.34, however, for butterfly valves; the requirements of AWWA C-504 shall also be met.

4. All gates and globe valves shall be without side screw and yoke with rising stem.
5. Gate valve below 100 NB shall be solid wedge/flexible wedge type, valve of size 100 NB and above shall be of flexible wedge type. However, for sized 100mm NB and above for temperature above 300 °C, parallel slide valves are also acceptable.
6. Specification for valve shall be as indicated in C&I subsection.
7. Stem for all valves shall be heat treated and hardened- minimum, hardness 200HB and surface finish of 16 RMS or better in area of stem packing.
8. Gland packing for gate and globe valves shall be alloy steel/SS wire reinforced graphite with stem corrosion inhibitor.
9. All bolts and nuts shall be ASTM A-193 Gr. B 7 and ASTM A-194 Gr. 2H respectively.
10. Hand wheel for valves shall be of malleable iron / carbon steel.
11. Minimum differential hardness between seat and other disc material shall be 50 HB in case of 13 % chrome hardened with heat treatment of steel.
12. Valves closure test shall be as per supplied complete with discharge elbow and drip pan along with drain.
13. For valve of size 65 NB and above in vacuum service, water gland-sealing arrangement shall be provided. For valve of size 50 NB and below, deep gland packing shall be provided. Butterfly valves, subjected to vacuum, shall be tested for vacuum as per relevant code.

33.6.23

SPECIFICATION FOR HANGERS/SUPPORTS

Design and manufacture of hangers/supports shall conform to ANSI B 31.1 MSS-SP-58, MSS-SP-89

Where hangers rod angularity exceed 4 degree from cold to hot position (at rated parameters), the hanger and structural attachments shall be offset in the cold position in such a manner that the hanger rod is vertical in hot position unless otherwise specified.

The contractor shall furnish, detailed arrangement sketches for each support, restrains, anchor, etc. the sketches shall include the key plan identification no. bill of quantities, design load , operating load, spring stiffness, amount of precompression, centre line elevation of pipe, spring box position/orientation, etc.

Hangers support tag no. shall be marked on all pipe hangers/support, restraints and anchor assemblies, the design loads, hot and /or cold loads shall be stamped on respective constant and variable springs.

33.6.24

TECHNICAL REQUIRMENTS

- (a) Each threaded connection and adjustable rod shall be provided with lock nuts.
- (b) Each rod of a double rod hanger support shall be designed for the full hydro test load coming on the double rod hanger assembly.