1X800 MW TANGEDCO NORTH CHENNAI TPP, STAGE III -FGD

VOLUME: II B & III

TECHNICAL SPECIFICATION
FOR
EFFLUENT TREATMENT PLANT

SPECIFICATION NO.: PE-TS-485-164-A001

BHARAT HEAVY ELECTRICALS LIMITED
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT
NOIDA, INDIA

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VOLUME-IIB & III

VOLUME-IIB

SECTION – A
SCOPE OF ENQUIRY

1. SCOPE OF INQUIRY/ INTENT OF SPECIFICATION

1.1 The specification is intended to cover design, engineering, manufacture, fabrication, assembly, inspection and testing at vendor's & sub-vendor's works, painting, **Mandatory spares** along with spares for erection and commissioning, startup and commissioning as required, forwarding, proper packing, shipment and delivery at site, unloading, handling & transportation at site , Erection & Commissioning, trial run, on FOR site basis, preparation & submission of "As Built" drawings, PG test at site and handing over of **Effluent Treatment Plant (ETP)** as per the details in different sections / volumes of this specification for **1X800 MW TANGEDCO NORTH CHENNAI TPP, STAGE III -FGD.**

1.2 While all efforts have been made to make the specification requirement complete & unambiguous, it shall be bidders' responsibility to ask for missing information, ensure completeness of specification, to bring out any contradictory / conflicting requirement in different sections of the specification and within a section itself to the notice of BHEL and to seek any clarification on specification requirement in the format enclosed under Vol-III of the specification. In absence of any such clarifications, in case of any contradictory requirement, the more stringent requirement as per interpretation of BHEL/Customer shall prevail and shall be complied by the bidder without any commercial implication on account of the same. Further in case of any missing information in the specification not brought out by the prospective bidders as part of pre-bid clarification, the same shall be furnished by BHEL/ Customer as and when brought to their notice either by the bidder or by BHEL/ customer themselves. However, such requirements shall be binding on the successful bidder without any commercial & delivery implication.

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1.4 Unless specified otherwise, all through the specification, the word contractor shall have same meaning as successful bidder/vendor and Customer/Purchaser/Employer will mean BHEL and/or Customer (**TAMILNADU GENERATION AND DISTRIBUTION CORPORATION (TANGEDCO))** including their consultant **(CONSULTANT: FICHTNER, INDIA**) as interpreted by BHEL in the relevant context. Bidder to refer GCC/SCC for more clarity.

SECTION – B
PROJECT INFORMATION

PROJECT INFORMATION

1.0	**General**		
1.1	Project Title	:	1 x 800 MW North Chennai Coal Based Super Critical Thermal Power Project Stage III.
1.2	Plant capacity	:	800 MW
1.3	Type of project	:	Brown field
1.4	Owner	:	Tamil Nadu Generation and Distribution Corporation Limited (TANGEDCO)
1.5	Plant site location	:	In the premises of North Chennai Thermal Power Station (NCTPS)
1.6	Location co-ordinates	:	80° 19' E to 80° 20' E Longitude 13° 13' N to 13° 18' N Latitude
1.7	Nearest Village	:	Ennore & Puzhudhivakkam Village
1.8	Nearest Town & City	:	Chennai (35 Km)
1.9	State Capital	:	Chennai (35 Km)
1.1	Nearest Railway Station	:	Athipattu Pudunagar (~ 5 Km) on Chennai – Vijayawada Line
1.11	Nearest Airport	:	Chennai (~ 60 Km)
1.12	Nearest Seaport	:	Ennore (~ 3 Km)
1.13	Nearest Road access	:	All weather road from Pattamandri on the Thiruvottiyur – Ponneri highway
2.0	**Meteorological Condition**		
2.1	Climate	:	Tropical, very dry and hot summer, dry and cold winter and good rain-fall in monsoon accompied with strong wind
2.2	Site Elevation	:	(+) 10.0 Meter above Mean Sea Level
2.3	Ambient Temperature		
a.	Annual Maximum Mean Temperature	:	45 ºC
b.	Annual Minimum Mean Temperature	:	15 ºC
c.	Design ambient temperature	:	30 ºC
2.4	Relative Humidity		
a.	Maximum	:	90%
b.	Minimum	:	36%
c.	Design	:	75%
2.5	Annual Rainfall		

	Maximum	:	2540 mm
	Average	:	1600 mm
	Minimum	:	1175 mm
2.6	Basic Design Wind Pressure	:	As per IS: 875 (Latest Edition)
2.7	Wind Speed	:	11.8 kmph (Avg), 50 m/s (max)
2.7	Seismic zone	:	Zone: III as defined in IS:1893-2002
2.8	Design ambient temperature for Electrical equipment	:	50 ℃

SECTION: C

SPECIFIC TECHNICAL REQUIREMENTS

SECTION – C1

(SPECIFIC TECHNICAL REQUIREMENTS FOR MECHANICAL)

1.0 GENERAL

The Effluent Treatment Plant and associated accessories shall conform to the technical specification.

2.0 SCOPE OF SUPPLY FOR EFFLUENT TREATMENT PLANT:

Broad scope of work of this package includes all equipment and accessories and shall be as per the following [please refer P&ID: PE-DG-485-164-A001 and Data Sheet-A]. [Please also refer Electrical (Section-C2) and C&I (Section-C3) for respective scopes].

- Lime Dosing Systems for Waste Water Tank including Lime Preparation Cum Dosing tank One number and Lime Dosing pumps two numbers with instrumentation, piping, fittings, Valves, Motors and other accessories.
- Hypo Dosing Systems for Waste Water Tank including Hypo Dosing tank One number and Hypo Dosing pumps two numbers with instrumentation, piping, fittings, Valves, Motors and other accessories.
- One Number Thickener with Motors, Scrapper, Full Bridge, Rack Lifting Mechanism, Torque Switch, Local Starter cum Control Panel and other accessories.
- Lime Dosing Systems for Thickener including Lime Preparation Cum Dosing tank One number and Lime Dosing pumps two numbers with instrumentation, piping, fittings, Valves, Motors and other accessories.
- FeCl3 Dosing Systems for Thickener including FeCl3 Preparation Cum Dosing tank One number and FeCl3 Dosing pumps two numbers with instrumentation, piping, fittings, Valves, Motors and other accessories.
- PE Dosing Systems for Thickener including PE Preparation Cum Dosing tank One number and PE Dosing pumps two numbers with instrumentation, piping, fittings, Valves, Motors and other accessories.
- One Number Clarified Water Storage Tank with instrumentation, piping, fittings, Valves, Motors and other accessories.
- Two numbers Clarified Water Transfer Pumps with instrumentation, piping, fittings, Valves, Motors and other accessories.
- One Number Sludge Pit with instrumentation, piping, fittings, Valves, Motors and other accessories.
- Two numbers Centrifuge Feed Pumps (Sludge Transfer Pumps) with instrumentation, piping, fittings, Valves, Motors and other accessories.
- One Number Centrifuge with VFD cum Local Starter Cum Control Panel, Motor and other accessories.
- PE Dosing Systems for Centrifuge including PE Preparation Cum Dosing tank One number and PE Dosing pumps two numbers with instrumentation, piping, fittings, Valves, Motors and other accessories.
- Two numbers Air blower for Sludge Pit with motors, instruments and other accessories.
- Electrical motors for pumps, blower, agitator, etc as per requirement.
- Four sets of safety equipment comprising PVC protection suits with hoods, rubber boots, face visors and thick PVC gauntlets shall also be provided. A personnel water drench shower and eye bath shall be provided.
- Chain pulley block (1 No each of 1 Ton Capacity) and Electrical hoist (1 No each of 2 Ton Capacity) with monorail for handling equipment in Chemical House.
- Exhaust fans (@20 air change/hr) and ventilation system in Chemical House.
- All tanks with inlet and outlet connections, bed support cum under drain system, inlets water distributors, all fittings and appurtenances etc. as specified and as required.
- Pipe racks shall be provided by BHEL wherever available. However where pipe racks are not available the pipe shall run on pipe pedestals. All auxiliary steel structures (U-clamps, nuts, bolts, channels etc.) for fixing the pipe on the pedestal or trestles shall be in the scope of bidder.
- If buried piping is required, Wrapping, coating and protection of all the buried pipe is also in bidder's scope & shall be as per IS 10221.
- All grout material in BHEL civil works and to support/ hold the equipment being supplied under this specification shall be in bidder's scope.
- Instrument hook up material shall be in bidder's scope.
- All necessary drains, vents and sampling points with valves as specified and as required are in bidder's scope.
- Wherever terminal points between BHEL and bidder indicated, bidder shall provide pipes with counter flange.
- All blank flanges/ counter flanges, isolations valves, tees etc. to interconnect the pipes at all terminal points.
- **Mandatory spares as per list attached in this specification.**
- All special tools necessary for proper maintenance or adjustment of the equipment packaged in permanent box.
- Start-up and commissioning spares as required.
- Hume Pipe 10 Nos (200 NB Size) each of 6 meter length.

- All handrails shall be of 32 mm nominal bore MS pipes (medium class) as per IS: 1161 galvanized using 750 gm/sq. m of zinc. Hand railing shall be a two-rail system with the top rail 1000 mm above the walkway surface and the intermediate rail 450 mm below the top rail. Handrail post spacing shall be limited to 1500 mm as far as possible but can be proportioned to the length of the opening. In such a case spacing shall not exceed 1850 mm centre to centre of posts. Hand railing shall be shop fabricated for specific locations and field welded or bolted to the erected structural steel. Railings shall be provided with 100 mm wide and 8 mm thick MS strip at bottom as toe guard all along the length of railing in horizontal plane. For RCC stairs, hand railing with 20 mm square MS bar balustrade with suitable MS flat and Aluminium / Teakwood handrail shall be provided, unless specifically mentioned otherwise.
- Finish paints for touch up painting of equipment after erection at site in sealed container. Bidder shall also provide one final coat additionally of same DFT as specified in tender specification at site after completion of erection of each equipment / item.
- Monitoring gadgets, instruments and equipment required for commissioning & maintenance (till PG test and plant handover).
- Wrapping, coating and protection of the entire buried pipe (for MS/CS/CI pipe) shall be as per IS 10221 or AWWA C 203-93.
- All required auxiliary steel (U Clamp, Nut, Bolts, Auxiliary Channel, etc for taking pipe support from pedestal /pipe rack) required for pipe routing on BHEL supplied pipe rack/pedestal shall be part of bidder scope.
- Permanent ladder (not rungs) for approaching the top of tanks, valves for All steel inserts with lugs, plates, bolts, nuts, sleeves, edge angles and all other embedding components etc as required to grout in civil works and to support/hold the equipment being supplied under this specification for opening/maintenance purpose.
- All the first fill and one Year's topping requirements of consumable such as greases, oil, lubricants, servo fluids/control fluids etc. which will be required to put the equipment covered under the scope of specifications, into successful commissioning / initial operation and to establish completion of facilities shall be in bidder's scope. Suitable standard lubricants as available in India are desired. Efforts should be made to limit the variety of lubricants to minimum.
- All Chemical for Trial Run (Minimum 15 Days) and for PG Test+First fill of all chemical tanks.
- Entire piping inside ETP area are in Bidder's scope.
- The following piping also are part of bidders's scope.
  - Clarified Water Transfer Pumps to Existing Guard Pond (1500 Meter).
  - Lime and Hypo Chlorite Dosing at waste Water Tank: 150 m Piping.
  - Service Water and Potable Water at 20 Meter Distance from Effluent Treatment Plant Boundary.
  - Service Air at 20 Meter Distance from Effluent Treatment Plant Boundary.

3.0 SCOPE OF SERVICE FOR EFFLUENT TREATMENT PLANT:

The bidder's scope also includes following services for scope under this specification:

1) Erection and Commissioning of Effluent Treatment Plant.
2) Arrangement of all instruments and lab facilities to carry out trial run/commissioning and PG test.
3) All personnel required during Pre-Commissioning, commissioning Trial Run and PG Test.
4) Performance testing (PG Test).
5) Painting as per enclosed painting schedule. However, being the plant is in costal area any variation in the painting schedule as finally approved by BHEL/FICHTNER/TANGEDCO shall be taken care by the bidder without any commercial and delivery implication. Color-coding scheme shall be intimated to vendor during detailed engineering.

4.0 TERMINAL POINT FOR EFFLUENT TREATMENT PLANT:

a. Effluent from Waste Water Tank to Effluent Treatment Plant: BHEL/BAP will terminate at 20 Meter from Effluent Treatment Plant.
b. Lime and Hypo Chlorite Dosing at waste Water Tank: 150 m Piping.
c. Service water and portable water & Service air: At ET Plant boundary at a distance of 20 meter (it may be at any direction, shall be decided during detailed engineering).
d. Clarified Water Transfer Pumps to Existing Guard Pond (Piping Distance=1500 Meter).

Note: Bidder to note that the pipe length indicated in the specification may vary by +/-10% for which no extra claim shall be applicable. For Pump Head Calculation bidder needs to add 12 Meter Static Head.

5.0 EXCLUSION FOR EFFLUENT TREATMENT PLANT:

- Service air.
- Fire fighting.
- Drinking water and service water.
- Total Civil works including Civil Raw Material (Cement, Steel, Sand, Aggregate, etc), Civil Engineering, however, Civil Input drawing shall be provided by bidder.
- Excavation/back filling for underground piping.
- Pipe trestles and pedestals (for outside Effluent Treatment Plant piping the gap between two support shall be 3 meter, further any support by Channel shall be provided by Bidder).
- Acid/alkali resistant lining including Epoxy Painting on RCC.
- DCS/DDCMIS.
- M.C.C. / Switch fuse feeder panels for the power plant and control cabling up to & beyond the battery limit (Refer electrical Scope Sheet for details).

6.0 QP AND SUBVENDOR APPROVAL FOR EFFLUENT TREATMENT PLANT:

a) Final quality plans and inspection criteria for all the items shall be subject to approval by BHEL/FICHTNER/TANGEDCO during detail engineering. Any additional vendors (not listed in the sub-vendor list as enclosed with Technical Specification-PE-TS-485-164-A001)) shall be subject to BHEL/FICHTNER/TANGEDCO approval during detailed engineering without any price/delivery implication.

7.0 DESIGN/CONSTRUCTION FOR EFFLUENT TREATMENT PLANT:

In addition to the requirements of Section-C & D the following shall also be complied under scope of this specification:

The P&ID (PE-DG-485-164-A001) is enclosed herein in this section for bidder's compliance.
The material of construction specified in Data Sheet-A are minimum requirements and material of construction for other components not specified shall be similarly selected by the bidder for intended duty which shall be subject to BHEL/FICHTNER/TANGEDCO approval during detailed engineering.

8.0 DRAWING/DOCUEMNTS REQUIREMENT (FOR MECHANICAL/ELECTRICAL/C&I/ETC) FOR EFFLUENT TREATMENT PLANT:

After award of LOI, following drawing/documents shall be submitted by the bidder for BHEL/FICHTNER/TANGEDCO approval as per Master Drawing List (MDL) enclosed elsewhere in this Specification. However, any additional drawing/document if found necessary for completion of the engineering, the same shall be submitted by bidder without any commercial implication.

9.0 DRAWING/DOCUEMNTS REQUIRED ALONG WITH BID FOR EFFLUENT TREATMENT PLANT:

- Compliance certificate.
- Filled Unpriced schedule and unit price schedule.

10.0 ENVIRONMENTAL STIPULATIONS FOR EFFLUENT TREATMENT PLANT:

The Effluent Treatment Plant shall fully comply with all requirements and limits specified in Environmental (Protection) Rules, 1986, along with all latest amendments to it, requirements and stipulations of the Central Pollution Control Board (CPCB), Ministry of Environment and Forests (MOEF); Government of India for the project, and any other central or local statutory requirements regarding environmental pollution and its abatement. As regards cases for which no Indian Standard exists, internationally accepted standards like the World Bank's standard, OSHA standards etc.shall be applicable. The Purchaser will decide such applications.

11.0 FUNCTIONAL GURANTEES FOR EFFLUENT TREATMENT PLANT:

Following effluent quality (at outlet of Thickener) shall be guaranteed: -

FUNCTIONAL GURANTEES FOR EFFLUENT TREATMENT PLANT (TABLE-1)
✓ TSS < 10 ppm

Note-1: Any item/work either supply of equipment or erection material which have not been specifically mentioned in but are necessary to complete the woks for trouble free and efficient operation of the plant shall be deemed to be included within the scope of this specification. The bidder without any extra charge shall provide the same.

Note-2: All major drawings/documents/Sub vendors shall be approved by BHEL/FICHTNER/TANGEDCO during detailed engineering. Stage. Successful vendor shall comply with the comment of the BHEL/FICHTNER/TANGEDCO without price & delivery implication.

Note-3: All sump pumps/drives shall be provided with electrically operated monorail hoist for weights weighing 500 kg.

Note-4: Bidder shall perform the guarantee parameters as per the specification requirement to the satisfaction of Owner. The exact modalities of verifying guarantee for the parameters indicated in the specification shall be finally as agreed with the Owner during detailed engineering & mutually agreed.

Note-5: The Bidder shall arrange all the monitoring gadgets / instruments / equipment required for performing guarantee parameters (returnable after PG test). Site facility as available or as extended by Owner shall only be provided.

Note-6: All equipments shall be dimensioned to provide as undisturbed space, free of pipes or similar obstacles of at least 1000 mm between installed equipment and surrounding enclosures or walkway to ensure proper access for maintenance and operation.

Note-7: Wherever pipe racks are not available, pipes shall run on pedestals or below ground. All auxiliary structure & fixing items such as U clamps, nuts, bolts, channels, insert plates etc. required to lay the pipes on pedestals shall be in bidder's scope of work. Wrapping, coating and protection of all the buried pipe is also in bidder's scope.

Note-8: The above Note-1 to 7 shall be applicable for Electrical and C&I also.

EFFLUENT WATER QUALITY AT WASTE WATER TANK FOR ETP DESIGN PURPOSE (TABLE-2A)

Sl no.	Particulars	Units	Maximum (approx.)
1	Chloride as Cl	ppm	20000
2	TSS	ppm	30000
3	pH	--	6.5-8.5
4	COD	ppm	100
5	Total Nitrogen	ppm	90
6	Soluble Mn	ppm	35
7	Fluoride as F	ppm	170
8	TDS	ppm	33270
9	Magnesium as Mg	ppm	5730
10	Aluminum as Al	ppm	1
11	Potassium as K	ppm	30
12	Sulfate as SO4	ppm	3520
13	Boron as B	ppm	1600
14	Sodium as Na	ppm	1065
15	Operating Temperature	--	53 Deg C.
16	Design Temperature	--	70 Deg C.

SERVICE RO REJECT WATER QUALITY AT CLARIFIED WATER STORAGE TANK (TABLE-2B)

Sl no.	Particulars	Units	Maximum (approx.)
1	**Flow**	**CuM/Hr**	**11.00 NORMAL / 15.00 MAXIMUM**
2	Chloride as Cl	ppm	1500
3	TSS	ppm	10
4	pH	--	6.5-8.5
5	Total Hardness as CaCO3	ppm	320
6	Alkalinity as CaCO3	ppm	400
7	Sodium as Na	ppm	800
8	Temperature	Deg C	35

EFFLUENT WATER QUALITY TO BE SENT TO EXISTING GUARD POND (TABLE-2C)

Sl no.	Particulars	Units	Maximum (approx.)
1	**Flow**	**CuM/Hr**	**4.00**
2	Chloride as Cl	ppm	20000
3	TSS	ppm	10
4	pH	--	6.5-8.5
5	COD	ppm	100
6	BOD	Ppm	Nil
7	Total Nitrogen	ppm	90
8	Soluble Mn	ppm	35
9	Fluoride as F	ppm	170
10	TDS	ppm	33270
11	Magnesium as Mg	ppm	5730
12	Aluminum as Al	ppm	1
13	Potassium as K	ppm	30
14	Sulfate as SO4	ppm	3520
15	Boron as B	ppm	1600
16	Sodium as Na	ppm	1065
17	Temperature	--	50 Deg C.

SUB VENDORS LIST [TABLE-3]

SR. NO.	ITEM	SUPPLIERS	PLACE	REMARKS
1.	ATMOSPHERIC/ STORAGE TANKS	GLOBAL STRUCTURES & COMPOSITE LTD	-	
		JASMINO POLYMERTECH	TALOJA	
		SYSCON ENGINEERS	AMBERNATH	
		S.V. FABRICATORS	NAVI MUMBAI	
		SPARK FABRICATORS / STEELCON	-	
		ANUP ENGINEERING	AHMEDABAD	
		MURTHAL TANKS & VESSELS	SONEPAT	
		TITAN ENGG.	DURGAPUR	
		RISHI INDUSTRIES	BAHALGARH	
		UNIVERSAL HEAT EXCHANGERS	-	
		UD-KAM	GREATER NOIDA	
		CHEM PROCESS SYSTEM	SANAND	
		PROGEN	CHENNAI	
		CRYSTAL ENGINEERING	HOSUR	
		ISHAN EQUIPMENTS	VADODARA	
2.	RUBBER LINING (AT SHOP)	TEMSEC	KOLKATA	
		RISHI INDUSTRIES	SONEPAT	
		CORI ENGINEERS	CHENNAI	
		POLY RUBBER	MUMBAI	
		INDUSTRIAL LINING	VADODARA	
		ARUL RUBBERS	CHENNAI	
		JASMINO POLYMERTECH	TALOJA	
		WESTERN RUBBER	NAVI MUMBAI	
		ELASTOMER LINNING	AMBERNATH	
		EMKAY RUBBER	MUMBAI	
3.	AIR BLOWERS	SWAN PNEUMATIC	NOIDA	
		EVEREST TRANSMISSION	NEW DELHI	
		KAY INTERNATIONAL	NEW DELHI / SONEPAT	
		EVEREST BLOWER	BAHADURGARH	
		KULKARNI POWER TOOLS	KOLHAPUR/ PUNE	
4.	METERING PUMPS	VK PUMPS	NASIK	
		MILTON ROY INDIA	CHENNAI	
		SWELLORE	AHMEDABAD	
		DENCIL PUMP	MUMBAI	
		METACHEM	MUMBAI	
5.	AGITATOR	REMI PEOCESS PLANT & M/C	MUMBAI	
		FIBRE & FIBRE	MUMBAI / SILVASA	
		CEECONS	CHENNAI	
		STANDARD ENGINEERS	MUMBAI	
6.	CENTRIFUGAL PUMPS	BEST AND CROMPTON ENGG LTD.	CHENNAI	
		BHARAT PUMPS & COMPRESSORS LTD	ALLAHABAD	
		FLOWMORE LTD.	GURGAON	
		FLOWSERVE INDIA CONTROLS PVT. LTD.	COIMBATORE	
		JYOTI LTD.	VADODARA	
		KIRLOSKAR BROTHERS LTD	PUNE	
		WILO MATHER & PLATT PUMPS PVT. LTD.	PUNE	

SR. NO.	ITEM	SUPPLIERS	PLACE	REMARKS
		V-FLO PUMPS & SYSTEMS CO. LTD.,	BEIJING-CHINA	
		WPIL LIMITED	KOLKATA	
7.	SCREW PUMP	UT PUMP		
		ROTO PUMPS		
		TUSHACO		
8.	NON METALLIC CENTRIFUGAL PUMPS	ENGINEERS COMBINE	THANE	
		ANTICORROSIVE	VALSAD	
		LEAK PROOF PUMPS PVT. LTD. (RAJEDIA)	-	
9.	COATING & WRAPPING MATERIAL TAPE	IWL LTD.	CHENNAI	
		MP TAR PRODUCT	BHILAI	
		PORWAL INDUSTRIES	RAIPUR	
		RUSTECH	KOLKATA	
		STP	JAMSHEDPUR	
		RACOLDS	FARIDABAD	
10.	CLARIFIER/ THICKENER MECHANISM	CLEAR WATER	DELHI	
		TRIVENI	NOIDA	
		PBJ ASSOCIATE	PUNE	
		PROGRESSIVE ENGINEERING	HOWRAH	
11.	CENTRIFUGE	HUMBOLT	-	
		HILLER	-	
12.	CAST IRON GATE/GLV/NRV/SRV	A.V. VALVES LTD	AGRA	
		ATAM VALVES PVT. LTD.	JALANDHAR	
		FLUIDLINE VALVES COMPANY PVT.LTD.	GHAZIABAD	
		G.M. DALUI AND SONS PVT.LTD.	HOWRAH	
		H.SARKER AND COMPANY	HOWRAH	
		LEADER VALVES LTD.	JALANDHAR	
		VENUS PUMPS AND ENGG. WORKS	KOLKATA	
13.	BALL VALVE (MANUAL /PNEUMATIC/ ELECTRIC) CLASS 150	A.V. VALVES LTD	AGRA	
		AKAY INDUSTRIES PVT.LTD.	DHARWAD	
		BELGAUM AQUA VALVES PVT. LTD.	BELGAUN	
		ASIAN INDUSTRIAL VALVES & INSTRUMENTS.	CHENNAI	
		ATAM VALVES PVT. LTD.	JALANDHAR	
		DEMBLA VALVES LTD.	THANE	
		M/S GM ENGINEERING	RAJKOT	
		HAWA VALVES (INDIA) PVT. LTD.	NAVI MUMBAI	
		INTERVALVE (INDIA) LTD.	PUNE	
		LEADER VALVES LTD.	JALANDHAR	
		MICROFINISH VALVES PVT LTD.	HUBLI	
		NILON VALVES PRIVATE LIMITED	AHMEDABAD	
		SURYA VALVES AND INSTRUMENTS MFG CO.	CHENNAI	
		UNIFLOW	CHENNAI	
		VALTECH INDUSTRIES	MUMBAI	
		VAAS AUTOMATION PVT. LTD.	NEW DELHI	
		WEIR BDK VALVES- A UNIT OF WEIR INDIA PVT. LTD.	NEW DELHI	
14.	ELECTRIC MOTOR	CROMPTON GREAVES	AHMEDNAGAR	
		LAXMI HYDRAULICS PVT. LTD	BANGALORE	
		RAJINDRA ELECT INDUSTRIES	FARIDABAD* / BANGALORE	

SR. NO.	ITEM	SUPPLIERS	PLACE	REMARKS
		GE-POWER		
		BHARAT BIJLEE	MUMBAI	
		SIEMENS	MUMBAI	
		NGEF	BANGALORE	
		KIRLOSKAR ELECTRIC CO LTD.		
		ASEA BROWN BOVERI		
		MARATHON	KOLKATA	
15.	BUTTER-FLY VALVE	ADVANCE VALVES PVT. LTD.	NOIDA	
		AV VALVES	AGRA	
		FLUIDLINE VALVES COMPANY PVT.LTD.	GHAZIABAD	
		INSTRUMENTATION LTD.	PALAKKAD	
		INTERVALVE (INDIA) LTD.	PUNE	
		R AND D MULTIPLES (METAL CAST) PVT LTD	MUMBAI	
		SURYA VALVES AND INSTRUMENTS MFG CO.	CHENNAI	
		PENTAIR VALVES AND CONTROLS INDIA PRIVATE LIMITED	NAVI MUMBAI	
		UPADHAYA VALVES MANUFACTURERS PRIVATE LIMITED,	KOLKATA	
		VENUS PUMPS AND ENGG. WORKS	KOLKATA	
		WEIR BDK VALVES- A UNIT OF WEIR INDIA PVT. LTD.	NEW DELHI	
16.	DIAPHRAGM VALVE	WEIR BDK	HUBLI	
		AV VALVES	AGRA	
		CRANE FLOW PROCESS	SATARA	
		PROCON	MUMBAI	
		MAJESTIC VALVES (LABLINE)	-	
		HAWA ENGINEERS	AHMEDABAD	
17.	GATE/GLOBE/BALL/ CHECK VALVES	ADVANCE VALVES PVT. LTD.	NOIDA	
		FLUIDLINE VALVES COMPANY PVT.LTD.	GHAZIABAD	
		AV VALVES	AGRA	
		R AND D MULTIPLES (METAL CAST) PVT LTD	MUMBAI	
		VENUS PUMPS AND ENGG. WORKS	KOLKATA	
18.	STRAINER	OTOKLIN GLOBAL BUSINESS LIMITED	MUMBAI	
		GRAND PRIX	FARIDABAD	
		JAYPEE INDUSTRIES PVT. LTD.	DELHI	
		UD KAM	GREATER NOIDA	
		FLOW WAY VALVES	-	
		BDK	-	
		MAJESTIC VALVES (LABLINE INST)	-	
		ADVANCE VALVES	-	
19.	SOLENOID VALVES	ROTEX	-	
		AVCON	-	
20.	PRESSURE GAUGE/ DIFFERENTIAL PRESSURE GAUGE	A.N. INSTRUMENTS PVT. LTD.	KOLKATA	
		ASHCROFT INDIA PVT LTD.	GUJARAT	
		BOSE PANDA INSTRUMENTS PVT.LTD.	KOLKATA	
		FORBES MARSHALL (HYD) LTD.	HYDERABAD	
		GAUGE BOURDON INDIA PVT. LTD.	MUMBAI	
		H.GURU INDUSTRIES	KOLKATA	
		H.GURU INSTRUMENTS (SOUTH INDIA) P. LTD	BANGALORE	

SR. NO.	ITEM	SUPPLIERS	PLACE	REMARKS
		BAUMER TECHNOLOGIES INDIA PVT. LTD.	MUMBAI	
21.	CHAIN PULLEY BLOCK	ARMSEL MHE PVT. LTD	BANGALORE	
		CENTURY CRANE ENGINEERS PVT. LTD.	FARIDABAD	
		HERCULES HOISTS LTD.	RAIGAD	
		LIFTING EQUIPMENTS AND ACCESSORIES	DELHI	
		TUOBRO FURGUSON (INDIA) PVT LTD	KOLKATA	
		TRACTEL TIRFOR INDIA PVT. LTD.	FARIDABAD	
		TECHNO INDUSTRIES	AHMEDABAD	
		ARMSEL MHE PVT. LTD	BANGALORE	
		ALPHA SERVICES	BHIWADI	
		CONSOLIDATED HOISTS PVT LTD	PUNE	
		CENTURY CRANE ENGINEERS PVT. LTD.	FARIDABAD	
		EDDY CRANES PVT. LTD.	MUMBAI	
		GRIP ENGINEERS PVT. LTD.,	FARIDABAD,	
		GLOBAL TECHNOLOGIES	HYDERABAD	
		HERCULES HOISTS LTD.	RAIGAD	
		LIFTING EQUIPMENTS AND ACCESSORIES	DELHI	
		MANGLA HOISTS PVT LTD	NEW DELHI	
		MEEKA MACHINERY PVT. LTD.	AHMEDABAD	
		REVA INDUSTRIES LTD.	FARIDABAD	
		ROCKWELL HOISTO CRANES PVT. LTD.	BAHADURGARH	
		SAFEX ENERGY PVT. LTD.	AHMEDABAD	
		TUOBRO FURGUSON (INDIA) PVT LTD	KOLKATA	
		TECHNO INDUSTRIES	AHMEDABAD	
22.	ELECTRIC HOIST	ARMSEL MHE PVT. LTD	BANGALORE	
		ALPHA SERVICES	BHIWADI	
		CONSOLIDATED HOISTS PVT LTD	PUNE	
		CENTURY CRANE ENGINEERS PVT. LTD.	FARIDABAD	
		EDDY CRANES PVT. LTD.	MUMBAI	
		GRIP ENGINEERS PVT. LTD.,	FARIDABAD,	
		GLOBAL TECHNOLOGIES	HYDERABAD	
		HERCULES HOISTS LTD.	RAIGAD	
		LIFTING EQUIPMENTS AND ACCESSORIES	DELHI	
		MANGLA HOISTS PVT LTD	NEW DELHI	
		MEEKA MACHINERY PVT. LTD.	AHMEDABAD	
		REVA INDUSTRIES LTD.	FARIDABAD	
		ROCKWELL HOISTO CRANES PVT. LTD.	BAHADURGARH	
		SAFEX ENERGY PVT. LTD.	AHMEDABAD	
		TUOBRO FURGUSON (INDIA) PVT LTD	KOLKATA	
		TECHNO INDUSTRIES	AHMEDABAD	
23.	PRESSURE/DP/VACUUM SWITCH	INDFOSS	GHAZIABAD	
		SOR	USA	
		DRESSOR	USA	
		DELTA CONTROL	UK	
		TRAFAG	RANIPET	
		GIC(GAUGES BOURDON)	PANVEL	
		ASHCROFT INDIA PVT LTD.	USA/GERMANY	
		SWITZER	CHENNAI	
24.	TEMPERATURE	A.N. INSTRUMENTS PVT. LTD.	KOLKATA	

SR. NO.	ITEM	SUPPLIERS	PLACE	REMARKS
	GAUGE	ASHCROFT INDIA PVT LTD.	GUJARAT	
		BUDENBERG GUAGE CO.LTD.	UK	
		FORBES MARSHALL (HYD) LTD.	HYDERABAD	
		GOA INSTRUMENTS INDUSTRIES PVT.LTD.,	GOA	
		GOA THERMOSTATIC INSTRUMENTS PVT.LTD.		
		GAUGE BOURDON INDIA PVT. LTD.	MUMBAI	
		H.GURU INDUSTRIES	KOLKATA	
		H.GURU INSTRUMENTS (SOUTH INDIA) P. LTD	BANGALORE	
		BAUMER TECHNOLOGIES INDIA PVT. LTD.	MUMBAI	
25.	LEVEL GAUGE (F&B, TUBULAR, REFLEX)	SBEM		
		CHEMTROL		
		PUNE TECHTROL		
		SIGMA		
		V AUTOMAT		
		GENERAL INSTRUMENTS		
26.	ROTAMETER	EUREKA INDUSTRIAL EQUIPMENTS PVT.LTD.	PUNE	
		FLOW STAR ENGINEERING PVT. LTD.,	FARIDABAD	
		FLOWTECH INSTRUMENTS SERVICRS	VADODARA	
		INSTRUMENTATION ENGINEERS PVT LTD	TELANGANA	
		SCIENTIFIC DEVICES (BOMBAY) PVT LTD,	NAVI MUMBAI	
27.	MAGNETIC FLOW METER	ABB	-	
		WAAREE (BAUMER INSTRUMENTS)	-	
		EUREKA	-	
		EMERSON	-	
		YOKOGAWA	-	
		HACH (POTENSE)	-	
		KROHNE MARSHALL	-	
28.	FLOW ELEMENT - NOZZLE	HYDROPNEUMATICS PVT. LTD.	GOA	
		INSTRUMENTATION LTD.	PALAKKAD	
		MICRO PRECISION PRODUCTS PVT. LTD.	FARIDABAD	
		MINCO (INDIA) FLOW ELEMENTS PVT. LTD.	GOA	
		STAR-MECH CONTROLS (I) PVT.LTD.	PUNE	
		SEIKO FLOW CONTROL GMBH	AUSTRIA	
29.	FLOW ELEMENT - ORIFICE	FLOW STAR ENGINEERING PVT. LTD.,	FARIDABAD	
		HYDROPNEUMATICS PVT. LTD.	GOA	
		INSTRUMENTATION LTD.	PALAKKAD	
		INSTRUMENTATION ENGINEERS PVT LTD	HYDERABAD	
		MICRO PRECISION PRODUCTS PVT. LTD.	FARIDABAD	
		MINCO (INDIA) PRIVATE LIMITED	GOA	
		STAR-MECH CONTROLS (I) PVT.LTD.	PUNE	
30.	FLOW TRANSMITTERS (ALL TYPES)	E & H	-	
		KHRONE MARSHALL	-	
		EMERSON	-	
		ABB	-	
		HONEYWELL	-	
		YOKOGAWA	-	
31.	LEVEL TRANSMITTERS (ALL TYPES)	EMERSON	-	
		E & H	-	
		ABB	-	

SR. NO.	ITEM	SUPPLIERS	PLACE	REMARKS
		HONEYWELL	-	
		EIP	-	
		V AUTOMAT	-	
		YOKOGAWA	-	
		SIEMENS	-	
		KROHNE MARSHALL	-	
32.	PRESSURE TRANSMITTERS	EMERSON	USA/PAWANE	
		LAXONS AUTOMATION	DAMAN	
		YIL	BANGALORE	
		SIEMENS	THANE	
		FUJI	CHINA	
		YOKOGAWA	JAPAN	
		HONEYWELL	USA/PUNE	
33.	TEMPERATURE TRANSMITTERS	EMERSON	-	
		E & H	-	
		ABB	-	
		HONEYWELL	-	
		V AUTOMAT	-	
		YOKOGAWA	-	
		SIEMENS	-	
		FORBES MARSHALL	-	
34.	PH TRANSMITTERS	EMERSON	-	
		YOKOGAWA	-	
		HONEYWELL	-	
		ABB	-	
		HACH	-	
		FORBES MARSHALL	-	
35.	ANALYSERS (ALL TYPES)	ABB	-	
		EMERSON	-	
		YOKOGAWA	-	
		HONEYWELL	-	
		HACH POLYMETRON	-	
		SIEMENS	-	
		FORBES MARSHALL	-	
36.	INSTRUMENT FITTINGS	AURA INCORPORATED	NEW DELHI	
		ASTEC VALVES & FITTINGS PVT. LTD.,	MUMBAI	
		ARYA CRAFTS & ENGINEERING PVT. LTD.	MUMBAI	
		COMFIT & VALVE PVT. LTD.	GUJARAT	
		FLUIDFIT ENGINEERS PVT. LTD.	MUMBAI	
		FLUID CONTROLS PVT. LTD.	MUMBAI	
		HP VALVES & FITTINGS INDIA PVT. LTD.	CHENNAI	
		PRECISION ENGINEERING INDUSTRIES	MUMBAI	
		PANAM ENGINEERS,	MUMBAI	
		PERFECT INSTRUMENTATION CONTROL (INDIA) PVT. LTD.	MUMBAI	
		VIKAS INDUSTRIAL PRODUCTS	NOIDA	
37.	JUNCTION BOX	AJMERA INDUSTRIAL & ENGINEERING WORKS	MUMBAI	
		FLEXPRO ELECTRICALS PVT. LTD.	GUJARAT	
		K.S.INSTRUMENTS PVT.LTD.	BANGALORE	

SR. NO.	ITEM	SUPPLIERS	PLACE	REMARKS
		SUCHITRA INDUSTRIES	BANGALORE	
		SHRENIK & COMPANY,	AHMEDABAD	
38.	CABLE GLAND	COMET	-	
		DOWELL	-	
		CHETNA	-	
39.	CABLE LUGS	ELECTRO BILLETS	-	
		COMET	-	
		DOWELL	-	
		CHETNA	-	
40.	MS PLATES	SAIL		
		ESSAR STEEL		
		TISCO		
		RINL		
		JINDAL		
		LLOYD		
		ISPAT		
		INDIAN IRON & STEEL CO. LTD		
41.	CS PIPE (ASTM A 106 GR. B)	INDIAN SEAMLESS METAL TUBES	AHMEDABAD	
		MAHARASHTRA SEAMLESS	RAIGAD	
42.	MS PIPES (IS: 1239 & 3589)	SAIL	ROURKELA	
		JINDAL	GHAZIBAD/HISSAR	
		SURYA ROSHNI	BAHADUR GARH	
		TATA TUBE	JAMSHEDPUR	
		PSL	CHENNAI/VIZAG/KUTCH/DAMAN	
		LALIT PROFILE	THANE	
		SAMSHI PIPES INDUSTRIES	VADODARA	
		MUKUT PIPES	RAJPURA	
		INDUS TUBES	G B NAGAR	
		MANN IND	INDORE	
		SURENDRA ENGG	RAJPURA	
		PRATIBHA PIPES & STRUCTURE PVT LTD	THANE	
		JCO GAS PIPE	CHINDWARA	
		NUKAT TANKS AND VESSELS	TARAPUR	
		DADU PIPES	SIKRANDRABAD	
		GOOD LUCK TUBES	SIKANDRABAD	
		ADVANCE STEEL TUBES	SAHIBABAD	
		BIHAR TUBES	SIKANDRABAD	
		HI TECH PIPES	SIKANDRABAD	
		RATNAMANI	KUTCH/AHMEDABAD/CHHATRAL	
		MAHARASHTRA SEAMLESS	RAIGAD	
		WELSPUN	ANJAR/BHARUCH	
43.	SS PIPES / TUBES	APEX TUBES	BEHROR (ALWAR)	
		RATNAMANI	CHATTRAL	
		REMI	TARAPUR	

SR. NO.	ITEM	SUPPLIERS	PLACE	REMARKS
		PRAKASH STEELAGE	-	
44.	POWER/CONTROL/INSTRUMENT CABLE	CORDS CABLE	BHIWADI	
		RADIANT CABLES	HYDERABAD	
		POLYCAB	DAMAN	
		KEI	BHIWADI	
		NICCO	KOLKATA	
		RAVIN CABLES	PUNE	
		INCAB	PUNE	
		HVPL	FARIDABAD	
		TORRENT CABLE	NADIAD	
		HAVELLS	ALWAR	
		PARAMOUNT	KHUSHKHERA	
		SRI RAM CABLES	BHIWADI	
		THERMOCABLES	HYDERABAD	
		TORRENT CABLE	NADIAD	
		UNIVERSAL CABLES	SATNA	
		GEMSCAB	BHIWADI	
		DELTON	FARIDABAD	
45.	SAFETY SHOWER	UNICARE	-	
		MOHAN INDUSTRIES	-	
		SUPER SAFETY SERVICES	-	
		EPP	-	
		DEEPA COMPOSITE	-	
		COROSEAL INDUSTRIES	-	
		CHEMICAL PROCESS & EQUIPMENT PVT LTD	-	
		J.R FIBRE INDUSTRIES PVT LTD	-	
		POLYPLAST	-	
		RATNA PRASAD	-	
46.	LOCAL CONTROL PANEL	INDUSTRIAL SWITCHGEAR & CONTROL	-	
		POSITRONICS	-	
		DELTA CONTROL	-	
		L & T	-	
		GE POWER	-	
		PYROTECH	-	
		C& S	-	
47.	TANK (FRP)	INDUSTRIAL SERVICE	KOLKATA	
		SUNRISE	BARODA	
		GANDHI & ASSOCIATES	AHMEDABAD	
		MODERN EQUIPMENTS	CHENNAI	
		EAGLE PLAST	PUNE	
		OMEGA PLAST	MUMBAI	
48.	STROKE CONTROLLER	V K PUMPS	NASIK	
		METACHEM	MUMBAI	
		SWELORE	AHMEDABAD	
		MILTON ROY INDIA	CHENNAI	
49.	SAFETY	METACHEM	MUMBAI	

SR. NO.	ITEM	SUPPLIERS	PLACE	REMARKS
	VALVES/RELIEF VALVES	KEYSTONE	BARODA	
		V K PUMPS	NASIK	
		MILTON ROY	CHENNAI	
50.	ORIFICE PLATE	MICRO PRECISION	FARIDABAD	
		INSTRUMENTAION LTD	PALGHAT	
		CARLO DYNAMICS	HYDERABAD	
51.	SLUICE GATE	H SARKAR	KOLKATA	
		JASH ENGINEERING	-	
		YASHWANT INDUSTRIES	-	
52.	3 WAY VALVE	HI TECH	AHMEDABAD	
		ADVANCE VALVES PVT.LTD	NOIDA	
		BDK	HUBLI	
		AV VALVE	AGRA	
		FOURESS ENGG.INDIA LTD.	MUMBAI	
		FLUIDLINEVALVES COMPANY PRIVATE LTD.,	MUMBAI	
		INSTRUMENTATION LTD.	PALAKAD	
		KIRLOSKAR BROTHERS LTD.	PUNE	
		VENUS PUMP & ENGG. WORKS	KOLKATA	
		SURYA VALVES AND INSTRUMENTS MANUFACTURING COMPANY	CHENNAI	
		STAFFORD CONTROLS LIMITED	PUNE	
		MICON VALVES (INDIA) PVT.LTD	MUMBAI	
53.	PLUG VALVE (MANUAL)	BDK	HUBLI	
		HAWA ENGINEERS / MARCK & CARE	-	
		MICON VALVES	-	
		A.V. VALVES LTD	AGRA	
		MICON VALVES (INDIA) PVT.LTD	MUMBAI	
54.	FITTINGS (CS/SS)	M.S. FITTINGS	KOLKATA	
		RELIANCE FORGE	MUMBAI	
55.	FLANGES (SS/CS)	M.S. FITTINGS	KOLKATA	
		RELIANCE FORGE	MUMBAI	
56.	PIPE & FILLTING (PP,HDPE,PVC & CPVC)	GEROGE FISHCHER	DELHI	
		ASTROL PLYTECHINC LTD	AHMEDABAD	
57.	VALVES (GATE/GLOBE/NRV /BALL)- (PP,HDPE,PVC & CPVC)	GEROGE FISHCHER IPING SYSTEMS PVT LTD	DELHI	
		ASTROL PLYTECHINC LTD	AHMEDABAD	
		ASAHI	-	
58.	AIR FILTER REGULATOR	SHAVO NORGEN	-	
		PLACKA INSTRUMENTS	-	
59.	FILTER MEDIA	GLOBAL ABSORBENT	KOLKATA	
		BHARAT MINERALS		
60.	SIGHT FLOW INDICATORS	B.K.EQUIPMENTS PVT.LTD.	CHENNAI	
		BLISS ANAND PVT. LTD.	GURGAON	
		FLOWTECH INSTRUMENTS SERVICRS	VADODARA	
		INSTRUMENTATION ENGINEERS PVT LTD	TELANGANA	

SR. NO.	ITEM	SUPPLIERS	PLACE	REMARKS
		SIGMA INSTRUMENTS CO.	MUMBAI	
		SCIENTIFIC DEVICES (BOMBAY) PVT LTD,	NAVI MUMBAI	
		TELACE EQUIPMENT PVT.LTD.	CHENNAI	
61.	PAINT	ASIAN PAINTS (I) LTD.		
		BERGER PAINTS INDIA LTD		
		GOODLASS NEROLAC		
		JENSON & NICHOLSON (I) LTD		
		CDC CARBOLINE (I) LTD.		
		SHALIMAR PAINTS LTD.		
		ADDISON PAINTS LTD		
		GRAND POLYCOAT		
		BOMBAY PAINTS		
		HEMPLE PAINTS (SINGAPORE)		
		JOTUN PAINTS		

Notes: -

a) All the finally selected sub vendors shall be subject to BHEL/FICHTNER/TANGEDCO approval during detailed engineering without any delivery/ commercial implications to BHEL/ FICHTNER/TANGEDCO.

b) This vendor list applicable for Mechanical, electrical and C&I items.

c) Any other sub vendors not listed in above list, but, required to complete the system shall be subject to BHEL/FICHTNER/TANGEDCO approval during detailed engineering without any delivery/ commercial implications to BHEL/FICHTNER/TANGEDCO. The same shall be proposed by main vendor during detailed engineering.

DRAWING/DOCUMENT DISTRIBUTION SCHEDULE [TABLE-4]

Documents:	PEM-Engineering	CONSULTANT/ CUSTOMER	BHEL SITE OFFICE	CUSTOMER SITE OFFICE
Documents for approval (1st submission and resubmission)	2+SOFT COPY	6+SOFT COPY	0	0
Documents for information (1st submission and resubmission)	2+SOFT COPY	6+SOFT COPY	0	0
Schedules, diagrams, lists, tables, calculation, specifications and other documents	2+SOFT COPY	6+SOFT COPY	0	0
Final & as-built drawings				
Final as-built drawings and final approved documents	2+SOFT COPY+2CD	5+SOFT COPY+2CD	6+SOFT COPY+2CD	6+SOFT COPY+2CD
Final O&M manuals	2+SOFT COPY+2CD	5+SOFT COPY+2CD	6+SOFT COPY+2CD	6+SOFT COPY+2CD
Detailed project time schedules	2+SOFT COPY	2+SOFT COPY	2+SOFT COPY	2+SOFT COPY

Note:

- Quantity of prints may change during detailed engineering stage based on BHEL / Customer requirement. However the same will be adhered by the bidder without any delivery/commercial implication to BHEL.
- All the drawing documents along with the O&M manual (of all the revisions) are necessarily to be submitted in soft copies in addition to hard copies.
- Bidder to submit soft copies of all the drawing and document along with quality plans for BHEL review and approval (P&ID in A2 size, Layout (electrical/piping/equipment) in A1/A0, QAP/Data Sheet in A4 size).
- The date of submission of drawing documents shall be considered as the date of submission of hard and soft copes whichever is later.
- All the drawings shall be prepared on computer auto cad and other documents (like datasheet etc.) on MS office software. Bidder not complying to the requirement shall not be considered. For the execution of the contract regular meeting (generally once in 15 days or as per project requirement) is required.
- Bidder has to come for meeting with the concerned dealing persons as per BHEL or customer requirement in a short notice.
- Bidder to submit instrument schedule, cable schedule and valve schedule in MS- Excel format during detailed engineering.
- Bidder to also furnish the auto cad copy / MS-word (as applicable)/MS-Excel (as applicable) of the following documents after award of contract. However, any other auto cad copy/MS-Excel/MS-word of any other document as per the insistence of BHEL / customer will also be submitted by the bidder without any delivery/commercial implication to BHEL.
  - P&IDs.
  - Process Sizing Calculation.
  - Equipment lay out.
  - Equipment Cable tray layout.
  - Equipment earthing layout.
  - Civil scope drawings.
  - Piping lay out drawing.
  - Valve schedule.
  - Instrument schedule.
  - Cable Schedule.

LIST OF MANDATORY SPARES [TABLE-5]

S.no.	Mandatory Spares	Total Quantity
1.0	**AGITATORS**	
1.1	Impeller Assembly	1 No. of each type and Size/Rating.
1.2	Bearing Assembly	1 No. of each type and Size/Rating.
1.3	Motor	1 No. of each type and Size/Rating.
1.4	Belt and Pulley (If applicable)	1 No. of each type and Size/Rating.
1.5	Gear Box Assembly (If Applicable)	1 No. of each type and Size/Rating.
1.6	Agitator shaft assembly	1 No. of each type and Size/Rating.
1.7	Complete Agitator assembly	1 No. of each type and Size/Rating.
2.0	**Horizontal Centrifugal Pumps**	
2.1	Complete Impeller Assembly	1 No. of each type and Size/Rating.
2.2	Casing Liners	1 Set of each type and Size/Rating.
2.3	Bearings	2 Sets of each type and Size/Rating.
2.4	Motors	1 No of each type and Size/Rating.
2.5	Pump discharge valve assembly	1 No of each type and Size/Rating.
2.6	V-Belt	2 Sets of each type and Size/Rating.
3.0	**MEASURING INSTRUMENTS**	
3.1	All type of Transmitters including sensors.	10% or 1 No. of each type and model whichever is more.
3.2	Limit switches for isolation valves.	2 Nos. of each type
3.3	Local Indicators like temperature gauges, pressure gauges, differential pressure gauges, flow gauges, flow meters etc.,	5% or 1 No. of each make, model and type whichever is more (to be divided to various ranges in proportion to main of all make, model, type population)
3.4	Process Actuated Switch Devices Includes all types of Pressure, differential pressure, flow, temperature, differential temperature, level switch Devices.	5% or 1 No. of each type and model whichever is more
4.0	**Any other instrument (as applicable)**	10% or 1 No. of each type and model whichever is more
5.0	**PROCESS CONNECTION PIPING** (For Impulse Piping / Tubing and Air Supply Piping as Applicable)	
5.1	Valves of all types and models	10% or 1 No. of each type, class, size and model whichever is more.
5.2	2 way, 3way, 5way valve manifolds	10% or 1 No. of each type, class, size and model whichever is more.
5.3	Fittings	10% or 1 packet of each type, class, size and model whichever is more.
5.4	Purge meters	5% of each model or 1 No. whichever is more.
5.5	Filter regulators	20% of each model or 2 Nos. whichever is more.
5.6	Valves of all types and models	10% or 1 No. of each type, class, size and model whichever is more.
5.7	2 way, 3way, 5way valve manifolds	10% or 1 No. of each type, class, size and model whichever is more.

Notes-1: Only applicable items shall be considered. Applicable items are those which are installed in the system.
Notes-2: Wherever quantity has been specified as percentage (%), it shall mean percentage (%) of the total population of the item in the station (project), unless specified otherwise and the fraction will be rounded off to the next higher whole number.
Note-3: Wherever set is mentioned, one set of the spares of that item shall be for complete replacement of that particular item for one equipment.

PAINTING SPECIFICATION

CLEANING, PROTECTIVE COATING AND PAINTING

1.0 General

This specification covers the general requirements related to the cleaning protective coating and painting of equipment, components and systems that are covered under main equipment / system specifications. The components and/or equipment shall be mechanically and /or chemically cleaned during the following stages of the Contract.

- Cleaning in workshop
- Cleaning before painting and/or corrosion protection (application of prime coat)
- Cleaning before erection and during installation.

Cleaning of fabricated component items shall be carried out after fabrication and final heat treatment or welding at manufacturer's works or at site, as appropriate. No paint shall be applied surfaces within 75 mm of field welded connections. These surfaces shall be coated with a consumable preservative and marked.

For cleaning in workshop and before painting, mechanical cleaning by power tool and scrapping with steel wire brushes shall be adopted to clear the surfaces. However, in certain locations where power tool cleaning cannot be carried out, hand scrapping may be permitted with steel wire brushes and/or abrasive paper. Cleaning with solvents shall be resorted to only in such areas where other methods specified above have not achieved the desired results. Cleaning with solvents shall be adopted only after written approval of the Owner / Engineer.

Machined surfaces shall be protected during the cleaning operations.

In the event of the surfaces not being cleaned to the Owner's satisfaction, such parts of the cleaning procedures or agreed alternatives as are deemed necessary to overcome the deficiencies shall be carried out at the supplier's sole expense.

For reclining small areas, hand cleaning by wire brushing may be permitted.

1.1 Codes and Standards

Painting of equipment shall be carried out as per the Codes indicated below and shall conform to the relevant IS Code for the material and workmanship.

The following codes and standards shall be followed for the surface preparation, surface protection and painting works.

IS: 5	Colors for ready mixed paints and enamels.
IS: 101	Methods of test for ready mixed paints and enamels.
IS: 104	Ready mixed paint, brushing, Zinc Chrome, priming.
IS: 158	Ready mixed paint, brushing, bituminous, black, lead free, acid, alkali, water and heat resisting.
IS: 161	Heat resistant paints
IS: 1303	Glossary of terms relating to paints.
IS: 1477	Code of practice for painting of ferrous metals in buildings (Parts I & II).
IS: 2074	Specifications for ready mixed paint, Air drying, red oxide zinc chrome priming.
IS: 2338	Code of practice for finishing of wood and wood based materials: Parts 2 schedules.
IS: 2339	Aluminum paint for general purposes, in dual container.
IS: 2395	Code of practice for painting of concrete, masonry and plaster

	surfaces: Part 2 schedules.
IS: 2524	Code of practice for painting of non-ferrous metals in buildings (Parts I & II).
IS: 2932	Specification for enamel, synthetic, exterior (a) undercoating, (b) Finishing
IS: 3140	Code of practice for painting asbestos cement building products.
IS: 6158	Recommended practice for design safeguarding against Embrittlement of hot dip Galvanized Iron & steel products.
IS: 6159	Recommended practice for design & fabrication of Iron &steel products prior to Galvanizing & metal spraying.
IS: 6278	Code of practice for white washing and Color - Washing.
IS: 10221	Code of practice for coating & wrapping of underground mild steel pipelines.
IS: 33	Inorganic pigments and extenders for paints –Methods of sampling & test.
IS: 13183	Aluminum paint, Heat resistant - specifications.
IS: 144	Specification for ready mixed paint brushing, petrol resisting, Air drying for Interior paints of tanks and containers, Red oxide.
IS: 9954	Pictorial surface preparation standards for painting of steel surfaces.
IS: 11883	Specification for Ready Mixed Paint, Air Drying, Red Oxide Priming for metals.
IS: 9404	Color code for identification of pipelines used in the Thermal Power Plants.
IS: 12744	Specification for Ready Mixed Paint, Air Drying, Red Oxide-Zinc Phosphate Priming.
BS: 2015	Glossary of paint selected terms.
BS: 5252	Final coat color.
BS: 7079A1/S1	Specification for rust grades and preparation grades of uncoated substrates after overall removal of previous coating.
BS: 7079A2	Preparations grades of previously coated steel substrates.
BS: 7079GrC	Surface roughness characteristics of blast cleaned steel substrates.
BS: 7079GrD	Methods for surface preparation.
BS-4232	Surface Finish of Blast cleaned steel for painting.
ASTM	American Standard for Testing Material.
ASTM A 780	Standard practice for repair of damaged galvanized coatings.
AWWA	American Water Works Association.
ASA-A-13.1-1981	Scheme for identification of piping system (American National Standard Institution).
DIN	Deutsehes Institute for Normung
S1S-055900-1967	Surface preparation standards for painting steel surfaces. (Swedish standard Institution)
SSPC-SP	Preparation Specifications (Steel structures painting council, U.S.A.).
	National Association of Corrosion Engineers, U.S.A. (NACE).

1.2 Scope of Work and General Requirements

This specification covers the surface preparation, method of application and material to be used for all coating of equipment, steel structures and piping. Steel material subjected to surface preparation on shop/site shall have minimum requirements in accordance with Rust Grade B (SSPC/SSPM Volume-2).

Coating materials according to SSPC, EN ISO, ASTM, BIS or DIN standards, shall be used. The paint shall comply with applicable laws, regulations, ordinances etc., of the local authority,

state or the nation pertains to the work. The materials shall be matched with each other so that they are compatible. Coatings deviating this specification shall be subject to approval.

Standards of surface preparation and painting shall give a time to first maintenance of minimum 10 years.

The paint to be applied shall be approved by Owner.

All paints & paint material used shall be procured from approved manufacturers. Paint shall be supplied in manufacturers original containers with the description of content, specification No., colour, ref no, date of manufacture, shelf life expiry date & pot life.

The paint manufacturers shall provide coating system data sheet for each coating system to be used containing the following information

a. Surface preparations
b. Film thickness (min and max)
c. Min and max recoating intervals at relevant temperatures
d. Mixing ratio, thinner details and coating repair systems

The sample for testing the paint being used may be taken by the Owner at any time.

In general Shop fabricated equipment will be delivered to the site coated with a shop applied system or the manufacturer's standard finish in accordance with the requirements of this specification.

For equipment that has received shop prime coat, all touch-up prime coat and additional coats shall be applied in accordance with the coating schedule. It is responsibility of the vendor to ensure compatibility between shop and field applied paint systems.

Necessary precautions shall be provided to all equipment, structures to protect other surfaces from abrasive blasting, coating over spray and spatter. Damage to other surfaces or equipment shall be repaired by the vendor.

The Contractor shall submit the following for review and approval by the Owner:

a. Manufacturer's recommended paint scheme for the project
b. Latest published product & instructions for application data,
c. Procedures for surface preparation and application.
d. Pre qualification for equipments and blasting materials, product, procedure and personnel qualifications for the paint and painting systems.
e. Painting repair procedures

Painting records shall contain:

- Equipment/components/location painted
- Application equipments
- Ambient conditions at the time of painting
- Surface temperature
- Drying time between coating, DFT and number of coatings
- Appropriate work plan for painting.

The supply of all necessary equipments, weather protection, and scaffolding for painting to ensure work is carried out in accordance with the specification and agreed programme.

Maintenance of the paint work until completion of the contract, this shall include repair of any damaged areas caused by third party.

Disposal of painting waste resulting from painting, shall comply with applicable laws, regulations, ordinances etc., of the local authority, state or the nation pertains to the work and coating materials.

It is a mandatory requirement that all operatives working to this procedure take full cognizance and implement necessary safety precautions.

2.0 Cleaning at manufacturer's works

Mechanical cleaning shall preferably be carried out by abrasive blasting. The Owner is prepared to consider alternative methods such as chemical cleaning provided they achieve the necessary surface condition.

In case of chemical cleaning, the detailed procedure for chemical cleaning as well as the system for which chemical cleaning is required shall be submitted by the contractor for Owner's approval. The procedure shall comprise of pre-treatment and acid treatment to achieve cleanliness equivalent to that specified for mechanical cleaning.

Surface condition:
The Metal surfaces shall be clean and free of mil scale, rust, dirt, grease and any other deleterious matter.

Where metal surfaces are to be painted the surface profiles shall conform to the painting specification requirements.

Where this does not apply, surfaces shall have a surface texture not coarser than Grade 80 abrasive paper.

Abrasives:
Abrasives containing silica, silicates or slag residues shall not be used for water/steam side surfaces of plant except for cleaning sand castings, where hydro blasting may be employed.

For austenitic materials only, abrasives containing 98% or more of alumina, $Al_2 O_3$, shall be used.

Removal of abrasive and debris:

After cleaning, abrasive and debris shall be thoroughly removed for components.

3.0 Protection at manufacturer's works

As soon as all items have been cleaned and within four hours of the subsequent drying, they shall be given suitable anti-corrosion protection.

All water, air and steam side surfaces shall be protected by the application of approved water soluble corrosion inhibitors, or vapor phase inhibitors that can be subsequently removed by site water washing or steam blowing.

The gas side of steam generating plant items shall be protected by the application of temporary protective that do not require to be removed before commissioning, but which are removed during initial firing.

The rate of application of volatile corrosion inhibitors shall be at least 10 grams per square meter or 35 grams per cubic metre, whichever is the greater, except for pipes up to 300 mm diameter for which the minimum application rates shall be 5 grams per square metre.

Immediately after the protective treatment has been applied all vessels and pipes shall be suitably sealed off by discs or caps or approved alternatives to prevent ingress from the surroundings. Cylindrical plugs shall not be driven into the ends of pipes. These protective covers shall not be removed until immediately before final connection is made to the associated equipment.

4.0 Weather conditions

Painting shall be done only when the surface temperature is above 5℃. Surface temperature must be at least 3℃ above dew point to ensure that condensation does not occur on the surface.

Reasonable protection against precipitation and seawater spray shall be exercised for the painting of outdoor parts.

Precautions shall also be taken against solar radiation to ensure that the specified dry film thickness of priming or finish coats is obtained.

Any prime coat exposed to excess humidity, rain, dust etc., before drying, shall be permitted to dry and the damaged area of primer shall be removed and the surface prepared and primed again.

Sheltered or unventilated horizontal surfaces on which dew may collect require more protection, and to achieve this additional top coat of paint shall be applied.

The temperature quoted as “normal” in the “Paint System Tables” refers to the average local climatic conditions.

5.0 Surface preparation

In preparing any surface to be coated, all loose paint, dirt, grease, rust, scale, weld slag or spatter or any other extraneous material shall be removed and defects repaired, so as to obtain a clean, dry, even surface to receive the priming or finishing coat (s) as called for in the painting schedules. Sharp edges should be rounded, especially when tank linings have to be applied.

All machined surfaces, including flange faces, shall be suitably covered to prevent damage during surface preparation.

All surfaces should be blast cleaned whenever possible.

Surface preparation methods:

Bare steel surfaces should be prepared by one of the methods described below in order of preference and in accordance with Swedish Standard SIS 05 59 00 or Steel Structures Painting Council, SSPC, Vis 1, or DIN 55928, section 4.

The relative humidity level should not be more than 60% & the steel surface temperature at least 3º C above the dew point during dry blast cleaning operations.

a. White metal blast cleaning Sa 3 or SSPC - SP 5

Sa 3 Blast cleaning to bare metal. Mill scale, rust and foreign matter must be removed completely. Subsequently, the surface is cleaned with vacuum cleaner, clean dry compressed air or a clean brush. It must then have a uniform metallic color and correspond in appearance to the prints designated Sa 3.

b. Near white metal blast cleaning Sa 2 1/2 or SSPC - SP 10

Sa 2 1/2. very thorough blast cleaning. Mill scale, rust and foreign matter shall be removed to the extent that the only traces remaining are slight imperfections in the form of spots or stripes. Subsequently, the surface is cleaned with a vacuum cleaner, clean dry compressed air or a clean brush. It must then correspond in appearance to the prints designated Sa 2 1/2.

Mechanical cleaning should only be used when procedures (a) and (b) are not practicable.

c. Near white metal blast cleaning P Sa 2 1/2 DIN 55928

Very thorough blast cleaning. Very adhesive coatings remain. From all other surface mill scale and rust are to be removed to such an extent that the only traces remaining are slight imperfections in the form of spots or stripes. Further treatments see Sub b).

The adhesivity of residual coatings in the transition zone has to be tested even after the application of the primer.

d. Very thorough mechanical scraping and wire brushing St 3

St 3 very thorough scraping and wire-brushing - machine brushing - grinding - etc. are to be preferred. Surface preparation as for St 2. But much more thoroughly. After the removal of dust, the surface must have a pronounced metallic sheen and correspond to the prints designated St. 3.

e. Thorough scraping and wire brushing St 2

St 2 Thorough scraping and wire-brushing - machine brushing - grinding - etc. The treatment shall remove loose mill scale, rust and foreign matter. Subsequently, the surface is cleaned with a vacuum cleaner, clean dry compressed air or a clean brush. It should then have a faint metallic sheen. The appearance must correspond to the prints designated St 2.

f. Air Blasting with Non-Metallic Abrasives Powder

Whenever the "Duplex"-process is to be applied (hot dip galvanising followed by painting), prepare the hot dip galvanised surface by water washing to remove flux residues and careful air blasting with non-metallic abrasive powder. Use an abrasive with grain size from 0.1 to 0.5 mm, at a greatly reduced air pressure, max. 2 bar (g) (28 psig).

This procedure also applies to stainless steel and aluminium surfaces to be coated.

Surface preparation methods	SIS 055900	DIN 55928 Part-4	BS 4232 only for blasting	SSPC-Vis
Blasting acc to item (a),(b),(c),	Sa 3		First quality	White metal SP 5
Blasting acc to item (b)	Sa 2 1/2		Second quality	near White SP 10
Blasting acc to item (c)	Sa 2		Third quality	Commercial blast SP 6
Hand/or power tool derusting acc to item (e)	St 2		--	Hand tool cleaning SP 2
acc to items (d) and (e)	St 3		--	Power tool cleaning SP 3

Surface preparation methods	SIS 055900	DIN 55928 Part-4	BS 4232 only for blasting	SSPC-Vis
Flame jet cleaning		F1	--	Flame cleaning SP 4
Pickling		Be	--	Pickling

Steel structures to be blast cleaned have to be free of pitting and other severely corroded places in accordance with B.S. 4232 and SIS 055900.

The abrasives used for blast-cleaning shall be graded flint, grit, shot or silica sand and shall be such that they will produce an average keying profile on the blast-cleaned surface of not more than 40 microns.

An air pressure of 7 bar g at the nozzle shall be used.

After blast-cleaning, all accumulated grit, dust, etc., must be removed leaving the surface clean, dry and free of mill scale, rust grease and other foreign matter.

In the event of rusting after completion of the surface preparation, the surface must be cleaned again in the manner specified.

Oil, grease, soil, cement, salts, acids or other corrosive chemicals shall be cleaned from steel surfaces, by the use of solvents, emulsions or cleaning compounds. The final wiping shall be with clean solvent and clean rags or brushes. There shall be no detrimental residue left on the surface.

Primed areas which suffer damage must be spot blasted on site to a degree of cleanliness Sa 2 1/2 before, touching up.

Protective coating must be applied as quickly as possible after the completion of surface preparation no matter what cleaning method has been used.

No blast-cleaned surface shall be allowed to remain uncoated overnight.

Steel work protected by shop primer after arrival on site must be cleaned of salt, sand, oil etc. Before the first coat of paint is applied on site. Shop primer damaged during transport must be rectified by blast-cleaning and coating before application of the site coats.

Wood surfaces shall be sanded clean. All nail holes shall be puttied and sanded before priming.

Concrete: If a protective coating is required, concrete shall be allowed to cure before painting.

6.0 Preparation of coating materials

All containers shall remain un-opened until required for use.

Primers and paints which have livered, gelled or otherwise deteriorated shall not be used.

The oldest primer or paint of each kind shall be used first.

All ingredients in any container shall be thoroughly mixed before use, and shall be agitated frequently during application to keep the primer in suspension.

Primer or paint mixed in the original container shall not be transferred until all settled pigment is incorporated into the body of liquid.

Mixing in open containers shall be done in a well ventilated area.

Primer or paint shall be mixed in a manner ensuring the breakdown of all lumps, complete dispersion of pigment and uniform composition.

Two-component primers shall be mixed in accordance with the manufacturer's instructions.

Thinners shall not be added to primers or paints unless necessary for proper application according to the manufacturer's instructions.

When use of thinners is permitted, it must be added to the primer or paint during mixing.

6.1 Primer Paint

After the surface is prepared, one coat of suitable primer shall be applied. After this first coat is dried up completely, second coat of primer shall be applied.

Primer shall be applied by brushing to ensure a continuous film without 'holidays'. The dry film thickness of each coat shall be as specified in Paint System of this specification.

The primer should be worked by brush application to cover the crevices, corners, sharp edges etc. in the presence of inspector.

The shades of successive coats should be slightly different in color in order to ensure application of individual coats, the thickness of each coat and complete coverage should be checked as per specification approved by Engineer before application of successive coats.

The contractor shall provide standard thickness measurement instrument with appropriate range(s) for measuring.

Elko meter for measuring the Dry film thickness of each coat, surface profile gauge for checking of surface profile in case of sand blasting. Holiday detectors and pinhole detectors for checking the painted surface discontinuities should be provided by the contractor.

The contractor shall make arrangements for paint manufacturer to provide expert technical service at site as and when required free of cost and without any obligation to the Owner, as it would be in the interest of the manufacturer to ensure that both surface preparation and application are carried out as per their recommendations.

Final inspection shall include measurement of paint dry film thickness, check of finish and workmanship.

6.2 Rub down and Touch Up of Primer

The shop coated surfaces shall be rubbed down thoroughly with emery paper to remove all dust, rust and other foreign matters, washed, degreased, then cleaned with warm fresh water and air dried.

The portions, from where the shop coat has peeled off, shall be touched up and allowed to dry before applying a coat of primer.

The compatibility between shop coat and field primer shall be ascertained from the paint manufacturer. In case degreasing with white spirit is not effective, the surface shall be finally wiped clean with aromatic solvent like xylol or light naphtha.

6.3 Non Compatible Shop Coat Primer

a) The compatibility of finishing coat shall be confirmed from the paint manufacturer. In the event of use of primer such as zinc rich epoxy, inorganic zinc silicate etc., the paint system shall depend on condition of shop coat. If the shop coat is in satisfactory condition showing no major defect, the shop coat shall not be removed. The touch up primer and finishing coat(s) shall be identified for application by Engineer. Shop coated (coated with primer & finishing coat) equipment shall not be repainted unless paint is damaged.

b) Shop primed equipment and surfaces shall only be 'spot cleaned' in damaged areas by means of power tool brush cleaning or hand tool cleaning and then spot primed before applying one coat of field primer unless otherwise specified. If shop primer is not compatible with field primer then shop coated primer shall be completely removed before application of selected paint system for particular environment. For package units/equipment, shop primer shall be as per the paint system given for particular environment.

c) In case of existing paint, compatibility between finishing coat and new selected finish coat shall be ascertained before application of finish coat. In case, the coat is selected for upgrading existing alkyd coating to high performance coating then, surface preparation shall be by manual/mechanical means to remove loose rust, peeled off/damaged paint, but sound old coating need not be removed. It shall be touched with suitable primer wherever it has peeled of before application of tie coat. The tie coat shall be applied after 7 days of curing of the primer. If, new paint system is not suitable to upgrade existing coating then complete paint shall be removed by mechanical or blast cleaning before application of new coating system.

6.4 Finish Paint

Suitable Finish paints as per the schedule shall be applied for the jobs. The color/shade shall be as approved by the Owner. After cleaning the dust on the dried up primer, first coat of finished paint shall be applied. After this first coat dries up hard, the surface is wet scrubbed cutting down to a smooth finish and ensuring that at no place the first coat is completely removed. After applying second coat, allowing the water to get evaporated completely, third finish coat of finish paint may be applied(if applicable).

7.0 Steel Structures Painting

Generally, all steel structures shall receive two primer coats and two finish coats of painting. First coat of primer shall be given in shop after fabrication before dispatch to erection site after surface preparation as described below. The second coat of primer shall be applied (if required) after erection and final alignment of the erected structures. Two finish coats shall also be applied after erection.

Steel surface which is to painted shall be cleaned off dust and grease and the heavier layers of rust shall be removed by chipping to grade ST-2 as per SIS05-5900 or as per IS: 1477 (part -I) prior to actual surface preparation. Suitable primer of required DFT shall be applied as specified in the Paint system of this document- Annex-1.

Suitable finish paint of required DFT shall be applied as specified in the Paint system of this document- Annex-1. The undercoat and finish coat shall be of different tint to distinguish the same from finish paint. All paints shall be of approved brand and shade as per the Owner’s requirement.

Joints to be site welded shall have no paint applied within 100 mm of welding zone. Similarly where Friction grip fasteners are to be used no painting shall be provided. On completion of the joint the surfaces shall receive the paint as specified.

Surfaces inaccessible after assembly shall receive two coats of primer prior to assembly. Surfaces inaccessible after erection including top surfaces of floor beams supporting gratings or chequered plate shall receive one additional coat of finish paint over and above number of coats specified before erection. Portion of steel member embedded / to be encased in concrete shall not be painted.

8.0 Paint Materials

The paints shall conform to the specifications given in this Annex and class - 1 quality in the products range of any of the following manufacturers:

a. Asian Paints (India) Ltd.
b. Bombay Paints
c. Berger Paints India Ltd.,
d. Good lass Nerolac Paints Ltd.,
e. Garware Paints
f. Jenson & Nicholson
g. Shalimar Paints
h. Equivalent other country manufacturer after prior approval of Owner.

9.0 Storage

All paints and painting material shall be stored only in rooms to Engineer's approval. All necessary precautions shall be taken to prevent fire. The storage building shall preferably be separated from adjacent buildings. A signboard bearing the words "PAINT STORAGE - NO NAKED LIGHT - HIGHLY INFLAMMABLE - DANGER - NO SMOKING" shall be clearly displayed outside. All paints shall be stored in the safest manner so that no container rolls down and causes accidents. The shelf life of the paints shall be ensured so that the paint materials are not in storage and use after the date of expiry.

10.0 Application

Health and safety of work

The supplier has to check all painting work to be carried out according to the specification of the paint supplier further to all relevant prescriptions and regulations concerning the health and safety of work.

The paint supplier has to present a written specification including at least the flash point of the paints, ventilation requirements, handling precautions such as inhalation, eye and skin protection, and first aid procedure, storage requirements, spill or leak procedure, fire precaution, waste disposal.

Methods

Quality of the surface to be painted or coated has to be tested acc. to DIN 55928 and DIN 8202.

Temporary corrosion protections are to be completely removed prior to applying the definite one, in acc. with DIN 55928.

All prime coatings shall be applied by brush or airless spray or a combination of these methods, as approved by the coating manufacturer.

All doors, windows, stairways, handrails (if painted), bolts, flanges and equipment supports shall be finish painted by brush.

Spray guns should not be used outside in windy weather or near surfaces of a contrasting colour unless the latter is properly protected.

All cold-spray painting shall be done using standard equipment in accordance with accepted standards and methods.

Care has to be taken not to connect spraying devices for nitro and backelite paints simultaneously to oil based paints.

Paint applied to items that are not being painted shall be removed at the supplier's expense, leaving the surface clean, unstained and undamaged.

Dry film thickness (DFT)

To the maximum extent practicable the coats shall be applied as a continuous film of uniform thickness and free of pores. Overspray, skips, runs, sags and drips should be avoided. The different coats shall not be of the same colour.

For a composite paint or coating system consisting of several coats, the total DFT must be at least equal to the sum of the minimal DFT's for the individual coats. If, the paint system does not have the required minimum DFT those areas should be marked & repainted. If the occurrence of those areas is high, the complete surface must be repainted. It is also critically important to check the DFT of primers and intermediate coats and to correct them where necessary.

For paintings based on Zinc silicate the DFT is limited as well on minimum DFT as on maximum (150µm) because of the risk of mud cracking.

Consumption of paints

Has to be evaluated according to DIN 53220. The paints shall be tested as per IS - 101.

Each coat of paint shall be allowed to harden before the next is applied. For epoxy paint the hardening time normally is 12-14 hours. Suppliers' recommendations regarding hardening time of epoxy paints must be followed.

Particular attention must be paid to full film thickness at edges.

The minimum total dry film thickness of the paint systems shall be as recommended in the following tables below. The DFT is given in microns (millionths of a metre).

11.0 Protective coatings and paint systems

The colour coding for identification of pipelines should comply with IS-2379 & IS -9404.

The type and number of protective coats for any item requiring painting are to be in accordance with DIN 55928 and are to be at least of a quality as shown in the attached Annex-1- Paint System.

Alternative to the Annex-1- Paint System specified, are to be presented on the schedule Departure from Specification, as indicated elsewhere.

Generally, all parts shall receive the specified prime coat (s) at the supplier's works to ensure that no corrosion occurs during transport to the site and storage at the site.

Parts which cannot be damaged during transport shall receive the full number of coats.

Types of Substrate, Base metal:

- Ferrous (Surface Temperature during operation < 120º C, EN ISO 12944:1998)

  To this group belongs carbon steel, low alloyed steel & high alloyed steel. All paint systems are inevitable for corrosion protection.

- Hot dip galvanized surfaces.

  Hot dip galvanized surfaces do require painting in a wet, industrial, chemicals and/or marine environment

- SS (EN ISO 12944:1998 conditionally applicable)

  In general, SS surfaces do not require painting unless in a chemical and/or marine environment. In case of chemical and/or marine environments determination of whether or not the surface requires painting depends on the chemical content of the base metal.

  The following formula applies
  W = Cr + 3.3 x Mo + 22.45 N2

  If W < 23, then the surface has to be painted.

  If W < 28 & W > 23, then the surface to be painted if splash contact with the media (i.e. sea) is possible. This may also occur if there is a strong wind carrying drops to the surface.
  If W > 28, then the surface need not be painted.

- Aluminium

  By default such surfaces/components will not be painted. Exceptions are architectural/ aesthetic reasons and high corrosive conditions, which shall be evaluated separately depending on aluminum alloys.

12.0 Galvanizing

Galvanizing works shall conform in all respect to B.S. 729, B.S. 3083 and B.S.C.P. 2008 and to DIN 50976 whatever requires the higher quality and shall be performed by the hot dip process, unless otherwise specified.

It is essential that details of steel members and assemblies which are to be hot-dip galvanized should be designed in accordance with B.S 4479.

Vent-holes and drain-holes should be provided to avoid high internal pressures and air-locks during immersion, which may cause explosions, and to ensure that molten zinc is not retained in pockets during withdrawal.

Careful cleaning of welds is necessary before welded assemblies are dipped. The welds and the surrounding metal should be cleaned separately, preferably be blast-cleaning, because the usual preliminary pickling cannot be relied on to remove the welding slag.

All defects of the steel surface including cracks, surface laminations, laps and folds shall be removed in accordance with B.S. 4360. All drilling, cutting, welding, forming and final fabrication of unit members and assemblies shall be completed, where feasible, before the structures are galvanized. The surface of the steelwork to be galvanized shall be free from paint, oil, grease and similar contaminants in accordance with DIN 55928, part 4 and DIN 50976. The weight of zinc coating per unit area has to be noted in the manufacturing documents in accordance with DIN 50976.

The minimum average coating weight shall be as specified in Table 1 of B.S. 729 or Table 2, DIN 50976, whatever requires higher quality.

Structural steel items shall be initially grit-blasted to B.S. 4232, second quality, (Sa 21/2) or by pickling in a bath and the minimum average coating weight on steel sections 5 mm thick and over shall be 900 g/m^2.

On removal from the galvanizing bath, the resultant coating shall be smooth, continuous, free from gross surface imperfections such as bare spots, lumps, blisters and inclusions of flux, ash or dross.

Galvanized contact surfaces to be joined by high-tensile friction-grip bolts shall be roughened before assembly so that the required slip factor (defined in B.S. 3294, part 1 and B.S. 4604, part 1) is achieved. Care shall be taken to ensure that the roughening is confined to the area of the mating faces.

Bolts, nuts and washers, including general grade high-tensile friction grip bolts (referred to in B.S. 3139, and B.S.4395 part 1) shall be hot dip galvanized and subsequently centrifuged (according to B.S. 729). Nuts shall be tapped up to 0.4 mm oversize after galvanizing and the threads oiled to permit the nuts to be finger-turned on the bolt for the full depth of the nut. No lubricant, applied to the projecting threads of galvanized high-tensile friction-grip bolt after the bolt has been inserted through the steelwork, must be allowed to come into contact with the mating faces of the steelwork,. A local remelting of the galvanized parts to achieve the nuts to be finger turned on the bolt is possible in accordance with DIN 50976.

Protected slings must be used for offloading and erection. Galvanized work which is to be stored at the works or on site shall be stacked so as to provide adequate ventilation to all surfaces to avoid wet storage staining (white rust).

Small areas of the galvanized coating damaged in any way shall be restored in accordance with DIN 55928, part A and DIN 50976 by:

- Cleaning the area of any weld slag rust and other impurities and by thorough wire brushing to give a metallic clean surface.

- Application of suitable number of coats of zinc-rich paint containing more than 90 % w/w of zinc in dried film. The dry film thickness shall exceed at least 50 % the thickness of the desired galvanization. In case of application of a low melting point zinc alloy repair rod, the rods shall be in accordance with DIN1707, the thickness of the alloy shall be at least as of the desired galvanization.

The restored area is not to exceed 1 % of the galvanized surface.

Surface restoration of parts in contact with drinking water is not allowed and the quality of the galvanization is to be in accordance with DIN 2444.

After fixing, bolt heads, washers and nuts shall receive two coats of zinc-rich paint. Connections between galvanized surfaces and copper, copper alloy or aluminum surfaces shall be protected by suitable preferably hydrophobe tape wrappings to the owner's approval.

13.0 Sprayed Metal Coatings

Corrosion protection may be also achieved by spraying of suitable metals as zinc and/or aluminum on the surfaces of structures. For special cases tin, copper, lead can be used as well. Methods of surface preparation have to conform to B.S. 2569 or to DIN 8567. A proper treatment of the surface followed by an immediate spraying is to apply to ensure adhesion of the sprayed metal. The surface has to be clean, free of impurities, rust, mill scale and rough enough to have binding properties to ensure good enticulation with the sprayed layer. Suitable

roughness can be achieved by blast cleaning acc. to BS 4232 or DIN 8567. Welds are to be cleaned and prepared with special care. All surfaces to be treated have to be dry and accessible.

Application of coatings, requirements for thickness, adhesion, composition of coating metals, and subsequent treatment have to conform to BS 2569, DIN 8565 and 8567.

Testing of the spray coated layers are to be carried out in accordance with DIN 8565.

The contractor has to specify the type, composition and thickness of the sprayed metal and of the sealing coating according to DIN 8565 including the corresponding warranties and tests if, sprayed metal coating will be applied.

Safety of work:

All precautions connected with this type of application of corrosion protection have to be in accordance with German regulation DVS 2307, page 1. 2.

Sprayed, unfused coating of metals and metallic compounds applied by combustion gas flame, plasma arc, detonation and similar processes, and the preparation of components, spraying techniques, sealing, finishing and inspection shall be according to B.S. 4761.

The hot galvanized surface has to be cleaned before the application of the coats to remove corrosion products, dirt, dust, grease.

The cleaning can be achieved by

- brush off
- washing with 1 - 1.5 % ammonia water with up to 0.1 % detergent added and followed by wet grinding to turn the foam to grey color,
- steam blasting.

14.0 Warning Notes / Signals

This Instruction serves the identification of the coated surfaces that are received from shop in assembled condition / module wise.

The warning note shall prevent any possible damage to the coated surfaces during transportation / assembly at site.

Eg.: Welding work OR Heat treatment work on the outside of coated or lined surfaces is prohibited.

15.0 Colour Code for Piping

a. The colour code scheme is intended for identification of the individual group of the pipeline. The system of colour coding consists of a ground colour and colour bands superimposed on it. The colour coding for the identification of pipelines shall comply with **Annex – 1** of this specification.

   Ground Colour shall be applied throughout the entire length for un insulated pipes. For insulated pipes, on the metal cladding or on the pipes of material such as non-ferrous metals, austenitic stainless steel etc., ground colour coating of minimum 2m length or of adequate length not to be mistaken as colour band shall be applied at places requiring colour bands. Colour band(s) shall be applied at the following location.

   i. At battery limit points

   ii. Intersection points & change of direction points in piping ways.

iii. Other points, such as midway of each piping way, near valves, junction joints of service appliances, walls, on either side of pipe culverts.

iv. For long stretch/yard piping at 50 M interval.

v. At start and terminating points.

b. Flow direction shall be indicated by an arrow in the location stated above and as directed by Engineer. Colors of arrows shall be black or white and in contrast to the color on which they are superimposed. The size of the arrows shall confirm to IS:2379. Product names shall be marked at pump inlet, outlet and battery limit in a suitable size as approved by Engineer. As a rule minimum width of color band shall conform to 75 mm up to 300 NB and to 100 mm over 350 NB. Whenever it is required by the Engineer to indicate that a pipeline carries a hazardous material, a hazard marking of diagonal stripes of red and golden yellow as per IS:2379 shall be painted on the ground color.

c. All uninsulated piping systems, hangers and supports shall have two coats of suitable primer coats and with suitable finish paints as per Annexure-3 Painting system. Shades shall be as per IS 5 or as indicated by Owner /Engineer. Service of the pipe/line designations shall be painted on all pipes at visible locations.

16.0 Identification of Vessels, Piping etc.

Equipment number shall be stenciled in black or white on each vessel, column, equipment and machinery after painting.

Line number in black or white shall be stenciled on all the pipelines of more than one location as directed by Engineer; size of letters printed shall be 150 mm (high) for column & vessels. 50 mm (high) for pump compressor and other machinery and shall be as per IS: 9404 for piping. The storage tanks shall be marked as detailed in the respective drawing.

17.0 Inspection and Testing

a) All painting materials including primers and thinners brought to site for application shall be procured directly from manufacturer as per specifications and shall be accompanied by manufacturer's test certificates. Paint formulations without certificates are not acceptable. Engineer at his discretion, may call for tests for paint formulations. Contractor shall arrange to have such tests performed including batch wise test of wet paints for physical & chemical analysis. All costs thereof shall be borne by the contractor. The paints shall be tested as per IS: 101 / equivalent international standard and approved by the Owner.

b) The painting work shall be subject to inspection by Engineer at all times. In particular, following stage wise inspection shall be performed and contractor shall offer the work for inspection and approval of every stage before proceeding with the next stage. The record of inspection shall be maintained in the registers. Stages of inspection shall be surface preparation, primer application and each coat of paint. In addition to above, record shall include type of shop primer already applied on equipment e.g. red oxide zinc chromate or zinc phosphate or Silicate primer etc.

c) Any defect noticed during the various stages of inspection shall be rectified by the contractor to the entire satisfaction of Engineer before proceeding further. Irrespective of the inspection, repair and approval at intermediate stages of work, contractor shall be responsible for making good of any defects found during final inspection/guarantee period/defect liability period as defined in general condition of contract. Dry film thickness (DFT) shall be checked and recorded after application of each coat and extra coat of paint shall be applied to make-up the DFT specified without any extra coat to the Owner.

18.0 Guarantee

The contractor shall guarantee that the chemical and physical properties of paint materials used are in accordance with the specifications contained herein/to be provided during execution of work. The contractor shall produce test reports from the manufacturer regarding the quality of the particular batch of paint supplied. The Engineer shall have the right to test wet samples of paint at random for quality of the same. Batch test reports of the manufacturer's for each batch of paints supplied shall be made available by the contractor.

19.0 Standard Final Colour of Equipment and Piping

19.1 Standard Colour Code for Mechanical Equipment

Sl. No.	Description	Ground Colour
A	**Service Water System**	Sea Green
B	**Crane & Hoist**	
1	EOT crane	Canary Yellow
C	**Compressed Air Plant**	
1	Air compressor	Sky Blue
2	Compressed air dryer	Sky Blue
3	Air receiver	Sky Blue
D	**Chemical Dosing**	Dark Admiralty Grey
E	**Fire Protection System**	Fire red
F	**Air Conditioning and Ventilation System**	
1	Refrigerant compressor	Sky Blue
2	Chilled / condenser pumps	Sea Green
3	Condenser water pipe	Sea Green
4	Fans	Grey

Notes:

This color code basically refers to IS:2379 for piping with necessary modifications
For any item left out, color coding will be decided after Owner's approval.

19.2 Standard Colour Code for Electrical Equipment

1	Transformers	Olive grey for power transformers and pebble grey for service transformer	RAL 7002 for power transformers and RAL 7032 for service transformers
2	Bus ducts	pastel turquoise for indoor and olive grey for outdoor	indoor 6034 and outdoor 7002
3	Junction boxes.	Pebble grey	RAL 7032
4	HT/LT Switchboards, Distribution boards, Control & Relay panels		
	a) Indoor	Pebble grey	RAL 7032
	b) Outdoor	Pebble grey	RAL 7032
5	UPS Panel, charger panels	Light grey	Exterior RAL 7032 Interior Brilliant white

7	LT Motor	Pebble grey	RAL 7032
8	HT Motor	Pebble grey	RAL 7032
9	Lighting fittings	As per manufacturer's standard	As per manufacturer's standard
10	Cable trays	Galvanized	

1. For interior coating, manufacturer's standard can be adopted subject to Owner's approval.

2. All panels that are to be erected at control room shall be painted using RAL 7032 (exterior colour). All Electrical, C&I, Fire alarm or any other panel shall have this colour.

19.3 Colour Coding for Identification of Pipelines used in Thermal Power Plants/FGD plants

		Ground Shade		Band Shade		
Sl.No	**Medium**	**Color**	**Color No. as per IS:5**	**Color**	**Color No. as per IS:5**	**Remarks**
1	Water system					
a)	Untreated or raw / service	Sea green	217	White	-	White is not included in IS - 5-2007
b)	Treated/dematerialized	Sea green	217	Light orange	557	
c)	Potable water	Sea green	217	French blue	166	
d)	Service & clarified water	Sea green	217	French blue	166	
2	Steam system					
a)	Auxiliary steam	Aluminum	-	Signal red	537	with aluminum
3	Air system					
a)	Instrument	Sky Blue	101	White	-	
b)	Service/Plant	Sky Blue	101	White	-	White not included in IS-5 - 2007
c)	Vacuum pipes	Sky Blue	101	Black	-	Black not included in
4	Transformer oil	Light brown	410	Light orange	557	
5	Fire services	Fire red	536	-	-	-
6	Effluent pipes	Black	-	-	-	-

19.4 Colour Code for Structural Steel

SL. NO	ITEM/SERVICE	COLOR	COLOR No. as per IS:5
1	Gantry girder & monorail	Brilliant green	221
2	Gantry girder & monorail stopper	Signal red	537
3	Building structural steel columns brackets, beams bracings, roof truss, purloin, side grit, louvers, stringers	Dark admiralty grey	632
4	Pipe rack structure & trestle	Dark admiralty grey	632
5	Chequered plate (Plain Face)	Black	-
6	Grating	Black	-
7	Ladder	Dark admiralty grey	632
	Hand railing		
8	Hand rail	Signal red	537
9	Middle rail	Signal red	537
10	Toe Plate	Signal red	537
11	Vertical post	Black	-
12	Structural steel for Silo	Smoke grey	692

Notes

1. Covering capacity and DFT depends on method of application. Covering capacity specified above is theoretical. Allowing the losses during application, min specified DFT shall be maintained.

2. All primers and finish coats shall be cold cured and air dried unless otherwise specified.

3. All paints shall conform to relevant Indian Standard and shall be applied in accordance with manufacturer's instructions for surface preparation, intervals, curing and application. The surface preparation, quality and workmanship shall be ensured.

4. Technical data sheets for all paints shall be supplied at the time of submission of quotations.

5. In case of use of epoxy tie coat, manufacturer shall demonstrate satisfactory test for inter coat adhesion. In case of limited availability of epoxy tie coat, alternate system may be used taking into consideration the service requirement of the system.

6. Contractor will submit the final colour shade for all equipments & piping under his scope for final approval by client / consultant.

Painting Systems						
Cleaning, Protective Coating and Painting. - Systems designed as per ISO 12944 with service life of 10 yrs.						
Surface/ Location	**Temp**	**Surface prep**	**Coat**	**No. of coats**	**Generic Type**	**Dft/Coat**
Structural Steel work, piping (Oil + Water), tanks outside surface, transmission towers cranes, steel floors, galleries, stairways, Outdoor.	< 130 Deg	SA 3	Primer	1	Solvent based IZS - VS of 60%. Zn Dust - 1.77 kg/ltr minimum. Zn dust by weight - minimum 85%. Pot life 12 hrs / 21 Deg.- Paint to meet compositional & performance specifications for SSPC Paint 20 , Level 1	75
			Touch up	1	Two component Zinc rich Primer meeting performance and compositional specifications of SSPC Paint 20 Level2	(75)
			Mid coat	1	2 pack High build High Solid Lamellar MIO based Epoxy Mid coat.	200
			Finish	1	2 pack Acrylic Aliphatic Polyurethane top coat - with Gloss retention of at least 90% on QUVB exposure of minimum 1000 hrs.	75
					Total	**350**
Surface/ Location	**Temp**					
Structural Steelwork, piping, indoor and outdoor	130 to 200 Deg	SA 3	Primer	1	Solvent based IZS - VS of 60%. Zn Dust - 1.77 kg/ltr minimum. Zn dust by weight - minimum 85%. Pot life 12 hrs / 21 Deg.- Paint to meet compositional & performance specifications for SSPC Paint 20 , Level 1.	75
			Touch up	1	Two component Zinc rich Primer meeting performance and compositional specifications of SSPC Paint 20 Level2	(75)
			Sealer	1	Single pack Heat Resistant Silicon Acrylic Finish paint.	25
			Finish	2	Single pack Heat Resistant Silicon Acrylic Finish paint.	25
					Total	**150**
Alternative -2		SA 3	Primer	1	Solvent based IZS - VS of 60%. Zn Dust - 1.77 kg/ltr minimum. Zn dust by weight - minimum 85%. Pot life 12 hrs / 21 Deg.- Paint to meet compositional & performance specifications for SSPC Paint 20 , Level 1.	75
				1	Single pack Moisture Cured, Inorganic Silicate based heat resisting finish up to 400 Deg - Grey shade./ white/ Aluminium.	50
			Finish	1		50
					Total	**175**

Surface/ Location	Temp	Surface prep	Coat	No. of coats	Generic Type	Dft/Coat
Alternative-3			Finish	1	Single pack Heat Resistant Silicon Acrylic Finish paint. - either Aviation White/ Aviation Orange.	80
					Total	**155**
Surface/ Location	**Temp**					
		Surface prep	Coat	No. of coats	Generic Type	Dft/Coat
Structural Steel work Piping, Un-insulated Carbon Steel Indoor and Outdoor	200 to 400 mmmm mDeg C.	SA 3	Primer	1	Solvent based IZS - VS of 60%. Zn Dust - 1.77 kg/ltr minimum. Zn dust by weight - minimum 85%. Pot life 12 hrs / 21 Deg.- Paint to meet compositional & performance specifications for SSPC Paint 20 , Level 1.	75
			Touch up	1	Two component Zinc rich Primer meeting performance and compositional specifications of SSPC Paint 20 Level 2.	(75)
			Finish	2	Heat Resisting Silicon Aluminium Paint. VS to be min 28%.	20
					Total	**115**
Structural Steel work, Piping (Oil + water) , Tanks Indoor.	<130 Deg.C	SA 3	Primer	1	Solvent based IZS - VS of 60%. Zn Dust - 1.77 kg/ltr minimum. Zn dust by weight - minimum 85%. Pot life 12 hrs / 21 Deg.- Paint to meet compositional & performance specifications for SSPC Paint 20 , Level 1.	75
			Touch up	1	Two component Zinc rich Primer meeting performance and compositional specifications of SSPC Paint 20 Level2	(75)
			Mid coat	2	2 pack High build High Solid Lamellar MIO based Epoxy Mid coat.	100
			Finish	2	Two component Polyamide Cured Epoxy Coating.	25
					Total	**325**
Surface/ Location	**Temp**					
Structural Steel work in the battery rooms, chlorination plant and water treatment plant, (extremely aggressive atmosphere)	Ambient	SA 3	Primer	1	Solvent based IZS - VS of 60%. Zn Dust - 1.77 kg/ltr minimum. Zn dust by weight - minimum 85%. Pot life 12 hrs / 21 Deg.- Paint to meet compositional & performance specifications for SSPC Paint 20 , Level 1	75
			Touch up		Two component Zinc rich Primer meeting performance and compositional specifications of SSPC Paint 20 Level2	(75)

Surface/ Location	Temp	Surface prep	Coat	No. of coats	Generic Type	Dft/Coat
			Mid coat	1	Two component, high build rust encapsulating, aluminium pigmented modified epoxy coating.	125
			Finish	1	Two component High Build high Solid Aliphatic Amine Cured Epoxy coating. - Min VS 85%	150
					Total	**350**
Steel Tanks inside Surface (Total) for Oil Storage	Normal	SA 2.5	Primer	1	Two component high build amine cured epoxy Primer with zinc phosphate pigment.	75
			Finish	2	Two component Self priming High Build Polyamine adduct cured epoxy coating.	125
					Total	**325**
Alternative-1			Finish	3	Two component Self priming High Build Polyamine adduct cured epoxy coating. **(No primer required. Self priming coating post blasting)**	125
					Total	**375**
Alternative-2			Finish	2	Two component High build high solid Solvent free epoxy coating - certified by CFTRI for Potable water usage.**(Primer same as above)**	150
					Total	**300**
Surface/ Location	**Temp**					
Steel Tanks inside Surface (Total) for Water Storage (Potable and Distilled Water)	Ambient	SA 3	Primer	1	Two component high build polyamide cured zinc phosphate Primer	75
			Finish	2	Two component Self priming High Build Polyamine adduct cured epoxy coating - certified by CFTRI for Potable water usage.	125
						325
Alternative 1			Finish	2	Two component High build high solid Solvent free epoxy coating - certified by CFTRI for Potable water usage. **(No primer required. Self priming coating post blasting)**	200
						400
Steelwork immersed in water such as inlet/	< 60 Deg C	SA 3	Primer	1	Two component High Build High Solid Rapid Curing Epoxy Zinc Phosphate Primer.	75

Surface/ Location	Temp	Surface prep	Coat	No. of coats	Generic Type	Dft/Coat
outlet structures, dolphins, sheet piling			Finish	1	Two component High build High Solid Modified Epoxy coating.	500
					Total	**575**
			Wherever TAR based product is not to be recommended.			
			Finish	1	Two component High build High Solid Modified Epoxy coating	500
					Total	**500**
			Finish	1	Two component High build High Solid Modified Epoxy coating with Glass Flake.	500
					Total	**500**
Alternative 1						
Cast Iron Water pipelines - Outside surface, buried in Soil	< 60 Deg C	SA 3	Primer	1	Solvent based IZS - VS of 60%. Zn Dust - 1.77 kg/ltr minimum. Zn dust by weight - minimum 85%. Pot life 12 hrs / 21 Deg.- Paint to meet compositional & performance specifications for SSPC Paint 20 , Level 1	75
			Finish	2	Polyamide Cured Coal Tar Epoxy, Vs min 65% black.	200
					Total	**475**
Alternate-1			Finish	1	Two component High build High Solid Modified Epoxy coating	500
Alternate -2			Finish	1	Two component High build High Solid Modified Epoxy coating with Glass Flake	500
Surface/ Location	**Temp**					
Steel Pipes - Inside surfaces such as cooling water lines.	< 60 Deg C	SA 3	Primer	1	Solvent based IZS - VS of 60%. Zn Dust - 1.77 kg/ltr minimum. Zn dust by weight - minimum 85%. Pot life 12 hrs / 21 Deg.- Paint to meet compositional & performance specifications for SSPC Paint 20 , Level 1.	75
			Finish	2	Coal Tar Epoxy, Vs min 65% black.	225
					Total	**525**
Water Pipelines - Outside Surface, Indoor	< 60 Deg C	SA 3	Primer	1	Solvent based IZS - VS of 60%. Zn Dust - 1.77 kg/ltr minimum. Zn dust by weight - minimum 85%. Pot life 12 hrs / 21 Deg.- Paint to meet compositional & performance specifications for SSPC Paint 20 , Level 1.	75

Surface/ Location	Temp	Surface prep	Coat	No. of coats	Generic Type	Dft/Coat
			Touch up	1	Two component Zinc rich Primer meeting performance and compositional specifications of SSPC Paint 20 Level2	(75)
			Finish	2	Two component High Build high Solid Aliphatic Amine Cured Epoxy coating. - Min VS 85%	100
					Total	**275**
Oil pipelines - Outside surface, above ground	< 100 Deg C	SA 3	Primer	1	Solvent based IZS - VS of 60%. Zn Dust - 1.77 kg/ltr minimum. Zn dust by weight - minimum 85%. Pot life 12 hrs / 21 Deg.- Paint to meet compositional & performance specifications for SSPC Paint 20 , Level 1.	75
			Touch up		Two component Zinc rich Primer meeting performance and compositional specifications of SSPC Paint 20 Level2	(75)
			Mid coat	2	Two component High Build high Solid Aliphatic Amine Cured Epoxy coating. - Min VS 85%	100
			Finish	1	2 pack Acrylic Aliphatic Polyurethane top coat - with Gloss retention of at least 90% on QUVB exposure of minimum 1000 hrs.	75
					Total	**350**
Surface/ Location	**Temp**					
Pumps, Motors, Turbine, Claddings, Steam Turbine Condenser, Indoor	Up to 90 Deg	SA 2.5	Primer	1	Catalysed Zn rich Primer with a VS of 60% min, complying to SSPC Paint 20 level 2.	75
			Finish	2	Two component High Build high Solid Aliphatic Amine Cured Epoxy coating. - Min VS 85%.	100
					Total	**275**
Alternative 1		SA 2.5	Primer	1	Catalysed Zn rich Primer with a VS of 60% min, complying to SSPC Paint 20 level 2.	75
			Mid coat	1	Two component High Build high Solid Aliphatic Amine Cured Epoxy coating. - Min VS 85%.	100
			Finish	2	2 pack Acrylic Aliphatic Polyurethane top coat - with Gloss retention of at least 90% on QUVB exposure of minimum 1000 hrs.	75

Surface/ Location	Temp	Surface prep	Coat	No. of coats	Generic Type	Dft/Coat
					Total	**250**
Heat Exchangers - Inside Surface.	Up to 60 Deg	SA 2.5	Primer	1	Solvent based IZS - VS of 60%. Zn Dust - 1.77 kg/ltr minimum. Zn dust by weight - minimum 85%. Pot life 12 hrs / 21 Deg.- Paint to meet compositional & performance specifications for SSPC Paint 20 , Level 1.	75
			Finish	2	Coal Tar Epoxy, Vs min 65% black.	200
					Total	**475**
Instrument panels, Electrical cubicles and similar steel sheet – indoor **(Can be used on Aluminium, steel, stainless steel and galvanized substrates.)**	Ambient	Oil grease and contamin atnts must be removed	Primer	1	Two pack , high build siloxane modified epoxy primer with zinc phosphate pigment.	75
			Mid coat	1	Two component High Build Surface Tolerant Epoxy coating pigmented with Aluminium and Lamellar Micaceous iron oxide	100
			Top coat	1	Two component High Build high Solid Aliphatic Amine Cured Epoxy coating. - Min VS 85%	100
					Total	**275**
Surface/ Location	**Temp**					
Instrument panels, Electrical cubicles and similar steel sheet – outdoor **(Can be used on Aluminium, steel, stainless steel and galvanized substrates.)**	Ambient	Oil grease and contamin atnts must be removed	Primer	1	Two pack , high build siloxane modified epoxy primer with zinc phosphate pigment.	100
			Mid coat	1	Two component High Build Surface Tolerant Epoxy coating pigmented with Aluminium and Lamellar Micaceous iron oxide.	150
			Top coat	1	2 pack Acrylic Aliphatic Polyurethane top coat - with Gloss retention of atleast 90% on QUVB exposure of minimum 1000 hrs.	75
					Total	**325**
Substrate, base metal: Carbon steel, HDG acc ISO 1461 Or. Equiv. Non Insulated. - Outdoor	<120 Deg	Air blasting with Nonmetallic	Touch up	1	Two component Zinc rich Primer meeting performance and compositional specifications of SSPC Paint 20 Level2	(75)
			Primer	1	Two pack , high build siloxane modified epoxy primer with zinc phosphate pigment.	50

Surface/ Location	Temp	Surface prep	Coat	No. of coats	Generic Type	Dft/Coat
		abrasive Powder	Mid coat	1	Two component High Build Surface Tolerant Epoxy coating pigmented with Aluminium and Lamellar Micaceous iron oxide	150
			Finish	1	2 pack Acrylic Aliphatic Polyurethane top coat - with Gloss retention of atleast 90% on QUVB exposure of minimum 1000 hrs.	75
					Total	**275**
Substrate, base metal: Carbon steel, HDG acc ISO 1461 Or. Equiv. Non Insulated.- Indoor	<120 Deg	Air blasting with Nonmetallic abrasive Powder	Touch up	1	Two component Zinc rich Primer meeting performance and compositional specifications of SSPC Paint 20 Level 2.	75
			Primer	1	Two pack, high build siloxane modified epoxy primer with zinc phosphate pigment.	125
			Finish	1	Two component High Build high Solid Aliphatic Amine Cured Epoxy coating. - Min VS 85%.	100
					Total	**225**
			For Outdoor Application			
			Touch up	1	Two component Zinc rich Primer meeting performance and compositional specifications of SSPC Paint 20 Level2	(75)
			Primer	1	Two pack , high build siloxane modified epoxy primer with zinc phosphate pigment.	125
			Finish	1	2 pack Acrylic Aliphatic Polyurethane top coat - with Gloss retention of at least 90% on QUVB exposure of minimum 1000 hrs.	75
					Total	**200**
			For Indoor Application			
Substrate, Stainless Steel - Non insulated.	< 120 Deg	Air blasting with Nonmetallic abrasive Powder	Primer	1	Two pack , high build siloxane modified epoxy primer with zinc phosphate pigment.	125
			Finish	1	Two component High Build high Solid Aliphatic Amine Cured Epoxy coating. - Min VS 85%	100
					Total	**225**
			For Outdoor Application			
			Primer	1	Two pack , high build siloxane modified epoxy primer with zinc phosphate pigment.	125

Surface/ Location	Temp	Surface prep	Coat	No. of coats	Generic Type	Dft/Coat
			Finish	1	2 pack Acrylic Aliphatic Polyurethane top coat - with Gloss retention of atleast 90% on QUVB exposure of minimum 1000 hrs.	75
					Total	**200**
Applicable for Water - Water Cooled heat Exchangers like Condensers, Flash box, Water - Water coolers etc. For Outdoor installations in corrosive atmosphere - like Chemical/ Marine.				**For Indoor Application**		
	< 120 Deg	Air blasting with Nonmetallic abrasive Powder	Primer	1	Two pack , high build siloxane modified epoxy primer with zinc phosphate pigment.	75
			Top coat	2	Two component High Build high Solid Aliphatic Amine Cured Epoxy coating. - Min VS 85%.	100
					Total	**275**
				For Outdoor Application		
			Primer	1	Two pack , high build siloxane modified epoxy primer with zinc phosphate pigment.	125
			Mid coat	1	Two component High Build high Solid Aliphatic Amine Cured Epoxy coating. - Min VS 85%.	100
			Top coat	1	2 pack Acrylic Aliphatic Polyurethane top coat - with Gloss retention of at least 90% on QUVB exposure of minimum 1000 hrs.	75
					Total	**300**

QUALITY PLAN

Items / Components \ Tests		Material Test	WPS/PQR/Welder Qualification	DPT/MPI	UT	RT	Hydraulic / Water Fill	Balancing	Type test	Performance Test	All test as per relevant Std/ Appd. Data Sheets	Visual & Dimension	Remarks
A	**Centrifugal pumps**												**LEGENDS:**
I	Casing	Y2	-	Y[3]	-	-	Y	-	-	-	-	Y	1 As per AWWA C 504
II	Impeller	Y2	-	Y[3]	-	-	-	Y	-	-	-	Y	2 One per heat/heat treatment batch.
III	Shaft	Y2	-	Y[3]	Y[5]	-	-	-	-	-	-	Y	3 On machined surface only.
IV	Fabricated components	Y	Y	Y[3]	-	-	Y	-	-	-	-	Y	4 Only DPT on root run after back gauging and finish weld.
V	Assembled Pumps	-	-	-	-	-	-	-	-	Y8	-	-	5 For shaft ≥ 50 mm
B	**Tanks & vessels**	Y	Y	Y[4]	Y[6]	Y[10]	Y	-	-	-	Y	Y	6 For plates ≥ 25mm
C	**R&W pipes**	Y	Y	Y[4]	-	Y[7]	Y	-	-	-	Y	Y	7 For pipes weld thickness ≥20mm
D	**RE joint**	Y	-	-	-	-	Y	-	-	Y		Y	8 As per HIS, USA
E	**Rubber lining**	Y	-	-	-	-	-	-	-	-	Y	Y	9 Void
F	**Pipes & Fittings**	Y[2]	Y	-	-	-	Y	-	-	-		Y[12]	10 On welds for dished ends manufactured with plates having weld joint. On vessel/tank as per design code.
G	**Gear box**	Y	-	Y	Y	-		-		Y	Y	Y	11 Seat leakage test for actuator-operated valves shall be checked for seat leakage by closing the valve with actuator.
H	**Gate/Globe/ Check valve**	Y	-	Y	-	-	Y[11]	-	-	-	Y	Y	12 Pipes and fittings for rubber lining shall be free from internal weld bead.

NOTE-1: - The above are minimum quality checks to be carried out at manufacturers works. The detailed quality plan based on above is to be developed by the main vendor incorporating witness stage for approval by BHEL/Customer.

NOTE-2: Butt welds, if any on-dished ends, shall be radio graphed after dishing. All dished ends for pressure vessels shall be stress relieved after dishing.

NOTE-3: Also refer data sheet-A for inspection for testing.

DATA SHEET-A

1.0	**WASTE WATER TANK [NOT IN ETP SUPPLIER SCOPE]**	
1.1	Quantity	One Number
2.0	**WASTE WATER TRANSFER PUMP [NOT IN ETP SUPPLIER SCOPE]**	
2.1	Quantity	Two Nos (1W+1S)
3.0	**LIME PREPARATION CUM DOSING TANK FOR WASTE WATER TANK**	
3.1	Quantity	One Number
3.2	Capacity	750 Ltrs or One day Storage capacity whichever is higher.
3.3	Material	MS with Epoxy Coated.
3.4	Type	Vertical, Flat Bottom, Cylindrical.
3.5	Concentration	10% W/V of 65% Purity of Lime.
3.6	Dosing Rate	100 ppm
3.7	Agitator	MOC-SS 316; Motor driven with reduction gear.
3.8	Dissolving Basket	1 No, MOC: MSEP
3.9	Instruments and valves and accessories	As per P&id.
4.0	**LIME DOSING PUMP FOR WASTE WATER TANK**	
4.1	Quantity	Two (1W+1S)
4.2	Capacity Required	(Flow x Dosing Rate/1000/% of Solution) =12 CuM/Hr x 100 ppm /1000/10% of 65% = 18.5 LPH
4.3	Capacity Selected	50 LPH (minimum)
4.4	Head	2 Kg/Cm2.
4.5	Type	Horizontal, Screw Type.
4.6	Material of Construction	Casing and Rotor Housing: Cast Iron as per IS 210 FG 260; Rotor & Shaft: CF 8/SS 304, Driving Gear- Hardened and tempered alloy steel with machine cut teeth and ground finish.
4.7	Shaft sealing	Mechanical seal
4.8	Instruments and valves and accessories	As per P&id.
5.0	**HYPO DOSING TANK FOR WAST WATER TANK**	
5.1	Quantity	One Number
5.2	Capacity	150 Ltrs or One day Storage capacity whichever is higher.
5.3	Material	FRP
5.4	Type	Vertical, Flat Bottom, Cylindrical.
5.5	Concentration	10-12% W/V Commercial Grade.
5.6	Dosing Rate	5 ppm
5.7	Instruments and valves and accessories	As per P&id.
6.0	**HYPO DOSING PUMP FOR WAST WATER TANK**	
6.1	Quantity	Two (1W+1S)
6.2	Capacity Required	(Flow x Dosing Rate/1000/% of Solution) =12 CuM/Hr x 5 ppm /1000/10% = 0.6 LPH
6.3	Capacity Selected	2 LPH (minimum)
6.4	Head	2 Kg/Cm2.
6.5	Type	Positive Displacement, Diaphragm Type with PRV.
6.6	Material of Construction	Wetted parts PP, Casing: CI, Plunger: CF8M.
6.7	Range of operation	0-100% by micrometer dial with manual stroke adjustment.
6.8	Pump Stroke Speed/minute (SPM)	100 (Max).
6.9	Instruments and valves and accessories	As per P&id.
7.0	**THICKENER**	
7.1	Quantity	One Number
7.2	Capacity	**17** m^3/Hr.
7.3	Type	Circular Gravity type– hopper bottomed, Center feed Sludge Thickener. Fixed Full Bridge type with Lifting Mechanism
7.4	Solid concentration in thickened sludge at outlet of thickener	6-7%
7.5	Solid Loading Rate	25 kg/day/ m2(minimum) and 80 kg/day/ m2(maximum)
7.6	MOC	RCC with epoxy coating. Bridge- IS 2062 Gr B / C with FRP coated. Rack & Scraper- IS 2062 Gr B / C with FRP coated
7.7	Access Ladder, Walkway and Platform	Access ladder with 1m width walkway and platform with hand railing shall be provided.
7.8	Instruments and valves and accessories	As per P&id.
8.0	**LIME PREPARATION CUM DOSING TANK FOR THICKENER**	
8.1	Quantity	One Number
8.2	Capacity	500 Ltrs or One day Storage capacity whichever is higher.
8.3	Material	MS with Epoxy Coated.
8.4	Type	Vertical, Flat Bottom, Cylindrical.
8.5	Concentration	10% W/V of 65% Purity of Lime.
8.6	Dosing Rate	30 ppm
8.7	Agitator	MOC-SS 316; Motor driven with reduction gear.
8.8	Dissolving Basket	1 No, MOC: MSEP
8.9	Instruments and valves and accessories	As per P&id.
9.0	**LIME DOSING PUMP FOR THICKENER**	
9.1	Quantity	Two (1W+1S)
9.2	Capacity Required	(Flow x Dosing Rate/1000/% of Solution) =17 CuM/Hr x 30 ppm /1000/10% of 65% = 7.9 LPH
9.3	Capacity Selected	20 LPH (minimum)

9.4	Head	2 Kg/Cm2.
9.5	Type	Horizontal, Screw Type.
9.6	Material of Construction	Casing and Rotor Housing: Cast Iron as per IS 210 FG 260; Rotor & Shaft: CF 8/SS 304, (All wetted parts shall be of SS 304). Driving Gear- Hardened and tempered alloy steel with machine cut teeth and ground finish.
9.7	Shaft sealing	Mechanical seal
9.8	Instruments and valves and accessories	As per P&id.
10.0	**FeCl3 PREPARATION CUM DOSING TANK FOR THICKENER**	
10.1	Quantity	One Number
10.2	Capacity	500 Ltrs or One day Storage capacity whichever is higher.
10.3	Material	FRP
10.4	Type	Vertical, Flat Bottom, Cylindrical.
10.5	Concentration	10% W/V of 45% Purity of FeCl3.
10.6	Dosing Rate	40 ppm
10.7	Agitator	MOC-MSFRP; Motor driven with reduction gear.
10.8	Dissolving Basket	1 No, MOC: FRP
10.9	Instruments and valves and accessories	As per P&id.
11.0	**FeCl3 DOSING PUMP FOR THICKENER**	
11.1	Quantity	Two (1W+1S)
11.2	Capacity Required	(Flow x Dosing Rate/1000/% of Solution) =17 CuM/Hr x 40 ppm /1000/10% of 45% = 15.1 LPH
11.3	Capacity Selected	40 LPH (minimum)
11.4	Head	2 Kg/Cm2.
11.5	Type	Positive Displacement, Diaphragm Type with PRV.
11.6	Material of Construction	Wetted parts PP, Casing: CI, Plunger: CF8M.
11.7	Range of operation	0-100% by micrometer dial with manual stroke adjustment.
11.8	Pump Stroke Speed/minute (SPM)	100 (Max).
11.9	Instruments and valves and accessories	As per P&id.
12.0	**PE PREPARATION CUM DOSING TANK FOR THICKENER**	
12.1	Quantity	One Number
12.2	Capacity	150 Ltrs or One day Storage capacity whichever is higher.
12.3	Material	FRP
12.4	Type	Vertical, Flat Bottom, Cylindrical.
12.5	Concentration	1% W/V
12.6	Dosing Rate	2 ppm
12.7	Agitator	MOC-SS 316; Motor driven with reduction gear.
12.8	Dissolving Basket	1 No, MOC: SS 304/FRP
12.9	Instruments and valves and accessories	As per P&id.
13.0	**PE DOSING PUMP FOR THICKENER**	
13.1	Quantity	Two (1W+1S)
13.2	Capacity Required	(Flow x Dosing Rate/1000/% of Solution) =17 CuM/Hr x 2 ppm /1000/1% = 3.4 LPH
13.3	Capacity Selected	10 LPH (minimum)
13.4	Head	2 Kg/Cm2.
13.5	Type	Positive Displacement, Diaphragm Type with PRV.
13.6	Material of Construction	Wetted parts PP, Casing: CI, Plunger: CF8M.
13.7	Range of operation	0-100% by micrometer dial with manual stroke adjustment.
13.8	Pump Stroke Speed/minute (SPM)	100 (Max).
13.9	Instruments and valves and accessories	As per P&id.
14.0	**CLARIFIED WATER STORAGE TANK**	
14.1	Quantity	One Number
14.2	Capacity	**15** m^3
14.3	Material	RCC with Epoxy coating.
14.4	Type	Above Ground with single compartment.
14.5	Instruments and accessories	As per P&id.
15.0	**CLARIFIED WATER TRANSFER PUMP**	
15.1	Quantity	Two (1W+1S)
15.2	Capacity (each)	**15** m^3/Hr.
15.3	Head	45 MWC (minimum)
15.4	Type	Horizontal, Centrifugal.
15.5	Material of Construction	Casing – Duplex SS with PREN >35. Impeller – Duplex SS with PREN >35. Shaft – Duplex SS with PREN >35. Shaft Sleeves- Duplex SS with PREN >35. (All wetted parts shall be of Duplex SS with PREN >35). Base Plate-MS with Epoxy Paint. Fastener- Stainless Steel.
15.6	Instruments and valves and accessories	As per P&id.
16.0	**SLUDGE PIT**	
16.1	Quantity	One Number
16.2	Capacity (each)	**12** m^3/Hr or Two hour Storage capacity whichever is higher.
16.3	Material	RCC with Epoxy coating.
16.4	Type	Under Ground with single compartment.
16.5	Instruments and accessories	As per P&id.
17.0	**CENTRIFUGE FEED PUMP (SLUDGE TRANSFER PUMP)**	
17.1	Quantity	Two (1W+1S)
17.2	Capacity (each)	**6** m^3/Hr.

17.3	Head	To meet the system requirement.
17.4	Type	Horizontal, Screw.
17.5	Material of Construction	Casing – Duplex SS with PREN >35. Impeller – Duplex SS with PREN >35. Shaft – Duplex SS with PREN >35. Shaft Sleeves- Duplex SS with PREN >35. (All wetted parts shall be of Duplex SS with PREN >35). Base Plate-MS with Epoxy Paint. Fastener- Stainless Steel.
17.6	Instruments and valves and accessories	As per P&id.
18.0	**CENTRIFUGE**	
18.1	Quantity	One Number
18.2	Type	Variable differential speed control type.
18.3	Capacity (each)	**6** m^3/Hr.
18.4	Outlet Sludge Consistency	25%
18.5	Material of Construction	Bowl: Duplex SS with PREN >35. Conveyor: Duplex SS with PREN >35. All wetted parts: Tungsten with Carbide Lining Wear Protection: Tungsten Carbide Lining Frame: MS fabricated with Epoxy Painting.
18.6	Trolley for Collection Cake	2 Nos (each of 8 hours cake holding capacity)
19.0	**PE PREPARATION CUM DOSING TANK FOR CENTRIFUGE**	
19.1	Quantity	One Number
19.2	Capacity	750 Ltrs or One day Storage capacity whichever is higher.
19.3	Material	FRP
19.4	Type	Vertical, Flat Bottom, Cylindrical.
19.5	Concentration	1% W/V
19.6	Dosing Rate	30 ppm
19.7	Agitator	SS 316; Motor driven with reduction gear.
19.8	Dissolving Basket	1 No, MOC: SS 304/FRP
19.9	Instruments and valves and accessories	As per P&id.
20.0	**PE DOSING PUMP FOR CENTRIFUGE**	
20.1	Quantity	Two (1W+1S)
20.2	Capacity Required	(Flow x Dosing Rate/1000/% of Solution) =6 CuM/Hr x 30 ppm /1000/1% = 18 LPH
20.3	Capacity Selected	50 LPH (minimum)
20.4	Head	2 Kg/Cm2.
20.5	Type	Positive Displacement, Diaphragm Type with PRV.
20.6	Material of Construction	Wetted parts PP, Casing: CI, Plunger: CF8M.
20.7	Range of operation	0-100% by micrometer dial with manual stroke adjustment.
20.8	Pump Stroke Speed/minute (SPM)	100 (Max).
20.9	Instruments and valves and accessories	As per P&id.
21.0	**BLOWER FOR SLUDGE PIT**	
21.1	Quantity	Two (1W+1S)
21.2	Capacity (each)	10 CuM/Hr (Minimum)
21.4	Head	400 MMWC (Minimum)
21.5	Type	Centrifugal /Twin Lobe Type
21.6	Material of Construction	Casing and lobes: CI as per IS 210 FG 260. Shaft: Carbon steel BS-970 En-8/ANSI-I045.
21.7	Accessories Required	Acoustic Enclosures. Suction Filter, Silencer, relief Valve etc
21.8	Instruments and valves and accessories	As per P&id.
22.0	**PIPE**	**Refer P&ID.**
23.0	**VALVES**	**All valves shall be of CPVC PN 10 or Class 150 (minimum).**
24.0	**SAFETY EQIPMENTS**	Four sets of safety equipment comprising PVC protection suits with hoods, rubber boots, face visors and thick PVC gauntlets shall also be provided. A personnel water drench shower and eye bath shall be provided.
25.0	**FASTENERS**	Stainless Steel
26.0	**CHEMICAL STORAGE**	Chemicals for 15 Days shall be stored in Chemical House (MOC RCC).

SECTION – C2

(SPECIFIC TECHNICAL REQUIREMENTS FOR ELECTRICAL)

ELECTRICAL EQUIPMENT SPECIFICATION

SPECIFIC TECHNICAL REQUIREMENTS: ELECTRICAL

1.0 Scope for supply, and erection & commissioning of various equipment forming part of electrical system for this package shall be as per [Scope of Work (Electrical)].

2.0 Make of all electrical equipment/ items supplied shall be reputed make. Same shall be subject to approval of BHEL/customer after award of contract without any commercial implications.

3.0 All QPs shall be subject to approval of BHEL/customer after award of contract without any commercial implication.

4.0 DOCUMENTS TO BE SUBMITTED ALONG WITH BID

4.1 Bidder shall confirm total compliance to the electrical specification without any deviation from the technical/ quality assurance requirements stipulated.

4.2 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.

5.0 LIST OF ENCLOSURES

5.1 Electrical scope between BHEL & vendor
5.2 Technical specification - Motors
5.3 Datasheet-A
5.4 Datasheets-C
5.5 Quality Plan for motors.
5.6 Load data format
5.7 Explanatory note for Cable routing & Cable schedule format
5.8 Tentative list of cable sizes

ELECTRICAL LOAD FORMAT

LOAD TITLE	RATING (KW / A)		UNIT (U)/STN (S)	Nos.		VOLTAGE CODE*	FEEDER CODE**	EMER. LOAD (Y)	CONT.(C)/ INTT.(I)	STARTING TIME >5 SEC (Y)	LOCATION	BOARD NO.	CABLE		BLOCK CABLE DRG. No.	CONTROL CODE	REMARKS	LOAD No.
	NAME PLATE	MAX. CONT. DEMAND (MCR)		RUNNING	STANDBY								SIZE CODE	NOs				
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19

NOTES: 1. COLUMN 1 TO 12 & 18 SHALL BE FILLED BY THE REQUISITIONER (ORIGINATING AGENCY); REMAINING COLUMNS ARE TO BE FILLED UP BY BHEL

2. ABBREVIATIONS : * VOLTAGE CODE (7):- (ac) A=11 KV, B=6.6 KV, C=3.3 KV, D=415 V, E=240 V (1 PH), F=110 V (dc): G=220 V, H=110 V, J=48 V, K=+24V, L=-24 V

: ** FEEDER CODE (8):- U=UNIDIRECTIONAL STARTER, B=BI-DIRECTIONAL STARTER, S=SUPPLY FEEDER, D=SUPPLY FEEDER (CONTACTER CONTROLLED)

BHEL	**LOAD DATA (ELECTRICAL)**	JOB NO.		ORIGINATING AGENCY	PEM (ELECTRICAL)
		PROJECT TITLE		NAME	DATA FILLED UP ON
		SYSTEM / S	CHLORINE DI OXIDE DOSING SYSTEM	SIGN.	DATA ENTERED ON
		DEPTT. / SECTION		SHEET 1 OF 1 REV. 00	DE'S SIGN. & DATE

ELECTRICAL SCOPE FOR VENDOR AND BHEL

ANNEXURE-I

ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR (FOR FGD PROJECTS)

PACKAGE : ETP

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

PROJECT: NORTH CHENNAI-III FGD

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) & lightning protection	BHEL	BHEL	Refer note no. 4 for electronic earthing

ANNEXURE-I

ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR (FOR FGD PROJECTS)

PACKAGE : ETP

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

PROJECT: NORTH CHENNAI-III FGD

S.NO	DETAILS	SCOPE SUPPLY	SCOPE E&C	REMARKS
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.
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.

SECTION – C3

(SPECIFIC TECHNICAL REQUIREMENTS FOR C&I)

The overall operation & control of entire ETP shall be through DCS (BHEL Scope) located in FGD Control Room.

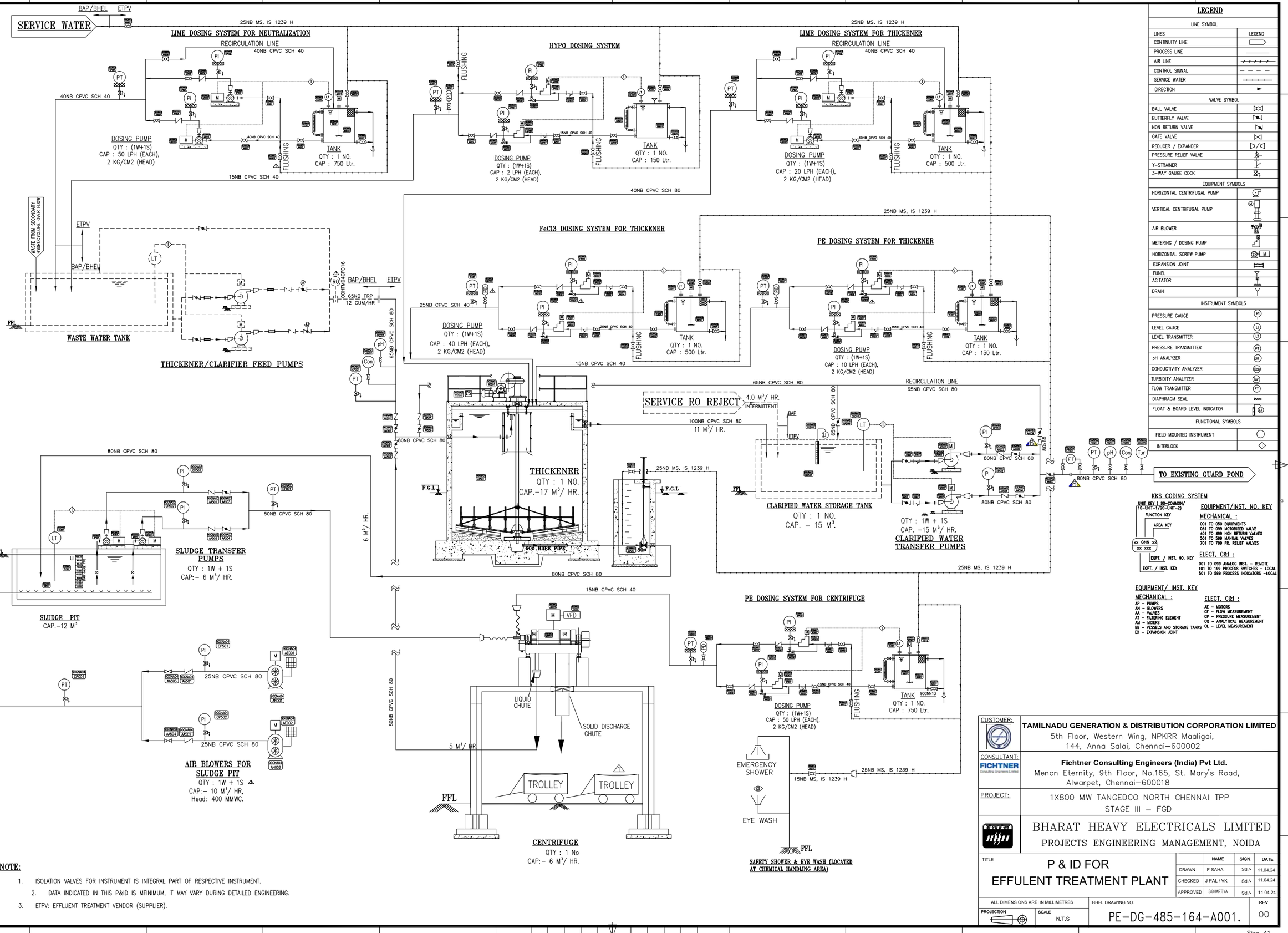
All sump pumps will be operated by level controls (low/ high) at the sump & pump discharge pressure (low/ high).

If the water quality at clarified water transfer pump discharge header (this is applicable for Turbidity less than 100 ppm and pH level 6.5 to 8.5) is not adequate then the treated water shall be recycled back to thickener inlet for further treatment.

For auto operation, one pump shall be kept in Auto running and the other pump shall be kept in Auto standby. The pump selected in Auto running shall start at high level LT and trip at low level LT.

All controls, fault indications/ alarms, interlocks, logics shall be implemented in DCS located in FGD Control Room.

P&ID FOR EFFLUENT TREATMENT PLANT



LEGEND

LINE SYMBOL	
LINES	LEGEND
CONTINUITY LINE	
PROCESS LINE	
AIR LINE	
CONTROL SIGNAL	
SERVICE WATER	
DIRECTION	
VALVE SYMBOL	
BALL VALVE	
BUTTERFLY VALVE	
NON RETURN VALVE	
GATE VALVE	
REDUCER / EXPANDER	
PRESSURE RELIEF VALVE	
Y-STRAINER	
3-WAY GAUGE COCK	
EQUIPMENT SYMBOLS	
HORIZONTAL CENTRIFUGAL PUMP	
VERTICAL CENTRIFUGAL PUMP	
AIR BLOWER	
METERING / DOSING PUMP	
HORIZONTAL SCREW PUMP	
EXPANSION JOINT	
FUNEL	
AGITATOR	
DRAIN	
INSTRUMENT SYMBOLS	
PRESSURE GAUGE	
LEVEL GAUGE	
LEVEL TRANSMITTER	
PRESSURE TRANSMITTER	
pH ANALYZER	
CONDUCTIVITY ANALYZER	
TURBIDITY ANALYZER	
FLOW TRANSMITTER	
DIAPHRAGM SEAL	
FLOAT & BOARD LEVEL INDICATOR	
FUNCTIONAL SYMBOLS	
FIELD MOUNTED INSTRUMENT	
INTERLOCK	

KKS CODING SYSTEM

UNIT KEY (80-COMMON/ 10-UNIT-1/20-UNIT-2)
FUNCTION KEY
AREA KEY
xx GNN xx
xx XXX
EQPT. / INST. NO. KEY
EQPT. / INST. KEY

EQUIPMENT/INST. NO. KEY

MECHANICAL :
001 TO 050 EQUIPMENTS
051 TO 099 MOTORISED VALVE
401 TO 499 NON RETURN VALVES
501 TO 599 MANUAL VALVES
701 TO 799 PR. RELIEF VALVES

ELECT. C&I :
001 TO 099 ANALOG INST. – REMOTE
101 TO 199 PROCESS SWITCHES – LOCAL
501 TO 599 PROCESS INDICATORS –LOCAL

EQUIPMENT/ INST. KEY

MECHANICAL :
AP – PUMPS
AN – BLOWERS
AA – VALVES
AT – FILTERING ELEMENT
AM – MIXERS
BB – VESSELS AND STORAGE TANKS
EX – EXPANSION JOINT

ELECT. C&I :
AE – MOTORS
CF – FLOW MEASUREMENT
CP – PRESSURE MEASUREMENT
CQ – ANALYTICAL MEASUREMENT
CL – LEVEL MEASUREMENT

NOTE:

1. ISOLATION VALVES FOR INSTRUMENT IS INTEGRAL PART OF RESPECTIVE INSTRUMENT.
2. DATA INDICATED IN THIS P&ID IS MFINIMUM, IT MAY VARY DURING DETAILED ENGINEERING.
3. ETPV: EFFLUENT TREATMENT VENDOR (SUPPLIER).

CUSTOMER:	**TAMILNADU GENERATION & DISTRIBUTION CORPORATION LIMITED** 5th Floor, Western Wing, NPKRR Maaligai, 144, Anna Salai, Chennai–600002
CONSULTANT:	**Fichtner Consulting Engineers (India) Pvt Ltd.** Menon Eternity, 9th Floor, No.165, St. Mary's Road, Alwarpet, Chennai–600018
PROJECT:	1X800 MW TANGEDCO NORTH CHENNAI TPP STAGE III – FGD
	BHARAT HEAVY ELECTRICALS LIMITED PROJECTS ENGINEERING MANAGEMENT, NOIDA

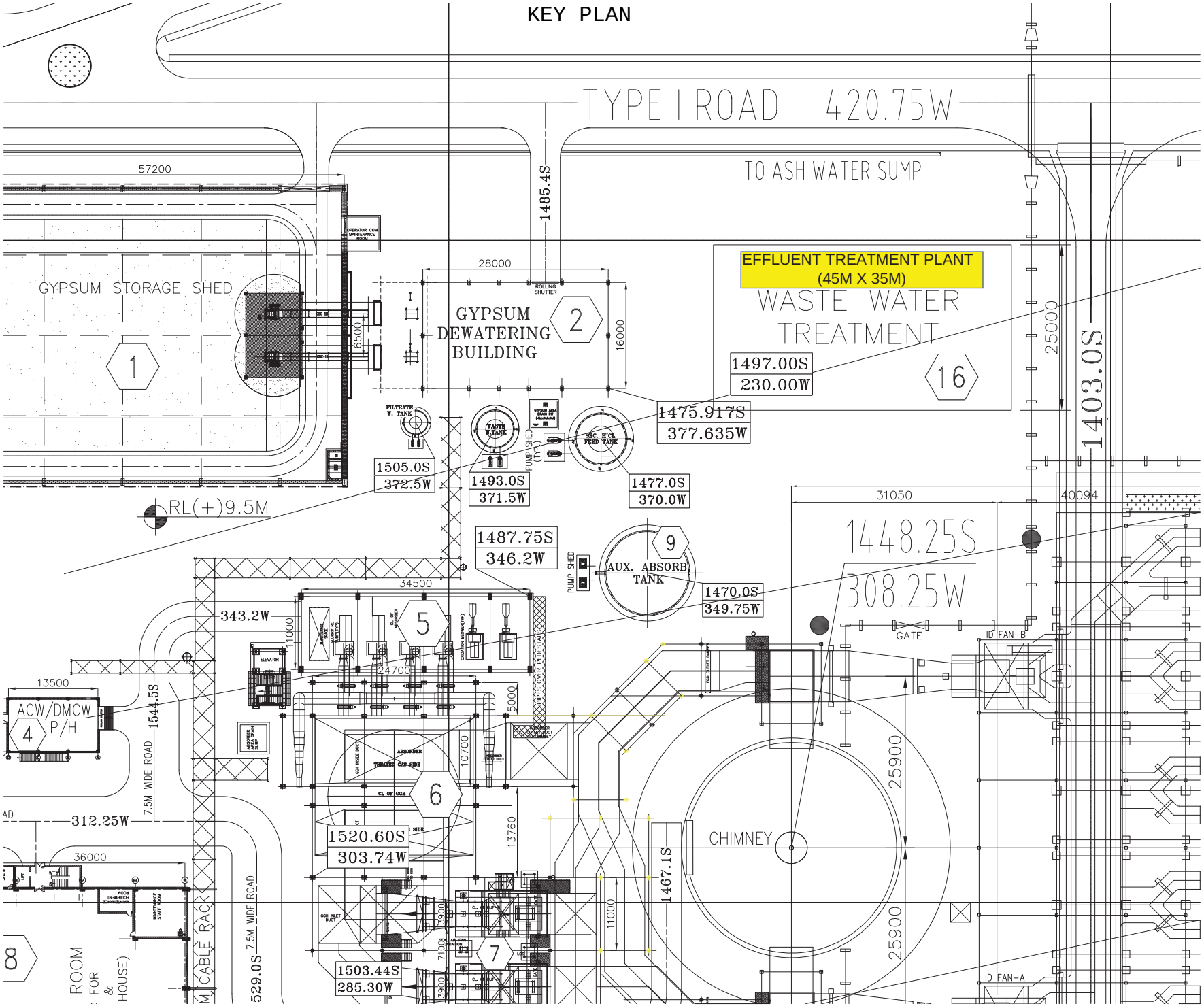
TITLE: **P & ID FOR EFFLUENT TREATMENT PLANT**

	NAME	SIGN.	DATE
DRAWN	F SAHA	Sd /-	11.04.24
CHECKED	J PAL / VK	Sd /-	11.04.24
APPROVED	S BHARTIYA	Sd /-	11.04.24

ALL DIMENSIONS ARE IN MILLIMETRES
PROJECTION
SCALE: N.T.S
BHEL DRAWING NO.: PE-DG-485-164-A001.
REV: 00
Size A1

KEY PLAN

KEY PLAN


TYPE I ROAD 420.75W
TO ASH WATER SUMP
57200
1485.4S
28000
GYPSUM STORAGE SHED
1
GYPSUM DEWATERING BUILDING
2
ROLLING SHUTTER
6500
16000
EFFLUENT TREATMENT PLANT (45M X 35M)
WASTE WATER TREATMENT
16
1497.00S
230.00W
25000
1403.0S
1475.917S
377.635W
FILTRATE W. TANK
WASTE W.TANK
SEC. H.CL. FEED TANK
PUMP SHED (TYP.)
1505.0S
372.5W
1493.0S
371.5W
1477.0S
370.0W
RL(+)9.5M
31050
40094
1487.75S
346.2W
9
AUX. ABSORB TANK
PUMP SHED
1448.25S
308.25W
34500
343.2W
1470.0S
349.75W
GATE
ID FAN-B
5
11000
ELEVATOR
24700
5000
PIPES OVER PEDESTALS
13500
ACW/DMCW P/H
4
1544.5S
7.5M WIDE ROAD
10700
ABSORBER
TREATED GAS SIDE
6
CL OF DGH
312.25W
36000
1520.60S
303.74W
13760
CHIMNEY
25900
1467.1S
11000
8
ROOM FOR & HOUSE)
CABLE RACK
7.5M WIDE ROAD
529.0S
7
1503.44S
285.30W
ID FAN-A

SECTION-D

(GENERAL TECHNICAL REQUIREMENT)

SECTION-D1

(GENERAL TECHNICAL REQUIREMENT FOR MECHANICAL)

GENERAL TECHNICAL REQUIREMENT FOR MECHANICAL FOR EFFLUENT TREATMENT PLANT

A. DESIGN CRITERIA AND DESCRIPTION OF PLANT (REFER ENCLOSED P&I DIAGRAM: PE-DG-485-164-A001).

The waste water treatment system for Flue Gas Desulphurization System Auxiliaries is provided to treat the overflow water collected from secondary hydro cyclone. The treatment shall comprise of neutralization, clarification and sludge handling facilities. The overflow water from Thickener shall be fed to existing Guard pond.

The waste water received from secondary hydro cyclone shall be collected in waste water collection tank. Lime and hypo dosing shall be provided in waste water collection tank to adjust pH and remove any organics present in the waste water.

After neutralization, the waste water shall be fed to Thickener to remove suspended solids. The following dosing systems are envisaged in the clarification system.

- ✓ Lime dosing system
- ✓ Ferric chloride dosing system
- ✓ Poly electrolyte dosing system

The overflow water from Thickener shall be collected in clarified water storage tank. The clarified water shall be transferred to Existing Guard pond.

The underflow from Thickener shall be collected in sludge pit and further transferred to centrifuge for dewatering. The supernatant water collected from centrifuge shall be fed to inlet of Thickener. The sludge cake collected from centrifuge shall be disposed offsite.

All the equipment related to Effluent Treatment Plant shall be located outdoor except chemical Dosing System and Chemical Storage facility which shall be Located/stored in Chemical House located at ETP Area.

PUMPS AND PIPE SELECTION CRITERIA

Pump and Pipeline carrying water and chemicals etc. shall generally be sized on the following velocities. However wherever minimum pipe sizes are defined in the drawing/datasheets, the selected size shall not be less than the specified size.

	VELOCITY IN m/sec.		
	BELOW 50 MM.	**50-150 MM**	**200 MM AND 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 for water	-------	1.5-2.4	2.1-2.4
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	--------
Gravity flows	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.		

Note 1- All piping system shall be capable of withstanding the maximum pressure in the corresponding line.

Note 2- TDH of all pumps shall be decided by the supplier assuming the following 'C values in Hazen & Williams equation for calculation of friction loss.

a) **Carbon steel pipes – 100**
b) **CI Pipes /Ductile Iron pipes –100**
c) **Rubber lined steel pipe – 120**
d) **UPVC/CPVC/PVC/HDPE pipes – 140**
e) **Stainless steel pipes -100**

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

SECTION-D2

(GENERAL TECHNICAL REQUIREMENT FOR ELECTRICAL)

(ONLY LT MOTORS APPLICABLE FOR THIS PACKAGE)

1.0.0 INTENT OF SPECIFICATION

This section covers the technical requirements of HT and LT Motors.

2.0.0 CODES AND STANDARDS

The equipment to be furnished under this specification shall be in accordance with the applicable section of the latest edition (including amendments) of the following Indian Standards (IS), IEC publications and other codes, especially the Indian Statutory Regulation, except where modified and /or supplemented by this specification.

-

a)	IS: 325	Three phase induction motors
b)	IS: 12615	Energy efficient induction motors
c)	IS: 900	Code of practice for installation and maintenance of induction motors
d)	IS: 996	Single-phase AC induction motor for general purpose
e)	IS: 1231	Dimensions of three-phase foot-mounted induction motors
f)	IS: 2223	Dimensions of flange mounted AC induction motors
g)	IS: 4029	Guide for testing three-phase induction motors
h)	IS: 8789	Values of performance characteristics for three-phase induction motors
i)	IS: 13555	Guide for selection and application of 3-phase AC induction motors for different types of driven equipment
j)	IS: 5571	Guide for selection of electrical equipment for hazardous areas
k)	IS: 12065	Permissible limits of noise level for rotating electrical machines
l)	IS: 12075	Mechanical vibration of rotating electrical machines
m)	IS: 9334	Electrical motor operated actuators
n)	IS 60034-5	Degree of protection provided by Integral design of rotating electrical machines
o)	IS 60034-8	Terminal marking and direction of rotation
p)	IS 60079-1	Equipment protection by flame proof enclosure
q)	IS 60034-1	Rotating electrical machines.
r)	IS 60079	Explosive atmospheres
s)	IS/IEC 60529	Degrees of protection provided by enclosures (IP code)
t)	IEC 60034	Rotating electrical machines.

3.0.0 TECHNICAL REQUIREMENTS

3.1.0 Design ambient temperature

Motors shall be suitable for an ambient temperature of 50 degree C and relative humidity of 95% and shall deliver the rated output without exceeding its guaranteed temperature limits. The equipment shall operate in highly polluted environment.

3.2.0 Supply voltage

Motors rated up to and including 415V are termed as LT motors and the motors rated higher than 415V are termed as HT motors.

Motors shall be capable of delivering the rated output under following voltage and frequency variations without exceeding its guaranteed temperature limits.

- Frequency variation : (+) 3% and (-) 5%
- Voltage variation for LT motors : (±) 10%
- Voltage variation for HT motors : (±) 10%
- Combined variation of voltage and frequency : 10% (absolute sum)

All the motors shall be so designed that maximum inrush currents, locked rotor torque and pullout torque developed at extreme voltage and frequency variations do not endanger the motor and the driven equipment.

3.3.0 System Parameters

Sl. No.	Description	HT System	LT System
1.	Voltage level	11 KV Above 2000 KW 6.6KV above 160KW & upto 2000KW	240 V : up to 0.2 KW 415 V : >0.2 KW and up to 160 KW.
2.	System earthing	Earthed through resistance. Earth fault current : 300 Amps	415V: Solidly grounded.
3.	System fault level	50 KA for 3 sec for 11KV 40KA for 1sec for 6.6KV	50 KA for 1 second
4.	Fault withstand rating of motor terminal box (Breaker operated)	50 KA for 0.25 sec for 11KV 40KA for 0.25 sec for 6.6KV	50 KA for 0.25 second

3.4.0 Type

- AC Motors shall be squirrel cage induction type unless otherwise it is specified. All the motor shall be bi-directional.

3.5.0 Duty

- All AC motors shall be squirrel cage three phase/single phase induction motors. All the motor shall be designed for bi-directional rotation.
- Motors shall be suitable for installation in hot, humid and tropical atmosphere and polluted at places with coal ash and fly ash or any dusty chemical handling area.
- All LV motors above 10KW shall be with S1 duty.

3.6.0 Design margin

- Motor rating shall be selected higher than the maximum load demand of the driven equipment, as per the criteria stated in mechanical section of this specification, under entire operating range, including voltage and frequency variation.
- The motor name plate rating shall have 15% margin over duty point input (or) 10% margin over the maximum demand of driven equipment whichever is higher considering highest system frequency.
- The motor characteristics shall match the requirements of the driven equipment so that adequate starting, accelerating; pull up, breakdown and full load torques are available for the intended service.
- Service shall be considered as 1.0 only.

3.7.0 Method of Starting

- All the motors shall be suitable for direct on-line starting on full load.
- HT Motors will be controlled through vacuum circuit breaker.
- LT motors rated less than 90KW will be controlled through MPCB/MCCB and contactor. LT motors rated 90 KW and above will be controlled through air circuit breaker (ACB).

3.8.0 Efficiency

All the continuous duty motors shall be energy efficient type. For LT motors, it shall be IE3 class as per IS 12615. For HT motors, efficiency shall be more than 95%.

3.9.0 Temperature rise

- Winding Insulation shall be Class F.
- Temperature rise of motors shall not exceed 70°C over air temperature of 50°C by resistance method, while delivering its maximum rated output.

3.10.0 Starting voltage

a) Motors shall be capable of starting and accelerating the load at following starting voltage, with direct on line starting, without exceeding specified winding temperatures.

- HT Motors : 85% of rated voltage
- LT motors : 80% of rated voltage

b) During fast changeover of power supply source, vector difference between the motor residual voltage and the incoming supply voltage will be about 150% of the rated voltage and the motors shall withstand voltage stress and torque stress developed during that time, which may last for a period of one (1) second.

c) The motor shall be capable of operating at full load at a supply voltage of 80% of the rated voltage for 5 minutes.

d) The motor shall be capable of withstanding the stresses imposed if started at 110% rated voltage.

e) Motor shall not stall if the supply voltage drops to 70% of the rated voltage two (2) second duration

3.11.0 No. of Starts

Continuous duty motors shall be suitable for the following starting requirements under the specified conditions of load, torque and inertia.

- No. of consecutive hot starts shall be 2 (with initial temperature of the motor at full load operating level).
- No. of consecutive cold starts shall be 3 (with initial temperature of the motor at ambient temperature).
- For conveyor motors, no. of consecutive hot starts shall be 3 (with initial temperature of the motor at full load operating level).

3.12.0 Starting current

- Motor shall be designed for direct online starting at full voltage. Starting current shall not exceed 6 times full load current for all auxiliaries. No further tolerances are applicable on starting current specified above for HT motors.
- For LT motors, the applicable starting current shall be limited to 7.2 times of full load current including all tolerance.

3.13.0 Locked rotor withstand time

- The locked rotor withstand time for HT motors under hot conditions at 110% rated voltage shall be more than the starting time at minimum permissible voltage specified above by atleast three seconds or 15% of the accelerating time whichever is greater.
- For the LT motors having starting time upto 20 seconds at minimum permissible voltage, the locked rotor withstand time under hot condition at highest voltage limit shall be at least 2.5 seconds more than the starting time.
- For the motors having starting time more than 20 seconds and up to 45 seconds at minimum permissible voltage, the locked rotor withstand time under hot condition at highest voltage limit shall be at least 5 seconds more than the starting time.
- For motors having starting time more than 45 seconds at minimum permissible voltage, the locked rotor withstand time under hot condition at highest voltage limit shall be more than starting time by at least 10% of the starting time.
- The motors shall be designed to withstand 120% of rated speed for 2 minutes without any mechanical damage
- All motors shall be so designed that maximum in rush currents and locked rotor and pull out torque developed by them at extreme voltage and frequency variation do not endanger the motor & driven equipment.

3.14.0 Torque Requirements

- Accelerating torque at any speed with the lowest permissible starting voltage shall be at least 10% motor full load torque.
- Pull out torque at rated voltage shall not be less than 205% of full load torque.
- Motors subjected to reverse rotation shall be designed to withstand the stresses encountered when starting with non-energized shaft rotating at 125% of rated speed in reverse direction.
- The motor shall be designed to withstand momentary overload of 60% of full load torque for 15 second without any damage.

3.15.0 Enclosure

a) All motor enclosures shall conform to the degree of protection IP 55 unless otherwise specified. Motor for outdoor or semi outdoor service shall be of weather proof construction.

b) For hazardous location, the enclosure of motors shall have flame proof construction conforming to applicable standard.

3.16.0 Cooling

- LT motors shall be totally enclosed fan cooled (TEFC), type IC411. The cooling shall be effected by self-driven bi-directional centrifugal fan protected by fan cover.
- HT motors can be totally enclosed fan cooled (TEFC) or totally enclosed tube ventilated (TETV) or closed air circuit air cooled (CACA) type.
- Motors rated >3000KW can be closed air circuit water cooled (CACW).
- Motors with CACA/CACW heat exchangers shall have dial type thermometer with adjustable alarm contacts to indicate the following:
  - Hot and cold air temperatures of the closed air circuit for CACA motors.
  - Hot and cold, air and water temperatures for CACW motors.
- The Alarm switch contact rating shall be minimum 0.5 A at 220 V DC and 5A at 240 V AC.

3.17.0 Winding

- Winding shall be class F insulation with temperature limited to class B. Insulation shall be Non-hygroscopic, oil resistant, and flame resistant. Winding, fittings and hardware shall be corrosion resistant. Winding shall be tropicalized and suitably varnished, baked and treated for operating satisfactorily in humid and corrosive atmosphere.
- For the VFD operated drives, insulation shall be designed to take care of stresses due to high Dv/dt. Motors shall be wound with dual coated winding wires and impregnated with VPI process. Further for such application, insulated bearings shall be provided to avoid circulating current caused by shaft induced voltages.
- Space heaters rated for 240V AC, 50 Hz supply shall be provided for motors rated 30KW and above to maintain windings in dry condition when motor is standstill.
- For HT motors, insulation shall be Vacuum Impregnated (VPI).
- HT motors shall withstand 1.2/50 microsec impulse Voltage wave of 4U+5 KV (U=Line voltage in KV). The coil inter-turn insulation shall be suitable for 0.3/3msec surge of 32KVp and 12KVp for 11KV & 6.6KV system respectively, followed by 1 min power frequency high voltage test of appropriate voltage on inter turn insulation.

Temperature Detectors

- All 11KV motors shall be provided with six (6) nos. duplex, or twelve (12) nos. simplex type winding temperature detectors, i.e. two (2) nos. duplex or four (4) nos. Simplex per phase.
- 11KV motor bearing shall be provided with duplex type temperature detectors.
- The temperature detector mentioned above shall be resistance type, 3 wire, platinum wound, 100 Ohms at 0℃.
- Leads of all simplex type motor winding RTDS and motor bearing RTDS shall be wired up to respective switchgear metering & protection compartment. From which one set of RTDS will be connected to numerical protection relay and another set shall be kept free for DCS/PLC connectivity.
- Five number of Temperature detectors / thermisters shall be provided for L.T. motors above 90 KW (3 numbers winding temperatures & 2 numbers bearing temperatures)

3.18.0 Bearings

- Motor shall be provided with antifriction bearings, unless sleeve bearings are required by the motor application. Bearings shall be provided with seals to prevent leakage of lubricant or entrance of foreign matters like dirt, water etc. into the bearing area.
- Sleeve bearings shall be split type, ring oiled with permanently aligned, close running shaft sleeves. Grease lubricated bearings shall be pre-lubricated and shall have provisions for in-service positive lubrication with grease nipple and relief holes.
- Vertical shaft motors shall be provided with thrust and guide bearings. Thrust bearing of tilting pad type is preferred. However, if anti-friction bearings can take vertical thrust, thrust and guide bearings are not required.
- Lubricant shall not deteriorate under all service conditions. The lubricants shall be limited to normally available types. For motors rated 30KW and above re-lubrication facility shall be provided.
- For motor with forced lubrication, a shaft driven oil pump shall be provided along with an electrical auxiliary pump. Alternatively, two motor driven pumps may be provided, one working and one standby. All necessary auxiliaries and accessories shall be provided to complete the system. A pressure gauge and pressure switch for low oil pressure warning and to start the standby oil pump automatically shall also be provided. A motor driven jacking oil pump may be provided, for heavy shaft loads.
- Flow switches shall be provided for monitoring oil flow of forced lubrication bearings, if used. Alarm switch contact rating shall be minimum 0.5 A at 220 V DC and 10A at 230 V AC.
- For bearing temperature measurement, duplex RTDs shall be provided for each bearing and shall be wired upto the terminal box.
- Each bearing shall be provided with dial type thermometer.
- For all VFD operated motors and motors rated above 1000KW shall have insulated bearings to prevent flow of shaft currents.

3.19.0 Terminal Boxes

- For single core cables, gland plate shall be non-magnetic material. Terminal box shall be capable of being turned 360° in steps of 90°, unless otherwise approved. The terminal boxes shall be split type with removable cover with access to connections.
- Terminals for motors shall be stud type, thoroughly insulated from the frame. The terminals shall be clearly identified by phase markings, with corresponding direction of rotation marked on the non-driving end of the motor.
- The terminal box shall be capable of withstanding maximum system fault current for 0.25 sec for all breaker operated motors and shall be provided with explosion vent.
- For contactor operated LT motors, the terminal box shall be capable of withstanding the fault current for 0.2 sec minimum and operating time of MPCB/MCCB.
- Removable gland plates of thickness not less than 2.5 mm sheet steel or 3 mm aluminium (for single core cables) shall be provided for cable boxes.
- Cable spreader box shall be provided for larger cable sizes.

- Cable boxes of HT motors shall be phase segregated type. The terminals of three phases shall be segregated by barriers of metal or fibre glass. For HT motors, cable box design shall be suitable for accommodating cable termination kits.
- Separate terminal box for space heaters shall be provided.
- A separate terminal box of IP 55 degree of protection shall be provided for temperature detectors.
- Motor 1000 KW and above shall be provided with three differential current transformers mounted over the neutral leads within the enclosure. Loose 3 numbers CT for mounting on switchgear side shall be in bidder's scope. The arrangement shall be such as to permit easy access for C.T. testing and replacement. Current transformer characteristics shall match Owner's requirements to be intimated later to the successful bidder. The CT details shall be finalized during detail engineering. Neutral terminal box shall have IP 55 degree of protection.
- The secondary leads of CT shall be wired to separate auxiliary terminal box of IP 55 degree of protection
- All the accessory terminal boxes shall be located on the same side of the main (power) terminal box.
- For LT motors, terminal box shall be located on top, unless otherwise specified.

3.20.0 Earthing Terminals

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

The grounding connection shall be suitable for accommodation of ground conductors as follows :

Above 100 to 200 KW	: 75x10 mm GS flat
Above 55 KW to 100 KW	: 50x6 mm GS flat
Above 22 KW to 55 KW	: 50x6 mm GS flat
Above 5.5 KW to 22 KW	: 25x6 mm GS flat
Fractional HP LV Motors	: 8 SWG GS Wire

3.21.0 Noise and Vibration

- Motors shall be selected with low noise levels in accordance with IS 12065. Noise level for all motors shall be limited to 85db (A).
- The peak amplitude of the vibration shall also be within the specified limits of IS: 12075.
- All HT motors shall be provided with vibration pads for mounting vibration detectors. Motors shall withstand vibration produced by driven equipment.

3.22.0 Name Plates

Motor shall have stainless steel nameplate(s) showing diagram of connections, all particulars as per IS: 325 / IS: 12615 and shall also have 'BEE' marking.

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

- Temperature rise in ºC under rated condition and method of measurement.

- Degree of protection.
- Bearing identification no. and recommended lubricant.
- Location of insulated bearings.

3.23.0 Drain plug

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

3.24.0 Lifting provision

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

3.25.0 Dowel pins

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

4.0.0 INSTALLATION

Installation shall be carried out as per IS: 900.

5.0.0 PAINTING

Painting shall be carried out by an approved process. Pretreatment shall conform to applicable standard. The equipment shall be subject to a coat of red oxide primer paint. All inside and outside surface shall be painted with epoxy based paint. The final thickness of paint film on steel shall not be less than 100 microns. Paint Shade for the Motor shall be RAL 7032 (Siemens Grey). Sufficient quantity of touch-up paint shall be furnished for application at site.

6.0.0 TESTING AND INSPECTION

6.1.0 Tests shall be performed in presence of Owner's representatives. Successful Bidder shall give atleast fifteen (15) days advance notice for witnessing the tests. Copies of certified reports of all tests carried out at the works shall be furnished. The equipment shall be dispatched from works, only after receipt of Owner's written approval of the test reports.

6.2.0 Routine and Type Tests are to be conducted for all HT motors and for LT motors above 60 KW rating in presence of customer's representative as per IS:325, IS:4722, IS:9283 and required copies of test certificates are to be furnished for approval.

6.3.0 Test certificates for Routine tests conducted as per IS:325, IS:4722, IS:9283 for motors of rating 60 KW and below shall be submitted for TANGEDCO review, approval and dispatch clearance.

6.4.0 The following minimum tests/ checks shall be conducted at site. Any other tests/ checks as per the manufacturer's recommendation shall also be carried out

i) Measurement of vibration.
ii) Measurement of insulation resistance and polarization index
iii) Measurement of full load current.
iv) Test running of the motors, checking the temperature rise and identifying the hot spot etc.

7.0.0 OTHERS

7.1.0 The responsibility of co-ordination with electrical agencies and obtaining all necessary clearances shall be the contractor.

7.2.0 Canopy shall be provided for outdoor motors.

7.3.0 Contractor shall provide fully compatible electrical system, equipment, accessories and services.

8.0.0 SPECIFIC REQUIREMENTS

8.1.0 The following shall be considered for control & protection of motors.

a) Motors below 18.5 KW: MPCB incomers

b) Above 18.5 KW but below 90 KW: contactor controlled with MCCB

c) 90 KW and above but 160 KW & below: ACB controlled with numerical relays

d) HT Motors shall have vacuum breakers

e) HV motors 1000KW above shall have differential protection

f) For motors 1000KW & above, neutral CT of Cl. PS shall be provided as each box on separate terminal box

g) Key phasor arrangement shall be provided for all motors

h) All motors shall be provided with an emergency stop PB near motor as per Indian Statutory regularity.

i) Spacious platform shall be provided around motor area with min. of 300mm below the level of motor base plate.

j) Capillary type temp. Gauge cum shall be provided for DE/NDE of HV motors

k) After erection of electrical equipment at site, corrosion proof paint touch up to be done before test & commissioning of equipment.

DATA SHEET A – MOTORS

TECHNICAL DATA SHEET - PART - A

SL.NO	DESCRIPTION	UOM	DETAIL
1.0	**DESIGN CODES & STANDARDS**		
1.1	Three phase induction motors		IS15999, IEC:60034
1.2	Single phase AC motors		IS 996, IEC:60034
1.3	Energy Efficient motors		IS 12615, IEC:60034-30
1.4	Designation of Methods of Cooling of Rotating Electrical Machines		IS:6362
1.5	Designation for types of construction and mounting arrangement of rotating electrical machines		IS:2253
2.0	**DESIGN /SYSTEM PARAMETERS**		
2.1	Rated voltage	V	415
2.2	Frequency	Hz	50
2.3	Permissible variations for		
a)	Voltage	%	a) 415 V/240 V: +/-10
b)	Frequency	%	(+)3 to (-)5
c)	Combined	%	10 (absolute sum)
2.4	System fault level at rated voltage for 1 sec	kA	a) 415 V systems - 50 kA
2.5	Short time rating for terminal boxes		a) 415 V systems- 50 kA for 0.25 sec
2.6	Type of motors		240 V : up to 0.2 KW 415 V : >0.2 KW and upto 200 KW AC Motors: a) AC Motors shall be squirrel cage induction type unless otherwise it is specified. All the motor shall be bi-directional. All the motors shall be suitable for Direct online starting on full load. b) Motors rated less than 90KW will be controlled through MPCB/MCCB and contactor. c) Motors rated 90 KW and above will be controlled through air circuit breaker (ACB).
2.7	Efficiency class		All the continuous duty motors shall be energy efficient type. Motors shall be IE3 class as per IS 12615.
2.8	TEMPERATURE RISE		a) Winding Insulation shall be Class F with temperature rise limited to class B. b) Temperature rise of motors shall not exceed 70°C over air temperature of 50°C by resistance method, while delivering its maximum rated output.
2.8	Rating		
a)	Motor duty		All motors above 10KW shall be with S1 duty
b)	Design margin over continous max. demand of the driven equipment (min)		The motor name plate rating shall have 15% margin over duty point input (or) 10% margin over the maximum demand of driven equipment whichever is higher considering highest system frequency
3.0	**CONSTRUCTION FEATURES**		
3.1	Winding and Insulation		Electrolytic grade Copper conductor, Non-hygroscopic, oil resistant, flame resistant Insulation.
3.2	Enclosure Details		
a)	Degree of protection		
	i) Indoor motors		IP 55 (For hazardous location, the enclosure of motors shall have flame proof construction conforming to applicable standard)
	ii) Outdoor motors		IP 55 (with weather proof construction and (For hazardous location, the enclosure of motors shall have flame proof construction conforming to applicable standard))

b)	Method of ventilation		Motors shall be totally enclosed fan cooled (TEFC), type IC411. The cooling shall be effected by self-driven bi-directional centrifugal fan protected by fan cover.
3.3	Insulation		
	240VAC, 415V AC & 220V DC motors:		Class F insulation with temperature limited to class B.
3.4	Bearings		Motor shall be provided with antifriction bearings, unless sleeve bearings are required by the motor application. Sleeve bearings shall be split type, ring oiled with permanently aligned, close running shaft sleeves. Vertical shaft motors shall be provided with thrust and guide bearings. Thrust bearing of tilting pad type is preferred. However, if anti-friction bearings can take vertical thrust, thrust and guide bearings are not required.
3.5	Main terminal box		
a)	Type		-Motor terminal box shall be detachable type and located in accordance with Indian Standards clearing the motor base- plate/ foundation. -Terminals shall be stud type, substantially constructed and thoroughly insulated from the frame. - The terminals shall be clearly identified by phase markings, with corresponding direction of rotation marked on the non-driving end of the motor.
b)	DOP		Same as motor
c)	Position when veiwed from the non driving end		Left hand side
d)	Rotation		360 Deg in steps of 90 Deg, unless otherwise approved.
e)	Space heater		Motors rated 30KW and above shall have space heater. Separate terminal box for space heaters & RTDs shall be provided.
f)	Cable glands and lugs		Motor terminal box shall be furnished with suitable cable lugs and double compression brass glands to match with cable used. Gland plates of thickness not less than 2.5 mm sheet steel or 3 mm aluminium (for single core cables) shall be provided in case of cable boxes.
g)	Minimum clearances to be provided between phase to phase and phase to earth	mm	25
3.6	Earthing points suitable for connection		Motor body shall be grounded at two earthing points on opposite sides with two separate and distinct grounding pads complete with tapped holes, GI bolts and washers. The terminal box shall have a separate grounding terminal.
3.7	Paint shade (Corrosion proof paints of colour shade)		RAL 7032 (Siemens Grey). The final thickness of paint film on steel shall not be less than 100 microns.
4.0	**PERFORMANCE PARAMETERS**		
4.1	Starting requirement		
a)	Minimum permissible voltage as a percentage of rated voltage, at start to bring the driven equipment upto the rated speed		Motors shall be capable of starting and accelerating the load at 80% of rated voltage, with direct on line starting, without exceeding specified winding temperatures.
b)	Maximum locked rotor current		as per IS 12615
c)	Starting duty		• No. of consecutive hot starts shall be 2 (with initial temperature of the motor at full load operating level). • No. of consecutive cold starts shall be 3 (with initial temperature of the motor at ambient temperature). • For conveyor motors, no. of consecutive hot starts shall be 3 (with initial temperature of the motor at full load operating level).
d)	The locked rotor withstand time under hot condition at highest voltage limit		
	for motors with starting time upto 20 secs. at minimum permissible voltage during starting		atleast 2.5 secs. more than starting time
	for motors with starting time more than 20 secs. and upto 45 secs. at minimum permissible voltage during starting		atleast 5 secs. more than starting time

	For motors with starting time more than 45 secs.at minimum permissible voltage during starting		more than starting time by at least 10% of the starting time
f)	Starting Current		Starting current shall not exceed 7.2 times of full load current including all tolerance.
4.2	Torque (percent of full load torque)		a) Accelerating torque at any speed with the lowest permissible starting voltage shall be at least 10% motor full load torque. b) Pull out torque at rated voltage shall not be less than 205% of full load torque.
4.3	Noise level (max.)		85 dB(A) as per IS 12065
4.4	Vibration shall be limited within the limits		as per IS:12075
5.0	**INSPECTION/TESTING**		**As per Technical Specification attached herewith**

DATA SHEET C– MOTORS

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

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

QUALITY PLAN (MOTOR)

MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS	STANDARD QUALITY PLAN		SPEC. NO :	DATE:
	CUSTOMER :		QP NO.: PE-QP-999-Q-006, REV-03	DATE: 16.02.2023
	PROJECT:		PO NO.:	DATE:
	ITEM: AC ELECT. MOTORS UPTO 55KW (LV (415V))	SYSTEM:	SECTION: II	SHEET 1 of 2

S. NO.	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	*	AGENCY			REMARKS
1	2	3	4	5	6		7	8	9	*	**			
					M	B / C				D	M	B	C	
1.0	ASSEMBLY	1.WORKMANSHIP	MA	VISUAL	100%	-	MFG. SPEC.	MFG. SPEC.	LOG BOOK		P	-	-	
		2.DIMENSIONS	MA	VISUAL	100%	-	MFG. DRG./ MFG. SPEC.	MFG. DRG./ MFG. SPEC.	LOG BOOK		P	-	-	
		3.CORRECTNESS COMPLETENESS TERMINATIONS/ MARKING/ COLOUR CODE	MA	VISUAL	100%	-	MFG.SPEC./	MFG.SPEC.	LOG BOOK		P	-	-	
2.0	PAINTING	1.SHADE	MA	VISUAL	SAMPLE	-	MFG. SPEC/ APPROVED DATASHEET	MFG. SPEC/ APPROVED DATASHEET	LOG BOOK	✓	P	V	-	
3.0	TESTS	1.ROUTINE TEST INCLUDING SPECIAL TEST	MA	VISUAL	100%	-	IS-12615/ APPROVED DATA SHEET	IS-12615	TEST/ INSPN. REPORT	✓	P	V *	-	* NOTE -1
		2.OVERALL DIMENSIONS & ORIENTATION	MA	MEASUREMENT & VISUAL	100%	-	APPROVED DRG/ DATA SHEET	APPROVED DRG/ DATA SHEET	TEST/ INSPN. REPORT	✓	P	V *	-	* NOTE -1 & NOTE-2
		3.NAMEPLATE DETAILS	MA	VISUAL	100%	-	APPROVED DATA SHEET	APPROVED DATA SHEET	TEST/ INSPN. REPORT	✓	P	V	-	
4.0	PACKING	SURFACE FINISH & COMPLETENESS	MA	VISUAL	100%	100%	AS PER MFG. STANDARD	AS PER MFG. STANDARD	INSPC. REPORT	✓	P	W	-	

BHEL					
ENGINEERING			QUALITY		
	Sign & Date	Name		Sign & Date	Name
Prepared by:		HEMA KUSHWAHA	Checked by:		KUSUM GAUTAM
Reviewed by:		PRAVEEN DUTTA	Reviewed by:		HARISH KUMAR

BIDDER/ SUPPLIER	
Sign & Date	
Seal	

FOR CUSTOMER REVIEW & APPROVAL			
Doc No:			
	Sign & Date	Name	Seal
Reviewed by:			
Approved by:			

	MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS	STANDARD QUALITY PLAN		SPEC. NO :	DATE:
		CUSTOMER :		QP NO.: PE-QP-999-Q-006, REV-03	DATE: 16.02.2023
		PROJECT:		PO NO.:	DATE:
		ITEM: AC ELECT. MOTORS UPTO 55KW (LV (415V))	SYSTEM:	SECTION: II	SHEET 2 of 2

NOTES:
1. Routine tests on 100% motors shall be done by the vendor. However, BHEL/ Customer shall witness routine tests on random samples. The sampling plan shall be mutually agreed upon.
2. For exhaust/ventilation fan motors of rating up to 1.5 KW, only routine test certificates shall be furnished for scrutiny.
3. In case test certificates for these tests on similar type, size and design of motor from independent laboratory are available, the same is valid for 5 years.
4. Latest revision/ year of issue of all the standards (IS/ ASME/ IEC etc.) indicated in QP shall be referred.

LEGENDS:

*RECORDS, INDENTIFIED WITH "TICK"(√) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION,
** **M**: SUPPLIER/ MANUFACTURER/ SUB-SUPPLIER, B: MAIN SUPPLIER/ BHEL/ THIRD PARTY INSPECTION AGENCY, **C**: CUSTOMER,
P: PERFORM, **W**: WITNESS, **V:** VERIFICATION, AS APPROPRIATE
MA: MAJOR, **MI**: MINOR**, CR:** CRITICAL
D: DOCUMENTATION

BHEL					
ENGINEERING			QUALITY		
	Sign & Date	Name		Sign & Date	Name
Prepared by:		HEMA KUSHWAHA	Checked by:		KUSUM GAUTAM
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BIDDER/ SUPPLIER	
Sign & Date	
Seal	

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Approved by:			

CABLE SCHEDULE FORMAT

CABLE SCHEDULE FORMAT

UNITCABLENO	FROM	TO	PURPOSE	CABLE SCOPE (BHEL PEM/ VENDOR)	REMARKS	CABLESIZE	PATHCABLENO	TENTATIVE CABLE LENGTH

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

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

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

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

(B) CABLE VOLTAGE CODES:
A = 11KV (Power cables)

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

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

(C) CABLE CODES

PVC Copper

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

PVC Aluminium

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

XLPE Copper

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

XLPE Aluminium

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

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

SECTION-D3

(GENERAL TECHNICAL REQUIREMENT FOR C&I)

FIELD INSTRUMENT DATA SHEET

TECHNICAL DATA - PART - A

SL.NO	DESCRIPTION	UOM	DETAIL
1.0	**DESIGN CODES & STANDARDS**		
1.1	Impulse pipes, tubes (material, rating)		ANSI B31.1, ANSI B31.1a, ANSI/ISA 77.70
1.2	Valves (material, pr. Class, size)		ASTM A182/ASTM A105 as per ASME 16.34
1.3	Fittings (size, rating, material)		ANSI B31.1, ANSI B31.1a, ASME B16.11
1.4	Installation schemes		BS 6739-2009, ANSI/ISA 77.70
1.5	Instruments and apparatus for pressure measurement		ASME PTC19.2
1.6	Electonic transmitters		BS-6447, IEC-60770
1.7	Bourdon tube pressure and vacuum gauges		IS-3624
1.8	Recommendations for the design of scales and indexes for indicating instruments for scales of 1 to 2 percent resolution		IS:3602
1.9	ASME standard for Pressure Gauges		ASME B 40.1
1.10	Code of practice for phosphating of iron and steel.		IS-6005
1.11	Colors for ready mixed paints and enamels.		IS-5
1.12	Circuit breaker for household and similar installations.		IS-8828
1.13	Low Voltage switchgear & control gear : Part-I (General Rules)		IS-13947 (Part-I)
1.14	Annunciator Sequences and Specification		ISA-18.1
1.15	Purged & Pressurised Enclosure for Electrical Equipment in Hazardous Locations		NFPA-496
1.16	Type of Enclosures		NEMA ICS Part - 6 - 1978 (with Rev. 1 4/80) through 110.22 (Type 4 to 13)
1.17	Racks, panels and associated equipment		EIA : RS - 310 C- 1983 (ANSI C83.9 - 1972)
1.18	Protection class for enclosures, cabinets, control panels & desks		IS:2147 -1962
1.19	**Codes for Orifice plate Design**		
	Orifice plate		ISO 5167
	Flange Standard for Orifice plate		ASME B16.36
1.20	**Codes for VFD Design**		
	DC reactor		IEC:60289
	Bushing		IS: 2099, IEC 60137
	Adjustable Speed Electrical Power Drive Systems		IEC 61800
	Semiconductor converters–General requirements		IEC 60146
	IEEE Recommended practices and requirements for harmonic control in electrical power systems		IEEE 519
	Degrees of protection provided by enclosures (IP Code)		IEC 60529
	Electrostatic immunity test		IEC1000-4-2
	Fast transient immunity test		IEC1000-4-4
	Surge immunity test		IEC1000-4-5
	AC electricity meters		IS: 722
	Metal oxide surge arrestor without gap for AC system		IEC: 60099-4

	Terminal blocks for copper conductors		IEC: 60947-7-1
	Contactor/Switches/Fuses etc.		IEC:60947, IS: 13947
	Harmonics & EM compatibility		IEEE:519/IEC: 61000
	VFD		IEC: 60034/ IEC: 61800
2.0	**DESIGN /SYSTEM PARAMETERS**		
2.1	**DATASHEET - PRESSURE TRANSMITTER, DIFFERENTIAL PRESSURE TRANSMITTER, DP BASED FLOW AND LEVEL TRANSMITTER**		
	Type/Construction		Sealed capacitance/ Inductance/ Silicon resonance type
	Body Material		SS316 T
	Diaphragm Material		316 SS
	Measurement element Material		Teflon seal
	Valves		Carbon steel for non-corrosive Applications SS316 for corrosive applications, SS super duplex for sea water application.
	Output signal		4 to 20 m Amp. DC (Two wires) HART Compatible
	Local Indicator		LCD indicator (5 digit) with scale of Engg. Unit
	Overall Accuracy		± 0.065% or better of FSR
	Turn down ratio		10:1 for vacuum / very low pressure application 30:1 for other applications
	Stability		± 0.15% for 10 years.
	Response time		100 msec.
	Power supply		24V DC nominal
	Drive capability		500 Ohms minimum
	Enclosure Class		IP-65 (Explosion proof as per NEC article 500 for hazardous area)
	Span and Zero		Locally adjustable, non-interacting
	Zero suppression / elevation		At least 100% of Span
	Connection		
	Process		Half (1/2) inch NPT (F)
	Electrical		Plug and socket, unused entry with blind plug.
	Span and zero adjustment facility		Required
	Accessories		
	For Absolute Pressure Transmitters		Two (2) valve SS316 manifold
	For Gauge & Vacuum pressure transmitter		Three (3) valve SS316 manifold
	For DP, level & flow Transmitter		Five (5) valve SS316 manifold
	For oil and corrosive liquids		Separator diaphragm seals
	Diaphragm material		SS super duplex
	Flush ring & drain		Provided for lime stone slurry based & sea water applications
	For all transmitters		Mounting bracket
	Mounting		Local (in LIE/LIR)
2.2	**DATASHEET - PRESSURE GAUGE, DIFFERENTIAL PRESSURE GAUGE**		
	Sensing Element and Materials		Bourdon for high pressure, diaphragm/bellow for low pressure of all materials in SS 316
	Case		SS 316/ Die-cast aluminum with stoved enamel black finish. Epoxy coating shall be provided for corrosive atmosphere.
	Protective Diaphragm		Teflon
	Dial size		150mm with shatter proof glass
	Scale Details		Graduations in black lines on white dial, 270 Deg pointer defection scale provided with glass cover. Smallest scale division shall be one (1) percent of full scale value or smaller. Pointer stop for all gauges.
	Accuracy		± One (1) percent or better
	Connection – Instrument Process		1/2 inch NPT Male Bottom
	Mounting		Local 1/2 inch NPT Male (Back entry) mounted on local gauge board.
	Accessories		
	3 way needle valve/manifolds		For all gauges
	Self-cleaning type Pulsation		Pump and compressor discharge lines
	Syphon		For all steam lines
	Protective separating		For fuel oil and corrosive liquid lines
	Other particulars		

	Zero & span adjustment Safety device		For all gauges
	Housing		IP 65
	Diaphragm material		SS super duplex
	Flush ring & drain		Provided for lime stone slurry based & sea water applications
	Ranges 5 to 20 Kg/cm²		Rubber blow out disc with open front construction
	Ranges above 20 Kg/cm²		Neoprene safety diaphragm at the back with solid front construction
	Over range protection		Fifty (50) percent of full scale Movement mechanism shall be glycerin filled for oil services & vibration prone area.
			For corrosive liquid lines diaphragm type sensors required. Armored capillary of 10 mtrs for Corrosive liquid service.
			Contact type pressure gauges are not acceptable for interlock & protection.
	Identification		Identification engraved with service legend or laminated phenolic name plate.
2.3	**Guided Wave Radar/Radar Level Transmitter (for Water sump/Tank level measurement)**		
	Type		Guided wave Radar (Contact type)/Radar (Non-contact type).
	Application		For Low pressure Vacuum vessels
	Environment Class		Highly abrasive with Gases and Fumes
	Orientation		Vertical
	Probe Type		Flexible Single lead with chuck
	Probe Material		SS 316L
	Connection Size & Type		2” Flanged ANSI 300 lb SS316L material
	Connection material		SS 316L
	Accuracy		±5 mm
	Resolution		±1 mm
	Type (Transmitter)		SMART, 2 Wire
	Operating Principle		Time Domain Reflectrometry
	Signal Output		4-20mA DC with **HART protocol** and
	Electrical Connection		1/2” NPT
	Enclosure Class		IP 65
	Electrical Power		11-42 V DC
	Housing material		Die Cast Aluminum
	Vent & Drain Plug material		SS
	Side Flange Material		SS
	Local Display		Provided (LCD Digital)

2.4	**DATASHEET - ULTRASONIC LEVEL TRANSMITTER**		
	Type		Non-contact Microprocessor based 2 wire type, HART protocol compatible
	Principle of Operation		Detection of reflected ultrasonic pulse
	Measuring Ranges		Up to 30 meters (typical)
	Signal Processing		Microprocessor Controlled Signal Processing
	Operating Freq.		10 KHz to 50 KHz (typical)
	Display		Head mounted Large alpha-numeric back lit LCD/LED
	Calibration & Configuration		Accessible from front of panel
	Diagnosis		On-line
	Status		For power, Hi / Lo / V. Hi / V. Lo-level indication, fault etc.
	Construction		Plug-on board
	Power supply		24 V DC +/- 10% or 230 VAC 50 Hz
	Signal Output		Galvanically isolated 4-20mA DC with HART protocol
	Hysteresis		Fully adjustable preferred
	False signal tolerance		Transmitter shall be capable of ignoring false echoes
	Output contacts		2SPDT Potential free changeover contacts @ 8A 230V AC.
	Accuracy & Repeatability		±0.25% of span or better
	Temperature compensation		To be provided with transducer
	Resolution		±0.1% of span
	Operating temp.		Transmitter-50 deg C and Sensor –80 deg C
	MOC Sensor		Body- PVDF and Face – Polyurethane or Corrosion resistant material to suit Individual application
	Humidity		1% to 95% non-condensing.
	Enclosure		IP-65 Epoxy painted die cast Aluminum or SS316L housing.
	Cable Connection		Plug and socket.
	Mounting		2” – 4” NPT or flanged
	Accessories		Cable gland, prefab cable, mounting accessories like EPDM seal, SS316 flanged etc.
			Additional separate local display unit with large Alphanumeric back light LCD/LED & to be provided for the applications which will be decided during detailed engineering.
			All weather canopy for protection from direct sunlight and direct rain.
			All mounting hardware and accessories required for erection and commissioning mounting fittings material shall be SS 316.
2.5	**DATASHEET - LEVEL GAUGE**		
	Type/Construction		Reflex
			Tubular (For tanks open to atmosphere only)
	Material:		
	Glass		Tempered toughened borosilicate resistant to thermal shock .
	Body material		Forged Carbon steel / SS 304
	Integral cocks		i) Forged carbon steel with drain valves stainless steel internals
			ii) Rubber lined corrosion resistant stainless steel 316 (for demineralized and Osmosis water service)
	Fittings		i) Forged carbon steel
			ii) Rubber lined 316 steel/PVC for corrosive liquids (for demineralized and Osmosis water service)
			iii) 304 Stainless Steel for non-corrosive liquids
	Packing		Teflon
	Dial size/scale		150 mm /1.4 Meters maximum length with
	Scale details		Aluminum/SS316 scale Graduated in mmwc
	Connection		25 Nb/40 Nb ANSI Flanged
	Enclosure protection		IP 65

	Accessories		a) Integral cocks
			b) Drain/vent valves 15 NB
			c) Bolts, nuts and gaskets for all KEL-F shield for transparent type
			d) Illuminating lamps as required
			e) Periscope as required
	Tests		Tested at two hundred (200) percent of the maximum process pressure
	Other details		For larger lengths, additional gauge glasses shall be provided with minimum of 50 mm overlap.
2.6	**DATASHEET - PH ANALYSER**		
	Type		Cell - flow through
	Accuracy		< ± 1% of reading
	Range		0 - 14 pH freely programmable (For others)
	No. of steams		Single
	Temp. compensation		Automatic
	Output signals Analog		4-20 mA DC galvanically isolated. If analyser provides superimposed HART signal on 4-20 mA DC output, It shall have provision also to be connected to PC based station.
	Output signals Binary		2 NO + 2 NC for high alarm
	Zero & span Adjustment		To be provided with range selection facility.
	Ambient temp.		50°C
	Indication		Digital Alphanumeric Display. Display of reading in engineering units shall be provided.
	Enclosure		Type/Material Weather & Dust proof (IP 65) Die cast Aluminium/SS.
	Type of Electronics		Microprocessor based with self-diagnostic.
	Digital Signal transmission		HART
	Calibration		Auto & Manual (from Remote)
	Power Supply		To be arranged by Bidder subject to Owner's approval
	Enclosure class		IP 65
	Others		All interconnection tubing and cabling between probe and analyzer / analyzer panel and cabling from analyzer/ analyzer panel to local junction box are to be provided
			All the calibration gases required for one year continuous operation shall be provided. The calibration gas container material shall not contaminate the calibration gas.
2.7	**DATASHEET - CONDUCTIVITY ANALYSER**		
	Type		Continuous flow through type
	Measuring Range	µS/cm	0 – 60000 µS/cm for sea water application 0-5000 µS/cm for other application
	Response Time	second	<= 5 sec (90% of full scale)
	Temperature Compensation		Automatic
	Power	V	230V AC
	Output signals Analog		4-20 mA DC galvanically isolated. If analyser provides superimposed HART signal on 4-20 mA DC output, It shall have provision also to be connected to PC based station.
	Binary		2 NO + 2 NC for high alarm
	Zero & span Adjustment		To be provided with range selection facility.
	Ambient temp.		50°C
	Indication		Digital Alphanumeric Display. Display of reading in engineering units shall be provided.
	Enclosure		Type/Material Weather & Dust proof (IP 65) Die cast Aluminium/SS.
	Type of Electronics		Microprocessor based with self-diagnostic.
	Digital Signal transmission		HART / RS 485 Port Modbus Protocol / Ethernet TCP/IP protocol for communication with plant control system.
	Calibration		Auto & Manual (from Remote)
	Power Supply		To be arranged by Bidder subject to Owner's approval

	Enclosure class		IP 65
	Others		All interconnection tubing and cabling between probe and analyzer / analyzer panel and cabling from analyzer/ analyzer panel to local junction box are to be provided
			All the calibration gases required for one year continuous operation shall be provided. The calibration gas container material shall not contaminate the calibration gas.
	Accuracy	%	<= +/-1 %
2.8	**DATASHEET - ORIFICE PLATE**		
	Type		Concentric as per ASME PTC-19.5 (Part-II), ISA RP-3.2, 1960 or BS-1042
	Material		316 SS, for sea water based application SS duplex
	Thickness		Thickness 3 mm for pipe dia. upto 250 mm
			6 mm for main pipe dia above 250 mm
			10 mm for main pipe dia. 500 & above
	Carrier ring		Required as per process requirement
	Material of branch pipe		Same as main pipe
	Root valve type		Globe
	Root valve material		316 SS, for sea water application SS duplex
	Root valve size		1 inch
	Impulse pipe of same material up to root valve		Required
2.9	**DATASHEET - SOLENOID VALVE**		
	Type		2/3/4 way SS 316/Forged Brass (depending on the application subject to Employer's approval during detailed Engg.)
	Power supply		24 V DC + 10%.
	Electrical connection		Plug and socket
	Insulation		Class 'H'
	IP Class		IP65
	Limit switches (for open/close feedback)		Required
2.10	**DATASHEET - LIMIT SWITCH**		
	Type		Inductive proximity type
	Mounting arrangement		Inside the enclosure
	Operating voltage Range	V	10-40 V DC
	Sensing system		Inductive Proximity type , 2 Wire
	Sensor Contact Type		NO
	Reverse polarity and short circuit protection		Yes
	IP Class-Sensor		IP67
	IP Class-Enclosure(Switch box)		IP67
	Cable entry-Enclosure(Switch box)		2 no-1/2" NPT
	Casing material-Sensor		Brass /SS
	Enclosure(Switch box) Housing material		FRP or SS
	Operating Ambient temp(sensors)	DegC	-5 to 70 deg C
	Max allowed Voltage Drop across sensor	V	5 V
	Standard applicable		EN 60947-5-2 or equivalent.
	Applicable for		Manual valves and solenoid operated on-off valves
2.11	**LOCAL INSTRUMENT ENCLOSURE AND LOCAL INSTRUMENT RACK**		
	Scope		LIE and LIR complete with all fittings, mountings & accessories, drains and utility lighting, cable & grounding cable etc.
	Construction		

	Rack	mm	1.6mm sheet plate
	Frame	mm	3mm thick channel frame of steel
	Free standing type		Yes
	Canopy		Yes, >=3mm thick steel, extended beyond the ends of the rack.
	Degree of Protection		IP-55 for LIE & JB of LIE/LIR
	Junction Box		Applicable
2.12	**JUNCTION BOX**		
	No. of ways		12/24/36/48/64/72/96/128 with 20% spare terminals.
	Material		4mm thick fibre glass reinforced polyester.
	Type		Screwed at all four corners for door. Door handle shall be self locking with common key. Door gasket shall be of synthetic rubber.
	Mounting clamps and structures etc		Suitable for mounting on walls columns
	Accessories		The brackets, bolts, nuts, screws, double compression glands and lugs required for erection shall be of brass, included in Bidders scope of supply. Race ways for routing of cables inside JBs shall be provided.
	Type of TB		Rail mounted maxi termi or cage-clamp type suitable for terminal conductor size upto 2.5mm2. A M6 earthing stud shall be blocks provided.
	Protection class		IP:65 minimum and Explosion/Flame Proof as per area classification
	Grounding		To be provided
	Color		Outside - RAL 7035, inside - Glossy White
	Spare Terminals		At least 20% unused terminals
2.13	**DATASHEET - VARIABLE FREQUENCY DRIVE (VFD)**		
2.13.1	**OPERATING CONDITIONS**		
	Ambient Temperature		50 Deg
	Relative Humidity		95% at 40DegC
	Rated frequency		50 Hz with a variation of +3% & -5%, and 10% variation of input supply voltage
	Voltage level for the VFD output to be fed to motor (Upto 400 kW)		415V/690V, Low Voltage, Three Phase AC (LV VFD)
2.13.2	**SYSTEM DESCRIPTION**		
	Type of drive		3-Phase Diode / Thyristor / Multi Stage IGBT / IGCT / SGCT/ IEGT
	Type of Cooling of VFD		Naturally air cooled/forced air cooled/Liquid cooled
	Converter Type		Full wave diode rectifier/active front end type
	Inverter Type		Thyristor/IGBT/IGCT/SGCT/IEGT
2.13.3	**GENERAL REQUIREMENTS**		
	Design		Modern proven design in power plant/industry
2.13.4	**TECHNICAL AND OPERATIONAL REQUIREMENTS**		
	System Design		shall be designed to deliver the motor input current and torque for the complete speed torque characteristics of the driven equipment, with worst input supply voltage and frequency variation.
			shall be suitable for the load characteristics and the operational duty of the driven equipment
	Overload capacity of the controller :		
	- for constant torque applications		150% of the rated current for one minute

	- for variable torque applications at rated voltage		110% of rated current for one minute
	- If the motor load exceeds the limit		Automatically reduction of the frequency and voltage to the motor to guard against overload.
	- If the load demand exceeds the current limit for more than 1 minute		shutdown to prevent overheating of motor and damage to drive.
	Operating modes		Variable torque changing as a function of speed / Constant torque over a specific speed range / Constant power over a specific speed range / Any other
	Total harmonic voltage and current distortion limits		shall comply to IEEE 519 & IEC 61800-4
	Withstanding power		capable of thermal, dynamic stresses and transient mechanical torque, resulting from short circuit.
	Damage control		Any damage resulting from short circuit or internal fault shall be limited to the component concerned.
	Allowable speed variation		within range 10-100% or as per the requirement of driven equipment with speed set accuracy of +1% of rated maximum speed and steady state regulation of +0.5% of rated speed as per system requirement
	Power Factor for LV VFD		0.95 (minimum)
	Maximum allowable audible noise		85 dB (A) at a distance of one meter under rated loaded with all cooling fan operating conditions.
	Circuit components protection		Suitably protected against over voltages, surges, lightning etc.
	Programmed warning and fault protection function		Display a message in complete English words or Standard English abbreviations
2.13.5	**VFD COMPATIBILITY WITH THE MOTOR**		
	Inherent output harmonic resonance		shall not be present in operating speed range
2.13.6	**BYPASS ARRANGEMENT (Optional)**		
	Bypass mode		operation of Motor with VFD bypassed
	Bypass mode operation		During starting (under rated conditions) the motor will be switched on in VFD Mode to limit the starting current and after gaining speed, the load would be switched over to bypass mode.
	Comprehensive motor protection scheme for		Shall be decided during detailed engineering
2.13.7	**STANDBY VFD ARRANGEMENT (Optional)**		
	Common standby arrangement with auto/manual switchover		Required
	Changeover module		Complete protection, interlocks & control required
2.13.8	**COOLING SYSTEM**		
	Type		Air cooled Design
	Air-flow pressure switches		Required for monitoring purpose
	Temperature detectors		Required for monitoring purpose
	Cooling fans		Integral to the VFD/ enclosure, If the fan fails, the system must generate the alarm/trip for the fan failure
2.13.9	**MOTOR**		
	Type		Suitable for VFD application
	Power Supply Requirement		Solid state power supply consisting of an adjustable frequency inverter for speed control
			Motor shall be suitable for the current waveforms produced by the power supply including the harmonics generated by the drive.
	Motor Insulation design		To accept the applied voltage waveform, within the Vpeak and dv/dt limits as per IEC-61800
2.13.10	**OUTPUT FILTER (AS APPLICABLE):**		
	Output/ dv/dt filter		Required for protection of motor from high voltage dv/dt stress, independent of cable length to motor.
			Shall be included within the VFD enclosure

2.13.11	**DC LINK CAPACITOR :**		
	Type		self-healing film or electrolytic type having high life time.
	Discharge resistors		Required, shall be capable of reducing the residual charges to zero just after the capacitor is disconnected from the supply source.
	Suitable for high ripple currents		Yes
2.13.12	**AC/DC Reactor (As applicable)**		
	Type		Dry type, air cored, self cooled, indoor type. Suitable for withstanding earth fault continuously
	Noise level		shall not exceed value specified in NEMA TR-1
2.13.13	**VFD PANEL REQUIREMENTS**		
	Upstream breaker indications		Required for "ON/OFF/TRIP"
	Push buttons		Required for remote breater closing and trip
	Cable entry		bottom of the panel with a removable bolted un-drilled gland plate.
	Enclosure Design Criteria		shall avoid harmonic and inductive heating effects and to shield any outside equipment from interference, to eliminate any radio frequency interference
	Protection against electromagnetic emissions		To be provided
	Ventilation using air filters and fans/pumps		Required, to ensure that maximum temperature inside the cubicle is within permissible limits for reliable and continuous operation of the system.
	Construction		
	Type		Skid mounted
	Construction		Folded
	Devices & equipments		Panel enclosure, semi conducting power devices (Diodes/IGBT).modules with protective devices, reactors (if required), filters (if required), control circuit, secondary instruments, annuniciation system, selector switch, push buttons, indicating lamps/ LED cluster, relays, MCBs, clamp on terminals, plug socket, panel light, space heater, nameplate, earth bus etc.
	Enclosure sheet material		Cold rolled sheet steel
	Enclosure sheet thickness		Minimum 3.0 mm for load bearing sections (mounted with instruments)
			2.0 mm for doors
			Minimum 2.0 mm for other sections
	Height		Minimum 1100 mm
	Frame thickness		Minimum 3.0 mm
	Internal plate thickness		2.5 mm
	Gland plate thickness		3.0 mm
	Class of protection		IP-41
2.13.14	**Power & control supply**		
	Input power supply		415V 3 phase AC
	No. Of feeders		Two
	Control supply		230V AC
	Additonal requirement for control supply		MCBs
			Supervisory relay along with a pilot lamp to indicate control supply 'on'
			Auto changeover unit mounted on panel

2.13.15	**Internal wiring**		
	Material & size		PVC insulated copper multi strand wire /flexible of 1.5mm2, power cable 2.5sqmm
	Routing and runs		Through PVC troughs, AC & DC wires shall be kept separately
	Colour		Separate colours for AC & DC wires
2.13.16	**Terminal block**		
	Type		Clip on, separate for AC & DC circuits
	Tb points		Cage clamp
	Mounting height from finished floor	mm	>=250 mm
	Spare	%	20%
	Identification strip		To be provided
2.13.17	**Illumination**		
	Light		Led tubelight / 11W CFL with switch and fuse
	Operating power supply		240V 50 Hz AC, 5/15A
2.13.18	**Earthing studs**		
	Copper earth bus size		50 x 6mm
	Provision for connection to plant earth grid		Required
	Insulation		Perspex type transparent insulating material for covering live compartments.
2.13.19	**Mounting devices on panel**		
	On front side		All operable and indicating devices
	Inside panel		Aux. Relays, terminal, PVC trough, MCBs etc.
	Easy access for operation / maintenance.		Required
2.13.20	**LT & HT CABLES**		Required, suitable for VFD system
2.13.21	**CONTROL AND PERFORMANCE REQUIREMENTS**		
	Automatic current limiting feature		Required, to control motor currents during startup and provide a “soft start” torque profile for the motor load combination.
	VFD induced torque pulsation		shall be limited to maximum 1% (even at low speed)
	Current and torque limit adjustments		Required
	Drive Speed control		Local or Remote mode
	Local / Remote selection provision		from VFD panel
	Parameter Monitoring/ metering		- Input and output voltage of Drive - Input and output current of Drive - Motor speed - Input and output power frequency of Drive - Torque - Output kWhr of Drive - Motor thermal state - Drive Thermal state - DC link voltage - Hour run - Run/stop and local/remote status displayed

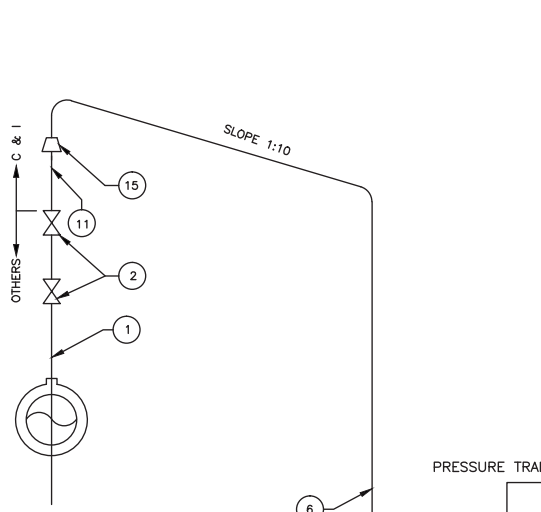
	Indicators on Operator control panel		i. Motor running ii. Motor stopped iii. VFD System Fault iv. System ready to start v. AC mains ON vi. Motor over speed vii. Rectifier output 'ON' viii. Motor zero speed ix. Rectifier breaker trip
	Audio visual annunciation (Common potential free contacts shall be provided, shall be provided on the front of the panel)		i. Rectifier fuse failure ii. Main AC failure iii. Inverter fuse failure iv. Inverter overload v. Inverter high temperature vi. Cooling system failure vii. Motor failed to start viii. transformer failure ix. Battery monitoring healthiness x. Communication and measurement system unhealthy xi. Motor temperature high xii. Harmonic filters monitoring
	Operator console panel features		front mounted
			backlit alphanumeric display
			a keypad with keys for parameterization and adjusting parameter
			facility / port to connect external hardware
			Upload and download of all parameter settings from one drive to another drive for start up and operation
			User-friendly licensed software for operation and fault diagnostic
	Protection features		i) Converter transformer: short circuit, over current, earth fault & winding temperature high protection.
			ii) Incoming and outgoing line surge protection.
			iii) Under / over voltage protection
			iv) Phase loss, phase reversal, overload, negative phase sequence, locked rotor protection.
			v) Instantaneous Over current & Earth fault protection
			vi) Converter/Inverter module failure indication.
			vii) Over frequency/speed protection.
			viii) Ventilation failure indication & alarm.
			ix) Over temperature of VFD
			x) Bearing temperature protection.
			xi) System earth fault protection.
			xii) Speed reference loss protection.
	Controls for VFD (on the front panel door)		Start / stop (in local/remote mode)
			Speed control (Raise / lower)
			Acknowledge/Accept/ Test Push Button for annunciation
			Auto / Manual / Test Mode select
			Emergency stop
			Sequential switching of filters
			Local / Remote
			Trip-Remote Breaker
2.13.22	**FAULT DIAGNOSTIC**		Information regarding failure of any of the system including shut down of the system shall be available for a period of minimum 4 days.
			It shall be possible to retrieve the record of events prior to tripping of the system or de-energization.
			Auxiliary supply to the system components or to the electronics (firmware) for the diagnostics / display shall be taken care of by the manufacturer for this purpose.

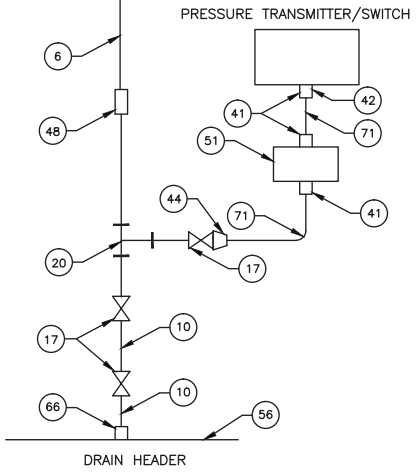
2.13.23	**RELIABILITY**		Expected lifetime of the drive shall be 25 years. minimum MTBF of 4 years for the system including all component.
	MAINTAINABILITY		Modular construction All power components in the converter sections shall be designed for rack-out accessibility for ease of maintenance and to minimize repair downtime
2.13.24	**PAINTING**		
	Through cleaning of all metal surfaces and degreasing		Required
	Preparation of under surface		Apply a coat of phosphate paint and a coat of yellow zinc chromate primer. The undersurface shall be made free from all imperfections before undertaking the finishing coat.
	After preparation of under surface		the panel shall be provided with epoxy based powder coating. Panel finish shall be free from imperfections like pinholes, orange peels, runoff painted.
	All unpainted steel parts		shall be zinc passivated, cadmium plated or suitably treated to prevent rust and corrosion. If these parts are moving elements, then these shall be greased.
	Final paint shade		shall be of Grade 631 of IS 5.
2.13.25	**TESTING & INSPECTION**		All tests shall be carried out at the manufacturer's works under his care and expense. The tests shall be witnessed by an inspector of the owner or an agency authorized by the owner. Prior notice of minimum of 4 weeks shall be given to the inspector for witnessing the test.

2.13.26	**ROUTINE TEST**		It involves checking of the various equipment's/components fault diagnostic unit, wiring, terminals, earthing ratings etc., in line with the approved drawings and visual inspection shall not be limited to the following; a) Dimensions and door layout Vis-à-vis the approved drawings b) Degree of protection of cubicles c) Simulation facility of control signals for testing purposes d) Memory function of fault diagnostic e) Voltage/Current rating power semiconductor elements f) Cable termination size and number of terminals, cable-supporting etc. g) Accessibility of components h) v External signals and indication/alarm signals on converter i) Earthing of cubicles and cubicle doors ii. Insulation Test iii. Light load and functional test iv. Load characteristics test v. Load duty test vi. Checking of Auxiliary devices vii. Checking the properties of the control equipment viii. Checking the protective devices ix. Checking of control and functional requirements x. High voltage test xi. Shaft current/bearing insulation
2.13.27	**TYPE TEST** (type test shall be performed on one system of each rating and type unless otherwise agreed between purchaser and manufacturer)		i. Allowable full load current versus speed ii. Efficiency iii. Temperature rise iv. EM Immunity v. EM Emission vi. Current sharing vii. Voltage division viii. Line side current distortion content ix. Power factor x. Audible noise xi. torque pulsation xii. Motor vibration xiii. Dynamic performance xiv. Current limit and current loop test xv. Speed loop test capability to ride through voltage less than 80% xvi. Test capability to restart the system and resynchronize converter onto running motor after a voltage interruption Type test certificate from independent testing agency for similar equipment can be accepted for d, e, f,
2.14	**PROCESS CONNECTION**		
2.14.1	**Impulse Tubing**		
	Low pressure and Low temperature services(Water)		Seamless carbon steel piping to STM A106 Gr.B
2.14.2	**Fittings Double compression type**		
	Material for socket weld fittings		ASTM A105 ASTM A182, Gr. F22 6000/3000 lbs
	Dimensions of fittings		ANSI B16.11

2.14.3	**Valves**		
	3-way valves		SS body/Forged CS body stellated internals and SW ends as per requirement for 2500 lb/600 lb ASA ratings.
	3-valve/5- valve manifolds		FAS body/FCS body 316SS stellated internals with NPT(F) SCRD ends for 2500 lb/1500 lb/600 lb ASA ratings.
	2-valve manifolds		FCS body, 316SS stellated internals, NPT(F) SCRD ends.
	Isolation and drain valves		Globe valves with FAS
2.14.4	**Flexible conduits with fittings**		Lead coated, paper insulated, heat resistant flexible metal conduits with necessary fittings.
2.14.5	**Instrument piping shall not be routed through**		a) Across equipment removal areas b) Below mono-rails and cranes c) Above or below removable gratings d) Above or below cable trays.
3.0	**INSPECTION/TESTING**		
3.1	Type Test requirement		Yes
	Item-1		Electronic Transmitters
	Test & Standard -1		As per Standard, BS-6447 / IEC-60770
	Item-2		Control Valve
	Test & Standard -2		CV Test, ISA 75.02 & 75.11
	Item-3		Orifice Plate
	Test & Standard -3		Calibration, ISO 5167
	Item-4		Junction Boxes
	Test & Standard -4		Degree of Protection test, IS-13947
	Test to be specifically conducted (for item1,2,&3)		No
	Customer’s approval required. on Test certificate (for item1,2,&3)		Yes
	Item-5		Pressure gauge
	Test & Standard -5.1		Degree of Protection test, IS-2147
	Test & Standard -5.2		Temp interference test, IS -3624
	Item-6		Temperature gauge
	Test & Standard -6		Degree of Protection test, IS-13947
	Test to be specifically conducted (for item 5 &		No
	Customer’s approval required. on Test certificate (for item 5 & 6)		No

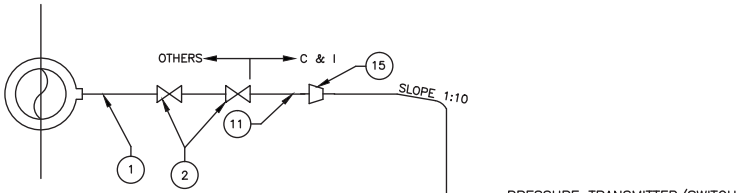
INSTRUMENT HOOK UP DIAGRAM

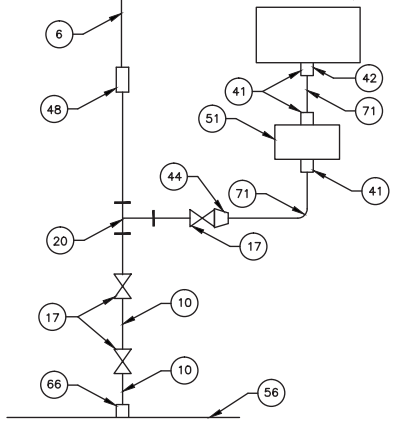




TRANSMITTER MOUNTED BELOW
INSTRUMENT SOURCE POINT

FIG–A





TRANSMITTER MOUNTED BELOW
INSTRUMENT SOURCE POINT

FIG–B

NOTES:–

1. FOR HIGH TEMP. SERVICE (MORE THAN 80°C) A 'U'–TUBE / SYPHON (REF. SHEET NO. 15) SHALL BE PROVIDED BETWEEN THE MANIFOLD AND THE TRANSMITTER/SWITCH.
2. FOR PRESSURE LESS THAN 40KG, ROOT VLV. OF SIZE 1/2"SW, NIPPLE PIECE(11), 1 TO 1/2"SW REDUCER(15) & ISOLATION VALVE(17) ARE NOT REQUIRED.
3. FOR SWITCHES PROCESS CONNECTION SHALL BE NPT(M) & HENCE SL.NO:41 SHALL BE REPLACED BY SL.NO:42.
4. FOR SEA WATER & SLURRY APPLICATION SS SUPER DUPLEX SHALL BE CONSIDERED.
5. FOR LIME STONE SLURRY BASED & SEA WATER APPLICATIONS FLUSH RING & DRAINS SHALL BE PROVIDED.

TAG NO.	DESCRIPTION	QTY. A	QTY. B
71	1/2"OD IMPULSE TUBE, SS–316/SS SUPER DUPLEX	AS REQD.	
66	1/2" GI SOCKET	1	1
56	2"NB GI DRAIN HEADER	AS REQD.	
51	3 VALVE MANIFOLDS, SS–316	1	1
48	1/2"SW,CS/AS BULK HEAD PIPE UNION	1	1
44	1/2"SW X 1/2"OD COMRESSION TUBE FITTING, SS–316/SS SUPER DUPLEX	1	1
42	1/2"NPT(F) X 1/2"OD TUBE COMPRESSION FITTING, SS–316/SS SUPER DUPLEX	1	1
41	1/2"NPT(M) X 1/2"OD TUBE COMPRESSION FITTING, SS–316/SS SUPER DUPLEX	3	3
20	1/2"SW EQUAL TEE,CS	1	1
17	1/2" SW,CS GLOBE VALVE / NEEDLE VALVE	3	3
15	1" TO 1/2" SW REDUCER	1	1
11	1" NPS SCH–80 CS/AS NIPPLE/SS SUPER DUPLEX	1	1
10	1/2" NPS,SCH 80/160, CS/AS NIPPLE/SS SUPER DUPLEX	2	2
6	1/2" NPS. SCH–80/160 CS/ AS PIPE/SS SUPER DUPLEX	AS REQD.	
2	1" ROOT VALVE	2	2
1	1" CARBON/ALLOY STEEL NIPPLE OF MTL. SAME AS THAT OF MAIN PIPE(AS PER PROCESS REQD.)	AS REQD.	

REV.	DATE	DESCRIPTION	DRN.	STR.	MECH.	ELEC.	INST.
				APPROVED BY			
0C	21.01.19	BASED ON COMMENTS	RV				KA
0B	20.12.18	BASED ON COMMENTS	RV				KA
0A	12.05.17	TENDER PURPOSE	KK				KA

PROJECT :

1 x 800MW NORTH CHENNAI TPP STAGE -III
FGD PACKAGE

OWNER :

TAMILNADU GENERATION & DISTRIBUTION CORPORATION LIMITED
CHENNAI-600 002, TAMILNADU, INDIA

OWNER'S ENGINEER

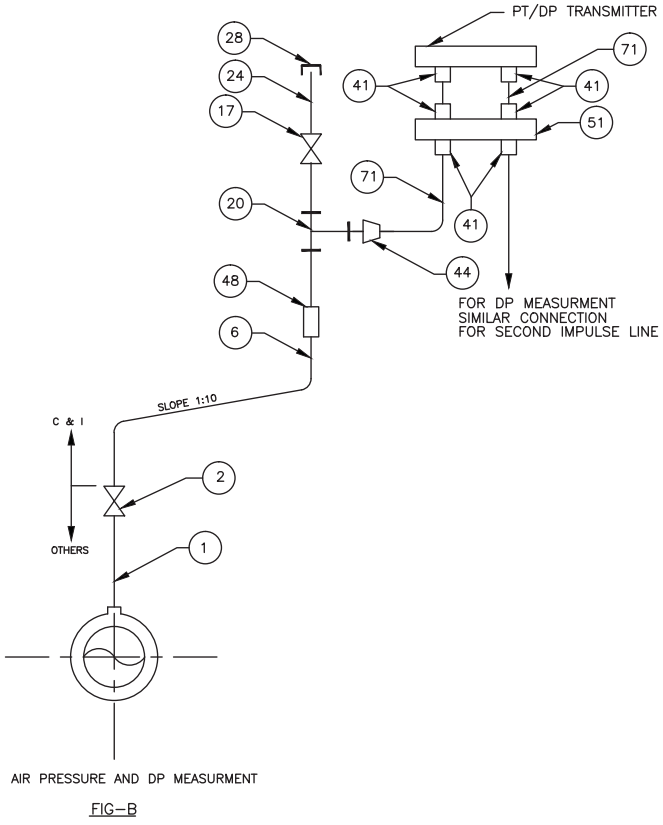
FICHTNER INDIA

FICHTNER Consulting Engineers (India) Private Limited
Chennai

	SIGNATURE	DATE
DRAWN	RV	21.01.19
DESIGNED	KRK	21.01.19
CHECKED	KRK	21.01.19
DEPT.HEAD	KA	21.01.19
PROJ.MGR.	SSR	21.01.19

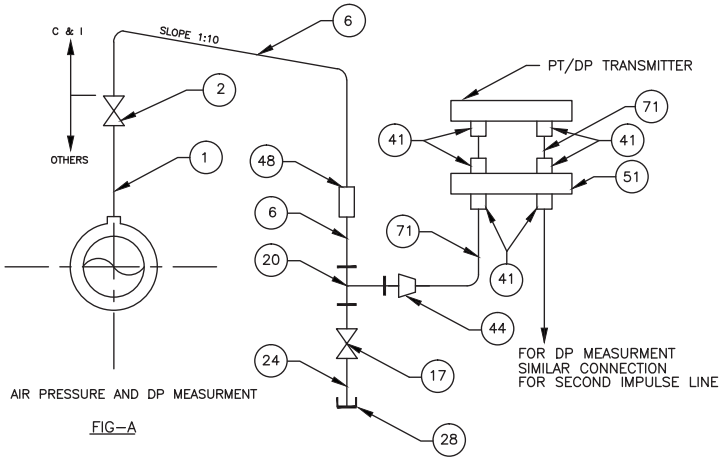
INST. DRAWING FOR PRESSURE & DIFFERENTIAL PRESSURE TRANSMITTER /SWITCH(STEAM & LIQUID SERVICE) – 1

RELEASED FOR			DEPT. C&I	JOB NO. 1116127	SCALE: NTS	REV.
	PRELIMINARY					
	TENDER	✓	DWG.NO. ANNEXURE–7			0C
	ENGINEERING					
	CONSTRUCTION					



AIR PRESSURE AND DP MEASURMENT

FIG–B



AIR PRESSURE AND DP MEASURMENT

FIG–A

NOTES:–

1. QUANTITY IN COLUMN A & B TO BE DOUBLED FOR DP TAPPING EXCEPT ITEM NO. 51
2. FOR INSTRUMENT AIR SERVICE, SL.NO 1 & 2 PIPE, ROOT VALVE SHALL BE SCREWED END AND ADDITIONAL CONNECTOR 1/2" SW X NPT(M) SHALL BE PROVIDED.

TAG NO.	DESCRIPTION	QTY. A	QTY. B
71	1/2"OD IMPULSE TUBE,SS–316	AS REQD.	
51	3/5 VALVE MANIFOLDS, SS–316	1	1
48	1/2" SW, CS/AS BULK HEAD PIPE UNION	1	1
44	1/2" SW X 1/2"OD TUBE FITTING, SS–316	1	1
41	1/2" NPT(M) X 1/2"00 TUBE COMPRESSION FITTING ,SS–316	6	6
28	1/2" NPT(F) CS CAP	1	1
24	1/2" NPS, SCH–80 X 1/2"NPS(M)CS NIPPLE	1	1
20	1/2" SW, EQUAL TEE, CS	1	1
17	1/2" SW, CS GLOBE VALVE	1	1
6	1/2" NPS. SCH–80 CARBON STEEL PIPE	AS REQD.	
2	1/2" ROOT VALVE – SW GLOBE VALVE	1	1
1	1/2" CARBON STEEL NIPPLE OF MTL. SAME AS THAT OF MAIN PIPE(AS PER PROCESS REQD.)	AS REQD.	

BILL OF MATERIAL

REV.	DATE	DESCRIPTION	DRN.	STR.	MECH.	ELEC.	INST.
				APPROVED BY			
0C	21.01.19	BASED ON COMMENTS	RV				KA
0B	20.12.18	BASED ON COMMENTS	RV				KA
0A	12.05.17	TENDER PURPOSE	KK				KA

PROJECT :

1 x 800MW NORTH CHENNAI TPP STAGE -III
FGD PACKAGE

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CHENNAI-600 002, TAMILNADU, INDIA

OWNER'S ENGINEER

FICHTNER INDIA

FICHTNER Consulting Engineers (India) Private Limited
Chennai

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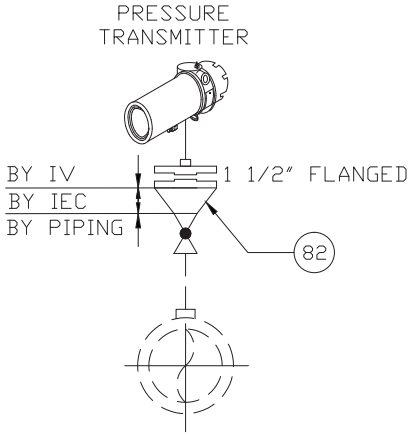
DESIGNED	KRK	21.01.19
CHECKED	KRK	21.01.19
DEPT.HEAD	KA	21.01.19
PROJ.MGR.	SSR	21.01.19

INST. DRAWING FOR PRESSURE & DIFFERENTIAL PRESSURE TRANSMITTER (AIR SERVICE)

RELEASED FOR			DEPT. C&I	JOB NO. 1116127	SCALE: NTS	REV.
	PRELIMINARY					
	TENDER	✓	DWG.NO.	ANNEXURE–7		0C
	ENGINEERING					
	CONSTRUCTION					



82	1"x1 1/2" CS EXPANDER, SW, SS316	1
TAG NO.	DESCRIPTION	QTY.
	BILL OF MATERIAL	

REV.	DATE	DESCRIPTION	DRN.	STR.	MECH.	ELEC.	INST.
				APPROVED BY			
0C	21.01.19	BASED ON COMMENTS	RV				KA
0B	20.12.18	BASED ON COMMENTS	RV				KA
0A	12.05.17	TENDER PURPOSE	KK				KA

PROJECT :

1 x 800MW NORTH CHENNAI TPP STAGE -III
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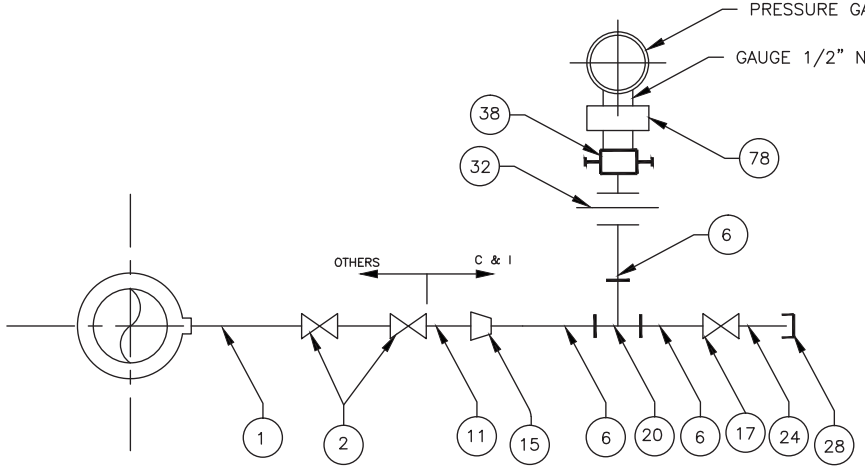
DEPT.HEAD	KA	21.01.19
PROJ.MGR.	SSR	21.01.19

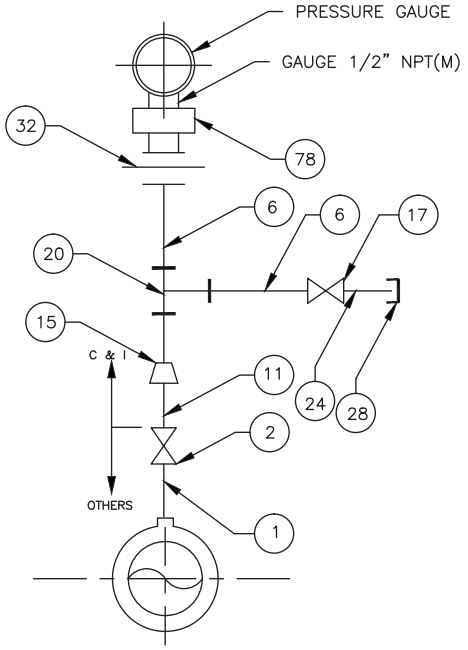
INST. DRAWING FOR
PRESSURE TRANSMITTERS
DIAPHRAGM SEAL TYPE

RELEASED FOR			DEPT. C&I	JOB NO. 1116127	SCALE: NTS	REV.
	PRELIMINARY					
	TENDER	✓	DWG.NO. ANNEXURE–7			0C
	ENGINEERING					
	CONSTRUCTION				SHEET: 06 OF 17	



STEAM/LIQUID SERVICE

FIG–A



AIR SERVICE

FIG–B

NOTE:–

1. FOR PRESSURE LESS THAN 40KG, ROOT VLV. OF SIZE 1/2"SW, NIPPLE PIECE(11) & 1 TO 1/2"SW REDUCER(15) ARE NOT REQUIRED.
2. BIDDER HAS TO PROVIDE SNUBBER AS REQUIRED.
3. FOR SEA WATER & SLURRY APPLICATION SS SUPER DUPLEX SHALL BE CONSIDERED.
4. FOR LIME STONE SLURRY BASED & SEA WATER APPLICATIONS FLUSH RING & DRAINS SHALL BE PROVIDED.

BILL OF MATERIAL

TAG NO.	DESCRIPTION	QTY. A	QTY. B
20	1/2"SW EQUAL TEE, CS/AS	1	1
17	1/2" SW CS/AS GLOBE VALVE	1	1
15	1" TO 1/2" SOCKET WELDED REDUCER	1	1
11	1" NPS SCH–80/160 CS/AS NIPPLE/SS SUPER DUPLEX	1	1
6	1/2" NPS. SCH–80/160 CS/ AS PIPE/SS SUPER DUPLEX	AS REQD.	
2	1/2"/3/4"/1" ROOT VALVE–SW GLOBE VALVE	2	1
1	1/2"/3/4"/1" CARBON/ALLOY STEEL NIPPLE OF MTL. SAME AS THAT OF MAIN PIPE(AS PER PROCESS REQD.)	AS REQD.	

BILL OF MATERIAL

TAG NO.	DESCRIPTION	QTY. A	QTY. B
78	1/2"NPT(F)X1/2"NPT(M) SNUBBER/PULSATION DAMPER AS APPLICABLE	1	1
59	1/2"SW, STRAIGHT PIPE CONNECTOR, CS/AS	AS REQD.	
38	3 WAY GAUGE VALVE 1/2" NB SW	1	–
37	6" COILED SYPHON SCH 80/160 1/2"NB CS/SS	AS REQD.	
32	1/2"NPS,3PIECE PIPE UNION WITH 1/2"NPT(F) SCREWED	1	1
28	1/2"NPT (F) CS CAP	1	1
24	1/2"NPS,SCH–80/160X1/2"NPT(M)CS/AS NIPPLE	1	1

REV.	DATE	DESCRIPTION	DRN.	STR.	MECH.	ELEC.	INST.
0C	21.01.19	BASED ON COMMENTS	RV				KA
0B	20.12.18	BASED ON COMMENTS	RV				KA
0A	12.05.17	TENDER PURPOSE	KK				KA

APPROVED BY

PROJECT :

1 x 800MW NORTH CHENNAI TPP STAGE -III
FGD PACKAGE

OWNER :

TAMILNADU GENERATION & DISTRIBUTION CORPORATION LIMITED
CHENNAI-600 002, TAMILNADU, INDIA

OWNER'S ENGINEER

FICHTNER INDIA

FICHTNER Consulting Engineers (India) Private Limited
Chennai

	SIGNATURE	DATE
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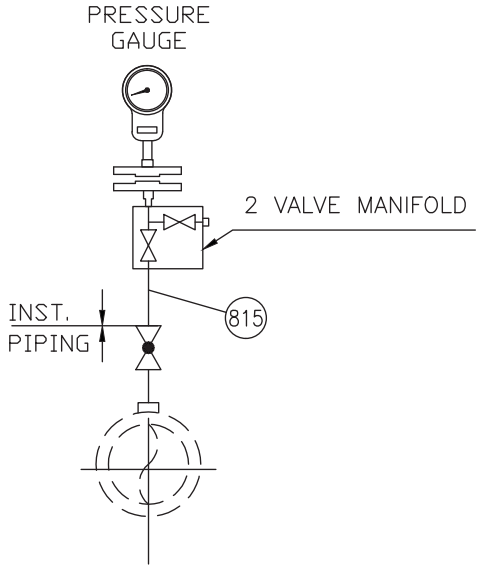
DESIGNED	KRK	21.01.19
CHECKED	KRK	21.01.19
DEPT.HEAD	KA	21.01.19
PROJ.MGR.	SSR	21.01.19

INST. DRAWING FOR LOCAL PRESSURE GAUGE

RELEASED FOR					
	PRELIMINARY		DEPT. C&I	JOB NO. 1116127	SCALE: NTS
	TENDER	✓	DWG.NO. ANNEXURE–7		REV. 0C
	ENGINEERING				
	CONSTRUCTION				

PRESSURE GAUGE WITH DIAPHRAGM SEAL



NOTE:–

1. 2 VALVE INTEGRAL MANIFOLD SHALL BE THE PART OF INSTRUMENT VENDOR SCOPE.
2. SNUBBER SHALL BE PROVIDED FOR PUMP DISCHARGE APPLICATION.
3. DIAPHRAGM SEAL SHALL BE PROVIDED FOR CHEMICAL/OILY WATER APPLICATION.

TAG NO.	DESCRIPTION	QTY.
	BILL OF MATERIAL	
1	NIPPLE (100mm), 1/2" NPTM X SW, SCH 80, SS316	1

REV.	DATE	DESCRIPTION	DRN.	STR.	MECH.	ELEC.	INST.
				APPROVED BY			
0C	21.01.19	BASED ON COMMENTS	RV				KA
0B	20.12.18	BASED ON COMMENTS	RV				KA
0A	12.05.17	TENDER PURPOSE	KK				KA

PROJECT :

1 x 800MW NORTH CHENNAI TPP STAGE -III
FGD PACKAGE

OWNER :

TAMILNADU GENERATION & DISTRIBUTION CORPORATION LIMITED
CHENNAI-600 002, TAMILNADU, INDIA

OWNER'S ENGINEER

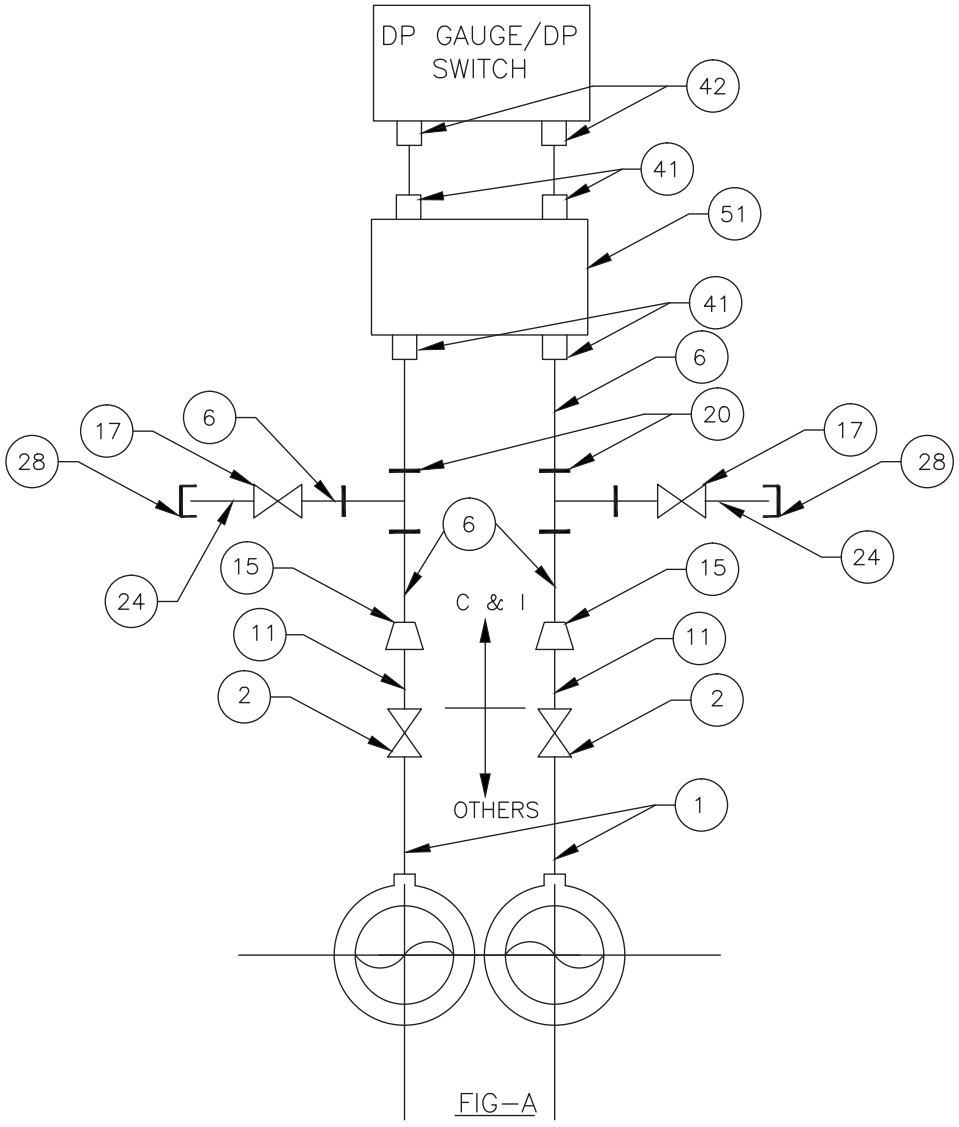
FICHTNER INDIA

FICHTNER Consulting Engineers (India) Private Limited
Chennai

	SIGNATURE	DATE
DRAWN	RV	21.01.19
DESIGNED	KRK	21.01.19
CHECKED	KRK	21.01.19
DEPT.HEAD	KA	21.01.19
PROJ.MGR.	SSR	21.01.19

INST. DRAWING FOR LOCAL PRESSURE GAUGE DIAPHRAGM SEAL TYPE

RELEASED FOR			DEPT. C&I	JOB NO. 1116127	SCALE: NTS	REV.
	PRELIMINARY					
	TENDER	✓	DWG.NO. ANNEXURE–7			0C
	ENGINEERING					
	CONSTRUCTION					



FIG–A

TAG NO.	DESCRIPTION	QTY.
51	3/5 VALVE MANIFOLDS, SS–316	1
42	1/2" NPT(F) X 1/2" OD TUBE COMPRESSION FITTING,SS–316/SS SUPER DUPLEX	2
41	1/2" NPT(M) X 1/2" OD TUBE COMPRESSION FITTING,SS–316/SS SUPER DUPLEX	4
28	1/2" NPT(F) CS. CAP	2
24	1/2" NPS,SCH 80/160 X 1/2" NPT(M) CS/AS NIPPLE/SS SUPER DUPLEX	2
20	1/2"SW EQUAL TEE CS/AS	2
17	1/2" SW,CS/AS, GLOBE VALVE	2
15	1" TO 1/2" SOCKET WELD REDUCER	2
11	1"NPS SCH 80/160 CS/AS NIPPLE/SS SUPER DUPLEX	2
6	1/2"NPS,SCH 80/160 CARBON/ALLOY STEEL PIPE/SS SUPER DUPLEX	AS REQD.
2	1/2"3/4"/1" ROOT VALVE – SW GLOBE VALVE	2
1	1/2"/3/4"/1" CARBON/ALLOY STEEL NIPPLE OF MTL SAME AS THAT OF MAIN PIPE (AS PER PROCESS REQD.)	AS REQD.

NOTE:–

1. FOR PRESSURE LESS THAN 40KG, ROOT VLV. OF SIZE 1/2"SW, NIPPLE PIECE(11) & 1 TO 1/2"SW REDUCER(15) ARE NOT REQUIRED.
2. FOR SEA WATER & SLURRY APPLICATION SS SUPER DUPLEX SHALL BE CONSIDERED.
3. FOR LIME STONE SLURRY BASED & SEA WATER APPLICATIONS FLUSH RING & DRAINS SHALL BE PROVIDED.

REV.	DATE	DESCRIPTION	DRN.	STR.	MECH.	ELEC.	INST.
				APPROVED BY			
0C	21.01.19	BASED ON COMMENTS	RV				KA
0B	20.12.18	BASED ON COMMENTS	RV				KA
0A	12.05.17	TENDER PURPOSE	KK				KA

PROJECT :

1 x 800MW NORTH CHENNAI TPP STAGE -III
FGD PACKAGE

OWNER :

TAMILNADU GENERATION & DISTRIBUTION CORPORATION LIMITED
CHENNAI-600 002, TAMILNADU, INDIA

OWNER'S ENGINEER

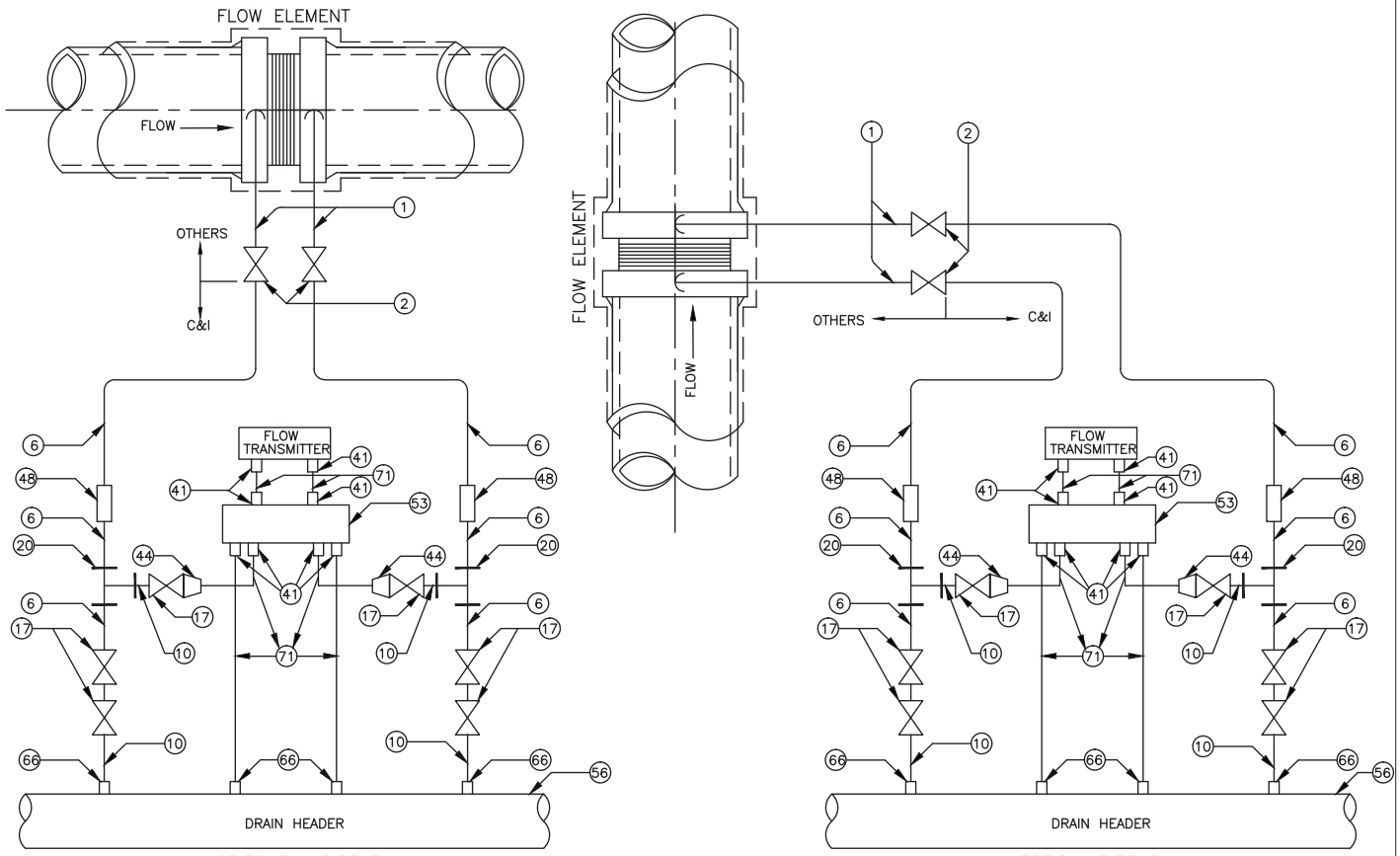
FICHTNER INDIA

FICHTNER Consulting Engineers (India) Private Limited
Chennai

	SIGNATURE	DATE
DRAWN	RV	21.01.19
DESIGNED	KRK	21.01.19
CHECKED	KRK	21.01.19
DEPT.HEAD	KA	21.01.19
PROJ.MGR.	SSR	21.01.19

INST. DRAWING FOR LOCAL PRESSURE & DIFFERENTIAL PRESSURE GAUGE/SWITCH

RELEASED FOR		DEPT. C&I	JOB NO. 1116127	SCALE: NTS	REV.
	PRELIMINARY				
	TENDER	DWG.NO. ANNEXURE–7			0C
	ENGINEERING				
	CONSTRUCTION				



NOTE:–

1. FOR SEA WATER APPLICATION MATERIAL FROM THE FLANGE SHALL BE SS SUPER DUPLEX.

TAG NO.	DESCRIPTION	A	B	TAG NO.	DESCRIPTION	A	B
20	1/2" SOCKET WELDED EQUAL TEE CS/AS	2	2	71	1/2"OD IMPULSE TUBE, SS–316	AS REQD.	
17	1/2" SOCKET WELDED CS GLOBE VALVE	6	6	66	1/2" GI SOCKET / FUNNEL	4	4
10	1/2" NPS SCH 80/160,CS/AS NIPPLE	4	4	56	2"NB GI DRAIN HEADER	AS REQD.	
6	1/2" NPS SCH 80/160 CS/AS PIPE	AS REQD.		53	5–VALVE MANIFOLD, SS–316	1	1
2	1/2" SOCKET WELDED GLOBE VALVE	2	2	48	1/2" SW, CS/AS BULK HEAD PIPE UNION	2	2
1	1/2" NPS SCH 80 NIPPLES OF MATERIAL SAME AS MAIN PIPE WITH NECESSARY ATTACH TO FLANGES	AS REQD.		44	1/2"SWX1/2"OD COMPRESSION TUBE FITTING,SS–316	2	2
				41	1/2"NPT(M)X1/2"OD TUBE COMPRESSION FITTING,SS–316	8	8

REV.	DATE	DESCRIPTION	DRN.	STR.	MECH.	ELEC.	INST.
				APPROVED BY			
0C	21.01.19	BASED ON COMMENTS	RV				KA
0B	20.12.18	BASED ON COMMENTS	RV				KA
0A	12.05.17	TENDER PURPOSE	KK				KA

PROJECT :

1 x 800MW NORTH CHENNAI TPP STAGE -III
FGD PACKAGE

OWNER :

TAMILNADU GENERATION & DISTRIBUTION CORPORATION LIMITED
CHENNAI-600 002, TAMILNADU, INDIA

OWNER'S ENGINEER

FICHTNER INDIA

FICHTNER Consulting Engineers (India) Private Limited
Chennai

	SIGNATURE	DATE
DRAWN	RV	21.01.19
DESIGNED	KRK	21.01.19
CHECKED	KRK	21.01.19
DEPT.HEAD	KA	21.01.19
PROJ.MGR.	SSR	21.01.19

INST. DRAWING FOR FLOW MEASUREMENT

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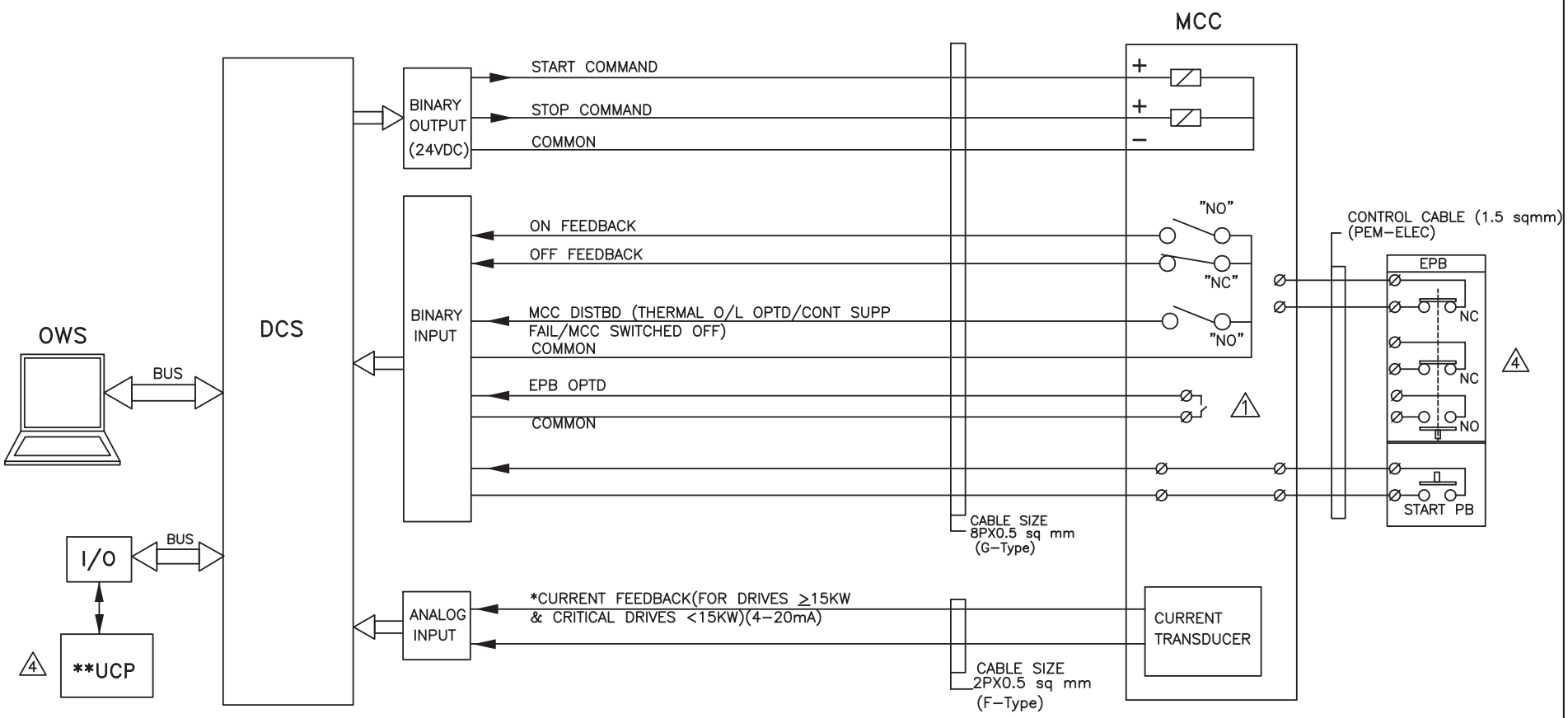
DEPT. C&I | JOB NO. 1116127 | SCALE: NTS | REV.

DWG.NO. ANNEXURE–7 | 0C

DCS INTERFACE FOR UNIDIRECTIONAL LT DRIVE(CONTACTOR OPERATED)



Note: Fibre optical cable is in BHEL Scope.

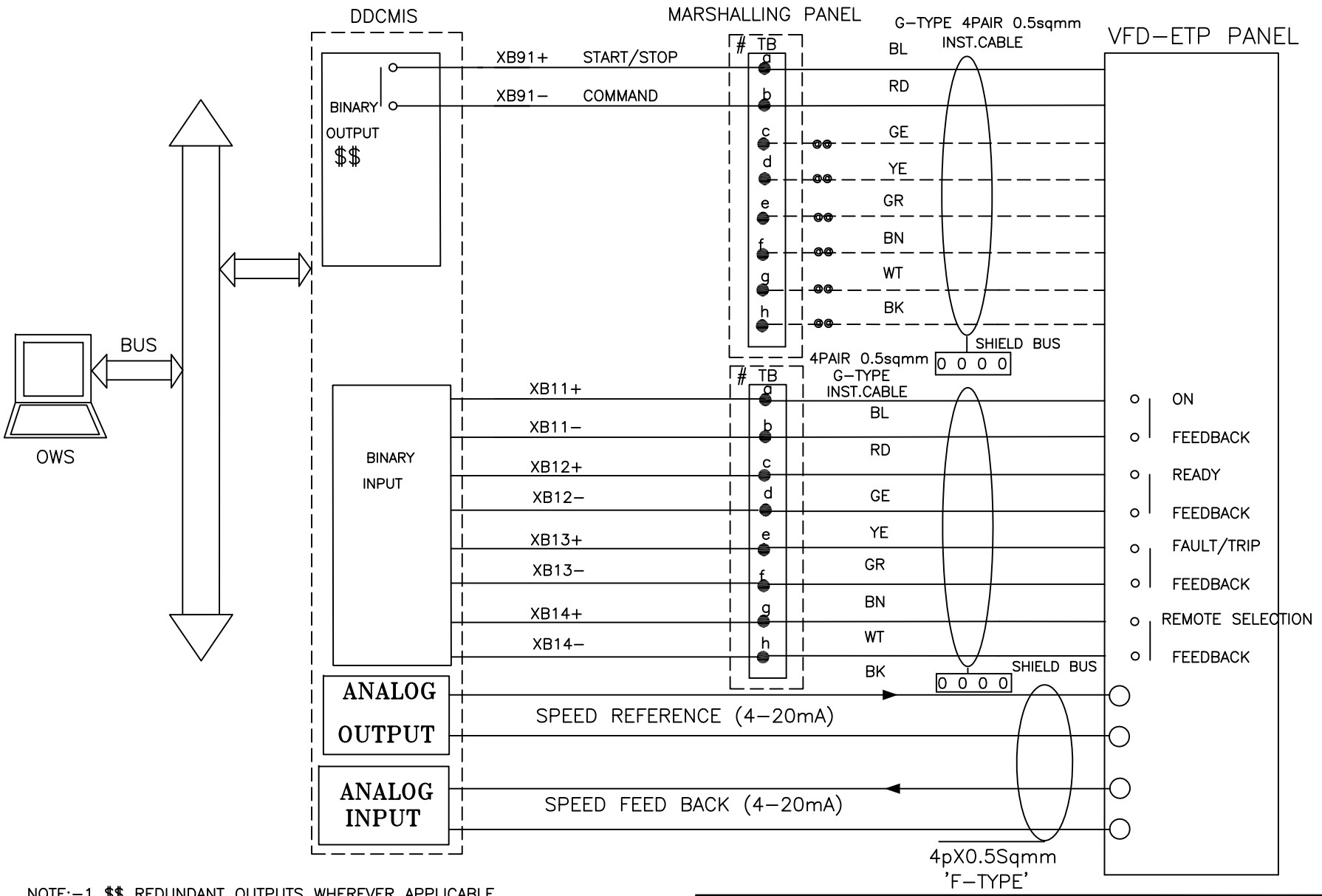
NOTE:

* FOR LTUD DRIVES, 4-20mA CURRENT TRANSDUCER SHALL BE CONSIDERED FOR BARRING GEARINGMOTOR, JOP, AIR HEATER MOTOR, LUBE OIL PUMPS, SCANNER AIR FANS, SEAL AIR FANS as applicable. 4

** FOR ESSENTIAL DRIVES FOR SAFE SHUT DOWN OF PLANT.

BHEL	PROJECT: 1X800 MW TANGEDCO NORTH CHENNAI TPP STAGE III-BTG	DRG.NO.	:PE-DM-423-145-I002
		DATE	31.10.2017
	TITLE DDCMIS INTERFACE FOR UNIDIRECTIONAL LT DRIVE	REV.NO.	06
		SHT	8 OF 11

DDCMIS INTERFACE WITH VFD OF ETP (VFD-ETP)



NOTE:-1 $$ REDUNDANT OUTPUTS WHEREVER APPLICABLE
NOTE:-2 # 8 LEVEL TERMINAL BLOCK
NOTE:-3 @@ INEACH DDCMIS POST,UNUSED TB'S ARE USED FOR SPARE CORE TERMINATION.
NOTE:-4 OTHER VFD SIGNALS WILL BE CONSIDERED AS PER IO LIST.

BHEL	DDCMIS INTERFACE WITH VFD OF ETP (VFD-ETP)	SHT	13 OF 34

LIST OF SCHEDULES

MASTER DRAWING LIST WITH SCHEDULE OF SUBMISSION

SL. No	DOCUMENT / DRAWING NO.	DRAWING / DOCUMENT TITLE	SCHEDULE OF SUBMISSION FROM LOI (WEEK)	SIZE
1.	PE-V0-485-164-A001	P&I DIAGRAM FOR EFFLUENT TREATMENT PLANT	4	A1
2.	PE-V0-485-164-A002	SUB VENDOR LIST FOR EFFLUENT TREATMENT PLANT	8	A4
3.	PE-V0-485-164-A003	LAYOUT PLAN FOR EFFLUENT TREATMENT PLANT	4	A0
4.	PE-V0-485-164-A004	PIPING LAYOUT FOR EFFLUENT TREATMENT PLANT	10	A0
5.	PE-V0-485-164-A005	CABLE TRAY/TRENCH & CONDUIT ROUTING DIAGRAM AND EARTHING LAYOUT OF EFFLUENT TREATMENT PLANT	10	A1
6.	PE-V0-485-164-A006	CONTROL PHILOSOPHY FOR EFFLUENT TREATMENT PLANT	8	A4
7.	PE-V0-485-164-A007	PROCESS SIZING CALCULATIONS FOR EFFLUENT TREATMENT PLANT	4	A4
8.	PE-V0-485-164-A008	DATA SHEET AND GA FOR THICKENER	8	A4
9.	PE-V0-485-164-A009	DATA SHEET AND GA FOR CENTRIFUGE	8	A4
10.	PE-V0-485-164-A010	DATA SHEET AND GA FOR CENTRIFUGAL PUMP	8	A4
11.	PE-V0-485-164-A011	DATA SHEET AND GA FOR METERING PUMP	8	A4
12.	PE-V0-485-164-A012	DATA SHEET AND GA FOR SCREW PUMP	8	A4
13.	PE-V0-485-164-A013	DATA SHEET AND GA FOR VALVES	8	A4
14.	PE-V0-485-164-A014	DATA SHEET AND GA FOR MOTORS	8	A4
15.	PE-V0-485-164-A015	DATA SHEET AND GA FOR INSTRUMENT	10	A4
16.	PE-V0-485-164-A016	GA FOR TANKS	10	A4
17.	PE-V0-485-164-A017	MECHANICAL GA FOR SUMPS	10	A3
18.	PE-V0-485-164-A018	ELECTRICAL LOAD LIST FOR EFFLUENT TREATMENT PLANT	10	A4
19.	PE-V0-485-164-A019	GA FOR JUNCTION BOX	10	A4
20.	PE-V0-485-164-A020	GA FOR AC DC POWER DISTRIBUTION BOARD	10	A4
21.	PE-V0-485-164-A021	QAP FOR EFFLUENT TREATMENT PLANT	10	A4
22.	PE-V0-485-164-A022	PAINTING SPECIFICATION FOR EFFLUENT TREATMENT PLANT	8	A4
23.	PE-V0-485-164-A023	I/O LIST AND DRIVE LIST FOR EFFLUENT TREATMENT PLANT	10	A4
24.	PE-V0-485-164-A024	MECHANICAL GA FOR CHEMICAL HOUSE AND CENTRIFUGE BUILDING.	10	A4
25.	PE-V0-485-164-A025	O&M FOR EFFLUENT TREATMENT PLANT	16	A4
26.	PE-V0-485-164-A026	DATA SHEET AND GA FOR BLOWERS	10	A4
27.	PE-V0-485-164-A027	DATA SHEET AND GA FOR AGITATORS	10	A4
28.	PE-V0-485-164-A028	INSTRUMENT SCHEDULE FOR EFFLUENT TREATMENT PLANT	10	A3
29.	PE-V0-485-164-A029	INSTRUMENT INSTALLATION/ HOOK UP DIAGRAMS	10	A4
30.	PE-V0-485-164-A030	FIELD JB TERMINATIONS /GROUPING DOCUMENT	10	A4
31.	PE-V0-485-164-A031	BLOCK LOGIC DIAGRAM	12	A4
32.	PE-V0-485-164-A032	VALVE SCHEDULE FOR EFFLUENT TREATMENT PLANT	10	A3
33.	PE-V0-485-164-A033	CABLE SCHEDULE (IN BHEL EXCEL FORMAT) & CABLE INTERCONNECTION DETAILS	10	A4
34.	PE-V0-485-164-A034	PG TEST PROCEDURE FOR EFFLUENT TREATMENT PLANT	10	A4
35.	PE-V0-485-164-A035	SKID GA	10	A3

1. Any additional drawings-documents required during detailed engineering stage shall be provided by bidder without any commercial, technical and delivery implication to BHEL and customer.
2. Bidder to note that the successful bidder, during detail engineering, will submit the drg/doc through web based Document Management System in addition to hard copies to be submitted as per the Annexure IV of this specification. Bidder would be provided access to the DMS for drg/doc approval and adequate training for the same. Detailed methodology would be finalized during the kick-off meeting. Bidder to ensure following at their end.

Internet explorer version – Minimum Internet Explorer 7

Internet speed – 2 mbps (Minimum preferred)

Pop ups from our external DMS IP (124.124.36.198) should not be blocked

Vendor's internal proxy setting should not block DMS application's link (http://124.124.36.198/wrenchwebaccess/login.aspx)"

DMS user manuals to be used by BHEL PEM vendors for uploading, viewing, revising, commenting and tracking documentson PEM's DMS have been uploaded on PEM internet website (www.bhelpem.com) under the Vendor session.
For quick access bidder may refer the link http://bhelpem.com/DMSManuals/DMSManuals.html

3. Re-submission of drawing/document shall be done within 10 days by supplier.
4. SL. No. 1, 3, 6 and 7 shall be consider as Basic Engineering Drawing/Documents.

SCHEDULE OF PRE-BID CLARIFICATION

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

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

PARTICULARS OF BIDDER / AUTHORISED REPRESENTATIVE				
NAME	DESIGNATION	SIGNATURE	DATE	COMPANY SEAL

COMPLIANCE CUM CONFIRMATION SCHEDULE

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

a.) The scope of supply, technical details, construction features, design parameters etc. shall be as per technical specification & there are no exclusions/ deviations with regard to same.

b.) QP/ test procedures shall be submitted in the event of order based on the guidelines given in the specification & QP enclosed therein.
QP will be subject to **BHEL/FICHTNER/TANGEDCO** approval in the event of order & customer hold points for inspection/ testing shall be marked in the QP at the contract stage. Inspection/ testing shall be witnessed as per same apart from review of various test certificates/ Inspection records etc.
The charges for 3rd party inspection (Lloyds, TUV or equivalent) for imported components shall be included in the base price of the equipment by the bidder

c.) All drawings/data – sheets etc. to be submitted during contract shall be subject to **BHEL/FICHTNER/TANGEDCO** review/ approval. GA drawings, as submitted with offer at tender stage are for reference purpose only and shall be subject to approval during contract stage.

d.) The offered materials shall be either equivalent or superior to those specified. Also for components where material is not specified it shall be suitable for intended duty, materials shall be subject to approval in the event of order.

e.) The commissioning spares (if any) are supplied on 'As Required Basis' & prices for same included in the base price (If bidders reply to this is "No commissioning spares are required" and if some spares are actually required during commissioning same shall be supplied by bidder without any cost to BHEL).

f.) All sub vendors shall be subject to **BHEL/FICHTNER/TANGEDCO** approval

g.) Any special tools & tackles, if required, shall be in bidder's scope.

h.) Demonstration parameters shall stand valid till the satisfactory completion of demonstration test and its acceptance by **BHEL/FICHTNER/TANGEDCO**.

*** Bidder shall include this schedule both in technical and Price offers**

DECLARATION

I ……..……certify that all the technical data and information pertaining to this specification are correct and are true representation of the equipment/system covered by our format proposal number Dated …….. and there is no deviation to the specification (except indicated in the deviation sheet (cost of withdrawal).

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

Biders Company Name …….

Authorised representative's
Signature …….

Name …….

Bider's Name

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