2 X 660MW UDANGUDI SUPERCRITICAL TPP STAGE-1

VOLUME: II B & III

TECHNICAL SPECIFICATION
FOR
EFFLUENT TREATMENT PLANT

SPECIFICATION NO.: PE-TS-435-164-A001

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

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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 **2 X 660MW UDANGUDI SUPERCRITICAL TPP STAGE-1.**

1.2 The contractor shall be responsible for providing all material, equipment & services, which are required to fulfil the intent of ensuring operability, maintainability, reliability and complete safety of the complete work covered under this specification, irrespective of whether it has been specifically listed herein or not. Omission of specific reference to any component / accessory necessary for proper performance of the equipment shall not relieve them of the responsibility of providing such facilities to complete the supply, erection and commissioning of **Effluent Treatment Plant (ETP).**

1.3 It is not the intent to specify herein all the details of design and manufacture. However, the equipment shall conform in all respects to high standards of design, engineering and workmanship and shall be capable of performing the required duties in a manner acceptable to purchaser who will interpret the meaning of drawings and specifications and shall be entitled to reject any work or material which in his judgment is not in full accordance herewith.

1.4 The extent of supply under the contract includes all items shown in the drawings, notwithstanding the fact that such items may have been omitted from the specification or schedules. Similarly, the extent of supply also includes all items mentioned in the specification and /or schedules, notwithstanding the fact that such items may have been omitted in the drawing.

1.5 The general terms and conditions, instructions to tenderer and other attachment referred to elsewhere are made part of the tender specification. The equipment materials and works covered by this specification are subject to compliance to all attachments referred to in the specification. The bidder shall be responsible for and governed by all requirements stipulated herein.

1.6 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.

1.7 Deviations, if any, should be very clearly brought out clause by clause in the enclosed schedule; otherwise, it will be presumed that the vendor's offer is strictly in line with NIT specification.

1.8 In case all above requirements are not complied with, the offer may be considered as incomplete and would become liable for rejection.

1.9 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 including their consultant as interpreted by BHEL in the relevant context. Bidder to refer GCC/SCC for more clarity.

1.10 The equipment covered under this specification shall not be dispatched unless the same have been finally inspected, accepted and dispatch release issued by BHEL/Customer.

1.11 BHEL's/Customer's representative shall be given full access to the shop in which the equipments are being manufactured or tested and all test records shall be made available to him.

1.12 The Effluent Treatment Plant (ETP) shall fully comply to meet all the requirements and limits specified in Environmental (Protection) Rulers,1986 along with all latest amendments, Requirements and stipulations of Central pollution control Board (CPCB), Ministry of Environment & Forests (MOEF), State Pollution Control Board (SPCB) and any other central or local statutory requirements regarding environmental pollution and its abatement.

SECTION – B
PROJECT INFORMATION

1.0.0 SITE CONDITION

1.1.0 Location and existing Infrastructure

The plant location details are as follows:

Country	:	India
State	:	Tamil Nadu
Administrative district	:	Thoothukudi
Next big cities to site	:	Thoothukudi (approx.45 kms from site)
Road access	:	East Coast Road – State high way (176)
Nearest Railway Station	:	Thiruchendur (approx.12 kms from site)
Nearest Airport	:	Vagaikulam (approx.60 kms from site)
Nearest Harbour	:	Tuticorin (approx.45 kms from site)

The proposed power project will be located at Udangudi in Tamil Nadu. The proposed power project site is located at about 45km South of Thoothukudi. The proposed marine facilities for the power project will be built on the coast adjoining the power project. The site is accessible by well developed roads.

The town of Tuticorin has all infrastructural facilities and has number of Industries. Tuticorin is well connected by both state highways, National highways and has direct rail link with State Capital Chennai.

1.1.1 Soil Profile

A Preliminary soil investigation report and topographical survey has been carried out by Owner. The results are furnished in a separate annexure.

The Detailed geotechnical Investigation and Setting out survey will be performed by the EPC contractor, and will be the basis for the detailed engineering for the project. The geotechnical report shall contain recommendations for foundation design during detailed engineering.

1.1.2 Seismic intensity

Seismic Intensity	:	As per IS : 1893 Latest
Zone	:	II
Intensity	:	As per IS:1893-Latest

1.1.3 Tide Levels

The recorded tide levels with respect to the Chart Datum (CD) near the identified intake point are as follows:

Mean high water-Spring	CD + 0.99 m
Mean high Water-Neap	CD + 0.71 m
Mean low Water-Neap	CD + 0.55 m
Mean low water-Spring	CD + 0.29m
Mean sea level	CD + 0.64 m
Highest High Tide Level	CD+ 1.026 m
Lowest Low Tide Level	CD + 0.110 m

1.2.0 Meteorological conditions

Ambient Air Temperature

Maximum dry bulb temperature	:	41℃
Minimum dry bulb temperature	:	17℃

Relative humidity

Mean Maximum humidity (Summer)	:	84%
Mean Minimum humidity (Summer)	:	62%
Maximum humidity (Monsoon)	:	97%
Minimum humidity (Monsoon)	:	45%

Rainfall

Annual rainfall (Maximum)	:	718.2 mm
Annual Rain fall (Minimum)	:	384.1 mm
Twenty four (24) Hour max	:	138.2 mm

High Flood Level

High Flood Level for site	:	RL 2.450 m

Wind

Mean Wind Speed (max)	:	20.6 km/h
Wind direction	:	North, North East, North West, East

The details given are arbitrary and may vary. The contractor should collect the actual data from the Meteorological Department pertaining to the site location and design the plant accordingly.

Meteorological data corresponding to Tuticorin observatory station shall be adopted. These data can be collected from Regional Meteorological Centre, India Meteorological Dept, 50, College Road, Chennai – 600 006.

1.3.0 Design Requirements related to site conditions

1.3.1 Design Ambient Data

Rainfall data:

The maximum rainfall in a year to be considered for design is 718.2 mm. 24 hours maximum to be considered is 138.2 mm. Area drainage study as required is in Contractor's scope of work.

Wind data

Wind loads to be considered for design of structures shall be based on the design wind speeds arrived at based on IS : 875 (Part -3) – Latest Edition. The parameters for calculation of design wind speed as per IS : 875 (Part -3) – Latest Edition are elaborated under Volume II, Section 5 of Detailed Technical Specification - Civil.

1.3.2 **Seismic Data**

Seismic loads to be considered for design of structures shall be as per as per IS : 1893. Seismic design criteria are elaborated under Volume - II, Section 5 of Detailed Technical Specification- Civil.

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-435-164-A001). Please also refer Electrical (Section-C2) and C&I (Section-C3) for respective scopes.

- Entire Effluent Treatment Plant as per P&ID (PE-DG-435-164-A001) and Data Sheet-A.
- Two numbers TG Area Oily Waste Transfer Pumps for Unit-1 with instrumentation, piping, fittings, Valves, Motors and other accessories.
- Two numbers TG Area Oily Waste Transfer Pumps for Unit-2 with instrumentation, piping, fittings, Valves, Motors and other accessories.
- Two numbers Transformer Area Oily Waste Transfer Pumps for Unit-1 with instrumentation, piping, fittings, Valves, Motors and other accessories.
- Two numbers Transformer Area Oily Waste Transfer Pumps for Unit-2 with instrumentation, piping, fittings, Valves, Motors and other accessories.
- Two numbers Fuel Oil OWS Waste Transfer Pumps with instrumentation, piping, fittings, Valves, Motors and other accessories.
- Two numbers Coal Mill Waste Transfer Pumps for Sump-1 for Unit-1 with instrumentation, piping, fittings, Valves, Motors and other accessories.
- Two numbers Coal Mill Waste Transfer Pumps for Sump-2 for Unit-1 with instrumentation, piping, fittings, Valves, Motors and other accessories.
- Two numbers Coal Mill Waste Transfer Pumps for Sump-1 for Unit-2 with instrumentation, piping, fittings, Valves, Motors and other accessories.
- Two numbers Coal Mill Waste Transfer Pumps for Sump-2 for Unit-2 with instrumentation, piping, fittings, Valves, Motors and other accessories.
- Two numbers Boiler Area Floor Wash Pit Transfer Pumps for Unit-1 with instrumentation, piping, fittings, Valves, Motors and other accessories.
- Two numbers Boiler Area Floor Wash Pit Transfer Pumps for Unit-2 with instrumentation, piping, fittings, Valves, Motors and other accessories.
- Two numbers OWS Feed Pumps with instrumentation, piping, fittings, Valves, Motors and other accessories.
- One number Oil Water Separator (OWS) with skimmer and accessories.
- Two numbers slop oil tank with accessories.
- Two numbers Tube Settler Feed Pumps with instrumentation, piping, fittings, Valves, Motors and other accessories.
- One number Flash Mixer with motor, reduction gear and other accessories.
- One number Flocculation Tank with accessories.
- One number Tube Settler with accessories.
- Two numbers Sludge Transfer Pumps with instrumentation, piping, fittings, Valves, Motors and other accessories.
- Two numbers Air blower for Sludge Collection Pit with accessories.
- PE Dosing Systems including PE Dosing tanks two numbers and PE dosing pumps two numbers with instrumentation, piping, fittings, Valves, Motors and other accessories.
- Lime Dosing Systems including Lime Dosing tanks two numbers and Lime dosing pumps two numbers with instrumentation, piping, fittings, Valves, Motors and other accessories.
- Alum Dosing Systems including Alum Dosing tanks two numbers and Alum dosing pumps two numbers with instrumentation, piping, fittings, Valves, Motors and other accessories.
- Two numbers Effluent Transfer Pump-1 for CHP Dust Suppression/Horticulture with instrumentation, piping, fittings, Valves, Motors and other accessories.
- Two numbers Effluent Transfer Pump-2 for CW Blowdown Line with instrumentation, piping, fittings, Valves, Motors and other accessories.
- Acid Dosing Systems including Acid dosing tank one number and Acid dosing pumps two numbers with instrumentation, piping, fittings, Valves, Motors and other accessories.
- Alkali Dosing Systems including Alkali dosing tank one number and Alkali dosing pumps two numbers with instrumentation, piping, fittings, Valves, Motors and other accessories.

- Electrical motors for pumps, blower, agitator, etc as per requirement.
- Safety equipment as indicated elsewhere in this technical specification.
- Chain pulley block (2 Nos each of 1 Ton Capacity) and Electrical hoist (2 Nos each of 2 Ton Capacity) with monorail for handling equipment.
- Electric hoist with monorail and weighing scale (1 No each of 1 Ton Capacity) with accessories in chemical house for chemical handling.
- All tanks and vessels complete with inlet and outlet connections, bed support cum under drain system, inlets water distributors, all fittings and appurtenances etc. as specified and as required.
- Inlet and outlet pipes for each equipment tanks with pipe connections to the respective equipment.
- Necessary pipe and piping inside and outside the Effluent Treatment Plant as specified elsewhere.
- All necessary valves (manual and actuated), actuators and fittings for the installations with the actuators necessary for their remote operation.
- All necessary drains, vents and sampling points, with valves, as specified and as required.
- Hangers and supports as per the requirement.
- All pipes, fittings etc as required, hand railing, mono rail for hoist and chain pulley block, platforms and ladders shall be in the scope of bidder. All insert plates, embedded plates, rung ladder, nuts and bolts, and matching counter flanges wherever applicable.
- Instrumentation (minimum) as per the enclosed P&ID (PE-DG-435-164-A001) and as per system requirement with accessories.
- All necessary structural steel for pipe supporting structure, platforms, walkways / pathways and access stairs, mechanical plant and equipment, mechanical services and pipe work associated with Effluent Treatment Plant.
- Start-up and commissioning spares as required.
- Mandatory spares as indicated in Technical Specification (PE-TS-435-164-A001).
- All special tools necessary for proper maintenance or adjustment of the equipment packed in permanent box.
- Finish paints for touch up painting of equipments after erection at site in sealed container.
- Initial charge of all lubricants and grease.
- Monitoring gadgets, instruments and equipments required for monitoring (till PG test and plant handover).
- First fill of all chemical including top up chemicals and all required chemicals for pre-commissioning, commissioning, trial run and PG test+3 months of chemical after successful commissioning at rated capacity are in bidder scope.
- Permanent ladder (not rungs) for approaching the sludge pits/sumps, valves for opening/maintenance purpose.
- 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 equipments being supplied under this specification.
- All auxiliary steel structures (U-clamps, nuts, bolts, channels etc.) for fixing the pipe on the pedestal or trestles.
- Arrangement of all instruments/lab facilities at non-returnable basis to carry out trial run/commissioning and PG test is in bidder scope.
- Coating, rapping and protection of buried piping.
- Suitable size and numbers hume pipe for road crossing, (for 100 NB pipe- 20 nos each for 6 meter road crossing, for 80 NB pipe-16 nos).

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 and PG Test.
4) Performance testing.
5) Painting as per enclosed painting schedule. However, any variation in the painting schedule as finally approved by BHEL/TCE/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 respective collection pit to ET plant area, refer P&ID (PE-DG-435-164-A001) for details.
b. Service water and portable water & Service air and instrument air: At ET Plant boundary at a distance of 20 meter (it may be at any direction, shall be decided during detailed engineering).
c. Other TP as marked in P&ID (PE-DG-435-164-A001).

Note: Bidder to note that the pipe length indicated in the specification may vary by +/-10% for which no extra claim shall be applicable.

5.0 EXCLUSIONS FOR EFFLUENT TREATMENT PLANT:

- Service air, Instrument air, upto the terminal point.
- Fire fighting and Ventilation facilities.
- Drinking water and service water.
- Total Civil work is in BHEL Scope of work, however Civil Input drawing shall be provided by bidder.
- Excavation/back filling for underground piping.
- Pipe trestles and pedestals.
- Acid/alkali resistant lining on RCC.

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/TCE/TANGEDCO during detail engineering. Any additional vendors (not listed in the sub-vendor list as enclosed with Technical Specification-PE-TS-435-164-A001)) shall be subject to BHEL/TCE/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-435-164-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/TCE/TANGEDCO approval during detailed engineering.

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

After award of LOI, following drawing/documents shall be submitted by the bidder for BHEL/TCE/TANGEDCO approval. However, any additional drawing/document if found necessary for completion of the engineering, the same shall be submitted by bidder without any commercial implication.

a) Detailed piping and instrument for process and utility, showing all equipments, machinery, piping and instruments. All pipes should be indicated with diameter, pipe class, pipe number, fluid flowing through it as per the Employer's legend to be furnished later.
b) Detailed configuration drawings, BOMs, Data Sheets, General arrangements and cross-sectional/assembly drags, along with the manufacturer's catalogue for all the items/equipment including control & instrumentation supplied by the bidder.
c) Detailed installation drawings for all instruments and instrumentation schedule.
d) Preparation and finalization of functional write-up and detailed logic diagram, for all control system, electrical wiring and schematic drgs for the development of logic diagrams, GA and layout drgs of control panels (as applicable), bill of material for panel drgs and terminal (as applicable), junction boxes, inter connection diagram for cabling, cable schedule, earthing layout and cable tray layout drawings..
e) Design calculation of process and mechanical design, equipments and systems. The bidder shall show, explain and prove the validity of the basis/procedures and methods used in these calculations.
f) Details civil scope/assignment drawing for all civil works.
g) Detailed piping layout drawings, pipe support drawings, complete bill of materials of the piping, valve schedule etc.
h) Submission of O&M manual.
i) PG Test procedure shall be submitted by bidder during detail engineering and shall be subject to approval by BHEL/TCE/TANGEDCO.
j) Against BHEL/TCE/TANGEDCO comments bidder has to give replies point wise during detailed engineering after award of contract.

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

- Deviation/clarification, if any, in the BHEL format.
- Compliance certificate.
- 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 (from Central Monitoring Basin) shall be guaranteed: -

FUNCTIONAL GURANTEES FOR EFFLUENT TREATMENT PLANT (TABLE-1)
✓ TSS < 100 ppm
✓ Oil & Grease < 20 ppm
✓ pH < 6.5- 8.5

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/TCE/TANGEDCO during detailed engineering. Stage. Successful vendor shall comply with the comment of the BHEL/TCE/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.

FEED WATER ANALYSIS FOR EFFLEUNT TREATMETN PLANT DESIGN PURPOSE [TABLE-2]

Sl no.	Particulars	Units	Maximum (approx.)
A	**TG AREA OILY WASTE (PIT NO E1 AND E2)**		
1	TDS	ppm	220
2	TSS	ppm	100
3	PH	--	8-8.4
4	Temperature	--	32 Deg C.
5	OIL	PPM	200
B	**TRANSFORMER AREA OILY WASTE (BURNT OIL) (PIT NO E3 AND E4)**		
1	TDS	ppm	220
2	TSS	ppm	100
3	PH	--	8-8.4
4	Temperature	--	32 Deg C.
5	OIL	PPM	1000
C	**FUEL OIL OWS WASTE (FROM FUEL OIL AREA) (PIT NO E5)**		
1	TDS	ppm	220
2	TSS	ppm	100
3	PH	--	8-8.4
4	Temperature	--	32 Deg C.
5	OIL	PPM	1000
D	**COAL MILL WASTE (FROM FUEL OIL AREA) (PIT NO E6, E7, E8 AND E9)**		
1	TDS	ppm	220
2	TSS	ppm	50
3	PH	--	8-8.4
4	Temperature	--	32 Deg C.
5	OIL	PPM	NIL
E	**BOILER AREA FLOOR WASH (PIT NO E10 AND E11)**		
1	TDS	ppm	220
2	TSS	ppm	100
3	PH	--	8-8.4
4	Temperature	--	32 Deg C.
5	OIL	PPM	NIL
F	**REGENERATION WASTE FROM N-PIT (CPU AND DM PLANT) (AT T1)**		
1	TDS	ppm	3500
2	TSS	ppm	100
3	PH	--	7.2-8.0
4	Temperature	--	32 Deg C.
5	OIL	PPM	NIL.
F	**BWRO REJECT FROM RODM (AT T2)**		
1	TDS	ppm	2500
2	TSS	ppm	NIL
3	PH	--	5.0-6.5
4	Temperature	--	32 Deg C.
5	OIL	PPM	NIL.
G	**TREATED COAL PILE RUN OFF WATER (AT T3)**		
1	TDS	ppm	100
2	TSS	ppm	200
3	PH	--	8-8.4
4	Temperature	--	32 Deg C.
5	OIL	PPM	NIL.

SUB VENDORS LIST [TABLE-3]

SR. NO.	ITEM	SUPPLIERS	PLACE	REMARKS
1.	PRESSURE VESSELS	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	-	
		ATS CHEM	SALEM/HOSUR	
		CHEM PROCESS SYSTEM	SANAND	
		PROGEN	CHENNAI	
		CRYSTAL ENGINEERING	HOSUR	
		ISHAN EQUIPMENTS	VADODARA	
2.	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	-	
		ATS CHEM	SALEM/HOSUR	
		CHEM PROCESS SYSTEM	SANAND	
		PROGEN	CHENNAI	
		CRYSTAL ENGINEERING	HOSUR	
		ISHAN EQUIPMENTS	VADODARA	
3.	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	
4.	AIR BLOWERS (TWIN LOBE TYPE)	SWAN PNEUMATIC	NOIDA	
		EVEREST TRANSMISSION	NEW DELHI	
		KAY INTERNATIONAL	NEW DELHI / SONEPAT	
		EVEREST BLOWER	BAHADURGARH	
		KULKARNI POWER TOOLS	KOLHAPUR/ PUNE	
5.	METERING PUMPS	VK PUMPS	NASIK	

SR. NO.	ITEM	SUPPLIERS	PLACE	REMARKS
		MILTON ROY INDIA	CHENNAI	
		SWELLORE	AHMEDABAD	
		DENCIL PUMP	MUMBAI	
		METACHEM	MUMBAI	
6.	AGITATOR	REMI PEOCESS PLANT & M/C	MUMBAI	
		FIBRE & FIBRE	MUMBAI / SILVASA	
		CEECONS	CHENNAI	
		STANDARD ENGINEERS	MUMBAI	
7.	HORIZONTAL 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	
		V-FLO PUMPS & SYSTEMS CO. LTD.,	BEIJING-CHINA	
		WPIL LIMITED	KOLKATA	
8.	VERTICAL CENTRIFUGAL PUMPS	BHARAT PUMPS & COMPRESSORS LTD	ALLAHABAD	
		FLOWMORE LTD.	GURGAON	
		FLOWSERVE INDIA CONTROLS PVT. LTD.	COIMBATORE	
		JYOTI LTD.	VADODARA	
		WILO MATHER & PLATT PUMPS PVT. LTD.	PUNE	
		SULZER PUMPS INDIA LTD.	THANE	
		WPIL LIMITED	KOLKATA	
9.	SCREW PUMP	UT PUMP		
		ROTO PUMPS		
		TUSHACO		
10.	HORIZONTAL CENTRIFUGAL PUMPS (RUBBER LINED)	KISHORE PUMPS	PUNE	
		SU MOTORS	MUMBAI	
11.	NON METALLIC (PP/FRP) HORIZONTAL CENTRIFUGAL PUMPS	ENGINEERS COMBINE	THANE	
		ANTICORROSIVE	VALSAD	
		LEAK PROOF PUMPS PVT. LTD. (RAJEDIA)	-	
12.	MISC. PUMP VERTICAL TURBINE TYPE	KBL	PUNE	
		M&P	PUNE	
		WPIL	GHAZIABAD	
		KISHORE PUMPS	PUNE	
		FLOWMORE	SAHIBABAD	
13.	BATTERY CHARGER FOR PLC	AMARA RAJA POWER SYSTEMS LIMITED	TRIPUTI	
		CHHABI ELECTRICALS PVT.LTD.	JALGAON	
		CHLORIDE POWER SYSTEMS & SOLUTIONS LIMITED	KOLKATA	
		DUBAS ENGG PVT LTD	BANGALORE	
		HBL POWER SYSTEMS LTD	HYDERABAD	
		JEMA ENERGY	SPAIN	
		MASS-TECH CONTROLS PVT.LTD.	MUMBAI	
		STATCON POWER CONTROLS LTD	NOIDA	

SR. NO.	ITEM	SUPPLIERS	PLACE	REMARKS
14.	UNDER BED NOZZLE	JONSONS SCREEN	AUSTRALIA/ IRELAND	
15.	COATING & WRAPPING MATERIAL TAPE	IWL LTD.	CHENNAI	
		MP TAR PRODUCT	BHILAI	
		PORWAL INDUSTRIES	RAIPUR	
		RUSTECH	KOLKATA	
		STP	JAMSHEDPUR	
16.	HEATER	ESCORTS	FARIDABAD	
		RACOLDS	FARIDABAD	
17.	CLARIFIER/ THICKENER MECHANISM	CLEAR WATER	DELHI	
		TRIVENI	NOIDA	
		PBJ ASSOCIATE	PUNE	
18.	CENTRIFUGE	HUMBOLT	-	
		HILLER	-	
19.	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	
20.	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	
21.	ELECTRIC MOTOR	CROMPTON GREAVES	AHMEDNAGAR	
		LAXMI HYDRAULICS PVT. LTD	BANGALORE / HUBLI*	
		RAJINDRA ELECT INDUSTRIES	FARIDABAD* / BANGALORE	
		GE-POWER		
		BHARAT BIJLEE	MUMBAI	
		SIEMENS	MUMBAI	
		NGEF	BANGALORE	
		KIRLOSKAR ELECTRIC CO LTD.		
		ASEA BROWN BOVERI		

SR. NO.	ITEM	SUPPLIERS	PLACE	REMARKS
		MARATHON	KOLKATA	
22.	BUTTER-FLY VALVE	ADVANCE VALVES PVT. LTD.	NOIDA	
		TECHNO VALVE	NASHIK	
		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	
23.	DIAPHRAGM VALVE	WEIR BDK	HUBLI	
		TECHNO VALVE	NASHIK	
		CRANE FLOW PROCESS	SATARA	
		PROCON	MUMBAI	
		MAJESTIC VALVES (LABLINE)	-	
		HAWA ENGINEERS	AHMEDABAD	
24.	DUAL PLATE CHECK VALVES	ADVANCE VALVES PVT. LTD.	NOIDA	
		FLUIDLINE VALVES COMPANY PVT.LTD.	GHAZIABAD	
		TECHNO VALVE	NASHIK	
		R AND D MULTIPLES (METAL CAST) PVT LTD	MUMBAI	
		VENUS PUMPS AND ENGG. WORKS	KOLKATA	
25.	Y-TYPE STRAINER	OTOKLIN GLOBAL BUSINESS LIMITED	MUMBAI	
		GRAND PRIX	NEW DELHI	
		JAYPEE	NEW DELHI	
		GREAVES COTTON	MUMBAI	
		MULTITEX FILTRATION ENGINEERS LIMITED,	NEW DELHI / NOIDA	
		FILTERATION ENGINEERS (I) PVT. LTD	MUMBAI	
		FLUIDNYE	-	
		SUNGOV ENGINEERING PVT. LTD.	DELHI	
		GRAND PRIX	FARIDABAD	
		JAYPEE INDUSTRIES PVT. LTD.	DELHI	
		BHATIA ENGINEERING CO.	DELHI	
26.	RUBBER FLAP TYPE CHECK VALVES	ASHVIK VALVES	-	
		FLOW WAY VALVES	-	
		TECHNO VALVE	NASHIK	
		BDK	-	
		MAJESTIC VALVES (LABLINE INST)	-	
		ADVANCE VALVES	-	
27.	SOLENOID VALVES	ROTEX	-	
		AVCON	-	
28.	PRESSURE GAUGE/ DIFFERENTIAL	A.N. INSTRUMENTS PVT. LTD.	KOLKATA	
		ASHCROFT INDIA PVT LTD.	GUJARAT	

SR. NO.	ITEM	SUPPLIERS	PLACE	REMARKS
	PRESSURE GAUGE	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	
		BAUMER TECHNOLOGIES INDIA PVT. LTD.	MUMBAI	
29.	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	
30.	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	
31.	CONTROL VALVE	SPX CORPORATION, USA	AHMEDABAD	
		CONTROL COMPONENT INC.	CALIFORNIA	
		DRESSER VALVE INDIA PVT. LTD	COIMBATORE	
		DAUME REGELARMATUREN GMBH,	GERMANY	

SR. NO.	ITEM	SUPPLIERS	PLACE	REMARKS
		EMERSON PROCESS MANAGEMENT CHENNAI LIMITED	CHENNAI	
		WEIR VALVES & CONTROLS UK LTD.	U.K	
		HOLTER REGELARMATUREN GMBH & CO.KG	GERMANY	
		INSTRUMENTATION LTD.	KERALA	
		KOSO INDIA PRIVATE LIMITED,	NASHIK	
		LESLIE CONTROLS, INC	USA	
		MIL CONTROLS LTD.	KERALA	
		METSO SINGAPORE PTE. LTD.,	SINGAPORE	
		PARCOL S.P.A	ITALY	
		R.K.CONTROL INSTRUMENTS PVT. LTD.	THANE	
		RINGO VALVULAS S.L,	SPAIN	
		SHENJIANG VALVE CO. LTD.	CHINA	
		VALVITALIA S.P.A. ,	ITALY	
		WALDEMAR PRUSS ARMATURENFABRIK GMBH	GERMANY	
32.	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	
33.	TEMPERATURE GAUGE	A.N. INSTRUMENTS PVT. LTD.	KOLKATA	
		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	
34.	LEVEL GAUGE (F&B, TUBULAR, REFLEX)	SBEM		
		CHEMTROL		
		PUNE TECHTROL		
		SIGMA		
		V AUTOMAT		
		GENERAL INSTRUMENTS		
35.	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	
36.	LEVEL SWITCH-CONDUCTIVITY TYPE	BLISS ANAND PVT. LTD.	GURGAON	
		FLOWTECH INSTRUMENTS SERVICRS	VADODARA	
		HI-TECH SYSTEMS & SERVICES LTD.	KOLKATA-	
		LEVCON INSTRUMENTS PVT. LTD.	KOLKATA	
		RAMAN INSTRUMENTS PVT.LTD.	MUMBAI	

SR. NO.	ITEM	SUPPLIERS	PLACE	REMARKS
		SIGMA INSTRUMENTS CO.	MUMBAI	
		SOR INC.	USA	
		SAPCON INSTRUMENT PVT LTD.	INDORE	
		V. AUTOMAT & INTRUMENTS (P) LTD.	NEW DELHI	
37.	LEVEL SWITCH (ALL TYPES)	LEVCON		
		CHEMTROLS SAMIL (INDIA) PVT LTD.		
		SWITZER		
		WAAREE (BAUMER INSTRUMENTS)		
		V AUTOMAT		
		PUNE TECHTROL		
38.	MAGNETIC FLOW METER	ABB	-	
		WAAREE (BAUMER INSTRUMENTS)	-	
		EUREKA	-	
		EMERSON	-	
		YOKOGAWA	-	
		HACH (POTENSE)	-	
		KROHNE MARSHALL	-	
39.	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	
40.	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	
41.	FLOW TRANSMITTERS (ALL TYPES)	E & H	-	
		KHRONE MARSHALL	-	
		EMERSON	-	
		ABB	-	
		HONEYWELL	-	
		YOKOGAWA	-	
42.	LEVEL TRANSMITTERS (ALL TYPES)	EMERSON	-	
		E & H	-	
		ABB	-	
		HONEYWELL	-	
		V AUTOMAT	-	
		YOKOGAWA	-	
		SIEMENS	-	
		KROHNE MARSHALL	-	
43.	PRESSURE TRANSMITTERS (ALL TYPES)	EMERSON	USA/PAWANE	
		LAXONS AUTOMATION	DAMAN	
		YIL	BANGALORE	
		SIEMENS	THANE	
		FUJI	CHINA	

SR. NO.	ITEM	SUPPLIERS	PLACE	REMARKS
		YOKOGAWA	JAPAN	
		HONEYWELL	USA/PUNE	
44.	TEMPERATURE TRANSMITTERS	EMERSON	-	
		E & H	-	
		ABB	-	
		HONEYWELL	-	
		V AUTOMAT	-	
		YOKOGAWA	-	
		SIEMENS	-	
		FORBES MARSHALL	-	
45.	PH TRANSMITTERS	EMERSON	-	
		YOKOGAWA	-	
		HONEYWELL	-	
		ABB	-	
		HACH	-	
		FORBES MARSHALL	-	
46.	ANALYSERS (ALL TYPES)	ABB	-	
		EMERSON	-	
		YOKOGAWA	-	
		HONEYWELL	-	
		HACH POLYMETRON	-	
		SIEMENS	-	
		FORBES MARSHALL	-	
47.	PROGRAMMABLE LOGIC CONTROLLER	GE INTELLIGENT PLATFORMS PRIVATE LIMITED	BANGALORE	
		HONEYWELL AUTOMATION INDIA LIMITED ,	PUNE	
		ROCKWELL AUTOMATION INDIA LTD	SAHIBABAD	
		SIEMENS LIMITED	MUMBAI	
		SCHNEIDER ELECTRIC INDIA PVT.LTD.	NEW DELHI	
48.	UPS	HITACHI-HIREL	GANDHINAGAR	
		APC	BANGALORE	
		DELTA	GURGAON	
		EMERSON	MUMBAI	
		DB POWER	PUNE	
		APLAB	MUMBAI	
49.	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	
50.	JUNCTION BOX	AJMERA INDUSTRIAL & ENGINEERING WORKS	MUMBAI	
		FLEXPRO ELECTRICALS PVT. LTD.		

SR. NO.	ITEM	SUPPLIERS	PLACE	REMARKS
			GUJARAT	
		K.S.INSTRUMENTS PVT.LTD.	BANGALORE	
		SUCHITRA INDUSTRIES	BANGALORE	
		SHRENIK & COMPANY,	AHMEDABAD	
51.	CABLE GLAND	COMET	-	
		DOWELL	-	
		CHETNA	-	
52.	CABLE LUGS	ELECTRO BILLETS	-	
		COMET	-	
		DOWELL	-	
		CHETNA	-	
53.	MS PLATES	SAIL		
		ESSAR STEEL		
		TISCO		
		RINL		
		JINDAL		
		LLOYD		
		ISPAT		
		INDIAN IRON & STEEL CO. LTD		
54.	CS PIPE (ASTM A 106 GR. B)	INDIAN SEAMLESS METAL TUBES	AHMEDABAD	
		MAHARASHTRA SEAMLESS	RAIGAD	
55.	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	

SR. NO.	ITEM	SUPPLIERS	PLACE	REMARKS
56.	SS PIPES / TUBES	APEX TUBES	BEHROR (ALWAR)	
		RATNAMANI	CHATTRAL	
		REMI	TARAPUR	
		PRAKASH STEELAGE	-	
57.	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	
58.	SAFETY SHOWER	UNICARE	-	
		MOHAN INDUSTRIES	-	
		SUPER SAFETY SERVICES	-	
59.	FRP TANKS & FITTINGS	GLOBAL COMPOSITE	-	
		EPP	-	
		DEEPA COMPOSITE	-	
		COROSEAL INDUSTRIES	-	
		CHEMICAL PROCESS & EQUIPMENT PVT LTD	-	
		J.R FIBRE INDUSTRIES PVT LTD	-	
		POLYPLAST	-	
60.	EJECTOR	ESSEM TECHNOLOGIES	-	
		RATNA PRASAD	-	
61.	LOCAL CONTROL PANEL	INDUSTRIAL SWITCHGEAR & CONTROL	-	
		POSITRONICS	-	
		DELTA CONTROL	-	
		L & T	-	
		GE POWER	-	
		PYROTECH	-	
		C& S	-	
62.	TANK (FRP)	INDUSTRIAL SERVICE	KOLKATA	
		SUNRISE	BARODA	
		GANDHI & ASSOCIATES	AHMEDABAD	
		MODERN EQUIPMENTS	CHENNAI	
		EAGLE PLAST	PUNE	
		OMEGA PLAST	MUMBAI	

SR. NO.	ITEM	SUPPLIERS	PLACE	REMARKS
63.	STROKE CONTROLLER	V K PUMPS	NASIK	
		METACHEM	MUMBAI	
		SWELORE	AHMEDABAD	
		MILTON ROY INDIA	CHENNAI	
64.	SAFETY VALVES/RELIEF VALVES	METACHEM	MUMBAI	
		KEYSTONE	BARODA	
		V K PUMPS	NASIK	
		MILTON ROY	CHENNAI	
65.	DUPLEX STRAINER	JAYPEE INDUSTRIES PVT. LTD.	NEW DELHI	
		MULTITEX FILTRATION ENGINEERS LIMITED,	NEW DELHI	
		OTOKLIN GLOBAL BUSINESS LIMITED	MUMBAI	
		SUNGOV ENGINEERING PVT. LTD.	CHENNAI	
66.	ORIFICE PLATE	MICRO PRECISION	FARIDABAD	
		INSTRUMENTAION LTD	PALGHAT	
		CARLO DYNAMICS	HYDERABAD	
67.	STEEL GATE/GLOBE/NR VALVES	A.V. VALVES LTD	AGRA	
		TECHNO VALVE	NASHIK	
		ATAM VALVES PVT. LTD.	JALANDHAR	
		FLUIDLINE VALVES COMPANY PVT.LTD.	KAUSHAMBI	
		M/S GM ENGINEERING	RAJKOT	
		INTERVALVE (INDIA) LTD.	PUNE	
		LEADER VALVES LTD.	JALANDHAR	
		NITON VALVE INDUSTRIES PVT LTD	MUMBAI	
		NSSL LIMITED.	NAGPUR	
		STEEL STRONG VALVES (I) PVT.LTD.,	NAVI MUMBAI	
		VENUS PUMPS AND ENGG. WORKS	KOLKATA	
		VALTECH INDUSTRIES	MUMBAI	
		V.K. VALVES PVT. LTD.,	JALANDHAR	
		WEIR BDK VALVES- A UNIT OF WEIR INDIA PVT. LTD.	NEW DELHI	
68.	SLUICE GATE	H SARKAR	KOLKATA	
		JASH ENGINEERING	-	
		YASHWANT INDUSTRIES	-	
69.	3 WAY VALVE	HI TECH	AHMEDABAD	
		ADVANCE VALVES PVT.LTD	NOIDA	
		BDK	HUBLI	
		TECHNO VALVE	NASHIK	
		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	

SR. NO.	ITEM	SUPPLIERS	PLACE	REMARKS
		MICON VALVES (INDIA) PVT.LTD	MUMBAI	
70.	PLUG VALVE(MANUAL)	BDK	HUBLI	
		HAWA ENGINEERS / MARCK & CARE	-	
		MICON VALVES	-	
		TECHNO VALVE	NASHIK	
		MICON VALVES (INDIA) PVT.LTD	MUMBAI	
71.	FITTINGS (CS/SS)	M.S. FITTINGS	KOLKATA	
		RELIANCE FORGE	MUMBAI	
72.	FLANGES (SS/CS)	M.S. FITTINGS	KOLKATA	
		RELIANCE FORGE	MUMBAI	
73.	PIPE & FILLTING (PP,HDPE,PVC & CPVC)	GEROGE FISHCHER	DELHI	
		ASTROL PLYTECHINC LTD	AHMEDABAD	
74.	VALVES (GATE/GLOBE/NRV /BALL)- (PP,HDPE,PVC & CPVC)	GEROGE FISHCHER IPING SYSTEMS PVT LTD	DELHI	
		ASTROL PLYTECHINC LTD	AHMEDABAD	
		ASAHI	-	
75.	AIR FILTER REGULATOR	SHAVO NORGEN	-	
		PLACKA INSTRUMENTS	-	
76.	FILTER MEDIA	GLOBAL ABSORBENT	KOLKATA	
		BHARAT MINERALS		
77.	DC LEAD ACID / NI-CD BATTERIES	AMCO SAFT INDIA LTD	BANGALORE	
		EXIDE INDUSTRIES LTD	NEW DELHI	
		HBL POWER SYSTEMS LTD	HYDERABAD	
		HOPPECKE BATTERIEN GMBH & CO.KG,	GERMANY	
78.	DC LEAD ACID BATTERIES	EXIDE INDUSTRIES LTD	NEW DELHI	
		HBL POWER SYSTEMS LTD	HYDERABAD	
		HOPPECKE BATTERIEN GMBH & CO.KG,	GERMANY	
79.	DC NI CD BATTERIES	AMCO SAFT INDIA LTD	BANGALORE	
		HBL POWER SYSTEMS LTD	HYDERABAD	
		HOPPECKE BATTERIEN GMBH & CO.KG,	GERMANY	
80.	SIGHT FLOW INDICATORS	B.K.EQUIPMENTS PVT.LTD.	CHENNAI	
		BLISS ANAND PVT. LTD.	GURGAON	
		FLOWTECH INSTRUMENTS SERVICRS	VADODARA	
		INSTRUMENTATION ENGINEERS PVT LTD	TELANGANA	
		SIGMA INSTRUMENTS CO.	MUMBAI	
		SCIENTIFIC DEVICES (BOMBAY) PVT LTD,	NAVI MUMBAI	
		TELACE EQUIPMENT PVT.LTD.	CHENNAI	
81.	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		

SR. NO.	ITEM	SUPPLIERS	PLACE	REMARKS
		HEMPLE PAINTS (SINGAPORE)		
		JOTUN PAINTS		
82.	PNEUMATIC ACTUATOR	PROCON ENGINEERS	-	
		TYCO	-	
		CRANE PROCESS	-	
		BDK	-	
		INTERVALVE	-	
		BRAY CONTROL	-	
83.	MOTORISED ACTUATOR	ROTARK	-	
		AUMA	-	
		LIMITORK	-	
84.	MBBR	Shall be procured from OEM only and credential shall be submitted during detailed engineering.		

Notes: -

a) All the finally selected sub vendors shall be subject to BHEL/TCE/TANGEDCO approval during detailed engineering without any delivery/ commercial implications to BHEL/ TCE/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/TCE/TANGEDCO approval during detailed engineering without any delivery/ commercial implications to BHEL/ TCE/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.
  - Equipment lay out.
  - Equipment Cable tray layout.
  - Equipment earthing layout.
  - Civil scope drawings.
  - Piping lay out drawing.
  - Valve schedule.
  - Instrument schedule.

LIST OF MANDATORY SPARES [TABLE-5]

S.no.	Mandatory Spares	Total Quantity
1.0	**Spares for Horizontal Centrifugal Pumps for each type and model of pump**	
1.1	Bearing	2 Sets.
1.2	Thrust Pads	1 Set.
1.3	Shaft Sleeves	1 Set.
1.4	Fasteners	1 Set for complete one pump assembly.
2.0	**Spares for Fuel Oil OWS Waste Transfer pump**	
2.1	Bearing or bearing metals and wearing parts for each rotating unit	1 complete set
2.2	Connecting coupling for each rotating units (coupling assembly)	1 set
2.3	Packing and gaskets of total installed	100%
2.4	Inner wear and tear parts for each size and type of pump	1 set
3.0	**LT Motors of Each Type and Rating**	
3.1	Driving end bearing	1 Set.
3.2	Non Driving end bearing	1 Set.
3.3	Terminal Block for Motors upto 30 kW	10 Nos
3.4	Terminal Block for Motors above 30 kW	5 Nos
3.5	Motor of each type and rating	10% of installed quantity or 1 No which ever is higher.
4.0	**Spares for C&I items**	
4.1	Electromatic Safety Valves Pressure switches, local PB stations and solenoid valves.	10% or 2 nos. of each type whichever is more.
4.2	Local Indicators like temperature gauges, pressure gauges, differential pressure gauges, flow gauges, flow metres etc.	10% or 2 nos. of each make, model and type whichever is more and for each plant (to be divide to various ranges in proportion to main of all make, model, type population)
4.3	Process Actuated Switch Devices Includes all type of Pressure, differential pressure, flow, temperature, differential temperature, level switch devices.	5% or 1 no, of each type and model whichever is more
4.4	PD Type Flow Transmitters	1 no. of each type and model
4.5	Water Analysers- pH Transmitter Cell Electronic cards	2 nos. or 20% of each type whichever is more 1 no. of each type
4.6	Transmitter Electronic Unit	1 no. of each type model
4.7	Electronic modules for analysers	I no. for each type
5.0	Electrical actuator, complete assembly, of each rating	2 Nos.
6.0	INSTRUMENTATION CABLE, INTERNET WIRING & ELECTRICAL FIELD (Applicable where main supply is under Effluent Treatment Plant supplier scope).	
6.1	Pre fabricated cable of each type.	10% of installed quantity
6.2	Pre fabricated cable connector of each type	10% or 1 no. of each type and model, whichever is more
6.3	Other cables	5% of each type, pair and size of actual installed quantity

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.

PAINTING SPECIFICATION

CLEANING, PROTECTIVE COATING AND PAINTING

1.0.0 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 for 2x660 MW Supercritical Thermal Power Plant. 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.

2.0.0 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).

3.0.0 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
- Date of painting
- Paint details such as specification No, colour, date of manufacture, shelf life, expiry date
- 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.

4.0.0 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.

5.0.0 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.

6.0.0 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.

7.0.0 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
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.

8.0.0 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.

8.1.0 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 the Annex- ANNEX 25.1.2 -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.

8.2.0 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.

8.3.0 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.

8.4.0 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).

9.0.0 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-25.1.1.

Suitable finish paint of required DFT shall be applied as specified in the Paint system of this document- Annex-25.1.1. 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.

10.0.0 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.

11.0.0 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.

12.0.0 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 **Annex 25.1.2**. The DFT is given in microns (millionths of a metre).

13.0.0 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-25.1.1- Paint System.

Alternative to the Annex-25.1.1- 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:
  $W = Cr + 3.3 \times Mo + 22.45\ N2$

  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.

14.0.0 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 610 g/m^2 (DFT = 85µ) .

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.

15.0.0 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.

16.0.0 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.

17.0.0 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 – 25.1.1** 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 Annex 25.1.2 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.

18.0.0 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.

19.0.0 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.

20.0.0 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.

ANNEX-25.1.1

STANDARD FINAL COLOUR OF EQUIPMENT AND PIPING

1.0.0 STANDARD COLOUR CODE FOR MECHANICAL EQUIPMENT

Sl. No.	Description	Ground Colour
A	**CLOSED COOLING WATER SYSTEM**	
1	Closed cooling water pumps	Sea Green
2	Plate heat exchanger	Sea Green
3	Closed Cycle cooling Water (CCCW) pumps	Sea Green
4	CCCW Expansion tank	Sea Green
5	CCCW chemical dosing tank	Sea Green
B	**WATER TREATMENT PLANT**	
1	Raw water	
a	Raw water pump	Sea Green
b	Clarifier	Sea Green
c	- Raw / Fire water storage tank	Sea Green
d	DM plant supply pump	Sea Green
e	Filter air blower	Sea Green
f	Filter back wash pump	Sea Green
g	Lime slaking tank & agitator	Sea Green
h	Lime slurry transfer pump	Sea Green
I	Lime solution tank	Sea Green
j	Lime solution dosing pump	Sea Green
k	Alum solution tank	Sea Green
l	Alum solution metering pump	Sea Green
m	Polyelectrolyte solution tank	Sea Green
n	Polyelectrolyte solution metering pump	Sea Green
o	Sludge feed pump	Sea Green
p	Filter press	Sea Green
q	Service water tank for DM building	Sea Green
r	Service water tank for control annex	Sea Green
2	Demineralization system	
a	Activated carbon filter	Sea Green
b	Cation exchanger	Sea Green
c	Anion exchanger	Sea Green
d	Degasser tower	Sea Green
e	Air blower for degasser tower	Sea Green
f	Strong base anion exchanger	Sea Green
g	Degassed water transfer pump	Sea Green
h	Strong base anion exchanger	Sea Green
I	Mixed bed polisher	Sea Green
j	Air blower for mixed bed polisher	Sea Green
k	DM Water Storage tank	Sea Green
l	DM water transfer pump	Sea Green
m	Acid unloading cum transfer pump	Dark Admiralty Grey
n	Bulk acid storage tank	Dark Admiralty Grey
o	Acid measuring tank for SAC	Dark Admiralty Grey
p	Acid measuring tank for MB	Dark Admiralty Grey
q	Regeneration water pump	Dark Admiralty Grey
r	Caustic Lye unloading cum transfer pump	Dark Violet
s	Bulk caustic storage tank	Dark Violet
t	Caustic regeneration tank & agitator	Dark Violet

Sl. No.	Description	Ground Colour
u	Caustic solution filter	Dark Violet
v	Caustic dilution tank for SBA/WBA	Dark Violet
w	Caustic dilution tank for MB	Dark Violet
x	Caustic pump for regeneration for WBA/SBA	Dark Violet
y	Waste water recirculation cum disposal pump	Sea Green
C	**CRANE & HOIST**	
1	Power house EOT crane	Canary Yellow
2	CW pump house EOT crane	Canary Yellow
D	**COMPRESSED AIR PLANT**	
1	Air compressor	Sky Blue
2	Compressed air dryer	Sky Blue
3	Air receiver	Sky Blue
E	**Chemical Dosing**	
1	Hydrazine preparation tank	Dark Admiralty Grey
2	Ammonia preparation tank	Dark Admiralty Grey
3	Hydrazine & ammonia dosing tank	Dark Admiralty Grey
4	Hydrazine & ammonia dosing pump	Dark Admiralty Grey
5	Phosphate preparation tank	Dark Admiralty Grey
6	Phosphate dosing tank	Dark Admiralty Grey
7	Phosphate dosing pump	Dark Admiralty Grey
8	Sampling system	Dark Admiralty Grey
F	**FIRE PROTECTION SYSTEM**	
1	Diesel engine driven pump	Fire Red
2	Fuel tank for diesel engine driven pump	Fire Red
3	Main hydrant pump (Electrical)	Fire Red
4	Jockey pump	Fire Red
5	Fire Water Storage tank	Fire Red
6	CO2 cylinder	Fire Red
G	**FUEL OIL SYSTEM**	
1	Fuel oil pumps skid	Light Brown
2	Fuel oil Storage tank	Light Brown
3	Fuel oil strainer	Light Brown
H	**ASH DISPOSAL SYSTEM**	
1	Ash transmitting vessel	Aluminium
I	**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:

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

2.0.0 STANDARD COLOUR CODE FOR ELECTRICAL EQUIPMENT

	Description	Colour	Colour No.
1	Generator	Two undercoats of high quality epoxy based primer followed by two coats of epoxy painting	
2	Generator circuit breaker a) Outdoor	-	RAL 7032
	b) Indoor	Glossy white	-
3	Transformers	Pebble grey	RAL 7032
4	Bus ducts	Pebble grey	RAL 7032
5	Junction boxes.	Pebble grey	RAL 7032
6	HT/LT Switchboards, Distribution boards, Control & Relay panels		
	a) Indoor	Pebble grey	RAL 7032
	b) Outdoor	Pebble grey	RAL 7032
7	UPS Panel, charger panels	Pebble grey	RAL 7032
8	DG Alternator	Onan Green	-
9	NGR	Pebble grey	RAL 7032
10	Motor	Pebble grey	RAL 7032
11	Lighting fittings	As per manufacturer's standard	As per manufacturer's standard
12	Cable trays	Galvanized	
13	Elevator	Red oxide primer paint	

1. For interior coating, manufacturer's standard can be adopted subject to Owner's approval.
2. All panels that are to be erected at CCR floor shall be painted using RAL 7032 (exterior colour). All Electrical, C&I, Fire alarm or any other panel shall have this colour.

3.0.0 COLOUR CODING FOR IDENTIFICATION OF PIPELINES USED IN THERMAL POWER 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)	Condensate	Sea green	217	Light brown	410	
d)	Potable water	Sea green	217	French blue	166	
e)	RO water	Sea green	217	Light orange	557	
f)	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	Gas system					
a)	Hydrogen	Canary yellow	309	Signal red	537	
b)	Chlorine	Canary yellow	309	Dark violet	796	
c)	Carbon dioxide	Canary yellow	309	Light grey	631	
d)	Oxygen	Canary yellow	309	White	218	White is not included in
5	Oils					

		Ground Shade		Band Shade		
Sl.No	**Medium**	**Color**	**Color No. as per IS:5**	**Color**	**Color No. as per IS:5**	**Remarks**
a)	LDO/HFO	Light brown	410	Brilliant green	221	
b)	Transformer oil	Light brown	410	Light orange	557	
6	Chemical feed					
a)	Acid piping (in water treatment plant)	Dark admiralty grey	632	Signal red	537	Hazard mark is given
b)	Alkali Piping (in water treatment plant)	Dark violet	796	Golden yellow	356	Hazard mark is given
7	Fire services	Fire red	536	-	-	-
8	Effluent pipes	Black	-	-	-	-

4.0.0 COLOUR CODE FOR STRUCTURAL STEEL

SL. NO	**ITEAM/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
8	Hand railing 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.

ANNEX 25.1.2 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 2 1/2	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**
Structural Steelwork, piping, indoor and outdoor	130 to 200 Deg	SA 2 1/2	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 2 1/2	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**
Alternative-3			Finish	1	Single pack Heat Resistant Silicon Acrylic Finish paint. - either Aviation White/ Aviation Orange.	80
					Total	**155**
Structural Steel work Piping, Un-insulated	200 to 400	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	75

ANNEX 25.1.2 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**
Carbon Steel Indoor and Outdoor	Deg C.				/ 21 Deg.- Paint to meet compositional & performance specifications for SSPC Paint 20 , Level 1.	
			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**
Carbon steel surfaces subjected to temperature up to 400℃. But Under Thermal Insulation.	< 400℃	Power tool cleaning to St 2 /3		**2**	Red-oxide Zinc phosphate primer to IS 12744	**30**
						60
Components coming in the gas path (other than Coils), including water walls, SH panels, SH Headers, Hot air ducts etc.		Power tool cleaning		**2**	Red-oxide Zinc phosphate primer to IS 12744	**30**
						60
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**
Structural Steel work in the battery rooms, chlorination plant and	Ambien t	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	75

ANNEX 25.1.2 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**
water treatment plant, (extremely aggressive atmosphere)					specifications for SSPC Paint 20 , Level 1	
			Touch up		Two component Zinc rich Primer meeting performance and compositional specifications of SSPC Paint 20 Level2	(75)
			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**
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
					Total	**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
					Total	**400**
Steelwork immersed in	< 60	SA 3	Primer	1	Two component High Build High Solid Rapid Curing Epoxy	75

ANNEX 25.1.2 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**
seawater such as inlet/ outlet structures, dolphins, sheet piling	Deg C				Zinc Phosphate Primer.	
			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
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
			Touch	1	Two component Zinc rich Primer meeting performance and	(75)

ANNEX 25.1.2 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**
			up		compositional specifications of SSPC Paint 20 Level2	
			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**
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
					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

ANNEX 25.1.2 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**
					Total	**475**
Heat exchanger Coils coming in the gas path . (Eco, SH, RH coils & Loose tubes etc.)		Power tool cleaning			One coat of dip-coat paint -Red-oxide Zinc phosphate primer	35
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**
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 abrasive Powder	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
			Mid coat	1	Two component High Build Surface Tolerant Epoxy coating pigmented with Aluminium and Lamellar Micaceous iron oxide	150

ANNEX 25.1.2 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**
			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
			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 -				**For Indoor Application**		

ANNEX 25.1.2 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**
Water Cooled heat Exchangers like Condensers, Flash box, Water - Water coolers etc. For Outdoor installations in corrosive atmosphere - like Chemical/ Marine.	< 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
A	**Centrifugal pumps**											
I	Casing	Y2	-	Y[3]	-	-	Y	-	-	-	-	Y
II	Impeller	Y2	-	Y[3]	-	-	-	Y	-	-	-	Y
III	Shaft	Y2	-	Y[3]	Y[5]	-	-	-	-	-	-	Y
IV	Fabricated components	Y	Y	Y[3]	-	-	Y	-	-	-	-	Y
V	Assembled Pumps	-	-	-	-	-	-	-	-	Y8	-	-
B	**Tanks & vessels**	Y	Y	Y[4]	Y[6]	Y[10]	Y	-	-	-	Y	Y
C	**R&W pipes**	Y	Y	Y[4]	-	Y[7]	Y	-	-	-	Y	Y
D	**RE joint**	Y	-	-	-	-	Y	-	-	Y		Y
E	**Rubber lining**	Y	-	-	-	-	-	-	-	-	Y	Y
F	**Pipes & Fittings**	Y[2]	Y	-	-	-	Y	-	-	-		Y[12]
G	**Gear box**	Y	-	Y	Y	-		-		Y	Y	Y
H	**Gate/Globe/ Check valve**	Y	-	Y	-	-	Y[11]	-	-	-	Y	Y

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.

Remarks

LEGENDS:

1 As per AWWA C 504
2 One per heat/heat treatment batch.
3 On machined surface only.
4 Only DPT on root run after back gauging and finish weld.
5 For shaft ≥ 50 mm
6 For plates ≥ 25mm
7 For pipes weld thickness ≥20mm
8 As per HIS, USA
9 Void
10 On welds for dished ends manufactured with plates having weld joint. On vessel/tank as per design code.
11 Seat leakage test for actuator-operated valves shall be checked for seat leakage by closing the valve with actuator.
12 Pipes and fittings for rubber lining shall be free from internal weld bead.

DATA SHEET-A

1.0	**TG AREA OILY WASTE PIT (FOR UNIT-1) [LOCATED OUTSIDE ETP AREA]**	
1.1	Quantity	One Number
1.2	Capacity (each)	**5** m^3
1.3	Material	RCC
1.4	Type	Underground with single compartment.
1.5	Instruments	As per P&id.
2.0	**TG AREA OILY WASTE TRANSFER PUMP (FOR UNIT-1) [LOCATED OUTSIDE ETP AREA]**	
2.1	Quantity	Two (1W+1S)
2.2	Capacity (each)	**5** m^3/Hr.
2.3	Head	As per System Requirement.
2.4	Type	Horizontal, Screw Type
2.5	Material of Construction	Casing and Rotor Housing: Cast Iron as per IS 210 FG 260; Rotor & Shaft: CF 8M/SS 316, Driving Gear- Hardened and tempered alloy steel with machine cut teeth and ground finish.
2.6	Shaft sealing	Mechanical seal
2.7	Instruments and valves	As per P&id.
3.0	**TG AREA OILY WASTE PIT (FOR UNIT-2) [LOCATED OUTSIDE ETP AREA]**	
3.1	Quantity	One Number
3.2	Capacity (each)	**5** m^3
3.3	Material	RCC
3.4	Type	Underground with single compartment.
3.5	Instruments	As per P&id.
4.0	**TG AREA OILY WASTE TRANSFER PUMP (FOR UNIT-2) [LOCATED OUTSIDE ETP AREA]**	
4.1	Quantity	Two (1W+1S)
4.2	Capacity (each)	**5** m^3/Hr.
4.3	Head	As per System Requirement.
4.4	Type	Horizontal, Screw Type
4.5	Material of Construction	Casing and Rotor Housing: Cast Iron as per IS 210 FG 260; Rotor & Shaft: CF 8M/SS 316, Driving Gear- Hardened and tempered alloy steel with machine cut teeth and ground finish.
4.6	Shaft sealing	Mechanical seal
4.7	Instruments and valves	As per P&id.
5.0	**TRANSFORMER AREA OILY WASTE PIT (FOR UNIT-1) [LOCATED OUTSIDE ETP AREA]**	
5.1	Quantity	One Number
5.2	Capacity (each)	**Minimum 85** m^3
5.3	Material	RCC
5.4	Type	Underground with single compartment.
5.5	Instruments	As per P&id.
6.0	**TRANSFORMER AREA OILY WASTE TRANSFER PUMP (FOR UNIT-1) [LOCATED OUTSIDE ETP AREA]**	
6.1	Quantity	Two (1W+1S)
6.2	Capacity (each)	**10** m^3/Hr.
6.3	Head	As per System Requirement.
6.4	Type	Horizontal, Screw Type
6.5	Material of Construction	Casing and Rotor Housing: Cast Iron as per IS 210 FG 260; Rotor & Shaft: CF 8M/SS 316, Driving Gear- Hardened and tempered alloy steel with machine cut teeth and ground finish.
6.6	Shaft sealing	Mechanical seal
6.7	Instruments and valves	As per P&id.
7.0	**TRANSFORMER AREA OILY WASTE PIT (FOR UNIT-2) [LOCATED OUTSIDE ETP AREA]**	
7.1	Quantity	One Number
7.2	Capacity (each)	**Minimum 85** m^3
7.3	Material	RCC
7.4	Type	Underground with single compartment.
7.5	Instruments	As per P&id.
8.0	**TRANSFORMER AREA OILY WASTE TRANSFER PUMP (FOR UNIT-2) [LOCATED OUTSIDE ETP AREA]**	
8.1	Quantity	Two (1W+1S)

8.2	Capacity (each)	**10** m^3/Hr.
8.3	Head	As per System Requirement.
8.4	Type	Horizontal, Screw Type
8.5	Material of Construction	Casing and Rotor Housing: Cast Iron as per IS 210 FG 260; Rotor & Shaft: CF 8M/SS 316, Driving Gear- Hardened and tempered alloy steel with machine cut teeth and ground finish.
8.6	Shaft sealing	Mechanical seal
8.7	Instruments and valves	As per P&id.
9.0	**FUEL OIL OWS WASTE PIT (COMMON FOR TWO UNITS) [LOCATED OUTSIDE ETP AREA]**	
9.1	Quantity	One Number
9.2	Capacity (each)	**5** m^3
9.3	Material	RCC
9.4	Type	Underground with single compartment.
9.5	Instruments	As per P&id.
10.0	**FUEL OIL OWS WASTE TRANSFER PUMP (COMMON FOR TWO UNITS) [LOCATED OUTSIDE ETP AREA]**	
10.1	Quantity	Two (1W+1S)
10.2	Capacity (each)	**5** m^3/Hr.
10.3	Head	As per System Requirement.
10.4	Type	Horizontal, Screw Type
10.5	Material of Construction	Casing and Rotor Housing: Cast Iron as per IS 210 FG 260; Rotor & Shaft: CF 8M/SS 316, Driving Gear- Hardened and tempered alloy steel with machine cut teeth and ground finish.
10.6	Instruments and valves	As per P&id.
11.0	**COAL MILL WASTE SUMP-1 AND 2 (FOR UNIT-1) [LOCATED OUTSIDE ETP AREA]**	
11.1	Quantity	One Number
11.2	Capacity	**5** m^3
11.3	Material	RCC
11.4	Type	Underground with single compartment.
11.5	Instruments	As per P&id.
12.0	**COAL MILL WASTE TREANSFER PUMP (FOR UNIT-1) [LOCATED OUTSIDE ETP AREA]**	
12.1	Quantity	Two (1W+1S) per sump/pit.
12.2	Capacity (each)	**5** m^3/Hr.
12.3	Head	As per System Requirement.
12.4	Type	Vertical, Centrifugal Type (Self lubricants type).
12.5	Material of Construction	Casing: Cast Iron as per IS 210 FG 260; Shaft: Stainless Steel Gr. 410, Impeller-Stainless Steel Gr. 316/CF8M.
12.6	Shaft sealing	Mechanical seal
12.7	Instruments and valves	As per P&id.
13.0	**COAL MILL WASTE SUMP-1 AND 2 (FOR UNIT-2) [LOCATED OUTSIDE ETP AREA]**	
13.1	Quantity	Two Numbers per Unit.
13.2	Capacity (each)	**5** m^3
13.3	Material	RCC
13.4	Type	Underground with single compartment.
13.5	Instruments	As per P&id.
14.0	**COAL MILL WASTE TREANSFER PUMP (FOR UNIT-2) [LOCATED OUTSIDE ETP AREA]**	
14.1	Quantity	Two (1W+1S) per sump/pit.
14.2	Capacity (each)	**5** m^3/Hr.
14.3	Head	As per System Requirement.
14.4	Type	Vertical, Centrifugal Type (Self lubricants type).
14.5	Material of Construction	Casing: Cast Iron as per IS 210 FG 260; Shaft: Stainless Steel Gr. 410, Impeller-Stainless Steel Gr. 316/CF8M.
14.6	Shaft sealing	Mechanical seal
14.7	Instruments and valves	As per P&id.
15.0	**BOILER AREA FLOOR WASH PIT (FOR UNIT-1) [LOCATED OUTSIDE ETP AREA]**	
15.1	Quantity	Two Numbers per Unit.
15.2	Capacity (each)	**5** m^3
15.3	Material	RCC
15.4	Type	Underground with single compartment.

15.5	Instruments	As per P&id.
16.0	**BOILER AREA FLOOR WASH PIT TRANSFER PUMP (FOR UNIT-1) [LOCATED OUTSIDE ETP AREA]**	
16.1	Quantity	Two (1W+1S)
16.2	Capacity (each)	**5** m^3/Hr.
16.3	Head	As per System Requirement.
16.4	Type	Vertical, Centrifugal Type (Self lubricants type).
16.5	Material of Construction	Casing: Cast Iron as per IS 210 FG 260; Shaft: Stainless Steel Gr. 410, Impeller-Stainless Steel Gr. 316/CF8M.
16.6	Instruments and valves	As per P&id.
17.0	**BOILER AREA FLOOR WASH PIT (FOR UNIT-2) [LOCATED OUTSIDE ETP AREA]**	
17.1	Quantity	Two Numbers per Unit.
17.2	Capacity (each)	**5** m^3
17.3	Material	RCC
17.4	Type	Underground with single compartment.
17.5	Instruments	As per P&id.
18.0	**BOILER AREA FLOOR WASH PIT TRANSFER PUMP (FOR UNIT-2) [LOCATED OUTSIDE ETP AREA]**	
18.1	Quantity	Two (1W+1S)
18.2	Capacity (each)	**5** m^3/Hr.
18.3	Head	As per System Requirement.
18.4	Type	Vertical, Centrifugal Type (Self lubricants type).
18.5	Material of Construction	Casing: Cast Iron as per IS 210 FG 260; Shaft: Stainless Steel Gr. 410, Impeller-Stainless Steel Gr. 316/CF8M.
18.6	Instruments and valves	As per P&id.
19.0	**COMMON OILY WASTE COLLECTION PIT (COMMON FOR UNIT-1 & 2) [LOCATED INSIDE ETP AREA]**	
19.1	Quantity	Two Numbers per Unit.
19.2	Capacity (each)	**50** m^3 [Considering one hour flow from each source at a time {5 M^3/Hr TG Area Oily Waste (2 Nos, for 1 Hours in a day) + 10 M^3/Hr for 4 Hrs oily waste from Transformer Yard from one Transformer in case of Fire/bursting of transformer} =(5x2+10)=20 m^3].
19.3	Material	RCC
19.4	Type	Above ground with single compartment.
19.5	Instruments	As per P&id.
20.0	**OWS FEED PUMP (FOR UNIT-2) [LOCATED INSIDE ETP AREA]**	
20.1	Quantity	Two (1W+1S)
20.2	Capacity (each)	**5** m^3/Hr. [m^3 [Average taken Considering 5 M^3/Hr TG Area Oily Waste (2 Nos, for 1 Hours in a day) + 10 M^3/Hr for 4 Hrs oily waste from Transformer Yard from one Transformer in case of Fire/bursting of transformer = (5x2x1+10X4X1)/24 = 2.08 m^3].
20.3	Head	As per System Requirement.
20.4	Type	Horizontal, Screw Type
20.5	Material of Construction	Casing and Rotor Housing: Cast Iron as per IS 210 FG 260; Rotor & Shaft: CF 8M/SS 316, Driving Gear- Hardened and tempered alloy steel with machine cut teeth and ground finish.
20.6	Instruments and valves	As per P&id.
21.0	**OIL WATER SEPARATOR (COMMON FOR UNIT-1 & 2) [LOCATED INSIDE ETP AREA]**	
21.1	Quantity	One Number
21.2	Capacity (each)	**5** m^3/Hr.
21.3	Type	Plate or Tube with Counter Flow / Cross Flow.
21.4	Material of Construction	Body: Carbon Steel. Plate: UV inhibited virgin FRP or GRP or PVC.
21.5	Treated water quality	Free Oil content not to exceed 10 ppm for free oil concentration 1000 ppm max. in feed waste to the Separator.
21.6	Oil Skimmer System	Shall be provided.
21.6	Instruments and valves	As per P&id.
22.0	**SLOP OIL STORAGE TANK [LOCATED INSIDE ETP AREA]**	
22.1	Quantity	Two (2)
22.2	Type	Vertical Cylindrical.
22.3	Type of fluid to be handled	Slop Oil.
22.4	Capacity (each)	1000 Ltrs.

22.5	Material of Construction	GRP/HDPE/PP
23.0	**COMMON COLLECTION PIT (COMMON FOR UNIT-1 & 2) [LOCATED INSIDE ETP AREA]**	
23.1	Quantity	One Number
23.2	Capacity (each)	**One hour holding time for peak condition, 450** m^3 [Considering 2.08 M^3/Hr from OWS continuous + 419.33 from Coal Pile Runoff (from entire coal pile run off pond During Peak Manson time) [**Refer Note below**] + 2 M^3/Hr per Coal Mill Waste Sump (4 Nos) continuous + 5 M^3/Hr per Boiler Area Floor Wash Pit (2 Nos, for 1 Hours in a day) = {2.08+419.3+2X4+5x2} = 439.38 m^3]. **Note:** **Total Coal pile area (Unit-I + Unit-II) =780m X 280m = 218,400 SqM.** **As per GTS, Volume-II, Section-1, Page 28 of 191, Maximum Rainfall per day = 138.2 mm, i.e, 138.2/24 mm/hr = 5.76 mm/Hr.** **Total rain water for 20 minutes heavy rainfall coming from entire coal pile area (Unit-I + Unit-II) to be considered for ETP sizing calculation = 5.76/1000x218,400x20/60 CuM =419.33 CuM.**
23.3	Material	RCC
23.4	Type	Above ground with single compartment.
23.5	Instruments	As per P&id.
24.0	**TUBE SETTLER FEED PUMP [LOCATED INSIDE ETP AREA]**	
24.1	Quantity	Two (1W+1S)
24.2	Capacity (each)	**30** m^3/Hr. [Average Taken from sl no 23.2 above, (2.08X24+419.33+2x4x24+5x2x1)/24 m^3/Hr = 27.96 m^3/Hr].
24.3	Head	As per System Requirement.
24.4	Type	Horizontal, Centrifugal.
24.5	Material of Construction	Casing: Cast Iron as per IS 210 FG 260; Shaft: Stainless Steel Gr. 410, Impeller-Stainless Steel Gr. 316/CF8M.
24.6	Instruments and valves	As per P&id.
25.0	**FLASH MIXER [LOCATED INSIDE ETP AREA]**	
25.1	Quantity	One Number
25.2	Type	Flash mixer with circular/rectangular shape.
25.3	Design residence time	60 sec
25.4	Material of Construction	MS (Epoxy Painted)
25.5	Agitator	SS 316; Motor driven with reduction gear.
26.0	**FLOCCULATION TANK [LOCATED INSIDE ETP AREA]**	
26.1	Quantity	One Number
26.2	Type	Flocculation Tank with circular/rectangular shape.
26.3	Design residence time	30 min
26.4	Material of Construction	MS (Epoxy Painted)
26.5	Material of Construction	MS (Epoxy Painted)
26.6	Material of Construction	RCC
26.7	Agitator	MS with Epoxy painted or SS 316, Motor driven with reduction gear.
27.0	**TUBE SETTLER [LOCATED INSIDE ETP AREA]**	
27.1	Quantity	One Number
27.2	Capacity	**30** m^3/Hr.
27.3	Type	Plate Type Lamella clarifier.
27.4	Output Capacity for each at rated condition, m^3/hr	**30** m^3/Hr.
27.5	Surface flow rate	Not exceed to 1.2 m2/m3/hr (based on Projected Effective Surface Area)
27.6	Material of Construction	Body: MS with epoxy paint, Plate: FRP
28.0	**SLUDGE COLLECTION PIT [LOCATED INSIDE ETP AREA]**	
28.1	Quantity	One Number
28.2	Capacity (each)	**5** m^3
28.3	Material	RCC
28.4	Type	Underground with single compartment.

28.5	Instruments	As per P&id.
29.0	**SLUDGE TRANSFER PUMP [LOCATED INSIDE ETP AREA]**	
29.1	Quantity	Two (1W+1S)
29.2	Capacity (each)	**4** m^3/Hr.
29.3	Head	As per system requirement.
29.4	Type	Horizontal, Screw Type
29.5	Material of Construction	Casing and Rotor Housing: Cast Iron as per IS 210 FG 260; Rotor & Shaft: CF 8M/SS 316, Driving Gear- Hardened and tempered alloy steel with machine cut teeth and ground finish.
29.6	Instruments and valves	As per P&id.
30.0	**AIR BLOWER FOR SLUDGE COLLECTION PIT [LOCATED INSIDE ETP AREA]**	
30.1	Quantity	Two (1W+1S)
30.2	Capacity (each)	**4** m^3/Hr (minimum) or Suitable to meet 100% of system requirement.
30.3	Head	As per system requirement.
30.4	Type	Rotary, twin lobe
30.5	Purpose	Sludge mixing in Sludge Pit.
30.6	Material of Construction	Casing: Cast Iron as per IS 210 FG 260; Lobes: CS to BS 970, EN9 Forged, Shaft: CS to BS 970, EN9 Forged .
30.7	Instruments and valves	As per P&id.
31.0	**PE DOSING FOR LAMELLA CLARIFIER [LOCATED INSIDE ETP AREA]**	
31.1	Number of Tanks	Two (1W+1S)
31.2	Capacity (each) of tank	100 Ltrs (considering 2 ppm dosing and 5% dilution in tank).
31.3	Material of Construction of Tank	SS 304
31.4	Agitator per tank	1 No (MOC: SS 316)
31.5	Number of Dosing Pumps	Two (1W+1S)
31.6	Capacity (each) of Pump	5 LPH.
31.7	Head of Pump	As per system requirement.
31.8	Type of pump	Positive Displacement Plunger Type.
31.9	Material of Construction of Pump	Wetted parts PP, Casing: CI, Plunger: EN8.
31.10	Strainer for Pump	1 No per Pump, 'Y' Type, MOC: PP.
32.0	**LIME DOSING FOR LAMELLA CLARIFIER [LOCATED INSIDE ETP AREA]**	
32.1	Number of Tanks	Two (1W+1S)
32.2	Capacity (each) of tank	250 Ltrs (considering 25 ppm dosing and 10% dilution in tank).
32.3	Material of Construction of Tank	SS 304
32.4	Agitator per tank	1 No (MOC: SS 316)
32.5	Number of Dosing Pumps	Two (1W+1S)
32.6	Capacity (each) of Pump	20 LPH.
32.6	Head of Pump	As per system requirement.
32.6	Type of pump	Positive Displacement Plunger Type.
32.6	Material of Construction of Pump	Wetted parts PP, Casing: CI, Plunger: EN8.
32.6	Strainer for Pump	1 No per Pump, 'Y' Type, MOC: PP.
33.0	**ALUM DOSING FOR LAMELLA CLARIFIER [LOCATED INSIDE ETP AREA]**	
33.1	Number of Tanks	Two (1W+1S)
33.2	Capacity (each) of tank	600 Ltrs (considering 50 ppm dosing and 6% dilution in tank).
33.3	Material of Construction of Tank	SS 304
33.4	Agitator per tank	1 No (MOC: SS 316)
33.5	Number of Dosing Pumps	Two (1W+1S)
33.6	Capacity (each) of Pump	50 LPH.
33.7	Head of Pump	As per system requirement.
33.8	Type of pump	Positive Displacement Plunger Type.
33.9	Material of Construction of Pump	Wetted parts PP, Casing: CI, Plunger: EN8.
33.10	Strainer for Pump	1 No per Pump, 'Y' Type, MOC: PP.
34.0	**CENTRAL MONITORING BASIN (CMB) [LOCATED INSIDE ETP AREA]**	
34.1	Quantity	One Number with two compartments.
34.2	Capacity (each compartment)	**460** m^3 [Considering 30 M^3/Hr from Tube settler continuous +120 M^3/Hr from N-Pit for 2 Hours in a day + BWRO reject (provisional) 20 M^3/Hr 4 Hours in a day = {(25x24+120x2 +20x4)/2=920/2=460}].
34.3	Material	RCC

34.4	Type	Above ground with two compartments.
34.5	Instruments	As per P&id.
35.0	**EFFLUENT TRANSFER PUMP-1 FOR CHP DUST SUPPRESION/HORTICULTURE [LOCATED INSIDE ETP AREA]**	
35.1	Quantity	Two (1W+1S)
35.2	Capacity (each)	**22** m^3/Hr. [Selected as per Water Balance Diagram PE-DG-435-172-N110].
35.3	Head	As per System Requirement.
35.4	Type	Horizontal, Centrifugal.
35.5	Material of Construction	Casing: Cast Iron as per IS 210 FG 260; Shaft: Stainless Steel Gr. 316/CF8M.Impeller-Stainless Steel Gr. 316/CF8M.
35.6	Instruments and valves	As per P&id.
36.00	**EFFLUENT TRANSFER PUMP-2 FOR CW BLOW DOWN LINE [LOCATED INSIDE ETP AREA]**	
36.1	Quantity	Two (1W+1S)
36.2	Capacity (each)	**50** m^3/Hr. **[Refer sl no 34.2 above: 920 CuM/24 Hrs=38.33 Cum/Hr]**
36.3	Head	As per System Requirement.
36.4	Type	Horizontal, Centrifugal.
36.5	Material of Construction	Casing: Cast Iron as per IS 210 FG 260; Shaft: Stainless Steel Gr. 316/CF8M.Impeller-Stainless Steel Gr. 316/CF8M.
36.6	Instruments and valves	As per P&id.
37.0	**ACID DOSING FOR CMB [LOCATED INSIDE ETP AREA]**	
37.1	Number of Tanks	One Number
37.2	Capacity (each) of tank	250 Ltrs
37.3	Material of Construction of Tank	HDPE
37.4	Number of Dosing Pumps	Two (1W+1S)
37.5	Capacity (each) of Pump	5 LPH.
37.6	Head of Pump	As per System Requirement.
37.7	Type of pump	Positive Displacement Plunger Type.
37.8	Material of Construction of Pump	Wetted parts PP, Casing: CI, Plunger: CF8M.
37.9	Strainer for Pump	1 No per Pump, 'Y' Type, MOC: PP.
38.0	**ALKALI DOSING FOR CMB [LOCATED INSIDE ETP AREA]**	
38.1	Number of Tanks	One Number
38.2	Capacity (each) of tank	250 Ltrs
38.3	Material of Construction of Tank	HDPE
38.4	Agitator per tank	1 No (MOC: SS 316)
38.5	Number of Dosing Pumps	Two (1W+1S)
38.6	Capacity (each) of Pump	5 LPH.
38.7	Head of Pump	As per System Requirement.
38.8	Type of pump	Positive Displacement Plunger Type.
38.9	Material of Construction of Pump	Wetted parts PP, Casing: CI, Plunger: CF8M.
38.10	Strainer for Pump	1 No per Pump, 'Y' Type, MOC: PP.
39.00	**CHEMICAL STORAGE AND HANDLING AREA [LOCATED INSIDE ETP AREA]**	
39.1	Number	One (1).
39.2	Type	Single storied building cum Industrial Shed Comprising One chemical store room for 30 days storage capacity, dosing system area under shed.
39.3	Building dimensions	Shall be decided during detailed engineering
40.00	**PIPE**	**Refer P&ID.**
41.0	**VALVES**	**Material of Construction**
41.1	Raw water/filter water/plant effluent water (non-corrosive)	**Butterfly** Butterfly valves shall be of double flanged confirming to AWWA-C-504 class 150 (min.) or BS:5155 PN 10 (min.) Body: cast Iron IS:210 Gr. FG 260 Disc: cast Iron IS:210 Gr. FG 260 Shaft: ASTM.A296 Gr. CF8M Seat rings: Nitrilerubber, EPDM, Hypalon All the butterfly valves shall be provided with Hand wheel or lever as per the requirements. All the butterfly valves shall be provided with an indicator to show the position of the disc. Flanges shall conform to ANSI B 16.5 Cl.150 (min.) **GATE VALVE**

		Type: Outside screw and rising stem type Stem, seat ring and wedge facing ring: SS, Rating: PN 10 (min). Other parts of the valve: As per IS:14846. **BALL VALVE** Type: Full bore. Rating: PN 10 (min). Body: cast Iron/carbon steel. Ball: stainless steel. Seat ring: PTFE. Stem: Stainless steel Seat: Nitrile rubber, PTFE **GLOBE** Type: Double flanged or wafer type. Rating: PN 10 (min). Body: Cast iron: IS 210 Gr FG260. Stem: Stainless steel Disc: Cast iron. **NON RETURN VALVE** These valves shall be swing check type or dual plate type. Body and disc: Cast iron. Hinge pin and door/disc pin: SS 304. Disc facing ring: SS 304. Body Seat ring: SS 304.
41.2	Corrosive application (**CMB and onwards application**).	**Butterfly Valve** The butterfly valves shall conform to CL No. 41.1 above except for the following requirements: a) Body shall be lined (minimum 3 mm) with natural rubber, ebonite, polypropylene or PVDF. b) Disc shall be lined with PVDF, Polypropylene or natural rubber. c) Seat rings shall be of Nitrile rubber or Hypalon. **NON RETURN VALVE** These valves shall be swing check type or dual plate type. Body and disc: Cast iron lined (minimum 3 mm) with natural rubber, ebonite, polypropylene or PVDF. Hinge pin and door/disc pin: SS 316L. Disc facing ring: SS 316L. Body Seat ring: SS 316L.
41.3	Acid and alkali service	All parts of the valves shall be SS 316 (except hand wheel).
41.4	ISOLATION GATE (SLUICE GATE)	GATE FRAME & SHUTTER: MILD STEEL IS:2062 Gr 'B' with FRP coated both side. BOTTOM RUBBER SEAL: EPDM RUBBER STEM/SPINDLE: MILD STEEL IS:2062 Gr 'A'. HEADSTOCK: CAST IRON IS :210 FG 200 STEM BLOCK/THRUST NUT: CF8 ASSEMBLY FASTNERS: ASTM A276 TYPE 304 YOKE: MILD STEEL IS:2062 Gr 'A'
42.0	**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.
43.0	**FASTENERS**	For corrosive application SS 316L (**CMB and onwards application**). and for normal application SS 316.

SECTION – C2

(SPECIFIC TECHNICAL REQUIREMENTS FOR ELECTRICAL)

ELECTRICAL EQUIPMENT SPECIFICATION

SPECIFIC TECHNICAL REQUIREMENTS:

1.0 EQUIPMENT & SERVICES TO BE PROVIDED BY BIDDER:

The equipment and services to be provided by bidder under this specification shall be as detailed here below but shall not be limited to the following:

a) Services and Equipment as per "Electrical Scope between BHEL and Vendor".

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

c) Supply of mandatory spares as specified in the specifications of mechanical equipments.

d) Electrical load requirement for Effluent Treatment Plant ~~& Sewage Treatment Plant~~.

e) All equipment shall be suitable for the power supply fault levels and other climatic conditions mentioned in the enclosed project information.

f) Bidder to furnish list of makes for each equipment at contract stage, which shall be subject to customer / BHEL approval without any commercial and delivery implications to BHEL.

g) Various drawings including GA drg, data sheet as per required format, quality plans, calculations, test reports, test certificates, operation and maintenance manuals, characteristic curves, wiring diagrams/schemes etc. shall be furnished as specified at contract stage. All documents shall be subject to customer / BHEL approval without any commercial implications to BHEL.

h) The sub-vendor list for various electrical items is subject to BHEL/Customer approval without any commercial implications.

i) Motors shall meet minimum requirement of Electric motor specification.

j) Purchaser will furnish data sheets to the vendor after award of contract. Vendor shall furnish filled in data sheets meeting the specification requirements.

k) Vendor to clearly indicate equipment locations and local routing lengths in their cable listing furnished to BHEL.

l) Cable BOQ worked out based on routing of cable listing provided by the vendor for "both end equipment in vendor's scope" shall be binding to the vendor with +10 % margin to take care of slight variation in routing length & wastages.

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

Refer "Electrical Scope between BHEL and Vendor".

3.0 **DOCUMENTS TO BE SUBMITTED ALONG WITH BID**

3.1 Bidder shall confirm total compliance to the electrical specification without any deviation from the technical / quality assurance requirements stipulated. In line with this, the bidder as technical offer shall furnish two signed and stamped copies of the following:

3.2 No technical submittal such as copies of data sheets, drawings, write-up, quality plans, type test certificates, technical literature, etc, is required during tender stage. Any such submission even if made, shall not be considered as part of offer.

4.0 **LIST OF ENCLOSURES**

4.1 Electrical scope between BHEL & vendor
4.2 Technical specification – Specification for Electric Motors/Actuators
4.3 Standard Technical specification – LV Motors
4.4 Datasheets ~~& quality plan~~ for motors.
4.5 Load Data Format. ~~(Annexure –II)~~
4.6 BHEL Cable listing format ~~(Annexure –III)~~

ELECTRICAL LOAD FORMAT

LOAD TITLE	RATING (KW / A)		FULL LOAD CURRENT FLC(A)	UNIT (U)/STN. (S)	Nos.		VOLTAGE CODE*	FEEDER CODE*	EMER. LOAD (Y)	CONT.(C)/ INTT.(I)	STARTING TIME> 5 SEC (Y)	LOCATION (Tag. No.)	RATING & FLC CHECKED FROM MOTOR/VALVE APPROVED DATASHEET (Y/N)	BOARD NO.	CABLE		BLOCK CABLE DRG. No.	CONTROL CODE	REMARKS	LOAD No.	KKS NO.
	NAME PALTE	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	20	21	22

NOTES: 1. COLUMN 1 TO 14 & 20 SHALL BE FILLED BY THE REQUISITIONER (ORIGINATING AGENCY); REMAINING COLUMNS ARE TO BE FILLED UP BY PEM (ELECTRICAL)

2. ABBREVIATTIONS : * 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 =220V, H = 110 V, J = 48 V, K = +24V, L= -24V

: **FEEDER CODE (8) :- U = UNIDIRECTIONAL STARTER, B = BIDIRECTIONAL STARTER, S = SUPPLY FEEDER, D = SUPPLY FEEDER (CONTACTOR CONTROLLED)

BHEL	LOAD DATA (ELECTRICAL)		JOB NO.			ORIGINATING AGENCY		PEM (ELECTRICAL)	
			PROJECT TITLE			NAME		DATA FILLED UP ON	
			SYSTEM / S			SIGN.		DATA ENTERED ON	
			DEPTT. /SECTION			SHEET 1/2	REV. R0	DE'S SIGN. & DATE	

ELECTRICAL SCOPE FOR VENDOR AND BHEL

ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR (FOR EPC PROJECTS)

PACKAGE: EFFLUENT TREATMENT PLANT

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

PROJECT: 2 X 660 MW UDANGUDI STPP STAGE-I

S.NO	DETAILS	SCOPE SUPPLY	SCOPE E&C	REMARKS
1	415V MCC	BHEL	BHEL	415 V AC, 3 phase, 3 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. However, any steel structure required for mounting of cable tray support shall be in vendor's scope.
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
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.

ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR (FOR EPC PROJECTS)

PACKAGE: EFFLUENT TREATMENT PLANT

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

PROJECT: 2 X 660 MW UDANGUDI STPP STAGE-I

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

C&I SPECIFIC TECHNICAL REQUIREMENT
FOR DCS BASED
EFFLUENT TREATMENT PLANT

Specific Technical Requirements (C&I):

1. Effluent Treatment Plant (ETP) shall be operated from DCS (BHEL's scope).

2. The Contractor shall provide complete Instrumentation for control, monitoring and operation of entire ETP. The requirements given are to be read in conjunction with detailed Technical specification enclosed in the specification. Further in case of any discrepancy in the requirement within the same section noted by the bidder in the specification, the same will be brought to the notice of BHEL in the form of pre- bid clarification. In absence of any pre-bid clarification, the more stringent requirement as per interpretation of customer shall prevail without any commercial implication.

3. The make/model of various instruments/items/systems shall be as per customer's approved vendor list. No commercial and delivery implication in this regard shall be acceptable. In case of any conflict and repetition of clauses in the specification, the more stringent requirements among them are to be complied with.

4. All instruments and control elements shall be terminated on JB/LCP in field and both instrument and JB/LCP are in bidder scope. Number of Junction Boxes shall be sufficient and positioned in the field to minimize local cabling (max 12-15 mtrs) and trunk cable.

5. For cable scope refer to electrical scope between BHEL and vendor defined in electrical specification.

6. Bidder to provide mandatory spares as per mandatory spares list.

7. Electrical Actuators with integral starter shall be provided for all on/off and inching type valves along with necessary interface units for linking to corresponding Control System as applicable, typical Hook-up diagram of drives is included for reference.

8. The specifications for instruments mentioned in the specification are minimum requirements. The detail specifications shall be finalized during detail engineering.

9. The bidders shall specifically mention any deviation they would like to take on the C&I specification. In absence of only deviation, a No deviation certificate is to be furnished.

10. The quantity of instruments for the system shall be as per tender P &ID wherever provided of the respective system as a minimum, for bidding purpose. However, Bidder shall also include in his proposal all the instruments and devices that are needed for the completeness of the plant auxiliary system/ equipment supplied by the bidder, even if the same is not specifically appearing in the P & ID. During detail engineering if any additional instruments are required for safe & reliable operation of plant, bidder shall supply the same without any price implication.

11. Bidder to terminate all instrumentation and control elements in junction boxes. Bidder to provide input/output list, drives list, junction box schedule and termination details, recommended control logics / write-up etc. the list of documents to be submitted after award of contract is to be referred by bidder.

12. All the transmitters supplied by Bidder shall be rack mounted. The transmitter racks shall be in Bidder's scope of supply. All transmitters shall be HART compatible.

13. Bidder to perform tests of C&I items/instruments/systems as per Quality plans/type test attached in the specification. However, if any test not specified in the quality plan but specified in specification Tests for I&C equipment included elsewhere in specification will have to perform by Bidder without any cost implication. The make/model of various instruments/items/systems shall be as per customer/BHEL approved vendor list. No commercial and delivery implication in this regard shall be acceptable. In case of any conflict and repetition of clauses in the specification, the more stringent requirements among them are to be complied with.

14. Instrument installation and accessories required for the same shall be in Bidder's scope and shall be submitted after award of contract. However, any instrument/ analyser installation not covered in the same shall be subject to customer and BHEL approval during detailed engineering.

15. Bidder to furnish electrical load/UPS load data during detailed engineering.

16. UPS Power supply shall be provided by BHEL at a single point, further distribution to various instruments/equipment of the system shall be in bidder scope. Bidder to include necessary power distribution board in his scope. Any power supply other than the above, if required by any instrument/equipment has to be derived by the bidder from the above supply & all necessary hardware for the same shall be in bidder scope. Bidder to submit the power requirement along with the bid.

17. Bidder’s presence is required for 3 Man days (Excluding travel time) at EDN Bangalore during FAT of DDCMIS for certifying correctness & completeness of implementation of Control logic. Intimation to attained FAT shall be informed in 2 days advance. All the expenses like boarding, lodging and travel, Air fare etc. shall be in bidder’s scope.

18. Bidder’s presence is required for 9 Man days (in three visit) at site during commissioning of DDCMIS for assistance related to process correctness. Three visit with total 15 Man days (Excluding travel time) in which one visit shall be of 3 Man days each. All the expenses like boarding, lodging and travel, Air fare etc. shall be in bidder’s scope.

19. Contractor shall furnish Instrument Schedule, I/O list, Drive list, Cable Schedule, Cable interconnection (DCS end terminal details shall be provided to vendor during detail engineering to incorporate in cable interconnection), JB grouping, Annunciation list, SOE list, List of Instruments/devices for HART in BHEL approved format. Also reusable database format like MS Excel, MS Access etc. of these documents shall also be provided by Contractor in BHEL approved format. Soft copy of the formats shall be provided to the successful bidder.

20. Interface of MCC, HT SWGR, Solenoid valves, field instruments, Actuators etc. with DDCMIS based control system shall be as per Drive Control Philosophy enclosed in specification.

21. Local control panel if any required for operation shall be in bidder scope.

22. The solenoid operated valves/Dampers/Gate shall have a limit switch for open/close feedback. Solenoid Valve shall be rated for 24V Dc only.

23. All field instruments enclosure shall be IP65 local panel/cabinet enclosure shall be IP 55, unless otherwise specified.

24. Diaphragm seal shall be provided with Instruments having contact with corrosive media.

25. Redundancy of sensors shall be provided by bidder

    (i) Triple redundancy for all analog and binary inputs required for protection of system/drives.
    (ii) For all other control functions dual redundancy of the sensors shall be provided by the bidder.

26. Double root valve shall be provided for all pressure tapings where the pressure exceeds 40kg/cm2.

27. Use of process actuated shall be avoided unless unavoidable.

28. Number of pairs to be selected for Screen /Control cable
    a) F-Type: 2P/4P/8P/12P (Size: 0.5sqmm2)
    b) G-Type: 2P/4P/8P/12P (Size: 0.5sqmm2)
    c) Core Cable: 3CX2.5sqmm2/ 5CX2.5sqmm2/ 12CX1.5sqmm2

29. Instrument installation shall be as per the attached "Standard Hook-up diagram of instrument."
30. In addition to requirements specified here, all C&I systems/ sub-systems/ equipment/ devices shall also meet other requirements stipulated under other Sub-sections/ parts/ sections of specification.

31. In case of any conflict and repetition of clauses in the specification, BHEL discretion will prevail.

32. All the outdoor field instruments such as analysers/transmitters/meters etc. shall be provided with suitable Free standing cabinet(s)/panel/rack so that the equipment are protected against rain/ sunlight etc.

33. Material described in the specification (for instrument, equipment, accessories etc.) are the minimum requirements, which shall be complied by bidder. Any other better material shall also be considered to suit the process and environmental conditions at site subject to owner's approval. Material, if found not suitable shall be changed without any price implication.

34. Painting Process/procedure & Painting material shall be suitable for sea water and saline conditions at site in line with national and international standards like ASTM, ISO etc.
35. Epoxy coated painting is required for all I & C Equipment & Instruments.

NOTE-1: The overall operation & control of entire ETP shall be through standalone control system of DDCMIS family, located in ETP Control Room near Central Monitoring Basin (CMB). Other sumps outside ETP area shall be controlled from nearby control system (BHEL scope).
Note-2: DCS/DDCMIS is in BHEL scope of supply.

P&ID FOR EFFLUENT TREATMENT PLANT

ETP AREA

OUT SIDE ETP

TG AREA OIL WASTE UNIT-1

TG AREA OIL WASTE TRANSFER PUMPS#UNIT-1

QTY : 1W + 1S
CAP. -5 M³/ HR.

E-1 TG AREA OIL WASTE PIT # UNIT-1 (CAP: 5 CUM)

TG AREA OIL WASTE UNIT-2

TG AREA OIL WASTE TRANSFER PUMPS#UNIT-2

QTY : 1W + 1S
CAP. -5 M³/ HR.

E-2 TG AREA OIL WASTE PIT # UNIT-2 (CAP: 5 CUM)

TRANSFORMER AREA OIL WASTE UNIT-1

TRANSFORMER AREA OILY WASTE TRF. PUMPS #UNIT-1

QTY : 1W + 1S
CAP. -10 M³/ HR.

E-3 TRANSFORMER AREA OILY WASTE PIT #UNIT-1 (CAP: 85 CUM)

TRANSFORMER AREA OIL WASTE UNIT-2

TRANSFORMER AREA OILY WASTE TRF. PUMPS #UNIT-2

QTY : 1W + 1S
CAP. -10 M³/ HR.

E-4 TRANSFORMER AREA OILY WASTE PIT #UNIT-2 (CAP: 85 CUM)

FUEL-OIL OWS WASTE TRANSFER PUMP

QTY : 1W + 1S
CAP. -5 M³/ HR.

E-5 FUEL-OIL OWS WASTE PIT
(REF. DRG. NO. : PE-DG-435-166-A001)

COAL MILL WASTE UNIT-1

COAL MILL WASTE TRANS. PUMPS

QTY : 1W + 1S
CAP. -5 M³/ HR.

E-6 COAL MILL WASTE SUMP-1; UNIT-1 (5 CUM)
(REF. DRG. NO. : PE-DG-435-163-A013)

COAL MILL WASTE UNIT-1

COAL MILL WASTE TRANS. PUMPS

QTY : 1W + 1S
CAP. -5 M³/ HR.

E-7 COAL MILL WASTE SUMP-2; UNIT-1 (5 CUM)
(REF. DRG. NO. : PE-DG-435-163-A013)

COMMON OILY WASTE COLLECTON PIT
CAP :50 M³

E-12

OWS FEED PUMPS
QTY : 1W + 1S
CAP. -5 M³/ HR.

OIL WATER SEPARATOR (OWS)
QTY : 1 NO.
CAP. - 5 M³/ HR.

SLOP OIL TANK
QTY : 2 NOS
CAP. - 1000 LITRES
MOC : GRP/HDPE/PP

TO SLUDGE COLLECTION PIT

BOILER/ESP FLOOR WASH AREA UNIT-1

BOILER AREA FLOOR WASH PIT TRANSFER PUMPS # UNIT-1

QTY : 1W + 1S
CAP. -5 M³/ HR.

E-10 BOILER AREA FLOOR WASH PIT # UNIT-1
CAP.-5 M³

BOILER/ESP FLOOR WASH AREA UNIT-2

BOILER AREA FLOOR WASH PIT TRANSFER PUMPS # UNIT-2

QTY : 1W + 1S
CAP. -5 M³/ HR.

E-11 BOILER AREA FLOOR WASH PIT #UNIT-2
CAP.-5 M³

RECIRCULATION LINE

TUBE SETTLER FEED PUMPS

QTY : 1W + 1S
CAP. -30 M³/ HR.

E-13 COMMON COLLECTION PIT
CAP.- 450 M³

ETP VENDOR SCOPE

CAP : 419.33 M³/ (Total from 2 Units) TREATED COAL PILE RUN OFF WATER (ONLY DURING PEAK MONSOON TIME)
(REF. DRG. NO :IS-4-DB-714-111-M079).

T-3

EMERGENCY SHOWER

EYE WASH

SAFETY SHOWER & EYE WASH (LOCATED AT CHEMICAL HANDLING AREA)

BHEL SCOPE

FROM SERVICE WATER
(REF. DRG. NO. : PE-DG-435-175-N003)

PR DOSING SYSTEM

PE DOSING TANK
QTY : 1W+1S
CAP : 100 Ltr.

DOSING PUMPS
QTY : (1W+1S)
CAP : 5 LPH (EACH)

LIME DOSING SYSTEM

LIME DOSING TANK
QTY : 1W+1S
CAP : 250 Ltr (EACH).

DOSING PUMPS
QTY : (1W+1S)
CAP : 20 LPH (EACH)

ALUM DOSING SYSTEM

ALUM DOSING TANK
QTY : 1W+1S
CAP : 600 Ltr (EACH).

DOSING PUMPS
QTY : (1W+1S)
CAP : 50 LPH (EACH)

ALKALI DOSING SYSTEM

TANK
QTY : 1 NO.
CAP : 250 Ltr.

DOSING PUMPS
QTY : (1W+1S)
CAP : 5 LPH (EACH)

ACID DOSING SYSTEM

TANK
QTY : 1 NO.
CAP : 250 Ltr.

DOSING PUMPS
QTY : (1W+1S)
CAP : 5 LPH (EACH)

TUBE SETTLER
QTY : 1 NO.
CAP. - 30 M³/ HR.

SLUDGE FROM OWS

RECIRCULATION LINE

SLUDGE TRANSFER PUMPS

QTY : 1W + 1S
CAP:- 4 M³/ HR.

E-14 SLUDGE COLLECTION PIT
CAP.-5 M³

AIR BLOWERS FOR SLUDGE COLLECTION PIT

FLOW : 5 M³/ HR.

ASH SLURRY PIT
REF. DRG. NO :IS-4-DC-714-303-M031.

CW BLOW DOWN LINE LOADING TO OUTFALL (PROVISION)

EFFLUENT TRANSFER PUMP-1

QTY : 1W + 1S
CAP. -22 M³/ HR.

FOR HORTICULTURE
(200M 65NB HDPE HOS PIPE)

EFFLUENT TRANSFER PUMP-2

QTY : 1W + 1S
CAP. - 50 M³/ HR.

E-15

COMPARTMENT-A
CAPACITY : 460 M³ EACH

COMPARTMENT-B
CAPACITY : 460 M³ EACH

CENTRAL MONITORING BASIN
TWIN COMPARTMENT
TYPE : RCC - ABOVE GROUND

INLET CHAMBER

ETP VENDOR

BHEL BAP
(REF. DRG. NO :1-WT-220-01574)

RWRO REJECT FROM ROOM PLANT

T-2

80 NB, UPVC, CAP :20 M³/Hr (PROVISION) (CONSIDER 50M PIPING IN ETP VENDOR SCOPE)

(REF. DRG. NO :PE-VD-435-155-A031)

200 NB, CPVC, CAP :120 M³/Hr (FOR TWO HOUR IN A DAY) (CONSIDER 50M PIPING IN ETP VENDOR SCOPE)

T-1

CPU & DM WASTE FROM N-PIT

ETP VENDOR

CPU VENDOR

PIPE SIZES OF CS MATL.

NB	OD	THICK.
200	219.1	6.4
250	273.0	6.4
300	323.9	8.0
350	355.6	8.0
400	406.4	8.3
450	457.0	8.0
500	508.0	8.0
600	610.0	10.0
700	711.0	10.0
800	813.0	10.0
900	914.0	10.0
1000	1016	12.0

LEGEND

LINE SYMBOL	
LINES	LEGEND
CONTINUITY LINE	
PROCESS LINE	
AIR LINE	
CONTROL SIGNAL	
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	M
FUNEL	
AGITATOR	
DRAIN	

INSTRUMENT SYMBOLS	
PRESSURE GAUGE	PI
LEVEL GAUGE	LI
LEVEL TRANSMITTER	LT
PRESSURE TRANSMITTER	PT
pH ANALYZER	pH
DIAPHRAGM SEAL	
FLOAT & BOARD LEVEL INDICATOR	LI

FUNCTIONAL SYMBOLS	
FIELD MOUNTED INSTRUMENT	
INTERLOCK	

KKS CODING SYSTEM

UNIT KEY (90-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

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

PIPE LENGTH (FROM OUTSIDE TO ETP AND ETP TO OUTSIDE)

NODE-1 TO NODE-2: 320 M. NODE-3 TO NODE-2: 50 M. NODE-2 TO NODE-4: 850 M.	NODE-5 TO NODE-6: 300 M. NODE-7 TO NODE-6: 75 M. NODE-6 TO NODE-8: 975 M.	NODE-9 TO NODE-10: 850 M.	NODE-11 TO NODE-12: 300 M. NODE-13 TO NODE-12: 50 M. NODE-12 TO NODE-14: 200 M.
NODE-15 TO NODE-16: 300 M. NODE-17 TO NODE-16: 50 M. NODE-16 TO NODE-14: 150 M.	NODE-14 TO NODE-18: 1000 M.	NODE-19 TO NODE-20: 300 M. NODE-21 TO NODE-20: 50 M. NODE-20 TO NODE-22: 950 M.	NODE-23 TO NODE-24: 675 M.
NODE-25 TO NODE-26: 1175 M.	NODE-27 TO NODE-28: 150 M.		

NOTE:

1. ETP COLLECTION SUMPS E-1 TO E-11 ARE LOCATED AT VARIOUS COLLECTION AREA.
2. E-12AND OTHER SYSTEMS ARE LOCATED IN ETP AREA.
3. ALL CHEMICAL DOSING SYSTEMS ARE LOCATED IN ETP AREA UNDER INDUSTRIAL SHED.
4. ISOLATION VALVES FOR INSTRUMENT IS INTEGRAL PART OF RESPECTIVE INSTRUMENT.

REFERENCE DRAWINGS:

1) PID -PLANT WATER SYSTEM P&ID PLANT WATER SYSTEM: PE-DG-436-172-N001.
2) PLOT PLAN: PE-DG-435-100-M001.

PROJECT	2 X 660MW UDANGUDI SUPERCRITICAL TPP STAGE-1 AT UDANGUDI, THOOTHUKUDI DISCTRICT, TAMIL NADU
OWNER	TAMILNADU GENERATION & DISTRIBUTION CORPORATION LTD.
OWNER'S CONSULTANT	TATA CONSULTING ENGINEERS LIMITED, BENGALURU.
EPC CONTRACTOR	BHARAT HEAVY ELECTRICALS LIMITED, POWER SECTOR. UNIT: PROJECT ENGINEERING MANAGEMENT, NOIDA.

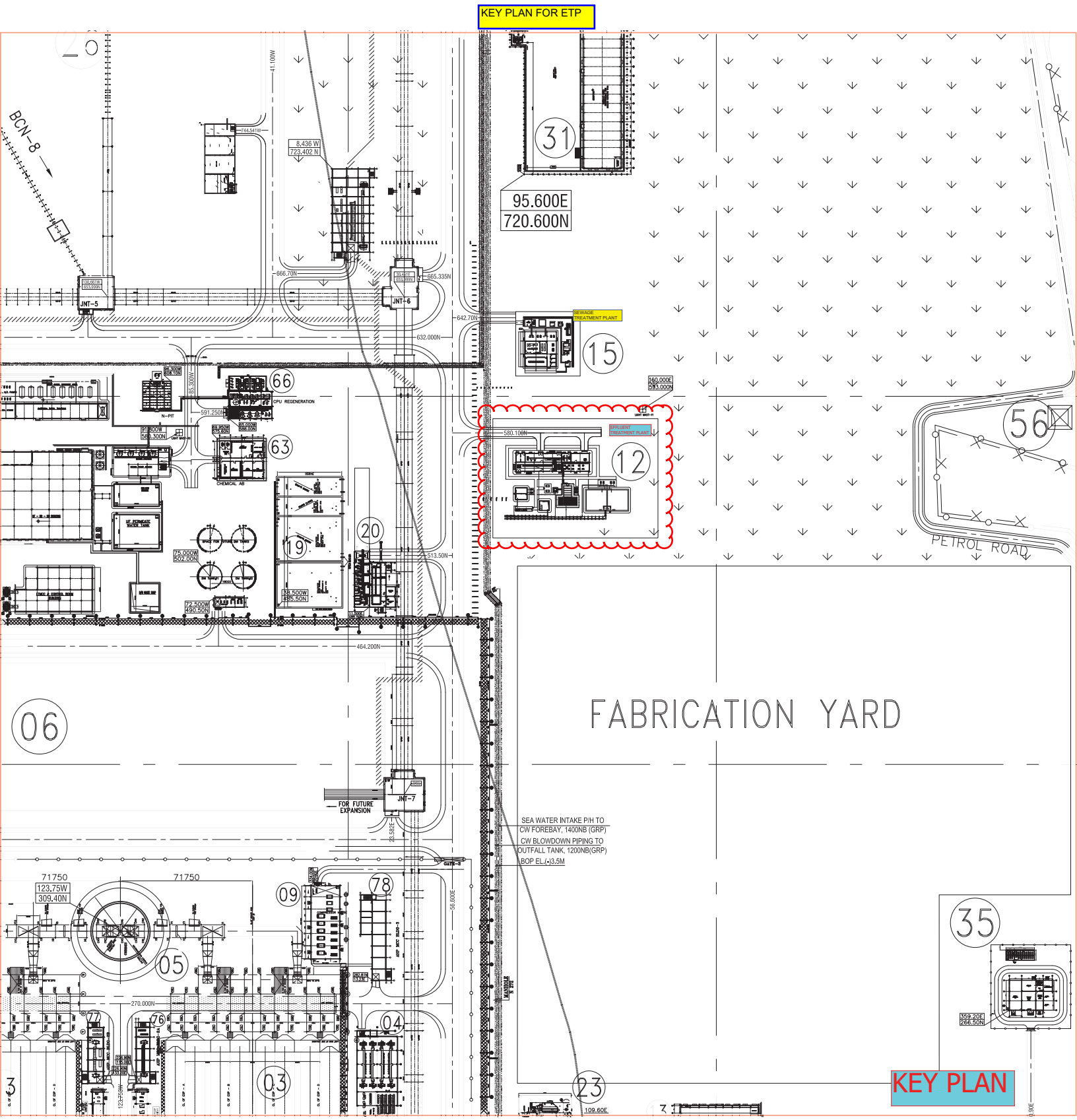
TITLE: P & ID FOR EFFULENT TREATMENT PLANT

	NAME	SIGN.	DATE
DRAWN	F SAHA	Sd /-	11.03.21
CHECKED	J PAL	Sd /-	11.03.21
APPROVED	S BHARTIYA	Sd /-	11.03.21

ALL DIMENSIONS ARE IN MILLIMETRES
PROJECTION
SCALE N.T.S
BHEL DRAWING NO. PE-DG-435-164-A001.
REV 00

Size A1

KEY PLAN


KEY PLAN FOR ETP
BCN-8
95.600E
720.600N
FABRICATION YARD
PETROL ROAD
SEA WATER INTAKE P/H TO
CW FOREBAY, 1400NB (GRP)
CW BLOWDOWN PIPING TO
OUTFALL TANK, 1200NB(GRP)
BOP EL.(+)3.5M
FOR FUTURE
EXPANSION
JNT-5
JNT-6
JNT-7
CPU REGENERATION
CHEMICAL AB
SEWAGE
TREATMENT PLANT
EFFLUENT
TREATMENT PLANT
KEY PLAN

SECTION-D

(GENERAL TECHNICAL REQUIREMENT)

SECTION-D1

(GENERAL TECHNICAL REQUIREMENT FOR MECHANICAL)

GENERAL TECHNICAL REQUIREMENT FOR MECHANICAL FOR EFFLUENT TREATMENT PLANT

A. DESIGN CRITERIA (REFER THE ENCLOSED P&I DIAGRAM: PE-DG-435-164-A001).

Following effluents will be transferred/ collected/ treated in the Effluent Treatment Plant of capacity 30 Cum/Hr:

- ETP sludge.
- N-PIT Waste from CPU and RO-DM Plant.
- Coal Mil Area Waste Water
- Boiler and ESP Area **Floor** Wash Water.
- Oily Effluent and floor Wash Water from Power House Area.
- Burnt oil from transformer yard.
- Treated Oily Waste Water from Fuel Oil Pump House.
- Coal Mil Area Waste Water
- Coal pile runoff water.

B. DESCRIPTION FOR FACILITIES LOCATED OUTSIDE EFFLEUNT TREATMENT PLANT AREA.

a) N-PIT Waste from RO-DM and CPU.

The neutralized regeneration waste/effluent from RO-DM shall be pumped to CPU N-Pit for further pumping to ETP (CMB-Central Monitoring Basin) for further disposal after neutralization in CPU N-pit. The total effluent will come from CPU N-pit 120 CuM/Hr for two hours in a day. This effluent is intermittent in nature.

b) BWRO Reject.

BWRO Reject shall be suitably used back in the Desalination Plant or shall be pumped to CMB located at ETP for CHP dust suppression/ green belt development as a provisional arrangement

c) Boiler and ESP Area Floor Wash Water.

Boiler & ESP area floor washing drain having high TSS will be led to a respective Boiler Area Waste Water Pit for further pumping to common collection pit located in Effluent Treatment Plant for further treatment through Tube Settler for TSS removal. The clear water/treated water shall be collected in CMB for further use in CHP Dust Suppression, Horticulture or Pumping to sea through CW Blow Down Line (optional). This effluent is intermittent in nature.

The trench that will convey boiler and ESP area wash water may receive huge rainfall runoff during heavy down pour. During such condition of continuous heavy rains, the total quantity of waste water at the trench leading to the respective pit will be so high that it cannot be handled in the respective pit and Tube Settler. In fact, after initial few minutes of heavy rains the rainfall runoff is not expected to contain any suspended solids. Hence, an overflow weir controlled by-pass system is proposed before the respective pit to divert such rainfall runoff to the nearby storm drain.

d) Oily Effluent and floor Wash Water from Power House Area.

Power House Area (TG area) Effluent generated from floor washings, leakages from bearing and turbine cooling systems, leakage from pumps, hydraulic couplings, oil leakage from oil burners etc. containing suspended solids and some oil and grease will be channelized to a respective unit's TG Area Oily Waste Pit for further pumping to Common Oily Waste Collection Pit located in Effluent Treatment Area for further treatment through Oil Water Separator (OWS). The normal effluent coming to these pits due to washing and the total effluent quantity shall be around 5 CuM per day. This effluent is intermittent in nature.

e) Transformer Yard Oily Waste Water.

In the event of fire and/ or bursting of transformer causing loss of containment of transformer oil, spilled oil is collected in respective unit's Retention Pit for Oily Waste Water (Total 2 nos. for

station) [Each Pit Cap (min).: 85 m^3] for further pumping to Common Oily Waste Collection Pit located in Effluent Treatment Area for further treatment through Oil Water Separator (OWS). The oil shall be floated over water in respective Retention Pit and the bottom water shall be pumped to ETP for oil removal. The water quantity is approximately 30 to 40 CuM. This effluent is intermittent in nature.

f) Oily Waste from Fuel Oil Handling & Storage System.

Oily effluent from Fuel Oil Pump House and Fuel Oil Storage Unloading Area after its collection in Oil Water Separation Pit shall be pumped to Common Oily Waste Collection Pit for further treatment through Oil Water Separator. Expected effluent quantity is around 5 CuM/day in case of rain. This effluent is intermittent in nature.

g) Coal Mil Area Waste Water.

Coal Mil Area Effluent containing slight suspended solids will be channelized unit wise to respective Coal Mil Oily Waste Water Sumps (2 nos. per unit, each of 5 m^3 cap.) from where it will be pumped to Common Collection Pit. The actual waste to be collected in each pit is 2.0 CuM/Hr. This effluent is continuous in nature.

h) Coal Pile Area Run Off System.

Coal Pile Area Run Off shall completely be taken care (handling/ treatment/ transfer) by BHEL's Coal Handling Plant agency. However, provision for storing treated coal pile runoff water during peak rainy season has been envisaged in CMB for further disposal to Sea. In fact, after initial few minutes of heavy rains the coal pile runoff is not expected to contain any suspended solids, hence, taken for maximum initial Twenty (20) minute rain fall and remaining portion of rain water after the specified period shall be bypassed to nearby storm water drain line. This effluent is intermittent in nature.

Note: following shall be taken care by BHEL respective group of coal handling system (**Ref. IS-4-DB-714-111-M079**): -

- Settling pond with overflow sump.
- Coal pile runoff Pumps.

C. DESCRIPTION FOR FACILITIES LOCATED INSIDE EFFLEUNT TREATMENT PLANT AREA.

a) Common Oily Waste Collection Pit.

The Common collection pit is designed to store the oily effluent from various sources like TG Area Oily waste (intermittent), Oily Waste from Transformer (intermittent) and Fuel Oil Area Oil Water Separator pit (continuous) to equalize the effluent for further treatment through Oil Water Separator located in Effluent Treatment area.

b) Oil Water Separator.

One number Oil Water Separator has been envisaged to remove oil from oily waste collected in Common Oily Waste Collection Pit.

The treated water shall be collected in Common Collection Pit for further treatment through Tube Settler and sludge shall be collected in Sludge Collection Pit for further disposal to Ash Slurry Pit. The separated oil shall be collected in Slop Oil Tank.

c) Common Collection Pit.

The Common collection pit is designed to store treated oil free water from Oil Water Separator (Continuous), Boiler & ESP Area Floor wash water (Intermittent) and Coal Mil waste (Continuous) and and Coal Pile Runoff during peak rainy season (for one hour) for further treatment through Tube Settler. Water recirculation line also envisaged for mixing.

d) Tube Settler.

One number Tube Settler has been envisaged to remove the suspended solids of effluent water collected in Common Collection Pit.

The sludge from Tube settler shall be collected in Sludge Collection Pit for further disposal to Ash Slurry Pit. The clear water from Tube settler shall be collected in Central Monitoring Basin for further use like Horticulture and CHP dust suppression.

Lime, Alum and PE dosing shall be done in Tube settler for enhancing the settlement of suspended partials.

i) Sludge Collection Pit.

The sludge from Tube Settler and Oil Water Separator shall be collected in Sludge Collection Pit for further disposal to Ash Slurry Pit. The pit size considered 5 CuM.

To avoid settling of sludge air blower and recirculation line has been envisaged.

e) Central Monitoring Basin

The Central Monitoring Basin is designed with two compartment to store treated water from Tube Settler, CPU/DM Plant N-pit waste and BWRO reject (provisional). Also in case of excess water from Tube settler and/or CPU/DM Plant N-pit waste and/or BWRO Reject the same shall be routed through Cooling Tower Blow Down water for further disposal.

Dosing facility for pH correction envisaged for CMB. In case the final outlet pH is not under limit then the water shall be recycled back to CMB for pH treatment.

C. OPERATION & CONTROL PHILOSOPHY

The overall operation & control of entire ETP shall be through standalone control system of DDCMIS/DCS family (In BHEL Scope of Supply), located in ETP Control Room near Central Monitoring Basin (CMB). Other sumps outside ETP area shall be controlled from nearby control system (In BHEL scope of supply).

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

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 standalone control system of DDCMIS family.

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)

GENERAL TECHNICAL REQUIREMENTS

FOR

LV MOTORS

SPECIFICATION NO.: PE-SS-999-506-E101 Rev 00

1.0 INTENT OF SPECIFIATION

The specification covers the design, materials, constructional features, manufacture, inspection and testing at manufacturer's work, and packing of Low voltage (LV) squirrel cage induction motors along with all accessories for driving auxiliaries in thermal power station.

Motors having a voltage rating of below 1000V are referred to as low voltage (LV) motors.

2.0 CODES AND STANDARDS

Motors shall fully comply with latest edition, including all amendments and revision, of following codes and standards:

IS:325	Three phase Induction motors
IS : 900	Code of practice for installation and maintenance of induction motors
IS: 996	Single phase small AC and universal motors
IS: 4722	Rotating Electrical machines
IS: 4691	Degree of Protection provided by enclosures for rotating electrical machines
IS: 4728	Terminal marking and direction of rotation rotating electrical machines
IS: 1231	Dimensions of three phase foot mounted induction motors
IS: 8789	Values of performance characteristics for three phase induction motors
IS: 13555	Guide for selection and application of 3-phase A.C. induction motors for different types of driven equipment
IS: 2148	Flame proof enclosures for electrical appliance
IS: 5571	Guide for selection of electrical equipment for hazardous areas
IS: 12824	Type of duty and classes of rating assigned
IS: 12802	Temperature rise measurement for rotating electrical machnines
IS: 12065	Permissible limits of noise level for rotating electrical machines
IS: 12075	Mechanical vibration of rotating electrical machines

In case of imported motors, motors as per IEC-34 shall also be acceptable.

3.0 DESIGN REQUIREMENTS

3.1 Motors and accessories shall be designed to operate satisfactorily under conditions specified in data sheet-A and Project Information, including voltage & frequency variation of supply system as defined in Data sheet-A

3.2 Motors shall be continuously rated at the design ambient temperature specified in Data Sheet-A and other site conditions specified under Project Information
Motor ratings shall have at least a 15% margin over the continuous maximum demand of the driven equipment, under entire operating range including voltage & frequency variation specified above.

3.3 Starting Requirements

3.3.1 Motor characteristics such as speed, starting torque, break away torque and starting time shall be properly co-ordinated with the requirements of driven equipment. The accelerating torque at any speed with the minimum starting voltage shall be at least 10% higher than that of the driven equipment.

3.3.2 Motors shall be capable of starting and accelerating the load with direct on line starting without exceeding acceptable winding temperature.

The limiting value of voltage at rated frequency under which a motor will successfully start and accelerate to rated speed with load shall be taken to be a constant value as per Data Sheet - A during the starting period of motors.

3.3.3 The following frequency of starts shall apply

i) Two starts in succession with the motor being initially at a temperature not exceeding the rated load temperature.

ii) Three equally spread starts in an hour the motor being initially at a temperature not exceeding the rated load operating temperature. (not to be repeated in the second successive hour)

iii) Motors for coal conveyor and coal crusher application shall be suitable for three consecutive hot starts followed by one hour interval with maximum twenty starts per day and shall be suitable for mimimum 20,000 starts during the life time of the motor

3.4 **Running Requirements**

3.4.1 Motors shall run satisfactorily at a supply voltage of 75% of rated voltage for 5 minutes with full load without injurious heating to the motor.

3.4.2 Motor shall not stall due to voltage dip in the system causing momentary drop in voltage upto 70% of the rated voltage for duration of 2 secs.

3.5 **Stress During bus Transfer**

3.5.1 Motors shall withstand the voltage, heavy inrush transient current, mechanical and torque stress developed due to the application of 150% of the rated voltage for at least 1 sec. caused due to vector difference between the motor residual voltage and the incoming supply voltage during occasional auto bus transfer.

3.5.2 Motor and driven equipment shafts shall be adequately sized to satisfactorily withstand transient torque under above condition.

3.6 Maximum noise level measured at distance of 1.0 metres from the outline of motor shall not exceed the values specified in IS 12065.

3.7 The max. vibration velocity or double amplitude of motors vibration as measured at motor bearings shall be within the limits specified in IS: 12075.

4.0 **CONSTRUCTIONAL FEATURES**

4.1 Indoor motors shall conform to degree of protection IP: 54 as per IS: 4691. Outdoor or semi-indoor motors shall conform to degree of protection IP: 55 as per IS: 4691and shall be of weather-proof construction. Outdoor motors shall be installed under a suitable canopy

4.2 Motors upto 160KW shall have Totally Enclosed Fan Cooled (TEFC) enclosures, the method of cooling conforming to IC-0141 or IC-0151 of IS: 6362.

Motors rated above 160 KW shall be Closed Air Circuit Air (CACA) cooled

4.3 Motors shall be designed with cooling fans suitable for both directions of rotation.

4.4. Motors shall not be provided with any electric or pneumatic operated external fan for cooling the motors.

4.5 Frames shall be designed to avoid collection of moisture and all enclosures shall be provided with facility for drainage at the lowest point.

4.6 In case Class 'F' insulation is provided for LV motors, temperature rise shall be limited to the limits applicable to Class 'B' insulation.
In case of continuous operation at extreme voltage limits the temperature limits specified in table-1 of IS:325 shall not exceed by more than 10°C.

4.7 **Terminals and Terminal Boxes**

4.7.1 Terminals, terminal leads, terminal boxes, windings tails and associated equipment shall be suitable for connection to a supply system having a short circuit level, specified in the Data Sheet-A.

Unless otherwise stated in Data Sheet-A, motors of rating 110 kW and above will be controlled by circuit breaker and below 110 kW by switch fuse-contactor. The terminal box of motors shall be designed for the fault current mentioned in data sheet "A".

4.7.2 unless otherwise specified or approved, phase terminal boxes of horizontal motors shall be positioned on the left hand side of the motor when viewed from the non-driving end.

4.7.3 Connections shall be such that when the supply leads R, Y & B are connected to motor terminals A B & C or U, V & W respectively, motor shall rotate in an anticlockwise direction when viewed from the non-driving end. Where such motors require clockwise rotation, the supply leads R, Y, B will be connected to motor terminals A, C, B or U W & V respectively.

4.7.4 Permanently attached diagram and instruction plate made preferably of stainless steel shall be mounted inside terminal box cover giving the connection diagram for the desired direction of rotation and reverse rotation.

4.7.5 Motor terminals and terminal leads shall be fully insulated with no bar live parts. Adequate space shall be available inside the terminal box so that no difficulty is encountered for terminating the cable specified in Data Sheet-A.

4.7.6 Degree of protection for terminal boxes shall be IP 55 as per IS 4691.

4.7.7 Separate terminal boxes shall be provided for space heaters.. If this is not possible in case of LV motors, the space heater terminals shall be adequately segregated from the main terminals in the main terminal box. Detachable gland plates with double compression brass glands shall be provided in terminal boxes.

4.7.8. Phase terminal boxes shall be suitable for 360 degree of rotation in steps of 90 degree for LV motors.

4.7.9 Cable glands and cable lugs as per cable sizes specified in Data Sheet-A shall be included. Cable lugs shall be of tinned Copper, crimping type.

4.8 Two separate earthing terminals suitable for connecting G.I. or MS strip grounding conductor of size given in Data Sheet-A shall be provided on opposite sides of motor frame. Each terminal box shall have a grounding terminal.

4.9 **General**

4.9.1 Motors provided for similar drives shall be interchangeable.

4.9.2 Suitable foundation bolts are to be supplied alongwith the motors.

4.9.3 Motors shall be provided with eye bolts, or other means to facilitate safe lifting if the weight is 20Kgs. and above.

4.9.4 Necessary fitments and accessories shall be provided on motors in accordance with the latest Indian Electricity rules 1956.

4.9.5 All motors rated above 30 kW shall be provided with space heaters to maintain the motor internal air temperature above the dew point. Unless otherwise specified, space heaters shall be suitable for a supply of 240V AC, single phase, 50 Hz.

4.9.6 Name plate with all particulars as per IS: 325 shall be provided

4.9.7 Unless otherwise specified, the colour of finish shall be grey to Shade No. 631 and 632 as per IS:5 for motors installed indoor and outdoor respectively. The paint shall be epoxy based and shall be suitable for withstanding specified site conditions.

5.0 INSPECTION AND TESTING

5.1 All materials, components and equipments covered under this specification shall be procured, manufactured, as per the BHEL standard quality plan No. PED-506-00-Q-006/0 and PED-506-00-Q-007/2 enclosed with this specification and which shall be complied.

5.2 LV motors of type-tested design shall be provided. Valid type test reports not more than 5 year shall be furnished. In the absence of these, type tests shall have to be conducted by manufacturer without any commercial implication to purchaser.

5.3 All motors shall be subjected to routine tests as per IS: 325 and as per BHEL standard quality plan.

5.4 Motors shall also be subjected to additional tests, if any, as mentioned in Data Sheet A.

6.0 DRAWINGS TO BE SUBMITTED AFTER AWARD OF CONTRACT

a) OGA drawing showing the position of terminal boxes, earthing connections etc.
b) Arrangement drawing of terminal boxes.
c) Characteristic curves:
(*To be given for motor above 55 kW unless otherwise specified in Data Sheet*).

i) Current vs. time at rated voltage and minimum starting voltage.
ii) Speed vs. time at rated voltage and minimum starting voltage.
iii) Torque vs. speed at rated voltage and minimum voltage.
For the motors with solid coupling the above curves i), ii), iii) to be furnished for the motors coupled with driven equipment. In case motor is coupled with mechanical equipment by fluid coupling, the above curves shall be furnished with and without coupling.
iv) Thermal withstand curve under hot and cold conditions at rated voltage and max. permissible voltage.

1.0.0 INTENT OF SPECIFICATION

This section covers the technical requirements of HT motors, LT Motors and DC 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 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 60034-5	Degree of protection provided by Integral design of rotating electrical machines
n)	IS 60034-8	Terminal marking and direction of rotation
o)	IS 60079-1	Equipment protection by flame proof enclosure
p)	IS 60034-1	Rotating electrical machines.
q)	IS 60079	Explosive atmospheres
r)	IS/IEC 60529	Degrees of protection provided by enclosures (IP code)
s)	IEC 60034	Rotating electrical machines.
t)	IS 3177	Code of practice for Design, Manufacture, Erection and testing of Cranes and Hoists

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.

3.2.0 Supply voltage

Motors rated up to and including 415 V are termed as LT motors and the motors rated higher than 415 V 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 : (±) 6%
- 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	11 kV and 6.6 kV System	LT System
1.	Voltage level	6.6 kV : Above 200 kW and upto 2000 kW 11 kV: Above 2000 kW	240 V : up to 0.2 kW 415 V: >0.2 kW and up to 200 kW.
2.	System earthing	Earthed through resistance, limiting earth fault current to 300 Amps	415 V system solidly grounded.
3.	Fault withstand rating of motor terminal box (Breaker operated)	50 kA for 0.2 sec for 11 kV and 31.5 kA for 0.2 sec for 6.6 kV	415 V system : 50/65 kA for 0.2 second

3.4.0 Type

AC Motors shall be squirrel cage induction type unless otherwise it is specified.

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.
- All the motors shall be rated for S1 duty for continuous operation. Motors of crane and hoist application shall be intermittent duty.
- DC motor shall generally be of shunt wound type rated for 220 V DC.
- Motors shall be suitable for installation in hot, humid and tropical atmosphere and polluted at places with coal ash and or fly ash.
- The motors shall be suitable for bus transfer schemes provided on the 11 kV/6.6 kV/415 V systems without any injurious effect on its life.

3.6.0 Design margin

Whenever the basis for motor rating are not specified in the corresponding mechanical specification section maximum continuous motor rating shall be atleast 10% above the maximum load derived of the driven equipment under entire operating range including voltage & frequency variation.

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. Where variable voltage and variable frequency (VVFD) operation is envisaged through VVFD drives, motors shall be specially designed for such application.
- LT motors rated up to 125 kW shall be controlled through MPCB/MCCB and contactor. LT motors rated more than 125 kW shall be controlled through air circuit breaker.
- HT Motors shall be controlled through vacuum circuit breaker.

3.8.0 Efficiency

All the duty motors shall be energy efficient type. For HT and LT motors, it shall be IE3 class as per IS 12615. For VFD controlled HT and LT motors, it shall be IE2 class as per IS 12615.

3.9.0 Temperature rise

- Winding Insulation shall be Class F.
- Temperature rise of air cooled motors shall not exceed 70°C over air temperature of 50°C by resistance method, while delivering its maximum rated output.
- Temperature rise of water cooled motors shall not exceed 80°C over inlet cooling water temperature 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 (up to 1000 kW) : 85% of rated voltage
- HT Motors (> 1000 kW up to 4000 kW) : 80% of rated voltage
- HT Motors (> 4000 kW) : 75% 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 shall 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 75% of the rated voltage for 5 minutes.

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

- Locked rotor current of HT motors for applications other than listed below shall be limited to 600% of the full load current, and is subject to IS tolerance.
- For energy efficient LT motors, locked rotor current shall be as per IS: 12615.
- Locked rotor current of the VFD controlled AC motors shall be limited to 300% of the full load current, and is subject to IS tolerance.
- Locked rotor current of the BFP motors shall be limited to 450% of the full load current of the motor, and is subject to IS 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. Provision of speed switch shall be avoided to the extent possible. In case the speed switch is required, it shall be indicated by the bidder in his offer
- For the LT motors having starting time up to 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.
- Speed switches mounted on the motor shaft shall be provided in cases where above requirements are not met.
- When a speed switch is mounted on the motor shaft, the same shall remain closed for speeds lower than 20% and open for speeds above 20% of the rated speed. The speed switch shall be capable of withstanding 120% over speed in either direction of rotation.

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.

3.15.0 Enclosure

a) Motors shall have IP 55 degree of protection.

b) For hazardous location, the enclosure of motors shall following have flame proof construction conforming to applicable standard.
   - Fuel oil area Group – IIB
   - Hydrogen generation plant area : Group – IIC)

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-IC6A1A1) type.
- Motors rated >3000 kW 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 10 A at 230 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 240 V AC, 50 Hz supply shall be provided for motors rated 30 kW 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 one minute power frequency voltage test or 1.2/50 micro sec lightning impulse Voltage wave of 4U+5 kV (U=Line voltage in kV) test on main insulation as per IEC 600034-15. The coil inter-turn insulation shall withstand steep front impulse withstand voltage as per IEC 600034-15.
- For HT motors, 12 nos. simplex or 6 nos. duplex RTDs (two per phase), each having D.C. resistance of 100 ohms at 0°C, embedded in the stator winding at locations where highest temperatures may be expected, shall be provided. The material of the ETD's shall be platinum.

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. For sleeve bearings, the bearing housing shall be preferably in end shield itself.
- 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 30 kW 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 10 A at 230 V AC.
- For bearing temperature measurement, duplex RTDs shall be provided for each bearing and shall be wired up to the terminal box.
- Each bearing shall be provided with dial type thermometer.
- For all VFD operated motors shall have insulated bearings to prevent flow of shaft currents.
- For motors rated above 1000 KW having shaft length more than 1.5 M shall have insulated bearings to prevent flow of shaft currents.
- All the motors rated <15 kW shall be provided with sealed ZZ bearings.
- Lub oil pressure transmitters shall be provided to DCS for remote monitoring. Lub oil pressure very low trip to HT equipment shall be 2 out of 3 logic.

3.19.0 Terminal Boxes

- Separate terminal boxes of IP 55 degree of protection shall be provided for stator leads. For single core cables, gland plate shall be non-magnetic material. Terminal box of HT motors shall be capable of being turned 360° in steps of 180°. Terminal box of LT motors shall be capable of being turned 360° in steps of 90°. 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 0.2 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 fiber 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.
- Motors rated >1000 kW shall be provided with neutral current transformers of PS class on each phase for differential protection in neutral side terminal box. The three phases shall be connected to form the star point after passing through the CTs. 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.

3.21.0 Noise and Vibration

- Motors shall be selected with low noise levels in accordance with IS 12065.
- 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.

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 Canopy

Canopy shall be provided for all the motors located outdoor. For details, please refer Civil section.

4.0.0 DC MOTORS

DC motors shall be provided where specified/required. DC Motors shall be sized for operation with fixed resistance starting for reliability. DC motors shall be shunt wound type. Motors shall be capable of delivering the rated output at 220 V DC with (+) 10% and (-) 15% variations without exceeding its guaranteed temperature limits. 220 V DC system shall be unearthed. Starting current of the DC motors shall be limited to 200% of the full load current of the motor, and is subject to IS tolerance. DC Motors shall be similar to AC Motors with respect to other features like enclosure type, cooling and class of insulation.

5.0.0 INSTALLATION

Installation shall be carried out as per IS: 900.

6.0.0 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. Finish shade shall be 631 of IS: 5 (smoke grey).

7.0.0 TESTING AND INSPECTION

7.1.0 Equipment offered shall be of type tested and proven type. Type test certificates for test conducted earlier on similar rating shall be furnished for the motors rated 30 kW and above.

7.2.0 The following type tests shall be conducted on LT motors.

- Measurement of resistance of windings of stator and wound rotor.
- No load test at rated voltage to determine input current power and speed
- Full load test to determine efficiency power factor and slip.
- Temperature rise test.
- Momentary excess torque test.
- High voltage test.
- Test for vibration severity of motor.
- Test for noise levels of motor
- Test for degree of protection
- Over speed test.

7.3.0 The following additional type tests shall be conducted on HT motors.

- No load saturation and loss curves up to approximately 115% of rated voltage
- Measurement of noise at no load.
- Momentary excess torque test
- Full load test
- Temperature rise test at rated conditions.
- Lightning Impulse withstand test on the sample coil shall be as per IEC-60034, part-15
- Surge-withstand test on interturn insulation shall be as per clause no. 5.1.2 of IEC 60034, part-15
- Degree of protection test for the enclosure followed by IR, HV and no load run test.
- Terminal box-fault level withstand test for each type of terminal box.

7.4.0 The following routine tests shall be carried out for the motors as per applicable standards.

- IR of Winding before and after HV tests
- HV test on main winding space heater, RTD, BTD
- Resistance measurement
- No load run test Major Electrical
- Phase sequence and direction of rotation
- Vibration check Major Electrical
- Reduced voltage running test
- Locked rotor test at reduced voltage
- Record of RTD & BTD resistance at the end of no load test
- Test on space heater & RTD
- Visual Control of terminal box and verification of construction with respect to short tested terminal box

7.5.0 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

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

8.0.0 DRAWINGS & DOCUMENTS

The following drawings and documents shall be submitted for approval during detail engineering stage.

- Motor sizing calculation
- Technical particulars
- General arrangement drawings
- Performance curves (Efficiency, power factor, starting current)
- Characteristic curves (Speed torque, Hot/cold with stand time, Negative sequence current)
- Terminal box details
- Test reports
- Sub-vendor list
- Manufacturing quality plan
- Field quality plan

DATA SHEET A – MOTORS

DATA SHEET-A

SL NO.	DESCRIPTION	2X660 MW UDANGUDI SUPERCRITICAL STPP
A	**General**	
1	Manufacturer & country of origin	
2	Motor type	Squirrel cage induction AC motors
3	Efficiency class	For all LT motors, it shall be IE3 class as per IS 12615 except for VFD controlled LT motors, it shall be IE2 class as per IS 12615
4	Type of starting	DOL
5	Maximum acceptable kW rating of LV motor	>0.2 kW and up to 200 kW. LT motors rated up to 125 kW shall be controlled through MPCB/MCCB and contactor. LT motors rated more than 125 kW shall be controlled through air circuit breaker.
6	Rating up to which Single phase motors permitted.	up to 0.2 Kw
7	Installation (Indoors/ Outdoors)	indoor/outdoor
8	Degree Of Protection	IP 55
9	Name of the equipment driven by motor & Quantity	
10	Maximum Power requirement of driven equipment	
11	Rated speed of Driven Equipment	As per system requirement
12	Design ambient temperature	50 deg C
B	**Design and Performance Data**	
1	Frame size & type designation	DURING DETAILED ENGINEERING
2	Type of duty	All the motors shall be rated for S1 duty for continuous operation. Motors of crane and hoist application shall be intermittent duty. The motors shall be suitable for bus transfer schemes provided on the 11 kV/6.6 kV/415 V systems without any injurious effect on its life.
3	Rated Voltage	240/415 V
4	Rated Frequency	50 Hz
5	System fault level at rated voltage	50 kA for 1 sec.
6	LV System grounding	solidly grounded
7	Permissible variation for	
a	Voltage	±10%
b	Frequency	+3% to -5%
c	Combined voltage & frequency	10%
8	Rated output at design ambient temp (by resistance method)	As per system requirement
9	Synchronous speed & Rated slip	As per system requirement
10	Minimum permissible starting voltage	80% of rated voltage During fast changeover of power supply source, vector difference between the motor residual voltage and the incoming supply voltage shall 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 75% of the rated voltage for 5 minutes.

11	TYPE OF STARTER PROVIDED IN MCC	DOL
12	Starting time in sec with mechanism coupled	
a	At rated voltage	As per manufacturers standard
b	At min starting voltage	
13	Locked rotor current as percentage of FLC (including IS tolerance)	For energy efficient LT motors, locked rotor current shall be as per IS: 12615. Locked rotor current of the VFD controlled AC motors shall be limited to 300% of the full load current, and is subject to IS tolerance
14	Torque	
a	Starting	
b	Maximum	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.
15	Permissible temp rise at rated output over ambient temp & method	Winding shall be class F insulation with temperature limited to class B
16	Noise level at 1.0 m (dB)	Motors shall be selected with low noise levels in accordance with IS 12065.
17	Amplitude of vibration	The peak amplitude of the vibration shall also be within the specified limits of IS: 12075.
18	Efficiency & P.F. at rated voltage & frequency	
a	At 100% load	Premium efficiency (IE3) IS: 12615 .
b	At 75% load	
c	At starting	
C	**Constructional Features**	
1	Method of connection of motor driven equipment	As per system requirement
2	Applicable Standard	as per relevant standard
3	DOP of Enclosure	IP55
4	Method of 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. The Alarm switch contact rating shall be minimum 0.5 A at 220 V DC and 10 A at 230 V AC.
5	Class of insulation	All motors shall have class F insulation but limited to class B temperature rise
6	Main terminal box	

a	Type	Separate terminal boxes of IP 55 degree of protection shall be provided for stator leads. For single core cables, gland plate shall be non-magnetic material. Terminal box of LT motors shall be capable of being turned 360° in steps of 90°. The terminal boxes shall be split type with removable cover with access to connections.
b	Power Cable details (Conductor, size, armour/unarmour)	DURING DETAILED ENGINEERING
c	Cable Gland & lugs details (Size, type & material)	DURING DETAILED ENGINEERING 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.
d	Permissible Fault level (kArms & duration in sec)	Fault withstand rating of motor terminal box (Breaker operated): 415 V system : 50/65 kA for 0.2 second
7	Earth Conductor Size & Material	DURING DETAILED ENGINEERING
8	Space heater details (30KW & ABOVE) (Voltage & watts)	Space heaters rated for 240 V AC, 50 Hz supply shall be provided for motors rated 30 kW'and above to maintain windings in dry condition when motor is standstill.
9	Flame proof motor details (if applicable)	For hazardous location: the enclosure of motors shall following have flame proof construction conforming to applicable standard. • Fuel oil area Group – IIB • Hydrogen generation plant area : Group – IIC)
a	Enclosure	
b	suitability for hazardous area	
i	Zone O / I / II	
ii	Group IIA / IIB / IIC	
c	Degree of Protection	
9	No. of Stator winding	As per manufacturers standard
10	Winding connection	As per system requirement
11	Kind of rotor winding	As per manufacturers standard

12	Kind of 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 inservice positive lubrication with grease nipple and relief holes. For sleeve bearings, the bearing housing shall be preferably in end shield itself. • 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 30 kW and above re-lubrication facility shall be provided. For bearing temperature measurement, duplex RTDs shall be provided for each bearing and shall be wired up to the terminal box. • Each bearing shall be provided with dial type thermometer. • For all VFD operated motors shall have insulated bearings to prevent flow of shaft currents. Lub oil pressure transmitters shall be provided to DCS for remote monitoring. Lub oil pressure very low trip to HT equipment shall be 2 out of 3 logic.
13	Direction of rotation when viewed from NDE	motor shall be bi-directional
14	Paint Shade & type	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. Finish shade shall be 631 of IS: 5 (smoke grey).
15	Net weight of motor	
16	Outline mounting drawing No (To be enclosed as annexure)	DURING DETAILED ENGINEERING
D	**Characteristic curves/ drawings**	
1	(To be enclosed for motors of rating >55KW)	
2	Torque speed characteristic	
3	Thermal withstand characteristic	
4	Current vs time	
5	Speed vs time	
E	**Tests on motors**	

NOTE:

1 Please write "As per manufacturers standard" where data is not defined in the project specification.
2 Please mention any project specific requirrement if any in the datasheet (Add extra row).
3 For details which is not applicable please write "NA"

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-02	DATE: 17.04.2020
		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	D	M	C	N	
					M	C/ N								
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-325 / IS-12615/ APPROVED DATA SHEET	IS-325 / IS-12615/ APPROVED DATA SHEET	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

BHEL					
ENGINEERING			QUALITY		
	Sign & Date	Name		Sign & Date	Name
Prepared by:		HEMA KUSHWAHA	Checked by:		KUNAL GANDHI
Reviewed by:		PRAVEEN DUTTA	Reviewed by:		RITESH KUMAR JAISWAL

BIDDER/ SUPPLIER	
Sign & Date	
Seal	

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Approved by:			

		3.NAMEPLATE DETAILS	MA	VISUAL	100%	-	IS-325 / IS-12615 / APPROVED DATA SHEET	SAME AS COL. 7	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	-	(#) REFER NOTE-8

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. BHEL reserves the right to perform repeat test, if required.
5. After packing and prior to issue MDCC, photographs of items to be despatched shall be sent to BHEL for review.
6. In case of any changes in QP commented by customer at contract stage, same shall be carried out by bidder without any implication to BHEL/ Customer.
7. Project specific QP to be developed based on customer requirement.
8. For export job, BHEL technical specification for seaworthy packing to be followed.
9. Packing shall be suitable for storage at site in tropical climate conditions.
10. 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

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Reviewed by:		PRAVEEN DUTTA	Reviewed by:		RITESH KUMAR JAISWAL

BIDDER/ SUPPLIER	
Sign & Date	
Seal	

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Approved by:			

	MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS	STANDARD QUALITY PLAN		SPEC. NO :	DATE:17.04.2020
		CUSTOMER :		QP NO.: PE-QP-999-Q-007, REV-04	
		PROJECT:		PO NO.:	
		ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV (415V))	SYSTEM:	SECTION: II	SHEET 1 OF 9

Sl No.	Component & Operations	Characteristics	Class	Type of Check	Quantum Of check		Reference Document	Acceptance NORMS	FORMAT OF RECORD		AGENCY			
1	2	3	4	5	6		7	8	9	*	**			
					M	C/N				D	M	C	N	
1.0	RAW MATERIAL & BOUGHT OUT CONTROL													
1.1	SHEET STEEL, PLATES, SECTION, EYEBOLTS	1.SURFACE CONDITION	MA	VISUAL	100%	-	-	FREE FROM BLINKS, CRACKS, WAVINESS ETC	LOG BOOK		P	-	-	
		2.DIMENSIONS	MA	MEASUREMENT	SAMPLE	-	MANUFACTURER'S DRG./SPEC	MANUFACTURER'S DRG./SPEC	LOG BOOK		P	-	-	
		3.PROOF LOAD TEST (EYE BOLT)	MA	MECH. TEST	SAMPLE	-	MANUFACTURER'S DRG./SPEC	MANUFACTURER'S DRG./SPEC	TEST REPORT		P/V	-		
1.2	HARDWARES	1.SURFACE CONDITION	MA	VISUAL	100%	-		FREE FROM CRACKS, UN-EVENNESS ETC.	TEST REPORT		P	-	-	
		2.PROPERTY CLASS	MA	VISUAL	SAMPLES	-	MANUFACTURER'S DRG./SPEC	MANUFACTURER'S DRG./SPEC	TC		P/V	-	-	PROPERTY CLASS MARKING SHALL BE CHECKED BY THE VENDOR
1.3	CASTING	1.SURFACE CONDITION	MA	VISUAL	100%	-	MANUFACTURER'S DRG./SPEC	FREE FROM CRACKS, BLOW HOLES ETC.	LOG BOOK		P/V	-		
		2.CHEM. & PHY. PROP.	MA	CHEM & MECH TEST	1/HEAT NO.	-	MANUFACTURER'S DRG./SPEC	MANUFACTURER'S DRG./SPEC	TC		P/V	-		HEAT NO. SHALL BE VERIFIED
		3.DIMENSIONS	MA	MEASUREMENT	100%	-	MANUFACTURER'S DRG.	MANUFACTURER'S DRG.	LOG BOOK		P/V	-		
1.4	PAINT & VARNISH	1.MAKE, SHADE, SHELF LIFE & TYPE	MA	VISUAL	100% CONTINUOUS	-	MANUFACTURER'S DRG./SPEC	MANUFACTURER'S DRG./SPEC	LOG BOOK		P/V	-		

BHEL					
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	Sign & Date	Name		Sign & Date	Name
Prepared by:		HEMA KHUSHWAHA	Checked by:		KUNAL GANDHI
Reviewed by:		PRAVEEN DUTTA	Reviewed by:		R K JAISWAL

BIDDER/ SUPPLIER	
Sign & Date	
Seal	

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Doc No:			
	Sign & Date	Name	Seal
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Approved by:			

MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS	STANDARD QUALITY PLAN		SPEC. NO :	DATE:17.04.2020
	CUSTOMER :		QP NO.: PE-QP-999-Q-007, REV-04	
	PROJECT:		PO NO.:	
	ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV (415V))	SYSTEM:	SECTION: II	SHEET 2 OF 9

Sl No.	Component & Operations	Characteristics	Class	Type of Check	Quantum Of check		Reference Document	Acceptance NORMS	FORMAT OF RECORD		AGENCY			
1	2	3	4	5	6		7	8	9	*	**			
					M	C/N				D	M	C	N	
1.5	SHAFT (FORGED OR ROLLED)	1. SURFACE COND.	MA	VISUAL	100%	-	-	FREE FROM VISUAL DEFECTS	LOG BOOK		P	-	-	VENDOR'S APPROVAL IDENTIFICATION SHALL BE MAINTAINED
		2. CHEM. & PHYSICAL PROPERTIES	MA	CHEM. & PHYSICAL TESTS	1/HEAT NO. OR HEAT TREATMENT BATCH NO	-	MANUFACTURER'S DRG./ SPEC.	MANUFACTURER'S DRG./ STD.	TC		P/V	-		
		3. DIMENSIONS	MA	MEASUREMENT	100%	-	MANUFACTURER'S DRG./ SPEC.	MANUFACTURER'S DRG.	LOG BOOK		P/V	-		
		4.INTERNAL FLAWS	CR	ULTRASONIC TEST	100%	-	ASTM-A388	MANUFACTURER'S STD.	INSPECTION REPORT	✔	P/W	V	-	FOR DIA OF 55 MM & ABOVE
1.6	SPACE HEATERS, CONNEC-TORS, TERMINAL BLOCKS, CABLES, CABLE LUGS, CARBON BRUSH TEMP. DETECTORS, RTD, BTD'S	1. MAKE & RATING	MA	VISUAL	100%	-	MANUFACTURER'S DRG./STD.	MANUFACTURER'S DRG./STD.	INSPECTION REPORT		P/V	-	-	
		2. PHYSICAL COND.	MA	VISUAL	100%	-	MANUFACTURER'S DRG./STD.	NO PHYS. DAMAGE, NO ELECTRICAL DISCONTINUITY	INSPECTION REPORT		P/V	-	-	
		3.DIMENSIONS (WHEREVER APPLICABLE)	MA	MEASUREMENT	SAMPLE	-	MANUFACTURER'S DRG./ STD	MANUFACTURER'S DRG. / STD.	INSPECTION REPORT		P/V	-	-	
		4.PERFORMANCE/ CALIBRATION	MA	TEST	100%	-	MANUFACTURER'S DRG./ STD	MANUFACTURER'S DRG. / STD.	TEST REPORT		P/V	-	-	

BHEL					
ENGINEERING			QUALITY		
	Sign & Date	Name		Sign & Date	Name
Prepared by:		HEMA KHUSHWAHA	Checked by:		KUNAL GANDHI
Reviewed by:		PRAVEEN DUTTA	Reviewed by:		R K JAISWAL

BIDDER/ SUPPLIER	
Sign & Date	
Seal	

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MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS	STANDARD QUALITY PLAN		SPEC. NO :	DATE:17.04.2020
	CUSTOMER :		QP NO.: PE-QP-999-Q-007, REV-04	
	PROJECT:		PO NO.:	
	ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV (415V))	SYSTEM:	SECTION: II	SHEET 3 OF 9

Sl No.	Component & Operations	Characteristics	Class	Type of Check	Quantum Of check		Reference Document	Acceptance NORMS	FORMAT OF RECORD		AGENCY			
1	2	3	4	5	6		7	8	9	*	**			
					M	C/N				D	M	C	N	
1.7	OTHER INSULATING MATERIALS LIKE SLEEVES, BINDINGS CORDS, PAPERS, PRESS BOARDS ETC.	1. SURFACE COND. ETC.	MA	VISUAL	100%	-	-	NO VISUAL DEFECTS	TEST REPORT		P/V	-	-	
		2.DIMENSION(BORE DIA, WALL THICKNESS, BDV AS RECEIVED, BDV AFTER FOLDING AT 180°	MA	TEST	SAMPLE	-	MANUFACTURER'S STD.	MANUFACTURER'S STD.	LOG BOOK AND OR SUPPLIER'S TC		P/V	-	-	
1.8	SHEET STAMPING (PUNCHED)	1. SURFACE COND.	MA	VISUAL	100%	-	-	NO VISUAL DEFECTS (FREE FROM BURS)	LOG BOOK		P	-	-	
		2.DIMENSIONS INCLUDING BURS HEIGHT	MA	MEASUREMENT	SAMPLE	-	MANUFACTURER'S DRG. .	MANUFACTURER'S DRG.	LOG BOOK		P/V	-	-	
		3. ACCEPTANCE TESTS	MA	ELECT. & MECH TESTS	SAMPLE	-	MANUFACTURER'S DRG./ STD.	MANUFACTURER'S DRG./ STD.	TC		P/V	-	-	
1.9	CONDUCTORS	1. SURFACE FINISH	MA	VISUAL	100%	-	-	FREE FROM VISUAL DEFECTS	LOG BOOK		*P/V	-	-	* MOTOR MANUFACTURER TO CONDUCT VISUAL CHECK FOR SURFACE FINISH ON RANDOM BASIS (10% SAMPLE) AT HIS WORKS AND MAINTAIN RECORD FOR VERIFICATION BY
		2.ELECT. PROP. & MECH. PROP	MA	ELECT. & MECH.TEST	SAMPLES	-	MANUFACTURER'S DRG./ SPEC.	MANUFACTURER'S / SPEC.	TC & VENDOR'S TEST REPORTS		P/V	-	-	

BHEL					
ENGINEERING			QUALITY		
	Sign & Date	Name		Sign & Date	Name
Prepared by:		HEMA KHUSHWAHA	Checked by:		KUNAL GANDHI
Reviewed by:		PRAVEEN DUTTA	Reviewed by:		R K JAISWAL

BIDDER/ SUPPLIER	
Sign & Date	
Seal	

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Doc No:			
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MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS	STANDARD QUALITY PLAN		SPEC. NO :	DATE:17.04.2020
	CUSTOMER :		QP NO.: PE-QP-999-Q-007, REV-04	
	PROJECT:		PO NO.:	
	ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV (415V))	SYSTEM:	SECTION: II	SHEET 4 OF 9

Sl No.	Component & Operations	Characteristics	Class	Type of Check	Quantum Of check		Reference Document	Acceptance NORMS	FORMAT OF RECORD		AGENCY			
1	2	3	4	5	6		7	8	9	*	**			
					M	C/N				D	M	C	N	
		3.DIMENSIONS	MA	MEASUREMENT	SAMPLES	-	MANUFACTURER'S DRG./ SPEC.	MANUFACTURER'S / SPEC.	LOG BOOK		P/V	-	-	
1.10	BEARINGS	1.MAKE & TYPE	MA	VISUAL	100%	-	MANUFACTURER'S DRG./ APPROVED DATASHEET	MANUFACTURER'S DRG./ APPROVED DATASHEET	LOG BOOK		P/V	-	-	
		2.DIMENSIONS	MA	MEASUREMENT	SAMPLE	-	APPROVED DATASHEET	APPROVED DATASHEET/ BEARING MANUF'S CATALOGUES	LOG BOOK		P/V	-	-	
		3.SURFACE FINISH	MA	VISUAL	100%	-	-	FREE FROM VISUAL DEFECTS	LOG BOOK		P/V	-	-	
1.11	SLIP RING (WHEREVER APPLICABLE)	1.SURFACE COND.	MA	VISUAL	100%	-	-	FREE FROM VISUAL DEFECTS	LOG BOOK		P	-	-	
		2.DIMENSIONS	MA	MEASUREMENT	SAMPLE	-	MANUFACTURER'S DRG	MANUFACTURER'S DRG	LOG BOOK		P	-	-	
		3.TEMP.WITH-STAND CAPACITY	MA	ELECT.TEST	SAMPLE	-	MANUFACTURER'S STD./ APPROVED DATASHEET	MANUFACTURER'S STD./ APPROVED DATASHEET	LOG BOOK		P/V	-	-	
		4.HV/IR	MA	-DO-	100%	-	MANUFACTURER'S STD./ APPROVED DATASHEET	MANUFACTURER'S STD./ APPROVED DATASHEET	LOG BOOK		P/V	-	-	
1.12	OIL SEALS & GASKETS	1.MATERIAL OF GASKET	MA	VISUAL	100%	-	MANUFACTURER'S DRG/SPECS	MANUFACTURER'S DRG./ SPECS.	LOG BOOK		P	-	-	
		2.SURFACE COND.	MA	VISUAL	100%	-	-	FREE FROM VISUAL DEFECTS	LOG BOOK		P	-	-	
		3.DIMENSIONS	MA	MEASUREMENT	SAMPLE	-	MANUFACTURER'S DRG	MANUFACTURER'S DRG	LOG BOOK		P	-	-	

BHEL					
ENGINEERING			QUALITY		
	Sign & Date	Name		Sign & Date	Name
Prepared by:		HEMA KHUSHWAHA	Checked by:		KUNAL GANDHI
Reviewed by:		PRAVEEN DUTTA	Reviewed by:		R K JAISWAL

BIDDER/ SUPPLIER	
Sign & Date	
Seal	

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MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS	STANDARD QUALITY PLAN		SPEC. NO :	DATE:17.04.2020
	CUSTOMER :		QP NO.: PE-QP-999-Q-007, REV-04	
	PROJECT:		PO NO.:	
	ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV (415V))	SYSTEM:	SECTION: II	SHEET 5 OF 9

Sl No.	Component & Operations	Characteristics	Class	Type of Check	Quantum Of check		Reference Document	Acceptance NORMS	FORMAT OF RECORD		AGENCY			
1	2	3	4	5	6		7	8	9	*	**			
					M	C/N				D	M	C	N	
2.0	IN PROCESS													
2.1	STATOR FRAME WELDING (IN CASE OF FABRICATED STATOR)	1.WORKMANSHIP & CLEANNESS	MA	VISUAL	100%	-	MANUFACTURER'S DRG	GOOD FINISH	LOG BOOK		P/W	-	-	
		2.DIMENSIONS	MA	MEASUREMENT	100%	-	MANUFACTURER'S DRG	MANUFACTURER'S DRG	LOG BOOK		P	-	-	
2.2	MACHINING	1.FINISH	MA	VISUAL	100%	-	-DO-	GOOD FINISH	LOG BOOK		P	-	-	
		2.DIMENSIONS	MA	MEASUREMENT	100%	-	MANUFACTURER'S DRG	MANUFACTURER'S DRG	LOG BOOK		P	-	-	
		3.SHAFT SURFACE FLOWS	MA	PT	100%	-	MANUFACTURER'S STD./ ASTM-E165	MANUFACTURER'S STD./ APPROVED DATASHEET.	LOG BOOK	✔	P	V	-	
2.3	PAINTING	1.SURFACE PREPARATION	MA	VISUAL	100%	-	MANUFACTURER'S STD./APPROVED DATASHEET	MANUFACTURER'S STD./APPROVED DATASHEET	LOG BOOK		P	-	-	
		2.PAINT THICKNESS (BOTH PRIMER & FINISH COAT)	MA	MEASUREMENT BY ELCOMETER	SAMPLE	-	MANUFACTURER'S STD./APPROVED DATASHEET	MANUFACTURER'S STD./APPROVED DATASHEET	LOG BOOK		P	-	-	
		3.SHADE	MA	VISUAL	SAMPLE	-	MANUFACTURER'S STD./APPROVED DATASHEET	MANUFACTURER'S STD./APPROVED DATASHEET	LOG BOOK		P	-	-	
		4.ADHESION	MA	CROSS CUTTING & TAPE TEST	SAMPLE	-	MANUFACTURER'S STD./APPROVED DATASHEET	MANUFACTURER'S STD./APPROVED DATASHEET	LOG BOOK		P	-	-	

BHEL					
ENGINEERING			QUALITY		
	Sign & Date	Name		Sign & Date	Name
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BIDDER/ SUPPLIER	
Sign & Date	
Seal	

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	CUSTOMER :		QP NO.: PE-QP-999-Q-007, REV-04	
	PROJECT:		PO NO.:	
	ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV (415V))	SYSTEM:	SECTION: II	SHEET 6 OF 9

Sl No.	Component & Operations	Characteristics	Class	Type of Check	Quantum Of check		Reference Document	Acceptance NORMS	FORMAT OF RECORD		AGENCY			
1	2	3	4	5	6		7	8	9	*	**			
					M	C/N				D	M	C	N	
2.4	SHEET STACKING	1.COMPLETENESS	MA	MEASUREMENT	SAMPLE	-	MANUFACTURER'S STD.	MANUFACTURER'S STD.	LOG BOOK		P	-	-	
		2.COMPRESSION & TIGHTENING	MA	MEASUREMENT	100%	-	MANUFACTURER'S STD.	MANUFACTURER'S STD.	LOG BOOK		P	-	-	
2.5	WINDING	1.COMPLETENESS	CR	VISUAL	100%	-	MANUFACTURER'S STD./APPROVED DATASHEET	MANUFACTURER'S STD./APPROVED DATASHEET	LOG BOOK		P	-	-	
		2.CLEANLINESS	CR	VISUAL	100%	-	MANUFACTURER'S STD./APPROVED DATASHEET	MANUFACTURER'S STD./APPROVED DATASHEET	LOG BOOK		P	-	-	
		3.IR-HV-IR	CR	ELECT. TEST	100%	-	IS-325/IS-12615/IEC-60034 PART-1	IS-325/IS-12615/IEC-60034 PART-1	TEST/INSPC. REPORT	✔	P	V	-	
		4.RESISTANCE	CR	ELECT. TEST	100%	-	IS-325/IS-12615/IEC-60034 PART-1	IS-325/IS-12615/IEC-60034 PART-1	TEST/INSPC. REPORT	✔	P	V	-	
		5.INTERTURN INSULATION	CR	ELECT. TEST	100%	-	IS-325/IS-12615/IEC-60034 PART-1	IS-325/IS-12615/IEC-60034 PART-1	TEST/INSPC. REPORT		P	-	-	
2.6	IMPREGNATION	1.VISCOSCITY	MA	PHY. TEST	AT STARTING	-	MANUFACTURER'S STANDARD	MANUFACTURER'S STANDARD	LOG BOOK		P	-	-	
		2.TEMP. PRESSURE VACCUM	MA	PROCESS CHECK	CONTINUOUS	-	MANUFACTURER'S STANDARD	MANUFACTURER'S STANDARD	LOG BOOK		P	-	-	
		3.NO. OF DIPS	MA	PROCESS CHECK	CONTINUOUS	-	MANUFACTURER'S STANDARD	MANUFACTURER'S STANDARD	LOG BOOK	✔	P	V	-	THREE DIPS TO BE GIVEN

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	Sign & Date	Name		Sign & Date	Name
Prepared by:		HEMA KHUSHWAHA	Checked by:		KUNAL GANDHI
Reviewed by:		PRAVEEN DUTTA	Reviewed by:		R K JAISWAL

BIDDER/ SUPPLIER	
Sign & Date	
Seal	

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Doc No:			
	Sign & Date	Name	Seal
Reviewed by:			
Approved by:			

MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS	STANDARD QUALITY PLAN		SPEC. NO :	DATE:17.04.2020
	CUSTOMER :		QP NO.: PE-QP-999-Q-007, REV-04	
	PROJECT:		PO NO.:	
	ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV (415V))	SYSTEM:	SECTION: II	SHEET 7 OF 9

Sl No.	Component & Operations	Characteristics	Class	Type of Check	Quantum Of check		Reference Document	Acceptance NORMS	FORMAT OF RECORD		AGENCY			
1	2	3	4	5	6		7	8	9	*	**			
					M	C/N				D	M	C	N	
		4.DURATION	MA	PROCESS CHECK	CONTINUOUS	-	MANUFACTURER'S STANDARD	MANUFACTURER'S STANDARD	LOG BOOK	✔	P	V	-	
2.7	COMPLETE STATOR ASSEMBLY	1.COMPACTNESS & CLEANLINESS	MA	VISUAL	100%	-	MANUFACTURER'S STANDARD	MANUFACTURER'S STANDARD	LOG BOOK		P	-	-	
2.8	BRAZING/COMPRESSION JOINT	1.COMPLETENESS	CR	VISUAL	100%	-	MANUFACTURER'S STANDARD	MANUFACTURER'S STANDARD	LOG BOOK		P	-	-	
		2.SOUNDNESS	CR	MALLET TEST & UT	100%	-	MANUFACTURER'S STANDARD	MANUFACTURER'S STANDARD	TEST/INSPC. REPORT	✔	P	V	-	
		3.HV	MA	ELECT. TEST	100%	-	MANUFACTURER'S STANDARD	MANUFACTURER'S STANDARD	TEST/INSPC. REPORT	✔	P	V	-	
2.9	COMPLETE ROTOR ASSEMBLY	1.RESIDUAL UNBALANCE	CR	DYN. BALANCE	100%	-	MANUFACTURER'S SPEC./ ISO 1940	MANUFACTURER'S DWG.	LOG BOOK		P	-	-	
		2.SOUNDNESS OF DIE CASTING	CR	ELECT. (GROWLER TEST)	100%	-	MANUFACTURER'S SPEC.	MANUFACTURER'S SPEC.	TEST/INSPC. REPORT	✔	P	V	-	
2.10	ASSEMBLY	1.ALIGNMENT	MA	MEAS.	100%	-	MANUFACTURER'S SPEC.	MANUFACTURER'S SPEC.	LOG BOOK		P	-	-	
		2.WORKMANSHIP	MA	VISUAL	100%	-	MANUFACTURER'S SPEC.	MANUFACTURER'S SPEC.	LOG BOOK		P	-	-	
		3.AXIAL PLAY	MA	MEAS.	100%	-	MANUFACTURER'S SPEC.	MANUFACTURER'S SPEC.	LOG BOOK	✔	P	V	-	
		4.DIMENSIONS	MA	MEAS.	100%	-	MANUFACTURER'S DRG./ MANUFACTURER'S SPEC.	MANUFACTURER'S DRG./ MANUFACTURER'S SPEC.	LOG BOOK		P	-	-	
		5.CORRECTNESS, COMPLETENESS TERMINATIONS/ MARKING/ COLOUR CODE	MA	VISUAL	100%	-	MANUFACTURER'S SPEC.	MANUFACTURER'S SPEC.	LOG BOOK		P	-	-	
		6. RTD, BTD & SPACE HEATER MOUNTING.	MA	VISUAL	100%	-	MANUFACTURER'S SPEC.	MANUFACTURER'S SPEC.	LOG BOOK	✔	P	V	-	

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Prepared by:		HEMA KHUSHWAHA	Checked by:		KUNAL GANDHI
Reviewed by:		PRAVEEN DUTTA	Reviewed by:		R K JAISWAL

BIDDER/ SUPPLIER	
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Sl No.	Component & Operations	Characteristics	Class	Type of Check	Quantum Of check		Reference Document	Acceptance NORMS	FORMAT OF RECORD		AGENCY			
1	2	3	4	5	6		7	8	9	*	**			
					M	C/N				D	M	C	N	
3.0	TESTS	1.TYPE TESTS INCLUDING SPECIAL TESTS	MA	ELECT.TEST	1/TYPE/SIZE	1/TYPE/SIZE	IS-325//IS-12615/APPROVED DATASHEET	IS-325/IS-12615/APPROVED DATASHEET	TEST REPORT	✔	P	W*	-	* NOTE - 1
		2.ROUTINE TESTS INCLUDING SPECIAL TEST	MA	ELECT.TEST	100%	-	IS-325//IS-12615/APPROVED DATASHEET	IS-325/IS-12615/APPROVED DATASHEET	TEST REPORT	✔	P	V$	-	$ NOTE - 2
		3.VIBRATION & NOISE LEVEL	MA	ELECT.TEST	100%	-	IS: 12075 / IEC 60034-14 & IS-12065	IS: 12075 / IEC 60034-14 & IS-12065	TEST REPORT	✔	P	V$	-	$ NOTE - 2
		4.OVERALL DIMENSIONS AND ORIENTATION	MA	MEASUREMENT & VISUAL	100%	100%	APPROVED DRG/DATA SHEET	APPROVED DRG/DATA SHEET &	TEST/INSPC. REPORT	✔	P	W	-	
		5.DEGREE OF PROTECTION	MA	ELECT. & MECH. TEST	1/TYPE/ SIZE	-	IEC 60034-5/IS-12615	APPROVED DATASHEET	TC	✔	P	V	-	TC FROM AN INDEPENDENT LABORATORY, REFER NOTE-3
		6. MEASUREMENT OF RESISTANCE OF RTD & BTD	MA	ELECT. & MECH. TEST	100%	-	IS-325//IS-12615/IEC-60034 PART-1/IS: 12802	IS-325/IS-12615/IEC-60034 PART-1/IS: 12802	TC	✔	P	V$	-	$ NOTE - 2
		7. MEASUREMENT OF RESISTANCE, IR OF SPACE HEATER	MA	ELECT. & MECH. TEST	100%	-	IS-325//IS-12615/IEC-60034 PART-1	IS-325/IS-12615/IEC-60034 PART-1	TC	✔	P	V$	-	$ NOTE - 2
		8. NAME PLATE DETAILS	MA	VISUAL	100%	-	IS-325//IS-12615& DATA SHEET	IS-325/IS-12615 & DATA SHEET	TEST/INSPC. REPORT	✔	P	V$	-	$ NOTE - 2
		9.EXPLOSION FLAME PROOF NESS (IF SPECIFIED)	MA	EXPLOSION FLAME PROOF TEST	1/TYPE	-	IS 2148 / IEC 60079-1	IS 2148 / IEC 60079-1	TC	✔	P	V	-	TC FROM AN INDEPENDENT LABORATORY, REFER NOTE-3
		10. PAINT SHADE, THICKNESS & FINISH	MA	VISUAL & MEASUREMENT BY ELKOMETER	SAMPLE	SAMPLE	APPROVED DATASHEET	APPROVED DATASHEET	TC	✔	P	W$	-	SAMPLING PLAN TO BE DECIDED BY INSPECTION AGENCY $ NOTE - 2

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Prepared by:		HEMA KHUSHWAHA	Checked by:		KUNAL GANDHI
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					M	C/N				D	M	C	N	
4.0	PACKING	SURFACE FINISH & COMPLETENESS	MA	VISUAL	100%	100%	AS PER MANUFACT. STANDARD / (#)	AS PER MANUFACT. STANDARD / (#)	INSPC. REPORT	✔	P	W	-	(#): REFER NOTE-8

NOTES:

1 DEPENDING UPON THE SIZE AND CRITICALLY, WITNESSING BY BHEL SHALL BE DECIDED.

2 ROUTINE TESTS ON 100% MOTORS SHALL BE DONE BY THE VENDOR. HOWEVER, BHEL/CUSTOMER SHALL WITNESS ROUTINE TESTS ON RANDOM SAMPLES. THE SAMPLING PLAN SHALL BE MUTUALLY AGREED UPON.

3 IN CASE TEST CERTIFICATES FOR THESE TESTS ON SIMILAR TYPE, SIZE AND DESIGN OF MOTOR FROM INDEPENDENT LABORATORY ARE AVAILABLE, THE SAME IS VALID FOR 5 YEARS.

4 BHEL RESERVES THE RIGHT TO PERFORM REPEAT TEST, IF REQUIRED.

5 AFTER PACKING AND PRIOR TO ISSUE MDCC, PHOTOGRAPHS OF ITEMS TO BE DESPATCHED SHALL BE SENT TO BHEL PURCHASE GROUP FOR REVIEW.

6 IN CASE , ANY CHANGES IN QP COMMENTED BY CUSTOMER AT CONTRACT STAGE SHALL BE CARRIED OUT BY BIDDER WITHOUT ANY IMPLICATION TO BHEL/ CUSTOMER.

7 PROJECT SPECIFIC QP TO BE DEVELOPED BASED ON CUSTOMER REQUIREMENT.

8 FOR EXPORT JOB, BHEL TECHNICAL SPECIFICATION FOR SEAWORTHY PACKING TO BE FOLLOWED.

9 PACKING SHALL BE SUITABLE FOR STORAGE AT SITE IN TROPICAL CLIMATE CONDITIONS.

10 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: DOCUMENT

BHEL					
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	Sign & Date	Name		Sign & Date	Name
Prepared by:		HEMA KHUSHWAHA	Checked by:		KUNAL GANDHI
Reviewed by:		PRAVEEN DUTTA	Reviewed by:		R K JAISWAL

BIDDER/ SUPPLIER	
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ELECTRICAL ACTUATOR DETAILS

ELECTRICAL ACTUATORS

1.0.0 INTENT OF SPECIFICATION

This section covers the requirements of motor operated electrical actuators.

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 applicable Indian Standards (IS), IEC publications and other codes except where modified and /or supplemented by this specification.

3.0.0 TECHNICAL REQUIREMENTS

3.1.0 Electric actuators shall be provided as specified in Mechanical and C&I section. It shall be equipped with 3 phase induction motor, rated for S2-15 minutes duty for ON/OFF valve and intermittent duty for inching duty

3.2.0 Motor shall be class F insulated with temperature rise limited to class B. Motor shall be of class H insulation with temperature limited to class B used for high pressure and high temperature valves.

3.3.0 Motor shall be surface cooled designed for enclosure protection class of IP 67. Motor shall be suitable for starting direct on-line.

3.4.0 For installation in potentially hazardous areas, the actuators shall have suitable explosion proof / flame proof type enclosure.

3.5.0 Actuators shall be suitable for operation at an ambient temperature of 50 degree C and relative humidity of 95%.

3.6.0 Maximum continuous motor rating shall be atleast 10% above the maximum load derived of the driven equipment under entire operating range including voltage & frequency variation.

3.7.0 Motors shall be capable of operating under following supply variations without exceeding its guaranteed temperature limits.

- Frequency variation : (+) 3% and (-) 5% of 50 Hz
- Voltage variation for LT motors : (±) 10% of 415 V
- Combined variation of voltage and frequency: 10% (absolute sum)

3.8.0 All actuators shall be of integral type. Duty cycle of actuators shall suit the system requirement. The actuators shall be capable of giving the required torque at the output shaft. The actuators shall be designed to take the full thrust.

3.9.0 Electrical Actuators of Inching type position transmitters of non contact type shall be interfaced to DCS.

3.10.0 Actuators shall be of totally enclosed weather proof and dust proof construction with NEMA-6/IP 65 enclosure and shall be suitable for outdoor application without the necessity for a canopy. The actuator shall be suitable for mounting directly on the valve. The actuator shall be capable of giving the required torque, rpm and thrust without the help of any spur gear arrangement. The actuator shall be suitable for mounting in any position. Actuators shall be provided with integral starters.

3.11.0 The actuator shall be complete with motor, reduction gears, change gears, terminal compartment, switch compartment with limit switches and torque switches, local position indicator, position transmitter for remote position indicator, thermistor, space heaters, cable glands, mechanical position indicator, hand wheel for manual operation, valve attachment etc.

3.12.0 Each actuator shall have a hand wheel fitted on it for emergency operation. The hand wheel shall be designed such that it is declutched automatically when the power supply to the motor is restored. The material of the hand wheel shall be either malleable iron or steel. The hand wheel shall have adequate clearance from housing for each gripping and operation. Actuators offered shall be with self-locking worm.

3.13.0 Two number adjustable torque switches (one for open and one for close) each with 2 NO and 2 NC potential free contacts shall be provided. It is required to have calibration for the torque switches so that the switches can be easily set to any value desired.

3.14.0 Two numbers of position limit switches (one for open and one for close) each with 2 NO and 2 NC potential free contacts shall be provided. Two auxiliary limit switches (one for open and one for close) with 2 NO and 2 NC potential free contacts shall also be provided. The limit switches shall be of independently adjustable type. Limit switches and actuating mechanism shall be rust proof suitable for damp atmospheres. Limit switch compartment shall be weather proof and spacious enough for easy setting. The limit switches shall be suitable for the following ratings, both 240 Volts AC, 10 A and 220 V DC, 0.5 Amps.

3.15.0 Each actuator shall have a space heater in the limit switch compartment suitable for 240 V AC 50 Hz single phase supply.

3.16.0 The wiring from the limit switches, torque switches etc. shall be brought out in a separate terminal box of adequate size, so as to easily terminate the control cables.

3.17.0 Actuators shall be supplied with integral starter which shall have sophisticated electronic controls with field programming feature. It shall be designed for remote control from DCS/Respective control system. Required interposing relays for receiving open/close/stop command from DCS/Respective control system shall be provided. Potential free contacts and transducers shall be provided to provide status indication at remote DCS/Respective control system..

3.18.0 A three position selector switch (marked as LOCAL-OFF-REMOTE) and push buttons OPEN-STOP-CLOSE (for local operation) with indication lamps for running OPEN and running CLOSE shall be provided.

3.19.0 The Remote command signal (OPEN-STOP-CLOSE) from DCS/Respective control system/Control panel shall be isolated from control electronics through opto-isolator.

3.20.0 The following individual sStatus annunciation LED's and fault annunciation LED's shall be provided locally (Integral to actuator) to annunciate the following for easy local monitoring.

- Actuator in local mode
- Actuator in remote mode
- Actuator running in OPEN direction
- Actuator running in CLOSE direction
- Actuator in inching mode.
- Actuator in self-retaining mode
- Limit switch OPEN trip
- Limit switch CLOSE trip
- Control voltage availability

3.21.0 The following individual fault annunciation LED's (Colour-Red) shall be provided locally. (Integral to Actuator)

- Torque switch OPEN
- Torque switch CLOSE
- Thermo switch trip
- Electronic overload relay trip
- Motor single phasing
- Common fault (Inclusive of any one or combination of above fault)

3.22.0 View port shall be provided on integral starter unit to monitor the above status annunciation and fault annunciation.

3.23.0 Electronic Overload relay shall be provided to trip actuator in case of overload.
Plug in connections/design shall be provided between:-

- Integral starter unit and basic actuator
- Between external customer connections and actuator.

3.24.0 OPEN-CLOSE indication /LED shall be provided for indication of full open/close position.

3.25.0 Automatic phase correction facility and potential free contact for annunciation of power failure shall be provided.

3.26.0 The following individual potential free relay contacts shall be provided in the actuator for remote annunciation to facilitate continuous monitoring of the actuator.

- Actuator (valve) running in OPEN direction.
- Actuator (valve) running in CLOSE direction.
- Actuator in remote mode.
- Actuator in local mode.
- Actuator power switched off /single phasing.
- Torque switch trip, thermo switch trip and overload relay trip

4.0.0 TESTING AND INSPECTION

Equipment offered shall be of type tested and proven type. Routine tests shall be carried out for all the equipment as per applicable standards. Copies of certified reports of all tests carried out at the works shall be furnished.

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.

- Measurement of insulation resistance.
- Measurement of full load current.
- Test running of the motors.

5.0.0 DRAWINGS & DOCUMENTS

The following drawings and documents shall be submitted for approval during detail engineering stage.

- Integral starter details
- Technical particulars of actuator
- Wiring diagram
- General arrangement drawings
- Test reports
- Manufacturing quality plan
- Field quality plan

CABLE SCHEDULE FORMAT

CABLE SCHEDULE FORMAT

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

2 X 660MW UDANGUDI SUPERCRITICAL TPP STAGE-1
VOLUME: II B
TECHNICAL SPECIFICATIONS FOR
EFFLUENT TREATMENT PLANT
SPECIFICATION NO.: PE-TS-435-164-A001

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)

DESIGN REQUIREMENT OF C&I

DESIGN REQUIREMENT

1.0.0 DESIGN REQUIREMENT

1.1.0 The Instrumentation and control systems shall be provided for safe, reliable and efficient operation of the thermal power project. In general a consistent control and instrumentation philosophy is to be applied throughout the power project. Adequate redundancy are to be ensured, so that no single point failure of the I&C systems/ equipments in the power project does not result in the overall reduction of the plant output. In general all I&C systems/ equipments should be of modern and compact design, incorporating proven technology and modern industrial practice.

1.1.1 The minimum target reliability of each piece of equipment like each electronic module/card, Power supply, Peripheral etc. considering its failure rate/mean time between failures (MTBF), meantime to repair (MTTR), such that the availability of the complete C&I system is assured for 99.7%.

1.1.2 The design of the control systems and related equipments shall adhere to the principle of 'Fail Safe' operation wherever safety of personnel / plant equipment is involved. 'Fail Safe' operation signifies that the loss of signal, loss of excitation or failure of any component shall not cause a hazardous condition. However, it shall also be ensured that the C&I system design with respect to control and protection functions is 'Fault Tolerant' to single faults such that the occurrence of false trips and degradation of functions are avoided / minimised. The types of failure which shall be taken into account for ensuring operability of the plant shall include but not limited to;

a) Failure of sensor or transmitter,
b) Failure of main and/or redundant controller, other electronic modules,
c) Loss of motive power to final control element,
d) Loss of control power.
e) Loss of instrument air

1.1.3 Standardization concepts shall be applied wherever possible to rationalize operation, maintenance and reduce spare parts The choice of hardware shall also take into account for sound maintainability principles and techniques. The same shall include but shall not be limited to the following:

a) Standardization of parts.
b) Minimum use of special tools.
c) Grouping of functions.
d) Interchangeability.
e) Malfunction identification facility/self surveillance facility.
f) Easy modular replacement.
g) Fool proof design providing proper identification and other features to preclude
h) Improper mounting and installation.
i) Appropriate derating of electronic components and parts.

1.1.4 The design, manufacture, assembly, testing as well as performance of the equipment shall conform to the latest edition of relevant IEC/ISA and other international codes/specifications. The I & C equipment and systems shall be designed, manufactured & installed to meet the specification requirements, and perform accurately and safely under the operating and environmental conditions existing in the power project. The Instrumentation and control equipment shall be designed suitably that are subjected to saline atmosphere.

1.1.5 All control and instrumentation functions shall be shown on the piping and instrumentation diagrams. The symbols to be used shall be in accordance with ISA / ISO standard. The identification system (tag numbers) shall be in accordance with the KKS identification system, and shall be subject to approval by the Owner. All measurements and alarms shall be listed. Complete schematic control diagrams shall be provided for all instrumentation. Functional application and also specific control (modulating/interlock) application (by short text) for each measurement along with signal destination shall be indicated in Process and Instrumentation Diagram (P&ID). All reference engineering documents shall also be indicated in the P&ID.

1.1.6 Automatic single push button start facility from the plant DCS to be provided for the main plant equipments such as BMS, BPS, STG, and other DCS controlled systems. For balance of plant systems such as water treatment plant, Instrument and service air compressor, seawater system etc the controls are to be designed such that fully automatic operation should be possible from the plant DCS and minimum local intervention.

1.1.7 The system will have 1:1 redundancy with respect to the processor modules, power supply modules, communication modules and network interface.

The system will be designed in such a manner that in the event of failure of the primary controller, the entire configuration of the failed controller will be instantaneously and automatically transferred to the back-up controller without operator's intervention. Mode changeover in either direction will be bumpless.

Dual redundant power supplies to be provided for all the I&C panels. Loss of single power supply shall be alarmed in DCS for corrective action by the operator

1.1.8 Measurement system (MS), Closed Loop Control System (CLCS) and Open Loop Control System (OLCS) will all be configured with redundancy at processor modules, communication modules, data bus and power supply modules.

1.1.9 Redundant Input and output modules shall be provided for all the drive level interface (both OLCS/CLCS). For the inputs, dual or triple measurement as described in clause 2.1.0 of Section 4.8 and Clause 2.1.0 of Section 4.9 shall be provided and the individual measurements (dual or triple) shall be wired to separate input modules. No redundancy at I/O card level is required which are executing purely Data acquisition/Monitoring functions. I/O's redundancy shall be truly redundant and not engineered I/O redundancy. For measurement system, redundancy at sensor level and I/O module level is not envisaged. Logics for the redundant drives shall not be in the same processor.

1.1.10 The Measurement system shall have the following features:

a) Linearization for temperature measurement i.e. mv Vs Deg. C
b) Square root extraction for flow measurement, where the measurement is in differential pressure.
c) Integration for totalizing the flow measurement, whenever applicable.
d) Compensation for variation in pressure or temperature or density for flow/ level measurement. E.g.: Feed water flow.
e) Limit value monitor for generation of contacts for alarm/interlock purpose.
   Eg.: Boiler Tube metal, Bearing, winding temperature measurements
f) Each of the analog transmitters shall be Smart type with the following:
   (i) 4-20mA DC signal with 24V DC interrogation.
   (ii) HART protocol based digital communication
g) All these Transmitters shall be hooked up to a PC based Centralised Calibration system (HART System), which shall have Diagnostic and Configuration software. This system shall be located in Computer room.
f) All contact inputs shall be interrogated with 24 / 48 V DC

1.1.11 Where redundant sensors are provided redundancy at I/O card level is not required. Redundant sensors will be provided for all control applications.

1.1.12 The communication sub system will be a real time reliable communication network between control processors, operator stations, printers and engineering station.

1.1.13 The plant bus and communication bus shall have dual redundancy

1.1.14 Triple Sensors for unit/equipment and protection trip are applicable for main plant equipments and equipments which will affect plant availability.

1.1.15 Dual redundant sensors shall be provided as a minimum in 1 out of 2 logic for all other closed loop and open loop controls used for protection.

1.1.16 Sequence of event recording system shall be integral to DCS

1.1.17 A consistent control and instrumentation philosophy shall be applied throughout the plant and be implemented in terms of a range of equipment exhibiting a minimum diversity of type and manufacture. Range of the instrument shall be so selected that max. operating value lies in 65-75% of the full scale range.

1.1.18 Control & Instrumentation shall be provided such that no single failure can cause a unit trip, loss of load/overall power output or even a forced outage of the power station. Modular redundant control systems shall be provided for all plant safety critical control and protection systems.

1.1.19 For hazardous area, the I & C systems to be designed as per the relevant area classification and applicable standards.

1.1.20 In the interest of a neat and clear, space-saving layout of the installation, easy maintenance, simple starting-up, operational checks and fault-recognition, a system made up of standard sub-assemblies with plug-in modules design shall be provided. The Systems shall have a decentralized design to a large extent. In the case of power supply failure no reprogramming shall be necessary and no controller parameter shall be lost.

1.1.21 To ensure smooth and optimal maintenance including efficient spare parts management of various I&C instruments/equipments like vibration monitoring analysis systems, all 4-20mA electronic transmitters/ transducers, control hardware, control valves, actuators and other instruments/ local devices etc. being furnished by the Bidder for SG, TG, BOP including its auxiliaries and systems like fuel system, circulating water system, chemical dosing system, Hydrogen Generation Plant (if applicable), Desal/WTP, cooling water system, electro chlorination system, effluent treatment plant, compressed air system, fire protection system, mill reject system, HVAC, potable water system, emergency DG facility etc. and other plant auxiliaries for similar applications, the Bidder shall ensure that they are of the same make, series and family of hardware. Bidder shall furnish a composite list of bought-out items along with proposed sub-vendors for each of the same.

1.1.22 The operator stations in the local and remote control rooms shall be housed in the enclosed control desk with interior lighting, louvers with brass mesh, space heater and telephones. The control desk shall be constructed of 2mm thick CRCA with IP 32 protection class for air conditioned environment and IP-44 for other indoor applications.

5.0.0 GENERAL TECHNICAL REQUIREMENTS

5.1.0 As a minimum the following pressure measurement points are to be provided by the Bidder,

Pressure gauges at the suction, discharge of the pumps, compressors and fans, common header of pumps and fans, inlets and outlet of heat exchangers, de-super heaters, pressurized vessels, and other main equipment outlet and inlet.

Pressure gauges at the discharge of compressors and at the air receiver tank.

Pressure switches at suction, permissive and trip of pumps and fans/blowers, discharge pressure low for auto-start of standby pumps and pre-trip alarm conditions.

Pressure switches at the discharge of the compressor and in the lube oil circuit. Differential pressure switches across the inlet air filters.

Differential pressure indicators across filters (Gas, water, oil service, air), strainers (Gas, water, oil service, air), cooling water line of the condensers,seal oil and hydrogen gas of generator.

Differential pressure switches across filters (Gas, water, oil service, air), strainers (Gas, water, oil service, air) & cooling water line of the condensers for high and high high alarm.

Differential pressure switches across bag filters.

Pressure transmitters at the suction and discharge of main process / pumps / compressors, for all controlled parameters, inlet and outlet of cooling water line of the condenser, flue gas line at inlet / outlet of various pressure parts, pressure conditions of major vessels like separator, de-aerator etc.

Pressure transmitter at the Compressor outlet, lube oil pressure, instrument air header and at the inter stages of the compressor

Pressure transmitters at HP/LP water pumps discharge, Water/Oil pumps. Vacuum transmitters at the vacuum pump discharge.

On both left and right sides of furnace, separate lines shall be laid and provided with furnace pressure transmitters. Independent impulse lines shall be installed to the transmitter in case of dual/trip redundant with double isolation.

Differential pressure transmitter across RO-Skid, Oil/Water strainers

Differential pressure transmitters for all level measurements, differential pressure measurements, flow measurements of condensate, steam, feed-water, air, seal oil and hydrogen gas of generator, across APH for flue gas, PA & SA paths, across membrane sections of RO plant etc.

DP Type flow transmitter shall be used at MB outlet.

DP Type level transmitter shall be used at PSF backwash tank and DG water storage tank.

Redundant pressure transmitters shall be provided when it is used for compensation algorithms.

5.2.0 As a minimum the following temperature measurement points to be provided by the Bidder,

Temperature gauges at main process pump discharge, where there is a change of temperature in the process, inlet / outlet of heat exchangers, de-super heaters etc.

Temperature switches to be provided wherever temperature abnormality to be alarmed if RTD and T/C is not provided, wherever equipment / system to be tripped on high temperature if RTD and T/C is not provided.

RTD for measuring the motor winding/bearing & bearing temperatures of compressors. Also installed at the interstages of the compressors and cooling water inlet and outlets

Temperature switches shall be of liquid filled or vapor actuated system. The bulb shall be of stainless steel with SS armored capillary tube of adequate length for installation.

Temperature gauges at the Cooling water inlet and outlet and interstages of the Compressor

Temperature gauge at the silo fluidizing blower common discharge header.

RTD is used for measuring the motor winding /bearing & bearing temperatures of ash slurry pumps, HP pumps.

Temperature gauge at the inlet of RO skid.

RTD is used for measuring the motor winding /bearing & bearing temperatures of RO HP pumps.

Temperature transmitter at the inlet of RO HPP/ Inlet of cartridge filter.

Temperature transmitters shall be provided for all control applications.

Resistance temperature detector shall be provided for monitoring points where temperature changes occur, bearing/ winding temperature.

Thermocouple for monitoring points shall be provided where temperature changes occur.

Metal temperature measurement shall be provided for super-heater, re-heater and Boiler drum.

Thermo-wells for performance test point, RTD, thermocouple, temperature switch, temperature indicators.

Redundant temperature transmitters shall be provided when it is used for compensation algorithms.

For SH/RH temperatures, the temperature sensors wires having SS shrouding are laid up to the Junction box and the terminal head shall be placed nearer to the JB.

For measurement of boiler metal temperature, flue gas temperature, air pre-heater grid temperature etc., the bidder shall provide permanent/removable duplex type mineral insulated thermo-couples terminated in junction boxes at boiler platforms. Compensating cable connecting metal temperature sensor shall be SS shrouded till the JB with Teflon coating

For measurement of turbine metal temperature turbine casing temperatures, stator winding temperature, Generator seal oil system, Turbine bearing temperature, Turbine oil temperature, Turbine bearing drain oil temperature, BFP turbine measurement parameters, MDBFP measurement parameters etc., the bidder shall provide permanent/ removable duplex type mineral insulated thermocouple/ RTD terminated in junction boxes at respective turbine side floors.

5.3.0 Flow nozzles will be used for main steam flow, feed-water flow and other critical measurements where weld-in construction is required. Orifice plates will be used for other liquid flow measurements where flanged construction is acceptable.

As for the water flow/steam flow measurements, necessary flow elements/transmitters are chosen in the process line and supplied such that their algebraic summation shall be mass balanced for calculating the system efficiency.

Venturi arrangement for PA flow for each pulverizer. Triple impulse lines + one spare impulse line to be provided in HP&LP of venturi arrangement provided for the PA flow of each pulverizer.

Coriolis mass flow meter to be used for Fuel oil and Ultrasonic flow meters for CW.

Flow glass to be provided for coolant from equipment, coolant from the coolers.

Flow switches shall be installed at the cooling water outlet flow.

Flow switches at the ejector outlet line.

Rotameter at the Pressure Sand Filter inlet, cartridge filter inlet Side Stream Filter inlet, service inlet of mixed bed and outlet of MCF – RO cleaning

Ultrasonic type flow meter shall be used for parshall flume flow, common outlet of SSF, RO module permeate line.

Electro magnetic flow meter shall be used at the inlet of PSF outlet and RO high pressure pump inlet.

Flow glasses are installed at water/oil line to the compressors & at slurry lines of bottom ash handling

Flow switches at cooling water return line/oil line to the compressors.

Flow transmitter cum switch to be provided for lube oil flow to the bearings of all HT drives, APH bearings etc

Vortex flow meter at the discharge of the compressors

Desal product to RO/DM plant (WT Plant) shall be provided with the flow transmitters.

RO plant outlet, RO plant inlet and CST inlet shall be provided with flow meters

Variable area flow indicators to be provided at the common outlet header of the identical equipment, CW blow-down etc.

Flow switches to be provided at the common outlet header of the identical equipment.

5.4.0 Guided wave radar type level transmitters shall be used for condenser hotwell level, LP heaters, Deareators, CBD and low pressure applications.

Radar type level transmitters shall be used for condensate storage tank

Non contact redundant ultrasonic type level transmitters for CW forebay, RW reservoir etc

Differential pressure transmitters will be used for general service level measurement of all separators, feed-water heaters, de-aerators and other pressurised and vented tanks.

Transparent gauge glasses will be used for low-pressure applications. Level gauges shall be provided for all surface mounted overhead tanks, hotwell, de-aerator and any other storage tanks.

Level switches shall be provided for lube oil reservoir of HT drives, for all tanks/sumps for low and high alarm,for all tanks /sumps for low low signal used for tripping the pump, for all tanks/sumps for adequate signal used for starting the pumps.

Level switch shall be used in the water cooling tower and expansion tank level.

Level transmitters shall be provided for hotwell, de-aerator feed tanks, blowdown tank, turbine main oil tank, condensate storage tank, DM storage tank, clarified water storage tank, sumps, Stator water tanks, expansion tanks etc.

Ultrasonic type level transmitters are used for clarified water storage tank, chemical storage and dosing tanks, DM water storage tank, sludge pit, RO Reject water storage tank and neutralization pit.

Radar Level transmitters are installed at the bulk acid storage, acid dosing tank.

Non contact type Ultarsonic level transmitters shall be used for CW sump level, CW fore bay, Raw water reservoir, water sump/tank etc

Level indicator at the ash conditioner water /drain sumps, ash water tanks

Level switch at the ash conditioner water /drain sumps
Level switch at the sump, tank of the dust suppression system.

Ultrasonic type level transmitters for ash slurry sump, ash water tank application.

Radar Level transmitters are installed at the fly ash silo

Continuous level measurement for unit coal bunker and other bunkers of Coal handling system shall be provided with two (2) numbers of radar type level transmitters for each bunkers with IP 65 protection for each bunker level measurement. Bunker level shall be monitored in Travelling tippler floor and CHP control room/ DCS. Radar type level transmitters shall be FMCWR type with drop in antenna and being operated at 24-26GHz.

RF Level switch are installed at the hoppers, fly ash silo

Open channel flow measurement at upstream of RO/Water treatment plant (before stilling chamber)

5.5.0 The following analyzers to be provided as a minimum in the pre-treatment/ RO–water treatment and other services.

Turbidity and free residual chlorine at the clarifier outlet

ORP, pH, SDI at RO plant inlet

Conductivity at RO membrane outlet

Chlorine analyser at pressure sand filter and degasser outlet.

Cation conductivity, specific conductivity, pH at SAC/SBA outlet

Conductivity, Silica, pH at Mixed bed outlet.

Dew point meter shall be installed at the outlet of air dryer to measure the quality of air.

pH at Cooling tower blow down to sea

Chloride and other requirements as per the statutory norms at Cooling tower blow down to sea

Vibration switch shall be provided to monitor vibration of Axial Flow Fan-Gear box assembly of wet cooling tower.

Airstat (Flow switch) is used to measure the air flow in the supply duct.

Humidistat used to measure the return air humidity.

Zero speed switches shall be provided for protection of the rotary vane feeder

Pull cord switches shall be provided for the conveyor protection

Zero speed switches shall be provided for protection of the conveyor

The belt sway switches to identify the misalignment of conveyor

Speed measurements for all HT drives having hydraulic coupling

Speed measurements for all HT drives having hydraulic coupling and VFD equipments.

FIELD INSTRUMENT DATA SHEET

FIELD INSTRUMENTS SPECIFICATION

FIELD INSTRUMENTS SPECIFICATION

1.0.0 TECHNICAL REQUIREMENT FOR INSTRUMENTATION

1.1.0 Field Instruments

a) Analog outputs signals from field instrumentation to the control systems are 4-20 Ma DC signals. Instrumentation can be self-powered, or loop powered from the control systems. Self-powered analog signals shall be true “isolated from ground” signals.

b) Field switches will be micro switch type with auto reset. Switches will have NO and NC contacts. Switch contacts shall be snap acting, 2 Nos of SPDT, hermetically sealed, potential-free with a minimum contact rating of 230 V AC 5A/ 24V DC 1A.

c) Transmitters will be used to provide the required 4 to 20Ma signals for all controllers and receivers. Transmitters will be of the electronic, two-wire type, capable of driving an output impedance of 600 ohms minimum at 24 V dc, and will be generally powered from the control system I/O cards. All the transmitters supplied shall be SMART type with HART capability.All the transmitter shall be provided with 5 digit local indicators

d) SMART transmitters’ calibration shall be carried out through a PC based system to be located in the computer room.

e) Pressure and differential pressure transmitters accuracy shall be within + 0.04% or better of FSR for BTG package, + 0.065% or better of FSR for BOP packages and + 0.2% for remote seal type transmitter. Repeatability shall be +0.05% of span or better. Errors caused by change in ambient temperature shall not exceed 0.01% of span per ℃ change. Stability 0.15% for five years.

f) The plant instrument air supply pressure shall be:

1. Maximum supply pressure 7 kg/cm^2
2.Minimum supply pressure 4.5 kg/cm^2

g) All instruments and analyzers shall employ EMI,RF protection in the system design**.**

h) Instrument tags should be permanently attached to the device. If this is not possible, the instrument tag should be fastened to the instrument with stainless steel wire.

i) Speed switches and the actual device should drive transducers, if possible.

j) All instrumentation mounted inside, away from direct exposure to the elements, shall be as a minimum IP-44 construction unless it is in an environmentally controlled environment (e.g the control room). If the instrument is mounted in an environmentally controlled environment the instrument shall be as a minimum IP-32 construction.

k) All instrumentation mounted outside shall be as a minimum IP-65 construction**.** IBR certification shall be provided for instruments / valve / Erection hardware wherever applicable.

l) Vibration switch (alarm, trip) and oil level switch to be provided for the cooling towers.

m) Transmitters and switches shall be grouped depending on the location. Individual instruments shall be mounted on stanchion or pipe mounted.

n) For saline applications and other applications which are corrosive in nature, the wetted part material to be selected which shall meet the process applications, preferably diaphragm seal to be used. Haste alloy C wetted part material and SS316L impulse piping / root valve material to be considered for the above applications.

o) All field instruments junctions boxes & local panels located in hazardous area shall be explosion proof as per the relevant applicable standards.

p) Reverse rotation switches to be provided for High Pressure Boiler Feed pumps, Main condenser cooling Water pumps, Condensate extraction pumps and sea water intake pumps

q) The following metric engineering units shall be used for all instrumentation devices :

1. Pressure – kg/cm^2g
2. Temperature - ℃
3. Steam flow – kg/hr / T/hr
4. Liquid flow – m^3/hr (Feed Water flow (in kg/hr or T/hr)
5. Distance – meters (m) or millimeters (mm)
6. Differential pressure – mmH20

r) For speed varying pumps/fans, speed measurement in 4 – 20 mA shall be connected to DCS.

s) Required Water analyzers for ACW pump discharge header mainly FRC (Free residual chlorine) analyzers shall be considered at CW /ACW common header return line.

t) Wireless transmitters :
For CW sump level, Raw water reservoir level, Turbine oil tank, coal bunkers, Ash Silo, LDO/HFO tank, DM water tanks, CS tank, Acid and alkali applications, only non contact type level transmitters like Ultrasonic or Radar based shall be provided by the bidders as per the specification and as approved by owner.

Considering the type of application, wireless technology to bring signals to DDCMIS may be adopted by interfacing with OPC gateway to avoid cabling from smart level transmitters as specified above. And for other applications, if any shall be decided during Detailed Engineering. However Wireless technology as adopted by Bidder shall be reliable and field proven in power plants and same shall be approved by Owner.

1.1.1 Pressure Instrumentation

a) Pressure transmitters are electronic, analog 2-wire transmitters with isolated 4-20Ma DC output signals.

b) Pressure transmitters will be supplied with integral mounted two valve manifolds.

c) All pressure transmitters shall be capable of withstanding their body rating conditions without permanent damage or loss of calibration.

d) Differential pressure transmitters of the capacitance type, regardless of the applied service, shall be capable of withstanding a differential pressure equal to full process

pressure on either side of the measurement element without damage or loss of calibration.

e) Differential pressure transmitters will be supplied with integral mounted three valve manifolds for air service and 5 way valve manifold for steam & water service. For pressure and differential pressure transmitters, overall Accuracy: + 0.04% or better of FSR for BTG package & + 0.065% or better of FSR for BOP packages. Accuracy shall be + 0.2% for remote seal type transmitter.

f) Pressure gauges will be generally 150mm dial, solid front safety case type with blowout back, ½" NPT bottom connection, drawn stainless steel case, 316SS bourdon and socket, stainless steel movement, micrometer pointer. Pulsation dampers will be provided for pulsating pressure services. Liquid filled gauges shall be used for all pump discharges, vibrating or pulsating services. Pigtail ressu shall be used for the steam service where gauges are mounted close to the tap.

g) Pressure switches will generally be snap acting type, DPDT action, with individual "on" and "off" points to be on a calibrated scale or dial. Pressure switches will have amphoral connection. Repeatability shall be +/- 0.5% or better. Pressure sensor shall be 316 SS with over range protection. Die cast aluminum with stored enamel black finish and epoxy coating for corrosive atmosphere.

h) Dual type control switches such as pressure switches having two sets of contacts with independently adjustable set points shall not be used where set point adjustment and deadband are a problem (e.g. low pressure and vacuum applications). If a potential problem exists, two single purpose switches shall be used. Switch differential shall be adjustable.

i) The indicating type switches are not acceptable. If application requires indication and switching function, then a separate blind switch and a gauge to be used.

j) All the switches are internally connected and brought to the surface with Amphenol male/female connection. Cabling need not be terminated inside the switch. Cable ends are to be soldered in connector and to be inserted for easy maintenance.

k) Condensate pots for pressure transmitters and siphons for gauges shall be used for steam and high temperature applications. Chemical seals to be used for highly corrosive and viscosity applications

l) The switches shall have the following:.

Contact rating	:	230V AC, 5A / 24V DC 1A.
Repeatability	:	±0.5% FSR

m) Turn down ratio to be 100:1

n) Response time for pressure and differential pressure transmitter shall be 100 ms.

o) Protection for gauges fitted in the vibration lines/equipments shall be provided

1.1.2 Temperature Instrumentation

a) For temperature up to 300℃ 3-wire RTD duplex type, PT 100 type shall be used. For temperature beyond 300℃ thermocouples shall be used. Thermocouples shall be manufactured in accordance with the ISA Standard MC96.1, Temperature Measurement Thermocouples. All thermocouples shall be Chromel Alumel (Type K) for 300℃≤ T < 850℃. R or S type for T> 850℃.

b) The Mv signal of thermocouple shall be used as input to the DCS. Cold junction compensation shall be achieved in the DCS

c) Thermocouples shall have duplex elements and ungrounded measuring junction.

d) An extension nipple / union / nipple of sufficient length to extend beyond lagging and connection head shall be furnished for each thermocouple assembly. Terminal blocks shall be marked with polarity and connectors shall be resistant to heat, vibration and galling. The cap shall provide a weather tight enclosure and a chain shall be provided to prevent loss of cap. The cap shall be made of cast aluminium.

e) RTDs of Duplex type furnished by the Supplier shall be of the three-wire type made with 100 ohm platinum resistance elements. They shall be certified to meet the requirements of the International Temperature Scale, calibrated to the IEC-751 standard (Alpha = 0.00385 Ohms/Ohm/℃).The RTDs shall be contained in an insulated material and a sheath or sleeve of stainless steel SS-316 and shall be so mounted that they can withstand the greatest shocks and vibrations that can be imposed upon them in the system piping without deterioration. Specific information shall be furnished concerning type and accuracy of bridge circuits to be used with the RTDs. RTDs shall be directly connected to DCS without any transmitters

f) Unless specified otherwise, each temperature element and thermometer shall be provided with a 1" socket weld type, 316 stainless steel tapered thermowell suitable for the requirements of the given application. Temperature element process connection shall be ½ NPTM.

g) Temperature transmitters of SMART type are to be provided for all temperature measurements that are used in any CLCS. For thermocouple, cold junction compensation shall be implemented within the transmitter.

h) Thermocouples will be of duplex MI type in ISA, K(chromel-Alumel), Platinum-Rhodium/Platinum with sheath OD 6 mm. RTD will be Duplex, Pt 100 ohm, 3 wire type as per DIN standard 43760 or equivalent. Thermo wells will be ASME PTC 19.3 latest revision with process connection M 33x2 for threaded connection and flanged connection for Air and Gas system & tanks.

i) Thermowell immersion length will generally be between 1/3 and ½ the distance to the center of the pipe. Where thermo wells are installed in lines smaller than 4 inches, the piping shall be expanded to 4 inch size to accommodate the thermo well. Thermowell shall be drilled from solid bar stock.

j) All thermo well in a high velocity line or duct shall have an ASME PTC 19.3 calculation for determination of the wells resonant frequency. Thermo wells that do not meet the acceptance criteria shall be resized or relocated as necessary.

k) Thermocouple extension wire is to be solid, shielded, twisted pairs.

l) If intermediate terminal blocks are required in a thermocouple measuring circuit, they need not be the same material as the thermocouple.

m) Dial thermometers shall be bimetallic, minimum 150mm dial, every angle form, hermetically sealed with external recalibration adjustment, ¼" OD SS stem, ½" NPT connection and SS case.

n) Temperature switches shall be actuated by filled bulb-type elements equipped with standard-length armored capillary tubing. All the switches are internally connected and brought to the surface with Amphenol male/female connection.

o) Temperature gauges shall have ±1% accuracy and overage protection of 125%.

p) Switches shall have the following:

Max. contact rating	:	230V AC, 5A
Repeatability	:	±0.5% FSR
Contact type	:	snap acting

Over all accuracy 0.1% of calibrated span

q) Protection for gauges fitted in the vibration lines/equipments shall be provided

r) For measurement of pulverizer outlet temperature, tungsten carbide block thermowell aborium resistant shall be used instead of tungsten carbide coated thermowell. And for sea water titanium sleeve thermowell or better shall be used

s) Switch differential shall be adjustable. Fan DE/NDE, motor DE/NDE temperature are to be fitted with capillary type dial thermometers with standard length.

1.1.3 Flow Instrumentation

a) Flow nozzles will be used for main steam flow, feed-water flow and other critical measurements where weld-in construction is required. Orifice plates will be used for other liquid flow measurements where flanged construction is acceptable. Accuracy of the measuring orifice plates, nozzles and annubar shall be minimum +-1%. Ultrasonic type flow meter shall be used for cooling water flow application with an accuracy of minimum +-0.4% of measured flow or better and haste alloy C wetted part material to be used if insertion type is provided.

b) Flow elements will be accompanied by IBR certification.

c) Flow nozzles and orifice plates shall conform to requirements of ASME “Fluid Meters”.

d) Flow nozzles shall be of the weld-in holding ring type ASME long radius, with dual wall taps and shall be of stainless steel. Flow nozzles shall be furnished complete with metered runs in accordance with ASME PTC 6.1. Metered pipe run and nozzle shall match the pipe material and size that metered section is to be installed in.

e) Orifice plates shall be 316SS, sharp square edge thin plate, and paddle type suitable for installation between raised face orifice flanges. Orifice flanges, gaskets and jacketing screws shall be furnished by the Supplier. Paddle shall be stamped with the orifice ID bore diameter on the upstream side. Orifice flanges will be of the raised face, weld-neck type with dual 2 sets of taps as required for redundancy.

f) Beta ratios shall be between 0.3 and 0.7. Flow elements (flow nozzle & orifice) sizing shall as per BS-1042/ISO-5167.

g) Differential type flow transmitters shall be supplied with three valve manifolds directly mounted to the transmitter for gas applications and five valve manifolds directly mounted to the transmitter for steam and liquid applications

h) Differential type flow transmitters shall be electronic, analog 2-wire transmitters with isolated 4-20 Ma dc output signals.

i) Square root extraction of the flow signal is performed in the DCS.

j) The flow sight glass shall be of rotary type with tempered glass, carbon steel body and bronze wetted parts.

k) Variable area flow indicators to be provided at the common outlet header of the identical equipment, CW blow-down etc. Carbon steel body with SS 316 float and scale shall be provided. Accuracy shall be minimum +-1%.

l) Flow switches to be provided at the common outlet header of the identical equipment. Carbon steel body with SS 316 element and contacts shall be provided.

m) Algebric summation of steam flow and water flow shall be mass balanced for calculating the system efficiency by providing necessary required flow transmitters and process lines

n) Accuracy for mass flow shall be 0.15% of measured value for liquid.

o) Accuracy for Vortex flow meter and turbine flow meter shall be 0.5% of full scale range.

1.1.4 Level Instrumentation

a) Differential pressure type level transmitters are electronic, analog 2-wire transmitters with isolated 4-20 Ma dc output signals. Radar and ultrasonic level transmitters will be 24V DC powered, with isolated 4-20 Ma dc output signals powered from the transmitters.

b) Constant head chambers shall be furnished for all differential pressure-type level transmitters used with ressurized vessels. Reservoir piping connections shall be ½ inch outlet and a ½ inch inlet socket-welded type suitable for the pressure and temperature encountered.

c) Transparent gauge glasses will be used for low-pressure applications. Transparent or reflex gauges will be used for high-pressure applications. All gauge glasses will be equipped with gauge valves, including a safety ball check.

d) Level switches shall generally be cage float / Displacer type, rated for ANSI B31.1 requirements.

e) Non contact type level measurement shall be provided for CW sumps and for CW make-up applications.

f) Electronic level indicator of discrete type based on electric conductivity of water and steam with 50mm gap between successive electrodes in the measuring range shall be provided in addition to level transmitter. The **vessel** holding electrodes **shall be IBR certified**.

1.1.14 Turbidity Analyzer

Turbidity analyzers shall be continuous type with accuracy of ±2% of reading or ±0.2 NTU whichever is better, response time of 2 sec of full scale. Operating principle shall be alternating light source and self cleaing facility shall be available.

The analyzer shall also include features such as auto temperature compensation, auto calibration, zero check and self cleaning system for electrode. The analyzer shall be provided with integral indicator. Housing for analyzer shall be waterproof with IP65 protection. Output shall be isolated 4-20 mA DC linear signal.Fault diagnosis data shall include faults in analog/digital circuits, contamination detection on optical window, failure of cleaning system, calibration fault and power supply failure.

1.1.16 Vortex flow meter

Transmitter type shall be capacitance / piezoelectric , microprocessor based electronics. Reynolds's no. shall be at least 20000 and minimum flow velocity shall be as specified by the manufacturer. For gas/air application, the bluff body shall be in horizontal position to avoid condensate and for liquids in vertical lines the flow shall be upwards to keep the line full. A location with minimum pipe vibration shall be selected. The pipe shall be supported at both ends, as necessary.If pressure and temperature compensation are required for gas/air flow application, the pressure taping shall be placed as close as possible to upstream of flow meter. The temperature tapping point shall be located at least 5D on the down stream of the flow meter. Straight length requirement shall be as specified by manufacturer. If meter is smaller than the line size, concentric pipe reducers shall be used. Eccentric reducers shall not be used as they disturb the flow profile.

1.1.17 Solenoid Valves

On line two (2) way solenoid valves shall be provided, where process line of less than 2 inch with low pressure & temperature application is involved.

Three (3) way solenoid valves shall be provided commonly, where the pressure is admitted or exhausted from a diaphragm valve or single acting cylinder.

Four (4) way solenoid valve shall be provided for operating double acting cylinders. If applicable.

Dual coil Solenoid valves shall be supplied for equipment trips and single coil for balance.

Body material of bronze, plug material of SS316 shall be provided with a leakage class of class IV.

All single coil solenoids shall be of continuous duty operating on 24V DC, 230 V AC and insulation class shall be H.

Double coil solenoid valve shall be provided for BMS services..For operation of the fuel oil corner nozzle valves, fuel oil trip valves etc., double coil solenoid valve (latch coil & relatch coil) shall be adopted.

Single coil usage requires always power and loss of power leads to closure of above valves resulting the unit trip or loss of generation.

On collection of water in the drains of instrument air lines, mechanical automatic drains and periodically solenoid operated drains (with electronic timer - 15m, 30m, 60m and 2 Hours & Timing adjustable) are to be provided.

For mechanical type & Electrical type, the locations to be provided in the instrument air lines of boiler area, Chimney area, turbine area etc., and same shall be decided during detailed Engineering.

For mechanical type & Electrical type, the locations to be provided in the instrument air lines of boiler area, Chimney area, turbine area etc., and same shall be decided during detailed Engineering.

Individual Moisture separator in the instrument air lines for vital final control elements or oxygen analysers shall be provided to enhance the cell life of oxygen probe or continuous operation of final control elements. The numbers and locations shall be finalized during the detailed engineering.

1.1.18 Position Transmitters / Positioners

Position Transmitters shall be provided for all motorized inching valves and control valves. Position transmitters shall be 24 VDC, 2 wire, system. SMART Positioners with HART communication shall be provided for all pneumatically operated control valves, power cylinders etc., for converting controller output of 4-20 Ma to 3-15 PSI (0.2 -1 kg/cm2) for interfacing with pneumatic actuators. Separate moisture separator unit for ensuring dryness of air entering Positioners/ E/P converters as well as the power cylinder is to be supplied. The I to P converters shall retain the pneumatic signal (last value) even in failure of control signal and shall have self volume boosters. The Positioners/ E/P converters shall retain the pneumatic signal (last value) even in failure of control signal and shall have self volume boosters.

1.1.19 I/P Converter

Two wire type I/P convertors with an accuracy of +0.25% accepting 4-20 mA dc signals from control system and converting to 0.2 to 1 kg/cm2 air pressure to operate valve positioner of all final control elements; Housed in cast aluminum casing (with polyurethane paint); NEMA 4 or equivalent degree of protection for enclosure. Material of accessories will be SS. I/P convertors shall have fail freeze (stay put) feature also. Process connection shall be 1/4" NPT (F) and Electrical connection shall be ½" NPT (F). Zero/span adjustment facility shall be provided. The I to P converters shall retain the pneumatic signal (last value) even in failure of control signal and shall have self volume boosters. Necessary air lock devices and pressure switches for air pressure low alarming shall be provided.

1.1.20 Air Filter Regulators

Air filter regulator along with gauges shall be provided in each of the
a) Air supply line to valve positioners /power cylinders
b) Air supply line to electric to pneumatic converters
c) Air supply line to pneumatic interlocked block valves

D. CONTROL BOARD

I. Control Desk / Console / Panel Construction

01.	Applicable for	:	Indoor Panel, Desk & console.
02.	Material of construction	:	Cold rolled steel sheet (Metal and plastic - Heat resistant, shrinkage free for mosaic tiles).
03.	Thickness of Sheet	:	a) 3.2 mm for faces supporting instruments / terminals. b) 2 mm for other sides and top.
04.	Construction	:	Welded throughout as per (metallic parts) approved National Standards.
05.	i) Corners	:	7 mm inner radius
	ii) Dimensional Tolerances	:	a) In height & length - 3 mm b) In height between adjacent sections - 2 mm. c) Total for a group - 6 mm
06.	Doors	:	Double, recessed, turned back edges
	i) Thickness of Sheet	:	2 mm
	ii) Hinges	:	Stainless steel
	iii) Door latches	:	Three point type
	iv) Door gaskets	:	Neoprene rubber on fixed frame to result dust proof / weatherproof enclosure.
	v) Opening of the doors	:	Outward
	vi) Louvers	:	With removable wire mesh to ensure dust and vermin proof.
07.	Color of interior	:	Glossy white
08.	Colour external	:	IS 5 No. 628 (Typical) [To be decided later]
09.	Protection of painting	:	Plastic peel coating
10.	Gland plates	:	Removable 4 mm thick (bottom)
11.	Cable entry	:	Bottom
12.	Hardware	:	a) Vibration dampeners b) Predrilled base channel ISMC - 100 or equivalent for all sides. c) Stainless steel buff- finished 2 mm thick kick plate for all sides. d) Stainless steel scratch strips along desk edges fixed with pan-head recessed screws. e) Rubber strips to ensure air tightness between kick plate and finished floor. f) Power supply points 5/15 A plug point with indication lamp 5 Nos.
13.	Enclosure Protection Class	:	IP-42 or as per environment condition.
14.	Earthing	:	4 per standards

E. FIELD INSTRUMENTS

I. PRESSURE

This section provides general hardware guidelines for field instruments and equipment to be supplied under this specification.

Field transmitters shall be smart type with **HART** protocol. Temperature & Pressure switches shall be of Dual Snap type for vibration prone areas.

A. Pressure Transmitter

01.	Working Principle	:	Smart
02.	Type	:	2 - Wire
03.	Output Signal	:	Simultaneous transmission of digital and 4-20 mA DC signal isolated linear standard protocol (HART).
04.	Signal Processing	:	Silicon solid state electronic circuitry
05.	Measuring Element	:	Capsule / Diaphragm
06.	Measuring element	:	AISI-316 (Stainless Steel) Diaphragm material
07.	Static Pressure	:	150 % of maximum span continuously, without affecting the calibration.
08.	Turn-down ratio	:	100 : 1 minimum.
09.	Span and Zero	:	Locally adjustable with interacting facility or remotely accessible with HART based communicator for elevation and suppression by 100% of span
10.	Enclosure Class	:	IP-65 (Explosion proof for NEC Class-1, Division 1 area)
11.	Output Indicator (Digital display)	:	LCD type in % and engineering unit and LCD failure shall not affect the transmitter operation.
12.	Nameplate	:	Tag number, service engraved in stainless steel tag plate
13.	Body	:	Forged Carbon Steel (SS for DM Water).
14.	Operating Voltage	:	18 - 36 Volts D.C.
15.	Load	:	750 Ohms (min.) at 24 Volts D.C.
16.	Ambient Temperature	:	0 - 85 ^{O}C
17.	Performance:		
	i) Accuracy	:	+ 0.04% or better of FSR for BTG package, + 0.065% or better of FSR for BOP packages and + 0.2% for remote seal type transmitter.
	ii) Repeatability	:	± 0.05% of calibrated Span or better
	iii) Warranty & stability	:	min. of 5 yrs or better
18.	Sealing/Isolation	:	10 meters SS armoured capillary with suitable fill fluid and flange remote seal diaphragm of SS 316 or suitable material as per application, for corrosive, viscous and dirty fluid application. Flange size and pressure rating as per application.
19.	Accessories	:	a) Universal mounting bracket suitable for 2" pipe and wall mounting. b) High tensile carbon steel U- bolts. c) Installation accessories as per relevant installation drawing. d) Syphons for steam and hot water services. e) ½" NPT 2-valve stainless steel manifold, constructed from SS316 bar stock.

f) Companion flange with nuts, bolts and gaskets.
g) Hand held configuration kit for diagnostics and calibration of Smart Transmitter locally or in remote.
h) ¾" ET cable gland
i) Flushing facility at process end diaphragm.
j) Reverse polarity protection required.
k) Three way SS manifold for (gauge) vacuum

B. Differential Pressure Transmitter

01.	Working Principle	:	Smart
02.	Type	:	2-Wire
03.	Output signal	:	Simultaneous transmission of digital and 4-20 mA DC signal isolated linear standard protocol -HART.
04.	Signal Processing Unit	:	Silicon solid-state electronic circuitry
05.	Measuring element	:	Capsule/Diaphragm
06.	Measuring element Material	:	AISI-316 (Stainless Steel)
07.	Static Pressure/ Overload Pressure	:	Maximum line (or static) pressure on either side without permanent deformation or loss of accuracy
08.	Turn-down ratio	:	100: 1 minimum
09.	Span and Zero	:	Locally adjustable, non-interacting
10.	Enclosure class	:	IP-65 (Explosion proof for NEC Class-1, Division 1 area)
11.	Zero suppression / Elevation	:	At least 100% of Span
12.	Output Indicator (Digital display)	:	LCD type in % and Engineering units
13.	Nameplate	:	Tag number and Service engraved in stainless steel tag plate
14.	Body	:	Forged Carbon Steel (SS for DM Water)
15.	Ambient temperature	:	0 - 85 ^{O} C
16.	Operating Voltage	:	18 - 36 Volts DC
17.	Load	:	750 Ohms at 24 Volts DC
18.	Performance:-		
	i) Accuracy	:	± 0.025 % of calibrated span or better
	ii) Repeatability	:	± 0.05 % of calibrated span or better
19.	Sealing/Isolation	:	6 meters SS armoured capillary with suitable fill fluid and flange remote seal diaphragm of SS 316 or suitable material as per application, for corrosive, viscous and dirty fluid application. Flange size and pressure rating as per application.
20.	Accessories	:	a) Universal mounting bracket suitable for 2" pipe and wall mounting. b) High tensile carbon steel U-bolts. c) Installation accessories as per relevant installation drawing. d) Syphons for steam and hot water services. l) ½" NPT 5-valve stainless steel manifold, constructed from SS316 bar stock. e) Companion flange with nuts, bolts and gaskets. f) Hand held configurator kit for diagnosis and calibration of Smart Transmitter. g) ¾" ET cable gland

h) Flushing facility at process end diaphragm.
i) Reverse polarity protection required.

C. Pressure Switch

01.	Type	:	Seal diaphragm, piston actuated.
02.	Sensing element material	:	AISI SS-316 diaphragm / piston. All other wetted part SS316.
03.	Case Material	:	Epoxy coated steel plate or die-cast aluminum alloy with neoprene gasket and clear glass where applicable.
04.	Setter Scale	:	Black graduation on white liner scale. Graduation 0-100% with red pointer for set points.
05.	Over range	:	150 % of maximum pressure
06.	Process Connection	:	1/2" NPT (M) bottom connected
07.	Switch configuration	:	Two SPDT Lead wires (3+3 Nos.) are to be brought externally to the male connector wherein the female pug connector will be inserted to connect the control room cables for easy removal & re - calibration
08.	Switch Rating	:	240V, 5A AC/220V, 0.5A DC
09.	Switch Type	:	Dual Snap acting, shock & vibration proof
10.	Adjustability	:	a) Set-point adjustable over span range. b) Differential adjustable by 10 percent of span (minimum).
11.	Sealing Ring	:	Viton, Buna-N
12.	Terminal Block	:	Suitable for full ring lugs for cable connection.
13.	Cable connection	:	3/4" ET compression gland.
14.	Enclosure Class	:	IP-65 (Explosion proof for NEC Class-1, Division 1 area).
15.	Performance	:	a) Accuracy $\pm$1.0% b) Accuracy of Setting Indication of $\pm$1.5%
16.	Ambient temperature	:	0 – 50 Deg.C
17.	Nameplate	:	Tag number, service engraved in stainless steel tag plate
18.	Accessories	:	a) Remote diaphragm seal with SS-316 armored capillary for typical application. MOC of seal material shall be as per process fluid requirement. b) Snubbers for pulsating fluid application. c) Retention ring and screws for surface mounting. d) 1/2” NPT 2 Valve SS-316 manifold constructed from bar stock e) ¾” ET cable gland

D. Differential Pressure Switch

01.	Type	:	Bellows / Diaphragm / Piston actuated
02.	Sensing element material	:	AISI SS-316. For all other wetted part SS 316
03.	Case Material	:	Epoxy coated steel plate or die-cast aluminum alloy with neoprene gasket and clear glass where applicable.
04.	Setter Scale	:	Black graduation on white scale with 0-100% graduation and provided with red pointer for set point adjustment
05.	Over range	:	Static pressure on any one side, the other side being open to atmosphere.
06.	Process Connection	:	1/2" NPT (M) bottom connected / back connected.

07.	Switch configuration	:	Two SPDT Lead wires (3+3 Nos.) are to be brought externally to the male connector wherein the female pug connector will be inserted to connect the control room cables for easy removal & re - calibration
08.	Switch rating	:	240V, 5A AC/220V, 0.5A DC.
09.	Switch type	:	Dual Snap acting type contacts, shock and vibration proof.
10.	Adjustability	:	a) Set point adjustable over span range. b) Differential adjustable by 10 % of span (minimum).
11.	Terminal Blocks	:	Suitable for full ring lugs for cable connection.
12.	Cable Connection	:	3/4" ET compression gland.
13.	Performance	:	a) Accuracy of repeatability: ±1.0% of span. b) Accuracy of set point Indication: ±1.5%
14.	Operating Ambient Temperature	:	0 - 50 ^{O} C (Maximum Continuous)
15.	Enclosure	:	IP – 65 (Explosion proof for NEC Class-1, Division 1 area).
16.	Accessories	:	a) Snubbers for pulsating fluid application. b) Retention ring and screws for surface mounting. c) 1/2” NPT 5 Valve SS-316 manifold constructed from bar stock d) 3 / 4” Cable gland
17.	Nameplate	:	Tag number, service engraved in stainless steel tag plate
18.	Preferred Features	:	Free floating bellows attached to high-pressure bellows for temperature compensation.
19.	Remote Seal type for special application	:	a) Silicone oil / fluorolube filled remote diaphragm seal for dirty / viscous / corrosive fluid. b) SS armored capillary at least 3 meters each. c) Adapter flanges with nuts, bolts and gaskets for instrument and process side

E. Pressure Gauge and Differential Pressure Gauge

01.	Type	:	Bourdon/Bellows/Diaphragm
02.	MOC Sensing & Socket	:	AISI-316 SS
03.	Movement Material	:	AISI-304 SS
04.	Case Material	:	Stainless steel casing bayonet type. Enclosure IP-65.
05.	Dial Size	:	Generally 150 mm (100 mm for SWAS gauges)
06.	Scale	:	Black lettering on white background in 270 Deg. arcs.
07.	Window	:	shatterproof toughened glass
08.	Range Selection	:	Normal process pressure – 50 ~ 70 % of range (approximately).
09.	Over-range Protection	:	125% of maximum range by internal stop. External stop at zero
10.	Adjustment	:	Micrometer screw for zero adjustment. Internal micrometer screw for range adjustment.
11.	Element Connection	:	Argon welding
12.	Process Connection	:	1/2" NPT (M) Bottom connection for local mounting, back connection for panel mounting.
13.	Performance	:	Accuracy of ± 1.0 % of span or better for Pressure gauge

			Accuracy of ± 1.6 % of span or better for Differential Pressure gauge
14.	Operating ambient Temperature	:	0 - 50 ^{O}C
15.	Safety Feature	:	Blow out disc. /diaphragm at the back
16.	Accessories	:	a) Snubbers and Glycerin filled for pulsating fluid applications and at pump discharge. b) Stainless steel 316 Diaphragm with Teflon coated seals for corrosive, viscous and solid-bearing or slurry type process fluids. c) 3-Way stainless steel Gauge cock for pressure gauges. Process connection ½" NPT. d) 5-valve SS316 manifold constructed from barstock for differential pressure gauge. Process connection ½" NPT. e) Union, nut & tail piece and other Installation accessories as required.
17.	Applicable standard	:	IS-3624 / 1996
18.	Electrical Contact rating	:	240V, 5A AC/ 220V, 0.5A DC (for gauges with alarm contact). Number of Contacts:2 SPDT
19.	Nameplate	:	Tag number, service engraved in stainless steel tag plate

II. LEVEL

A. Radar Level Transmitters

01.	a) Type	:	1. Guided wave Radar type transmitter of TDR type 2-10 GHz for liquids 2. Radar type transmitter of FMCWR type 24-26 GHz, drop in antenna for coal level
	b) Probe	:	Coaxial
	c) Probe material	:	SS 316 / SS 316L
02.	calibration range	:	as per application
03.	Process medium	:	as per application
04.	Process temperature	:	as per application
05.	Static Pressure	:	Capable of working in vacuum also
06.	Power supply	:	range to be specified by the bid (Loop power available = 24V DC)
07.	Reverse polarity protection	:	required
08.	Output	:	4 to 20mA, 2wire & HART
09.	Accuracy	:	±.03% of measure distance or ±3 mm
010.	Stability	:	Contractor specify
011.	Communication	:	Communication / configuration shall be possible either through integral key pad and display or through hand communicator. If integral key pad is not available, one number hand held communicator common for all the transmitters shall be supplied
012.	Load limitation	:	max 600 ohm at 24V
013.	Span & zero	:	adjustable
014.	Flange mounting	:	yes
015.	Environmental protection	:	IP 66 or better
016.	Process connection	:	traditional flange with ¼" – 18 NPT on flange with process adapters (Flange & drain vent- 316SST)
017.	Electronic housing	:	Aluminium alloy
018.	Electrical connection	:	Preferably ½" – 14 NPT with gland.

B. Capacitance Type Level Transmitter

The total system shall consist of capacitance probe, pre-amplifier and transmitter

01.	Type	:	Capacitance type
02.	Probe	:	a) Rod or suspended electrode. b) Rope type probes may be used only where required probe length is greater than 3 meters
03.	Probe Mounting :	:	Stainless steel 1-1/2 ANSI RF Flange / ¾“ NPT (M)
04.	Material of construction	:	316 SS
05.	Insulation	:	PTFE Part/Full as per service.
06.	Transmitter	:	The transmitter shall receive output of the preamplifier and convert it into 4-20 mA DC output signals.
07.	Accuracy	:	±0.1%
08.	Load	:	750 Ohms or more
09.	Enclosure	:	Powder/Epoxy coated Die cast aluminium. with neoprene gasket conforming to IP-65. (Explosion proof for NEC Class-1, Division 1 area).
10.	Ambient temperature	:	0-60 ºC.
11.	Mounting	:	Wall / Surface
12.	Supply voltage	:	(90-250) V AC, 50 Hz / (18-36) V DC
13.	Response time	:	100 msec or better
14.	Cable connection	:	¾” ET Compression gland
15.	Accessories	:	Counter flange, Cable gland, prefab cable if any
16.	Preferable features	:	Alarm output contacts with adjustable set point facility

C. Ultrasonic Level Transmitter

01.	Type of Transmitter	:	Non contact Microprocessor based 2 wire type, HART protocol Compatible
02.	Output Signal	:	Galvanically isolated 4 – 20 mA DC along with superimposed digital signal (HART protocol)
03.	Sensor Accuracy	:	± 0.25% of calibrated span
04.	Sensor Repeatability	:	3 mm or better
05.	Power Supply	:	18 - 36V DC
06.	Temperature Compensation	:	To be provided within transducer
07.	Configuration	:	Sensor and electronic unit are separate. Electronic unit shall be possible to mount on the accessible location near the transducer. All cables, weather proof fittings for connection between transducer and electronic unit.
08.	Housing	:	IP 55 with durable corrosion resistant Epoxy coating
09.	Calibration	:	Through HART communicator
10.	Zero and Span adjustment	:	Continuous, Tamper proof, Remote as well as manual adjustability. Provision to calibrate the instrument without any level in the tank or sump etc.
11.	Sensor Material	:	Corrosion resistant to suit the individual application
12.	False signal tolerance	:	Facility to be provided. Shall have adjustable damping circuitry.
13.	Range	:	To be decided during detail Engg, with a facility to take care of frequency attenuation due to different obstructions (Surface, vapor)

14.	Display	:	Minimum 4 character display with integral key pad, access protected features.
15.	Diagnostics	:	Loss of echo alarm
16.	Load impedance	:	500 Ω minimum or as per vendor specification.
17.	Electrical connection	:	Plug and socket
18.	Accessories	:	Canopy for protection sunlight and rain Mounting hardware's and accessories shall be SS 316

D. Level Switch

01.	Type	:	External cage float operated. Magnetically coupled.
02.	Float Material	:	AISI-316 stainless steel
03.	Other wetted parts	:	AISI-316 stainless steel
04.	External Cage	:	Carbon steel / Stainless steel as per process requirements, welded type / flanged construction. Cage pressure rating shall equal or exceed the rating of the main vessel.
05.	External cage mounting	:	Side – Side with drain valve.
06.	External cage connection	:	25 NB socket weld to vessel or RF flanged.
07.	Switch housing	:	Epoxy coated die-cast aluminum alloy with neoprene gasket conforming to IP-65. (Explosion proof for NEC Class-1, Division 1 area).
08.	Type of switch Configuration	:	2 SPDT (two nos.) Snap acting magnetically operated hermetically sealed.
09.	Contact rating	:	5A, 240V/AC, 0.5A, 220V DC
10.	Accessories	:	a) Counter flange, nuts & bolts, suitable gasket etc. b) Steel globe type drain valve. c) ¾ " ET cable gland d) Stainless steel alpha-numeric engraved for service and tag.
11.	Preferred feature	:	Switch operating point marked on cage
12.	Temperature rating	:	As per application

E. Conductivity Type Level Switch

01	Type	:	Conductivity discrimination.
03	Mounting	:	Flanged – on standpipe.
04	Probe MOC	:	Stainless steel with high purity ceramic.
05	Probe rating	:	> Maximum design pressure of vessel.
06	Input	:	four independent channels with selectable switching threshold for water conductivity.
07	Relay Output	:	Four isolated output relays for HI, LO, HI-HI, LO-LO.
08	Contact type & rating	:	2SPDT @ 0.5A 220V DC / 5 A 240V AC
09	Local Display	:	Colored LEDs for HI, LO, HI-HI, LO-LO. Power & fault.
10	Power supply	:	Dual (90-250) V AC, 50 Hz, 1Ph.
11	Enclosure	:	IP–65, corrosion resistant & wall mounting type (Explosion proof for NEC Class-1, Division-1 area).
12	Accessories	:	Teflon (PTFE) cable having Teflon wrapped individual cores and necessary sheathing shall be used to connect the probe with electronics
13	Test pressure	:	Two times rated pressure
14.	Cable connection	:	¾" ET Compression gland

F. Capacitance Type Level Switch

01	Type	:	Capacitance type
02	Probe	:	a) Rod or suspended electrode b) Rope type probes may be used only where required probe length is greater than 3 meters.
03.	Probe Mounting	:	Stainless steel 1 ½" ANSI RF Flange / ¾ "NPT (M)
04.	Material of construction	:	316 SS
05.	Insulation	:	PTFE Part/Full as per service.
06.	Enclosure	:	Powder/Epoxy coated Die cast Aluminium with neoprene gasket conforming to IP-65. (Explosion proof for NEC Class-1, Division 1 area).
07.	Ambient temperature	:	0-60 ºC.
08.	Mounting	:	On Tap
09.	Supply voltage	:	(90-250) V AC, 50 Hz / 18-36 V DC
10.	Relay output	:	2 SPDT @ 0.5 A 220V DC / 5A 240V AC
11.	Response time	:	100 msec or better
12.	Cable connection	:	¾" ET Compression gland
13.	Accessories	:	Counter flange, Cable gland, prefab cable and stainless steel name plate engraved with alpha-numeric.

G. Level Switch (Ultrasonic Type)

Ultrasonic type level switch, IP-65 protection; Switch with 2 nos. of SPDT contacts (1 NO and 1 NC) rated for 0.2 A, 220 V DC; Accuracy ±0.25%; Resolution 1mm; Repeatability ±0.1%; Linearity ±1%; Response time 150ms; Beam angle <12º; Auto false echo-suppression; Accessories like integral cable between sensor and transmitter unit with connectors on both side, gasket and cable gland, digital panel meter, name plate & metal tag; the material of accessories will be SS.

H. Level Switch (Radar Type)

Radar type level switch, top mounted, IP-65 protection; Switch with 2 nos. of SPDT contacts (1 NO and 1 NC) rated for 0.2 A, 220 V DC, Accuracy ±1%; Resolution 0.04"; Repeatability ±0.04"; Linearity ±0.01%; Beam angle <20º; Accessories like integral cable between sensor and transmitter unit with connectors on both side, gasket and cable gland, name plate & metal tag; the material of accessories will be SS.

I. Conductivity Type Electronic Level Indicator

01	Type	:	Conductivity discrimination.
02	No. of Probes	:	14, 16 or 32 as per application.
03	Probe Mounting	:	Screw type / Flanged – on standpipe.
04	Probe MOC	:	Stainless steel with high purity ceramic.
05	Probe rating	:	> Maximum design pressure of vessel.
06	Input	:	Independent channel with selectable switching threshold for water conductivity.
07	Relay Output	:	Four isolated output relays for Hi, Lo, Hi-Hi, Lo-Lo.
08	Contact type & rating	:	2 SPDT @ 0.5 A 220V DC / 5A 240V AC
09	Current output	:	Isolated 4-20 mA DC & HART
10	Local Display	:	Red, Green and flashing yellow LED's for steam, water and fault indication respectively.
11	Remote Display	:	Red, Green & flashing yellow LEDs for steam, Water & Fault indication respectively.
12	Power supply	:	Dual (90-250) V AC, 50 Hz, 1Ph.

13	Enclosure	:	i) IP–65, corrosion resistant & wall mounting type for local electronics. ii) IP-42 for remote indicator
14	Accessories	:	i) PTFE cable from probe to electronics ii) Mounting accessories. iii) Standpipe iv) Washer & gaskets
15	Test pressure	:	Two times design pressure
16.	Alarm levels	:	Probe number shall be selectable for HI, LO, HIHI, LOLO

J. Level Gauge (Float & Tape)

01.	Type	:	Float and Tape
02.	Float & Tape MOC	:	AISI 316
03.	Pulley material	:	Aluminium
04.	Guide wire	:	SS 316 Stainless steel
05.	Accuracy	:	+/- 2 mm
06.	Indication	:	On circular or vertical dial
07.	Rating	:	Twice the design pressure

K. Silo pilot

01.	Application	:	Solid material in Material bins, silos, etc.
02.	Power supply	:	(90-250) V AC, + 10%, 50 Hz selectable.
03.	Mounting	:	Top with ANSI RF Flange
04.	Protection class	:	IP-65.
05.	Ambient	:	65 ^{O} C (Max.) dust laden atmosphere
06.	Housing	:	Cast aluminum with sun Cover
07.	Measuring rope	:	Corrosion resistant steel
08.	Counting step	:	1 pulse/1-10cm depending on application
09.	Output from sensor	:	Change over contact
10.	Motor	:	1 phase

Electronics

01.	Type	:	Microprocessor based
02.	A/M Switch	:	Yes, in auto mode level measurement in regular interval as set in the instrument.
03.	Output	:	a) 4-20 mA DC (stored D/A) & if applicable HART protocol b) 2 nos. SPDT contacts
04.	No. of set points	:	2 nos.
05.	Min. counting pulse	:	20 mins.
06.	Mounting	:	Wall or 19” rack
07.	Enclosure	:	IP 65

III. FLOW INSTRUMENTS

1. Mass Flow Meter

A Sensor

01.	Measuring Principle	:	Coriolis Mass flow.
02.	Primary Element	:	Flow Tube of 316SS or better (Suitable for the process fluid)
03.	Heating Arrangement	:	Integral with Flow Element.
04.	Temperature Control For Heating	:	To be provided.
05.	Process Connection	:	ANSI RF Flanged and rating as per process requirement.
06.	Drain	:	Self-draining facility

07.	Accessories	:	Counter flanges, Mounting nuts, bolts, gaskets etc.

B Transmitter

01.	Measured quantities	:	Mass Flow rate, Total Mass Flow, Density, Temperature as minimum.
02.	Input Signal Processing	:	Digital Processing.
03.	Display	:	Digital Display (LCD).
04.	Output	:	2 Nos. isolated output of 4-20mA DC selectable from four measured quantities.
05.	Load	:	< 750 ohms.
06.	Power supply	:	(90-250) V AC, 50 Hz.
07.	Turn Down	:	100:1
08.	Accuracy	:	$\pm$ 0.2% of measured value
09.	Ambient Temperature	:	85°
10.	Repeatability	:	$\pm$ 0.05%
11.	Housing	:	IP 65 (Explosion proof for NEC Class-1, Division 1 area)
12.	Hazardous duty Version	:	FM Standards.
13.	Nameplate	:	Tag number, service engraved in stainless steel tag plate
14.	Accessories	:	a) As required for field mounting b) Handheld configurator c) Mounting U-bolts, nuts, bolts, prefab cable etc. d) ¾" ET cable gland

2. Turbine Flow Meter

A. Sensor

01.	Type	:	Turbine (in line full-bore, based on magnetic pick of pulses)
02.	Output Signal	:	Pulse
03.	Material of Construction	:	a) Body : AISI 316 b) Rotor: AISI 431 or 410 c) Bearings: Tungsten Carbide / Stellited Sleeve
04.	Flow rate range	:	As required.
05.	Linearity	:	$\pm$0.25% or better.
06.	Repeatability	:	$\pm$ 0.02% or better.
07.	Ambient temperature	:	50 ^{O}C
08.	Mounting	:	On-Line mounting with ANSI RF flanges of stainless steel.
09.	Enclosure	:	IP 65

B. Transmitter

01.	Electronics	:	Solid State
02.	Power Supply	:	(90-250) V AC, 50 Hz.
03.	Input	:	Input from Sensor
04.	Display	:	4 1/2 digit LCD
05.	Output	:	Isolated 4-20mA DC & HART
06.	Measuring Accuracy	:	$\pm$ 0.5% of full scale range
07.	Totalized Value	:	Required
08.	Housing	:	IP-65 (Explosion proof for NEC Class-1, Division 1 area)
09.	Nameplate	:	Tag number, service engraved in stainless steel tag plate
10.	Accessories	:	a) clamping strip, bracket, prefab cable etc. b) Calibration or configurator kit. c) ¾" ET cable gland

3. Vortex Flow Meter

A. Sensor

01.	Type	:	Vortex
02.	Output Signal	:	Pulse
03.	Material of Construction	:	AISI 316
04.	Sensor Seal	:	PTFE / higher based on temperature
05.	Flow range	:	As required.
06.	Linearity	:	±0.25% or better.
07.	Repeatability	:	± 0.1 of actual flow rate or better.
08.	Ambient temperature	:	85 ^{O}C
09.	Mounting	:	On-Line mounting with flanges of stainless steel.
10.	Enclosure	:	IP 65
11.	Accessories	:	Nuts, bolts, gaskets etc.

B. Transmitter

01.	Electronics	:	Solid State
02.	Power Supply	:	(90-250) V AC, 50 Hz.
03.	Input	:	Input from Sensor
04.	Display	:	4 ½ digit LCD
05.	Output	:	Isolated 4-20mA DC & HART
06.	Measuring Accuracy	:	± 0.025% of span
07.	Totalized Value	:	Required
08.	Housing	:	IP-65 (Explosion proof for NEC Class-1, Division 1 area)
09.	Nameplate	:	Tag number, service engraved in stainless steel tag plate
10.	Accessories	:	a) Clamping strip, bracket, prefab cable etc. b) Special tool kit for calibration / configuration. c) ¾" ET cable gland

4. Electro-Magnetic Flow Meter

A. Sensor

01.	Measuring Principle	:	Faraday's law of Electro-magnetic induction.
02.	Primary Element	:	Flow Tube of 316SS or better
03.	Service	:	Conductive Liquids and Slurries
04.	Sensor type	:	Insertion style / Wafer style
05.	Process Connection	:	ANSI RF Flanged and rating as per process requirement.
06.	Accessories	:	Counter flanges, Mounting nuts, bolts, gaskets etc.

B. Transmitter

01.	Measured quantity	:	Volumetric Flow rate
02.	Input Signal Processing	:	Digital Processing.
03.	Display	:	Digital Display (LCD).
04.	Output	:	Isolated output of 4-20mA DC & HART
05.	Load	:	< 750 ohms.
06.	Power supply	:	(90-250) V AC, 50 Hz.
07.	Turn Down	:	100:1
08.	Ambient Temperature	:	74℃
09.	Accuracy	:	± 0.25% of measured value
10.	Repeatability	:	± 0.1% of Reading.
11.	Housing	:	IP 65 (Explosion proof for NEC Class-1, Division 1 area)
12.	Hazardous duty Version	:	FM Standards.

13. Nameplate : Tag number, service engraved in stainless steel tag plate
14. Accessories : a) As required for field mounting
e) Handheld configurator
f) Mounting U-bolts, nuts, bolts, prefab cable etc.
g) ¾" ET cable gland

5. Ultra sonic type Flow Meter

Ultra sonic type flow elements shall be provided for measurement of CW flow.

i) Ultrasonic Flow meter shall be dual path transit time clamp-on type.

ii) The flow meters shall be of proven reliability, accuracy and repeatability requiring a minimum of maintenance. They shall comply with relevant international standards and shall be subject to approval.

iii) All accessories required for mounting/erection of these instruments shall be furnished, erected and installed as necessary for completeness of the system though not specifically asked for. Also the equipment shall include necessary cables, flexible conduits, junction boxes required for the purpose.

iv) Flow meters shall be provided with suitable environment protection devices/structures such that they shall be suitable for continuous operation in the operating environment of a coal fired utility station without any loss of function or departure from the specification requirements.

Type	Transit time Clamp On Ultrasonic meter
Mounting Style	Dual path with two sets of transducers on the same pipe
Flow measurement	Instantaneous Flow rate as well as totalized flow
Power supply	230 V AC
Outputs :	
Analog Current	Isolated 4-20mA linear outputs for each path
Binary	Contact relay outputs, 2 NO + 2 NC for alarm
Communication ports	RS 232 C digital Hand held terminal port
Display/Indication	Flow meter with LCD screen backlight based local display and keypad. If required, transmitter shall be suitably located away from the sensor for better access and visibility.
Recording / Totalizing /Logging Facilities	Yes. Should be able to compute cumulative flow over intervals selectable by owner i.e., daily, weekly, monthly etc. The data shall be stored in the memory of flow computer for access in future
Software features	Compensation for any cross path errors Programming, configuration, shall be possible from front panel.
Diagnostics	False signal tolerance , power supply failure etc
Protection class	IP-65 or better, Weather protection against direct sunlight, rain etc for Flow meter and suitable for Cooling water for Transducer
Accuracy	+/- 1%
Electrical connection	Plug and socket
Accessories	All mounting hardware required like clamping fixtures, mechanism to remove the transducers online, interconnecting cables etc All weather canopy for protection from direct sunlight and direct rain. Material of all fittings shall be SS316.

6. Rotameter

01.	Type	:	On-line and by-pass
02.	Metering tube	:	Borosilicate glass
03.	Float	:	AISI 316-SS unless the process fluid demands some other material.
04.	Packing material	:	Teflon
05.	Body MOC	:	CS or SS as per fluid condition.
06.	Scale	:	Graduated- Engraved black on white background.
07.	Process connection	:	Flanged (RF) to line size as per ANSI standards.
08.	Accuracy	:	± 2% of full scale detection or better for on-line type and ±4% of full-scale detection or better for by-pass type.
09.	Nameplate	:	Tag number, service engraved in stainless steel tag plate
10.	Accessories	:	Slip-on orifice plate of 316-SS and taps of CS / SS as per application requirements. Applicable CS / SS Isolation valves and SS Range Orifice - for bypass type rotameters.
11.	Pressure Rating	:	As per application
12.	Flow & Scale length	:	To be decided by Contractor.

7. Orifice Plate

01.	Type	:	Ring joint / Flange type or other required type (To be decided by Contractor)
02	Material l	:	316 SS connection office
03.	Application	:	Low fluid velocity flow measurement
04.	Design Standard	:	BS-1042, Part-I
05.	Number of Tapings	:	One additional pair of taps for performance test. (i.e. for control measurement, 3+1 pair of taps to be provided, for monitoring measurement, 2+1 pair of taps to be provided)
06.	Diameter Ratio	:	Between 0.4 to 0.7
07.	Accessories	:	Flanges, gaskets, nuts & bolts, root valves jack screw etc.

8. Flow Nozzle : flow element shall have 3 pair of differential pressure tapping

01.	Application	:	High fluid velocity flow measurement
02.	Design Standard	:	ASME PTC 19.5
03.	Number of Tapings	:	One additional pair of taps for performance evaluation (i.e. for control measurement, 3+1 pair of taps to be provided, for monitoring measurement, 2+1 pair of taps to be provided)
04.	Diameter Ratio	:	Between 0.4 and 0.7
05.	Accessories	:	Meter run pipe, nipples and root valves. (Inspection port assembly for nozzles used in plant performance purpose)

9. Sight Glass

01.	Type	:	Flap-type
02.	End connection	:	Screwed / Flanged
03.	Material:		
	a) Body	:	SS-304
	b) Cover Plate	:	SS-304
	c) Indicator	:	SS-316
04.	Sight Glass	:	Toughened Borosilicate
05.	Gasket	:	Neoprene
06.	Bolts & Nuts	:	High tensile steel

07.	Hydraulic Test Pressure	:	1.5 times maximum working pressure
08.	Accessories	:	As required

10. Gauge Glass : flow element shall have 3 pair of differential pressure tapping

01.	Type	:	Reflex
02.	Glass	:	Toughened borosilicate. Resistant to mechanical and thermal shocks.
03.	Body material	:	SS-304 / 316 / Carbon steel – As per process requirements (Flanged Connection)
04.	Pressure rating	:	Twice the maximum working pressure
05.	Temperature rating	:	300 ^{O} C
06.	Bolts and nuts	:	Rust proof alloy steel
07.	Accessories	:	Suitable ball check valves of SS- 304/316 body, gaskets, companion flange etc.

11. Flow Switches

Indicating, Differential pressure, flapper type on line flow switches for line sizes up to 80 mm with an accuracy of +/-0.5% of span and dial size of min. 50 mm having 316 SS flapper/SS 316 bellows housed in die cast aluminium. Micro switch with adjustable range with 2 SPDT contacts rated for 0.2 A, 220 V DC. IP 65 or equivalent degree of protection for enclosure. The material of accessories shall be SS. Repeatability shall be +/-0.5% of span. Over range protection shall be 50% above maximum flow. Setting shall be tamper proof external adjustment & scale shall be provided for setting. Range spring & orifice plate shall be SS 316 for DP type. NPT for sizes below 2" & for sizes above 2" ANSI 150 RF shall be provided. Accessories like nameplate, mating flanges with gaskets, bolts & nuts, pipe assembly with orifice plate, etc. 5 way manifold, pipe, fittings (DP type), etc. shall be supplied

IV TEMPERATURE INSTRUMENTS

1. Thermocouples

01.	Type	:	a) Type-T (Copper Constantan) or Type-K (Chromel Alumel) [As per specification requirement] b) Duplex c) Ungrounded
02.	Wire gauge	:	16 AWG
03.	Standard	:	ANSI-MC 96.1.
04.	Protecting Tube:-		
	i) O.D.	:	8 mm (approx.)
	ii) Material	:	316-SS Seamless
	iii) Filling	:	Magnesium Oxide (Purity above 99.4%)
05.	Response time	:	a) Less than 2 to 6 seconds. . b) Less than 10 seconds for control.
06.	Head:		
	i) Type	:	IP-65 universal screwed type. (Explosion proof for NEC Class-1, Division 1 area)
	ii) Material	:	Die cast aluminum or better
	iii) Terminal blocks	:	Nickel plated Brass - screw type / silver plated
	iv) Cable connection	:	3/4" ET gland and grommet.
	v) Others	:	Terminal head cover with SS chain and suitable gasket
07.	Accessories	:	a) Adjustable nipple-union-nipple with thermowell connection

			b) Compression fittings/unions c) Flanges etc. (for flanged connections only) c) SS 316 forged thermowell as per ASME PTC code.
08.	Nameplate	:	Tag number, service engraved in stainless steel tag plate
09.	Static Pressure Limit	:	As per application.
10.	Length	:	As per application
11.	Limits of error @ 0 Deg Ref.:		For K type + 1 Deg C or 0.4% (Greater Value) For T type + 0.5 Deg C or 0.4% (Greater Value)

2. Resistance Temperature Detector

01.	Type	:	Platinum (Duplex), ungrounded class 'A'
02.	Resistance	:	100 ohm at 0 ^{O}C
03.	Base	:	Wound on ceramic (anti-inductive)
04.	Wiring	:	3 Wire
05.	Protecting Tube :-		
	i) O.D.	:	8 mm (approx).
	ii) Material	:	SS-316, Seamless
	iii) Filling	:	Magnesium oxide (Purity above 99.4%).
	iv) Length	:	As per application
06.	Response time	:	a) 1 to 2 seconds
07.	Head:		
	i) Type	:	IP-65 universal screwed type. (Explosion proof for NEC Class-1, Division 1 area)
	ii) Material	:	Die cast aluminum or better
	iii) Terminal blocks	:	Nickel plated Brass-screw type / silver plated
	iv) Cable connection	:	3/4" ET gland and grommet.
	v) Others	:	Terminal head cover with SS chain and suitable gasket
08.	Accessories	:	a) Adjustable nipple-union-nipple with thermowell connection b) Compression fittings/unions c) Flanges etc. (for flanged connections only) d) SS 316 forged thermowell as per ASME PTC code.
09.	Nameplate	:	Tag number, service engraved in stainless steel tag plate
10.	Standard	:	Standard DIN 43760
11.	Limit of error	:	@ 0 Deg C $\pm$ 0.06 Ohm @ 100 Deg C + 0.13 Ohm @ 200 Deg C $\pm$ 0.20 Ohm @ 300 Deg C $\pm$ 0.27 Ohm

3. Field Mounted Temperature Transmitters

01.	Working Principle	:	Smart
02.	Type	:	Two wire
03.	Input	:	Universal (T/C of different types, PT 100 RTD and other RTDs)
03.	Output Signal	:	Simultaneous transmission of digital and 4-20 mA DC signal with HART.
04.	Signal Processing Circuitry	:	Microprocessor based Solid State Electronic
05.	Span and Zero	:	Adjustable in field, Non-interacting facility for elevation and suppression of zero.
06.	Enclosure Class	:	IP-65 (Explosion proof for NEC Class-1, Division 1 area)
07.	Output Indicator	:	LCD type

08.	Span Adjustability	:	Yes
09.	Nameplate	:	Tag number to be engraved on metallic tag plate rigidly fixed to the body.
10.	Body	:	Die Cast aluminum
11.	Operating Voltage	:	18-36 V DC
12.	Load	:	600 Ohms at 24V DC (Min.)
13.	Performance		
	i) Accuracy	:	0.2% of span
	ii) Repeatability	:	±0.05% of span
	iii) Cold Junction Compensation	:	Built-in
	iv) Calibration	:	As per N.I.S.T Monograph 125 for T/C and European Curve Alpha = 0.00385 for RTD
14.	Accessories	:	a) Universal mounting bracket suitable for pipe and surface mounting. b) Hi-tensile Carbon Steel U-bolts.

4. Thermo Well

Thermo wells Pipe/equipment mounted temperature test wells of 316 SS with a process connection of M33x2 thread or 150 RF flanged and instrument connection of ½" NPT (F) in general or 150 RF flanged.. Accessories like name plate, plug with chain, etc. shall be provided. Material of accessories shall be SS. Thermowell shall be hex head of barstock assembly. In case flanged wells are required for any specific application, the same shall be supplied as required. The thermo well construction shall meet the ANSI 19.3 (latest) requirements. Thermo well shall be designed such that the resonant frequency is above the exciting frequencies generated by vortex shedding in the process fluid. All Test thermo well shall have the plug of SS316.

For measurement of pulveriser outlet temperature tungsten carbide block thermowells abrasion resistant not tungsten carbide coated thermowell shall be used. Also the terminals of Thermocouple shall not be at the top of Mills itself. The thermocouple wires are to be laid up to JB through SS tubing of required diameter and the head shall be placed nearer to the JB. Compensating cable exposed to atmosphere in the conventional method melts away due to high temperature at the top of Mill.

For measurement of sea water temperature SS with titanium sleeve thermo wells or better, shall be used.

5. Temperature Switch

01.	Type	:	Mercury filled-in
02.	Sensing Element Material	:	Bellow / Bourdon AISI SS-316
03.	Bulb Material	:	AISI SS-316
04.	Capillary	:	Stainless steel armored
05.	Movement Material	:	AISI SS-304
06.	Case material	:	Epoxy coated steel plate or die-cast aluminum alloy with neoprene gasket and clear glass where applicable cover conforming to IP-65. (Explosion proof for NEC Class-1, Division 1 area).
07.	Scale	:	Black lettering on white background
08.	Over range Protection	:	120 %
09.	Instrument connection	:	Bottom
10.	Switch configuration	:	Two SPDT Lead wires (3+3 Nos.) are to be brought externally to the male connector wherein the female pug connector will be inserted to connect the control room cables for easy removal & re - calibration

11.	Switch rating	:	240V, 5A AC/220V, 0.5A DC
12.	Switch type	:	Snap acting, shock and vibration-proof.
13.	Adjustability	:	a) Internal Set point adjustable over span range b) Differential adjustable by 10% of span (minimum)
14.	Cable connection	:	3/4" ET compression gland.
15.	Compensation	:	a) Capillary compensation with invar wire throughout the capillary length. b) Case compensation
16.	Performance:		
	i) Scale Accuracy	:	±1.0 % of full scale
	ii) Repeatability	:	< 0.5 % of full range
	iii) Response time	:	Less than 40 seconds with thermowell
17.	Capillary length	:	5 meters (minimum) for local mounting/15 meters for local panel mounting.
18.	Nameplate	:	Tag number, service engraved in stainless steel tag plate
19.	Accessories	:	Mounting accessories, 3/4”ETcable gland

6. Temperature Gauge

01.	Type	:	Mercury filled-in remote mounting system Capillary armoured / rigid system type (backward entry / bottom entry)
02.	Sensing Element Material	:	Bourdon - AISI-316 SS
03.	Capillary Armoring	:	Stainless steel flexible
04.	Movement Material	:	AISI 304 SS / Direct Bourdon tip connection to pointer spindle
05.	Bulb Diameter and Length	:	As required
06.	Bulb Material	:	AISI 316
07.	Capillary	:	Stainless Steel
08.	Thermometer	:	M 20 x 1.5 Male adjustable gland on stem to suit associated Thermowell
09.	Case Material	:	Stainless steel bayonet type with clear glass cover conforming to IP-65.
10.	Dial Size	:	150 mm in general (100 mm for SWAS gauges)
11.	Scale	:	Black lettering on white background in 270 Deg. arc.
12.	Mounting	:	Surface/Panel
13.	Over range Protection	:	125 % of range or more
14.	Instrument connection	:	Bottom connection for local mounting and back connection for panel mounting.
15.	Range	:	50% ~ 70% range of operating temperature of application approximately.
16.	Compensation	:	Case compensation
17.	Zero adjuster	:	Micrometer screw adjustable from front.
18.	Window	:	Shatterproof toughened glass.
19.	Performance	:	Accuracy of ± 1 % of full-scale deflection or better.
20.	Enclosure Class	:	IP-65
21.	Capillary	:	5 meters (local)/15.0 meters (local panel) - armored stainless steel
22.	Preferred Feature	:	Capillary Compensation
23.	Accessories	:	a) Forged SS 316 thermowell weldable or screwed as per ASME PTC code b) Installation accessories as required.
24.	Nameplate	:	Tag number, service engraved in stainless steel tag plate
25.	Immersion length	:	Adjustable up to 300 mm including bulb length or as per application

	Analyzer		
20.	Error code	:	To be indicated in LCD display for correction
21.	Instrument Configuration	:	Through HART configuration and through the keyboard.

2. PH Analyser

A.	**SENSOR**		
01.	Type of Cell	:	Flow through type and maintenance free
02.	Process Connection	:	Screwed
03.	Type of measurement	:	General purpose
04.	Temperature Compensation	:	Automatic (Integral) upto 0-120°C with PT-100 Sensor
05.	Preamplifier	:	Integrated not be separate
06.	Range	:	0-14 pH
07.	Measuring Electrode and Liquid Junction	:	Cartridge type
08.	Pressure Rating	:	10 kg/cm^2
09.	Accessories	:	Tee / Vessel (PVC or HASTALLOY)
10.	Cable	:	Upto transmitter in flexible conduct
B.	**TRANSMITTER**		
01.	Type	:	Microprocessor based & Smart
02.	Mounting	:	Flush Panel
03.	Protection Class	:	IP – 65 or better
04.	Output	:	Simultaneous transmission of digital and 4-20 mA DC (isolated) , HART protocol for recorder for configuration and diagonosis
05.	Display		i) 3½" Digit LCD display of process variable in Engineering unit, Temperature, Alarm status, Units of measurements etc. ii) Character Height 18 mm
06.	Calibration	:	Two-point calibration with standard buffer solutions.
07.	Temperature Compensation	:	Manual or Automatic - selectable through keyboard
08.	Diagnostic	:	Self diagnostic for "Calibration required"/ "Calibration O.K.", electrode checking etc.
09.	Alarm	:	Dual alarm set point, hysteresis and time delay adjustable on membrane keyboard. 2Nos. SPDT potential free contacts rated 5A 240V AC / 0.5A 220V DC Set point programmable through keyboard
10.	Enclosure	:	Polypropylene , Weather proof corrosion resistant NEMA 4X
11.	Cable Termination	:	Internal (cable entry through conduit)
12.	Accuracy	:	± 0.02 pH or better
13.	Repeatability	:	± 0.1% or better
14.	Response Time	:	7 seconds for FSD or better
15.	Stability	:	± 0.01 pH/month/non-cumulative
16.	Power Supply	:	240 V AC, 50 Hz
17.	Operating Temp.	:	0 - 50°C
18.	Accessories	:	a) Ultrasonic Electrode Cleaner. b) Phenolic nameplate giving tag number, service, etc.

c) Pre-amplifier, special cable, ultrasonic cleaner, etc.

d) Buffer tablets.

19.	Load	:	500 ohms or more at 24V DC
20.	Software security lock for programming the Analyzer	:	To be provided
21.	Error code	:	To be indicated in LCD display for correction
22.	Instrument Configuration	:	Through HART configuration and through the keyboard.

3. Silica Analyzer

01.	Type	:	Colorimetric monitor, gravity / pumped feed Microprocessor based (With auto request shut of feature case of sample loss or power loss built in phosphate inhibit feature.
02.	Operating range	:	0-50/500/5000µg/liter (field adjustable).
03.	Output	:	Simultaneous transmission of digital and 4-20 mA DC (isolated), with load 500 ohms & HART for for configuration and diagonosis
04.	Display	:	5½" Digit LCD display of process variable in engineering unit
05.	Accuracy	:	$\pm$ 1 % of span
06.	Repeatability	:	$\pm$ 2% of F.S.D. or better
06A	sencitivity	:	0.2 Micrograms /litre
07.	Calibration	:	Manual & automatic
08.	Operating ambient Temperature	:	0-50 ^{O}.C
09.	Ambient humidity	:	Up to 95% relative humidity
10.	Mounting	:	Flush panel
11.	Life of light source	:	10,000 hours (min.)
12.	Power supply	:	(90-250) V, 50 Hz, 1 Phase
13.	Alarm Facility	:	2 SPDT potential free contacts rated 5 A 230V AC / 0.5A 220V DC. Alarm set points independently programmable through keypad. (Snap action micro switch)
14.	Alarm for	:	a) Monitor mal-function b) Monitor on standby c) Monitor auto-zeroing d) Concentration high e) Loss of sample f) Concentration low g) Loss of reagent
15.	Preferred features	:	a) HI and LO alarm in LCD display. b) Power supply on/failure LED visible from front. d) 3 channel instrument is preferred.Auto sampling facility with necessary valves & solenoids in the sample lines shall be provided
16.	Accessories	:	a) Reagent cabinet b) Sample strainer c) Solenoid valves, pressure gauges d) Phenolic name plate e) Reagents & consumables

G. ELECTRICAL SYSTEMS METERS AND ACCESSORIES

A. Push Button

01.	Type	:	Shrouded square format
02.	Face Dimension	:	32 x 32 mm (maximum)
03.	Contact Configuration	:	2 NO + 2 NC
04.	Contact Addition	:	Add-on block up to 4 each with 2 pairs of contacts
05.	Contact Material	:	Hard Silver Alloy
06.	Contact Rating	:	500V / 10 A

07.	Utilization Category	:	AC11 / DC11
08.	Insulation Voltage	:	2 KV for 1 minute between terminals and earth
09.	Mechanical Life	:	1 million operations
10.	Construction	:	Aluminum shrouding with plastic lens
11.	Colors	:	Red, Green, Yellow, Black, etc.
12.	Connection	;	Screw terminals
13.	Enclosure Class	:	IP-52
14.	Legend	:	Engraving

B. Illuminated Push Button

01.	Type	:	Square format
02.	Face Dimension	:	32 x 32 mm (maximum)
03.	Contact Configuration	:	2 NO + 2 NC (minimum)
04.	Contact Addition	:	Add-on-Block up to 4 each with 2 pairs of contacts
05.	Contact Material	:	Hard Silver Alloy
06.	Contact Rating	:	500 V/ 10A
07.	Utilization Category	:	A C11 / DC11
08.	Insulation Voltage	:	2 KV for 1 minute between terminals and earth
09.	Mechanical Life	:	1 Million Operations
10.	Lamp	:	LED with built-in resistors as required
11.	Lamp Rating:-		
	a) Voltage	:	240 V AC
	b) Watt	:	2 Watt (approx.)
12.	Lamp and Lens Replacement	:	From front
13.	Construction	:	Transparent Plastic Lens
14.	Color	:	Red, Green, Amber, Yellow etc.
15.	Connection	:	Screw terminals
16.	Enclosure Class	:	IP-52
17.	Legend	:	Engraving

C. Selector Switch

01.	Type	:	2/3/4 position stay put type with rotary lever actuator.
02.	Face Dimension	:	32 x 32 mm (maximum)
03.	Contact Configuration	:	4 pair of contacts
04.	Contact Addition	:	Add-on-Block up to 4 each with 2 pairs of contact
05.	Contact Material	:	Hard silver Alloy
06.	Contact Rating	:	500 V / 10 A
07.	Utilization Category	:	AC11 / DC11
08.	Insulation Voltage	:	2 KV for 1 minute between terminals and earth
09.	Mechanical Life	:	1 million operation
10.	Construction	:	Aluminum shrouding
11.	Connection	:	Screw terminals
12.	Enclosure Class	:	IP-52

D. Indicating Lamp

01.	Type	:	LED with built-in resistor (LED must not glow if the voltage is less than 180 V)
02.	Face Dimension	:	32 x 32 mm (maximum)
03.	Voltage	:	230 V, 50 Hz, 1 Phase
04.	Watt	:	2.5 Watt (approximate)
05.	Lamp and Lens Replacement	:	From front
06.	Construction	:	Transparent Plastic lens
07.	Color	:	Red, Green, Amber, Yellow etc.
08.	Connection	:	Screw terminals

09.	Legend	:	Engraving

E. Indicating Meters (A.C)

01.	Type	:	Rectifier type taut band
02.	Face Dimension	:	96 x 96 mm
03.	Scale	:	Radial arc of 240 Deg.
04.	Accuracy	:	1.5% of full scale. ±0.5 Hz for frequency meter
05.	Input	:	0-1/0-5A for current measurement, 0-240V, 50 ± 2.5 Hz for voltage measurement
06.	Zero Adjustment	:	Screw on meter face
07.	Enclosure	:	Shielded Case IP-52
08.	Mounting	:	Flush Panel
09.	End Scale Suppression	:	6 times the measuring range only for motor ammeters

F. Indicating Meters (D.C)

01.	Type	:	Taut band moving coil
02.	Face Dimension	:	96 x 96 mm
03.	Scale	:	Radial arc of 240 Deg.
04.	Accuracy	:	1.5% of full scale
05.	Input	:	0-75 mV for current measurement. Direct reading for voltage measurement.
06.	Zero Adjustment	:	Screw on meter face
07.	Enclosure	:	Shielded case IP-52
08.	Mounting	:	Flush Panel
09.	End Scale Suppression	:	2 times the measuring range only for motor ammeters.

G. Auxiliary Relay

01.	Type	:	Plug-in type with base/DIN rail Mounted
02.	Coil voltage	:	230 V, 50 Hz, 1 Phase
03.	Contact Configuration	:	2 NO & 2 NC (Minimum), additional contacts as per requirement
04.	Contact rating	:	250V/5A (A.C/D.C.)
05.	Operating range	:	80 to 110% of rated voltage
06.	Insulation	:	2 KV for 1 minute between terminals & earth.
07.	Mechanical life	:	20 million operations
08.	Enclosure	:	Transparent cover
09.	Connection	:	Screw terminals.
10.	Mounting	:	Projection mounting inside panel /DIN rail mounting

H. Coupling Relay

01.	Type	:	Miniature plug-in type/ DIN rail Mounting
02.	Coil voltage	:	24 V D.C. / 48V DC
03.	Contact	:	2 NO & 2 NC (Minimum)-Additional contact as per requirement
04.	Contact rating	:	250 V/5A (A.C)/220V/2A (D.C)
05.	Operating range	:	70 to 110% of rated voltage.
06.	Insulation	:	2 KV for 1 minute between terminal & earth.
07.	Mechanical life	:	20 million operations
08.	Coil protection	:	Diode
09.	Indication	:	Coil on LED
10.	Enclosure	:	Transparent cover
11.	Connection	:	Screw terminals.
12.	Mounting	:	Projection mounting inside panel / DIN rail mounting

I. Distribution Boards

01.	Type	:	Fixed, Modular.
02.	Power distribution	:	Through MCCB
02.	Enclosure	:	Sheet Steel, IP54
03.	Mounting	:	Free standing (Can be attended from both front & back)

J. Electrical Junction Box

01.	Type of Enclosure	:	Dust tight, Weatherproof and Waterproof, generally conforming to IP 65.
02.	Material	:	16 SWG sheet steel hot-dip galvanized / Cast aluminum LM6.
03.	Type of Cover	:	Solid unhinged with retention chain
04.	Number of Paint	:	One base + two finish coatings of anti corrosive epoxy
05.	Mounting	:	Surface
06.	Cable Entry	:	Conduit Knockout/Threaded Hub
07.	Gasket	:	Neoprene
08.	Grounding	:	Brass earth lug with green screw head External-2 Nos, Internal-1no.M6.
09.	Number of Drain Holes	:	Two at bottom capped.
10.	Tag Plate	:	a) JB Number b) Cable Numbers on top c) Cable numbers with ferrules (side)
11.	Accessories	:	a) Rail mounted Terminal blocks with makers b) Cable gland

K. Cable Gland

01.	Type	:	Double compression
02.	Entry Thread	:	ET
03.	Material	:	Brass
04.	Finish	:	Cadmium Plated.
05.	Protection	:	IP – 54 or better
06.	Accessories	:	Neoprene gasket, locknuts, reducers etc.

L. Cable Tray

01.	Material	:	Mild steel
02.	Thickness	:	not less than 2.5 mm
03.	Finish	:	Hot dip galvanized
04.	Perforation	:	As per MFR standard.
05.	Cover	:	Suitable for tray

M. Digital Display Unit

To display the digital value of any analog process parameter with sign and decimal point of any analog input assigned though operator. Accuracy shall be Ω0.25% of reading; type of display – LED; Seven segment or dot matrix as option; five digits, sign and decimal point; Range & offset – programmable or configurabledigit size shall be minimum of 50mm; colour of display shall be Red or Green; enclosure shall be IP32 or equal; all DDUs shall be mounted on the Unit Control Panel. The DDUs common for both Units shall be mounted in the Center of Control room with suitable arrangement. Which will be decided during detail engineering

N. Hybrid Recorders

Microprocessor based Chartless Hybrid Recorder with an accuracy of ±0.2%; response time of 0.5sec (for 10% to 100% change); data storage in Hard disk – Hard disk shall have a capacity to store data of all points, at an average interval of 30 secs (settable), for one week. data retrieval through USB port or RS232/485/ethernet with associated software (to be loaded in the PC); Alarms for each Channel; no. of Channels

shall be 48; shall accept universal inputs (T/C, RTD, DC volts, 4-20mA, etc); scan rate of 20 ms scanning with 48 channel (1 Nos.) for boiler parameters, 20 ms scanning with 48 channel (3 Nos.) for generator, 20 ms scanning with 48 channel (2 Nos.) for turbine parameters ; display shall be coloured LCD or fluorescent tube with user selectable span; programmability (selection of input & scan/storage rate) shall be through Front panel keyboard; the recorder shall have the capability of being drawn out from the front side of the housing for maintenance and shall have electrical connection of plug-in type; material of casing shall be die-cast aluminium with epoxy coating and with a non-glare shatter proof Glass; enclosure shall be IP32 The quantity of Hybrid recorders shall be decided during detail engineering. The recorders are all to be connected through through Ethernet cable to a PC with necessary software for downloading the data from recorder and also the PC shall be capable of viewing the data / uploading the configuration on the recorder. The Ethernet cable of sufficient quantity with necessary connectors, windows based software for file transfer from recorder to PC are also to be supplied.

O. Interposing Relays (IPR)

Electro magnetictype IPRs with plug-in type connections, suitable for channel / rail mounting in cabinets; coil rating 24V D.C; 2 set of silver plated Change over contacts rated for 0.2A 220V DC. Freewheeling diode across relay coil (copper) and self reset typestatus indicator flag (electronic) shall be provided. All relays shall be mounted in IPR cabinet & relay base (silver plated) internally wired to the external cabling termination block in IPR cabinet. Wiring connection shall be cage-clamp & termination shall be suitable for0.5 sq. mm to 2.5 sq. mm size wiring. Facility to simulate relay operation manually shall be provided. Relays of different contact interrogation voltages shall be separated by a barrier in IPR cabinet. Accessories like name plate (SS) with tag & service inscription, relay base mounting rail/channel, nuts & bolts, etc. shall be supplied. In each cabinet, a DC Voltmeter shall be provided to check the Field Interrogation voltage.

H. CONTROL VALVE, FITTINGS AND ACCESSORIES

1. Control Valve

01.	Pipe material	:	Contractor to furnish
02.	Pipe size	:	Contractor to furnish
03.	Pipe thickness	:	Contractor to furnish
04.	Fluid	:	Contractor to furnish
05.	Flow	:	As per application
06.	Inlet pressure	:	As per application
07.	Outlet pressure	:	As per application
08.	Inlet Temperature	:	As per application
09.	Specific Gravity	:	As per application
10.	Viscosity	:	As per application
11.	C_v Calculated	:	As per application
12.	C_v Selected	:	As per application
13.	% opening	:	As per application
14.	Vapor pressure @ inlet temperature	:	As per application
15.	Noise	:	As per application
16.	Valve type	:	Globe
17.	Valve model	:	Contractor to furnish
18.	Body size	:	Contractor to furnish
19.	Port size	:	Contractor to furnish
20.	Body material / Rating	:	Contractor to furnish
21.	End Connection	:	Contractor to furnish
22.	Bonnet type	:	Contractor to furnish
23.	Packing Material	:	Contractor to furnish
24.	Trim material / type	:	Contractor to furnish

25.	Characteristics	:	Contractor to furnish
26.	Plug / Ball / Disk material	:	Contractor to furnish
27.	Seat / Stem material	:	Contractor to furnish
28.	Actuator type	:	Pneumatic Diaphragm
29.	Actuator model	:	Contractor to furnish
30.	Supply air / Power fail condition	:	FO / FC / FL
31.	Positioner type	:	E / P Positioner (Digital smart position)
32.	Opening / Closing time	:	Contractor to furnish
33.	Actuator bench range	:	Contractor to furnish
34.	Position transmitter	:	To be provided
35.	Limit switch	:	To be provided
36.	Air lock relay	:	To be provided
37.	Handwheel	:	To be provided
38.	Air set	:	To be provided
39.	Solenoid valve	:	To be provided
40.	Solenoid valve model	:	Contractor to furnish
41.	Local control station	:	To be provided
42.	Junction box	:	To be provided
43.	ANSI / FCI leakage class	:	Class IV
44.	IBR certificate	:	To be provided

2. Solenoid Valve

01.	Operating Principle	:	Electromagnetic (noiseless) Latch / release coil shall be used in the required application where the safety is to be ensured.
02.	Coil voltage rating	:	240 V AC /110V AC / 24 V DC / 48 V DC / 220 V DC (As required).
03.	Ways	:	3 ways (normally open + normally closed) [general], other depending on requirement
04.	Port size	:	1/2" NPT / As per site requirement
05.	Body	:	SS Bar Stock
06.	Trim	:	AISI SS-316
07.	Manual Operator	:	In built
08.	Duty	:	Suitable for continuous energization
09.	Sealing	:	Airtight and leak proof
10.	Ambient Temperature	:	0 - 50 ^{O} C
11.	Fluid Temperature	:	0-150 ^{O} C or as per application
12.	Coil Enclosure	:	Stainless Steel
13.	Insulation	:	Class-H
14.	Coil Casing	:	IP-65 (Explosion proof for NEC Class-1, Division-1 area)
15.	Mounting	:	On pipe or on panel
16.	Cable Connection	:	3/4" ET Compression gland
17.	Accessories	:	Mounting brackets, nuts and bolts
18.	Special feature	:	i) Temperature operated fuse at Explosion proof enclosure. ii) Solenoid valve directly integral to actuator body shall have NAMOOR interface.
19.	Pressure Rating	:	As per application

3. Power Cylinders (Pneumatic)

01.	Mounting Type	:	a) Fixed position mounting (End mounting).
		:	b) Trunnion mounting
02.	Control Signal	:	0.2 to 1 Kg/Sq. cm. from I/P converter for modulating purposes. 24V/48VDC operated solenoid valve operating on pneumatic line. The

			Pilot solenoid will have separate coils for open closing purpose.
03.	Supply Air	:	0-7 Kg / Cm^2.
04.	Selection	:	Based upon thrust / torque, stroke length, angular movement, full-scale travel time, repeatability, space factor etc. Provision for air-to-open and air-to-close operation.
05.	Casing	:	IP-65.
06.	Accessories (as required)	:	a) Air lock relay b) Hand wheel. c) Air filter regulator with gauge. d) Volume Booster. e) Limit Switches. f) Positioner with Input, Output and supply pressure gauges. g) Pilot Solenoid Valve (Double Coil type) h) Position Transmitter (4-20 mA DC linear output).
07.	Fail-safe operation	:	Stay put, open or close position on pneumatic / electrical power supply failure as per process safety criteria.
08.	Repeatability	:	Better than 0.5% of full travel.
09.	Hysteresis	:	Less than ±1% of full travel.

4. Air Filter Regulator

01.	Filter Element	:	Sintered Bronze
02.	Filter Size	:	5 microns
03.	Input Air	:	10.0 Kg/Sq. cm (maximum)
04.	Output	:	Adjustable from 0-2.0 Kg / Sq. cm or 0-7.0 Kg / Sq. cm (continuous) as applicable.
05.	Effect of Supply	:	Maximum 0.02 Kg/Sq. cm for a change pressure variation in supply pressure of 4 Kg/Sq. cm
06.	Bowl Material	:	Metallic cover around high temperature area/clear transparent polycarbonate with metallic cover for ordinary applications.
07.	Accessories	:	2" dial size output pressure gauge
08.	Desirable Feature	:	No perceptible drop of pressure on opening the drain port.

5. Seamless Stainless Steel Tube

01.	Reference	:	ASTM A-312 TP 304
02.	Size	:	12 mm OD /10 mm ID
03.	Materials	:	AISI 304 SS
04.	Type	:	Cold drawn fully solution annealed, pickled passivated, de-scaled, ,hydraulically cleaned
05.	Properties	:	The tube shall be suitable for bending and capable of being flared by hardened and tapered steel pin. The expanded tube shall show no cracking or rupture.
06.	Test Pressure	:	Burst pressure 400 Kg/Sq. Cm
07.	Tolerance	:	± 0.13 mm for outside diameter ± 15 % for wall thickness
08.	Test	:	Flare, Hardness, Ball and Bubble Test

6. Stainless Steel Tube Fittings

01.	Reference	:	ASTM-A-182
02.	Type	:	Double Compression

03.	Material	:	316 Stainless Steel Forgings (as per process hook-up drawing)
04.	Ferrule	:	316 Stainless Steel
05.	Pressure Rating	:	250 Kg/Sq. cm
06.	Temperature Rating	:	-100 to +400 °C
07.	Type of Fittings	:	Male / Female connector, elbow, cross, equal tee, straight connector, bulkhead union, ferrule etc. as required to suit installation.
08.	Size	:	To suit SS tubing and end connection

7. G.I. Pipe

01.	Reference	:	IS-1239, Part-I
02.	Type	:	Medium grade, threaded at both ends protected with end caps
03.	Material	:	Continuous ERW galvanized MS pipe
04.	General	:	Pipe shall be galvanized both inside and outside
05.	Size	:	1/2", 3/4",1" as required

8. G.I. Pipe Fittings

01.	Reference	:	IS-1239, Part-II for material, dimension, thread etc.
02.	Style	:	Threaded
03.	Type of Fittings	:	Equal tee, three piece union, unequal tee, straight socket, 90 Deg. elbow, reducing socket cap. etc. to suit installation.
04.	Size	:	1/2", 3/4", 1" as required

9. C.S. Pipe

01.	Reference	:	ASTM-A 106 Gr. B / Gr. C for Material ANSI B36.10 for dimensions
02.	Material	:	Cold drawn seamless black C.S.
03.	Type	:	Plain ends
04.	Schedule	:	160, 80 as required
05.	Size	:	15 NB, 25 NB etc.

10. C.S. Pipe fittings

01.	Reference	:	ASTM-A 105 for Material ANSI B 16.11 for Dimensions
02.	Material	:	Carbon Steel
03.	Type	:	Socket Weld / Screwed
04.	Ratings	:	3000 lbs / 6000 lbs / 9000 lbs
05.	Size	:	As required to suit relevant Process Hook-up drawings(1/2", 1").
06.	Type of Fittings	:	Reducing coupling, male-female reducer, straight coupling, equal tee, three piece union, elbow, cap etc.

11. A.S. Pipe

01.	Reference	:	ASTM-A 335 Gr. P22 for Material ANSI B36.10 for dimensions
02.	Material	:	Cold drawn seamless A.S.
03.	Type	:	Plain ends
04.	Schedule	:	XXS,80,160 as required
05.	Size	:	15 NB, 25 NB etc.

12. A.S. Pipe Fittings

01.	Reference	:	ASTM-A 182 F22 for Material ANSI B 16.11 for Dimensions
02.	Material	:	Alloy Steel

03.	Type	:	Socket Weld / Screwed
04.	Ratings	:	3000 lbs / 6000 lbs / 9000 lbs
05.	Size	:	1/2" , 1".
06.	Type of Fittings	:	Reducing coupling, male-female reducer, straight coupling, equal tee, three piece union, elbow, cap etc.

13. C.S. Globe Valve

01.	Reference	:	ASTM A-105 for material
02.	Type	:	Globe
03.	Pattern	:	Straight through
04.	Construction	:	Forged Body Cadmium Plated
05.	End Connection	:	Socket Weld / Screwed
06.	Proof Pressure	:	400 Kg/Cm2
07.	Material	:	Body - CS or equivalent (Cadmium plated) Stem - Hardened Steel Plug - AISI 316 SS
08.	Packing	:	Teflon Bush
09.	Bonnet	:	Inside screw, same as body material.
10.	Bar Handle	:	Aluminum
11.	Basic Specification and Testing	:	As per ANSI B 16.34
12.	Accessories	:	Plugs for all ports

14. S.S. Globe Valve

01.	Reference	:	ASTM A-105 for material
02.	Type	:	Globe
03.	Pattern	:	Straight through
04.	Construction	:	Forged Body
05.	End Connection	:	Screwed / Double Compression Fitted
06.	Proof Pressure	:	400 Kg/Cm^2
07.	Material		Body - SS 316 Stem - 410SS Plug - AISI 316 SS
08.	Packing	:	Teflon Bush
09.	Bonnet	:	Inside screw, same as body material.
10.	Bar Handle	:	Aluminum
11.	Basic Specification and Testing	:	As per ANSI B 16.34
12.	Accessories	:	Plugs for all ports

15. Condensate Pot

Fabricated from 4" Sch.160, Alloy Steel pipe with 3 nos. 1/2" SW connection, one in the side and other two are on top and bottom. Condensate pot shall be used for steam services.

16. Instrument Manifolds

Technical Particulars

01.	Type	:	a) Two valve manifold b) Five valve manifold
02	Mounting	:	Remote 2" Pipe Mounting
03.	Construction	:	Single block (bar stock)
04.	Material	:	Forged body and bonnet AISI 316 stainless steel
05.	Ports	:	1/2 " NPT (F)
06.	Rating	:	420 Kg/Sq. cm at ambient

07.	Operating Temperature	:	(-) 30 to (+) 170 Deg C
08.	Packing	:	PTFE Wafer
09.	Seat & Stem	:	AISI 316 SS
10.	Plug	:	AISI 316 SS free to turn on stem / 17-4 PH
11.	Handle Bar	:	AISI 316 SS
12.	Connection	:	Straight
13.	Accessories	:	i) Plugs for all ports ii) Mounting Bracket, bolts, nuts

17. Air Header

TECHNICAL PARTICULARS

			For Panel	**For Field**
01.	Material of Construction	:	Cast Brass	Cast Brass
02.	Inlet Connection	:	2" NPT (M)	1" NPT (M)
03.	Header Take-off	:	Brazed Brass Port	Brazed Brass Port
04.	Take off connection	:	1 / 2" NPT (M)	1/ 2" NPT (M)
05.	Take-off Valves	:	Brass Valves on Nipple	Brass Valves on Nipple
06.	Tube Take-off	:	Tube Adapter on Valve	Tube Adapter on Valve
07.	Drain	:	Drain valve at Lowest Point	Brass Drain Valve

18. S.S. Pipe

01.	Reference	:	ASTM-A 312 TP316 ANSI B36.10
02.	Material	:	SS 316 cold drawn seamless
03.	Type	:	Plain ends
04.	Schedule	:	80S,40S as required
05.	Size	:	15 NB, 25 NB etc.

9.	Conductor Identification	:	See "Cable Details" as below
10.	Armour	:	Galvanised steel wire/strip to IS:3975
11.	Multiple pair identification	:	Each pair numbered every 250 mm

Power Cylinders (Pneumatic)

Mounting Type	:	a) Fixed position mounting (End mounting).
	:	b) Trunnion mounting
Control Signal	:	0.2 to 1 Kg/Sq. cm. from I/P converter for modulating purposes. 24V/48VDC operated solenoid valve operating on pneumatic line. The Pilot solenoid will have separate coils for open closing purpose.
Supply Air	:	0-7 Kg / Cm2.
Selection	:	Based upon thrust / torque, stroke length, angular movement, full-scale travel time, repeatability, space factor etc. Provision for air-to-open and air-to-close operation.
Casing	:	IP-65.
Accessories (as required)	:	a) Air lock relay b) Hand wheel. c) Air filter regulator with gauge. d) Volume Booster. e) Limit Switches. f) Positioner with Input, Output and supply pressure gauges. g) Pilot Solenoid Valve (Double Coil type) h) Position Transmitter (4-20 mA DC linear output, LVDT or non contact type).
Fail-safe operation	:	Stay put, open or close position on pneumatic / electrical power supply failure as per process safety criteria.
Repeatability	:	Better than 0.5% of full travel.
Hysterisis	:	Less than Ω1% of full travel

J. Miscellaneous Instruments

01. Nucleonic Type Density Meter (For Ash Handling Plant):-

Type	:	Nuclear type radiation
Application	:	Abrassive Slurries & Corrosive Chemicals
Accuracy	:	< 1% of Span
Orientation	:	As per requirement.
System Type	:	Radiation Source & Scintillation Detector
Meter Material	:	SS 316L/ Aluminum with PVC coating
Connection material	:	SS 316L
Compensation	:	Temp. Compensation required
Type (Transmitter)	:	SMART, 2 Wire HART based
Operating Principle	:	As the density increase, the lower the radiation field at detector and vice versa.
Output	:	With photomultiplier, 4-20 mA, DC
Electrical Connection	:	½" NPT
Enclosure Class	:	IP 66
Local Display	:	Provided

Accessories	:	Radiation Survey Meter and all erection/installation hardware

02. Non - Nucleonic (Vibration) Type Density Meter (For DM & AHP Plant):-

Application	:	Liquid Density measurement
Detector		
1. Orientation	:	As per requirement.
2. Case Material	:	SS 316/ Cast Aluminum alloy
3. Wetted part material	:	SS 316
4. Operating Principle	:	Vibration Density measurement
Convertor		
1. Output	:	4-20 mA DC isolated.
2. Electrical Connection	:	½" NPT
3. Enclosure Class	:	IP 65
4. Local Display	:	Digital 5 digit, density display with temp. compensation.
5. Accuracy	:	+/- 1%
6. Response time	:	< 1 minute.
7. Power Supply	:	240 V AC, +/- 10%, 50 Hz. From UPS

03. Pull Chord switch

Type	:	Addressable Type
Body	:	Cast Iron
Contact rating	:	Continuous 10 Amp, Breaking 2 Amp. (240 V AC)
No. of contact	:	2 NO + 2 NC
Reset facility	:	Manual Reset
Type of enclosure	:	Die Cast Aluminum
Degree of protection	:	Explosion proof for NEC class 1, Division 1 area
Local trip indication	:	Required
Accessories	:	1. Canopy over lever of pull Cord switch. 2. Linking of switchesthrough a single cable for each section. 3. Each pull cord switch shall be provided with red LED indication lamp for prominent visible indication of tripping. 4. "One number indicator panel which shall display the exact number of safety switches (pull cord and belt sway switches) operated in a loop of conveyor. It shall also monitor the condition of field cable connecting the switches in series & generate signal if field cable is found broken or short. The indicator panel shall display the operated switch number. The same indication shall also be available in CHP operator station.

04. Belt Sway Switch

Type	:	Addressable Type
Body	:	Cast Iron
Contact rating	:	Continuous 10 Amp, Breaking 2 Amp. (240 V AC)
No. of contact	:	2 NO + 2 NC
Reset facility	:	Auto Reset
Type of enclosure	:	Die Cast Aluminum

Degree of protection	:	Explosion proof for NEC class 1, Division 1 area
Accessories	:	1. Canopy 2. The belt sway switches shall be provided with a common bridging push button which may be kept pressed to bypass the limit switch before restarting the conveyor.

05. Zero Speed Switch

Type	:	Microprocessor Based
Body	:	Cast Iron
Contact rating	:	Continuous 10 Amp. (240 V AC)
No. of contact	:	2 NO + 2 NC
Reset facility	:	Manual Reset
Type of enclosure	:	Die Cast Aluminum
Degree of protection	:	Explosion proof for NEC class 1, Division 1 area

Accuracy : +/- 5%
Repeatability : +/- 1%
Differential : +/- 5%
Accessories : Canopy

06. Chute Block Switch

Type	:	RF Based
Sensor Material	:	SS 316
Mounting	:	Flanged
Insulation Material	:	PTFE
Contacts	:	2 NO + 2 NC
Type of enclosure	:	Die Cast Aluminum
Degree of protection	:	IP 66
Electrical Connection	:	¾ " ET
Repeatability	:	0.05%
Local Indication	:	To be provided
Accessories	:	a) Neoprene Gasket and Stud Bolt

b) SS Tag plate, Nickel plated brass double Compression type cable gland

07. Dew Point meter

Type : 2 Wire Loop Powered Dew point Transmitter
Overall Range : -60℃ to +20℃ Dew point
Accuracy : ± 2℃ Dew point
Material : SS316 (wetted parts)
Features : AUTOMATIC CALIBRATION

- Can be Configured for Linear 4-20mA signal in ℃ & ℉ Dew point, ppm(v), ppb(v), g/m3
- Temperature Compensation
- Failure Diagnostics
- Long Term Stability
- Fast Response
- IP 66 / NEMA4X Protection
- Supplied with Calibration Certificate Traceable to National & International Humidity Standards
- Sensor protection with sintered filter
- Local LCD Display for Dew Point

08. Junction Boxes

Type	:	Flame proof/weather proof
Enclosure	:	IP-65/Explosion/Flame Proof as per area classification.

Material	:	FRP with protective Coating
Cable entry	:	Bottom or Side
Cable glands	:	Double compression type – Nickel plated brass with PVC hoods.
Mounting	:	Indoor/Outdoor
No. of terminals	:	As required with standardization with 20% spare of each size & type.
Terminals	:	Phoenix/Wago (screw less cage clamp type spring loaded)
Grounding	:	Two terminals for body and shield ground
Door	:	Hinged, lockable type.

Suitable mounting clamps and other accessories shall be in scope of bidder.

The brackets, bolts, nuts, screws, glands, lugs required for erection shall be of brass, included in bidder scope of supply. High voltage & insulation resistance test shall also be conducted.

M6 Ni plated Brass earthing stud shall be provided (external 2 nos. internal 1 no.)
Gasket (Normal)- Neoprene thickness 6.0 mm

09. Recorders (Chartless)

Type	:	Micro-processor based, Digital TFT display type
No. of Channels	:	Forty Eight (48) point).

6 **Nos. of recorders** shall be supplied for BTG and the parameters shall be decided during detailed Engineering. Quantities of recorders for BOP packages shall be decided during detailed Engineering. (Simultaneous parameter display preferred)

Input Signal	:	Fully configurable multi range (Programmable) universal (input)
Recording method	:	Continuous with different colour, for each channel
Display colour	:	Selectable from 30 Colours
Bar graph facility	:	To be provided
Digital indication	:	To be provided
Accuracy	:	+/- 0.1 % for reading for DCV Input And 0.1 Deg for TC/RTD input
Programmability	:	Front key board
Data Storage	:	hard disk/ Flash Memory
Data Retrieval	:	Compact 4 GB flash Memory card and USB port with 8 GB USB drive.
Scan rate	:	< 20 m second for individual channel.

Selection of scan time for individual channel is required.

Power Supply	:	240 VAC 1 Phase UPS
Ambient Temperature	:	0-50 Degrees
Mounting	:	Front panel mounted weather & Dust proof IP 65
Application software	:	Yes, To be provided
Internal Memory	:	400 MB or more
Screen	:	> 10.5” colour LCD TFT
Resolution	:	> 640 X 480 Pixels
Type of Display	:	i) Trends
ii) Bar Graph		
iii)Digital display/ values		
Event Sampling	:	1/2/5/10/30/60/120 sec.
Zoom & Scroll Facility	:	Required

OWS and printer connectivity port	:	Required
	:	Necessary software shall be supplied for uploading the data.
Communication	:	MODBUS/PROFIBUS ports connectivity between recorder and third party systems

10. Digital Indicator

Type	:	Programmable electronic digital indicator with floating point decimal.
Input	:	4-20 mA DC/1-5V DC/RTD/T/C.
Number of inputs	:	One
Range	:	As per requirement/adjustable by end user through key pad available on the indicator.
Number of digits	:	Four plus sign
Digit height	:	20 mm or larger
Display	:	Fluorescent red
Input over range/open	:	All digits to flash sensor (T/C)
Input hold time	:	0.7 seconds max.
Accuracy	:	+0.05% of span
Power supply	:	240V AC, 50Hz
Mounting	:	Flush panel, compatible for mounting on mosaic grid panel
Size	:	96x48 mm
Other Particular	:	Indicator receiving thermocouple signal shall have automatic cold junction compensation.
	:	Retransmission Output 4-20 mA isolated required.
	:	24 V DC inbuilt power supply
	:	Alarm contact with 2 NO/NC contact (rating 5A/230 V AC)

11. Receiver Indicators (Single/Dual Channel)

Type	:	Analogue indicator
Input Signal	:	Universal input (T/C, RTD, 4-20 mA, Voltage)
Scale	:	Range fully configurable and programmable
Measurement Accuracy	:	+ 0.2% of span + 1 count
Resolution	:	0.5% Span
Dead band	:	+ 0.2% of span
Repeatability	:	0.2% of span
Full scale response time	:	Less than two(2)seconds
Power Supply	:	240V AC, 50 Hz
Connection	:	Plug in type
Accessories	:	Mounting Bracket for Bins
Other Particulars	:	Indicator receiving thermocouple Signal shall have automatic cold junction compensation.
	:	Retransmission Output 4-20 mA isolated required.

12. Temperature Scanner

Type	:	Microprocessor based Electronic Digital Scanner.
No. of channels	:	16/24 (as per the application)
Input	:	RTD /Thermocouple/4-20mA
Accuracy	:	+ 0.1 of FS + 1 count
Number of digits	:	4 digit (7 segment display with Engg. Units)
Digit height	:	12 mm or larger

MOTORIZED VALVE ACTUATOR DETAILS

MOTORISED VALVE ACTUATORS' SPECIFICATION & DATA SHEET

SECTION–3.17: ELECTRICAL ACTUATORS

1.0.0 INTENT OF SPECIFICATION

This section covers the requirements of motor operated electrical actuators.

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 applicable Indian Standards (IS), IEC publications and other codes except where modified and /or supplemented by this specification.

3.0.0 TECHNICAL REQUIREMENTS

3.1.0 Electric actuators shall be provided as specified in Mechanical and C&I section. It shall be equipped with 3 phase induction motor, rated for S2-15 minutes duty for ON/OFF valve and intermittent duty for inching duty

3.2.0 Motor shall be class F insulated with temperature rise limited to class B. Motor shall be of class H insulation with temperature limited to class B used for high pressure and high temperature valves.

3.3.0 Motor shall be surface cooled designed for enclosure protection class of IP 67. Motor shall be suitable for starting direct on-line.

3.4.0 For installation in potentially hazardous areas, the actuators shall have suitable explosion proof / flame proof type enclosure.

3.5.0 Actuators shall be suitable for operation at an ambient temperature of 50 degree C and relative humidity of 95%.

3.6.0 Maximum continuous motor rating shall be atleast 10% above the maximum load derived of the driven equipment under entire operating range including voltage & frequency variation.

3.7.0 Motors shall be capable of operating under following supply variations without exceeding its guaranteed temperature limits.

- Frequency variation : (+) 3% and (-) 5% of 50 Hz
- Voltage variation for LT motors : (±) 10% of 415 V
- Combined variation of voltage and frequency: 10% (absolute sum)

3.8.0 All actuators shall be of integral type. Duty cycle of actuators shall suit the system requirement. The actuators shall be capable of giving the required torque at the output shaft. The actuators shall be designed to take the full thrust.

3.9.0 Electrical Actuators of Inching type position transmitters of non contact type shall be interfaced to DCS.

3.10.0 Actuators shall be of totally enclosed weather proof and dust proof construction with NEMA-6/IP 65 enclosure and shall be suitable for outdoor application without the necessity for a canopy. The actuator shall be suitable for mounting directly on the valve. The actuator shall be capable of giving the required torque, rpm and thrust without the help of any spur gear arrangement. The actuator shall be suitable for mounting in any position. Actuators shall be provided with integral starters.

3.11.0 The actuator shall be complete with motor, reduction gears, change gears, terminal compartment, switch compartment with limit switches and torque switches, local position indicator, position transmitter for remote position indicator, thermistor, space heaters, cable glands, mechanical position indicator, hand wheel for manual operation, valve attachment etc.

3.12.0 Each actuator shall have a hand wheel fitted on it for emergency operation. The hand wheel shall be designed such that it is declutched automatically when the power supply to the motor is restored. The material of the hand wheel shall be either malleable iron or steel. The hand wheel shall have adequate clearance from housing for each gripping and operation. Actuators offered shall be with self-locking worm.

3.13.0 Two number adjustable torque switches (one for open and one for close) each with 2 NO and 2 NC potential free contacts shall be provided. It is required to have calibration for the torque switches so that the switches can be easily set to any value desired.

3.14.0 Two numbers of position limit switches (one for open and one for close) each with 2 NO and 2 NC potential free contacts shall be provided. Two auxiliary limit switches (one for open and one for close) with 2 NO and 2 NC potential free contacts shall also be provided. The limit switches shall be of independently adjustable type. Limit switches and actuating mechanism shall be rust proof suitable for damp atmospheres. Limit switch compartment shall be weather proof and spacious enough for easy setting. The limit switches shall be suitable for the following ratings, both 240 Volts AC, 10 A and 220 V DC, 0.5 Amps.

3.15.0 Each actuator shall have a space heater in the limit switch compartment suitable for 240 V AC 50 Hz single phase supply.

3.16.0 The wiring from the limit switches, torque switches etc. shall be brought out in a separate terminal box of adequate size, so as to easily terminate the control cables.

3.17.0 Actuators shall be supplied with integral starter which shall have sophisticated electronic controls with field programming feature. It shall be designed for remote control from DCS/Respective control system. Required interposing relays for receiving open/close/stop command from DCS/Respective control system shall be provided. Potential free contacts and transducers shall be provided to provide status indication at remote DCS/Respective control system..

3.18.0 A three position selector switch (marked as LOCAL-OFF-REMOTE) and push buttons OPEN-STOP-CLOSE (for local operation) with indication lamps for running OPEN and running CLOSE shall be provided.

3.19.0 The Remote command signal (OPEN-STOP-CLOSE) from DCS/Respective control system/Control panel shall be isolated from control electronics through opto-isolator.

3.20.0 The following individual sStatus annunciation LED's and fault annunciation LED's shall be provided locally (Integral to actuator) to annunciate the following for easy local monitoring.

- Actuator in local mode
- Actuator in remote mode
- Actuator running in OPEN direction
- Actuator running in CLOSE direction
- Actuator in inching mode.
- Actuator in self-retaining mode
- Limit switch OPEN trip
- Limit switch CLOSE trip
- Control voltage availability

3.21.0 The following individual fault annunciation LED's (Colour-Red) shall be provided locally. (Integral to Actuator)

- Torque switch OPEN
- Torque switch CLOSE
- Thermo switch trip
- Electronic overload relay trip
- Motor single phasing
- Common fault (Inclusive of any one or combination of above fault)

3.22.0 View port shall be provided on integral starter unit to monitor the above status annunciation and fault annunciation.

3.23.0 Electronic Overload relay shall be provided to trip actuator in case of overload.
Plug in connections/design shall be provided between:-

- Integral starter unit and basic actuator
- Between external customer connections and actuator.

3.24.0 OPEN-CLOSE indication /LED shall be provided for indication of full open/close position.

3.25.0 Automatic phase correction facility and potential free contact for annunciation of power failure shall be provided.

3.26.0 The following individual potential free relay contacts shall be provided in the actuator for remote annunciation to facilitate continuous monitoring of the actuator.

- Actuator (valve) running in OPEN direction.
- Actuator (valve) running in CLOSE direction.
- Actuator in remote mode.
- Actuator in local mode.
- Actuator power switched off /single phasing.
- Torque switch trip, thermo switch trip and overload relay trip

4.0.0 TESTING AND INSPECTION

Equipment offered shall be of type tested and proven type. Routine tests shall be carried out for all the equipment as per applicable standards. Copies of certified reports of all tests carried out at the works shall be furnished.

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.

- Measurement of insulation resistance.
- Measurement of full load current.
- Test running of the motors.

5.0.0 DRAWINGS & DOCUMENTS

The following drawings and documents shall be submitted for approval during detail engineering stage.

- Integral starter details
- Technical particulars of actuator
- Wiring diagram
- General arrangement drawings
- Test reports
- Manufacturing quality plan
- Field quality plan

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Data Sheet A & B

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

GENERAL*	* PROJECT	2 X 660 MW UDANGUDI TPP	
	OFFER REFERENCE		
	* TAG NO. SERVICE		
	* DUTY	☐ ON / OFF ☐ INCHING	
	* LINE SIZE (inlet/outlet): MATERIAL		
	* VALVE TYPE	☐ GLOBE ☐ GATE ☐ REG. GLOBE ☐ BUTTERFLY	
	* OPENING / CLOSING TIME		
	* WORKING PRESSURE		
	AMBIENT CONDITION	SHALL BE SUITABLE FOR CONTINUOUS OPERATION UNDER AN AMBIENT TEMP. OF -20 to70 DEG C AND RELATIVE HUMIDITY OF 0-95%IN HOT HUMID AND TROPICAL ATMOSPHERE AND HIGHLY POLLUTED AT PLACES OF COAL DUST AND FLY DUST	
	VALVE SEAT TEST PRESS	BIDDER TO SPECIFY	
	REQUIRED VALVE TORQUE	BIDDER TO SPECIFY	
	ACTUATOR RATED TORQUE	BIDDER TO SPECIFY	
CONSTRUCTION AND SIZING	CONSTRUCTION	TOTALLY ENCLOSED, WEATHER PROOF,DUST TIGHT SUITABLE FOR OUTDOOR USE WITHOUT CANOPY, NEMA6/IP:68	
	MECHANICAL POSITION INDICATOR	TO BE PROVIDED FOR 0-100% TRAVEL	
	BEARINGS	DOUBLE SHIELDED, GREASE LUBRICATED ANTI-FRICTION.	
	GEAR TRAIN FOR LIMIT SWITCH/TORQUE SWITCH OPERATION	METAL (NOT FIBRE GEARS). SELF-LOCKING TO PREVENT DRIFT UNDER TORQUE SWITCH SPRING PRESSURE WHEN MOTOR IS DE-ENERGIZED.	
	SIZING	OPEN/CLOSE AT RATED SPEED AGAINST DESIGNED DIFFERENTIAL PRESSURE AT 90% OF RATED VOLTAGE. FOR ISOLATING SERVICE THREE SUCCESSIVE OPEN-CLOSE OPERATIONS OR 15 MINS. WHICHEVER IS HIGHER. **FOR INCHING SERVICE - 150 STARTS/HR MINIMUM.**	
HANDWHEEL	* REQUIRED	■ YES ☐ NO	
	* ORIENTATION	☐ TOP MOUNTED ☐ SIDE MOUNTED	
	*TO DISENGAGE AUTOMATICALLY DURING MOTOR OPERATION.		
ELECTRIC ACTUATOR	ACTUATOR MAKE/MODEL	BIDDER TO SPECIFY	
	MOTOR MAKE / MODEL / TYPE / RATING (KW)	BIDDER TO SPECIFY	
	@ MOTOR TYPE	SQUIRREL CAGE INDUCTION MOTOR, STARTING CURRENT LIMITED TO SIX TIMES THE RATED CURRENT-INCLUSIVE OF **I.S.** TOLERANCE	
	ACTUATOR APPLICABLE WIRING DIAGRAM	■ ENCLOSED (BIDDER TO CONFIRM) A: ☐ DRG. NO. 3-V-MISC-24227 R00 B: ☐DRG. NO. 3-V-MISC-24550 R00 C: ■ DRG. NO. 3-V-MISC-24283 R00 D: ☐ DRG. NO. 4-V-MISC-90271 R11 E: ☐ For Thyristor based Integral starter, Bidder/Vendor to furnish wiring diagram	
	COLOUR SHADE	☐ BLUE (RAL 5012) ■ SIEMENES GRAY RAL 7030	
	PAINT TYPE **(## Refer Notes)**	☐ ENAMEL ■ EPOXY ☐	
	SHAFT RPM	BIDDER TO SPECIFY	
	OLR SET VALUE	BIDDER TO SPECIFY	
	@ STARTING / FULL LOAD CURRENT	BIDDER TO SPECIFY	
	NO. OF REV FOR FULL TRAVEL	BIDDER TO SPECIFY	
	@ PWR SUPP TO MTR / STARTER	415V +/- 10%, 3 Phase, 3 Wire 50HZ +/-5%	
	@ CONTROL VOLTAGE REQUIREMENT	TO BE DERIVED FROM THE POWER SUPPLY TO THE STARTER ☐ 230 V ■ 110 V	

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Data Sheet A & B

	DATA SHEET-A (TO BE FILLED BY PURCHASER)			DATA SHEET-B (TO BE FILLED-UP BY BIDDER)
	@ ENCLOSURE CLASS OF MOTOR	☐ IP 68 ☐ FLAME PROOF		
	@ INSULATION CLASS	CLASS-F TEMP. RISE LIMITED TO CLASS-B		
	@ WINDING TEMP PROTECTION	■ THERMOSTAT (3 Nos.,1 IN EACH PHASE) ☐ ----------		
	SINGLE PHASE / WRONG PHASE SEQUENCE PROTECTION	REQUIRED		
INTEGRAL STARTER	INTEGRAL STARTER	■ REQUIRED ☐ NOT REQUIRED		
	TYPE OF SWITCHING DEVICE	■ CONTACTORS(Reversing type) ☐ THYRISTORS		
	TYPE	■ CONVENTIONAL ☐ SMART (NON-INTRUSIVE)		
	IF SMART			
	a) SERIAL LINK INTERFACE	☐ INTEGRAL ☐ FIELD MOUNTED		
	b) SERIAL LINK PROTOCOL	☐ FOUNDATION FIELD-BUS ☐ PROFI-BUS ☐ DEVICE NET ☐.....		
	c) SERIAL LINK MEDIA	☐ TWISTED PAIR Cu-CBL ☐ CO-AXIAL Cu-CBL ☐ OFC		
	d) HAND HELD PROGRAMMER	☐ REQUIRED ☐ NOT REQUIRED		
	e) TYPE OF HAND HELD PROGRAMMER	☐ BLUETOOTH ☐ INFRARED ☐.....		
	f) MASTER STATION	☐ REQUIRED ☐ NOT REQUIRED		
	g) MASTER STN INTRFACE WITH DCS	☐ MODBUS ☐ TCP/IP		
	h) DETAILS OF SPECIAL CABLE	☐ ENCLOSED ☐ NOT REQUIRED		
	STEP DOWN CONT. TRANSFORMER	■ REQUIRED		
	OPEN-STOP-CLOSE PB(running open/close LED) THREE POSITION SELECTOR SWITCH	■ REQUIRED ☐ NOT REQUIRED		
	INDICATING LAMPS	■REQUIRED ☐ NOT REQUIRED		
	LOCAL-OFF- REMOTE S/S(THREE POSITION SELECTOR SWITCH)	■REQUIRED ☐ NOT REQUIRED		
	STATUS CONTACTS FOR MONITORING	■ REQUIRED ☐ NOT REQUIRED		
	INTEGRAL STARTER DISTURBED SIGNAL	REQUIRED (MOTOR THERMOSTAT TRIPO/L RELAY OPERATED, CONT. /POWER SUPPLY FAILED, S/S IN LOCAL/REMOTE/OFF MODE, TORQUE SWITCH OPEN/CLOSE CUT OFF/STOP PB OPTD.)		
INTERPOSING RELAY/OPTO COUPLER (Applicable for integral Starter)	TYPE OF ISOLATING DEVICE	☐INTERPOSING RELAY ■OPTO COUPLER ☐ EITHER		
	QUANTITY	■ 2 NOs. ☐ 3 NOs.		
	DRIVING VOLTAGE	■ 20.5 – 24V DC ☐ _____V DC		
	DRIVING CURRENT	■ 125mA MAX ☐ _____mA MAX		
	LOAD RESISTANCE	■ > 192 ohms - <25 k ohms ☐ > _____ohms - < _____ohms		
TORQUE SWITCH (Not Applicable for Smart Actuator) **($$ Refer Notes)**	MFR & MODEL NO.	BIDDER TO SPECIFY		
	OPEN / CLOSE	■1 No. ☐2Nos. / ■1 No. ☐2Nos		
	CONTACT TYPE	2 NO + 2 NC		
	RATING	10A 240V AC AND 0.5A 220V DC		
	CALIBRATED KNOBS(OPEN&CLOSE TS)	REQUIRED FOR SETTING DESIRED TORQUE		
	ACCURACY	+3% OF SET VALUE		
LIMIT SWITCH (Not Applicable for Smart Actuator) **($$ Refer Notes)**	MFR & MODEL NO.	BIDDER TO SPECIFY		
	OPEN : INT : CLOSE	■2 Nos.	2 nos(adj)	1 No. ■2Nos.
	CONTACT TYPE	2 NO + 2 NC		
	RATING (AC / DC)	10A 240V AC AND 0.5A 220V DC		

BHEL	**SPECIFICATION FOR MOTORISED VALVE ACTUATOR**	SPECIFICATION NO.: VOLUME II B SECTION D REV. NO. 02 DATE: 22.07.2019 SHEET 3 OF 4

Data Sheet A & B

	DATA SHEET-A (TO BE FILLED BY PURCHASER)		DATA SHEET-B (TO BE FILLED-UP BY BIDDER)
POSITION TRANSMITTER	POSITION TRANSMITTER (For inching duty & other specific applications)	REQUIRED for regulating/inching duty only.	
	MFR & MODEL NO.	BIDDER TO SPECIFY	
	TYPE	☐ ELECTRONIC (2 WIRE) R/I CONVERTER ■ ELECTRONIC (2 WIRE) contactless inductive type	
	SUPPLY	■ 24V DC ☐	
	OUTPUT	■ 4-20mA	
	ACCURACY	± 1% FS	
SPACE HEATER	@SPACE HEATER	REQUIRED	
	@ POWER SUPPLY (NON INTEGRAL)	240V AC,1 PH.,50 Hz	
	@ POWER SUPPLY (INTEGRAL)	BIDDER TO SPECIFY	
	@ RATING		
TERMINAL BOX	ACTUATOR/MOTOR TERMINAL BOX	REQUIRED	
	ENCL CLASS ACTUATOR/MOTOR T.B.	@■ IP 68 @☐ NEMA6	
	@ EARTHING TERMINAL	REQUIRED	
	PLUG & SOCKET(9 PIN) (FOR COMMD, LS/TS FEED BACK, PoT)	■ REQUIRED ☐ NOT REQUIRED☐ ■ 2 NOS. ☐ ----------	
CABLE GLANDS	@ POWER CABLE GLAND	SIZE:----------	
	@ SPACE HEATER CABLE GLAND	SIZE:----------	
	OTHER CONTROL CABLE GLANDS-1	☐ 1No. for BFV of CW PUMP(Cable size 2Px1.5mm2)	
	OTHER CONTROL CABLE GLANDS-2	1 no suitable for 8P X 0.5 sq mm Additional 1 no suitable for 2P X 0.5 sq mm(inching duty only)	

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Data Sheet A & B

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

WEIGHT	TOTAL WEIGHT (ACTUATOR + ACCESSORIES)	BIDDER TO SPECIFY	_____ Kg.

NOTES:

1. **SCOPE**: DESIGN, MANUFACTURE, INSPECTION, TESTING AND DELIVERY TO SITE OF ELECTRIC ACTUATOR FOR INCHING OR OPEN / CLOSE DUTY.

2. **CODES & STANDARDS**: DESIGN AND MATERIALS USED SHALL COMPLY WITH THE RELEVANT LATEST NATIONAL AND INTERNATION STANDARD. AS A MINIMUM, THE FOLLOWING STANDARDS SHALL BE COMPLIED WITH:
   IS-9334, IS-2147, IS-2148, IS-325, IS-2959, IS-4691 AND IS-4722

3. TEMPERATURE RISE SHALL BE RESTRICTED TO 70 DEG. C FOR AMBIENT TEMPERATURE OF 50 DEG C.

4. CABLE GLANDS OF DOUBLE COMPRESSION TYPE, BRASS MATERIAL SHALL BE PROVIDED.

5. THE TORQUE SWITCHES SHALL BE PROVIDED WITH MECHANICAL LATCHING DEVICE TO PREVENT OPERATION WHEN UNSEATING FROM THE END POSITIONS. THE LATCHING DEVICE SHALL UNLATCH AS SOON AS THE VALVE LEAVES THE END POSITION. IF SUCH PROVISION IS NOT POSSIBLE, THE TORQUE SWITCHES SHALL BE BYPASSED BY END-POSITION LIMIT SWITCHES WHICH OPENS ON VALVE LEAVING END POSITION.THESE LIMIT SWITCHES ARE ADDITIONAL TO THE NUMBER OF LIMIT SWITCHES SPECIFIED ELSEWHERE.

6. THE MOTOR SHALL OPERATE SATISFACTORILY UNDER THE +/- 10% SUPPLY VOLTAGE VARIATION AT RATED FREQUENCY, -5% TO +3% VARIATION IN FREQUENCY AT RATED SUPPLY VOLTAGE, SIMULTANEOUS VARIATION IN VOLTAGE & FREQUENCY THE SUM OF ABSOLUTE PERCENTAGE NOT EXCEEDING 10%.

7. THE MOTOR SHALL BE SUITABLE FOR DIRECT ON LINE STARTING.

$$ **TORQUE SWITCH & LIMIT SWITCH SHALL ACT INDEPENDENT OF EACH OTHER. TANDEM OPERATION IS NOT ACCEPTABLE.**

**EPOXY PAINT IS RECOMMENDED FOR COASTAL AREAS.**

8. IT SHOULD BE POSSIBLE TO OPERATE THE ACTUATOR LOCALLY. LOCKABLE LOCAL/REMOTE SELECTION SHALL BE PROVIDED ON THE ACTUATOR.

9. POSITION INDICATOR SHALL BE PROVIDED FOR 0 TO 100 % TRAVEL

10. WIRING SHALL BE SUITABLE VOLTAGE GRADE COPPER WIRE 1.5 SQ. MM.

11. THE MOTOR SHALL BE CAPABLE OF STARTING AT 85 PERCENT OF RATED VOLTAGE AND RUNNING AT 80 PERCENT OF RATED VOLTAGE AT RATED TORQUE AND 85 PERCENT RATED VOLTAGE AT 33 PERCENT EXCESS RATED TORQUE FOR A PERIOD OF 5 MINUTES EACH.

12. THE ACTUATORS SHALL BE DESIGNED TO BE SELF-LOCKING UPON LOSS OF POWER. MOTOR SHALL BE DESIGNED TO CLOSE IN 30 SECS. FROM FULL OPEN POSITION AND SHALL HAVE ADEQUATE CAPACITY TO OPEN AND CLOSE UNDER FULL UNBALANCED DESIGN PRESSURE.

13. THE INTEGRAL STARTER WHICH SHALL HAVE SOPHISTICATED ELECTRONIC CONTROLS WITH FIELD PROGRAMMING FEATURE. IT SHALL BE DESIGNED FOR REMOTE CONTROL FROM DCS/RESPECTIVE CONTROL SYSTEM. REQUIRED INTERPOSING RELAYS FOR RECEIVING OPEN/CLOSE/STOP COMMAND FROM DCS/RESPECTIVE CONTROL SYSTEM SHALL BE PROVIDED. POTENTIAL FREE CONTACTS AND TRANSDUCERS SHALL BE PROVIDED TO PROVIDE STATUS INDICATION AT REMOTE DCS/RESPECTIVE CONTROL SYSTEM.

14. THE REMOTE COMMAND SIGNAL (OPEN-STOP-CLOSE) FROM DCS/RESPECTIVE CONTROL SYSTEM/CONTROL PANEL SHALL BE ISOLATED FROM CONTROL ELECTRONICS THROUGH OPTO-ISOLATOR.

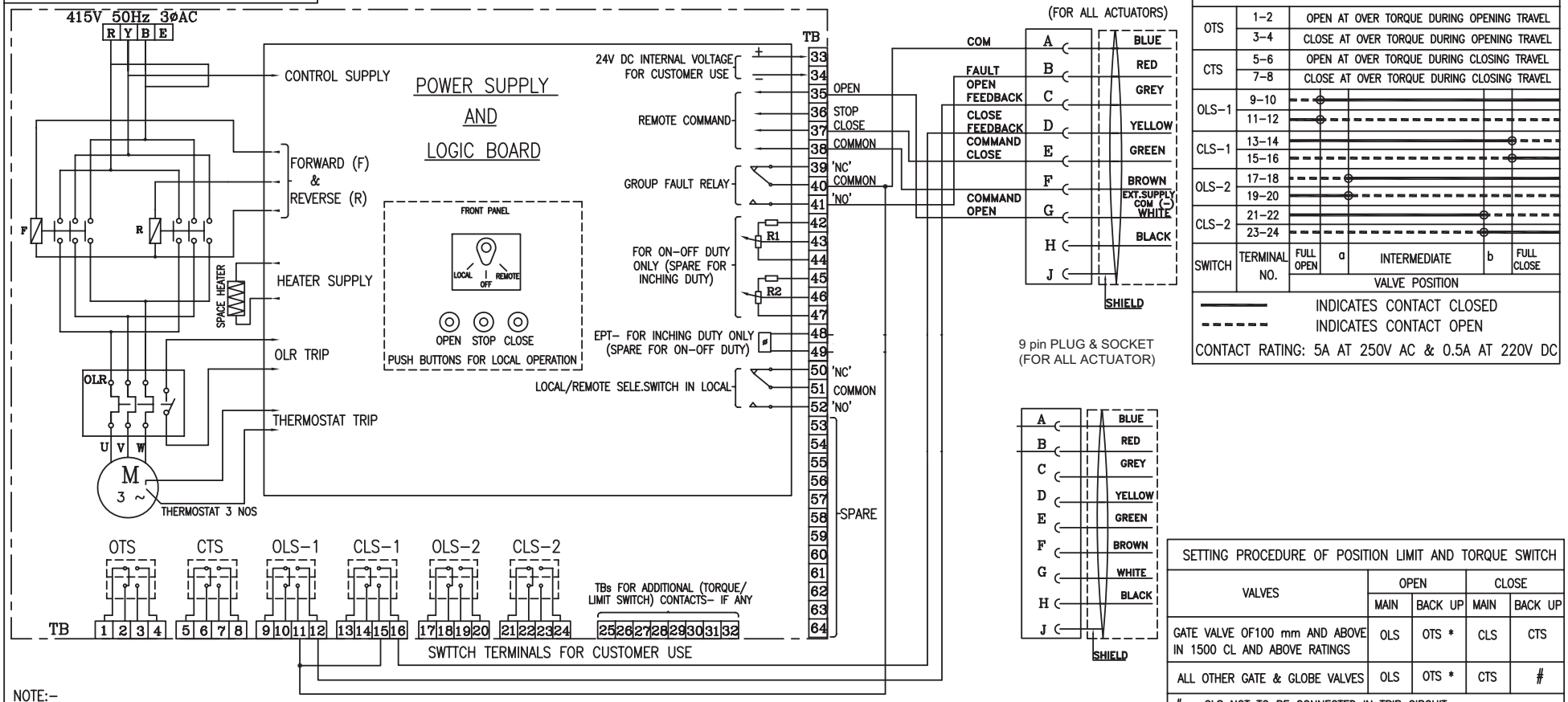
15. THE FOLLOWING INDIVIDUAL STATUS ANNUNCIATION LED'S (COLOUR-GREEN) SHALL BE PROVIDED LOCALLY (INTEGRAL TO ACTUATOR) TO ANNUNCIATE THE FOLLOWING FOR EASY LOCAL MONITORING.
    ACTUATOR IN LOCAL MODE
    ACTUATOR IN REMOTE MODE
    ACTUATOR RUNNING IN OPEN DIRECTION
    ACTUATOR RUNNING IN CLOSE DIRECTION
    ACTUATOR IN INCHING MODE.
    ACTUATOR IN SELF-RETAINING MODE
    LIMIT SWITCH OPEN TRIP
    LIMIT SWITCH CLOSE TRIP
    CONTROL VOLTAGE AVAILABILITY

16. AUTOMATIC PHASE CORRECTION FACILITY AND POTENTIAL FREE CONTACT FOR ANNUNCIATION OF POWER FAILURE SHALL BE PROVIDED.

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

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

DRAWING NO. 3-V-MISC-24283



CONTACT DEVELOPMENT DIAGRAM

OTS	1-2	OPEN AT OVER TORQUE DURING OPENING TRAVEL
	3-4	CLOSE AT OVER TORQUE DURING OPENING TRAVEL
CTS	5-6	OPEN AT OVER TORQUE DURING CLOSING TRAVEL
	7-8	CLOSE AT OVER TORQUE DURING CLOSING TRAVEL
OLS-1	9-10	
	11-12	
CLS-1	13-14	
	15-16	
OLS-2	17-18	
	19-20	
CLS-2	21-22	
	23-24	

SWITCH / TERMINAL NO. — FULL OPEN | a | INTERMEDIATE | b | FULL CLOSE — VALVE POSITION

INDICATES CONTACT CLOSED
INDICATES CONTACT OPEN

CONTACT RATING: 5A AT 250V AC & 0.5A AT 220V DC

SETTING PROCEDURE OF POSITION LIMIT AND TORQUE SWITCH

VALVES	OPEN		CLOSE	
	MAIN	BACK UP	MAIN	BACK UP
GATE VALVE OF100 mm AND ABOVE IN 1500 CL AND ABOVE RATINGS	OLS	OTS *	CLS	CTS
ALL OTHER GATE & GLOBE VALVES	OLS	OTS *	CTS	#

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

NOTE:-

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

REV	DATE	ALTERED
		CHD & APPD

TYPE OF PRODUCT: ELECTRICAL VALVE ACTUATORS (AC) WITH INTEGRAL STARTERS
2 X800 MW UPPUR TPP
(DRAWN FOR INTERMEDIATE POSITION OF VALVES)

BHARAT HEAVY ELECTRICALS LTD.,
UNIT: HIGH PRESSURE BOILER PLANT.
TIRUCHIRAPALLI-620014.
365-121

	NAME	SIGN	DATE	NO.OF VAR.
DRN	N.P.ESWAR	N.P	17.03.05	-
CHD	D.DINAKARAN	D.D	17.03.05	
APPD	K.ARUNACHALAM	K.A	17.03.05	

DEPT	SCALE	WEIGHT (KG).	REFERENCE INFORMATIONS	NO. OF ITEMS
VL	NTS	-		-
CODE -				

TITLE: WIRING DIAGRAM (TERMINAL PLAN)
FOR ACTUATOR WITH INTEGRAL STARTER WITH PLUG & SOCKET

CARD CODE: U 01

DRAWING NO.: 3-V-MISC-24283

REV: 0

Size A3

INSTRUMENT HOOK UP DIAGRAM

INSTRUMENT INSTALLATION DRAWING & STUB DETAILS

NOTES :–

1. IMPULSE PIPES SHALL BE OF SEAMLESS AND ANNEALED CONFORMING TO ANSI B36.10 IN LINE WITH THE MAIN PIPE MATERIAL.
2. PIPE FITTINGS SHALL BE OF FORGED MATERIAL CONFORMING TO ANSI B16.11–1991.
3. SNUBBER SHALL BE PROVIDED FOR PUMP DISCHARGE PRESS MEASUREMENTS.
4. IN CASE OF STEAM SERVICE SYPHON SHALL BE MADE BY BENDING THE TUBE OR PIPE.
5. VALVE MANIFOLDS & SNUBBER SHALL BE OF FORGED SS–316.
6. FOR SEA WATER APPLICATION SS316L FITTINGS TO BE PROVIDED.
7. 25NB x 15NB WELDED REDUCER SHALL BE USED FOR ROOT VALVE OF 25NB SIZE.
8. ROOT VALVES SHALL BE AS FOLLOWS:

   i) FOR PRESS <40 ATA & TEMP <425 DEG C, ONE(1) NO. 15Nb, ROOT VALVE OF SUITABLE CLASS SHALL BE USED.
   ii) FOR PRESS >40 ATA & TEMP <425 DEG C, TWO(2) NO. 15Nb, ROOT VALVE OF SUITABLE CLASS SHALL BE USED.
   iii) FOR PRESS >40 ATA & TEMP >425 DEG C, TWO(2) NO. 25Nb, ROOT VALVES OF SUITABLE CLASS SHALL BE USED.

9. HORIZONTAL PIPE RUNS SHOULD HAVE A SLOPE IN THE DIRECTION  SHOWN OF 1:20 AS MINIMUM.
10. FOR PRESSURISED STEAM & WATER SERVICE THE ASSOCIATED INSTRUMENT SHOULD BE MOUNTED BELOW THE TAPPING POINT. FOR VACUUM/AIR/GAS SERVICE, THE ASSOCIATED INSTRUMENT SHOULD BE MOUNTED ABOVE THE TAPPING POINT.
11. SEAMLESS PIPE/SEAMLESS TUBE/CAPILLARY LENGTH SHALL BE SUCH THAT THE GAUGES/TRANSMITTERS/SWITCHES ARE MOUNTED IN ACCESSIBLE AREA.

LEGEND :–

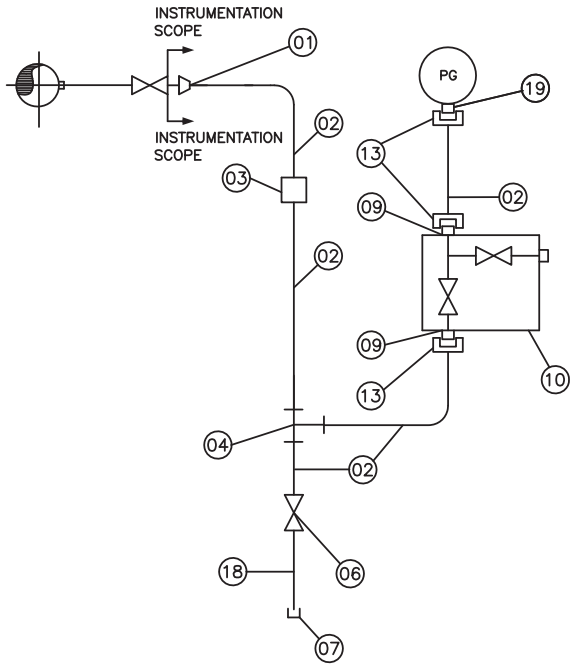
A/R – AS REQUIRED

NPTF – NATIONAL PIPE THREAD FEMALE

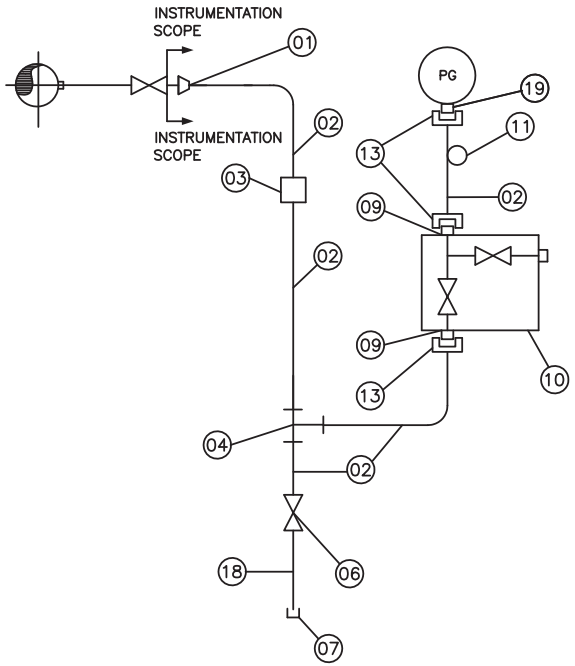
NPTM – NATIONAL PIPE THREAD MALE

SW – SOCKET WELD

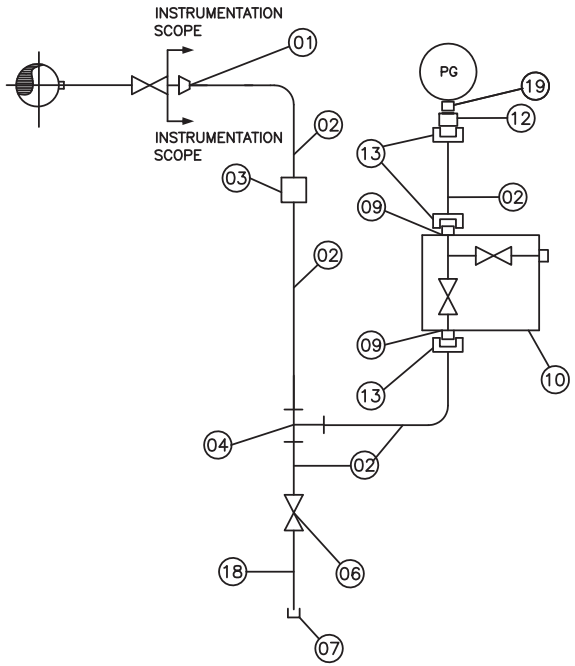
BHEL	TITLE :– INSTRUMENT INSTALLATION DIAGRAM NOTES	DRG. NO.	PE–DG–999–145–IXXX	
		REV. NO.	00	DATE 05.11.13
		SHT	2 OF 9	



WATER SERVICE

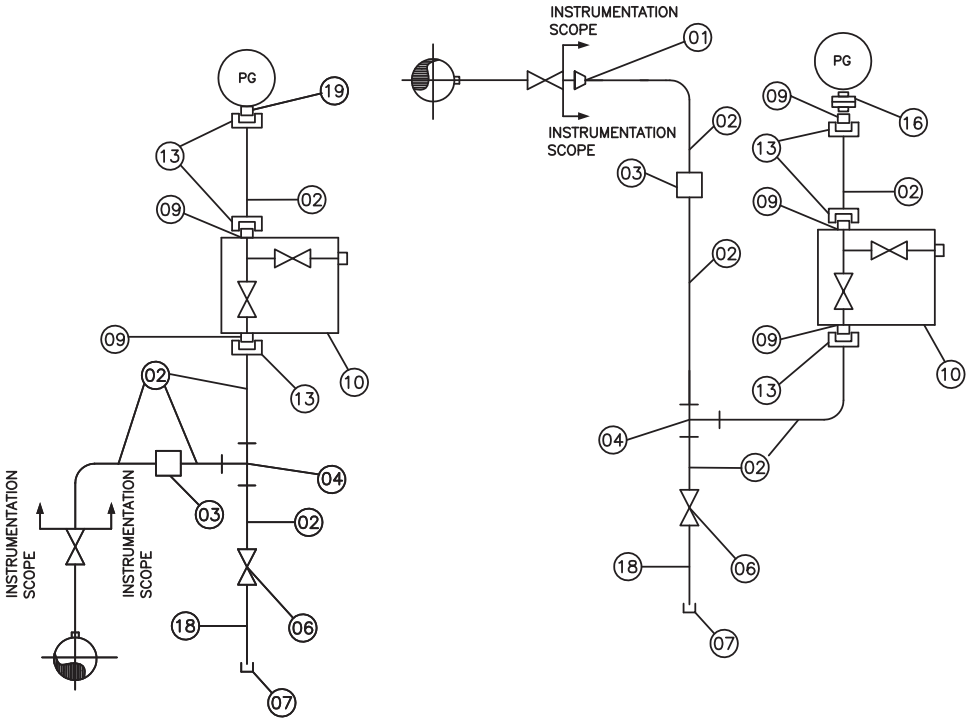


STEAM SERVICE



PULSATING SERVICE

BHEL	TITLE :- INSTRUMENT INSTALLATION DIAGRAM PRESSURE GAUGES	DRG. NO.	PE-DG-999-145-IXXX	
		REV. NO.	00	DATE 05.11.13
		SHT	3 OF 9	



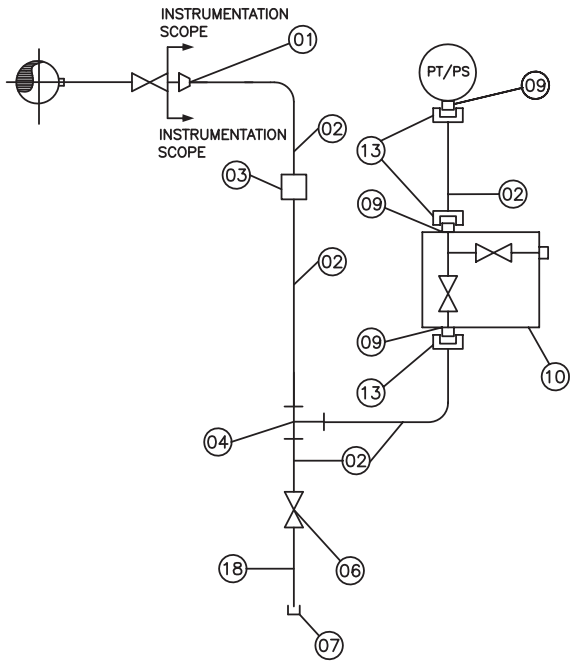
AIR SERVICE

WITH CHEMICAL SEAL

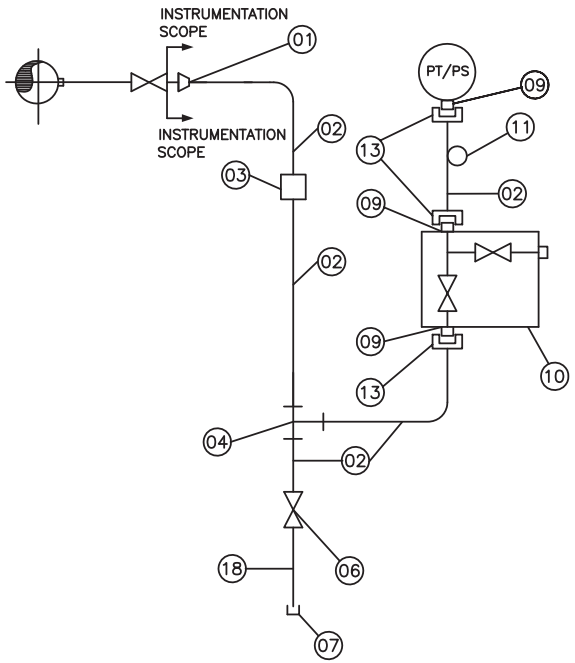
(FOR VISCOUS NON–CORROSIVE FLUID ONLY)

ITEM NO	ITEM/DESCRIPTION	MATERIAL	SIZE	QTY				
				WATER	STEAM	PULSATING	AIR	CHEMICAL
01	REDUCER (IF APPLICABLE)	SAME AS MAIN PIPE	1" X 1/2"SW	01	01	01	00	01
02	SEAMLESS PIPE	SAME AS MAIN PIPE	1/2"	A/R	A/R	A/R	A/R	A/R
03	FORGED COUPLING	SAME AS MAIN PIPE	1/2" SW	A/R	A/R	A/R	A/R	A/R
04	FORGED TEE	SAME AS MAIN PIPE	1/2" SW	01	01	01	01	01
06	FORGED GLOBE VALVE	SAME AS MAIN PIPE	1/2" SW	01	01	01	01	01
07	CAP	SAME AS MAIN PIPE	1/2" NPTF	01	01	01	01	01
09	ADAPTER – M TO M	SS316	M20X1.5M X 1/2" NPTM	02	02	02	02	03
10	TWO VALVE 3 WAY MANIFOLD WITH VENT PLUG	SS316	1/2" NPTF	01	01	01	01	01
11	SYPHON	SS316	1/2" SW	00	01	00	00	00
12	SNUBBER	SS316	M20X1.5M X M20X1.5F	00	00	01	00	00
13	NUT & TAIL PIECE WITH ANNEALED COPPER/SS304 WASHER	SS316	NUT SIZE : M20 X 1.5 WITH 100MM TAIL	03	03	03	03	03
16	CHEMICAL SEAL	SS316	1/2" NPTF X 1/2" NPTF	00	00	00	00	01
18	NIPPLE	SAME AS MAIN PIPE	1/2" NPTM X 1/2" SW	01	01	01	01	01
19	ADAPTER – M TO F	SS316	M20X1.5M X 1/2" NPTF	01	01	01	01	00

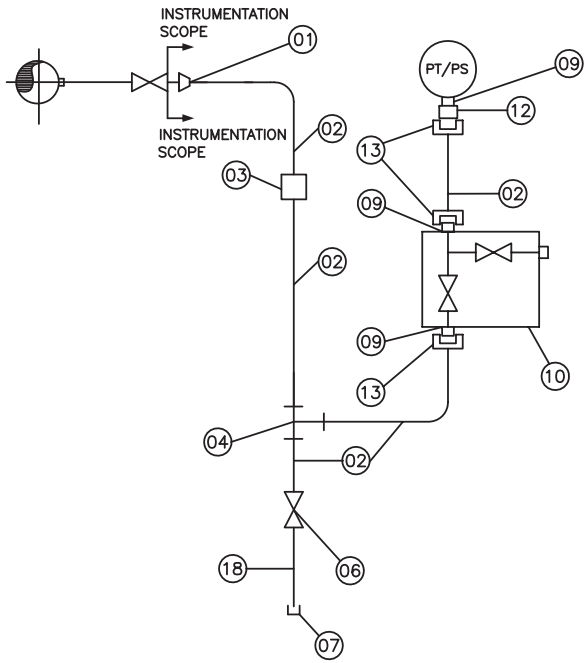
BHEL	TITLE :– INSTRUMENT INSTALLATION DIAGRAM PRESSURE GAUGES	DRG. NO.	PE–DG–999–145–IXXX	
		REV. NO.	00	DATE 05.11.13
		SHT	4 OF 9	



WATER SERVICE

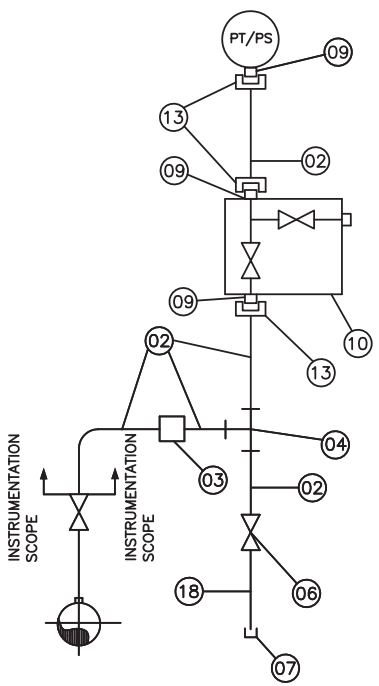


STEAM SERVICE

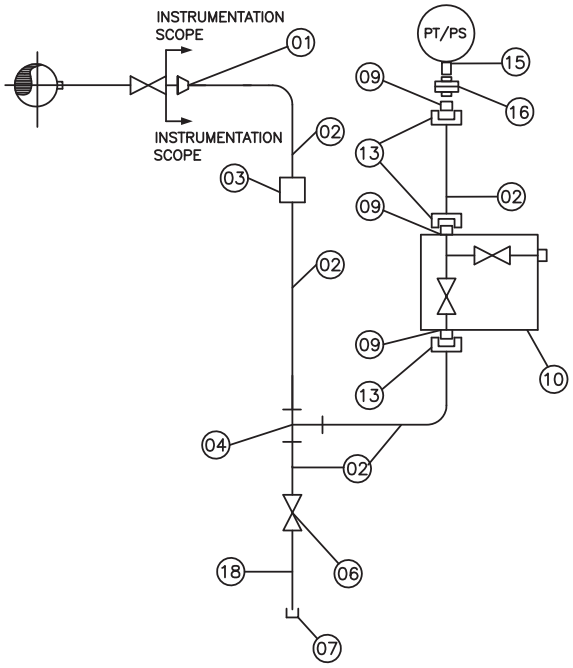


PULSATING SERVICE

BHEL	TITLE :- INSTRUMENT INSTALLATION DIAGRAM PRESSURE SWITCHES/TRANSMITTERS	DRG. NO.	PE-DG-999-145-IXXX	
		REV. NO.	00	DATE 05.11.13
		SHT	5 OF 9	



AIR SERVICE



WITH CHEMICAL SEAL
(FOR VISCOUS NON–CORROSIVE FLUID ONLY)

ITEM NO	ITEM/DESCRIPTION	MATERIAL	SIZE	QTY				
				WATER	STEAM	PULSATING	AIR	CHEMICAL
01	REDUCER (IF APPLICABLE)	SAME AS MAIN PIPE	1" X 1/2"SW	01	01	01	00	01
02	SEAMLESS PIPE	SAME AS MAIN PIPE	1/2"	A/R	A/R	A/R	A/R	A/R
03	FORGED COUPLING	SAME AS MAIN PIPE	1/2" SW	A/R	A/R	A/R	A/R	A/R
04	FORGED TEE	SAME AS MAIN PIPE	1/2" SW	01	01	01	01	01
06	FORGED GLOBE VALVE	SAME AS MAIN PIPE	1/2" SW	01	01	01	01	01
07	CAP	SAME AS MAIN PIPE	1/2" NPTF	01	01	01	01	01
09	ADAPTOR – M TO M	SS316	M20X1.5M X 1/2" NPTM	03	03	03	03	03
10	TWO VALVE 3 WAY MANIFOLD WITH VENT PLUG	SS316	1/2" NPTF	01	01	01	01	01
11	SYPHON	CS	1/2" SW	00	01	00	00	00
12	SNUBBER	SS316	M20X1.5M X M20X1.5F	00	00	01	00	00
15	CONNECTOR – M TO M	SS316	1/2" NPTM X 1/2" NPTM	00	00	00	00	01
16	CHEMICAL SEAL	SS316	1/2" NPTF X 1/2" NPTF	00	00	00	00	01
13	NUT & TAIL PIECE WITH ANNEALED COPPER/SS304 WASHER	SS316	NUT SIZE : M20 X 1.5 WITH 100MM TAIL	03	03	03	03	03
18	NIPPLE	SAME AS MAIN PIPE	1/2" NPTM X 1/2" SW	01	01	01	01	01

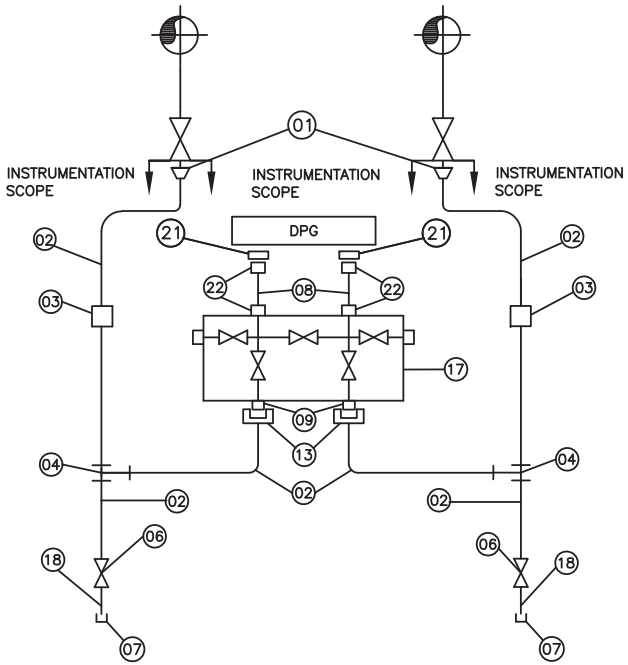
BHEL

TITLE :–

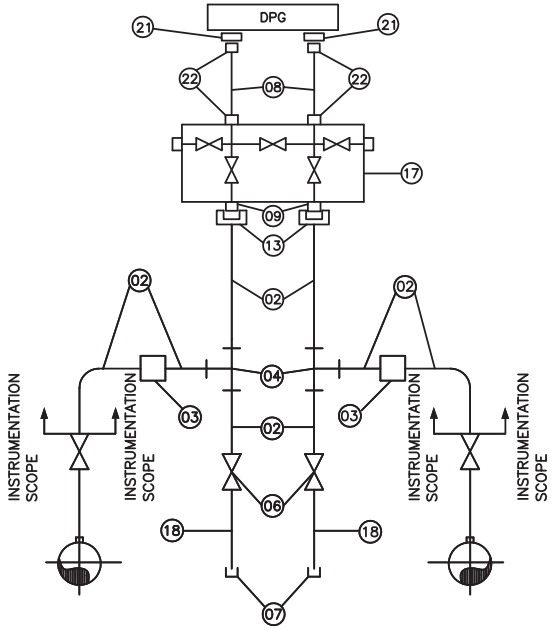
INSTRUMENT INSTALLATION DIAGRAM

PRESSURE SWITCHES/TRANSMITTERS

DRG. NO.	PE–DG–999–145–IXXX		
REV. NO.	00	DATE	05.11.13
SHT	6 OF 9		



WATER SERVICE



AIR SERVICE

ITEM NO	ITEM/DESCRIPTION	MATERIAL	SIZE	QTY	
				WATER	AIR
01	REDUCER (IF APPLICABLE)	SS316	1" X 1/2"SW	02	00
02	SEAMLESS PIPE	SAME AS MAIN PIPE	1/2"	A/R	A/R
03	FORGED COUPLING	SAME AS MAIN PIPE	1/2" SW	A/R	A/R
04	FORGED TEE	SAME AS MAIN PIPE	1/2" SW	02	02
06	FORGED GLOBE VALVE	SAME AS MAIN PIPE	1/2" SW	02	02
07	CAP	SAME AS MAIN PIPE	1/2" NPTF	02	02
08	SEAMLESS TUBE	SS316	1/2" OD	A/R	A/R
09	ADAPTOR – M TO M	SS316	M20X1.5M X 1/2" NPTM	02	02
17	FIVE VALVE MANIFOLD WITH DRAIN PLUG	SS316	1/2" NPTF	01	01
16	CHEMICAL SEAL	SS316	1/2" NPTF X 1/2" NPTF	00	00
13	NUT & TAIL PIECE WITH ANNEALED COPPER/SS304 WASHER	SS316	NUT SIZE : M20 X 1.5 WITH 100MM TAIL	02	02
18	NIPPLE	SAME AS MAIN PIPE	1/2" NPTM X 1/2" SW	02	02
22	TUBE FITTING DFDC	SS316	1/2" NPTM X 1/2"OD TUBE	04	04
21	CONNECTOR – F TO F	SS316	1/2" NPTF X 1/2" NPTF	02	02

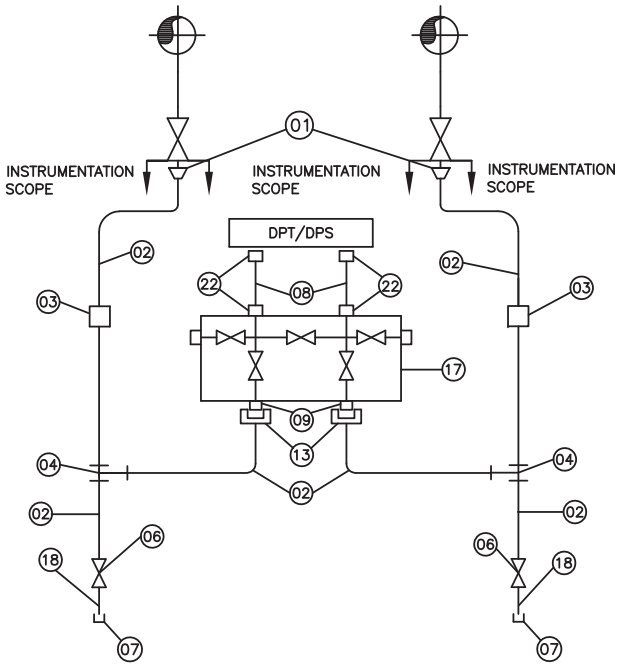
BHEL

TITLE :–

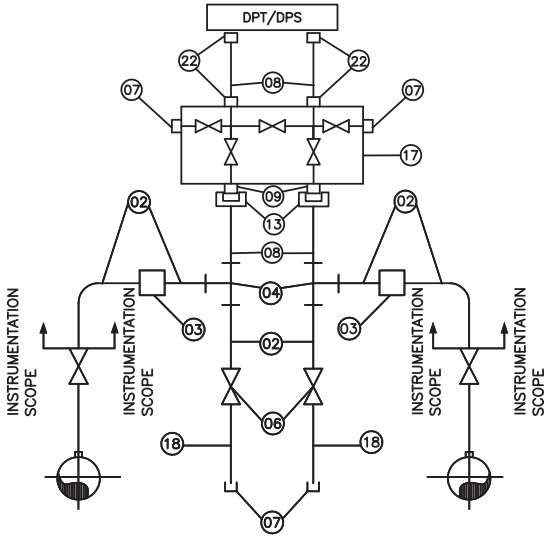
INSTRUMENT INSTALLATION DIAGRAM

DIFFERENTIAL PRESSURE GAUGES

DRG. NO.	PE–DG–999–145–IXXX		
REV. NO.	00	DATE	05.11.13
SHT	7 OF 9		



WATER SERVICE



AIR SERVICE

ITEM NO	ITEM/DESCRIPTION	MATERIAL	SIZE	QTY	
				WATER	AIR
01	REDUCER (IF APPLICABLE)	SS316	1" X 1/2"SW	02	00
02	SEAMLESS PIPE	SAME AS MAIN PIPE	1/2"	A/R	A/R
03	FORGED COUPLING	SAME AS MAIN PIPE	1/2" SW	A/R	A/R
04	FORGED TEE	SS316	1/2" SW	02	02
06	FORGED GLOBE VALVE	SS316	1/2" SW	02	02
07	CAP	CS	1/2" NPTF	02	02
08	SEAMLESS TUBE	SS316	1/2" OD	A/R	A/R
09	ADAPTER – M TO M	SS316	M20X1.5M X 1/2" NPTM	02	02
17	FIVE VALVE MANIFOLD WITH DRAIN PLUG	SS316	1/2" NPTF	01	01
16	CHEMICAL SEAL	SS316	1/2" NPTF X 1/2" NPTF	00	00
15	CONNECTOR – M TO M	SS316	1/2" NPTM X 1/2" NPTM	00	00
13	NUT & TAIL PIECE WITH ANNEALED COPPER/SS304 WASHER	SS316	NUT SIZE : M20 X 1.5 WITH 100MM TAIL	02	02
18	NIPPLE	SAME AS MAIN PIPE	1/2" NPTM X 1/2" SW	02	02
21	CONNECTOR – F TO F	SS316	1/2" NPTF X 1/2" NPTF	00	00
22	TUBE FITTING DFDC	SS316	1/2" NPTM X 1/2"OD TUBE	04	04

BHEL

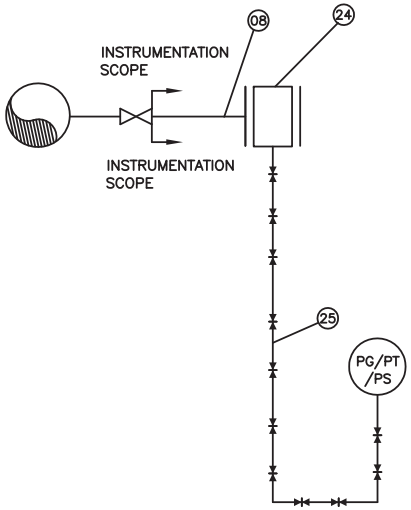
TITLE :–

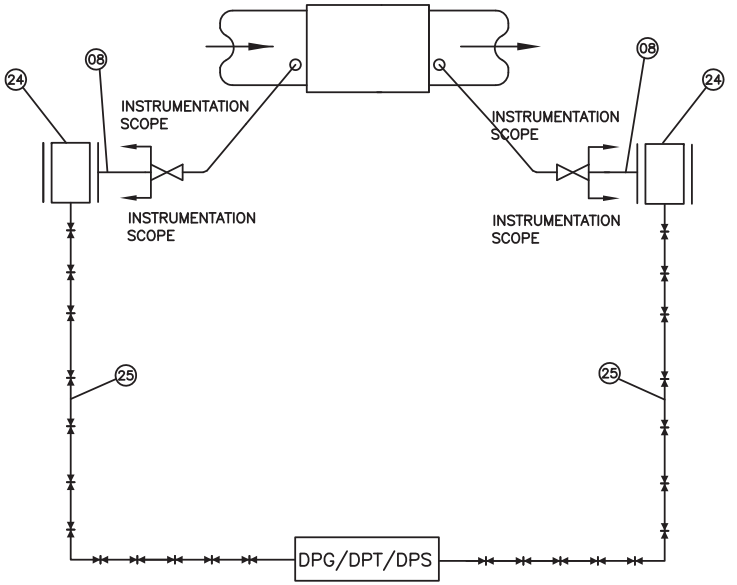
INSTRUMENT INSTALLATION DIAGRAM

DIFFERENTIAL PRESSURE SWITCHES/TRANSMITTERS

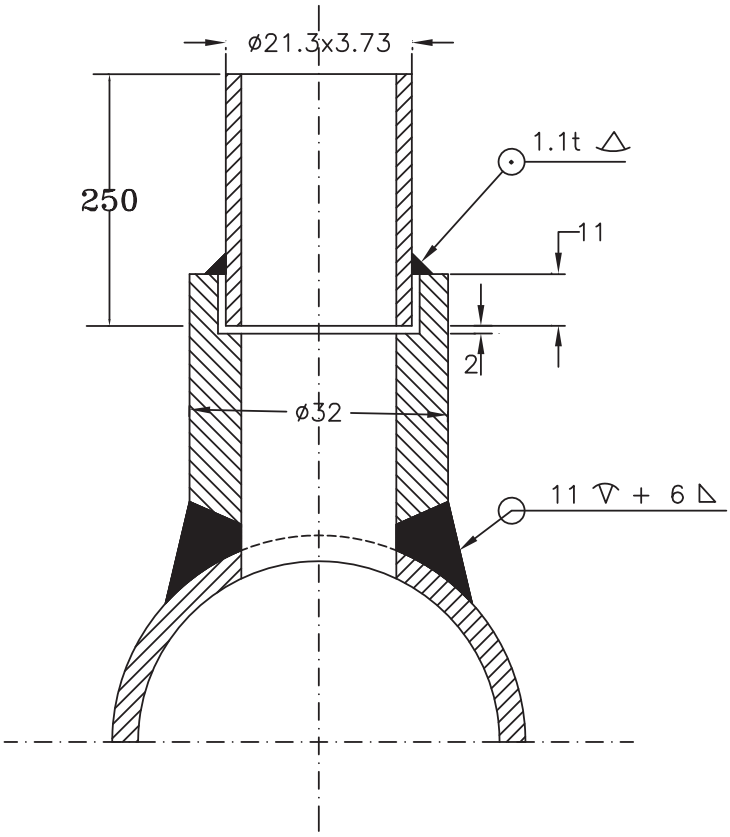
DRG. NO.	PE–DG–999–145–IXXX		
REV. NO.	00	DATE	05.11.13
SHT	8 OF 9		

ITEM NO	ITEM/DESCRIPTION	MATERIAL	SIZE	QTY	
				PG/PS/PT	DPG/DPS/DPT
24	FLANGE SUPPLIED WITH PG/PS PT/DPG/DPS/DPT TO SUIT 1/2" OR 1" NB PIPE	SAME AS MAIN PIPE	1/2" SW	01	02
08	SEAMLESS PIPE	SAME AS MAIN PIPE	1/2"	A/R	A/R
25	SS ARMORED CAPILLARY TUBE (MINIMUM 5M IN LENGTH)	SS316	–	A/R	A/R





BHEL	TITLE :– INSTRUMENT INSTALLATION DIAGRAM WITH CAPILLARY TUBES	DRG. NO.	PE–DG–999–145–IXXX	
		REV. NO.	00	DATE 05.11.13
		SHT	9 OF 9	

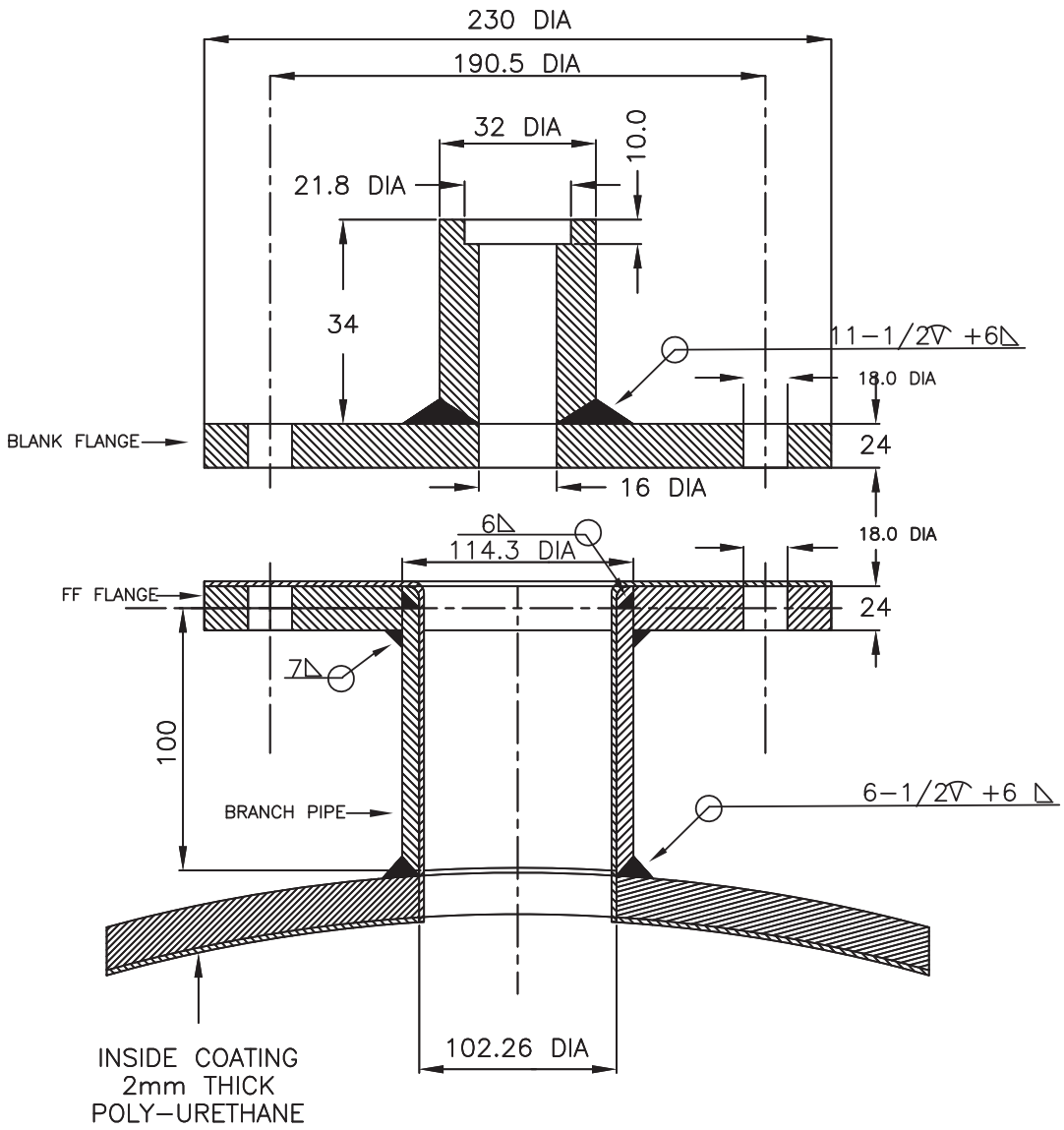


NOTE :

1. MATERIAL OF THE BOSS AND NIPPLE SHALL BE THE SAME AS THE PIPE INTO WHICH IT IS WELDED AND CONFORM TO ANSI B16.11.
2. THE LENGTH OF NIPPLE SHALL BE 250 MM.
3. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE INDICATED
4. EDGE HOLE MUST BE CLEAN AND SQUARE OR ROUNDED SLIGHTLY (1/64" RADIUS) FREE FROM BURRS, WIRE EDGES OR OTHER IRREGULARITIES
5. FOR PU COATED PIPE REFER SHT NO–9.

TITLE :
INSTRUMENT STUB DETAILS
FOR PRESSURE MEASUREMENT
(PRESS UPTO 40 Kg/cm2, TEMP<400 DEG C AND CLASS 3000#)

DRG. NO.
PE–DG–435–145–I101
REV. 01
SH. 4 OF 10



NOTES :–

1. THIS TYPE OF PRESSURE TAPPING IS APPLICABLE FOR PU COATED PIPING.
2. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE INDICATED.
3. MATERIAL OF BLANK FLANGE, BOSS WILL BE OF SS316L.
4. BRANCH PIPE MATERIAL SHALL BE SAME AS MAIN PIPE MATERIAL.
5. FF FLANGE SHALL BE NB100, CLASS 150 AND OF THE SAME MATERIAL AS THAT OF MAIN PIPE.
6. FOR LOW PRESS APPLICATION, MOC OF IMPULSE TUBING & IMPULSE PIPE SHALL BE CPVC(3/8") SCH 80 OR BETTER, INDUSTRAIL GRADE UPTO MANIFOLD. MOC OF IMPULSE TUBING, FITTINGS(FROM MANIFOLD TO INST) & MANIFOLD SHALL BE SUPER DUPLEX SS.

भेल BHEL

TITLE :
INSTRUMENT STUB DETAILS
INST. STUB DETAILS (PRESS)
APPLICABLE FOR PU COATED PIPES
(CW/ACW SYS, SEA WATER INTAKE SYS)

DRG. NO.
PE–DG–435–145–I101
REV. 01
SH. 9 OF 10

INSTRUMENT ERECTION DETAIL

C&I ERECTION

VOLUME II

SUB-SECTION 4.21

C&I ERECTION

1.0.0 TECHNICAL REQUIREMENT

1.1.0 Panels

Panels and control desk shall be freestanding type and fabricated preferably from 2.5 mm thick cold rolled steel sheet. Angle iron framework shall use a minimum section of 50 × 50 × 6 mm angle. The finish shall include sand blasting, grinding, chemical cleaning, and surface finishing by suitable filter and two coats of high-grade lacquer with wet sanding between coats. Two coats of paint in panel color shall be given for non-glossy high stain finish. Panel face final color in general shall be RAL 7035. A final coat of paint shall be given at site.

Panels and control desk shall have removable hinged doors, generally at the back for easy maintenance and accessibility of the instruments. Doors shall be double leaved type with handle and shall be provided with lock and key. Adequate illumination shall be provided inside the panel. All light fittings shall be suitable for 230V, 50Hz A.C.

The local panel construction shall be suitable for the site condition and shall meet IEC requirements in accordance with electrical area classification.
Pressurization or purging shall be as per NFPA 496 or equivalent.

No process fluid except air shall be piped to the control panel.

Mounting heights

1. Annunciators (top row)
2. Miniature and subminiature instruments (next 3 rows)
3. Electric push buttons (last row)

Control room panels shall have IP protection of IP 32 if mounted in an air- conditioning room and IP-45 if mounted inside a room and IP-55 if mounted outside.

1.2.0 Cable Trays

All I&C cables / tubes shall run on perforated cable trays. These cable trays shall be made out of galvanized MS and shall be of sheet steel of 2.5 mm thick. The width shall be so selected that 60% of tray space is available for future use of the complete installation.

Suitable cable clamps shall be supplied for binding the cables / tubes at every 500 mm. Cable tray shall be provided with Hot dip galvanized finish. Cable tray shall be provided with the perforation as per manufacture standards. Suitable cable tray cover shall be provided for all trays.

Cable tray shall be continuous and solid grounded. Cable tray shall not have sharp edges, Burrs or projection which is injurious to insulation or outer sheath of the cable.

The supporting arrangement of cable tray system shall be able to withstand the weight of the cable and cable tray system. The supporting interval shall not be more than the recommended span for the above loading for the type cable tray selected. The tray shall not overhang by more than one meter from the support at the dead end.

1.3.0 Process Impulse Lines /Tubes & Fittings

Impulse lines for instruments shall be ½" OD tubing of SS316 material according to ASTM A-269. All fittings to be used for tubing shall also be SS316, double compression type of standard make. Impulse pipes for high pressure applications shall be used with material and rating as same as that of the process line. Size and thickness of piping/tubing shall be suitable for the design pressure and temperature conditions as per ANSI16.11. Compression tube fittings are used in low pressure process systems. Socket weld tube fittings shall be used in high pressure process systems

For impulse pipes/tubes and fittings, IBR certificate shall be provided as applicable. The bidder shall provide thermal insulation (preferably mineral wool) for sampling pipes for the purpose of personnel protection so that temperature outside the insulation is 60 deg. C. Tubing shall be complete with union connections and end fittings at supply and receiving ends. Nipple shall be provided for root valves size more than ½" and the nipple size shall be same as the root valve size. Reducer / adapter shall be provided to suit instrument connection, where nipple, root valve size is more than ½". Bulk head fitting socket welded type to be provided at instrument rack/enclosure.

Impulse pipes, fittings and air supply and signal piping/tubing shall be supplied for all the instruments under the scope of this specification. Instrument piping shall be designed for maximum design pressure and temperature of the process. Pressure measurement connection shall be ½'' or 12mm pipe depending on the temperature and pressure conditions of the fluid. Instrument on Vacuum system at CEP inlet should have vent lines connected to high point in the condenser. Instrument air tubing shall be SS.

Minimum bending radius of instrument sensing line is 3 times the tube diameter. Independent impulse lines shall be installed between the flow elements and the transmitter in case of dual/triple redundant

Instrument sensing lines are sloped in their horizontal runs, a minimum of ½" per foot. In general, liquid and steam lines slope from their process tap connection down to the instrument. In general, gas and non-condensing vapor lines slope from their process tap connection up to the instrument.

Instrument sensing lines shall be routed as directly as practicable from the process root valve to the instrument. The length of instrument tubing from the root valve to the instrument shall be limited to maximum of 12 meters for compressible fluids and 15 meters for non-compressible fluids. Wherever it is not possible to access the main root valve a additional root valve shall be provided near to the instrument.

Instrument sensing lines shall be grouped together as much as possible to benefit from the use of common support members and to present a finished installation that is routed in a neat and orderly manner.

The maximum process temperature for all transmitters shall be limited to 80℃. To dissipate the excess heat, a minimum of 1 meter of tubing for each 30℃ of excess heat shall be installed to isolate the process media from the instrument. An additional isolation valve shall be used at the instrument for isolation on those instruments without valve manifolds

Funnel with drain header shall be provided in the racks for blowing/draining out the process fluid in the impulse tubings. The size of the drain header shall be 1". When instruments are mounted local to the tapping point and are not mounted in the rack, or panel or enclosure, the drains shall be connected to the nearest floor level or plant drain.

The erection hardware shall meet the following specifications:-

	Item	Specification
a)	Impulse Piping	
i)	High pressure and high temperature services (Medium: Steam & Water and furnace region)	Seamless Alloy Steel Piping to ASTM A335 GR.P22 (schedule 160 for high pressure & high temperature)
ii)	Low pressure and low temperature services Gr.B (Medium: Steam & Water)	Seamless carbon steel piping to ASTM A106
iv)	Steam and Water Analysis system	Seamless stainless steel piping to ASTM A312 Gr. TP-321
v)	Seamless copper tubing	ASTM B-75
b)	Fittings	
i)	Material for socket weld fittings	ASTM A105 ASTM A182 Gr. F22 6000/3000 lbs
ii)	Dimensions of fittings	ANSI B16.11
iii)	Fittings for steam and water analysis	ASTM A182 Gr. F-321

1.4.0 Instrument Valves and Manifolds

Bidder shall supply instrument valves (miniature type) and valve manifolds as per the Instrument Installation / Mounting diagrams.

Body material and rating shall be SS316 whichever is better and shall be forged type. Valve trim material shall be SS316.

Double root valve shall be provided under the conditions of pressure > = 40bar.

a)	Valves	
i)	3-way valves	SS body/Forged CS body stellited internals and SW ends as per requirement for 2500 lb/600 lb ASA ratings.
ii)	3-valve/5- valve manifolds	FAS body/FCS body 316SS stellited internals with NPT(F) SCRD ends for 2500 lb/1500 lb/600 lb ASA ratings.
iii)	2-valve manifolds	FCS body, 316SS stellited internals, NPT (F) SCRD ends.

b)	Isolation and drain valves	Globe valves with FAS body/FCS body, 316SS stellited internals, SW ends for 2500 lb/1500 lb/ 600 lb ASA ratings.
c)	Condensation vessels	FAS/FCS body with NPT (F) SCRD connection and vent plugs for 2500/600 lb ASA ratings.
d)	Dust separating chambers	ERW carbon steel pipe to IS-1239 Heavy Class
e)	Racks and Associated Equipment	ANSI C83.9-1972
f)	Code for pressure piping, welding and Hydrostatic testing	ANSI B-31.1
g)	Flexible conduits with fittings	Lead coated, paper insulated, heat resistant flexible metallic conduits with necessary fittings

1.5.0 Instrument Support / Structural Steel

Bidder shall supply instrument stands (stanchions) and other structural steel material required for supporting the Junction boxes, cable trays, impulse lines and instruments.

All field mounted instrument tubing shall be supported with steel angles/channels of a minimum 1/8" thickness fabricated to present a neat appearance. Sharp corners in the support material to be avoided

1.6.0 Transmitter Enclosures

a) Transmitter Enclosures shall be free standing, enclosed type offering protection against dust, moisture and vermin. Enclosures shall be suitable for outdoor installations, in Udangudi Supercritical Thermal Power Project.

b) The enclosures shall comprise of rigid welded structural frames enclosed with cold rolled sheet steel of thickness not less than 3 mm.

c) Instrument piping inside the enclosure shall conform to the specification and in line with typical installation drawings enclosed with the specification.

d) Blow down header shall be provided inside the enclosure as called for.

e) Bulkhead connection shall be provided to receive and terminate the impulse pipes from root valves.

f) Instrument tubing, fittings and isolation, drain valves shall be to ANSI code for pressure piping. Piping/tubing shall be subjects to hydrostatic tests at 1.5 times maximum system pressure.

g) Support angles shall be provided for valve manifolds, wiring trays etc. Enclosures shall be complete with necessary bulk head fittings, junction boxes, drain header and other accessories as needed on the basis of approved hook up drawings.

h) Sufficient spacing among adjacent transmitters shall be maintained to offer easy accessibility and operational convenience. The enclosure shall be designed with sizes to suit the grouping and to completely include all the hardware for hooking up the transmitters to the process on the basis of approved installation diagrams. A maximum of five (5) transmitters are envisaged to be grouped in one enclosure.

i) Hydrostatic tests for piping/tubing and functional checks for correct wiring shall be carried out.

j) The doors shall be the three-point locking type constructed of not less than 10 gauge steel. Doors shall have concealed quick removal type pinned hinges and locking handles. Doors locks shall accept the same key. Module assemblies shall be fabricated by bolting together two or more modules to form one continuous rigid structure. End covers shall then be added to complete the end closure. Gaskets shall be used between all mating sections to achieve NEMA type-12 dust proof enclosure rating for the modules and a NEMA type-4 water proof and dust tight rating on the terminal boxes. All enclosures shall have access doors on front and backsides.

k) The quality of the erection hardware/equipment used for complete instrumentation and control equipment shall meet all the requirements indicated in the other clauses.

1.7.0 Mountings for Vibration Transducers

Vibration transducer mounting design and location shall be acceptable to the Owner and to the vibration transducer manufacturer and shall be installed in accordance with API 670. The Bidder shall provide drawings to the vibration monitoring system supplier to indicate the arrangement and dimensions of bearing housings, shaft supports, reinforcing struts, ribs, and adjacent structures. These drawings shall be in sufficient detail to allow the vibration monitoring system supplier to select and locate the vibration transducers.

1.8.0 Junction Boxes

Bidder shall supply junction boxes wherever required. These shall be of Industrial grade Fibre glass Reinforced Polyester (FRP) to weather proof, with cable entering on bottom and side entry shall be provided.

These boxes shall have terminals suitable for min 2.5 mm^2 cable termination (klip on) mounted on rails. 30% spare terminals shall be supplied in each junction box.

Junction box shall be provided with double compression glands.

Telephone socket shall be provided in junction boxes. Each junction box shall have a minimum of 20% or 2 nos., whichever is more, spare entry duly provided with plugs (weather proof/explosion proof, as applicable). Protection class shall be IP-65 minimum for JB and enclosures.

In general junction boxes shall be designed in accordance with NEC, Article 370, paragraphs 18, 19 and 20 or equivalent standards. Junction boxes for use in outdoor or damp locations shall be galvanized malleable iron or steel coated inside and outside. The enclosure shall conform to NEMA-4 with hinged door lockable type. Conduit and cable shall enter the lower portion of the box in such a manner that all terminals strips are above conduit entry points.

2.0.0 ERECTION SERVICES

2.1.0 Instrument Air Supply System

Dry instrument air shall be distributed to various equipments of I&C system like control valves, Analyzer purging, pneumatic On-Off dampers. The Bidder shall supply total Instrument air requirement Calculations, and design of Air compressor system along with the bid. On collection of water in the drains of instrument air lines, mechanical automatic drains and periodically solenoid operated drains (with electronic timer - 15m, 30m, 60m and 2 Hours & Timing adjustable) are to be provided.

For mechanical type & Electrical type, the locations to be provided in the instrument air lines of boiler area, Chimney area, turbine area etc., shall be decided during detailed Engineering

2.2.0 Installation of Instruments

All electronic instruments shall be generally installed on supports as per installation standards. No instrument shall be installed in such a way that it depends for support on the impulse pipes, hand rails, floor grills, process pipes or structure in the passage.

Field mounted instruments shall be mounted on brackets, subpanels, or placed on a suitable pedestal. They shall be easily accessible from grade, ladder or platform. All local indicators shall be readable from grade or operating level and if used for manual control, shall be visible from the related valve.

Wherever possible, local mounted instruments shall be mounted at approximately 1.35 meters above the platform or floor in an accessible position. Instruments shall be mounted as close to the sensing points as possible (<15 mtrs).

2.3.0 Instrument Tubing Installation

All primary piping / tubing shall be installed in the best workman-like manner and shall follow installation standard in each case. Where there is no installation standard, the decision of the Engineer-in-Charge shall be followed.

Horizontal and vertical lines shall be installed using spirit levels and plumb and shall be supported to permanent structure at every 1.5 meters.

All threaded joints shall be jointed using Teflon tapes and no other tube-jointing compound shall be used except on higher temperature services where graphited sealing compounds shall be used. Brand of Teflon tape, insulation tape, graphite compound is to be approved by the engineer in charge.

Tubing shall be bent with correct size tubing bender wherever possible to avoid the use of fittings. Tubing cutter shall always be used to cut tubing. The use of short length of tubing in long runs shall be avoided. Wherever required coils shall be provided.

All tubing shall be run in such a manner as to give the maximum protection against mechanical damage. Tubing runs shall be grouped together where possible. Tubing shall be arranged so that couplings can be tightened without disturbing lines.
Tubes installed but not connected, shall have the ends closed in an approved fashion to prevent the entry of foreign material. For a period of up to one-week, adhesive tape may be used for longer periods, caps or plugs shall be used.

All reasonable precautions shall be taken to prevent foreign material entering pipelines before and during erection. All lines shall be blown through with filtered air before connection to instruments.

No tube shall be left with mechanical strain on it.

On tubing to pipe connections and in making up screwed pipe joints, Teflon tape shall be applied to make thread in a manner to insure tape is not over the end of the male fittings.

2.4.0 Piping Supports

Piping and tubing shall be adequately supported and fixed at distances not exceeding those in the following table:

Single Tubing / Pipe Maximum distance between Supports 3/8" OD and less Continuous to 3/4" Nom. size 2 Meters (6 ft.) 3,L-4" to 1" Nom. size 3 Meters (9 ft.). All field mounted instrument tubing shall be supported with steel angles/channels of a minimum 1/8" thickness fabricated to present a neat appearance. Sharp corners in the support material to be avoided.

2.5.0 Process Connection and Installation

Installation of pressure instruments at locations subject to excessive vibration shall be avoided. An additional block valve and vent valve shall be required adjacent to the transmitter. Means shall be provided for venting pressure from the line and gauge, so that gauges may be removed safely. Primary injection testing shall be incorporated together in a manifold.

Approved ball valves shall be used where temperature conditions permit. The valves shall be rated for not less than the line pressure on the main pipeline. If the pressure piping is of such length that the isolating valve is inaccessible from the instrument location, a suitable valve shall also be fitted at the instrument itself.

All pressure instruments shall be installed vertically. Those for steam must be tapped directly from above, for pressure transmitters and switches, there shall also be a condensing leg The same applies to gas and vacuum measurements, but adequate provision should be made to ensure no condensation can take place along the line, ie. The slope shall be adequate to drain any condensate back to the main lines (sloping upwards from the sensing point). Tapping points for liquids shall be made at an angle of 450 from the bottom of the main pipe and these are to be sloped downwards from the sensing point.

SIZE OF TAPPING POINT STUB, NO. AND SIZE OF ROOT VALVES FOR DIFFERENT TYPE OF MEASUREMENTS

Sl. No	Qty. 0f Root	Root Valve Size	Root Valve Service Conditions
A. Pressure & Differential Pressure Measurement			
(i)	2	25	>=62 bar OR 425 degree C
(ii)	1	15	< 62 bar AND425 degree C
B. Level Measurement			
B1-Level Gauge and Switch			
(i)	2	25	>=62 bar OR 425 degree C
(ii)	1	15	< 62 bar AND425 degree C
B2-Level Transmitter (Displacement Type)			
2		25	>=62 bar OR 425 degree C
1		15	< 62 bar AND425 degree C
B3-Standpipe For Level Measuring Instrument			
2		25	>=62 bar OR 425 degree C
1		15	< 62 bar AND425 degree C
C-Flow Measurement			
2		25	>=62 bar OR 425 degree C
1		15	< 62 bar AND425 degree C
D. Sampling System Measurement (Steam & Water Service)			
2		25	>=62 bar OR 425 degree C
1		15	< 62 bar AND425 degree C

Transmitters, temperature switches, pressure switches and the like shall be supported independent of the pressure connection; the type of support shall depend upon the make of instrument and location. When installing pressure instruments, care must be taken to avoid the possibility of imposing stresses from the pressure piping, conduit etc. which may cause malfunction.

When the pressure impulse line is liquid filled, the measuring unit shall be compensated for static head. The head correction shall be stated on the all process connections, pressure impulse lines and instrument arrangements shall be fully detailed and to the approval of the Engineer-in-charge.

2.6.0 Laying and Termination of cables

Multicore / multipair cables shall always be installed on trays or ducts and properly clamped. At every vertical drop to/from junction boxes they shall be clamped at frequent intervals as per instruction of Engineer in charge. They shall be connected inside the junction boxes strictly according to the numbering systems mentioned in the junction box schedule.

The accessories like double compression cable glands, cable lugs, cable tags (SS), cable ties and accessories required for the cable termination shall be included in scope of supply. Insulated lugs and ferrules with proper identification shall be used for all I&C cables.

At bends, minimum radius shall be maintained as per manufacturer's standard. Multicore/Multipair cables to be laid from instrument location to control room as per required standard. Identification tags shall be provided on either end of individual cores, Multicore/paircables including unused cores as per wiring diagram/cable/junction boxes schedules. PVC ferrules shall be used, for identification of cores. SS tag plates shall be used for identification of cable/junction boxes.

All cables shall be cut, after the exact site measurements are taken, between ends and the cable drums shall be so selected before cutting the lengths, as to avoid any wastage. Meggering should be done for each drum and length. While terminating the leads at the field instruments, a 300mm length loop shall be provided to facilitate easy removal of instruments.

In the field, the cables shall be laid in the overhead ducts / trays as per layout drawings. While laying cables in ducts/trenches or burying them, care shall be taken to ensure that two signal cables like alarm, analyzer cables, special cables compensating cables, etc. are separated from other power supply cables. Separation of low signal cables and power supply cables in trays/ducts shall be done as shown in the tray/duct drawing. Jointing of cables are not permitted.

At each road crossing and other places where cables enter pipe sleeves, adequate bed of sand shall be given so that the cables do not slack and get damaged by pipe ends after pack filling. All cables shall be laid in accordance with the layout drawings and cable schedule and tubing schedule. Multicore/Multipair cables shall be bent in a large radius as per manufacturer's standards.

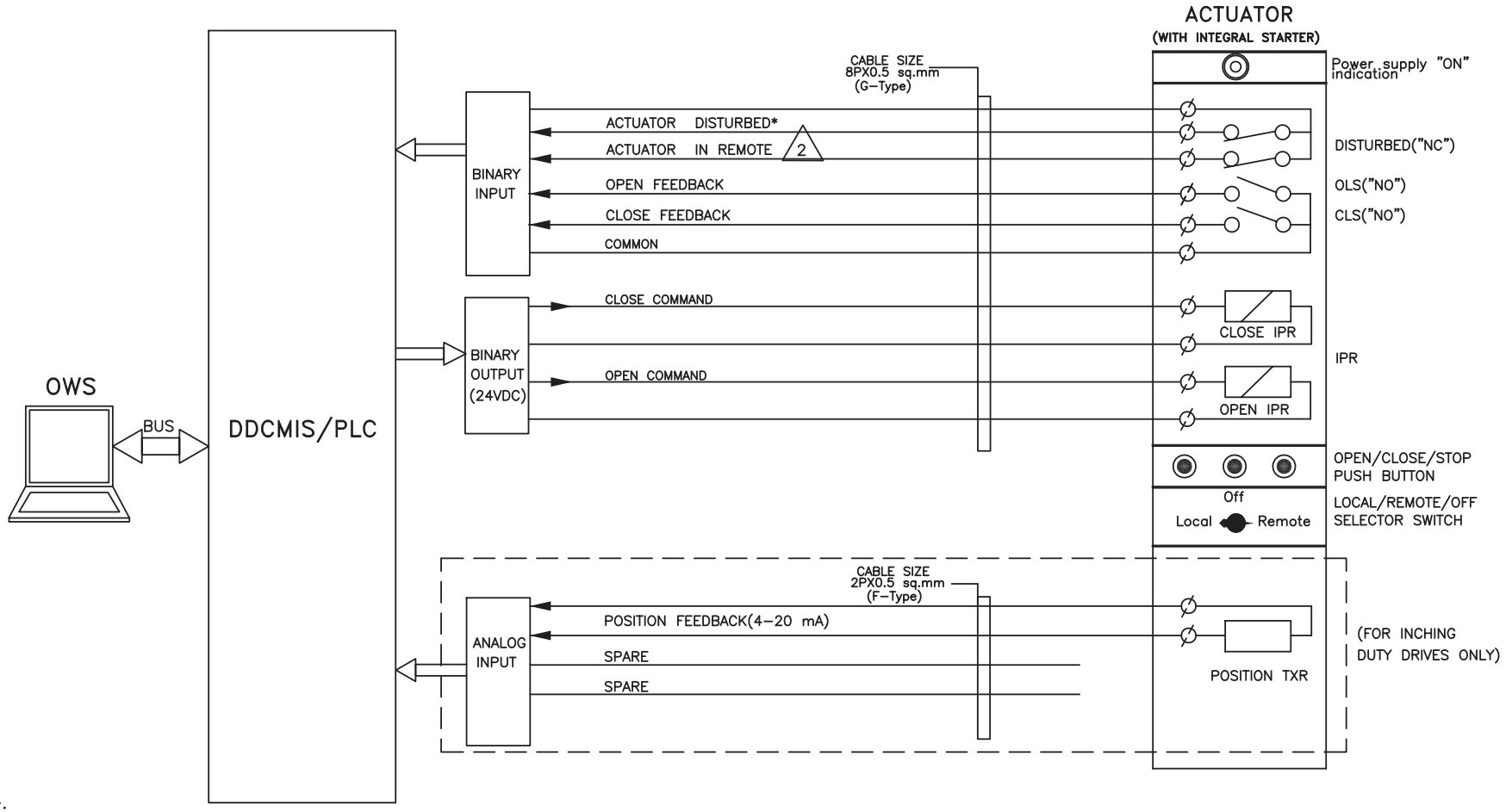
Cables shall be rigidly supported on structural steel and masonry individually or in groups as required using individual cast or malleable iron galvanized clips, multiple cable supports or cable trays. If drilling of steel must be resorted to, approval must be secured and steel must be drilled where the weakening of the structure will be minimum. Cable shall be supported at every 500mm. In case no such supports are available, the bidder shall provide suitable supports for the cable wherever required.

No cable shall be terminated or left with mechanical strain on it in any conduit or trenching. Where cables are run through conduit the entry and exit shall be smooth and free from burrs. The use of conduits shall be kept to a minimum, as far as possible. Cables must be pulled into ducts/conduit in a way that ensures there is no damage to the cable.

All multicables laid in ducts shall be properly dressed and tied with nylon wire of 3 mm diameter. All cables finally entering JBs/cabinets shall run through flexible PVC conduits for approximately 500mm.

DDCMIS/DCS INTERFACE FOR DRIVE

DCS INTERFACE FOR BIDIRECTIONAL DRIVE(WITH INTEGRAL STARTER)



NOTE:

1) Position Feedback of Bidirectional Inching duty drives in vicinity may be grouped together in the field during cable engineering. Junction Boxes and Single Trunk cable of higher size may be used to connect.

2) Redundancy of I/Os shall be as per contract specification requirement. 1

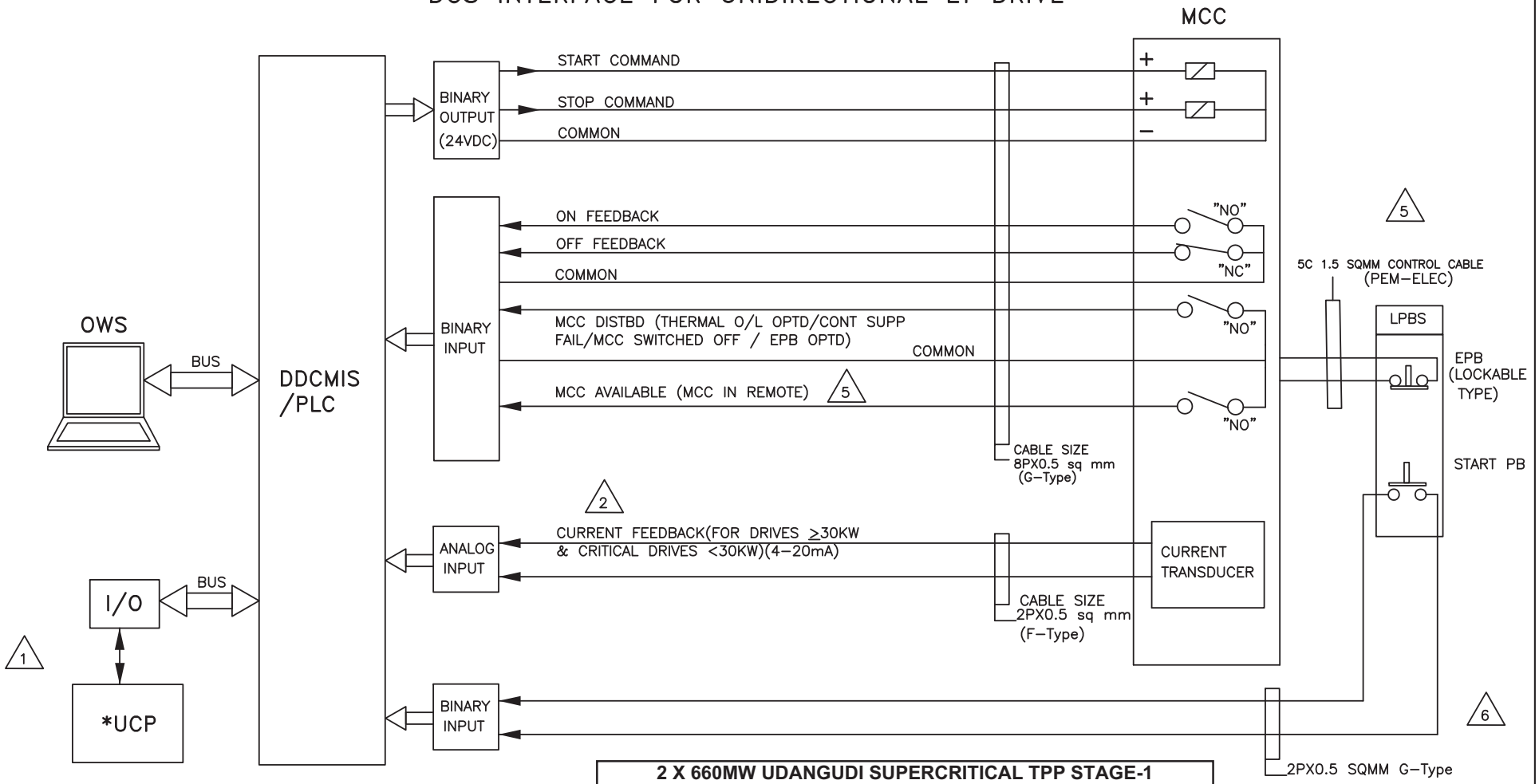
3) Two Nos of 9 pin plug in connectors, type connection shall be provided for interfacing with DDCMIS. 2

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

2 X 660MW UDANGUDI SUPERCRITICAL TPP STAGE-1
VOLUME: II B
TECHNICAL SPECIFICATIONS FOR
EFFLUENT TREATMENT PLANT
SPECIFICATION NO.: PE-TS-435-164-A001

BHEL	PROJECT: 2X660 MW TANGEDCO UDANGUDI STAGE I STPP	DRG.NO.	PE–DM–435–145–I002
		DATE	05.11.2019
	TITLE DDCMIS INTERFACE FOR BIDIRECTIONAL DRIVE	REV.NO.	07
		SHT	7 OF 11

DCS INTERFACE FOR UNIDIRECTIONAL LT DRIVE



2 X 660MW UDANGUDI SUPERCRITICAL TPP STAGE-1
VOLUME: II B
TECHNICAL SPECIFICATIONS FOR
EFFLUENT TREATMENT PLANT
SPECIFICATION NO.: PE-TS-435-164-A001

* As Applicable

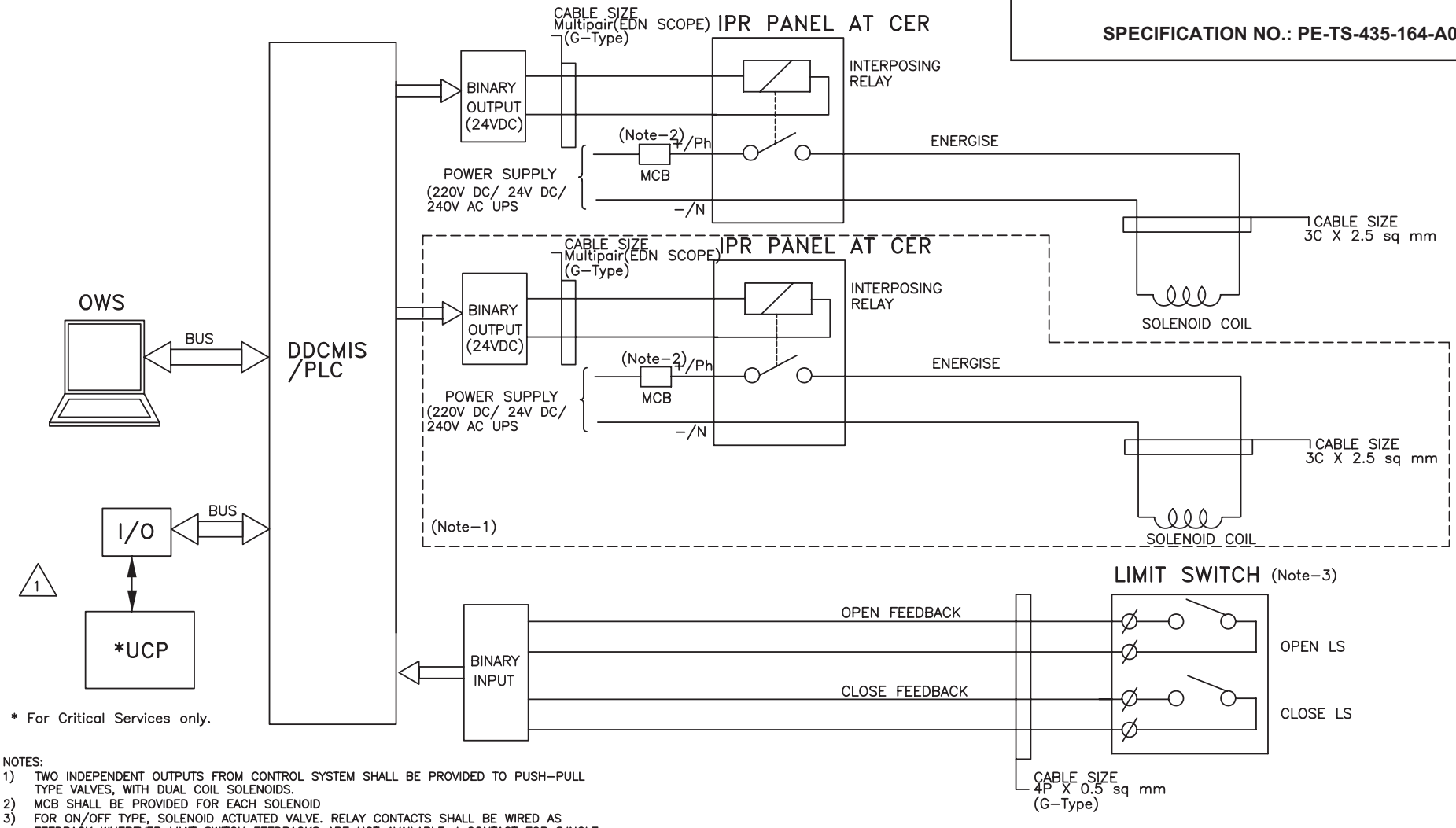
NOTE:

1) Redundancy of I/Os shall be as per contract specification requirement.

1

BHEL	PROJECT: 2X660 MW TANGEDCO UDANGUDI STAGE I STPP	DRG.NO.	PE–DM–435–145–I002
		DATE	05.11.2019
	TITLE DDCMIS INTERFACE FOR UNIDIRECTIONAL LT DRIVE	REV.NO.	07
		SHT	8 OF 11

DCS INTERFACE FOR SOLENOID DRIVE
(220V DC/ 24V DC / 240V AC UPS)



NOTES:
1) TWO INDEPENDENT OUTPUTS FROM CONTROL SYSTEM SHALL BE PROVIDED TO PUSH–PULL TYPE VALVES, WITH DUAL COIL SOLENOIDS.
2) MCB SHALL BE PROVIDED FOR EACH SOLENOID
3) FOR ON/OFF TYPE, SOLENOID ACTUATED VALVE. RELAY CONTACTS SHALL BE WIRED AS FEEDBACK WHEREVER LIMIT SWITCH FEEDBACKS ARE NOT AVAILABLE. 1 CONTACT FOR SINGLE COIL & 2 CONTACT FOR DUAL COIL (OPEN LIMIT SWITCH & CLOSED LIMIT SWITCH.
4) BHEL WILL TAKE CARE OF DE–ENERGISE TO TRIP PHILOSOPHY FOR FAIL SAFE CONTROL SYSTEM (WHEREVER REQUIRED)
5) REDUNDANCY OF IO SHALL BE AS PER SPECIFICATION REQUIREMENT.
6) FEEDBACK OF SOLENOID DRIVES IN VICINITY MAY BE GROUPED TOGETHER IN THE FIELD USING JUNCTION BOXES & SINGLE TRUNK CABLE OF HIGHER SIZE MAY BE USED TO CONNECT TO THE DCS.

BHEL	PROJECT: 2X660 MW TANGEDCO UDANGUDI STAGE I STPP	DRG.NO.	PE–DM–435–145–I002
		DATE	05.11.2019
	TITLE: DDCMIS INTERFACE FOR SOLENOID DRIVE	REV.NO.	07
		SHT	9 OF 11

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-V0-435-164-A001	P&I DIAGRAM FOR EFFLUENT TREATMENT PLANT	4	A1
2.	PE-V0-435-164-A002	LAYOUT PLAN FOR EFFLUENT TREATMENT PLANT INCLUDING SUMPS	4	A0
3.	PE-V0-435-164-A003	PROCESS SIZING CALCULATIONS FOR EFFLUENT TREATMENT PLANT	4	A4
4.	PE-V0-435-164-A004	SUB VENDOR LIST FOR EFFLUENT TREATMENT PLANT	10	A4
5.	PE-V0-435-164-A005	CONTROL PHILOSOPHY FOR EFFLUENT TREATMENT PLANT	10	A4
6.	PE-V0-435-164-A006	QAP FOR VALVES OF EFFLUENT TREATMENT PLANT	12	A4
7.	PE-V0-435-164-A007	QAP FOR HORIZONTAL / VERTICAL CENTRIFUGAL/SCREW PUMPS WITH MOTOR OF EFFLUENT TREATMENT PLANT	14	A4
8.	PE-V0-435-164-A008	QAP FOR METERING PUMPS WITH MOTOR OF EFFLUENT TREATMENT PLANT	12	A4
9.	PE-V0-435-164-A009	QAP FOR BLOWERS WITH MOTOR OF EFFLUENT TREATMENT PLANT	10	A4
10.	PE-V0-435-164-A010	QAP FOR ATMOSPHERIC TANKS OF EFFLUENT TREATMENT PLANT	12	A4
11.	PE-V0-435-164-A011	QAP / ICL OF EFFLUENT TREATMENT PLANT (FOR BALANCE OF ITEMS)	8	A4
12.	PE-V0-435-164-A012	ELECTRICAL LOAD LIST FOR EFFLUENT TREATMENT PLANT	10	A4
13.	PE-V0-435-164-A013	GA DRAWINGS FOR TANKS FOR EFFLUENT TREATMENT PLANT	24	A4
14.	PE-V0-435-164-A014	TECHNICAL DATASHEET OF VALVES FOR EFFLUENT TREATMENT PLANT	8	A4
15.	PE-V0-435-164-A015	TECHNICAL DATASHEET FOR INSTRUMENTS FOR EFFLUENT TREATMENT PLANT	20	A4
16.	PE-V0-435-164-A016	TECHNICAL DATA SHEET OF HORIZONTAL / VERTICAL CENTRIFUGAL/SCREW PUMPS FOR EFFLUENT TREATMENT PLANT	10	A4
17.	PE-V0-435-164-A017	TECHNICAL DATA SHEET FOR METERING PUMPS FOR EFFLUENT TREATMENT PLANT	12	A4
18.	PE-V0-435-164-A018	TECHNICAL DATA SHEET OF BLOWERS FOR EFFLUENT TREATMENT PLANT	10	A4
19.	PE-V0-435-164-A019	TECHNICAL DATASHEET FOR MOTORS	8	A4
20.	PE-V0-435-164-A020	TECHNICAL DATASHEET FOR AGITATORS FOR EFFLUENT TREATMENT PLANT	10	A4
21.	PE-V0-435-164-A022	MECH. GA OF SUMPS AND GUARD POND	10	A4
22.	PE-V0-435-164-A023	MECH. GA OF OIL WATER SEPARATOR AND INCLINED SURFACE SETTLERS	16	A4
23.	PE-V0-435-164-A024	PIPING LAYOUT FOR EFFLUENT TREATMENT PLANT	16	A0
24.	PE-V0-435-164-A025	YARD PIPING LAYOUT FOR EFFLUENT TREATMENT PLANT	16	A0
25.	PE-V0-435-164-A026	INSTRUMENT SCHEDULE FOR EFFLUENT TREATMENT PLANT	10	A3
26.	PE-V0-435-164-A027	VALVE SCHEDULE FOR EFFLUENT TREATMENT PLANT	10	A3
27.	PE-V0-435-164-A028	INSTRUMENT INSTALLATION/ HOOK UP DIAGRAMS	16	A4
28.	PE-V0-435-164-A029	FIELD JB TERMINATIONS /GROUPING DOCUMENT	16	A4
29.	PE-V0-435-164-A031	BLOCK LOGIC DIAGRAM	14	A4
30.	PE-V0-435-164-A032	MECHANICAL GA OF CHEMICAL HOUSE	14	A1
31.	PE-V0-435-164-A033	CABLE SCHEDULE (IN BHEL EXCEL FORMAT) & CABLE INTERCONNECTION DETAILS	16	A4
32.	PE-V0-435-164-A035	CABLE TRAY/TRENCH & CONDUIT ROUTING DIAGRAM AND EARTHING LAYOUT OF EFFLUENT TREATMENT PLANT	16	A1
33.	PE-V0-435-164-A036	QAP FOR PIPES	8	A4

34.	PE-V0-435-164-A037	PG TEST PROCEDURE FOR EFFLUENT TREATMENT PLANT	16	A4
35.	PE-V0-435-164-A038	O&M MANUAL FOR EFFLUENT TREATMENT PLANT	20	A4
36.	PE-V0-435-164-A039	DATA SHEET AND GA FOR ISOLATION GATE	10	A4
37.	PE-V0-435-164-A040	PAINTING SPECIFICATION	8	A4
38.	PE-V0-435-164-A041	DATA SHEET FOR MOTORISED VALVE ACTUATOR	10	A4
39.	PE-V0-435-164-A042	QAP FOR OIL WATER SEPARATOR	12	A4
40.	PE-V0-435-164-A044	QAP FOR ISOLATION GATE	14	A4
41.	PE-V0-435-164-A045	QAP FOR FM, FLOCC, TUBE SETTLER FOR EFFLUENT TREATMENT PLANT	14	A4
42.	PE-V0-435-164-A046	SKID GA	12	A2
43.	PE-V0-435-164-A048	GA FOR SLOP OIL TANK	12	A3
44.	PE-V0-435-164-A049	QAP FOR SLOP OIL TANK	14	A4

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 documents on PEM's DMS have been uploaded on PEM internet website (www.bhelpem.com) under the Vendor session.

· For quick access bidder may refer the link http://bhelpem.com/DMSManuals/DMSManuals.html

3. Re-submission of drawing/document shall be done within 10 days by supplier.

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

SCHEDULE OF DEVIATION WITH COST OF WITHDRAWL

TENDER ENQUIRY REFERENCE:-

NAME OF BIDDER:-

SL NO	VOULME/ SECTION	PAGE NO.	CLAUSE NO.	TECHNICAL SPECIFICATION/ TENDER DOCUMENT	COMPLETE DESCRIPTION OF DEVIATION	COST OF WITHDRAWL OF DEVIATION	REFERENCE OF PRICE SCHEDULE ON WHICH COST OF WITHDRAWL OF DEVIATION IS APPLICABLE	NATURE OF COST OF WITHDRAWL OF DEVIATION (POSITIVE/ NEGATIVE)	REASON FOR QUOTING DEVIATION
TECHNICAL DEVIATIONS									
COMMERCIAL DEVIATIONS									

PARTICULARS OF BIDDERS/ AUTHORISED REPRESENTATIVE

NAME	**DESIGNATIONS**	**SIGN & DATE**	

NOTES:

1. Cost of withdrawal of deviation will be applicable on the basic price (i.e, excluding taxes, duties & freight) only.
2. All the bidders has to list out all their Technical and Commercial Deviations (if any) in detail in the above format.
3. Any deviation not mentioned above and shown separately of found hidden in offer, will not be taken cognizance of.

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

4. Bidder shall submit duly filled unpriced copy of above format indicating "quoted" in "cost of withdrawal of deviation" column of the schedule above along with their Techno-commercial offer, wherever applicable. in the absence of same, such deviation(s) shall not be considered and offer shall be considered in total compliance to NIT
5. Bidder shall furnish price copy of above format along with price bid.
6. The final decision of acceptance/ rejection of the deviations quoted by the bidder shall be at discretion of the Purchaser.
7. Bidders to note that any deviation (technical/commercial) not listed in above and asked after Part-I opening shall not be considered.
8. For deviations w.r.t. Credit Period, Liquidated damages, Firm prices if a bidder chooses not to give any cost of withdrawal of deviation loading as per **Annexure-VII of GCC, Rev-07** will apply. For any other deviation mentioned in un-priced copy of this format submitted with Part-I bid but not mentioned in priced copy of this format submitted with Priced bid, the cost of withdrawal of deviation shall be taken as NIL.
9. Any deviation mentioned in priced copy of this format, but not mentioned in the un-priced copy, shall not be accepted.
10. All techno-commercial terms and conditions of NIT shall be deemed to have been accepted by the bidder, other than those listed in un-priced copy of this format.
11. Cost of withdrawal is to be given separately for each deviation. In no event bidder should club cost of withdrawal of more than one deviation else cost of withdrawal of such deviations which have been clubbed together shall be considered as NIL.
12. In case nature of cost of withdrawal (positive/negative) is not specified it shall be assumed as positive.
13.In case of discrepancy in the nature of impact (positive/ negative), positive will be considered for evaluation and negative for ordering.

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/TCE/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/TCE/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.) There are no other deviations with respect to specification other than those furnished in the 'Schedule of Deviations'

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

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

g.) All sub vendors shall be subject to BHEL/TCE/TANGEDCO approval

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

i.) Demonstration parameters shall stand valid till the satisfactory completion of demonstration test and its acceptance by BHEL/TCE/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.