



TITLE:
4 X 270 MW BHADRADRI TPS

SPECIFICATION NO. PE-TS-411-164-A001

**TECHNICAL SPECIFICATION FOR
EFFLUENT TREATMENT PLANT**

REV. NO. 00

DATE : 24/07/2017

20.5	Hand railing	To be provided by bidder
21.0	ETP CLARIFIER I & II SLUDGE SUMP	
21.1	ETP CLARIFIER I SLUDGE SUMP	
21.1.1	Number	One (1)
21.1.2	Compartment	Two
21.1.3	Service	To collect the sludge generated from Clarifier I & II
21.1.4	Capacity	Each compartment to store four hour sludge generated from Clarifier I & II simultaneously.
21.1.5	Material of construction	RCC
21.1.6	Hand railing	To be provided by bidder
21.2	ETP CLARIFIER II SLUDGE SUMP	
21.2.1	Number	One (1)
21.2.2	Compartment	Two
21.2.3	Service	To collect the sludge generated from Clarifier I & II
21.2.4	Capacity	Each compartment to store four hour sludge generated from Clarifier I & II simultaneously.
21.2.5	Material of construction	RCC
21.2.6	Hand railing	To be provided by bidder
22.0	FeCl₃ DOSING SYSTEM (@ 70 ppm) FOR CLARIFIER I	
22.1	Measuring Tank	Number-One Number Capacity (effective) - 24 Hrs storage capacity of 10% FeCl ₃ solution +20% margin excluding freeboard to dose FeCl ₃ to Clarifier I . Type – vertical cylindrical. Material- (4.5 MM Thick RL), IS 2062, Gr. B. Motorized Stirrer (Shaft, Impeller Material of Agitator- SS 316 L / MS with FRP lining) - One (1) number (Top/Side mounted). Dissolving Basket-One no. (MOC: SS 316)
22.2	Pump	Number-Two (2) numbers (1W+1S). Type – Simplex hydraulically operated Diaphragm type. Capacity and Head- As per system requirement. MOC: Liquid end (pump head valve, valve housing, etc.), valve spring- PP / FRP/ CPVC/Rubber lined steel and Diaphragm-TEFLON. Pumps shall be provided with accessories such as Y-type suction strainers, pressure dampeners, Pressure Gauge, safety relief valves along with recirculation to tank etc
22.3	FeCl₃ STORAGE TANK	
22.3.1	Number	One
22.3.2	MOC	MS (8 mm thick with 4.5 mm inside RL).
22.3.3	Capacity	15 Days Storage capacity
22.3.4	Type	Horizontal cylindrical as per BS 12285
22.3.5	Location	Outdoor
22.4	FeCl₃ UNLOADING PUMPS	
22.4.1	Number	Two (2X100 %)
22.4.2	Capacity and Head	10 CuM/Hr and the head shall be as per system requirement
22.4.3	MOC of Casing & Impeller	PP
22.4.4	MOC of Shaft	EN 8
22.4.5	MOC of shaft sleeve	Ceramic
22.4.6	Type	Horizontal centrifugal
22.4.7	Location	Outdoor
22.4.8	Accessories	Pumps shall be provided with accessories such as Y-type suction strainers, Pressure Gauge



TITLE:
4 X 270 MW BHADRADRI TPS

SPECIFICATION NO. PE-TS-411-164-A001

**TECHNICAL SPECIFICATION FOR
EFFLUENT TREATMENT PLANT**

REV. NO. 00

DATE : 24/07/2017

23.0	LIME DOSING SYSTEM (@ 30 ppm) FOR CLARIFIER I	
23.1	Tank	Number-One Number Capacity (effective) - 24 Hrs storage capacity of holding lime solution (of about 6% W/V concentration) + 20% margin excluding freeboard to dose lime to CLARIFIER I . Material- RCC with 2 coats of Bitumastic paint over 2 coats of primer Motorized Stirrer (MOC-SS 316)- One (1) number (Top/Horizontal mounted). Dissolving Basket-One no. (MOC: SS 316)
23.2	Pump	Two (2X100% capacity) numbers of Screw type each suitable for lime dosing to Clarifier I at designed dosage rate (suitable for lime of 6% W/V strength) and head as required. Suction condition: Flooded. Pump casing: 2.5% Ni-Cast Iron to IS 210 FG 260 Stator: EPDM rubber Shaft and shaft sleeve: SS 410, recirculation of pumps shall be connected to tank.
24.0	POLYMER DOSING SYSTEM FOR CLARIFIER (@ 1 ppm) FOR CLARIFIER I	
24.1	Tank	Number-Two Number (1W+1S/Under Preparation) Capacity (effective) - Each tank to store 12 Hrs storage capacity of 0.5% PE solution +20% margin excluding freeboard to dose PE to CLARIFIER I . Type – vertical cylindrical. Material- MSRL (4.5 MM Thick RL), IS 2062, Gr. B. Motorized Stirrer (MOC-SS 316)- One (1) number (Top mounted)
24.2	Pump	Number-Two (2) numbers (1W+1S). Type – Simplex hydraulically operated Diaphragm type. Capacity and Head- As per requirement. MOC: Liquid end (pump head valve, valve housing, etc.), valve spring- PP / FRP/CPVC/Rubber lined steel and Diaphragm-TEFLON Pumps shall be provided with accessories such as Y-type suction strainers, pressure dampeners, Pressure Gauge, safety relief valves along with recirculation to tank etc
25.0	NaOCl DOSING SYSTEM FOR CLARIFIER I	
25.1	NaOCl PREPARATION TANK	
25.1.1	Number	One
25.1.2	MOC	MS (3 mm Thick) with 4.5 MM RL
25.1.3	Capacity	To store 24 hours solution (prepared) requirement.
25.2	NaOCl Dosing Pump	
25.2.1	Number	Two (2X100%)
25.2.2	Type	Simplex hydraulically operated Diaphragm type.
25.2.3	Displacer	Plunger/diaphragm
25.2.4	Capacity and pressure	As per system requirements
25.2.5	Capacity variation	0-100%
25.2.6	Materials of construction	SS 316
25.2.7	Accessories	Pumps shall be provided with accessories such as Y-type suction strainers, pressure dampeners, Pressure Gauge, safety relief valves along with recirculation to tank etc
26.0	ETP CLARIFIER I & II SLUDGE SUMP PUMP	
26.1	ETP CLARIFIER I SUMP PUMP	



TITLE:
4 X 270 MW BHADRADRI TPS

SPECIFICATION NO. PE-TS-411-164-A001

**TECHNICAL SPECIFICATION FOR
EFFLUENT TREATMENT PLANT**

REV. NO. 00

DATE : 24/07/2017

26.1.1	Number	Two (2X100 %)
26.1.2	Capacity	10 Cum/Hr (each)
26.1.3	Head	As per system requirement.
26.1.4	Type	Vertical Centrifugal (Non-clog type).
26.1.5	Material	
26.1.5.1	Impeller (Semi open Type)	SS 316
26.1.5.2	Discharge Elbow/Head/Casing/ Column pipe	SS 316
26.1.5.3	Shaft and Shaft Coupling	SS 316
26.1.5.4	Base plate	IS 2062 Gr. B with epoxy coating
26.2	ETP CLARIFIER II SUMP PUMP	
26.2.1	Number	Two (2X100 %)
26.2.2	Capacity	10 Cum/Hr (each)
26.2.3	Head	As per system requirement.
26.2.4	Type	Vertical Centrifugal (Non-clog type).
26.2.5	Material	
26.2.5.1	Impeller (Semi open Type)	SS 316
26.2.6.2	Discharge Elbow/Head/Casing/ Column pipe	SS 316
26.2.6.3	Shaft and Shaft Coupling	SS 316
26.2.6.4	Base plate	IS 2062 Gr. B with epoxy coating
27.0	PSF ACF FEED PUMPS	
27.1	Number	Three (2W+1S)
27.2	Capacity	30 CuM/Hr (each)
27.3	Head	As per system requirement.
27.4	Type	Horizontal Centrifugal
27.5	Material	
27.5.1	Impeller (Closed Type)	SS 316
27.5.2	Discharge Elbow/Head/Casing/ Column pipe	SS 316
27.5.3	Shaft and Shaft Coupling	SS 316
27.5.4	Base plate	IS 2062 Gr. B with epoxy coating
28.0	PRESSURE SAND FILTER (PSF)	
28.1	Number	Two (2) (1W+1S/Under Backwash)
28.2	Capacity (each)	60 CuM/Hr (Net).
28.3	Type	Vertical cylindrical
28.4	Media type	Sand/Gravel
28.5	Vessel particulars	
28.5.1	Material	Mild Steel as per IS 2062 for shell and Mild Steel as per IS 2002 for dish ends
28.5.2	Design code	IS 2825 or ASME VIII DIV I.
28.5.3	Internals	CSRL
28.5.4	Frontal pipe work	CPVC
28.6	Protection	
28.6.1	a) Internal	Rubber lining (4.5 mm)
28.6.2	b) External	Three (3) coats of epoxy finish paint over two (2) coats epoxy based primer.
28.7	Back wash interval	24 hrs.
28.8	Free board	75%
28.9	Design surface flow rate.	Design specific.
28.10	Design pressure	Shall be designed for shut off head of upstream pumps plus static head (if any) + 5% overall margin.
28.11	Media trap	Shall be provided by bidder at outlet of each filter
28.12	Under drain system	
28.12.1	Type	Strainer on plate type, designed to avoid any non-uniform flow.



TITLE:
4 X 270 MW BHADRADRI TPS

SPECIFICATION NO. PE-TS-411-164-A001

**TECHNICAL SPECIFICATION FOR
EFFLUENT TREATMENT PLANT**

REV. NO. 00

DATE : 24/07/2017

28.12.2	Material of Construction	For strainer on plate, plate MSEP and strainer PP/ PVC
28.13	Suspended solids & turbidity at the outlet	2 ppm and 2 NTU respectively
28.14	Minimum Bed Depth	1000 mm (excluding supporting bed material)
28.15	Design Surface Flow Rate at design flow	10 M3/Hr/M2
28.16	Backwash flow rate	As per system requirement
29.0	AIR BLOWER (FOR PSF)	
29.1	Number	Two (2X100%) common for all PSF.
29.2	Duty	Intermittent
29.3	Type	Positive displacement.
29.4	Capacity	As per system requirement.
29.5	Material of construction	Cast Iron.
29.6	Accessories Required for each blower	Suction Filter, Silencer, relief Valve etc
30.0	ACTIVATED CARBON FILTER (ACF)	
30.1	Number	Two (2) (1W+1S/Under Backwash)
30.2	Capacity (each)	60 CuM/Hr (Net).
30.3	Type	Vertical cylindrical
30.4	Vessel particulars	
30.4.1	Material	Mild Steel as per IS 2062 for shell and Mild Steel as per IS 2002 for dish ends
30.4.2	Design code	IS 2825
30.4.3	Internals	CSRL
30.4.4	Frontal pipe work	CPVC
30.5	Internal	Rubber lining (4.5 mm)
30.6	External	Three (3) coats of epoxy finish paint over two (2) coats epoxy based primer.
30.7	Back wash interval	24 hrs.
30.8	Free board	75%
30.9	Design pressure	Shall be designed for shut off head of upstream pumps plus static head (if any) + 5% overall margin.
30.10	Media trap	Shall be provided by bidder at outlet of each filter
30.11	Under Drain System	
30.11.1	Type	Strainer on plate, designed to avoid any non-uniform flow.
30.11.2	Material of Construction	For strainer on plate, plate MSEP and strainer PP/ PVC
30.12	Minimum Bed Depth	1000 mm (excluding supporting bed material)
30.13	Design Surface Flow Rate at design flow	Maximum 15 M3/Hr/M2
30.14	Backwash flow rate	As per system requirement
31.0	FILTERED WATER OVERHEAD TANK	
31.1	Number	One (1)
31.2	Compartment	One
31.3	Service	Storage of filtered water for one PSF backwashing + one ACF backwashing + one backwashing of basket strainer + chemical preparation for lamella clarifier / tube settler, clarifier I and Clarifier II dosing facilities simultaneously.
31.4	Capacity	To store for filtered water for one PSF backwashing + one ACF backwashing + one backwashing of basket strainer + chemical preparation for lamella clarifier / tube settler, clarifier I and Clarifier II dosing facilities simultaneously + 20% margin



TITLE:
4 X 270 MW BHADRADRI TPS

SPECIFICATION NO. PE-TS-411-164-A001

**TECHNICAL SPECIFICATION FOR
EFFLUENT TREATMENT PLANT**

REV. NO. 00

DATE : 24/07/2017

31.5	Material of construction	RCC.
32.0	PSF & ACF BACKWASH PUMP	
32.1	Number	Two (1w+1s)
32.2	Type	Horizontal Centrifugal
32.3	Capacity	As per system requirement.
32.4	Material of construction	Casing - CI as per IS 210 FG 260 with rubber lining. Impeller (Closed Type)- CF8M. Shaft- Hardened carbon steel EN-8.
32.6	Head	As per system requirement.
33.0	BASKET TYPE STRAINER (BSF)	
33.1	Number	Two (1W+1S)
33.2	Mesh size	50 Micron
33.3	Capacity (Each)	60 CuM/Hr
33.4	Material	
33.4.1	a) Casing	SS 316
33.4.2	b) Perforated sheet	SS 316
33.5	Backwashing of BSF	To be provided by bidder from PSF and ACF backwash pumps
34.0	ULTRAFILTRATION SKID	
34.1	Number of skid	Two (2X50 %)
34.2	Feed flow rate	30 Cum/Hr (Each).
34.3	Recovery	90%
34.4	Average flux	50 Liter/SqM/Hr.
34.5	Membrane area	Minimum 300 Sq.ft/Manufacturer's Standard practice.
34.6	Number of modules	As per system requirement.
34.7	Size of module	As per Manufacturer's Standard practice.
34.8	Make	As per sub vendor list
34.9	Membrane model	As per Manufacturer's Standard practice.
34.10	Membrane type	Hollow Fiber.
34.11	Membrane material	Polysulphone/PVDF.
34.12	Pore size of membrane	As per Manufacturer's Standard practice.
34.13	Guaranteed life of membrane	3 years (minimum)
34.14	Frontal pipe	CPVC
34.15	Resistance of membrane fouling	Excellent
34.16	Chlorine resistance (continuous)	5 ppm on regular basis.
34.17	pH range	2 to 10
34.18	Backwash frequency	As per system requirement.
34.19	Duration of backwash	As per system requirement.
34.20	Design Temperature	10 deg C to 40 deg C
35.0	UF PERMEATE CUM BACKWASH TANK	
35.1	Number	One (1) with two compartment.
35.2	Capacity of each compartment	One hour storage capacity + backwash water required for one UF skid + chemical preparation requirement for UF and RO system
35.3	MOC	RCC with tiling.
36.0	UF BACKWASH PUMP	
36.1	Number	Two (1W+1S)
36.2	Type	Horizontal Centrifugal
36.3	Capacity	As per system requirement.
36.4	Head	As per system requirement.
36.7	MOC	Casing-SS 316, Impeller (Closed Type)-SS 316 and shaft-SS 316.
38.0	BACKWASHED WATER SUMP (BWS) FOR PSF, ACF AND UF	
38.1	Number	One (1) with two compartment.
38.2	Capacity of each compartment	Backwash water from one PSF+ one ACF+ one UF+ one basket strainer + 20% margin



TITLE:
4 X 270 MW BHADRADRI TPS

SPECIFICATION NO. PE-TS-411-164-A001

**TECHNICAL SPECIFICATION FOR
EFFLUENT TREATMENT PLANT**

REV. NO. 00

DATE : 24/07/2017

38.3	MOC	RCC with acid /alkali resistant lining
39.0	BACKWASHED WATER TRANSFER PUMP FOR PSF, ACF AND UF	
39.1	Number	Two (1W+1S)
39.2	Type	Horizontal Centrifugal (Non-clog type)
39.3	Capacity	To evacuate within 4 hours
39.4	Head	As per system requirement.
39.5	MOC	Casing, impeller: Rubber lined cast iron IS: 210 Grade FG 260 and shaft-SS 316.
40.0	MICRON CARTRIDGE FILTER (MCF) FEED PUMP	
40.1	Number	Three (3X50 %)
40.2	Capacity (each)	27 CuM/Hr
40.3	Head	As per system requirement
40.4	Type	Horizontal Centrifugal
40.5	MOC	Impeller (Closed Type)-SS 316. Discharge Elbow/Head/Casing/Column pipe-SS 316. Shaft and Shaft Coupling-SS 316 Base plate- IS 2062 Gr. B with epoxy coating
41.0	MICRON CARTRIDGE FILTER (MCF)	
41.1	Number	Two (2X100 %)
41.2	Capacity (each)	54 CuM/Hr
41.3	MOC	Housing-Carbon Steel Rubber Lined. Cartridge-PP.
42.0	HIGH PRESSURE RO FEED PUMPS (FOR STAGE I AND STAGE II)	
42.1	Number	Three (3X50%) for RO Stage I and Three (3X50%) for RO Stage II
42.2	Capacity (each)	As per system requirement.
42.3	Head	As per system requirement.
42.4	Type	Horizontal Centrifugal
42.5	MOC	Impeller (Closed Type)-SS 316. Discharge Elbow/Head/Casing/Column pipe-SS 316. Shaft and Shaft Coupling-SS 316 Base plate- IS 2062 Gr. B with epoxy coating
43.0	REVERSE OSMOSIS (RO) SYSTEM	
43.1	Number of module	Two (2X55 %)-1 st stage Two (2X55 %)- 2 nd stage
43.2	Overall flow rate at RO outlet from both stages	50 CuM/Hr (minimum)
43.3	Type of membrane	Hollow Fiber
43.4	Make	As per sub vendor list
43.5	MOC	Membrane- Polyamide Pressure Tube- FRP Low Pressure Piping-CPVC High Pressure Piping- CPVC
43.6	Total number of membrane	As per system requirement.
43.7	RO Recovery (overall including both stages)	90% (minimum)
43.8	Salt rejection capacity (overall including both stages)	90% (minimum)
43.9	Design Temperature	10 deg C to 40 deg C
44.0	DEGASSER TOWER	
44.1	Numbers Required	One.
44.2	Type	Forced Draft Type
44.3	Normal Flow Rate per tower	55 Cum/Hr.
44.4	Fill Material	Polypropylene or equivalent
44.5	CO ₂ content in effluent	Not more that 5 ppm as CO ₂
44.6	Shell Material	MS as per Specified Code



TITLE: 4 X 270 MW BHADRADRI TPS
TECHNICAL SPECIFICATION FOR EFFLUENT TREATMENT PLANT

SPECIFICATION NO. PE-TS-411-164-A001	
REV. NO. 00	DATE : 24/07/2017

44.7	Internal Lining	Rubber, 4.5 mm thick
44.8	External Painting	Chlorinated rubber Paint
45.0	AIR BLOWER (FOR DEGASSER)	
45.1	Capacity of each Blower	As per system requirement.
45.2	Number	Two (2X100 %)
45.3	Duty	Continuous
45.4	Type	Positive displacement.
45.5	Capacity	As per system requirement.
45.6	Material of construction	Cast Iron.
45.7	Accessories Required for each blower	er, Silencer, relief Valve etc
46.0	RO PERMEATE WATER STORAGE TANK	
46.1	Numbers	One.
46.2	Capacity	55 CuM
46.3	Type	Horizontal Atmospheric Type with dished ends
46.4	Material	MS with rubber lining (4.5 mm)
46.5	External Painting	Chlorinated rubber Paint
47.0	RO PERMEATE WATER TRANSFER PUMP	
47.1	Number	Two (2X100 %)
47.2	Capacity each	55 CuM/Hr
47.3	Head	As per system requirement.
47.4	Type	Horizontal Centrifugal
47.5	MOC	Impeller (Closed Type)-SS 316 Discharge Elbow/Head/Casing/Column pipe-SS 316. Shaft and Shaft Coupling-SS 316 Base plate- IS 2062 Gr. B with epoxy coating
48.0	RO REJECT SUMP	
48.1	Number	One (1)
48.2	Compartment	Two, below ground
48.3	Service	Storage of RO Reject
48.4	Capacity	Each compartment Shall capable to store one hour total RO Reject generated + Clear water from lamella clarifier + sludge from Clarifier II.
48.5	Material of construction	RCC.
49.0	RO REJECT DISPOSAL PUMP	
49.1	Number	Two (1w+1s)
49.2	Type	Vertical Centrifugal
49.3	Capacity	To evacuate each compartment of RO reject sump within one hour
49.4	Material of construction	Casing - CI as per IS 210 FG 260 with rubber lining. Impeller (Closed Type)- CF 8M. Shaft- Hardened carbon steel EN-8.
49.4	Head	Suitable to transfer the reject to ash water sump
50.0	ACID (HCL) DOSING SYSTEM FOR RO	
50.1	ACID MEASURING TANK	
50.1.1	Number	One
50.1.2	MOC	MSRL (3 MM Thick with 4.5 MM inside RL)
50.1.3	Effective Capacity	To store 12 hours solution (prepared) requirement.
50.2	ACID DOSING PUMP	
50.2.1	Number	Two (2X100 %)
50.2.2	Capacity and Head	As per system requirement.
50.2.3	MOC of wetted parts	PP
50.2.4	Type	Positive displacement plunger type.
50.2.5	Accessories	Pumps shall be provided with accessories such as Y-type suction strainers, pressure dampeners, Pressure Gauge, safety relief valves along with



TITLE:
4 X 270 MW BHADRADRI TPS

SPECIFICATION NO. PE-TS-411-164-A001

**TECHNICAL SPECIFICATION FOR
EFFLUENT TREATMENT PLANT**

REV. NO. 00

DATE : 24/07/2017

		recirculation to tank etc
50.3	BULK ACID STORAGE TANK	
50.3.1	Number	One
50.3.2	MOC	MS (8 mm thick with 4.5 mm inside RL).
50.3.3	Effective Capacity	15 Days Storage capacity
50.3.4	Location	Outdoor
50.3.5	Type	Horizontal cylindrical as per BS 12285
50.4	BULK ACID UNLOADING PUMP	
50.4.1	Number	Two (2X100 %)
50.4.2	Capacity and Head	10 CuM/Hr and the head shall be as per system requirement.
50.4.3	MOC of wetted parts	PP
50.4.4	Type	Horizontal centrifugal.
50.4.5	Location	Outdoor
50.4.6	Accessories	Pumps shall be provided with accessories such as Y-type suction strainers, Pressure Gauge
51.0	SODIUM META BIO SULFATE (SMBS) DOSING SYSTEM FOR RO	
51.1	SMBS MEASURING TANK	
51.1.1	Number	One
51.1.2	MOC	MS (3 mm Thick) with 4.5 MM RL
51.1.3	Effective Capacity	To store 12 hours solution (prepared) requirement.
51.2	SMBS DOSING PUMP	
51.2.1	Number	Two (2X100 %)
51.2.2	Capacity and Head	As per system requirement.
51.2.3	MOC of wetted parts	SS 316
51.2.4	Type	Positive displacement plunger type.
51.2.5	Accessories	Pumps shall be provided with accessories such as Y-type suction strainers, pressure dampeners, Pressure Gauge, safety relief valves along with recirculation to tank etc
52.0	SCALE INHIBITOR DOSING SYSTEM FOR RO	
52.1	SCALE INHIBITOR DOSING TANK	
52.1.1	Number	One
52.1.2	MOC	HDPE
52.1.3	Effective Capacity	To store 12 hours solution (prepared) requirement.
52.2	SCALE INHIBITOR DOSING PUMP	
52.2.1	Number	Two (2X100 %)
52.2.2	Capacity and Head	As per system requirement.
52.2.3	MOC of wetted parts	PP
52.2.4	Type	Positive displacement plunger type.
52.2.5	Accessories	Pumps shall be provided with accessories such as Y-type suction strainers, pressure dampeners, Pressure Gauge, safety relief valves along with recirculation to tank etc
53.0	Na₂CO₃ DOSING SYSTEM FOR RO	
53.1	Na₂CO₃ MEASURING TANK	
53.1.1	Number	One
53.1.2	MOC	MS (3 mm thick) with Rubber Lining (4.5 mm thick).
53.1.3	Effective Capacity	To store 12 hours solution (prepared) requirement.
53.2	Na₂CO₃ Dosing Pump	
53.2.1	Number	Two (2X100 %)
53.2.2	Capacity and Head	As per system requirement.
53.2.3	MOC of wetted parts	SS 316
53.2.4	Type	Positive displacement plunger type.
53.2.5	Accessories	Pumps shall be provided with accessories such as Y-type suction strainers, pressure dampeners,



TITLE: 4 X 270 MW BHADRADRI TPS
TECHNICAL SPECIFICATION FOR EFFLUENT TREATMENT PLANT

SPECIFICATION NO. PE-TS-411-164-A001	
REV. NO. 00	DATE : 24/07/2017

		Pressure Gauge, safety relief valves along with recirculation to tank etc
54.0	CHEMICAL CLEANING SYSTEM FOR RO	
54.1	CHEMICAL CLEANING TANK	
54.1.1	Number	One
54.1.2	MOC	MS (6 mm) with 4.5 mm RL.
54.1.3	Effective Capacity	5 CuM.
54.2	CHEMICAL CLEANING PUMP	
54.2.1	Number	Two (2X100 %)
54.2.2	Capacity	As per system requirement.
54.2.3	Pump head	As per system requirement.
54.2.4	Type	Horizontal centrifugal.
54.2.5	MOC of wetted parts	SS 316
54.2.6	Accessories	Pumps shall be provided with accessories such as Y-type suction strainers, Pressure Gauge, recirculation to tank etc.
54.3	MCF FOR CHEMICAL CLEANING	
54.3.1	Number	One
54.3.2	Capacity	As per system requirement.
54.3.3	MOC	Housing-Carbon Steel Epoxy painted. Cartridge-PP.
55.0	CHEMICAL ENHANCED CLEANING FOR UF	
55.1	MEASURING TANK FOR CHEMICAL ENHANCED CLEANING	
55.1.1	Number	One
55.1.2	MOC	MS (3 mm Thick) with 4.5 MM RL
55.1.3	Effective Capacity	1000 Ltrs. or to store 12 hours solution (prepared) requirement whichever is higher.
55.2	DOSING PUMP FOR CHEMICAL ENHANCED CLEANING	
55.2.1	Number	Two (2X100 %)
55.2.2	Capacity and Head	As per system requirement.
55.2.3	MOC of wetted parts	PP
55.2.4	Type	Horizontal centrifugal.
55.2.5	Accessories	Pumps shall be provided with accessories such as Y-type suction strainers, Pressure Gauge, recirculation to tank etc.
56.0	ACID DOSING SYSTEM FOR UF	
56.1	ACID DOSING TANK	
56.1.1	Number	One
56.1.2	MOC	MSRL (3 MM Thick with 4.5 MM inside RL)
56.1.3	Effective Capacity	To store 12 hours solution (prepared) requirement.
56.2	ACID DOSING PUMP	
56.2.1	Number	Two (2X100 %)
56.2.2	Capacity and Head	As per system requirement.
56.2.3	MOC of wetted parts	PP
56.2.4	Type	Positive displacement plunger type.
56.2.5	Accessories	Pumps shall be provided with accessories such as Y-type suction strainers, pressure dampeners, Pressure Gauge, safety relief valves along with recirculation to tank etc
57.0	ALKALI DOSING SYSTEM FOR UF	
57.1	ALKALI DOSING TANK	
57.1.1	Number	One
57.1.2	MOC	MSRL (3 MM Thick with 4.5 MM inside RL)
57.1.3	Effective Capacity	To store 12 hours solution (prepared) requirement.
57.2	ALKALI DOSING PUMP	
57.2.1	Number	Two (2X100 %)
57.2.2	Capacity and Head	As per system requirement.



TITLE:
4 X 270 MW BHADRADRI TPS

SPECIFICATION NO. PE-TS-411-164-A001

**TECHNICAL SPECIFICATION FOR
EFFLUENT TREATMENT PLANT**

REV. NO. 00

DATE : 24/07/2017

57.2.3	MOC of wetted parts	SS316
57.2.4	Type	Positive displacement plunger type.
57.2.5	Accessories	Pumps shall be provided with accessories such as Y-type suction strainers, pressure dampeners, Pressure Gauge, safety relief valves along with recirculation to tank etc
58.0	BIO DISPERSANT DOSING SYSTEM FOR UF	
58.1	BIO DISPERSANT DOSING TANK	
58.1.1	Number	One
58.1.2	MOC	MSRL (3 MM Thick with 4.5 MM inside RL)
58.1.3	Effective Capacity	To store 12 hours solution (prepared) requirement.
58.2	BIO DISPERSANT DOSING PUMP	
58.2.1	Number	Two (2X100 %)
58.2.2	Capacity and Head	As per system requirement.
58.2.3	MOC of wetted parts	PP
58.2.4	Type	Positive displacement plunger type.
58.2.5	Accessories	Pumps shall be provided with accessories such as Y-type suction strainers, pressure dampeners, Pressure Gauge, safety relief valves along with recirculation to tank etc
59.0	CHEMICAL STORAGE SPACE (In RCC building)	
59.1	Storage area for chemicals	15 days
60.0	WEIGHING SCALE	
60.1	Type	Platform, dial type.
60.2	Number	One (1)
60.3	Capacity	0-1000 Kgs
61.0	HOIST	
61.1	Type	Electric in monorail in chemical dosing area
61.2	Number	One (1).
61.3	Capacity	2 Ton.
62.0	SAFETY ARRANGEMENT	
62.1	Safety shower	One number safety shower shall be provided near acid unloading area and one in chemical preparation area
62.2	Personal protection	Two sets of safety equipment each comprising PVC protection suits with hoods, rubber boots, face visors and thick PVC gauntlets shall also be provided by the bidder.
63.0	PIPING	Pipe carrying instrument air or service air or air blower line shall be of ASTM A-53 type E Gr-B galvanized/IS 3589 Gr 410 galvanized/ IS 1239 heavy galvanized to IS 4736 or equivalent. All CS / MS pipes shall be of heavy grade as per IS1239 / IS 3589 Rest MOC of pipes as per P & ID CPVC pipes shall be of minimum schedule 80 or as per system requirement whichever is higher. PVC pipes shall be of minimum schedule 80 or as per system requirement whichever is higher. SS 316 pipe shall be minimum sch 40. HDPE pipes shall be of minimum PE 80 or as per system requirement whichever is higher. Pipe MOC not mentioned in P & ID or in this datasheet shall be suitably selected as per system requirement and similar type of application indicated in technical specification and P & ID.



TITLE: 4 X 270 MW BHADRADRI TPS
TECHNICAL SPECIFICATION FOR EFFLUENT TREATMENT PLANT

SPECIFICATION NO. PE-TS-411-164-A001	
REV. NO. 00	DATE : 24/07/2017

64.0	VALVES	
64.1	Specification of valves included for Sump E1, E2, E3, E4, E5, E6, E7, E8, E9, E10, E11, E12, E13, E14, E15, E16, E18, common oily waste collection sump, oily waste treatment system in lamella clarifier / tube settler system, Clarifier II, service water, potable water.	<u>BUTTERFLY VALVE</u> Butterfly valves shall be of double flanged or lugged wafer type of low leakage rate confirming to AWWA-C-504 class 150 (min.) or BS:5155 PN 10 (min.) Body: cast Iron IS:210 Gr. FG 260 Disc: SS 316. Shaft: ASTM.A296 Gr. CF8M Seat rings: Nitrile rubber, EPDM, Hypalon All the butterfly valves shall be provided with Hand wheel or lever as per the requirements. All the butterfly valves shall be provided with an indicator to show the position of the disc. Flanges shall conform to ANSI B 16.5 Cl.150 (min) <u>DIAPHRAGM VALVE</u> The Diaphragm shall conform to following requirement i) Design standard: BS:5156 or equivalent of required rating/class. (minimum rating of valves shall be PN 10. ii) Type: Flanged and lined body ends, sealed bonnet, weir pattern, tight shut off type iii) Material of Construction - Body , Bonnet: Cast iron IS 210 Gr. FG 260 or equivalent or Cast steel ASTM A-216 Gr. WCB - Body lining : Soft natural rubber, ebonite, Polypropelene - Hand wheel : Cast Iron - Compressor : Stainless Steel - Stem and Bush : Stainless Steel <u>GATE VALVE</u> Type :Outside screw and rising stem type Stem,seat ring and wedge facing ring:SS, Rating: PN 10 (min). Other parts of the valve:As per IS:14846. <u>BALL VALVE/PLUG VALVE</u> Type :Full bore Rating: PN 10 (min). Body: cast Iron/carbon steel Ball: stainless steel Seat ring: PTFE Stem: Stainless steel Seat:Nitrile rubber,PTFE <u>GLOBE</u> Type: Double flanged or wafer type Rating: PN 10 (min). Body: Cast iron:IS 210 Gr FG260 Stem:stainless steel Disc: Cast iron. <u>NON RETURN VALVE</u> These valves shall be swing check type or dual plate type Swing check type (non-corrosive application) Body and disc: Cast iron. Hinge pin and door/disc pin: Cast steel ASTM A216 Gr. WCB



TITLE:
4 X 270 MW BHADRADRI TPS

SPECIFICATION NO. PE-TS-411-164-A001

**TECHNICAL SPECIFICATION FOR
EFFLUENT TREATMENT PLANT**

REV. NO. 00

DATE : 24/07/2017

			Disc facing ring: stainless steel Body Seat ring: Stainless steel		
64.2	Rest all facilities (Other than sl. No. 64.1 above included in P & ID of ETP)		All type of valves shall be of CPVC MOC however valves of chemical dosing tanks and pumps shall be of PVC.		
65.0	Pump Description	Quantity	PUMP TYPE	Capacity and Head	Material of Construction
65.1	Transformer Yard Oily waste collection Pit (Unit-1)	Two (2X100%)	Single screw, vertical	10 CuM/Hr. (each) and Head shall be as per requirement.	Casing – 2% NiCi as per IS 210 FG 260 Rotor: CF8M, Shaft: CF8M, Stator: Nitrile Black
65.2	Transformer Yard Oily waste collection Pit (Unit-2)	Two (2X100%)	Single screw, vertical	10 CuM/Hr. (each) and Head shall be as per requirement.	Casing – 2% NiCi as per IS 210 FG 260 Rotor: CF8M, Shaft: CF8M, Stator: Nitrile Black
65.3	Transformer Yard Oily waste collection Pit (Unit-3)	Two (2X100%)	Single screw, vertical	10 CuM/Hr. (each) and Head shall be as per requirement.	Casing – 2% NiCi as per IS 210 FG 260 Rotor: CF8M, Shaft: CF8M, Stator: Nitrile Black
65.4	Transformer Yard Oily waste collection Pit (Unit-4)	Two (2X100%)	Single screw, vertical	10 CuM/Hr. (each) and Head shall be as per requirement.	Casing – 2% NiCi as per IS 210 FG 260 Rotor: CF8M, Shaft: CF8M, Stator: Nitrile Black
65.5	Common Oily waste transfer pump	Two (2X100%)	Single screw, vertical	10 CuM/Hr. (each) and Head shall be as per requirement.	Casing – 2% NiCi as per IS 210 FG 260 Rotor: CF8M, Shaft: CF8M, Stator: Nitrile Black
65.6	Floor Wash Water Transfer pumps for Boiler and TG area unit-1 & 2	Two (2X100%)	Single screw, vertical	100 CuM/Hr. (each) and Head shall be as per requirement.	Casing – 2% NiCi as per IS 210 FG 260 Rotor: CF8M, Shaft: CF8M, Stator: Nitrile Black
65.7	Floor Wash Water Transfer pumps for Boiler and TG area unit-3 & 4	Two (2X100%)	Single screw, vertical	100 CuM/Hr. (each) and Head shall be as per requirement.	Casing – CI IS-210 Gr. Casing – 2% NiCi as per IS 210 FG 260 Rotor: CF8M, Shaft: CF8M, Stator: Nitrile Black
65.8	Floor Wash Water Transfer pumps for ESP area unit-1	Two (2X100%)	Vertical Centrifugal Impeller – open	15 CuM/Hr. (each) and Head shall be as per requirement.	Casing – CI IS-210 Gr. FG 260. Pump shaft/line shaft – SS 410 / EN 8 TO BS 970. Impeller – SS 304.
65.9	Floor Wash Water Transfer pumps for ESP area unit-2	Two (2X100%)	Vertical Centrifugal Impeller – open	15 CuM/Hr. (each) and Head shall be as per requirement.	Casing – CI IS-210 Gr. FG 260. Pump shaft/line shaft – SS 410 / EN 8 TO BS 970. Impeller – SS 304.
65.10	Floor Wash Water	Two (2X100%)	Vertical	15 CuM/Hr.	Casing – CI IS-210



TITLE:
4 X 270 MW BHADRADRI TPS

SPECIFICATION NO. PE-TS-411-164-A001

**TECHNICAL SPECIFICATION FOR
EFFLUENT TREATMENT PLANT**

REV. NO. 00

DATE : 24/07/2017

	Transfer pumps for ESP area unit-3		Centrifugal Impeller – open	(each) and Head shall be as per requirement.	Gr. FG 260. Pump shaft/line shaft – SS 410 / EN 8 TO BS 970. Impeller – SS 304.
65.11	Floor Wash Water Transfer pumps for ESP area unit-4	Two (2X100%)	Vertical Centrifugal Impeller – open	15 CuM/Hr. (each) and Head shall be as per requirement.	Casing – CI IS-210 Gr. FG 260. Pump shaft/line shaft – SS 410 / EN 8 TO BS 970. Impeller – SS 304.
65.12	Boiler Blow Down Transfer pump for unit-1	Two (2X100%)	Vertical Centrifugal Impeller – open	50 CuM/Hr. (each) and Head shall be as per requirement.	Casing – CI IS-210 Gr. FG 260. Pump shaft/line shaft – SS 410 / EN 8 TO BS 970. Impeller – SS 304.
65.13	Boiler Blow Down Transfer pump for unit-2	Two (2X100%)	Vertical Centrifugal Impeller – open	50 CuM/Hr. (each) and Head shall be as per requirement.	Casing – CI IS-210 Gr. FG 260. Pump shaft/line shaft – SS 410 / EN 8 TO BS 970. Impeller – SS 304.
65.14	Boiler Blow Down Transfer pump for unit-3	Two (2X100%)	Vertical Centrifugal Impeller – open	50 CuM/Hr. (each) and Head shall be as per requirement.	Casing – CI IS-210 Gr. FG 260. Pump shaft/line shaft – SS 410 / EN 8 TO BS 970. Impeller – SS 304.
65.15	Boiler Blow Down Transfer pump for unit-4	Two (2X100%)	Vertical Centrifugal Impeller – open	50 CuM/Hr. (each) and Head shall be as per requirement.	Casing – CI IS-210 Gr. FG 260. Pump shaft/line shaft – SS 410 / EN 8 TO BS 970. Impeller – SS 304.
65.16	Side stream filtration backwash waste sump I transfer pump	Two (2X100%)	Vertical Centrifugal Impeller – open	50 CuM/Hr. (each) and Head shall be as per requirement.	Casing – CI IS-210 Gr. FG 260. Pump shaft/line shaft – SS 410 / EN 8 TO BS 970. Impeller – SS 304.
65.17	Side stream filtration backwash waste sump II transfer pump	Two (2X100%)	Vertical Centrifugal Impeller – open	50 CuM/Hr. (each) and Head shall be as per requirement.	Casing – CI IS-210 Gr. FG 260. Pump shaft/line shaft – SS 410 / EN 8 TO BS 970. Impeller – SS 304.
65.18	Side stream clear water transfer pump	Two (2X100%)	Horizontal Centrifugal	100 CuM/Hr. (each) and Head shall be as per requirement.	Casing and impeller – Rubber lined cast iron IS: 210 Grade FG 260 Pump shaft – Stainless steel-SS 316
65.19	Clarifier I feed pump	Two (2X100%)	Horizontal Centrifugal	60 CuM/Hr. (each) and Head shall be as per	Casing and impeller – Rubber lined cast iron IS: 210 Grade FG 260



TITLE:
4 X 270 MW BHADRADRI TPS

SPECIFICATION NO. PE-TS-411-164-A001

**TECHNICAL SPECIFICATION FOR
EFFLUENT TREATMENT PLANT**

REV. NO. 00

DATE : 24/07/2017

				requirement.	Pump shaft – Stainless steel-SS 316
65.20	ETP Clarifier I sludge transfer pumps	Two (2X100%)	Vertical Centrifugal	10 CuM/Hr. (each) and Head shall be as per requirement.	Casing and impeller – Rubber lined cast iron IS: 210 Grade FG 260 Pump shaft – Stainless steel-SS 316
65.21	ETP Clarifier II sludge transfer pumps	Two (2X100%)	Vertical Centrifugal	10 CuM/Hr. (each) and Head shall be as per requirement.	Casing and impeller – Rubber lined cast iron IS: 210 Grade FG 260 Pump shaft – Stainless steel-SS 316
65.22	Lamella Clarifier clear water Transfer pump	Two (2X100%)	Vertical Centrifugal	10 CuM/Hr. (each) and Head shall be as per requirement.	Casing – CI IS-210 Gr. FG 260. Pump shaft/line shaft – SS 410 / EN 8 TO BS 970. Impeller – SS 304.

Note: 1. Separate flange joint shall be provided by bidder for NRV of Pump.

2. Bidder to note that intermediate capacities of different item / equipment have been mentioned in the tender drawing / specification. However minor modification may take place during detailed engineering to meet the overall system requirement of overall RO permeate of 2X25 m3/hr.

ELECTRIC HOIST

Sl.no	DESCRIPTION	TECHNICAL PARTICULARS
1.0	Type	Steel wire electric hoist with electrically operated trolley
2.0	Scope (Qty., Capacity, Lift, Travel Length)	As per specification and layout requirement
3.0	Type of service	Indoor
4.0	Overload test	125% of SWL
5.0	Design Ambient temperature	50° C
6.0	General Design	As per IS: 3938 / 1983 or latest, Class-II duty
7.0	Operating speed	
7.1	Hoisting speed	3 MPM.
7.2	Trolley speed	15 MPM
8.0	Type of transmission	Through Electric motor and gear box.
9.0	Wire Rope	
9.1	Construction / core	6 x36/ 6X37 (Steel core)
9.2	Code	IS:2266
9.3	Number of falls	Min. 4
9.4	Factor of safety	Not less than 5
10.0	Load Hook and block	NORMALISED HOOK ONLY



TITLE:
4 X 270 MW BHADRADRI TPS

SPECIFICATION NO. PE-TS-411-164-A001

**TECHNICAL SPECIFICATION FOR
EFFLUENT TREATMENT PLANT**

REV. NO. 00

DATE : 24/07/2017

10.1	Type of load hook	Plain shank trapezoidal section with safety latch.
10.2	Load hook Code	IS: 15560
10.3	Load hook Material	As per IS:15560
10.4	Hook suspension	Thrust bearing
10.5	Material of block suspension	Fabricated from steel plate, Material: IS: 2062
11.0	Gearing	
11.1	Type	Spur / Helical
11.2	Gear/ pinion material	as per IS 3938
11.3	Lubrication	Oil splash/ grease lubricated
11.4	Bearing type	Antifriction Ball / Roller
12.0	Trolley drive	
12.1	Wheel	Single flange taper thread
12.2	Wheel conform to (Std. / code)	IS: 3938
12.3	Wheel material	As per IS:3938
12.4	Bearing type	Antifriction Ball / Roller
12.5	Trolley type	Rolled structural steel with side plates extended beyond wheel flanges to protect wheels.
12.6	Hardness	Max hardness 200 BHN
13.0	SHEAVE	
13.1	Material	Fabricated from steel plate. IS: 2062 Gr. A or Gr. B / as per IS: 3938
13.2	Bearing type	Antifriction Ball / Roller.
14.0	BRAKE (HOIST and TROLLEY)	
14.1	Type	DC EM brakes disc type (fail to safe).
14.2	Capacity	As per IS 3938.
14.3	Number	One number for each motor.
15.0	ROPE DRUM	
15.1	Material	Cast iron, cast steel or mild steel.
15.2	Flange / Flangeless	Flanged
15.3	Type of groove	As per manufacturers standard to suit the layout requirement.(Shall be decided during detail engineering)
17.0	TYPE OF DSL	
17.1	CT travel	PVC Shrouded bus bar conductor type DSL
18.0	MOTORS	
18.1	Type	Sq. Cage induction, TEFC, S4 duty, 40% CDF.
18.2	Number of start	150 starts / hr
18.3	Voltage, Phase and	415V $\pm$ 10%, 3 phase, 4 wire, 50 Hz



TITLE:
4 X 270 MW BHADRADRI TPS

SPECIFICATION NO. PE-TS-411-164-A001

**TECHNICAL SPECIFICATION FOR
EFFLUENT TREATMENT PLANT**

REV. NO. 00

DATE : 24/07/2017

	Frequency		
18.4	Class of insulation	Class “F” and temperature rise limited to class B.	
18.5	Type of enclosure	TEFC	
18.6	Degree of protection provided for enclosure	IP-54/IP-55 depending upon Indoor / Outdoor application	
18.7	Margin	Motor rating will be calculated keeping margin of at least 15% over the maximum power requirement in the duty condition specified.	
19.0	LIMIT SWITCHES	Hoisting	Trolley
19.1	Type	Snap action, self actuating type	Lever type
20.0	Control panel	* Fabricated from Cold rolled sheet steel not less than 2.5mm for front & rear & 2mm for side, top & bottom portion with gland plate of 3mm thick. * Degree of protection shall be IP 54. * Power on indicating lamps shall be provided * Panel illumination lamps operated by door switch. * 2 nos earthing terminals on panel. * 20 % spares terminals (clip on type) shall be provided. * Power and control terminals (clip on type) shall be on separate channels. * Gland plate shall be double brass compression type.	
20.1	Qty	1 No.	
21.0	Pendent Push buttons	Up /down / forward / Reverse push buttons. Indicative marking for easy operation shall be provided.	
22.0	Power cables	FRLS / EPR flexible Cu cable / Aluminum cable	
23.0	Control cable	FRLS / EPR flexible Cu cable	
24.0	Control Voltage	110 V	
25.0	Painting	A) <u>Structural</u> Surface preparation : De greasing and Mechanical cleaning with wire brush or hand tool. (SA 1/ ST 2 / ST 3 as applicable) Primer : Red oxide Zinc phosphate (Alkyd medium)- 2 coat , DFT 35 μ per coat. Finish Coat : Synthetic enamel (Alkyd medium) as per IS: 2932- 2 coats, DFT 35 μ per coat. Total DFT : 140μ B) <u>Electrical /Control Panel</u> Surface preparation: Seven tank process Primer : Red Oxide Zinc phosphate (Alkyd medium)- 2 coat , Minimum DFT 35 μ per coat.	



TITLE:
4 X 270 MW BHADRADRI TPS

SPECIFICATION NO. PE-TS-411-164-A001

**TECHNICAL SPECIFICATION FOR
EFFLUENT TREATMENT PLANT**

REV. NO. 00

DATE : 24/07/2017

		Finish Coat : Synthetic enamel (Alkyd medium) as per IS: 2932- 2 coats, Minimum DFT 35 μ per coat. Total DFT : 140 μ
MANUAL HOIST (CHAIN PULLEY BLOCK)		
1	Type	Chain pulley block with/without travelling trolley
2	General Design	IS: 3832
3	Duty Class as per IS:3832	Class –II
4	Hoisting Mechanism	
a)	Type	Hand operated gear transmission
b)	Type of gear	Spur / Helical
c)	Load Chain	
i)	Type	Link type
ii)	Material	T (8) as per IS: 6216
iii)	Conforms to (Std./Code)	IS: 6216
d)	Hand Chain	
i)	Type	Link type
ii)	Material	Mild steel Grade 30
iii)	Conform to Std.	IS:2429 (Part I)
e)	Load Hook & Hook Block	
i)	Type of load hook	Plain shank- Trapezoidal section
ii)	Load hooks conforms to	IS: 15560
iii)	Type of hook suspension	Swivelling type with lock
iv)	Type of make of bearing	Thrust ball bearing of hook suspension
v)	Type & Material of hook	Carbon steel/forged steel As per IS 15560
f)	Gears/ Pinion	
i)	Type	Spur
ii)	Material	Alloy steel / carbon steel
iii)	Type of Bearing	Antifriction ball bearing / Roller
h)	Sprockets:	
	Type of bearings used	Antifriction ball bearing / Roller
i)	Method of lubrication	
	Bearings	Grease
	Gearing & Pinions	Grease
	Sprockets	Grease
j)	Brakes	
	Type	Screw and friction disc type
5	Trolley and Bridge drive	
a)	Trolley	
i)	Type	Geared (Manually operated)
ii)	Material of frame	Mild steel (IS:2062 Grade A or B)
b)	Drive Chain	
i)	Type	Link type



TITLE:
4 X 270 MW BHADRADRI TPS

SPECIFICATION NO. PE-TS-411-164-A001

**TECHNICAL SPECIFICATION FOR
EFFLUENT TREATMENT PLANT**

REV. NO. 00

DATE : 24/07/2017

ii)	Material	Steel Gr.30 as per IS 2429 (part 1)
c)	Wheel	
i)	Number of pairs of wheel	Two in each trolley/bridge
ii)	Flange	Single flanged
iii)	Wheel material	Cast Iron Gr. FG 200 as per IS:210
iv)	Type of bearings need	Antifriction
d)	Gears	
i)	Type	Spur / helical
ii)	Material	EN8
iii)	Type of bearings used	Antifriction
e)	Method of lubrication for	
i)	Bearings	Grease
ii)	General	Grease
iii)	Sprockets	Grease
6	Painting	As per manufacturer standard



TITLE:
4 X 270 MW BHADRADRI TPS

**TECHNICAL SPECIFICATION FOR
EFFLUENT TREATMENT PLANT**

SPECIFICATION NO. PE-TS-411-164-A001

REV. NO. 00

DATE : 24/07/2017

SUB-SECTION IB

SPECIFIC TECHNICAL REQUIREMENTS (ELECTRICAL)



**ELECTRICAL EQUIPMENT SPECIFICATION
FOR WATER SYSTEM MAUX PACAKGES
EFFLUENT TREATMENT PLANT
4X270 MW BHADRADRI TPS**

SPECIFICATION NO.

VOLUME NO. : **II-B**

SECTION :

REV NO. : **00** DATE : 30/03/17

SHEET : 2 OF 3

1.0 EQUIPMENT & SERVICES TO BE PROVIDED BY BIDDER:

- a) Services and equipment as per “Electrical Scope between BHEL and Vendor”.
- b) Any item/work either supply of equipm ent or erection m aterial which have not been specifically mentioned but are necessary to complete the work for trouble free and efficient operation of the plant shall be deemed to be included within the scope of this specification. The sam e shall be provided by the bidder without any extra charge.
- c) Supply of m andatory spares as specified in the specifications of m echanical equipments.
- d) Electrical load requirement for EFFLUENT TREATMENT PLANT
- e) All equipment shall be suitable for the power supply fault levels and other climatic conditions mentioned in the enclosed project information.
- f) Bidder to furnish list of m akes for each equipment at contract stage, which shall be subject to custom er/BHEL approval without any com mercial and delivery implications to BHEL
- g) Various drawings, data sheets as per required format, Quality plans, calculations, test reports, test certificates, operation and maintenance manuals etc shall be furnished as specified at contract stage. All docum ents shall be subject to customer/BHEL approval without any commercial implication to BHEL.
- h) Motor shall meet the general technical requirements for motor.
- i) Vendor to clearly indicate equipm ent locations and local routing lengths in their cable listing furnished to BHEL.
- j) Cable BOQ worked out based on routing of cable listing provided by the vendor for “both end equipm ent in vendor’ s scope”shall be binding to the vendor with +10 % margin to take care of slight variation in routing length & wastages.

**2.0 EQUIPMENT & SERVICES TO BE PROVIDED BY PURCHASER FOR
ELECTRICAL & TERMINAL POINTS:**

Refer “Electrical Scope between BHEL and Vendor”.



**ELECTRICAL EQUIPMENT SPECIFICATION
FOR WATER SYSTEM MAUX PACAKGES
EFFLUENT TREATMENT PLANT
4X270 MW BHADRADRI TPS**

SPECIFICATION NO.

VOLUME NO. : **II-B**

SECTION :

REV NO. : **00** DATE : 30/03/17

SHEET : 3 OF 3

3.0 DOCUMENTS TO BE SUBMITTED ALONG WITH BID

- 3.1 The electrical specification without any deviation from the technical/quality assurance requirements stipulated shall be deemed to be complied by the bidder in case bidder furnishes the overall compliance of package technical specification in the form of compliance certificate/No deviation certificate.
- 3.2 No technical submittal such as copies of data sheets, drawings, write-up, quality plans, type test certificates, technical literature, etc, is required during tender stage. Any such submission even if made, shall not be considered as part of offer.

4.0 List of enclosures :

- a) Electrical scope between BHEL & vendor (Annexure –I)
- b) General technical requirements for LV motors.
- c) Datasheet A & C.
- d) Quality plan for motors.
- e) Electrical Load data format (Annexure –II)
- f) BHEL cable listing format (Annexure –III)

ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR(FOR EPC PROJECTS)

PACKAGES : EFFLUENT TREATMENT PLANT

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

S.NO	DETAILS	SCOPE SUPPLY	SCOPE E&C	REMARKS
1	415V MCC	BHEL	BHEL	240 V AC (supply feeder)/415 V AC (3 PHASE 4 WIRE) supply shall be provided by BHEL based on load data provided by vendor at contract stage for all equipment supplied by vendor as part of contract. Any other voltage level (AC/DC) required will be derived by the vendor.
2	Local Push Button Station (for motors)	BHEL	BHEL	Located near the motor.
3	Power cables, control cables and screened control cables for a) both end equipment in BHEL's scope b) both end equipment in vendor's scope c) one end equipment in vendor's scope	BHEL BHEL BHEL	BHEL Vendor BHEL	1. For 3.b) & c): Sizes of cables required shall be informed by vendor at contract stage (based on inputs provided by BHEL) in the form of cable listing. Finalisation of cable sizes shall be done by BHEL. Vendor shall provide lugs & glands accordingly. 2. Termination at BHEL equipment terminals by BHEL. 3. Termination at Vendor equipment terminals by Vendor.
4	Junction box for control & instrumentation cable	Vendor	Vendor	Number of Junction Boxes shall be sufficient and positioned in the field to minimize local cabling (max 10-12 mtrs) and trunk cable.
5	Any special type of cable like compensating, co-axial, prefab, MICC, optical fibre etc.	Vendor	Vendor	Refer C&I portion of specification for scope of fibre Optical cables if used between PLC/ microprocessor & DCS.
6	Cable trays, accessories & cable trays supporting system 100/ 50 mm cable trays/ Conduits/ Galvanised steel cable troughs for local cabling	BHEL Vendor	BHEL Vendor	Local cabling from nearby main route cable tray (BHEL scope) to equipment terminal (vendor's scope) shall be through 100/ 50 mm. cable trays/ conduits/ Galvanised steel cable troughs, as per approved layout drawing during contract stage.
7	Cable glands ,lugs and bimetallic strip for equipment supplied by Vendor	Vendor	Vendor	1. Double compression Ni-Cr plated brass cable glands 2. Solder less crimping type heavy duty tinned copper lugs for power and control cables.
8	Conduit and conduit accessories for cabling between equipment supplied by vendor	Vendor	Vendor	Conduits shall be medium duty, hot dip galvanised cold rolled mild steel rigid conduit as per IS: 9537.
9	Lighting	BHEL	BHEL	
10	Equipment grounding (including electronic earthing) &	BHEL	BHEL	Refer note no. 4 for electronic earthing

ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR(FOR EPC PROJECTS)

PACKAGES : EFFLUENT TREATMENT PLANT

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

PROJECT:

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

NOTES:

1. Make of all electrical equipment/ items supplied shall be reputed make & shall be subject to approval of BHEL/customer after award of contract.
2. All QPs shall be subject to approval of BHEL/customer after award of contract without any commercial implication.

ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR(FOR EPC PROJECTS)

PACKAGES EFFLUENT TREATMENT PLANT

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

3. In case the requirement of Junction Box arises on account of Power Cable size mis-match due to vendor engineering at later stage, vendor shall supply the Junction Box for suitable termination.
4. Vendor shall indicate location of Electronic Earth pit in their Civil assignment drawing.

REV: 00 DATE:

PACKAGE: EOT FOR EFFLUENT TREATMENT PLANT
STANDARD ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR (FOR EPC PROJECTS)

PROJECT : 4 X 270 MW BHADRADRI TPS

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

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

DATA SHEET A

SL.NO.	PARAMETERS	4X270MW BHADRADRI
1	Design ambient temperature	50 °C
2	Maximum acceptable kW rating of LV motor	160KW *
3	Installation (Indoors/ Outdoors)	As required
4	Degree Of protection for motor/ terminal box	IP 54/ IP 55
5	Type of Cooling	TEFC/CACA/TETV
6	Details of supply system	
a)	Rated voltage (with variation)	415V $\pm$ 10%
b)	Rated frequency (with variation)	50 Hz + 3 % to - 5%
c)	Combined voltage & freq. variation	10% (sum of absolute values)
d)	System fault level at rated voltage	50 kA for 1 sec
e)	Short time rating for terminal boxes	
i)	110 kW and above (Breaker Controlled)	50 KA for 0.25 sec..
ii)	Below 110 Kw (Contactor Controlled)	50 KA protected by HRC fuse
f)	LV System grounding	Solidly
7	Class of insulation	Class 'F', with temp rise limited to class B.
8	Minimum voltage for starting (As percentage of rated voltage)	(a) 85% below 110KW (b) 80% from 110KW to 160KW (c) 85% above 160KW to 1000KW (d) 80% from 1001 KW to 4000KW (e) 75% > 4000KW
9	Power cables data	Shall be given during detailed engg.
10	Earth Conductor Size & Material	415 V motors : Above 90 kW - 50 x 6 Galvanised MS Flat 415 V motors : Above 30 upto 90 kW - 35 x 6 Galvanised MS Flat 415 V motors : Above 2.2 upto 90 kW - 25 x 3 Galvanised MS Flat 415 V motors : Upto 2.2 kW - 8SWG GI/GS Wire
11	Space heater supply	240 V, 1 ϕ , 50 Hz (for motors above 30 Kw)
12	Rating up to which Single phase motor	Acceptable below 0.20 kW
13	Locked rotor current Limit as percentage of FLC	As per IS 12615*
14	Flame-proof motor	
a)	Enclosure suitable (As per IS: 2148)	As per requirement
b)	Classification of Hazardous area (As per IS: 5572 part-I)	As per requirement
15	Makes	BHEL/ Customer approval
16	Paint shade	Shall be given during detailed engg
17	TESTING	All motors shall be subjected to Type tests & routine tests as per IS: 325 and approved quality plan.
18	Energy efficient motors	* Continuous duty LT motors up to 160 KW Output rating (at 50 deg.C ambient temperature), shall be premium efficiency (IE3) as per IEC: 60034-30/ IS:12615.

	TITLE	MOTOR DATA SHEET – C 4 X 270 MW BHADRADRI TPS	SPECIFICATION NO.	
			VOLUME	II B
			SECTION	D
			REV NO. 00	DATE
			SHEET	1 OF 2

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

NAME OF VENDOR			SEAL	REV.	
NAME	SIGNATURE	DATE			

	TITLE	MOTOR DATA SHEET – C 4 X 270 MW BHADRADRI TPS	SPECIFICATION NO.		
			VOLUME		II B
			SECTION D		
			REV NO.00 DATE		
			SHEET	2	OF

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

NAME OF VENDOR			SEAL	REV.	
NAME	SIGNATURE	DATE			

[illegible]

ANNEXURE III

Page 268 of 537

CUSTOMER :			PROJECT			SPECIFICATION :		
QUALITY PLAN			TITLE			NUMBER :		
BIDDER/ VENDOR			QUALITY PLAN			SPECIFICATION :		
SYSTEM			NUMBER PED-506-00-Q-007, REV-03			TITLE		
CAT.			ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)			SECTION		
CHARACTERISTIC			REFERENCE			AGENCY		
CHECK			DOCUMENT			REMARKS		
EXTENT OF CHECK			NORM			P W V		
TYPE/ METHOD OF CHECK			FORMAT OF RECORD			10		
CAT.			7			11		
3			8			9		
2			6			5		
4			5			4		
1			3			2		
1.0			1.0			1.0		
1.1			1.1			1.1		
1.2			1.2			1.2		
1.3			1.3			1.3		
1.4			1.4			1.4		
BHEL			BHEL			BHEL		
PARTICULARS			BIDDER/VENDOR			BIDDER/VENDOR		
NAME			NAME			NAME		
SIGNATURE			SIGNATURE			SIGNATURE		
DATE			DATE			DATE		
BIDDER'S/VENDORS COMPANY SEAL			BIDDER'S/VENDORS COMPANY SEAL			BIDDER'S/VENDORS COMPANY SEAL		

BHEL		CUSTOMER :			PROJECT		SPECIFICATION :					
		QUALITY PLAN			TITLE		NUMBER :					
							SPECIFICATION :					
		SHEET 2 OF 9			SYSTEM		TITLE					
CHARACTERISTIC CHECK		CAT.		TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	SECTION		VOLUME III	
COMONENT/OPERATION		3	4	5	6	7	8	9	10	REMARKS		
SL. NO.	1	2	3	4	5	6	7	8	9	10	11	
1.5	SHAFT (FORGED OR ROLLED)	1. SURFACE COND.	MA	VISUAL	100%	-	FREE FROM VISUAL DEFECTS	-DO-	3	-	-	VENDOR'S APPROVAL IDENTIFICATION SHALL BE MAINTAINED
		2. CHEM. & PHYSICAL PROPERTIES	MA	CHEM. & PHYSICAL TESTS	1/HEAT NO. OR HEAT TREATMENT BATCH NO	MFG. DRG. SPEC.	RELEVANT IS	SUPPLIER'S TC	3	-	2	
		3. DIMENSIONS	MA	MEASUREMENT	100%	-DO-	MANUFR'S DRG.	LOG BOOK	3	-	2	
		4.INTERNAL FLAWS	CR	UT	-DO-	ASTM-A388	MANUFR'S SPEC. BHEL SPEC.	-DO-	3	2	1	FOR DIA OF 55 MM & ABOVE
1.6	SPACE HEATERS, CONNECTORS, TERMINAL BLOCKS, CABLES, CABLE LUGS, CARBON BRUSH TEMP. DETECTORS, RTD, BTD'S	1. MAKE & RATING	MA	VISUAL	-DO-	MANUFR'S DRG. SPEC.	MANUFR'S DRG. SPEC.	-DO-	3	-	2	
		2. PHYSICAL COND.	MA	-DO-	-DO-	-	NO PHYS. DAMAGE, NO ELECTRICAL DISCONTINUITY	-DO-	3	-	2	
		3.DIMENSIONS (WHEREVER APPLICABLE)	MA	MEASUREMENT	SAMPLE	MANUFR'S DRG./ SPEC.	MANUFR'S DRG. / SPEC.	-DO-	3	-	2	
		4.PERFORMANCE/ CALIBRATION	MA	TEST	100%	-DO-	-DO-	INSP. REPORT	3	-	2	
BHEL		PARTICULARS		BIDDER/VENDOR								
		NAME										
		SIGNATURE										
		DATE										
		BIDDER'S/VENDORS COMPANY SEAL										

		QUALITY PLAN		CUSTOMER :		PROJECT TITLE		SPECIFICATION : NUMBER :			
SHEET 3 OF 9		BIDDER/ : VENDOR		SYSTEM CAT.		QUALITY PLAN NUMBER PED-506-Q-007, REV-03		SPECIFICATION : TITLE			
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	TYPE/METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	SECTION AGENCY	VOLUME III REMARKS		
								P	W	V	
1	2	3	4	5	6	7	8	9	10		11
1.7	OTHER INSULATING MATERIALS LIKE SLEEVES, BINDINGS CORDS, PAPERS, PRESS BOARDS ETC.	1. SURFACE COND. ETC.	MA	VISUAL	100%	-	NO VISUAL DEFECTS	INSPT. REPORT	3	-	2
		2. OTHER CHARACTERISTICS	MA	TEST	SAMPLE	MANUF'S SPEC.	MANUF'S SPEC.	LOG BOOK AND OR SUPPLIER'S TC	3	-	2
1.8	SHEET STAMPING (PUNCHED)	1. SURFACE COND.	MA	VISUAL	100%	-	NO VISUAL DEFECTS (FREE FROM BURS)	LOG BOOK	3	-	-
		2.DIMENSIONS INCLUDING BURS HEIGHT	MA	MEASUREMENT	SAMPLE	MANUF'S DRG. .	-DO-	MANUF'S DRG.	3	-	2
1.9	CONDUCTORS	3. ACCEPTANCE TESTS	MA	ELECT. & MECH TESTS	-DO-	MANUF'S SPEC./ RELEVANT IS	RELEVANT IS	SUPPLIER'S TC	3	-	2
		1. SURFACE FINISH	MA	VISUAL	100%	-	FREE FROM VISUAL DEFECTS	LOG BOOK	3*	-	2*
		2.ELECT. PROP. & MECH. PROP	MA	ELECT. & MECH.TEST	SAMPLES	RELEVANT IS/ BS OR OTHER STANDARDS	RELEVANT IS/ BS OR OTHER STANDARDS	SUPPLIERS TC & VENDOR'S INSPN. REPORTS	3	-	2
BHEL		PARTICULARS		BIDDER/VENDOR							
		NAME									
		SIGNATURE									
		DATE									
		BIDDER'S/VENDORS COMPANY SEAL									

		QUALITY PLAN		CUSTOMER :		PROJECT		SPECIFICATION :	
COMPONENT/OPERATION		SHEET 4 OF 9		BIDDER/ VENDOR		TITLE		NUMBER :	
SL. NO.		CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	SECTION TITLE
1	2	3	4	5	6	7	8	9	10
									11
1.10	BEARINGS	3.DIMENSIONS 1.MAKE & TYPE 2.DIMENSIONS	MA	MEASUREMENT VISUAL MEASUREMENT	-DO- 100% SAMPLE	MANFR'S DRG./ APPROVED DATASHEET BHEL DATA SHEET	-DO- MANFR'S DRG./ APPROVED DATASHEET BHEL DATA SHEET BEARING MANUF'S CATALOGUES	Log Book -DO- -DO-	3 - 2 3 - 2 3 - 2
1.11	SLIP RING (WHEREVER APPLICABLE)	1.SURFACE COND. 2.DIMENSIONS 3.TEMP.WITH-STAND CAPACITY	MA	VISUAL MEASUREMENT ELECT.TEST	100% SAMPLE -DO-	- MANUF'S DRG MANUF'S SPEC./ BHEL SPEC.	FREE FROM VISUAL DEFECTS -DO- MANUF'S DRG MANUF'S SPEC./ BHEL SPEC.	-DO- -DO- -DO- -DO-	3 - - 3 - - 3 - 2
1.12	OIL SEALS & GASKETS	1.MATERIAL OF GASKET 2.SURFACE COND. 3.DIMENSIONS	MA	-DO- VISUAL VISUAL MEASUREMENT	100% 100% 100% SAMPLE	-DO- MANUF'S DRG/SPECS - MANUF'S DRG	-DO- MANUF'S DRG/ SPECS. FREE FROM VISUAL DEFECTS MANUF'S DRG	-DO- -DO- -DO- -DO-	3 - - 3 - - 3 - - 3 - -
BHEL		PARTICULARS		BIDDER/VENDOR					
		NAME							
		SIGNATURE							
		DATE							
				BIDDER'S/VENDORS COMPANY SEAL					

		QUALITY PLAN		CUSTOMER :		PROJECT TITLE		SPECIFICATION : NUMBER :					
SHEET 5 OF 9		BIDDER/ VENDOR		SYSTEM		QUALITY PLAN NUMBER PED-506-00-Q-007, REV.03 ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)		SPECIFICATION :					
								TITLE					
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	SECTION AGENCY			VOLUME III REMARKS	
									P	W	V		
1	2	3	4	5	6	7	8	9	10				11
2.0	IN PROCESS												
2.1	STATOR FRAME WELDING (IN CASE OF FABRICATED STATOR)	1.WORKMANSHIP & CLEANNESS	MA	VISUAL	100%	-DO-	GOOD FINISH	LOG BOOK	3/2	2	-		
		2.DIMENSIONS	MA	MEASUREMENT	-DO-	MANUF'S DRG	MANUF'S DRG	-DO-	2	-	-		
2.2	MACHINING	1.FINISH	MA	VISUAL	100%	-DO-	GOOD FINISH	LOG BOOK	2	-	-		
		2.DIMENSIONS	MA	MEASUREMENT	-DO-	MANUF'S DRG	MANUF'S DRG	-DO-	2	-	-		
		3.SHAFT SURFACE FLOWS	MA	PT	-DO-	RELEVANT SPEC./ ASTM-E165	MANUF'R'S SPEC./ BHEL SPEC./	-DO-	2	-	1		
2.3	PAINTING	1.SURFACE PREPARATION	MA	VISUAL	100%	MANFR'S SPEC/BHEL SPEC./ RELEVANT STAND	BHEL SPEC. SAME AS COL.7	LOG BOOK	2	-	-		
		2.PAINT THICKNESS (BOTH PRIMER & FINISH COAT)	MA	MEASUREMENT BY ELCOMETER	SAMPLE	-DO-	-DO-	-DO-	2	-	-		
		3.SHADE	MA	VISUAL	-DO-	-DO-	-DO-	Log Book	2	-	-		
		4.ADHESION	MA	CROSS CUTTING & TAPE TEST	-DO-	-DO-	-DO-	Log Book	2	-	-		
BHEL													
			PARTICULARS		BIDDER/VENDOR								
			NAME										
			SIGNATURE										
			DATE										
BIDDER'S/VENDORS COMPANY SEAL													

GET IT FIRST 		QUALITY PLAN		CUSTOMER :		PROJECT TITLE		SPECIFICATION : NUMBER :					
SHEET 6 OF 9		BIDDER/ VENDOR SYSTEM		BIDDER/ VENDOR SYSTEM		QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03		SPECIFICATION : TITLE					
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	SECTION VOLUME III				
1	2	3	4	5	6	7	8	9	10	11			
2.4	SHEET STACKING	1.COMPLETENESS	MA	MEASUREMENT	SAMPLE	MANUF'R'S SPEC.	MANUF'R'S SPEC.	Log Book	2	-	-		
		2.COMPRESSION & TIGHTENING	MA	MEASUREMENT	100%	-DO-	-DO-	-DO-	Log Book	2	-	-	
		3.CORE LOSS & HOTSPOT	MA	ELECT.TEST	-DO-	-DO-	-DO-	-DO-	Log Book	2	1*	1	
2.5	WINDING	1.COMPLETENESS	CR	VISUAL	100%	MANUF'R'S SPEC./BHEL SPEC.	MANUF'R'S SPEC./BHEL SPEC.	Log Book	2	-	-		
		2.CLEANLINESS	CR	-DO-	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	-	
		3.IR-HV-IR	CR	ELECT. TEST	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	1	
		4.RESISTANCE	CR	-DO-	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	1	
		5.INTERTURN INSULATION	CR	-DO-	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	-	
		6.SURGE WITH STAND AND TAN.DELTA TEST	CR	-DO-	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	1	
2.6	IMPREGNATION	1.VISCOSITY	MA	PHY. TEST	AT STARTING	-DO-	-DO-	Log Book	2	-	-		
		2.TEMP. PRESSURE VACCUUM	MA	PROCESS CHECK	CONTINUOUS	-DO-	-DO-	-DO-	Log Book	2	-	-	
		3.NO. OF DIPS	MA	-DO-	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	1	
												THREE DIPS TO BE GIVEN	
BHEL										PARTICULARS		BIDDER/VENDOR	
										NAME			
										SIGNATURE			
										DATE			
												BIDDER'S/VENDORS COMPANY SEAL	

		QUALITY PLAN		CUSTOMER :		PROJECT		SPECIFICATION :	
COMPONENT/OPERATION		SHEET 8 OF 9		BIDDER/	VENDOR	TITLE		NUMBER :	
SL. NO.	2	3	4	5	6	7	8	9	10
1	3.0	TESTS	MA	ELECT. TEST	1/TYPE/ SIZE	IS-325/ BHEL SPEC./ DATA SHEET	IS-325/ BHEL SPEC./ DATA SHEET	TEST REPORT	2
		1. TYPE TESTS INCLUDING SPECIAL TESTS AS PER BHEL SPEC.	MA	-DO-	100%	-DO-	-DO-	-DO-	2
		2. ROUTINE TESTS INCLUDING SPECIAL TEST AS PER BHEL SPEC.	MA	-DO-	100%	-DO-	-DO-	-DO-	2
		3. VIBRATION & NOISE LEVEL	MA	-DO-	100%	IS-12075 & IS-12065	IS-12075 & IS-12065	-DO-	2
		4. OVERALL DIMENSIONS AND ORIENTATION	MA	MEASUREMENT & VISUAL	100%	APPROVED DRG/DATA SHEET	APPROVED DRG/DATA SHEET & RELEVANT IS	INSPC. REPORT	2
		5. DEGREE OF PROTECTION	MA	ELECT. & MECH. TEST	1/TYPE/ SIZE	RELEVANT IS	BHEL SPEC. AND DATA SHEET	TC	2
		6. MEASUREMENT OF RESISTANCE OF RTD & BTD	MA	-DO-	100%	-DO-	-DO-	-DO-	2
		7. MEASUREMENT OF RESISTANCE, IR OF SPACE HEATER	MA	-DO-	100%	-DO-	-DO-	-DO-	2
		8. NAMEPLATE DETAILS	MA	VISUAL	100%	IS-325 & DATA SHEET	IS-325 & DATA SHEET	INSPC. REPORT	2
		9. EXPLOSION FLAME PROOF NESS (IF SPECIFIED)	MA	EXPLOSION FLAME PROOF TEST	1/TYPE	IS-3682 IS-8239 IS-8240	IS-3682 IS-8239 IS-8240	TC	2
		10. PAINT SHADE, THICKNESS & FINISH	MA	VISUAL & MEASUREMENT BY ELKOMETER	SAMPLE	BHEL SPEC. & DATA SHEET	BHEL SPEC. & DATA SHEET	TC	2
BHEL									
BIDDER/VENDOR									
PARTICULARS									
NAME									
SIGNATURE									
DATE									
BIDDER'S/VENDORS COMPANY SEAL									

	QUALITY PLAN		CUSTOMER :		PROJECT TITLE		SPECIFICATION : NUMBER :					
			BIDDER/ VENDOR :		QUALITY PLAN NUMBER PED-506-Q-007, REV-03		SPECIFICATION : TITLE					
	SHEET 9 OF 9	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	SECTION AGENCY		VOLUME III REMARKS
										P	W	
1	2	3	4	5	6	7	8	9	10	11		
NOTES: 1 DEPENDING UPON THE SIZE AND CRITICALLY, WITNESSING BY BHEL SHALL BE DECIDED. 2 ROUTINE TESTS ON 100% MOTORS SHALL BE DONE BY THE VENDOR. HOWEVER, BHEL SHALL WITNESS ROUTINE TESTS ON RANDOM SAMPLES. THE SAMPLING PLAN SHALL BE MUTUALLY AGREED UPON. 3 IN CASE TEST CERTIFICATES FOR THESE TESTS ON SIMILAR TYPE, SIZE AND DESIGN OF MOTOR FROM INDEPENDENT LABORATORY ARE AVAILABLE, THESE TEST MAY NOT BE REPEATED. 4 WHEREVER CUSTOMER IS INVOLVED IN INSPECTION, AGENCY (1) SHALL MEAN BHEL AND CUSTOMERS BOTH TOGETHER. <u>Legends for Inspection agency</u> 1. BHEL/CUSTOMER 2. VENDOR (MOTOR MANUFACTURER) 3. SUB-VENDOR (RAW MATERIAL/COMPONENTS SUPPLIER) P. PERFORM W. WITNESS V. VERIFY												
BHEL												
PARTICULARS												
NAME												
SIGNATURE												
DATE												
BIDDER'S/VENDORS COMPANY SEAL												

QUALITY PLAN		CUSTOMER :		PROJECT		SPECIFICATION :						
		BIDDER/ VENDOR		TITLE		NUMBER :						
COMPONENT/OPERATION		SYSTEM		QUALITY PLAN NUMBER PED-506-00-Q-006, REV-01		SPECIFICATION TITLE						
SL. NO.	CHARACTERISTICS CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	SECTION			VOLUME III REMARKS	
								P	W	V		
1	2	3	4	5	6	7	8	9	10			11
1.0	ASSEMBLY	1.WORKMANSHIP	MA	VISUAL	100%	MANUF'S SPEC	MANUF'S SPEC	-DO-	2	-	-	
		2.DIMENSIONS	MA	-DO-	-DO-	MFG. DRG./ MFG. SPEC.	MFG. DRG./ MFG. SPEC.	-DO-	2	-	-	
		3.CORRECTNESS COMPLETENESS TERMINATIONS/ MARKING/COLOUR CODE	MA	VISUAL	100%	MFG.SPEC./ RELEVANT IS	MFG.SPEC. RELEVANT IS	-DO-	2	-	-	
2.0	PAINTING	1.SHADE	MA	VISUAL	SAMPLE	MANUF'R SPEC/BHEL SPEC./RELEVANT STANDARD	BHEL SPEC. SAME AS COL.7	LOG BOOK	2	-	-	
3.0	TESTS	1.ROUTINE TEST INCLUDING SPECIAL TEST AS PER BHEL SPEC.	MA	-DO-	100%	IS-325/ BHEL SPEC./ DATA SHEET	SAME AS COL.7	TEST REPORT	2	1		NOTE -1 & NOTE-3
		2.OVERALL DIMENSIONS & ORIENTATION	MA	MEASUREMENT & VISUAL	100%	APPROVED DRG/DATA SHEET	APPROVED DRG/DATA SHEET & RELEVANT IS	INSPN. REPORT	2	1	-	NOTE -1 & NOTE-3
BHEL		PARTICULARS			BIDDER/VENDOR							
		NAME										
		SIGNATURE										

	QUALITY PLAN		CUSTOMER :		PROJECT TITLE		SPECIFICATION : NUMBER :				
			BIDDER/ VENDOR		QUALITY PLAN		SPECIFICATION : TITLE :				
	SHEET 2 OF 2		SYSTEM CAT.		ITEM AC ELECT. MOTORS BELOW 55KW (LV)		SECTION AGENCY				
	COMPONENT/OPERATION CHARACTERISTICS CHECK		TYPE/ METHOD OF CHECK		EXTENT OF CHECK		REFERENCE DOCUMENT		ACCEPTANCE NORM		FORMAT OF RECORD
1	2	3	4	5	6	7	8	9	10	11	
		3.NAMEPLATE DETAILS	MA	VISUAL	100%	IS-325 & DATA SHEET	IS-325 & DATA SHEET	INSPN. REPORT	2 1 -		
NOTES: 1 ROUTINE TESTS ON 100% MOTORS SHALL BE DONE BY THE VENDOR. HOWEVER, BHEL SHALL WITNESS ROUTINE TESTS ON RANDOM SAMPLES. THE SAMPLING PLAN SHALL BE MUTUALLY AGREED UPON 2 WHERE EVER CUSTOMER IS INVOLVED IN INSPECTION, (1) SHALL MEAN BHEL AND CUSTOMERS BOTH TOGETHER. 3 FOR EXHAUST/VENTILATION FAN MOTORS OF RATING UPTO 1.5KW , ONLY ROUTINE TEST CERTIFICATES SHALL BE FURNISHED FOR SCRUTINY.											
<u>Legends for Inspection agency</u> 1. BHEL/CUSTOMER 2. VENDOR (MOTOR MANUFACTURER) 3. SUB-VENDOR (RAW MATERIAL/COMPONENTS SUPPLIER) P. PERFORM W. WITNESS V. VERIFY											
BHEL		PARTICULARS		BIDDER/VENDOR							
		NAME									
		SIGNATURE									
		DATE									
BIDDER'S/VENDORS COMPANY SEAL											



TITLE:
4 X 270 MW BHADRADRI TPS

**TECHNICAL SPECIFICATION FOR
EFFLUENT TREATMENT PLANT**

SPECIFICATION NO. PE-TS-411-164-A001

REV. NO. 00 DATE : 24/07/2017

SUB-SECTION IC

SPECIFIC TECHNICAL REQUIREMENTS (CONTROL & INSTRUMENTATION)



TITLE:
4 X 270 MW BHADRADRI TPS

SPECIFICATION NO. PE-TS-411-164-A001

**TECHNICAL SPECIFICATION FOR
EFFLUENT TREATMENT PLANT**

REV. NO. 00

DATE : 24/07/2017

1. Bidder to include Field instrumentation and Field Junction Box (JB's), in his scope of supply. Field instrument specification and Data Sheet are given elsewhere in this spec.
2. All fields cabling for instruments/motor/pump/blower to JB is in bidder's scope and details are given elsewhere in this spec. JB to PLC shall be provided by BHEL as free issue whereas cable schedule, cable interconnections and wiring diagram for the same shall be in bidders' scope.
3. Instrument installation drawings are to be provided by bidder. All instrument fitting and erection hardware as per instrument installation diagram shall be in bidder's scope.
4. All manual valves at pump discharge shall be provided with Open and Close Limit Switches.
5. PLC control system as defined in the enclosed specs and DATA Sheets shall be in bidder scope. The PLC system shall comprise of (i) PLC based local panel (ii) UPS Power supply (iii) Operator interface in the form of CRT, keyboard and OWS, along with required furniture.
6. PLC shall have the facility to synchronize its time with BHEL supplied GPS. Necessary Hardware (IRIG-B port) for same at PLC end to be provided by bidder. The cable connecting PLC and GPS shall be in BHEL scope.
7. PLC shall be connected to DCS through serial link with OPC Compliant for monitoring/Control. For detailed, please refer PLC Architecture Diagram.
8. Two number RIO panels to be provided with Fiber Optic cable for connecting the RIO with the PLC. The network communication between RIO and PLC shall be redundant. All the necessary hardware and software is in ETP Vendor scope of supply. The fiber optic cable of 2 KM is required.
9. Back panel shall be provided with Colored MIMIC, Push Button, Lamps and Hardwire Annunciation.
10. All furniture (tables, chairs etc.) required for PLC operator HMI shall be in bidder's scope. Chairs shall be capable of being adjusted for height and position of backrest. The chairs shall be mounted on five castors, shall swivel and shall have arm rests'. One table and chair shall be provided for each operator station and separate table for each printer.
11. The requirements given below are to be read in conjunction with detailed Technical specification enclosed.



TITLE:
4 X 270 MW BHADRADRI TPS

SPECIFICATION NO. PE-TS-411-164-A001

**TECHNICAL SPECIFICATION FOR
EFFLUENT TREATMENT PLANT**

REV. NO. 00

DATE : 24/07/2017

12. For any other cable type, the scope of cable and cable type in 'Electrical scope split sheet' in Electrical portion of the specification shall be final.
13. Every panel-mounted instrument, requiring power supply, shall be provided with a pair of easily replaceable glass cartridge fuses of suitable rating. Every instrument shall be provided with a grounding terminal and shall be suitably connected to the panel grounding bus.
14. Supplied system shall provide group alarms to be hardwired to plant DCS.
15. Provision for separate Terminal block/wiring diagram for power and control blocks of control panel to be ensured.
16. Provision for earthing of the panel to be provided by vendor.
17. Vendor to submit GA drawing of control panel indicating layout of instruments, construction details, wiring diagram, class of protection for enclosure, paint type, paint color, thickness and material of enclosure sheet, control scheme during detailed engineering.
18. Layout & space requirement of panel to be specified during detailed engineering.
19. All bidirectional drives (Motor Operated Valves, MOVs) are integral starter type. Typical Hook Up diagram of all types of drives is attached for use(subject to Customer approval).
20. Bidder shall provide Cable Schedule in BHEL excel format provided in Electrical portion of the specification. Also, Cable Interconnections details for Complete System shall be in Bidders' scope.
21. 415 V AC (3 Phase, 3 Wire) supply shall be provided by BHEL at a single point as per 'Electrical scope split sheet' in Electrical portion of the specification. Further distribution to various instruments/Equipment shall be in Bidder's scope. Bidder to include the necessary power distribution board in his scope. Any power supply other than the above, if required for any instrument/equipment has to be derived from the above supply & all the necessary hardware for the same shall be in Bidder's scope.



TITLE:
4 X 270 MW BHADRADRI TPS

SPECIFICATION NO. PE-TS-411-164-A001

**TECHNICAL SPECIFICATION FOR
EFFLUENT TREATMENT PLANT**

REV. NO. 00

DATE : 24/07/2017

22. Bidder to provide all control panels, system cabinets, termination & relay cabinets complete with all accessories, wiring and all mounting and erection hardware including junction boxes, canopies, structural steel as required. All instruments/drives shall be terminated on Junction Boxes/Panel in Bidder scope of supply. 20% Spare terminals shall be provided on Junction Boxes.
23. Bidder to delegate/depute their person/experts as per owner/consultant requirements.
24. All the furniture for OWS/ Printer required for the system shall be in bidder's scope of supply.
25. The make of all the items shall be from approved sub-vendor list.
26. The design, manufacture, inspection, testing, site calibration and installation of all C&I equipment and systems covered under this specification shall conform to the latest editions of applicable codes and standards eg. ANSI, ASME, IEEE, ISO, IEC, IGCI, AWS, NFPA, AISC, IGS, SAMA, UBC, UL, NESC, NEMA, ISA, DIN, VDE, IS etc.
27. Bidder shall provide the signal exchange, to Plant DCS in BHEL prescribed format to be furnished during detailed engineering.

NOTES:

1. All equipment items shall be of latest design with proven on track record from reputed experienced manufacturers of specified type and range of equipment. The make/model of various instruments/items/systems and instrument sub-vendor shall be subject to approval of BHEL/Customer during detailed engineering stage.
2. The above given scope is indicative & minimum. Any item/ equipment not indicated above however required for the completeness of the system is to be supplied by bidder without any technical, commercial and delivery implication to BHEL.
3. Documents of C&I System shall be submitted to end user/owner for approval during detail engineering. Changes, if any, shall be accommodated by the bidder without any price/time implication.



TITLE:
4 X 270 MW BHADRADRI TPS

SPECIFICATION NO. PE-TS-411-164-A001

**TECHNICAL SPECIFICATION FOR
EFFLUENT TREATMENT PLANT**

REV. NO. 00

DATE : 24/07/2017

Additional Specific requirement

Remote I/O

Remote I/O panels shall be provided by bidder with pushbuttons, indicating lamps and hardwired annunciation system for local control/ operations.

Ethernet Specification

Networking (LAN) components:

Networking (LAN) components including switches, Firewall, fibre optics cable, other cable as required, jack panel with wire manager, patch cord, coupler, rack with all accessories, connectors, port, etc. shall be provided by bidder.

- A) The Industrial graded, IEC 61850-3 Std compliant, Managed Ethernet Switches shall meet following minimum requirements:
- i) 48 X Gigabit Ethernet Port
 - ii) 24 or 48 x 10/100/1000 Base TX ports (STP)
 - iii) SNMP, RMON, VOIP, VLAN, Multi link Trunk support
 - iv) Broadcast/multicast storm control
 - v) Supervisor Engine redundancy capability
 - vi) Redundant Power Supply
 - vii) Extra expansion slots for future up gradation.
 - viii) Integrated Security features (IPS, ACL, Firewall)
 - ix) 10 GB module support for future upgradeability

Expandability / stackability through a dedicated high speed expansion port.

Routable, remotely manageable, configurable.

One intelligent SNMP manageable mini-UPS for 30 minutes backup shall be provided with all accessories and software.

- B) Secondary switches shall have the following features:

- i) 24 or 48 X 10/100/1000 Base TX ports (STP)
- ii) 2 or 4 X Gigabit Ethernet Port
- iii) SNMP, RMON, VOIP, VLAN, Multi link Trunk support.
- iv) Support for stacking with high throughput
- v) Broadcast/multicast storm control

- C) The Firewall shall meet following minimum requirements:

Firewall appliance shall facilitate multi-vendor, multi-application environment and shall support third-party products on open alliance. It shall support Active-Active configuration.

- i) The firewall shall contain following features:

- a) Stateful inspection of packets.
- b) NAT functionality, including dynamic and static NAT translations
- c) Latest version of SNMP

- ii) The firewall must send log information to a separate log server via an encrypted connection. Firewall logging must not impact firewall performance.



TITLE:
4 X 270 MW BHADRADRI TPS

SPECIFICATION NO. PE-TS-411-164-A001

**TECHNICAL SPECIFICATION FOR
EFFLUENT TREATMENT PLANT**

REV. NO. 00

DATE : 24/07/2017

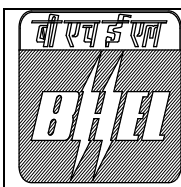
- iii) Remote network access to the firewall shall only be possible through the administration interface.
- iv) The firewall administration station must be capable of pushing firewall security policies and configurations to individual or multiple firewalls through a secure, encrypted connection to the firewall administration interfaces.
- v) Graphical User Interface (GUI) and a Command Line Interface (CLI) for making changes to the firewall rules set shall be provided. (Access to the firewalls via the GUI or the CLI must be through a secure encrypted channel).
- vi) Any changes or commands issued by an authenticated user shall be logged to a database configured on any of the machines in the LAN. The administration station must allow for a hierarchical architecture for rules set administration and viewing of firewall configurations Management.
- vii) The firewall must not support any unencrypted means of access to the firewall.
- viii) It shall Monitor ALL network traffic-traffic at Firewalls (Internet and external networks), in the DMZ and detect known threat through deep packet inspection.
- ix) Detects unknown threats via anomaly scanning.
- x) Detect unknown threats via behavior pattern to protect from zero day attacks.
- xi) Keeps up-to-date on new threats and vulnerabilities.

D) Intrusion Detection System (IDS) and Intrusion Prevention System (IPS)

Features:

In order to inspect all inbound and outbound network activity and identify suspicious patterns that may indicate a network or system attack from someone attempting to break into or compromise a system on the Station LAN Network, the recommended IDS/IPS shall contain the following combined features. Any feature can be selected depending on whether it is to be configured as IPS or IDS.

- i) Able to analyze, detect and report on security related events.
- ii) Able to inspect traffic and to drop malicious traffic based on the configuration of security policy.
- iii) Able to inspect the content of network packets for unique sequences/signatures.
- iv) Able to detect and prevent known types of attacks such as worm or Trojan infections and hacks.
- v) Able to prevent denial of service (DOS) and Distributed Denial of Service attacks.
- vi) Able to prevent abnormal behaviors by monitoring and learning normal network behaviors.
- vii) Keeps up-to-date on new threats and vulnerabilities.
- viii) Shall provide user friendly interface to queries and reports on threats and event data so that security administrators can gain a better understanding of their ability to protect their network.
- ix) Shall provide detailed activity logs for auditing.
- x) Able to detect known threats via deep-packet inspection.
- xi) Able to detect unknown threats via anomaly scanning.



TITLE:
4 X 270 MW BHADRADRI TPS

SPECIFICATION NO. PE-TS-411-164-A001

**TECHNICAL SPECIFICATION FOR
EFFLUENT TREATMENT PLANT**

REV. NO. 00

DATE : 24/07/2017

- xii) Able to detect unknown threats via behavior pattern to protect from zero day attacks.

UPS signal IO List

The following minimum hardware/software signal shall be provided between UPS and PLC by bidder. These analog & digital signals shall be updated in HMI MIMICS.

- a. Main I/P 1, 2 alternate I/P voltage, currents.
- b. After line transformer -1&2 voltages
- c. DC O/P VOLTAGE, current and battery charging , discharging currents,
- d. Inverter o/p voltage, current.
- e. Static switch main I/P, alternate i/p voltage.
- f. SCVS O/P VOLTAGE, CURRENT, HZ
- g. UPS-1 & 2 –KVA, KW o/ps
- h. ACDB -1&2 VOLTAGE, CURRENT
- i. UPS-1,2 –POWER FACTOR

SENSOR REDUNDANCY

Following redundancy criteria shall be met:

1. Two out of three measurements philosophy shall be adopted for all CLCS (Closed Loop Control System) and Protection for reliability of operation. The control system shall select the median value for the normal control purpose. In case of deviation of one transmitter output from the other two, the same shall be automatically isolated and average output of the remaining transmitters shall be fed to the control and measurement system and the control loop in this case shall be maintained on auto, with an alarm on the operator's work station as well as on the engineer's station. In case of failure of the two remaining transmitters in circuit, deviation of one transmitter output is more than the pre-set limit compared to the other transmitter, there shall be automatic bump less transfer to manual and Changeovers shall have suitable alarms in the operator's work station as well as engineer's station.
2. For signal compensations, separate signals from separate transmitters other than used for measurement & control shall be used.
3. For OLCS (Open Loop Control System) all sensors used for the protection shall be triple redundant All sensors for permissive and interlock shall be dual redundant.

GENERAL POINTS:

1. The Instrumentation furnished in the PID is a minimum requirement however any instrument required for completeness of the system shall be provided by bidder without any cost implication. The requirement shall be decided during detailed engineering.
2. Solenoid Valves shall be mounted in Pneumatic Junction Boxes only and Pneumatic Junction box shall be in the scope of bidder. (Typical photo of Pneumatic Junction Box is attached for ready reference)



TITLE:
4 X 270 MW BHADRADRI TPS

SPECIFICATION NO. PE-TS-411-164-A001

**TECHNICAL SPECIFICATION FOR
EFFLUENT TREATMENT PLANT**

REV. NO. 00

DATE : 24/07/2017

3. LIE/LIR shall be provided for mounting of the instrument and LIE/LIR shall be in the scope of bidder.





TITLE:
4 X 270 MW BHADRADI TPS

**TECHNICAL SPECIFICATION FOR
EFFLUENT TREATMENT PLANT**

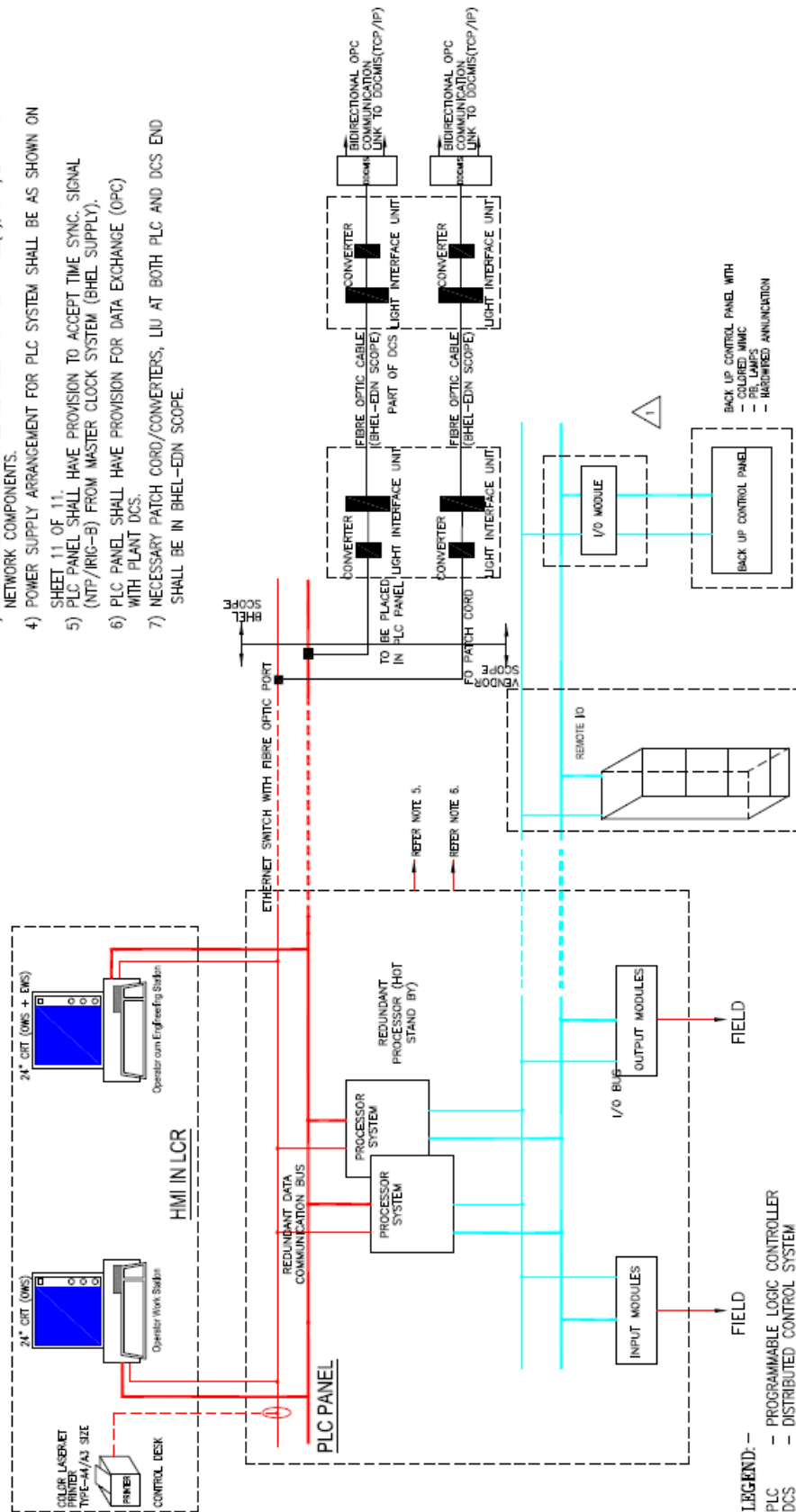
SPECIFICATION NO. PE-TS-411-164-A001

REV. NO. 00

DATE : 24/07/2017

NOTES:

- 1) TABLE TOP OWS/EWS SHALL BE 24" OR AVAILABLE INDUSTRY STANDARD.
- 2) PLC SYSTEM SHALL HAVE REDUNDANCY IN PROCESSOR, POWER SUPPLY AND COMMUNICATION SYSTEM.
- 3) UPS POWER SUPPLY SHALL BE USED FOR PLC PANEL(S), OWS/EWS AND NETWORK COMPONENTS.
- 4) POWER SUPPLY ARRANGEMENT FOR PLC SYSTEM SHALL BE AS SHOWN ON SHEET 11 OF 11.
- 5) PLC PANEL SHALL HAVE PROVISION TO ACCEPT TIME SYNC. SIGNAL (NTP/IRIG-B) FROM MASTER CLOCK SYSTEM (BHEL SUPPLY).
- 6) PLC PANEL SHALL HAVE PROVISION FOR DATA EXCHANGE (OPC) WITH PLANT DCS.
- 7) NECESSARY PATCH CORD/CONVERTERS, LIU AT BOTH PLC AND DCS END SHALL BE IN BHEL-EDN SCOPE.



LEGEND:-

- PLC - PROGRAMMABLE LOGIC CONTROLLER
- DCS - DISTRIBUTED CONTROL SYSTEM
- UPS - UNINTERRUPTED POWER SUPPLY
- OWS/EWS - OPERATOR WORK STATION/ ENGINEERING WORK STATION
- HMI - HUMAN MACHINE INTERFACE
- NTP - NETWORK TIME PROTOCOL
- OPC - OLE PROCESS CONTROL
- MCCB - MOULDED CASE CIRCUIT BREAKER
- MCB - MINIATURE CIRCUIT BREAKER
- LCR - LOCAL CONTROL ROOM

 Bharat Heavy Electricals Limited	PROJECT: 4X270 MW BHADRADI TPS		DRG. NO.	PE-DW-411-145-1900	
	TITLE: PLC CONFIGURATION EFFLUENT TREATMENT PLANT		DATE	01.07.2015	
			REV. NO.	02	
			SHT	6	OF



TITLE:
4 X 270 MW BHADRADRI TPS

SPECIFICATION NO. PE-TS-411-164-A001

**TECHNICAL SPECIFICATION FOR
EFFLUENT TREATMENT PLANT**

REV. NO. 00

DATE : 24/07/2017

SECTION – II

GENERAL TECHNICAL REQUIREMENTS

SUB-SECTION IIA - GENERAL TECHNICAL REQUIREMENTS (MECHANICAL)

SUB-SECTION IIB - GENERAL TECHNICAL REQUIREMENTS (ELECTRICAL)

SUB-SECTION IIC - GENERAL TECHNICAL REQUIREMENTS (CONTROL & INSTRUMENTATION)



TITLE:

4 X 270 MW BHADRADRI TPS

SPECIFICATION NO. PE-TS-411-164-A001

**TECHNICAL SPECIFICATION FOR
EFFLUENT TREATMENT PLANT**

REV. NO. 00

DATE : 24/07/2017

SUB-SECTION IIA

GENERAL TECHNICAL REQUIREMENTS (MECHANICAL)

	TITLE: 4 X 270 MW BHADRADRI TPS		SPECIFICATION NO. PE-TS-411-164-A001	
	TECHNICAL SPECIFICATION FOR EFFLUENT TREATMENT PLANT		REV. NO. 00	DATE : 24/07/2017

1. REFERENCE DOCUMENTS

A. ANNEXURE – XIII	:	WATER ANALYSIS
B. PE-DG-411-164A-A001	:	P & ID FOR EFFLUENT TREATMENT PLANT
C. DATASHEET – A	:	EFFLUENT TREATMENT PLANT
D. PE-DG-411-100-M001	:	PLOT PLAN

2. DESIGN REQUIREMENTS

Following effluents will be collected /treated in the Effluent treatment plant. (Please refer the enclosed P & I Diagram for Effluent Treatment Plant for more details):

- a) SG, TG and Boiler Area Floor Wash waste
- b) Transformer Yard oily waste and Fuel oil area oily waste
- c) Boiler Blow down
- d) Side stream filtration backwash waste
- e) DM regeneration waste
- f) ESP area wash water
- g) Excess cooling tower blowdown

a) SG, TG and Boiler Area Floor Wash waste

Effluent waste generated in SG and Boiler area shall be collected in local sump. In addition, waste collected in condenser pit shall also be pumped to this local sump. This sump is common for Unit 1 & 2. Another sump is also envisaged for Unit 3 & 4. This waste contains suspended solids and oil. Further this waste shall be transferred common oily waste collection sump located in ETP area for further treatment in lamella clarifier / tube settler. Oil shall be collected in oil drums and clear water shall be transferred to RO reject sump, in addition sludge generated from lamella clarifier / tube settler shall be transferred to sludge trolley as well as sludge sump.

b) Transformer Yard oily waste and Fuel oil area oily waste

The oily waste from Transformer area and fuel oil area shall be collected in common oily waste collection sump for further treatment in lamella clarifier / tube settler as per P & ID attached.

c) Boiler Blow down

Boiler blow down shall be collected and transferred to cooling tower forebay. Temperature of Boiler blowdown shall be approx. 90 deg C. Bidder to design equipments accordingly.

d) DM regeneration waste

Neutralized DM plant regeneration waste shall be led to equalization tank.

e) ESP area wash water

Washing waste generated in ESP area shall be led to ash clarifier.

f) Excess cooling tower blowdown

Excess cooling tower blowdown shall be led to Equalization tank for further treatment.

g) Side Stream Filtration Backwash waste

Backwash waste from Side stream filtration shall be collected in sumps and transferred to ETP area in clarifier for further removal of TSS.



TITLE: 4 X 270 MW BHADRADRI TPS	SPECIFICATION NO. PE-TS-411-164-A001	
TECHNICAL SPECIFICATION FOR EFFLUENT TREATMENT PLANT	REV. NO. 00	DATE : 24/07/2017

2.1 TREATMENT FROM EQUALISATION TANK

Waste collected in equalization tank shall be treated through aerator and clarifier I for TSS removal. Sludge generated from clarifier shall be transferred to ETP clarifier sludge sump for further transfer to RO reject sump. Further clarified water shall be pumped to ultrafiltration unit after treatment through PSF and ACF. UF permeate shall be collected in UF permeate tank for further pumping to RO plant. Backwash waste of UF shall be recycle to clarifier I of ETP. Permeate from RO shall be collected to RO permeate tank and the same shall be transferred to clarified water storage tank of PT plant for further use. In addition, reject from RO shall be collected in RO reject sump for further disposal to ash water sump. Chemical dosing and chemical cleaning system shall be provided for Clarifier I, UF and RO system by bidder.

2.2 TREATMENT OF SIDE STREAM FILTRATION WASTE

Side stream filtration waste shall be transferred to stilling chamber of Clarifier II. Clarified water shall be collected in SSF clarifier water storage tank which will further pump to Forebay I and Forebay II. Sludge generated from clarifier shall be transferred to RO reject sump. Chemical dosing system shall be provided by bidder for Clarifier II.

3. TECHNICAL REQUIREMENT OF EFFLUENT TREATMENT PLANT

- 3.1 Complete effluent treatment plant shall include associated design for all equipments, mechanical, electrical, control & instrumentation work.
- 3.2 The effluent water from effluent treatment system / equipments shall meet the guaranteed parameters.
- 3.3 All the equipments of ETP shall be designed to operate simultaneously.
- 3.4 All the sumps, tanks, pits, settling ponds, pump house etc shall be RCC construction unless otherwise mentioned.
- 3.5 All the pumps & drives of ETP shall be provided with maintenance bay/area.
- 3.6 Operating platforms shall be provided for all the structures such as flash mixer, flocculation chamber, Tube Settlers/Lamella Clarifiers, with ladders and hand railing. All the sumps, tanks, reservoirs and other water retaining structures shall be provided with access ladders/rungs from operating platforms/ground level as the case may be and de-watering pits one for each section. Supply and erection of hand railing will be bidder's scope.
- 3.7 All the tanks shall be provided with vent, overflow, drain and sample connections. Effective capacity for chemical tanks & water retaining structures/ tanks/sumps means the capacity between the bottoms of the overflow nozzle to the top of the outlet nozzle. Outlet nozzle centre line shall be kept at least 200 mm from the Invert Level of the chemical tanks / water retaining structures / tanks/sumps. A minimum free board of 300 mm shall be provided in all the water retaining structures of ETP above the maximum water level / overflow level as the case may be excluding the thickness of the slab / beam thickness if any.
- 3.8 All effluent sumps shall be covered at top as per requirement.
- 3.9 All the sump pumps shall be provided with re-circulation system from the pump discharge.
- 3.10 Maximum operating speed of all the pumps shall be limited to 1500 rpm or less unless specified otherwise.
- 3.11 Minimum thickness of atmospheric steel and non-metallic tanks shall be 6 mm.

3.12 LAMELLA CLARIFIER / TUBE SETTLER

- 3.11.1 The tube settler/ Lamella Clarifier shall be capable of handling the specified design flow rate and producing effluent water quality as indicated datasheet A.
- 3.11.2 Tube settler / Lamella Clarifier shall be provided with one flash mixer and Flocculation.
- 3.11.3 Chemical shall be added to the wastewater in the flash mixer. Flash mixer shall be circular/rectangular type. Water from the flash mixer shall flow to adjacent flocculation chamber by gravity. Suitable mechanical stirrer, driven by electric motor through speed reducing gearbox, shall be provided in flash mixer to ensure adequate mixing of chemicals Flash mixer shall provide minimum one-minute storage at the design flow rate of the flash mixer.
- 3.11.4 Water from flash mixer shall flow to a flocculation chamber by gravity. Adequate retention time (minimum 10-minute storage at the design flow rate) shall be provided for the incoming water to allow



TITLE: 4 X 270 MW BHADRADRI TPS	SPECIFICATION NO. PE-TS-411-164-A001	
	TECHNICAL SPECIFICATION FOR EFFLUENT TREATMENT PLANT	REV. NO. 00 DATE : 24/07/2017

formation of uniform flocks. The flocculation chamber shall be of circular/rectangular type with suitable mechanical agitator driven by electric motor through speed reducing gearbox. Water from the bottom of flocculation chamber shall flow to the Tube Settler / Lamella Clarifier by gravity. Designs with flocculation chamber and separator integral in the same unit are also acceptable.

- 3.11.5** The tube settler/ Lamella Clarifiers shall be provided with walkway (bridge) and platform to approach all the internals. Clear width of the bridge shall not be less than 1200 mm.
- 3.11.6** All metallic parts inside the tube settler/ Lamella Clarifiers coming in contact with water shall be painted with three (3) coats of epoxy paint over one (1) coat of primer to prevent corrosion Total thickness 300 micron. Other components shall be painted with one coat of red lead primer and three coats of suitable rust preventing paint Total thickness 200 micron.
- 3.11.7** Design of the sludge removal system should be such as to reduce loss of water during sludge blow off within 5% of rated flow.
- 3.11.8** The tube settler/ Lamella Clarifiers periphery shall have sufficient width to have an easy walkway along-with hand-railing for general inspection. Access ladders (at least from two locations) with platforms and hand-railing shall be provided in the separator for good approach. However, the manual sludge valves shall be operable from the top of the sludge chamber through head stock and extended spindle arrangement.
- 3.11.9** Suitable sampling connections shall be provided for performance monitoring.
- 3.11.10** The tube settler/ Lamella Clarifiers shall be circular / rectangular with distinct tube /plate separation zones, sludge thickener zone, clear water zone and oil skimming zone. The tube settler/ Lamella Clarifiers shall be counter flow or cross flow type. Co-flow type units are not acceptable.
- 3.11.11** The unit shall be designed with minimum side water depth of 4 M. The overall area of unit shall be based on an average flow velocity not more than 5 m³/hr/m²
- 3.11.12** The inclined tubes/plates shall be spaced so that stable flow conditions are available. The flow through the tube/plates shall be viscous / laminar. The cross sectional area of each tube shall be such that the effective hydraulic diameter is 80 mm (min). The material of tube pack shall be UV inhibited virgin PVC.
- 3.11.13** In case of plate type separator, the distance between the successive plates shall be 50 mm (min). The plates shall be made of GRP (glass reinforced plastic). The resin for the manufacturing of GRP plates shall be orthophthallic type.
- 3.11.14** The length of the tubes/plates through which the water flow shall not be less than 1.5 M.
- 3.11.15** The tubes/plates shall be inclined by 50-80 deg. angle to the horizontal. The tubes/plates shall be arranged such that the complete water travels through all the tubes across the cross section of separator.
- 3.11.16** To remove settled particles from the plates/tubes suitable water jet arrangement shall be provided. Pumping and piping arrangement shall be separately provided for this purpose if required. The tube/ plates shall be easily accessible for the cleaning purpose. The tube pack / plates shall be placed inside the separator such that these may be individually removed for maintenance even when separator is operating.
- 3.11.17** The entire pack shall be rigid and shall not deflect by self-weight, water load or operator movement over the pack. Special features of pack/plate support arrangement and maintenance shall be brought out in the bid.
- 3.11.18** Treated water shall be collected in a trough provided with adjustable weir.
- 3.11.19** The unit shall be capable of delivering constant effluent water quality without any sludge/oil carryover, even at the time of rapid increase in influent water flow or change in influent water quality, or changes in raw water temperature.
- 3.11.20** The bidder shall justify the design basis of entire plate/tube type separator unit and individual components of the entire unit with backup calculations and also by means of supplying documentary evidence from their earlier installed plants in the form of drawings, certificates, etc.
- 3.11.21** The tube settler/ Lamella Clarifiers shall employ positive removal system of consistent density, central sludge concentrating sump, water flushing nozzles etc. as per the standard design of manufacturer. Sludge removal system shall be designed to thicken the sludge to minimum 2% consistency before disposing from separator bottom. All the pipelines carrying the sludge shall be provided with flushing connection. The pumps and piping if required for flushing purpose shall also be separately provided. Angle of inclination of sludge hopper shall be minimum 55 deg. to horizontal plane for effective collection of sludge.
- 3.11.22** Sludge blow-off shall be affected by the static head of water in the Tube settler/ Lamella Clarifier. Sludge outlet pipe from the concentrated sludge hopper shall be branched into main disposal line.



TITLE:
4 X 270 MW BHADRADRI TPS

SPECIFICATION NO. PE-TS-411-164-A001

**TECHNICAL SPECIFICATION FOR
EFFLUENT TREATMENT PLANT**

REV. NO. 00

DATE : 24/07/2017

Main sludge disposal line should consist of blow-off valve which would be operated manually and drain sludge to the sludge disposal sump. This would be an intermittent operation. Continuous sludge disposal line shall consist of a telescopic stand pipe, the top of which would be maintained at a desired elevation to ensure trickle flow of water of sludge water mixture to the sludge sump. Sludge shall be led into sludge sump provided for lamella clarifier sludge.

The design criteria of lamella clarifier / tube settler shall be as per following:

Parameter	Maximum value	inlet	Outlet value
Oil (Free) and grease	50 ppm		10 ppm
TSS	500 ppm		10 ppm

OUTLET GUARANTEE PARAMETERS:

- Effluent TSS: 10 ppm at design flow
- Effluent TSS: 15 ppm at 20% overflow condition.
- Effluent Oil & grease: 5 ppm (maximum)

3.13 AERATOR

The aerator shall be of stepped design and shall allow water to flow downward after spreading over inclined thin sheets and the turbulence is secured by allowing the water to pass through a series of steps and baffles. Exposure time shall be suitably designed by providing adequate number of steps in the aerator.

Water from aerator launder shall be led into the Stilling Chamber.

1.1.2.1 STILLING CHAMBER

The stilling chamber shall be provided with a baffle wall so that water shall enter the chamber from the bottom and velocity of water rise through the stilling chamber shall be selected to avoid any turbulence of the incoming water and volume of stilling chamber shall have a retention time. Draining arrangement with a valve shall be provided for the stilling chamber.

1.1.2.2 CLARIFIER

The type of clarifier shall be Clariflocculator type with variable frequency driven at adjustable rate to produce consistent water quality at varying hydraulic load and turbidity.

These clarifiers shall be provided with following features: -

- 1) The unit shall be designed with a minimum retention time as specified in datasheet A in the settling zone. Larger retention time may be provided to meet the outlet guarantee.
- 2) The overall area of the unit shall be based on an average flow velocity approx. $1.2 \text{ m}^3/\text{m}^2/\text{hr}$.
- 3) Weir loading shall not exceed $300 \text{ m}^3/\text{m}/\text{day}$. For uniform overflow over weirs, triangular notches (saw tooth weir) shall be provided as necessary.
- 4) Clear width of the bridge shall not be less than 1200 mm.
- 5) Design of the sludge removal system should be such as to reduce loss of water during sludge blow off within 3% of rated flow. Inlet portion of the unit, (i.e. pumps, stilling chamber, inlet channel and clarifier) shall be designed to handle excess water to make good for water loss during sludge blow-off.
- 6) The clarifier periphery (all around) shall have sufficient width (minimum 1200 mm) to have an easy walkway for general inspection. This walkway shall be provided with handrail along with periphery access ladders (at least from two locations) with platforms and hand railing for the clarifier for good approach. Permanent ladders shall also be provided (not rungs) for approaching the sludge pipeline valves for maintenance. (However the sludge valves shall be operatable from the top of the sludge chamber through head stock and extended spindle arrangement. Hand railing shall be provided by bidder.
- 7) The sludge blanket shall be suspended and maintained in the lower portion.



TITLE:

4 X 270 MW BHADRADRI TPS

SPECIFICATION NO. PE-TS-411-164-A001

**TECHNICAL SPECIFICATION FOR
EFFLUENT TREATMENT PLANT**

REV. NO. 00

DATE : 24/07/2017

- 8) The clarifier unit shall be circular, central feed / side feed type with sampling points at different elevation, flocculation zone and clarification zone in RCC construction.
- 9) Stilling chamber, flash mixer and Clarifiers shall all be of RCC construction unless otherwise mentioned.
- 10) The hydraulic circuit shall be designed in such a way that water from Aerator / stilling chamber shall flow by gravity up to the clarified water storage tank under various flow rates up to maximum flow.
- 11) Bridge type rake arm and suitable equipment such as turbine/ impeller shall be provided for internal sludge recirculation.
- 12) Complete clarification system shall design to run continuously.
- 13) Layout shall be designed in such a way that all units (e.g.- aerator, stilling chamber, clarifier, inlet channel, outlet channel and clarified water storage shall be interconnected by at least 1.2 M wide walkway at appropriate elevations with hand-railing on both sides and pathway at ground level.
- 14) The design of the turbine/ impeller shall be such as not to break the flocks during recirculation.
- 15) Suitable mechanism for varying the recirculation rate (VFD) shall also be provided by bidder for both the clarifiers such that the clarifier shall be capable of operating at varying hydraulic load and turbidity with consistent effluent quality.
- 16) Clarifiers shall be provided with radial launders.
- 17) The bottom of clarifier shall be sloped towards the center and mechanically driven sludge scraper and collector shall be used to remove the settled sludge down the sloping bottom to the central sludge area. Rubber squeezer pads shall be provided on sludge scraper and skimmer. Sludge removal system design shall consist of central sludge area with rotating pickets and back flush arrangement for proper control of sludge accumulation at the bottom.
- 18) Suitable scum collecting arrangement shall be provided in the clarifying section for removal of floating debris, foam etc. if possible. The scrapper shall consist of blades (Mild steel with rubber inserts with bitumastic paint protective coating) which are inclined to the radius in the opposite direction to that of the floor scraper.
- 19) The rake bridge and agitators shall be constructed of structural steel and suitably braced to provide rigidity.
- 20) Sludge blow off shall be effected by the static head of water in the clarifier unit. Sludge outlet pipes from the concentrated sludge hopper shall be branched into main disposal line and continuous sludge disposal line. Main sludge disposal line, which includes a blow-off valve, shall drain sludge to the sludge disposal pump sump. This is an intermittent operation. Continuous sludge disposal line consists of telescopic stand pipe, the top of which is maintained at a desired elevation to ensure trickle flow of water or sludge water mixture to the sludge sump. The de-sludging of clarifiers shall be done twice in a shift. The de-sludging of Clarifier shall not exceed one (1) hour. All equipments/ sumps shall be designed accordingly.
- 21) Arrangement of clarifier sludge pit/ sump shall be as indicated in data sheet and schematic drawings. Minimum capacity of the pit shall be referred in the data sheets. Bidder shall supply all necessary piping, valves and other accessories as required. Pit shall be provided with agitation by recirculation (jetting nozzles) systems.
- 22) Suitable sampling connections from the various levels and zones of clarifier and at the outlet shall be provided for performance monitoring.
- 23) Clarifier shall be provided by bidder with gates as per P & ID for isolation.
- 24) Clarifiers shall be of half bridge type.
- 25) Detention time in flocculation zone and clarification zone shall be selected by bidder to maintain the outlet TSS meeting minimum specification requirement.

1.1.2.3 OVERHEAD FILTERED WATER STORAGE TANK

The Filtered Water Overhead Tank shall be located at top of building and have approach through permanent staircases (RCC) and door. The water level in the tank shall be maintained by means of a float operated valve. The tank shall be provided with an overflow and drain connection with valve.

3.14 UF SYSTEM



TITLE: 4 X 270 MW BHADRADRI TPS	SPECIFICATION NO. PE-TS-411-164-A001	
	TECHNICAL SPECIFICATION FOR EFFLUENT TREATMENT PLANT	REV. NO. 00 DATE : 24/07/2017

UF system (2 x 50%) is envisaged for further filtration and removal of suspended particles, to achieve the design SDI value of final permeate. The water from clarified water storage tank is pumped to PSF, ACF and then to UF system which includes ultra-filter membrane modules. Water is filtered and then stored in the UF permeate storage tank. Necessary automatic backwash flushing and membrane cleaning system are envisaged (as per membrane manufacturer recommendation) for smooth trouble free operation. UF permeate transfer pumps are provided to transfer feed water to RO system via cartridge filter.

- ✓ Membrane shall be selected and designed for all operating temperature.
- ✓ Membranes shall be of hollow fiber type of PVDF or Polysulfone polymeric material. The pore size of membranes shall not be more than 0.04 microns.
- ✓ Each stream shall be provided with 2 x 100% strainers at inlet to membrane skid. Pressure indicators at upstream and downstream of each strainer and pressure differential transmitter across each strainer shall be provided.
- ✓ Membrane cleaning system like chemical preparation cum dosing tanks (1 no. for each type chemical) and dosing pumps (2 x 100% dosing pumps for each type of chemical) etc. shall be provided as per standard practice of ultra-filtration system designer/ recommendation of membrane manufacturer. The preparation cum dosing tank shall be with minimum 6.0 mm thickness.
- ✓ UF permeate storage tank shall store water to supply feed water to Reverse Osmosis (through micron cartridge filter) system on continuous basis and to provide water for back washing of Ultra filtration membranes. Capacity of this tank shall be calculated based on backwashing cycle and time taken for backwashing.
- ✓ Back washing of membranes shall be done automatically. However, CEB shall be decided by manufacturer.

3.15 MICRON CARTRIDGE FILTERS

Three (2 x 100%) cartridge filters shall be provided in the upstream of RO module.

- ✓ Cartridge filter vessels shall have a capacity sufficient to hold the required number and size of the cartridge elements to filter feed water.
- ✓ Extent of filter fouling shall be identified by measuring a differential pressure drop across the inlet & outlet line of a Cartridge filter. Cartridge vessel shall be provided with pressure relief valve, drain valve and vent valve.
- ✓ The filter elements shall be cylindrical cartridges, constructed from continuously wound polypropylene fibers, which have a 5 micron nominal 90% efficient rating. The filter elements used in the membrane cleaning system shall be identical to the filter elements used to treat the RO feed water.
- ✓ Cartridge shall be self-supporting with no reinforcing structures or resins.
- ✓ Polypropylene material shall be 100% polypropylene with no binders, resins lubricants or other residuals from the manufacturing process.
- ✓ The filter vessel shall be designed in accordance with ASME boiler and Pressure vessel code section VIII, Division-I. Each vessel shall have type bolts and nuts of SS-304. Each vessel shall have a cover gasket with Buna N "O" rings. The vessel shall be provided with both clean and dirty water drain nozzles, as well as an air vent at the top. Each vessel shall be provided with a cover-lifting davit arrangement capable of lifting the cover and swinging it to the side. Each vessel shall be provided with a flanged inspection port shall be installed on the clean side plenum 90 degree from the inlet center line.

3.16 HIGH PRESSURE PUMPS



TITLE:
4 X 270 MW BHADRADRI TPS

SPECIFICATION NO. PE-TS-411-164-A001

**TECHNICAL SPECIFICATION FOR
EFFLUENT TREATMENT PLANT**

REV. NO. 00

DATE : 24/07/2017

3 x 50% high pressure pumps for each stage (i.e. Stage– I & Stage– II each) shall be provided to feed the pressurized water in RO membranes of each stage.

- ✓ The HP feed pump shall be of a horizontal multistage centrifugal type. The high-pressure pump shall be designed not to introduce flow and/or pressure pulsation in the feed or brine stream. The reverse osmosis system has to be operated with fluctuating feed salinity and feed temperature. An appropriate regulation of the feed pressure for each reverse osmosis train separately by a corresponding design of the high-pressure pumps and automatic feed pressure control is required.
- ✓ Selection of parameters (Capacity & Head) of HP Pump & its drive shall take into account requirements of membrane manufacturer and shall be designed to deliver required parameters throughout the design life of membrane
- ✓ The complete unit shall include the pump, motor drive and the lubrication system on a common base plate.

3.17 REVERSE OSMOSIS SYSTEM

RO system consists of following as minimum: -

Two (2 x 100%) cartridge filters shall be provided in the upstream of RO Stage (i.e. Stage –I & Stage– II). The filter element shall be cylindrical cartridges constructed from continuous wound polypropylene fibres. Cartridge shall be self-supporting with no reinforcing structures.

UF treated water shall be fed to the suction of the MCF feed pump then pressurised by High-pressure feed pump (3 x 50%) stage -I and then fed to RO membranes (2 x 55%) Stage -I. The RO reject generated of Stage– I shall be boost up by High-pressure feed pump (3 x 50%) stage -II for further feed to RO stage -II. Permeate from RO shall be pass through degassifier unit. The RO reject generated from Stage –II shall be led to RO reject sump.

Each RO stream shall be provided with a dedicated HP pump and one common stand-by. The HP pump shall be able to discharge reject against a backpressure without the need for additional pumping equipment. At the discharge side of the HP feed pump a pressure control valve shall be installed to regulate the feed pressure to the membrane assembly according to the salinity of the feed water. The HP pump shall be designed to operate in the entire range of operation of the feed system.

Filtered water shall be pressurized so that part of it is driven through a semi permeable membrane, whereby the required driving force must exceed the osmotic pressure of the brine. Brine leaving the permeator outlet connection at a pressure close to the feed pressure shall be controlled by a flow control valve. The permeate water is discharged to product water system where it is treated to for removal of excess CO₂, correction of pH etc. and stored.

Cleaning and Flushing systems shall be provided for membrane protection. While the cleaning system facilitate cleaning of the fouled membranes and the flushing system flushes the membranes off High TDS water with low TDS water during shutdown operation.

Each RO train or stream shall be a self-contained section, with its own feed, reject and product flow control equipment, operable thru control system. Each train/ stream shall be cleaned and treated separately, independent of other trains/streams production.

A train/stream is composed of one or more blocks (membrane assembly unit) connected in parallel and each block comprise group of modules in parallel. Each RO module is basically cylindrical pressure vessel containing membrane elements. The term element means a single RO membrane element (permeators). Each block (membrane assembly unit) shall be provided with necessary valves and piping to facilitate block wise isolation, monitoring and cleaning facility.

3.18.1 RO MEMBRANE ASSEMBLY



TITLE: 4 X 270 MW BHADRADRI TPS	SPECIFICATION NO. PE-TS-411-164-A001	
	TECHNICAL SPECIFICATION FOR EFFLUENT TREATMENT PLANT	REV. NO. 00 DATE : 24/07/2017

Each stream shall be capable of operating either independently or in combination with the other ones. The streams shall be skid-mounted and be furnished complete with all headers and related piping, mounted on the skid.

The skid shall contain all necessary supports, fixings and clamps required to support the permeators, headers and related piping.

The skid shall be designed such that adequate space for servicing and monitoring of the equipment shall be available.

The removal of a single permeator or a major piece of the equipment must be possible, without removing surrounding equipment and also while the RO-train is in operation, by means of flexible, self-closing couplings.

Design and selection of RO stream/ train will be such that (i.e. it will be divided into certain number of equal blocks which can operate independently) it can facilitate the following advantages:

- ✓ Repair/maintenance of permeators/ pipes/ valves and chemical cleaning in a particular block can be carried out without shutdown the whole stream.
- ✓ For easier Performance monitoring of permeators, simpler fault identification to render permeators replacement activities easier.

3.18.2 RO MEMBRANE

The Reverse osmosis membrane shall be spiral wound type. The membrane shall be non-telescopic, non-flexing and leak free.

The membranes provided for the RO process of this project shall be one of the following membrane manufactures.

- ✓ Dow chemicals– Filmtec
- ✓ Hydronautics.
- ✓ KOCH membranes -Fluid systems.
- ✓ Toray

The membrane system process design calculation shall be provided by system supplier during detail engineering stage and the same shall be duly vetted by the membrane manufacturer. The system supplier shall take 'fouling allowance and salt passage' into consideration while preparing the process design calculation document during the guaranteed (specified) life of the membrane.

The process design calculation shall adopt to produce the specified capacity of permeate with an average flux rate as specified in "Technical Data Sheet".

The average flux rate shall be calculated based on effective membrane area considering standard length & diameter element.

For the designed water quality and the permeate water capacity required, the RO Plant shall be designed, tested to perform and guaranteed to have an undiminished overall recovery (Including stage I & II) of not less than 90%.

Notes:-

- i) Standard Length & Diameter of membrane used for design will be made available from at least three (3) manufacturers to deliver water of specified quality so that Employer may install membranes from other manufacturers during operation stage of the plant.
The design calculation shall furnish data regarding change in parameters of the RO plant such as design net output, recovery, energy consumption etc. in case such alternate membranes are used later by Employer in the Membrane Assembly supplied by System supplier.
- ii) Normalisation of performance during operation of the RO plant shall be made using



TITLE: 4 X 270 MW BHADRADRI TPS	SPECIFICATION NO. PE-TS-411-164-A001	
	TECHNICAL SPECIFICATION FOR EFFLUENT TREATMENT PLANT	REV. NO. 00 DATE : 24/07/2017

membrane manufacturers software supplied as a part of the system. The exact methodology for the normalization of capacity shall be submitted by the membrane manufacturer.

3.18.3 PRESSURE VESSELS

Pressure vessels shall have a diameter and length so as to contain required numbers standard diameter, standard length spiral wound elements.

Materials to be selected shall meet the following minimum requirements:

Membranes:	As per datasheet A
Pressure vessels:	As per datasheet A
End caps or plates:	Non - metallic material of proven Reliability may also be used subject to approval; Fiberglass epoxy as minimum requirement.
Segmental rings, Connectors	Corrosion resistant material conforming to ASTM A312 S31254 / ASTM A 744 CN3MN/ ASTM A995 Gr 5A/ ASTM A1049 F56 / F57/ ASTM 890 Gr 5A/ ASTM A182 F44 or ASTM A473 S3260 (depending on form of product used) or equivalent.
Coupling:	Victaulic / Equivalent of SS-316

Details of the design, fabrication, and testing requirements for the pressure vessels shall be in accordance with ASME Section X to allow a code stamp or meet the minimum requirements of ASME Section X.

Vessels shall be designed to allow membrane elements to be connected to a permeate port at both ends of the vessel so that permeate can be taken from either ends. The unused pressure vessel permeate port shall be available and piped to permit probing. End closures shall be approved for use in pressure vessel construction to the code requirements.

3.18.4 FLUSHING SYSTEM

Flushing system for RO stage– I and Stage– II consist of 2 nos. (2 x 100%) flushing pumps shall be provided to enable flush-out of the RO unit stream including HP pump, with low TDS permeate water during shut down of the stream.

The flushing water feed pipeline and the drain lines shall be designed for the high flow rate that is expected during flushing.

The flushing water feed lines shall be connected upstream of each HP pump inlet and the flushing feed line shall be provided with a motorized flush feed valve. The shutdown program shall automatically initiate the flushing feed valve to open and flush the RO train when required.

3.18 DEGASSER SYSTEM

1 x 100 % degasser tower is envisaged for permeate from RO block. Degasser tower shall be designed to reduce dissolved CO₂ in treated water to the level as indicated in the guarantees. Blowers shall be provided to remove CO₂ from water. Degassed water after pH correction shall be stored in RO permeate water storage tank.

3.19 OTHER REQUIREMENTS



TITLE: 4 X 270 MW BHADRADRI TPS	SPECIFICATION NO. PE-TS-411-164-A001	
	TECHNICAL SPECIFICATION FOR EFFLUENT TREATMENT PLANT	REV. NO. 00 DATE : 24/07/2017

- 3.13.1** The lining shall be of rubber having hardness of 65+/-5 shore – A meeting the requirements of IS 4682 Part – 1. 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 full face of all flanged connections and shall have a minimum thickness of 3 mm in all such external areas.
- 3.13.2** Bidder to note that sluice / isolation gates are not part of civil work and all sluice gates shall be in the scope of bidder.
- 3.13.3** Bidder has to take care for all equipments / items those are open to sky and required weather and dust proof.
- 3.13.4** Bidder to note that influent to equalization tank can be either simultaneous or individually hence the system should be designed accordingly to take care all operating condition.
- 3.13.5** The Cooling tower blowdown temperature expected is 46 deg C. Bidder to accordingly design the system to suit the system requirement.
- 3.13.6** The effluent treatment plant should be designed to operate under all operating condition of inlet and outlet values.

SECTION: VIII**TECHNICAL SPECIFICATION
FOR
PIPING, FITTINGS & VALVES****1.00.00 INTENT OF SPECIFICATION**

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

2. 00.00 SCOPE

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

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

3. 00.00 **CODE & STANDARDS**

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

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

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

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

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

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

4. 00.00 **DESIGN, MANUFACTURE, FABRICATION AND ERECTION**

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

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

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

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

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

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

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

4.04.00 Material & Dimensional Standards for Piping and Fittings

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

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

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

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

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

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

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

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

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

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

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

- 4.07.00 Piping Layout

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

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

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

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

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

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

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

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

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

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

4.08.00 Line Joints

Line Joints shall be envisaged as follows:

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

4.08.01 Welded joints

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

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

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

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

4.08.02 Screwed joints

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

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

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

4.08.03 Flanged joints

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

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

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

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

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

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

4.09.00 Fabrication of Pipes

4.09.01 General Requirements

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

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

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

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

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

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

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

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

4.09.02 Rolled and Welded /Spiral Welded Pipes

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

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

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

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

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

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

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

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

4.09.04 Rubber Lined Pipes

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

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

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

4.09.05 Welding

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

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

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

Weld shall not be made in pipe bends.

4.10.00 Supports for Overground Pipe

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

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

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

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

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

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

4.10.06 All material for supports shall be of tested quality.

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

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

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

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

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

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

water soluble preventive coating.

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

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

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

4.14.00 Valves & Isolation Gates

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Globe valves shall conform to the following technical specifications:

For sizes 50 mm NB and below

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

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

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

For sizes above 50 mm NB

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

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

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

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

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

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

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

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

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

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

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

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

The metallic diaphragm valves shall conform to the following requirements.

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

- rating/class. (minimum rating of valves should be PN 10).
- b) Type : Flanged and lined body ends, sealed bonnet, weir pattern, tight shut off type.
- c) **Material of Construction**
- Body/Bonnet : Cast Iron IS-210 Grade FG.260 or Equivalent (subject to approval by Purchaser).
- Cast steel ASTM-A 216 Grade WCB.
- Body lining : Soft Natural rubber - 3 mm thick as per IS-4682 (hardness 85-90 on shore A), Ebonite polypropylene, PVDF.
- Diaphragm : Reinforced rubber, Hypalon
- Handwheel : Cast Iron
- Compressor : Stainless Steel
- Stem & Bush : Stainless Steel
- d) Ends will be flanged and compatible with ANSI-B 16.5 Cl. 150 (min.) piping flanges, full face rubber lined and shall be cast / integral with the body.
- e) Handwheels shall be marked with the direction of closure.
- f) Valves shall be provided with a position indicator to show the open and closed condition.
- h) Valves provided with pneumatic actuators shall be provided with a handwheel for manual operation. The valves operators shall be designed as per applicable International Standard.
- i) The testing of valves will be as per BS EN-13397 and rubber lining will be tested as per IS-4682.

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

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

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

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

The plug valves shall conform to the following requirements.

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

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

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

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

The valves shall conform to the following specifications.

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

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

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

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

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

4.14.10

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

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

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

4.14.11

Valves for Sampling / Instrument Isolation Service

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

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

4.14.12 Valves for Air Service

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

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

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

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

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

4.14.13 Safety / Relief Valves

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

4.14.14 Valves for Resin Transfer Line

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

4.14.15 Isolation Gates

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

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

Material of Construction

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

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

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

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

4.15.00 Strainers4.15.01 Basket Strainers

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

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

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

4.15.02 Y-Type Strainer

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

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

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

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

4.16.00 Resin Traps

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

proper bonding of coating to surface.

5.01.02 Site Test

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

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

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

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

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

5.02.00 Tests & Inspection for Valves / Gates / Strainers

5.02.01 Shop Tests

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

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

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

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

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

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

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

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

5.02.02 Site Tests

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

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

SECTION-VII**TECHNICAL SPECIFICATION
FOR
PRESSURE AND STORAGE VESSELS****1.00.00 INTENT OF SPECIFICATION**

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

2.00.00 CODES AND STANDARDS

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

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

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

3. 00.00 GENERAL DESIGN FEATURES

3. 01.00 Design of all pressure vessels shall conform to IS 2825 or ASME Section VIII Division-I or equivalent code / standard (subject to approval by Purchaser).
3. 02.00 Design of all vertical cylindrical atmospheric storage tanks containing water, acid, alkali and other chemicals shall conform to IS-803.
- Supporting frame where required for design of Demineralized Water Storage Tanks shall be in accordance with IS-800. The tank shall be "Non-pressure" fixed roof type with atmospheric vents.
3. 03.00 Design of all horizontal cylindrical atmospheric storage tank containing decationized water, acid, alkali and other chemicals shall conform to BS EN 12285-2.
3. 04.00 Design temperature of all pressure vessels and atmospheric storage tanks shall be 10 deg. C higher than the maximum temperature that any part of the vessel / tank is likely to attain during operation.
3. 05.00 Design pressure shall be the maximum expected pressure to which the vessels may be subjected to plus 5% additional margin. Maximum expected pressure for vessels placed in the discharge line of pumps shall be based on the shut-off head of the pumps plus static head at pumps suction, if any.
3. 06.00 In case, tank is subjected to vacuum under any situation, the same shall be duly considered as one of the criteria for design of the tank.
3. 07.00 Each pressure vessel / atmospheric storage tank without inside rubber lining shall have a corrosion allowance of minimum 2.0 mm.
3. 08.00 Mill tolerance as per applicable code (minimum 0.3 mm) shall be duly considered for each shell as well as dished end.
3. 09.00 Thinning allowance of 2.0 mm (minimum) shall be considered for each dished end.

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

5. 00.00 FABRICATION

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

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

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

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

Material of construction should be as follows:

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

7.00.00 **ERECTION**

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

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

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

Telangana State Power Generation Corporation Ltd.
1x800 MW Kothagudem TPS

EPC Bid Document
e-PCT/TS/K/02/2014-15

SECTION : IX

TECHNICAL SPECIFICATION FOR HORIZONTAL CENTRIFUGAL PUMPS

1.00.00 INTENT OF SPECIFICATION

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

2.00.00 CODES AND STANDARDS

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

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

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

3.00.00 DESIGN AND CONSTRUCTION

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

3.01.01 Casing

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

3.01.02 Impeller

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

V.III-C/S-IX: 1

**Telangana State Power Generation Corporation Ltd.
1x800 MW Kothagudem TPS****EPC Bid Document
e-PCT/TS/K/02/2014-15**

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

3.01.03 Impeller/Casing Wearing Rings

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

3.01.04 Shaft

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

3.01.05 Shaft Sleeves

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

3.01.06 Bearings

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

3.01.07 Thrust Bearings

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

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

3.01.09 Stuffing Boxes

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

3.01.10 Pump Shaft-Motor Shaft Coupling

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

Telangana State Power Generation Corporation Ltd.
1x800 MW Kothagudem TPS
EPC Bid Document
e-PCT/TS/K/02/2014-15

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

3.01.11 Base Plate

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

3.01.12 Drain, Vent and Priming Connections

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

3.01.13 Drive Motor and Its Control

Please refer Electrical Specification enclosed herewith this specification.

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

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

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

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

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

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

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

Telangana State Power Generation Corporation Ltd.
1x800 MW Kothagudem TPS

EPC Bid Document
e-PCT/TS/K/02/2014-15

4.00.00 TESTING

4.01.00 Testing and Inspection at Manufacturer's Works

4.01.01 All tests required shall be conducted to ensure that the equipment furnished shall conform to the requirements of this specification and in compliance with requirements of the applicable codes.

The particulars of the proposed tests and the procedures for the tests shall be submitted for approval before conducting the tests.

4.01.02 The representatives of Purchaser shall be given full access to all tests. Prior to pump performance tests, the manufacturer shall inform the Purchaser allowing adequate time so that if the Purchaser desires, his representatives can witness the test.

4.01.03 All materials and casting used for the equipment shall be of tested quality. The test certificates shall be made available to Purchaser.

4.01.04 The pump casing shall be hydraulically tested at 200% of pump rated head or at 150% of shut-off head, whichever is higher. The test pressure shall be maintained for at least half an hour.

4.01.05 The pump rotating parts shall be subjected to static and dynamic balancing tests.

4.01.06 All pumps shall be tested at the shop for capacity, head efficiency and brake horse power and cavitation. The tests are to be done according to the requirement of the "Hydraulic Institute" of USA, ASME Power Test Code PTC-8.2 (latest edition) and Indian Standards as applicable.

4.01.07 The pump accessories e.g. the thrust bearing, the motor pump shaft coupling etc. will be subjected to tests as per Manufacturer's standard.

4.01.08 The combined vibration of pump and motor should be restricted to the limits specified by Hydraulic Institute Standards, USA, when the pump is in operation at any load singly or in parallel.

4.01.09 Tests on motors shall be conducted as per electrical specification enclosed herewith this specification.

4.01.10 The reports and certificates of all the above mentioned tests to ensure satisfactory operation of the system shall be submitted to the Purchaser before despatch.

4.01.11 Cast heat marks are to be provided on castings for casing and impeller.

4.02.00 Tests at Site

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

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

V.III-C/S-IX: 4

**Telangana State Power Generation Corporation Ltd.
1x800 MW Kothagudem TPS**

**EPC Bid Document
e-PCT/TS/K/02/2014-15**

**TECHNICAL SPECIFICATION
FOR
VERTICAL CENTRIFUGAL PUMPS**

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

V.III-C/S-X: 1

**Telangana State Power Generation Corporation Ltd.
1x800 MW Kothagudem TPS**

**EPC Bid Document
e-PCT/TS/K/02/2014-15**

SECTION: X

TECHNICAL SPECIFICATION FOR VERTICAL CENTRIFUGAL PUMPS

1.00.00 INTENT OF SPECIFICATION

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

2.00.00 CODES AND STANDARDS

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

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

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

3.00.00 DESIGN AND CONSTRUCTION

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

V.III-C/S-X: 1

**Telangana State Power Generation Corporation Ltd.
1x800 MW Kothagudem TPS**
**EPC Bid Document
e-PCT/TS/K/02/2014-15**
3.01.00 Pump Type

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

3.02.00 Discharge Head Assembly

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

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

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

3.03.00 Bowl

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

3.04.00 Impeller

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

3.05.00 Pump Shaft and Motor Shaft Coupling

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

3.06.00 Column Pipe and Shaft
DEVELOPMENT CONSULTANTS

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

V.III-C/S-X: 2

**Telangana State Power Generation Corporation Ltd.
1x800 MW Kothagudem TPS**

**EPC Bid Document
e-PCT/TS/K/02/2014-15**

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

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

3.07.00 Shaft Sleeves

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

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

3.09.00 Thrust Bearings

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

3.10.00 Line Shaft and Bowl Bearing

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

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

3.12.00 Shaft Enclosing Tube

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

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

V.III-C/S-X: 3

**Telangana State Power Generation Corporation Ltd.
1x800 MW Kothagudem TPS**

**EPC Bid Document
e-PCT/TS/K/02/2014-15**

3.13.00 Suction Bell

The pump shall be complete with adequately dimensioned suction bell to guide and streamline intake fluid.

3.14.00 Adjustment of Impeller

The pump shaft shall have suitable arrangement for vertical adjustment of impeller position from an accessible point.

3.15.00 Pump Characteristics

Head capacity curve should be rising upto the shut-off head condition. Power versus capacity curve shall be non-overloading type beyond rated duty point.

The characteristic curves of each set of pumps shall match each other for equal load sharing in case of parallel operation. The pump shall however, be also designed for smooth and trouble-free continuous solo operation in the event of trip-out of the remaining pumps running in parallel.

3.16.00 The pumps shall be designed for reverse flow through them. The drive motor shall be capable of bringing the pump to its rated speed in the normal direction from the point of maximum possible reverse speed when power to the drive is restored.

3.17.00 The pumps shall be designed to have best efficiency at the rated duty point.

The pumps shall be suitable for continuous operation within a wide range above and below the rated duty point. Such range of operation within which the pumps can satisfactorily operate on continuous basis, shall be clearly indicated.

3.18.00 Drive motors for the pumps shall be suitable for use on 415V $\pm$ 10%, 3 ϕ , 50 Hz, $\pm$ 5% and neutral grounded system. Drive motors shall have 15% spare margin over the maximum power requirement of the pump within its range of operation.

4.00.00 TESTING

4.01.00 Testing and Inspection at Manufacturer's works

DEVELOPMENT CONSULTANTS

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

V.III-C/S-X: 4

**Telangana State Power Generation Corporation Ltd.
1x800 MW Kothagudem TPS**

**EPC Bid Document
e-PCT/TS/K/02/2014-15**

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

Telangana State Power Generation Corporation Ltd.
1x800 MW Kothagudem TPS

EPC Bid Document
e-PCT/TS/K/02/2014-15

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

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

V.III-C/S-X: 6

Telangana State Power Generation Corporation Ltd.
1x800 MW Kothagudem TPS

EPC Bid Document
e-PCT/TS/K/02/2014-15

**TECHNICAL SPECIFICATION
FOR
POSITIVE DISPLACEMENT PUMPS**

SECTION: XI

TECHNICAL SPECIFICATION FOR POSITIVE DISPLACEMENT PUMPS

1.00.00 INTENT OF SPECIFICATION

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

2.00.00 GENERAL DESIGN FEATURES

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

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

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

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

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

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

2.06.00 Material of construction should be as follows :

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

Telangana State Power Generation Corporation Ltd.
1x800 MW Kothagudem TPS
EPC Bid Document
e-PCT/TS/K/02/2014-15

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

- 2.07.00 Suitable gland seal should be provided to prevent leakage.
- 2.08.00 Electric drive motor particulars should follow Electrical Specification, enclosed herewith.
- 3.00.00 TESTING
- 3.01.00 Testing and Inspection at Manufacturer's Works
- 3.01.01 The Manufacturer shall conduct all tests required to ensure that the equipment furnished conforms to the requirements of this specification and is in compliance with requirements of the applicable codes.
- The particulars of the proposed tests and the procedures for the tests shall be submitted to Purchaser for approval before conducting the tests.
- 3.01.02 The representatives of Purchaser shall be given full access to all tests prior to pump performance tests. The Manufacturer shall inform the Purchaser allowing adequate time so that if the Purchaser so desires, his representatives can witness the test.
- 3.01.03 All materials and castings used for the equipment shall be of tested quality. The test certificates shall be made available to Purchaser.
- 3.01.04 The pump casing shall be hydraulically tested at 200% of pump operating pressure or 15 Kg/Sq.Cm(g) whichever is higher. The test pressure shall be maintained for at least half an hour.
- 3.01.05 The rotating parts of pump drive shall be subjected to static balancing.
- 3.01.06 All pumps shall be tested at the shop for capacity volumetric accuracy, repeatability accuracy, power and volumetric efficiency. The tests are to be done according to the requirements of the "Hydraulic Institute" of U.S.A. ASME Power Test Code and Indian Standards or as per API.- 675.
- 3.01.07 The pump accessories e.g. gear box, speed reduction unit etc. will be subjected to tests as per Manufacturer's standards.
- 3.01.08 The combined vibration of pump and motor should be restricted within limits specified by Hydraulic Institute Standards, USA, when the pump is in operation singly or in parallel.

**Telangana State Power Generation Corporation Ltd.
1x800 MW Kothagudem TPS**

**EPC Bid Document
e-PCT/TS/K/02/2014-15**

- 3.01.09 Test reports and certificates of all the above mentioned tests to ensure satisfactory operation of the system shall be submitted to the Purchaser before despatch.
- 3.01.10 Performance test shall be carried out for the setting of pressure relief valve.
- 3.02.00 Test at Site
- After erection at site, pumps under different services shall be operated to prove satisfactory performance as individual equipment as well as a system.