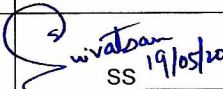
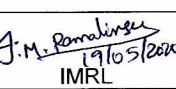


	SPECIFICATION FOR ELECTRO CHLORINATION PLANT	SPEC.NO.ROS: 6282
		REV.: 00

**BHARAT HEAVY ELECTRICALS LIMITED,
RANIPET- 632 406.**

**TECHNICAL SPECIFICATION
FOR
ELECTRO CHLORINATION PLANT**

**UDANGUDI STPP 2x660MW
THOOTHUKUDI DISTRICT, TAMIL NADU**

00	16.05.20	 ABH	 SS	 IMRL	Fresh issue
Rev.No	Date	Prepared	Checked	Approved	Remarks



SPECIFICATION FOR
ELECTRO CHLORINATION PLANT

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SECTION – 1

1.0 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 Electro Chlorination Plant as per the details in different sections / volumes of this specification for 2X660 MW UDANGUDI STPP, THOOTHUKUDI DISTRICT, TAMIL NADU .
- 1.2** The contractor shall be responsible for providing all material, equipment & services, which are required to fulfill 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 Electro Chlorination plant.
- 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 do not figure in 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 do not figure in the drawing
- 1.5** The general terms and conditions, instructions to tenderer and other attachment referred to elsewhere in the specification are 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

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format enclosed with this 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 (TANGEDCO: TAMIL NADU GENERATION AND DISTRIBUTION CORPORATION Ltd.) including their consultant as interpreted by BHEL in the relevant context.
- 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 equipment is being manufactured or tested and all test records shall be made available to him.

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SECTION – 2

2.0 PROJECT INFORMATION-

1	Name of the Project	Udangudi Supercritical Thermal Power Project - Stage -1
2	Station Capacity	2x660 MW (Coal Based)
3	Owner	TANGEDCO(Tamil Nadu Generation And Distribution Corporation Ltd.)
4	Site Location	The project site is located at about 45km South of Thoothukudi.
5	Latitude	8° 25.548' N
6	Longitude	78° 5.511' E
7	Nearest Town	Thoothukudi (approx.45 kms from site)
8	Nearest railway Station	Thiruchendur (approx.12 kms from site)
9	Nearest Airport	Vagaikulam (approx.60 kms from site)
10	Nearest Harbour	Thoothukudi (approx.45 kms from site)
11	Site Conditions	
	Elevation above MSL	CD +0.64 m (CD-Chart Datum)
	Temperature - Minimum DBT	17°C
	- Maximum DBT	41°C
	Relative Humidity	45 – 97 %
	Annual Rainfall	
	- Maximum	718.2 mm
	- Lowest	384.1 mm
	- 24 hour max	138.2 mm
	Mean Wind Speed	20.6 kmph
	Wind direction	North, North East, North West, East
	Siesmic Intensity	As per IS 1893 Latest
12	Source of water	Source of water is Sea water.
13	Source of Coal	The boiler is designed for pulverised coal either 100% imported or 70% imported & 30% Domestic coal or 50% imported & 50% Domestic coal .

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SECTION - 3

3.0 SCOPE OF SUPPLY

This specification is intended to cover the Design, engineering, manufacture, assembly, inspection and testing at manufacturer's and/or his sub-contractors works, proper packing, delivery at site, transportation, unloading/handling at site, storage at site, site fabrication, site painting, erection including testing/ commissioning at site and performance testing of Electro Chlorination plant for 2x660 MW UDANGUDI STPP including complete C&I and Civil Works as specified and as necessary.

1. Broad Scope of supply shall be
 - a. Electro chlorination plant (ECP) comprising of Auto Self-cleaning filters, Booster pumps, Electrolysers, NaOCl Storage tanks, CW NaOCl continuous & shock dosing pumps, PT& Desal plant NaOCl dosing pumps, Intake NaOCl continuous & shock dosing pumps, H2 dilution blowers for NaOCl Storage tanks, Bulk acid storage tank, Acid circulation pumps, Acid measuring tank, Transformer-rectifiers, diffuser assemblies required at dosing points, hydrogen detectors, chlorination piping within Electro chlorination plant, Material handling arrangement, piping, valves, and all other equipment and accessories required for Complete Electrochlorination plant of 2x660MW Udangudi STPP.
 - b. All integral and interconnected pipe works, valves, strainers, pressure relief valves, instrument stubs, specialities, all types of pipe supports, pipe racks, pipe bridges etc. for the entire system as per terminal points specified in this tender specification.
 - c. Necessary piping, fitting, valves, drains, vents, sampling etc. required for the complete Electro Chlorination Plant. Pipe racks shall be provided by BHEL wherever available. Wherever pipe racks are not available, pipe shall be laid on pedestal (provided by BHEL). However, all auxiliary steel structure (U-clamps, nuts, bolts, channels etc) for fixing pipes on pedestal or racks shall be in bidder's scope.
 - d. Necessary flanges and counter flanges as applicable for interconnection.
 - e. Safety requirement
 - f. Start-up and commissioning spares as required
 - g. Mandatory spares as per Annexure-1 enclosed
 - h. All special tools necessary for proper maintenance or adjustment of the equipment packed in permanent box
 - i. 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 electro chlorination Plant
 - j. Permanent ladder (not rungs) for approaching the top of tanks, valves for opening/maintenance purpose
 - k. Operating platforms, permanent ladders (not rungs), supports and other structural works for each tanks, valves etc. to facilitate accessibility for operation and maintenance
 - l. All steel inserts with lugs, plates, bolts, nuts, sleeves, edge angles and all other embedding components etc as required to grout in civil works and to support/hold the equipment being supplied under this specification. All nuts, bolts, etc shall be of SS 316L.

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- m. Finish paints for touch up painting of equipment after erection at site in sealed container
- n. Instrument hook up material shall be in bidder's scope
- o. All auxiliary steel structures (U-clamps, nuts, bolts, channels etc.) for fixing the pipe on the pedestal or trestles
- p. Initial charge of all lubricants and grease which will be required to put the equipment covered under the scope of specifications, into successful commissioning / initial operation and to establish completion of facilities shall be in bidder's scope. Suitable standard lubricants as available in India are desired. Efforts should be made to limit the variety of lubricants to minimum.
- q. Any item/work either supply of equipment or erection material which have not been specifically mentioned in but are necessary to complete the works for trouble free and efficient operation of the plant shall be deemed to be included within the scope of this specification and shall be in bidder's scope without any commercial, technical and delivery implication to BHEL
- r. All other items are also included in scope of supply as specified in other part of the specification.
- s. All required elbow, tee, pipe fittings etc. required for erection of the complete system including piping shall be in bidder's scope. Bidder to provide the detailed BOQ during detail engineering
- t. Bidder shall perform the guarantee parameters as per specification requirement. 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.

2. Electrical

The Specification of Electrical items, scope & terminal Points shall be as per Electrical spec. ROS4268

3. Control & Instrumentation

Control & Instrumentation - Refer C& I portion of this specification

4. Scope of Services

- a. Design & engineering of Electro chlorination plant
- b. Erection and Commissioning, material receipt, unloading, storage and handling at site of all equipment of ECP.
- c. Arrangement of all instruments, reagents, gadgets for monitoring, pre-commissioning, carrying out trial run & commissioning and Performance guarantee test.
- d. Pre-Commissioning work such as flushing, hydraulic testing etc. Necessary consumables and instrumentation as required for inspection and testing at works as well as at site including pre-commissioning activities shall be arranged by the successful bidder at their own cost.
- e. Arrangement of all lubricants, instruments, reagents for carrying out trial run, commissioning and PG test
- f. Monitoring gadgets, instruments and equipment required for maintenance (till PG test and plant hand over)
- g. Complete grouting for equipment including foundation bolt & base frame filling and finishing, fixing and any concreting inside the vessels and lining.

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- h. All personnel required during maintenance, Commissioning and Performance guarantee test.
- i. All special tools necessary for proper maintenance or adjustment of the equipment packed in a suitable Tool box shall be provided by Bidder. The same shall be handed over to BHEL at the Time of plant take over.
- j. Trial run for requisite period.
- k. Performance guarantee test
- l. Painting shall be as specified in “Surface Preparation & Painting” of this technical specification. Bidder to note that paint schedule shall be finalized during detailed engineering as per customer & BHEL requirement and any variation in the painting schedule as finally approved by customer shall be taken care by bidder without any commercial and delivery implication
- m. Final touch up paint at site
- n. All statutory clearances required, including local Govt. body / municipal offices as applicable shall be in Bidder’s scope
- o. Material receipt, storage and issue for Erection & Commissioning shall be in Bidder’s scope. Bidder shall store all high value items under lock & key, using containers only.
- p. Preparation & submission of all drawings including Piping isometric drawing for all piping in ECP package.
- q. Preparation of drawings / document / P&ID’s in 3D modelling software and providing soft copy of same to BHEL
- r. Training of plant Owner’s personnel, O&M operators’ personnel on plant operation and maintenance
- s. Any other service required for making the installation complete in all respect within battery limits and for satisfactory erection & commissioning of the system as well as to meet any statutory requirement relevant to the package, unless specifically EXCLUDED from scope of services

5. Painting

Supply and application of shop painting and final painting at manufacturer's works and at site for the entire system as specified elsewhere in this Bid Document

6. Consumables

- a. All consumables (lubricating oil, inhibitor for oil, etc.) as applicable for operation of the ECP, required for pre commissioning, commissioning, trial run and PG test shall be in the scope of the Bidder. Bidder shall to relevant clauses in the entire tender document.
- b. All spares required for erection and commissioning of complete system, new set of special tools and tackles, fixtures etc. required for regular operation and maintenance of the system as addressed elsewhere in the entire specification shall be considered by Bidder.

7. Terminal points

- a. The details regarding terminal points are provided in Design memorandum, Layout and P&ID drawings.
- b. Raw sea water from CT make up discharge line for ECP shall be terminated at one point near ECP boundary by BHEL. Further piping to ECP shall be in Bidder’s scope.

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- c. NaOCl dosing piping for CW forebay shall be terminated at common discharge line of CW NaOCl dosing pumps (both shock & continuous dosing) by Bidder. Further piping upto CW forebay (terminal point coordinates indicated in drawing) shall be by BHEL. Piping, distribution, diffusers in CW forebay area shall be in Bidder's scope. Bidder to refer to GA drawing of CW forebay & pump house PE-DE-435-165-N004.
- d. NaOCl dosing piping for Intake pump house shall be terminated at common discharge line of Intake NaOCl dosing pumps (both shock & continuous dosing) by Bidder. Further piping upto Intake pump house (terminal point coordinates indicated in drawing) shall be by BHEL. Piping, distribution, diffusers in Intake pump house shall be in Bidder's scope.
- e. NaOCl dosing piping for Intake well shall be terminated at common discharge line of Intake NaOCl dosing pumps (both shock & continuous dosing) by Bidder. Further piping upto Intake well including distribution and diffusers shall be by BHEL.
- f. NaOCl dosing piping for PT & Desalination plant shall be terminated at PT plant stilling chamber (including distribution & diffuser) and Clarified water tank outlet chamber (including distribution & diffuser) by Bidder. Bidder to refer PT plant layout attached. Bidder to consider ~100m for piping upto stilling chamber and ~260m for piping upto Clarified water tank outlet chamber.
- g. HCl required for cleaning of the Electrolysers will be provided by BHEL. BHEL shall terminate HCl at Acid measuring tank inlet. Acid measuring tank, further piping, pumping shall be in Bidder's scope.
- h. Service water line will be terminated by BHEL at one point near ECP boundary. Further piping and distribution within ECP for various purposes shall be in Bidder's scope.
- i. Potable water line will be terminated by BHEL at one point near ECP boundary. Further piping and distribution within ECP shall be in Bidder's scope.
- j. Service Air at 5-7 kg/cm² will be terminated near ECP boundary by BHEL. Further distribution within ECP shall be in Bidder's scope.
- k. All plant drains and chemical cleaning waste shall be terminated in nearby trenches leading to Neutralization pit. Drain channels and neutralization pit shall be in BHEL's scope.

8. Exclusion

- a. All civil work including foundation of equipment by BHEL. However, complete grouting for equipment, fixing and any concreting inside vessels, etc., shall be in the scope of bidder.
- b. Pedestals for pipe supports by BHEL. However, auxiliary structure, supports components for piping is in bidder's scope.
- c. Chemicals
- d. Fire fighting facilities. However, bidder to furnish the requirement of same after award of contract.
- e. Air conditioning, ventilation & fire fighting facilities.
- f. Refer to E, C&I specification for exclusions
- g. Drinking water (or potable water), service water up to terminal points is by BHEL and further piping and termination as per requirement is in Vendor scope.
- h. Chemical cleaning effluents and other drains from equipment, vessels, tank etc shall be drained to N-pit through drain trenches.

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- i. Monorail (I Beam) for hoist/crane movement is excluded from bidder scope

9. Civil

- a. Entire civil design & works required for the ECP required to meet the process requirement is in BHEL's scope. However, complete grouting for equipment, fixing and any concreting inside vessels and lining shall be in the scope of the bidder. All embedment's and inserts with lugs including anchor fasteners, bolts etc., dressing of foundations, grouting of pockets and underpinning of base plates for equipment / structures and fixing supports, filling and finishing of openings in walls, floors, cladding, roof and trenches shall be in Bidder's scope.

10. Material handling requirements

- a. 1No. Electrically operated monorail hoist (1MT capacity) for pump area of Electro chlorination building
- b. 1No. Electrically operated monorail hoist (1MT capacity) for Electrolyser area of Electro chlorination building
- c. Capacity of monorail hoists/ crane or chain pulley block wherever indicated are minimum and capacity of such hoists/ cranes etc. shall be suitable for handling 125% of maximum weight to be handled during erection and maintenance of the equipment in the pump house, buildings etc. as the case may be.
- d. Bidder to refer to Hoists specification for guidelines for selecting cranes/ hoists

11. Guarantee parameters

- a. The ECP shall generate Sodium hypochlorite at the rate of 234kg/hr on continuous basis.
- b. The continuous power consumption of the ECP shall be limited to 1330kW
- c. Bidder to meet other technical and guarantee requirements as specified in Design memorandum.

12. GENERAL DESIGN REQUIREMENTS

The common requirements for the system are stated in general design requirements. However, requirements indicated in the technical specification for mechanical equipment section shall be strictly complied with.

A. COMMON REQUIREMENTS:

1. Only latest revision of standards shall be considered for Design & manufacturing.
2. MOC of all components coming in direct contact with chemical shall be compatible to the respective chemical.
3. All rotating equipment's noise level shall be < 85dBA measured at 1 mtr distance from the equipment.
4. Sampling connections and air vent at the top most point of piping and vessels shall be provided at all stages of the Unit.
5. The size of the overflow pipes of all storage tanks shall be one size higher than inlet pipe sizes of these tanks.

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6. All the piping & valves are shall be located to facilitate easy accessibility and operation from ground level.
7. All flange fasteners shall be SS316 MOC.
8. Fasteners shall be stud type with spring washers & nuts.
9. Direction of Flow shall be indicated by an arrow at regular intervals on all pipelines with good visibility.

B. CENTRIFUGAL PUMPS:

1. The critical speed of the pumps shall be well away from the operating speed and not less than 130% of the rated Speed.
2. The pumps shall have stable head Vs capacity characteristic continuous rising towards shut-off with an approximate shut-off head of 15% more than the design head for radial flow type pumps.
3. The characteristic curves of given set of pumps shall match for load sharing in case of parallel operation.
4. Pumps shall be provided with non-return valve & shut off valve on discharge side and shut-off valve on suction side.
5. Unfiltered vibration velocity for horizontal pumps up to 3000 rpm with antifriction bearing or sleeve bearings when measured at the bearing housing in horizontal or vertical direction shall not exceed 4 mm/sec RMS.
6. Tolerance in pump guaranteed efficiency and rated head for the rated flow shall be minus 2% to plus 3%.
7. Pressure gauges shall be provided on discharge side of all pumps.
8. Each pump suction and discharge shall be installed with an expansion bellow.
9. The pumps shall be designed for continuous operation at its best efficiency to satisfy the performance requirements.
10. The pumps shall be controlled from remote panel and locally.

SECTION-4

4.0 GENERAL REQUIREMENTS OF SPECIFICATION

1. Approved Design memorandum (Drg.no.: 4-WT-040-01234)
2. P& ID (Drg.no.: 1-WT-040-01694)
3. Layout (Drg.: 1-WT-040-01386)
4. Qualification requirement shall be as per tender specification.
5. Bidder to refer the **Annexure-1** for list of Mandatory spares and include the same in scope of supply.

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6. Indicative Sub Vendor list is attached (**Annexure-2**). However, Bidder shall submit the Vendor list along with compliance for all the equipment during contract stage for approval by BHEL/ TANGEDCO.
7. Quality plan shall be as per attached typical quality plan document (**Annexure-3**). Bidder shall submit Quality plan for all the equipment supplied, services & works during contract stage for approval by BHEL.
8. Minimum list of drawings shall be as per attached master drawing list (**Annexure-4**). Bidder shall submit list of all drawings during contract stage for approval by BHEL.
9. Bidder shall submit the PG test procedure for Electro Chlorination plant for approval and same shall be followed as specified in **Annexure-5**.
10. List of reference documents/ drawings which are part of this tender are provided as **Annexure-6**.
11. Project schedule for Electrochlorination plant shall be submitted by Bidder for approval.
12. Refer **Annexure-7** for Technical requirements for Hoist.
13. Refer **Annexure-8** for Quality Assurance requirements.
14. Refer **Annexure-9** for List of Drawings & Documents to be submitted along with bid and after award of contract.
15. Bidder shall refer to Painting Specification in **Annexure-10** for meeting the requirements of this package.
16. Bidder shall also refer to the General conditions of contract (GCC).
17. Bidder shall refer to Health Safety and Environment plan for Site Operation by Subcontractors in **Annexure-11**.
18. Refer **Annexure-12** for Raw Sea water analysis
19. Refer **Annexure-13** for Power Guarantee.
20. Refer **Annexure-14** for Spares, Tools, Tackles & Consumables
21. Refer **Annexure-15** for General specification for Erection, Commissioning, PG test & handing over
22. Refer **Annexure-A** for Technical Deviation format.
23. Refer **Annexure-B** for Compliance and confirmation schedule.
24. Bidder shall provide requirement of Material handling system of this package along with basis & supporting technical details. Bidder shall provide basis with support documents if the same is not considered. BHEL decision on provision of the Material Handling system is Final & binding.
25. Bidder shall consider proper Packaging for shipping and storage at site and the procedure shall be duly submitted to Customer
26. Bidder shall furnish 3D model in editable format to ensure integration with overall 3D model of the Power plant.
27. Customer approved Design Memorandum and P&ID attached with this specification is minimum requirement and shall be complied by Bidder. Bidder to design the equipment/system for safe and trouble free operation of Plant to meet the performance duty required by system.
28. The Electro Chlorination plant complete with all accessories shall conform to this technical specification, Design memorandum & PID. Discrepancies shall be clarified with BHEL. The decision of BHEL shall be final if not clarified otherwise.

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29. All the instruments shall be supplied along with necessary fittings, accessories, valve manifold, root valves, Canopy & Structural steel as required. Instrument Installation, along with hardware shall be in bidder scope
30. The make shall be as per approved vendor list. The model of various instruments/items/systems shall be subject to approval of owner/purchaser during detailed engineering stage. No commercial implication in this regard shall be acceptable. In case of any conflict or repetition of clauses in the specification, the more stringent requirements among them are to be complied with.
31. Each valve/instrument shall be fitted with a stainless steel or aluminum nameplate indicating the valve/instrument service and reference number in accordance with the approved equipment coding system
32. All valves above 150NB shall be double flanged. All valves flange drilling standard shall be as per ANSI B16.5 standards.
33. The above given scope is indicative & minimum. Any item/ equipment not indicated above however required for the completeness of the system shall be supplied by bidder without any technical, commercial and delivery implication to BHEL.
34. Uniformity of make and type of instruments and control components shall be followed throughout for rationalization of spares' inventory, except for certain proprietary items where this requirement cannot be met.

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SECTION- 5

5.0 PIPING & VALVES SELECTION CRITERIA

5.1 Piping

Sl. No.	Pipe Size	Velocity in m/sec		
		Below 50mm	50mm-150mm	200mm & above
1	Pump Suction for Water		1.2-1.5	1.2-1.8
2	Pump Discharge for Water	1.2-1.8	1.8-2.4	2.1-2.5
3	Header		1.5-2.4	2.1-2.4
4	Compressed Air Below 2Kg/cm2(g)	15-20	20-30	25-35
5	Compressed Air Above 2Kg/cm2(g)	20-30	25-40	35-45
6	Suction to compressor/Blowers		7-8	
7	Pump Suction for Chemical Solution	1.0-1.2	1.1-1.3	
8	Pump Discharge for chemical solution	1.2-1.4	1.3-1.5	
GRP & cPVC PIPES (for sea water application & hypochlorite lines)				
9	For Pipe with negative suction		1.2 (Max)	2 (Max)
10	For Pipe with pressurized suction		1.5 (Max)	
11	For Pipe Delivery		2.0 (Max)	2.0 (Max)
	GRP pipes & fittings	PN10 rating/ sch.40		
	cPVC pipes & fittings	PN10 rating/ Sch.40		
Acid lines		cPVC sch.80		
Air lines (H2 Blower discharge)		GI Heavy grade, as per IS 1239/ IS 3589		
Bidder to follow P&ID drawing (1-WT-040-01694) for minimum pipe sizes & MOC.				

5.2 Valves

Sl. No.	Service	Size	Body	Disc	Seat
1	Sea water applications (butterfly valves)	All	Ductile Iron & Al Bronze	Duplex SS	EPDM/ Nitrile Rubber
2	Non-return valves	All sizes	Duplex SS	Duplex SS	
3	Chemical application (HCl, etc.)	All sizes	cPVC	cPVC	EPDM
4	Air blower line (Butterfly valves, Check valves)	All sizes	CI/CS	CI/CS	EPDM/ Nitrile Rubber
5	Compressed air application	< DN50 > DN65	Gun metal Cast/ Forged		

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SECTION-6

6.0 IMPORTANT POINTS TO BIDDERS

1. If the vendor has suggestions/requirements of any additional instruments/equipment over & above as shown in the P & ID drawing, the same shall be clearly indicated and suitably covered in the commercial bid also separately.
2. The specification for the instruments/equipment available in the main specification shall be taken for such additional requirements (or) Customer should be contacted.



2 X 660 MW, UDANGUDI STPP (STAGE-1)

BAP-RANIPET

TECHNICAL SPECIFICATION FOR
ELECTRO CHLORINATION PLANT (E, C & I)

No: ROS: 4268, REV: 0
Part of ROS6282, REV:0

**BHARAT HEAVY ELECTRICALS LIMITED,
RANIPET- 632 406.**

TECHNICAL SPECIFICATION

FOR

ELECTRO CHLORINATION PLANT (E, C & I)

					
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Rev. No	Date	Prepared	Checked	Approved	Remarks



2 X 660 MW, UDANGUDI STPP (STAGE-1)

BAP-RANIPET

**TECHNICAL SPECIFICATION FOR
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SECTION: A

INTRODUCTION

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1. INTRODUCTION

This section sets out the scope of supply, services and design/technical requirements of Electrical, instrumentation and control equipment. Electrical, Instrumentation and control systems specified here are only basic and minimum, detailed design shall be carried out by the bidder for safe, reliable, efficient, automatic operation of the Electro chlorination plant of Udangudi Supercritical Thermal Power Project. Any items not included hereunder but specified elsewhere in this specification shall also be included. The type and make of E, C & I equipment shall be proven in similar power projects and shall be approved by the Owner. Measurement and control equipment offered shall be complete in all respects and any equipment / accessories not explicitly indicated in this specification, but considered essential for proper functioning of equipment and process shall be included in the Bidder's scope of supply and work. If the Bidder proposes or supplies any additional plant/equipment, all corresponding instrumentation and control equipment shall be included in his scope, along with all necessary special tools and product specific configuring and diagnostic devices.

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)

Meteorological conditions

Ambient Air Temperature

Maximum dry bulb temperature : 41°C

Minimum dry bulb temperature : 17°C

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

The Meteorological details given are arbitrary and may vary.



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SECTION: B

ELECTRICAL

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SECTION: B

B.1 GENERAL TECHNICAL REQUIRMENTS (ELECTRICAL):

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

1. Services and Equipment as per "Scope Division between BHEL and Vendor".
2. 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.
3. Supply of mandatory spares as specified in mechanical equipment.
4. Electrical load requirement for Electro Chlorination Plant shall be furnished.
5. All equipment shall be suitable for the power supply fault levels and other climatic conditions mentioned in the enclosed project information.
6. Rectifier transformer shall be Dry type (air cooled) and meet the requisite standards. It shall have local indications and shall be interfaced with PLC for viewing status and faults.
7. 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.
8. 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.
9. Motors shall meet minimum requirement of Electric motor specification. (SECTION: B.2.1)
10. Vendor shall clearly indicate equipment locations and local routing lengths in their cable listing furnished to BHEL.

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SECTION: B

B.2 DETAILED TECHNICAL REQUIREMENTS (ELECTRICAL):

B.2.1 LT MOTOR SPECIFICATION

1. INTENT OF SPECIFICATION

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. All motors shall be chosen for non-hazardous SAFE area application.

2. SUPPLY OF LT MOTORS

All equipments, system and service covered under this specification shall comply with the requirements of the latest statutes regulations and safety codes as applicable in the locality where the equipments/systems will be installed. The Bidder shall fully acquaint himself with these requirements and shall ensure compliance with them. The equipments, systems and services furnished as per this specification shall conform to the codes and standards elsewhere in the specification. However, in the event of any conflict between the requirements of two standards or between the requirements of any standard and this specification, the more stringent requirements shall apply unless confirmed otherwise by the Owner in writing. The decision of the Owner shall be final and binding in all such cases.

2.1. CODES AND STANDARDS

All motors shall confirm to the latest editions including all applicable amendment of relevant IS, IEC standards/Publications and all other applicable ANSI, ASME, IEEE, NEC, NEMA, ISA, DIN, VDE, NFPA, IEC, EIA, TIA standards. In case any other standard is followed that ensures equal or better quality, may be accepted. However, the English version of the Standard adopted shall be submitted. Bidder to note that in no case, OEM/manufacturers own standards shall be accepted.

Motors shall fully comply with latest edition, including all amendments and revision, of following codes and standards. Any other applicable Indian standards for any component part even if not covered in the list shall also be followed.

- | | |
|---------------|--|
| 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 |



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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

2.2. SYSTEM PARAMETERS

Motors having a voltage rating of below 1000V are referred to as low voltage (LV) motors. Maximum rating of the LV motor shall be 160 KW. Motors rated 0.20 KW and below shall be 240v, 1Ph, 50Hz motors and all other motors will be 415V, 3 Ph, 50 Hz motors unless otherwise specified. Space heater supply 230V+/-10%, 1Ph, 50Hz+/-5%, 10% (Absolute sum)

S. No.	Description	LT System
1	Voltage level	240 V: up to 0.2 kW 415 V: >0.2 kW and up to 200 kW.
2	System earthing	415 V system solidly grounded.
3	Fault withstand rating of motor terminal box (Breaker operated)	415 V system : 50/65 kA for 0.2 second

2.3. DESIGN REQUIREMENTS

2.3.1 Duty

- For the purpose of design of equipments /systems, an ambient temperature of 50 °C and relative humidity of 95% shall be considered. The equipment shall operate in hot, humid and a highly polluted (coal and fly ash) environment.
- All AC motors shall be squirrel cage three phase/single phase induction motors. All the motor shall be designed for bi-directional rotation.
- All motors shall be continuously rated (S1 duty). However, crane and hoist motors shall be intermittent (S4 duty), 40% cyclic duration factor.
- All the motors shall be suitable for direct on-line starting with any type of breaker on full load. Where variable voltage and variable frequency (VVFD) operation is envisaged through VVFD drives, motors shall be specially designed for such application.
- All LV motors with S1 duty shall be compulsorily of Energy efficient level IE 3 as per IS 12615. For VFD controlled motors it shall be level IE 2 as per IS 12615

2.3.2 Design Margin

- The motor rating shall be arrived at considering 15% margin over the duty point input or 10% over the maximum demand of the driven equipment, whichever is higher, considering highest system frequency.
- Whenever the basis for motor ratings are not specified in the corresponding mechanical specification sub-sections, maximum continuous motor ratings shall be at least 10%

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above the maximum load demand of the driven equipment under entire operating range including voltage and frequency variations. 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.

3. Service shall be considered as 1.0 only.
4. Motors that are operated through VFD as per process requirement shall meet IEC 60034-17 and the motor insulation shall withstand the peak voltage, dV/dt and rise time as specified in IEC 60034-17 (for standard motors when controlled by VFD drives). In addition, these motors shall be provided with insulated bearings from motor frame size 160 and onwards on the non-driving end side of the motor. Vacuum Pressure Impregnation (VPI) shall be provided to windings for motors identified with VFD operation. This shall have no additional cost implication to BHEL.

2.4. STARTING REQUIREMENTS

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.
2. Starting Voltage requirement motors :80 % of rated voltage for all motors. Motors shall be capable of starting and accelerating the load with direct on line starting without exceeding acceptable winding temperature.
3. Motors shall be capable of restarting under full load after a momentary loss of voltage with the possibility of 150 % nominal voltage during fast bus transfer.
4. The motor shall be designed for direct on line starting at full voltage. Starting current shall not exceed 6 times full load current for all auxiliaries, subject to IS tolerance.
5. The motor shall be capable of withstanding the stresses imposed if started at 110% rated voltage.
6. Transient voltage dip on starting of the largest motor with DOL shall be limited to 20% of the nominal system voltage at the voltage terminals.

2.5. TORQUE REQUIREMENTS

1. Accelerating torque at any speed with the lowest permissible starting voltage shall be at least 10% motor full load torque.
2. Pull out torque at rated voltage shall not be less than 205% of full load torque. It shall be 275% for crane duty motors.
3. 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.

2.6. The following frequency of starts shall apply

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

1. No. of consecutive hot starts shall be 2 (with initial temperature of the motor at full load operating level).
2. No. of consecutive cold starts shall be 3 (with initial temperature of the motor at ambient temperature).

2.7. RUNNING REQUIREMENTS

1. Minimum voltage required for starting the motors shall be 85% of rated voltage



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

2.8. STRESS DURING BUS TRANSFER

1. All motors shall be so designed that maximum inrush currents and locked rotor and pullout torque developed by them at extreme voltage and frequency variations do not endanger the motor and driven equipment.
2. The motors shall be suitable for bus transfer schemes provided on the 11 kV, 3.3 kV/415V systems without any injurious effect on its life.
3. 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.
4. Motor and driven equipment shafts shall be adequately sized to satisfactorily withstand transient torque under above condition.
5. The max. vibration velocity or double amplitude of motors vibration as measured at motor bearings shall be within the limits specified in IS: 12075.

2.9. LOCKED ROTOR WITHSTAND TIME

1. Locked rotor current of the LV motor shall not exceed 600% of full load current inclusive of IS tolerance.
2. The locked rotor withstand time under hot condition at 110% rated voltage shall be more than motor starting time at minimum permissible voltage of 80% rated voltage by at least 3 seconds or 15% of the accelerating time whichever is greater. Provision of speed switch shall be avoided to the extent possible.
3. 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.
4. 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.
5. 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.
6. Speed switches mounted on the motor shaft shall be provided in cases where above requirements are not met.
7. 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.
8. Hot thermal withstand curve shall have a margin of at least 10% over the full load current of the motor to permit relay setting utilising motor rated capacity.

2.10. CONSTRUCTIONAL FEATURES

1. Canopy shall be provided for outdoor motors.
2. Bidder shall provide fully compatible electrical system, equipments, accessories and services.
3. All the equipment, material and systems shall, in general, conform to the latest edition of relevant National and international Codes & Standards, especially the Indian Statutory Regulations.
4. **Bearings**

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- a. 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.
- b. 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.
- c. 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.
- d. All motors below 15 kW shall be provided with sealed ZZ bearings.
- e. For motors rated above 1000 KW having shaft length more than 1.5 M shall have insulated bearings to prevent flow of shaft currents.
- f. For all VFD operated motors shall have insulated bearings to prevent flow of shaft currents.
5. Motors shall be designed to easy access for drilling holes through motor feed of mounting flange for installation of dowel pins after assembly of the motor and driven equipment.
6. For bearing temperature measurement, duplex RTDs shall be provided for each bearing and shall be wired up to the terminal box.
7. Degree of Protection: Motors and Cable Box: IP 55
8. Non-hygroscopic, oil resistant, flame resistant
9. Suitable single phase space heaters shall be provided on motors rated 30 kW and above to maintain windings in dry condition when motor is standstill. Separate terminal box for space heaters & RTDs shall be provided.
10. 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
11. Motors shall be designed with cooling fans suitable for both directions of rotation.
12. Motors shall not be provided with any electric or pneumatic operated external fan for cooling the motors.
13. Frames shall be designed to avoid collection of moisture and all enclosures shall be provided with facility for drainage at the lowest point.
14. 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 deg C.
15. Winding and insulation
 - a. 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.
 - b. 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.
 - c. All insulated winding shall be of copper.
 - d. Two hot starts in succession, with motor initially at normal running temperature
16. Noise and vibration
 - a. The peak amplitude of the vibration shall be within IS specified limits.



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- b. Noise level and vibration shall be limited within the limits prescribed in IS: 12065 & IS: 12075 respectively. Motors shall withstand vibrations produced by driven equipment.

17. Grounding

Motor body shall be grounded at two earthing points on opposite sides with two separate and distinct grounding pads complete with tapped holes, GI bolts and washers.

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

LT Motors	
a. Fractional HP	8 SWG GI wire
b. Up to 25 KW	25 x 3 mm flat
c. 25 to 125 KW	25 x 6 mm flat
d. above 125 KW	50 x 6 mm flat
Control Desks, Control/relay panels, LDBs, PDBs, Lighting Panels, Power receptacles, Lighting Masts, Lighting Poles	25 x 3 mm flat
LPB stations, Limit/Pressure switches, Starters, CT/PT terminal Boxes	8 SWG GI wires
Columns, Fence, Gates, Cable trays etc	50 x 6mm flat

18. The cable terminal box shall have a separate grounding pad, Terminals and Terminal Boxes.

- The motor terminal box shall be suitable for withstanding the maximum system fault current for a duration of at least 0.25 seconds.
- 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 below.
- Unless otherwise stated, 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 Short time rating for terminal boxes below 110 kW (Contactor controlled) shall be 50 KA protected by fuse for 0.25 sec
- Unless otherwise specified or approved, phase terminal boxes of horizontal motors shall be positioned on top or left hand side of the motor when viewed from the non-driving end.
- 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 V, W & V respectively.
- 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.
- 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.



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- h. Degree of protection for terminal boxes shall be IP 55 as per IS 4691.
 - i. 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.
 - j. Phase terminal boxes shall be suitable for 360 degree of rotation in steps of 90 degrees for LV motors.
 - k. Suitable Double Compression type Cable glands and cable lugs shall be provided. Cable lugs and lugs shall be as specified elsewhere in the specification. The cable sizes will be informed during detail engineering.
 - l. Two separate earthing terminals suitable for connecting G.I. or MS strip grounding conductor of size suitable for solidly grounded system shall be provided on opposite sides of motor frame. Each terminal box shall have a grounding terminal.
19. Painting: Motor including fan 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).
- 20 Lifting Provisions: Motor weighing 25 kg or more shall be provided with eye bolt or other adequate provision for shifting.

2.11. GENERAL

- 1. Motors provided for similar drives shall be interchangeable.
- 2. Suitable foundation bolts are to be supplied along with the motors.
- 3. Necessary fitments and accessories shall be provided on motors in accordance with the latest Indian Electricity rules 1956
- 4. 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.
- 5. Name plate with all particulars as per IS: 325 shall be provided
- 6. Necessary cable glands & cable lugs for the motors shall be supplied by the bidder
- 7. Motors with heat exchangers shall have dial type thermometer with adjustable alarm contacts to indicate inlet and outlet primary air temperature.
- 8. Name Plate: 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.

2.12. INSPECTION AND TESTING

- 1. All materials, components and equipment covered under this specification shall be procured, manufactured, as per the Approved quality plan.
- 2. LV motors of type-tested design shall be provided. Valid type test reports not more than 5 year (from Enquiry date) shall be furnished. In the absence of these, type tests shall have to be conducted by manufacturer without any commercial implication to purchaser.
- 3. All motors shall be subjected to routine tests as per IS: 325. Noise level measurement and vibration test as per standards shall be conducted on all motors.
- 4. Inspection: for Motors Upto 55KW –Inspection by BHEL, for motors with a rating more than 55KW inspection is by BHEL, Customer and Consultant.

2.12.1. LIST OF TESTS TO BE CONDUCTED FOR HV, MV and LV MOTORS

1. TYPE TESTS

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.



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The following type tests shall be conducted on LT motors.

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

2. ROUTINE TESTS

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

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

3. INSPECTION AND TESTING AT SITE

Insulation resistance of 415V motors shall be measured between the winding of the machine and its frame by means of a 500/1000V megger. A minimum value of 1 mega ohm for 415V motors shall be considered a safe value. In case of lower I.R. Value, the insulation value shall be brought up by any of the following methods as desired by the Site Engineer:

- a. Blowing hot air in case of big motors.
- b. Putting the motor in electric oven in case of smaller motors.
- c. Placing heaters or lamps around and inside in case of small motors after making suitable guarding and covering arrangements so as to conserve the heat.

4. Site Test

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

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

2.13. DATA SHEET

LT MOTORS (A.C.)

1. Application :
2. Type : Energy Efficient (IE3)
3. Frame size :
4. Manufacturer :
5. Rated output in KW :
6. Duty cycle : Continuous, S1



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7. Rated voltage, no. of phases and frequency : 415 V, 3 Ph, 50 Hz
8. Allowed voltage variation : $\pm 10\%$.
9. Allowed frequency variation : (+) 3% and (-) 5%
10. Combined voltage and Frequency Variation : 10 % (Absolute sum)
11. At rated Voltage and frequency
 - a. Full load current (Amps) :
 - b. Rated speed :
 - c. Full load efficiency :
 - d. Full load power factor :
- e. Starting torque in % of FLT :
12. Method of starting :
13. Degree of protection :
14. Method of ventilation :
15. Class of insulation : "F" (temp. rise limited to class B)
16. Stator winding connection :
(For continuous run) (Delta / Star)
17. Full load torque :
18. Breakdown torque in % of FLT :
19. Pull up torque in % of FLT :
20. Locked rotor current in Amps :
(600% with tolerance of 20%)
21. Motor efficiency and P.F.AT :
 - a. 100 % load
 - b. 75% load
 - c. 50% load
 - d. 25% load
22. Locked rotor withstand time under hot/cold condition at 110 % Voltage :
23. Maximum permissible starting time :
24. No load current in Amps. :
25. Starting time in seconds with driven equipment coupled at
 - a. rated voltage :
 - b. Min. Voltage :
 - c. Max. Voltage :
26. Actual temperature rise over an ambient of 50°C when motor is delivering rated output
 - a. By thermometer method :
 - b. By resistance method : (70°C for air cooled motors)
27. Number of successive starts with driven equipment coupled and motor initially at rated load temperature :
28. Minimum voltage required by the motor to bring the driven equipment to rated speed: To be 80% of RV.
29. Resistance per phase in ohms at 20 degrees :
30. Direction of rotation from driving end :
31. Make, type and size of bearing
 - a. At drive end :
 - b. At Non drive end :
32. Type of mounting and shaft Orientation :
33. Location of terminal box viewed from driving end :



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34. Type and number of terminals brought out :
35. Type and size of cable gland & lugs for power cables & (if applicable) space heater cable : (size will be given during Detail engg)
36. Cable gland entry side :
37. Tropical & fungicidal treatment :
38. GD² of the motor :
39. Weight of the motor :
40. Space heater Rating & other details (for 30KW and above motors) :

3. SPECIFICATION FOR CABLE GLANDS & LUGS

3.1. Specification for Cable Glands

- a. Bidder shall provide all cable glands required for glanding the above mentioned cables both at field instrument and local control panel side, junction boxes side and at control room side.
- b. Cable glands
 - i. Cable glands shall conform to BS: 6121 and be of robust construction capable of clamping cable and cable armour (for armoured cables) firmly without injury to insulation.
 - ii. Cable glands shall be made of heavy duty. Brass machine finished and nickel chrome plated. Thickness of plating shall not be less than 10 micron. All washers and hardware shall also be made of brass with nickel chrome plating. Rubber components shall be of neoprene and of tested quality. Necessary cable dimensions shall be furnished to the successful contractor.
 - iii. Cable glands shall be double compression type for indoor and outdoor use. Glands for classified hazardous areas shall be double compression type flameproof and weather proof duly certified by CMRS and approved by CCE.

3.2. Cable lugs/ferrules

The cables lugs shall be conforming to IS: 8309. Machine ferruling shall be adopted.

Cable lugs for power cables shall be Aluminium solder less crimping type suitable for aluminium compacted conductor cables.

- i) Copper tubular terminal end for solder less crimping to copper conductors.
- ii) Cable lugs for control cable termination shall be insulated type. These lugs shall be flat type/ring type/U type to suit the terminals provided in the panel.
- iii) Pin type lugs shall not be used.
- iv) Aluminium tubular terminal ends for solder less crimping of to Aluminium conductor.

Solder less crimping of terminals shall be done by using corrosion inhibiting compound. The cable lugs shall suit the type of terminals provided on the equipment. Lugs for control/instrumentation cables shall be PVC insulated/sleeved type.

4. LIST OF MANDATORY SPARES

As mentioned in mechanical section (ROS: 6282, Rev-0).

NOTE: Commissioning spares are part of Bidder scope of supply. Mandatory spares as indicated above do not cover commissioning spares.

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4.1. INTERCHANGEABILITY & PACKING

All spares supplied under this contract shall be strictly interchangeable with the parts for which they are intended for replacements. The spares shall be treated and packed for long storage under the climatic conditions prevailing at the site. e.g. small items shall be packed in sealed transparent plastic bags with desiccators packs as necessary.

4.2. IDENTIFICATION

Each spare shall be clearly marked and labeled on the outside of the packing with its description. When more than one spare part is packed in a single case, a general description of the contents shall be shown on the outside of such case and a detailed list enclosed. All cases, containers, and other packages must be suitably marked and numbered for the purpose of identification.

4.3. CONTRACT-QUANTITIES

The quantities & mandatory spares shall be as specified herein. Any other mandatory spares not listed above however required for any instrumentation item shall also be supplied by bidder. The final quantities may require addition/deletion during the contract stage. The Bidder shall furnish unit price for each mandatory spare under appropriate schedules which shall be used for adjusting the contract price in the event of addition/deletion from contract quantities specified herein.

5. PACKING AND DISPATCH

Equipment shall be packed with suitable desiccants sealed in water-proof, vapour-proof wrapping, and packed in lumber or plywood enclosures, suitably braced tied and skidded. Lumber enclosures shall be solid, not slatted.

Review by the Owner of the Bidder's proposed packaging methods shall not relieve the Bidder of responsibility for damage or deterioration to the equipment and materials specified.

All equipment and materials shall be suitably coated, wrapped or covered end boxed or crated for moist humid tropical shipment and to prevent damage or deterioration during handling and storage at the site.

All itemized list of contents shall be enclosed inside each case, and one other copy securely fastened to the outside of the case in a tin or light weight sheet metal envelope or pocket. The lists shall be plainly marked and placed in accessible locations to facilitate receipt and inspection. The packing list shall indicate whether shipment is partial or complete and shall incorporate the following information on each container, etc. according to its individual shipping number:

- a) Export case markings.
- b) Case number.
- c) Gross weight and net weight in Kilograms
- d) Dimensions in centimeters.
- e) Complete description of material including order number.

Electrical equipment controls and instrumentation shall be protected against moisture and water damage. All external gasket surfaces and flange faces, couplings, motor pump shafts, bearings and like items shall be thoroughly cleaned and coated with rust preventive compound as specified above and protected with suitable wood, metal or other substantial type covering to ensure their full protection.

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1	KIRLOSKAR ELECTRIC CO LTD	BENGALURU/CHENNAI
2	NGEF (HUBLI) LTD	BENGALURU
3	SIEMENS INDIA LTD	JOKA
4	BHARAT BIJILEE LTD	MUMBAI
5	CROMPTON GREAVES LIMITED	CHENNAI
6	LAXMI HYDRAULICS PVT LTD	SOLAPUR
7	JYOTI LIMITED	VADODARA
8	BHEL ELECTRICAL MACHINES LTD	KASARAGOD
9	BHARAT BIJLEE LIMITED	CHENNAI
10	ABB LIMITED	CHENNAI
11	MARATHON ELECTRICAL MOTORS INDIA LIMITED	CHENNAI

Note: This Bidder list is subject to customer approval

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SECTION: B

B.2.2 ELECTRICAL ACTUATOR (INCHING DUTY)

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. **For inching service, the actuator shall be suitably time-rated for the duty cycle involved with necessary number of starts per hour, but in no case less than 150 starts per hour.**
- 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. Canopy shall be provided for outdoor service.
- 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, with starting current limited to 6 times full-load current.
- 3.4.0 The actuator is placed in non-hazardous area.
- 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 at least 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.



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- 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. The maximum hand wheel force of 500N must not be exceeded. For limiting hand wheel forces, for control and operation purposes it may be necessary to install appropriate gears.
- 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. Earthing terminals shall be provided on either side of the motor. All terminals must be suitable for 2.5 sq.mm wires.
- 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. The actuator shall be designed for mounting in any position without any lubricant leakage or operating difficulty.

The actuator shall have:

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- One (1) built-in local position indicator for 0-100% travel.
 - One (1) position transmitter, 4-20 mA current signals as position feedback to DCS.
- In addition, all actuators for valves are to be fitted with socket and plug of well-established make to IEC 60309 or equivalent for the power cable connection. For the control cable connection separate socket and plug shall be provided.
- 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.
- The following controls to be provided as a part of the Electric actuated valves- Inching duty.
1. Commands for Open, Close, Stop
 2. Limit switch Feedbacks for Open, Close at any position within 0-100%, OTS, CTS
 3. 4-20 mA current signals as position feedback
- 3.20.0 The following individual Status 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.

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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 MANDATORY SPARES

As mentioned in mechanical section

5.0.0 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.



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SECTION: C

CONTROL & INSTRUMENTATION (C&I)

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SECTION: C

C.1 GENERAL TECHNICAL REQUIREMENT (C&I)

- 1.0 Bidder shall provide complete and independent control & instrumentation system with all accessories, auxiliaries and associated equipments for the safe, efficient and reliable operation of auxiliary systems.
- 2.0 The quantity of instruments for auxiliary 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.
- 3.0 Measuring instruments/equipment and subsystems offered by the bidder shall be from reputed experienced manufacturers of specified type and range of equipment, whose guaranteed and trouble free operation has been proven. Further all the instruments shall be of proven reliability, accuracy, and acceptable international standards and shall be subject to employer's approval. All instrumentation equipment and accessories under this specification shall be furnished as per technical specification, ranges, makes/ numbers as approved by the employer' during detail engineering.
- 4.0 The necessary root valves, impulse piping, drain cocks, gauge-zeroing cocks, valve manifold and all the other accessories required for mounting/ erection of these local instruments shall be furnished, even if not specifically asked for, on as required basis. The contacts of equipment mounted instruments; sensors, switches etc for external connection including spare contacts shall be wired out to suitably located junction boxes.
- 5.0 When there is mismatch in specification and Customer Specific Technical Requirement, the stringent clause shall prevail.
- 6.0 Supply of mandatory spares as specified in the specifications of mechanical equipment.

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C.2 DETAILED TECHNICAL REQUIREMENTS (C&I):

The control of Electro chlorination Plant shall be through PLC based control system having hot redundant Central Processing Unit, PLC remote I/Os, power supply, communication module, redundant communication link all hardware, software, other interfaces, cables and field sensors / instruments / erection hardware envisaged to control and monitor it.

The operation and control philosophy of Electro chlorination Plant has been elaborated in separate section in the specification. The package shall be controlled from Electro chlorination Plant Control Room. One no. OWS with 24" LED monitor with anti-glare coating, one no. Operating cum engineering station (OWES) with redundant hot standby processor with one no. A4 size B/W Laser jet printer and Control panel cum desk with HW annunciation windows, ILPBs, Ammeters, Annunciation & desk PBs, mimic, lamps, Indicators, recorders, etc. The Complete PLC based control system with OWS, Laptop, Remote I/Os, Printer, UPS (for PLC, OWS, Remote I/Os, Printer etc.), desk along with furniture for Electro chlorination Plant shall be in Bidder's scope. PC for OWS shall be of workstation grade. Additional laptop shall be provided with the Electro chlorination Plant. Operator station in the Electro chlorination system local control room shall be provided with the access to monitor the main plant operations

1. The communication between PLC and Main plant DCS shall be OPC compliant (Data Access 2.0) TCP/IP on Fibre Optic link. The communication link between PLC and Main plant DCS shall be redundant. The necessary hardware/software including LIU (Light Interface unit), HDPE Pipe (25 NB), Patch cables, Optic termination kits/junction boxes etc., at PLC end shall be in Bidder's scope. Repeaters if required for interfacing shall also be provided by the bidder. For communication between main plant DCS and PLC, the PLC end shall be considered as server and DCS shall be considered as client. For details, please refer Detailed specification of PLC (**Section: F.2.2**)
2. PLC control system shall be time synchronized with the Master clock system of the main plant to ensure uniform time indication throughout the Plant. The required provision (IRIG-B) shall be made by the bidder at the PLC end to achieve the same.
3. Bidder to note that all type of hardwares & electronic modules like controllers, I/O cards, communication modules and interface modules etc. used in PLC shall be of same family and sourced/supplied from their Principal's works.
4. The software and hardware for offered PLC system shall be of latest version and shall be upgradable. Bidder to ensure the availability of spares and service support for the offered PLC system for minimum 15 years after guarantee period.
5. Bidder shall provide Customer training on the proper application and maintenance of ECP package equipment, instruments and PLC Hardware & Software at Vendor's work

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and at UDANGUDI site. Duration of the training, number of persons & the topics to be covered shall be discussed & mutually agreed during contract finalization stage.

6. Interface of MCC, HT SWGR, Actuators etc. with PLC based control system shall be as per Drive Control Philosophy attached in the specification. The attached philosophy is for DCS based control system. However, the same is applicable for PLC as well.
7. PLC network shall have Intrusion Detection System (IDS) and Intrusion Prevention System (IPS) activity and identify suspicious patterns that may indicate a network or system attack from someone attempting to break into or compromise a system on the Station LAN Network.
8. Complete Industrial grade furniture required for placing OWS, swivel chairs, printers, keyboards, computers etc. shall also be furnished by bidder. The exact details shall be finalized & approved by owner/purchaser during detailed engineering.
9. Backup mimic control panel will act as interface between the PLC and the operator for commands & feedbacks for all pumps, respective valves and alarm/indication from field instruments. Detailed specification of Control Panel is also part of the specification and bidder shall consider the same
10. Bidder must offer general tools and tackles and special calibration instruments required during start-up, trial run, operation and maintenance of the system.
11. Uninterrupted power supply (UPS in bidder scope) shall be considered for PLC & instrumentation loads. Detailed specification of UPS (**SECTION: F.1.2**) and with respective single line diagram (**PE-DG-435-145-I004 Rev:08 UPS SLD**) is also part of the specification and bidder shall consider the same. BHEL shall provide 3phase 415 VAC power supply feeder from BHEL MCC.
12. The motor operated valves shall have limit switches for open/ close feedback. Motor operated valves for valve sizes less than 50 NB shall be rated for 240 V single phase AC only. For other higher sizes, the motor operated valves shall be rated for 415 V three phase only. Refer Drive Control Philosophy (PE-DM-435-145-I002 Rev 07). Detailed specification of electric actuators (**SECTION: B.2.2**) is also part of the specification and bidder shall consider the same.
13. The junction boxes/LIE/LIR for termination of instruments /motorised valve limit switches etc are in bidder's scope. The JB sizes and dimensions are to be chosen as per the detailed specification of junction boxes/LIE/LIR.
14. Panel dimensions shall be chosen with double door opening at front /rear or both to accommodate the panels within ECP control room layout. Maximum single (half door)

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width acceptable is 600mm. The panel sizes will be finalized during detailed engineering by BHEL

15. Bidder to include all the instruments (LI, PI, PIT, LIT, TIT, FIT, FCV, Chlorine Analyser, H2 Detector etc.) required for the package along with necessary fittings, remote chemical seal diaphragm accessories and valve manifolds etc.
 - a. Instrument installation drawings are to be provided by bidder. All instrument fitting and erection hardware as per instrument installation diagram shall be in bidder's scope.
 - b. Every panel- mounted instrument, requiring power supply, shall be provided with a pair of easily replaceable glass cartridge fuses of suitable rating. Every instrument shall be provided with a grounding terminal and shall be suitably connected to the panel grounding bus.
 - c. Site calibration of instruments until handover to the owner in bidders scope.
16. Provision for separate Terminal block/wiring diagram for power and control blocks of control panel to be ensured. These requirements shall be considered in addition to that specified in LCP & JUNCTION BOXES SPECIFICATION.
17. The make/model of various instruments/items/systems shall be subject to approval of owner/purchaser during detailed engineering stage. No commercial implication in this regard shall be acceptable. In case of any conflict or repetition of clauses in the specification, the stringent requirements among them are to be complied with.
18. The design, manufacture, inspection, testing, site calibration and installation of all C&I equipment and systems covered under this specification shall conform to the latest editions of applicable codes and standards eg. ANSI, ASME, IEEE, ISO, IEC, IGCI, AWS, NFPA, AISC, IGS, SAMA, UBC, UL, NESC, NEMA, ISA, DIN, VDE, IS etc.
19. The make of all the items shall be from approved sub-vendor list.
20. Mandatory spares shall be supplied by bidder.
21. For instrument & control cable scope of supply refer 'Scope Division sheet between BHEL & vendor'.
22. Each communication Network shall be industrial grade and shall be provided with industrial grade managed type Ethernet switches, external surge protection system/devices and industrial firewall. Industrial grade managed type Ethernet switches shall be provided with in built diagnostic features, 20% spare parts & in built redundant power supply.

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23. Interface of MCC, HT SWGR, Actuators etc. with PLC based control system shall be as per Drive Control Philosophy attached in the specification. The attached philosophy is for DCS based control system. However, the same is applicable for PLC as well.
24. All approval/Inspection are to be carried out by Owner or owner appointed agency only.
25. Bidder shall provide the necessary hardware & software required for connecting the PLC system to Bidder's remote service centre, through which the diagnostics & fault analysis of the PLC system can be carried out. The method of connection shall be as per Bidder's standard practice. However, it is preferred to have the connection through a single point in the PLC system.
26. Bidder shall offer latest system available at the time of supply / dispatch & shall also confirm that DDCMIS/PLC system/microprocessor based control system, MIS, ERP system etc. hardware / software shall be upgraded free of cost (for hardware up to commissioning of the project and software up to handing over of the project), whenever at later stage such up gradation takes place for his system offered by him or by his collaborator.
27. Vendor representative shall be available at site at the time of commissioning, PG test and handover of the system and Vendor to delegate/depute their person/experts as per owner/consultant requirements.

NOTES:

- 1 All equipment items shall be of latest design with proven on track record from reputed experienced manufacturers of specified type and range of equipment. The make/model of various instruments/items/systems and instrument sub-vendor shall be subject to approval of BHEL/Customer during detailed engineering stage.
- 2 The above given scope is indicative & minimum. Any item/ equipment not indicated above however required for the completeness of the system is to be supplied by bidder without any technical, commercial and delivery implication to BHEL.
- 3 Uniformity of make and type of instruments and control components shall be followed throughout for rationalization of spares' inventory, except for certain proprietary items where this requirement cannot be met.

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ELECTRO CHLORINATION PLANT (E, C & I)****No: ROS: 4268, REV: 0****Part of ROS6282, REV:0****SECTION: C****C.2.1 FRP JUNCTION BOX****1. SCOPE OF SUPPLY:**

The scope of supply of Junction box includes design, manufacturing, inspection, testing, packing and delivery of junction Boxes (FRP) as per this specification and attached drawings.

2. APPLICATION:

The junction boxes are used in power station to interconnect various field-mounted electrical equipment's and instruments pertaining to water treatment plant.

3. SITE CONDITIONS:

3.1.	Ambient temperature:	50 Deg. C
3.2.	Relative humidity :	100% RH
3.3.	Atmospheric condition:	Highly dusty, abrasive and polluted, conducive to fungus growth, climate is tropical. Environment is as prevalent in a coal fired thermal power station.
3.4.	Design temperature :	50 Deg. C
3.5.	Location:	Out door

4. GENERAL REQUIREMENTS

4.1.	Enclosure material & gland plate	4 mm FRP sheet (UV stabilised)
4.2.	Enclosure protection:	IP 65 as per IEC 60529
4.3.	Terminal block type & arrangement:	Phoenix/Wago (screwless cage clamp type spring loaded) mounted on DIN rail. Suitable for 2.5 sq. mm cable.
4.4.	Terminal block insulating material:	Melamine, Polyamide
4.5.	Terminal block voltage grade :	650 V (Minimum)
4.6.	Door Gasketing:	Synthetic Neoprene gasket 6 mm thick
4.7.	Door Opening:	SS Hinges, lockable type
4.8.	Number of earthing terminals:	Two as per attached drawing.
4.9.	Location of earthing symbol:	Just above the earthing terminal Symbol to be black lines on yellow background.
4.10.	Rated voltage grade of junction box:	415V
4.11.	All fasteners supplied	SS 316

4.12. In general junction boxes shall be designed in accordance with NEC, Article 370, paragraphs 18, 19 and 20 or equivalent standards. The enclosure shall conform to NEMA-4 with hinged door lockable type

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- 4.13. Suitable DIN rails along with clamps and screws shall be provided for terminal block mounting. All terminals are to be numbered serially by suitable identification label of PVC material in white background with black numbers. Terminal blocks shall be fixed to TB supporting DIN rail by means of suitable end plates with screws.
- 4.14. Non rusting name plate of 2 ply lamicaid in white colour with the inscription (after order) in black letters shall be fixed to the name plate mounting bracket on top of the junction box with SS screws.
- 4.15. Junction boxes shall be provided with lockable door on the front side. The locks of the junction boxes shall be identical and operable by one key. JB's shall be screwed at all four corners for door. Door handle shall be of SS. Suitable SS door hinges shall be provided for all JB's.
- 4.16. Mounting plate of 2 mm thick mild steel to be provided inside JB, mounting clamps suitable for mounting on walls, columns, structures etc.
- 4.17. Mounting fasteners: 4 sets of chromium plated bolts, nuts and spring washers for mounting the JB shall be supplied.
- 4.18. Gland holes shall be provided at the bottom of the JB. Gland holes to be covered with blanking covers that can be easily placed or removed. Glands to be Packed and placed using fasteners in the respective JB.
- 4.19. Terminal blocks shall be arranged with at least 100mm clearance between two sets of terminal blocks, terminal blocks and junction box walls.
- 4.20. Suitable cable channel shall be provided on both sides of TB's for all JB's.
- 4.21. The name plate indicating the name of the supplier shall be provided on the door. Name plate shall contain Tag Name (will be provided after order), vendor details like year of manufacture, weight of the job, BHEL PO number & date.
- 4.22. Suitable cable channel shall be provided on both sides of the TB's of all the JB's
- 4.23. The tolerance dimensions shall be as per IS 2102.
- 4.24. Earthing bolts and nuts with rose Courtney washer shall be provided at opposite points on outside of the junction box body with earth symbol made of aluminium.
- 4.25. Earth terminal bus bar shall be provided for termination of shield wires.

5. APPLICABLE STANDARDS:

The Junction boxes shall be manufactured and tested as per the following standards.
IEC 60947-1&2, 7-1 - Low Voltage Switchgear and Control Gear specification.

6. MAKE OF COMPONENTS

- 6.1 Terminal block: ELMEX/TOSHA/CONNECTWELL/WAGO/PHOENIX
- 6.2 Crimping type lug: DOWELL
- 6.3 Cable glands: COMET / BRACCO / ARUP ENGG. / QPIE/ SUNIL & Co./ ELECTROMAC
- 6.4 PVC wires: IEC STANDARD/CERTIFIED MAKES

7. INSPECTION

By BHEL/BHEL inspection agency at vendor's works.

8. PACKING

Each FRP JB shall be packed in polythene bag with bubble wrap and then packed in a carton box. A group of such boxes (maximum 6 No.) shall be put in a wooden crate. Packing sheets, air, sponge shall be provided in between boxes. Considering the fragile nature of the product, vendor to ensure the JB's are packed against any transit or handling damages. The Glands inside the JB shall be fastened and packing air bags to be provided so that JB internals will not be damaged during transit.

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C.2.2 LOCAL INSTRUMENT RACK (LIR) & LOCAL INSTRUMENT ENCLOSURE (LIE)

1. GENERAL

- Devices (Transmitters/ Switches) located in the field shall be suitably grouped together to the extent possible and installed in the LIE (Closed Rack) and LIR (Open Rack) in Electro chlorination plant.
- Racks and enclosure shall be factory prefabricated & painted and shall complete with internal piping, tubing, manifold, isolation valves, blowdown valves, integral junction box, illumination etc.
- No more than six instruments shall be grouped in a single rack / enclosure.
- Racks shall be installed above the tapping points for air, application whereas for applications such as for water and steam, racks to be installed below the source point.
- Attention shall be paid in the layout to avoid air traps in liquid piping and water accumulation in air /gas piping.
- Welding of impulse lines shall comply with the provisions of the latest applicable ANSI Code for Pressure Piping.
- Earth stud shall be furnished at rack for safety grounding.

2. LOCAL INSTRUMENT ENCLOSURE (LIE)

- Enclosure shall be free standing type. Racks shall be adequately reinforced to ensure true surfaces and to provide support. Major load - bearing posts shall be suitably supported by gusset plates or moment members.
- Enclosure outer shall be constructed from at least 3 mm thick steel plate and epoxy painted to shade gray. Base frame shall be made of ISMC 100 and black colour finish.
- 2" NB galvanized pipes shall be laid horizontally and supported at two end channels to mount transmitters at accessible height. Center posts or any member, which would reduce access, shall be avoided.
- Double leaf interlocking front opening doors with three-point locking shall be provided and shall be arranged for maximum possible access to the interior. Key shall be of identical for all enclosures.
- Doors shall have concealed quick removal type pinned stainless steel hinges and locking handles. Gaskets shall be used between all mating sections to achieve dust and weather proof enclosure rated for IP-65 including the internal junction box. All enclosures shall have access doors on front side.
- Removable type bulkhead plates of thickness not less than 6 mm shall be mounted at the racks with suitable high temperature gasket. Impulse lines within the enclosures shall be properly clamped.



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- g. All internal wirings between the instruments and junction box shall run through flexible conduits. No exposed wirings within transmitter racks both open and closed type, is admissible.
- h. Each rack shall be provided with one receptacle, light fixtures with wire guard and one lighting switch each at instrument & Junction box compartments with wire guard. Lighting switches may be door actuated & mounted inside the panel. Outlet box, switch box and device covers shall be of galvanized stamped steel. Light switches and receptacles shall be installed inside the enclosure on the wall near the latch side of the enclosure door. Light fixtures shall be installed on the ceilings of the enclosures.
- i. Power supplies for miscellaneous devices shall be provided with MCB located within the enclosures. MCB shall be mounted in fuse blocks. Nameplates shall be furnished above the MCB blocks, identifying the devices being served.
- j. Vibration dampeners shall be installed for supporting each enclosure. The loading at each corner of the enclosure shall be determined by actual test weighting when construction is complete to determine the correct length of each dampener for proper loading of the dampener in accordance with manufacturer's recommendations

3. LOCAL INSTRUMENT RACK (LIR)

- a. Rack shall be free standing type constructed from 6 mm thick steel channel frame provided with a canopy to protect the instrument from dripping water or falling objects and shall be epoxy painted. Canopy shall be of CRCA steel sheet of at least 3 mm thickness.
- b. Rack Major load-bearing posts shall be suitably supported by gusset plates or moment members. Suitable fenders grill shall be welded to the end-posts of the rack to outline a boundary beyond which no mounted equipment shall project to protect instrument from accidental contact during personnel movement. Center posts or any member, which would reduce access, shall be avoided.
- c. 2" NB galvanized pipes laid horizontally and supported at two end channels shall be employed at working accessible height for mounting of instruments.
- d. All internal wirings between the instruments and junction box shall run through flexible conduits. No exposed wirings are admissible.
- e. Power supplies for miscellaneous devices shall be provided with MCB located within the enclosures. MCB shall be mounted in fuse blocks. Nameplates shall be furnished above the MCB blocks, identifying the devices being served.

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C.2.3 FURNITURE

All the furniture in the ECP control Room is under Bidder's scope of supply. The furniture shall be modern, aesthetically designed, modular, flexible, space saving, easy operational features and future safe. Bidder shall provide following industrial grade furniture items as a minimum from reputed manufacturers/suppliers meeting International Standards.

1. WORK STATION FURNITURE

Modular work station furniture, suitable for mounting operator and programmer stations, PC based systems, printer (A4/A3 color laserjet) etc. shall be provided.

2. PC RACK

PC Racks shall be provided to mount CPUs of workstations/PCs of OWS in control room. For each PC / workstation / monitor at least one chair shall be included.

3. CHAIRS

Industry standard revolving chairs with wheels and with provision for adjustment of height (hydraulically/gas lift) shall be provided for the operators, unit-in-charge & other personnel in control room area. These shall be designed for sitting for long duration such that these are comfortable for the back.

4. ALMIRAH

Steel Almira shall be provided for keeping documents in the control room. Glass doors for each rack shall be provided such that the documents are visible from outside. Size of the rack shall be sufficient to easily fit technical manuals. The exact details shall be approved by Owner during detailed Engineering.

5. LOCKERS

Suitable lockers shall be provided in the room adjacent to the control room for storing of personal articles of control room personnel. Details shall be finalized and approved by Owner during detailed engineering.



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DOCUMENTATION

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D. DOCUMENTATION

Documents of C&I System shall be submitted to end user/owner for approval during detail engineering. Changes, if any required, shall be accommodated by the bidder without any price/time implication.

Following documents to be furnished by the bidder along with the bid:

- Proposed PLC system configuration drawing with write-up
- Duly stamped and signed copy of Quality Plan.
- Product catalogues and specifications for PLC as well as HMI application.
- Requirement of electronic earthing, if any, for PLC based control system.
- Electrical power requirement in prescribed format duly signed and stamped.
- SDDR of Enquiry documents.
- General arrangement, cross section details of junction boxes

- 1 Editable & PDF copy of Drawings/Documents and data to be furnished within two months after award of the contract:
 - 1.1 C&I System Design Basis Report incorporating Control philosophy / operation philosophy / Design philosophy / Redundancy philosophy.
 - 1.2 GA & wiring diagram of local control panel and its Power Requirement.
 - 1.3 Local control panel and field instruments quality plan. Local control panel & instruments data sheet.
 - 1.4 JB grouping document. LIE/LIR for Transmitter Groupings (P, DP, F, L and transmitters)
 - 1.5 Cable schedule and cable interconnection drawing& Instrument schedule indicating range, operating pressure, flow etc., along with selected make & model.
 - 1.6 Instrument hook-up diagram.
 - 1.7 Electronic Earthing schemes
 - 1.8 Mandatory spare BOQ and recommended spare list.
 - 1.9 Filled up Electrical Load data as per Attached Formats
 - 1.10 Filled up UPS load list.
 - 1.11 Filled up Motor datasheets as per Attached Formats
 - 1.12 Filled up Cable Schedule as per Attached Formats
 - 1.13 Detailed technical catalog about the Analog / Digital input and output modules, drive control modules, main control processor, operator consoles, printers etc, shall be furnished for scrutiny.
 - 1.14 Logic diagrams with system description / functional write-up.
 - 1.15 System Architecture/System Configuration Drawing for PLC including MMI, interface with Third party systems, Master clock and Local Control Desks/ Annunciator panel
 - 1.16 Duly signed schedule of performance guarantees, List of softwares included.
 - 1.17 Detail wiring diagrams of all panel desk, control consoles, system cabinets etc.



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- 1.18 Motors: Detailed catalogue, part number and subassembly/assembly drawings with manufacturer's cross reference for each spare part. The data and information furnished shall be of nature and content as per owner's approval.
- 1) OGA drawing showing the position of terminal boxes, earthing connections etc.
 - 2) Arrangement drawing of terminal boxes.
 - 3) Characteristic curves:
 - i. Current vs. time at rated voltage.
 - ii. Speed vs. time at rated 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.
 - v. Load performance curves.
- 1.19 Junction Box
- a. General arrangement drawing, cross section details of junction boxes and the same shall be subject to BHEL/CUSTOMER's/CONSULTANT approval during detailed engineering stage.
 - b. Manufacturing Quality Plan.
 - c. Valid Type test report, voltage & Insulation Resistance test & IP 65 test of similar product dated within last 10 years from the date of Enquiry.
- 1.20 Electric Actuator documents
- Integral starter details
 - Technical particulars of actuator
 - Wiring diagram
 - General arrangement drawings
 - Test reports
- 1.21 Engineering documents For PLC based control systems:
- 1 Bill of Quantity for PLC based system
 - 2 Instrument Schedule with set points
 - 3 I/O List
 - 4 Drive List/ Solenoid Valve List
 - 5 Annunciation List
 - 6 SOE list.
 - 7 Process mimics/graphics indicating Analog and digital parameters
 - 8 List of logs with point assignment
 - 9 Time Synchronisation System
 - 10 Historical Storage and Retrieval (HSR) system details.
 - 11 Rack schedule
 - 12 Control valve schedule

NOTE:

1. Documents mentioned in other sections of this specification is included.
2. Any other document decided during detailed engineering to be submitted.



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SECTION: E

SCOPE DIVISION BETWEEN BHEL AND VENDOR



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E. SCOPE DIVISION BETWEEN BHEL AND VENDOR

S.NO	DETAILS	SCOPE SUPPLY	SCOPE E&C	REMARKS
1	415V MCC	BHEL	BHEL	1. 415 V AC (3 Phase, 3 Wire) supply to motors, 415 V AC (3 Phase, 4 Wire) supply to other equipment etc. shall be provided by BHEL based on load data provided by vendor at contract stage for the equipment supplied by vendor as part of contract. 2. 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 will be done by BHEL. Vendor shall provide lugs & glands accordingly in his scope. 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 15 mtrs) and trunk cable.
5	Any special type of cable like compensating, co-axial, prefab, MICC, fibre optical etc.	Vendor	Vendor	Refer C&I portion of specification for scope of fibre Optical cables if used between PLC & DCS.
6	a. Cable trays, accessories & cable trays supporting system b. 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, which shall be supplied by vendor.
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 Aluminium lugs for Aluminium power cables and heavy duty tinned copper lugs for copper power cables



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				3. Solder less crimping type heavy duty copper lugs for control and instrumentation cables.
8	Conduit and conduit accessories for cabling between equipments 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 & lightning protection	BHEL	BHEL	
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. All motors shall be 3 Phase only.
13	Mandatory spares	Vendor	-	Vendor to quote as per specification.
14	Recommended O & M spares	Vendor	-	Not applicable for this project.
15	Instruments & Fittings	Vendor	Vendor	Field tray and cabling for instruments in vendors scope.
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 (excluding power cables) 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.
19	Uninterrupted Power supply	Vendor	Vendor	415 V AC (3 Phase, 4 Wire) supply to UPS shall be provided by BHEL based on load data provided by vendor at contract stage for the equipment supplied by vendor as part of contract. Further cabling to battery racks,



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				UPS to ACDB, ACDB to field equipment cabling by vendor.
20	PLC System	Vendor	Vendor	PLC power from ACDB to PLC & signal cabling to field equipment cabling by vendor. OFC cabling (if applicable as per specification) shall be by vendor. Electronic earthing cables upto nearest earth pit shall be by vendor.
21	Electric Operated Hoist with isolating switch	Vendor	Vendor	BHEL will provide one number 415 V (3ph, 4W) supply feeder only up to isolating switches for crane hoist. Any other voltage level (AC/DC) required will be derived by the vendor. Motor starter shall be part of crane control panel. Flexible Power cables (festoon cable)/ shrouded DSL from isolator to hoist & upto motor shall be supplied by vendor. Earthing arrangement shall be part of hoist cable. Input Power Cable from MCC supply feeder to isolating switch shall be in BHEL scope.
22	Transformer Rectifier	Vendor	Vendor	All the necessary equipment, accessories for connecting the Rectifier to Electrolyser is in Vendor scope. BHEL will only give the power supply to the incoming of Transformer.
23	Any other equipment/ material/ service required for completeness of system but not specified above (to ensure trouble free and efficient operation of the system).	Vendor	Vendor	

NOTES:

1. Make of all electrical equipments/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 mismatch 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.



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CUSTOMER SPECIFIC TECHNICAL REQUIREMENT

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F. CUSTOMER SPECIFIC TECHNICAL REQUIREMENT

F.1 ELECTRICAL (VOLUME-II, SECTION: 3)

F.1.1 BATTERY (SUB-SECTION: 3.14)

1.0.0 INTENT OF SPECIFICATION

This section covers the requirements of Battery.

2.0.0 SCOPE OF WORK

The scope of work shall include supply, installation, testing and commissioning of the following:

- a) Lead acid Plante battery for Electro chlorination plant.
- b) Battery impedance tester
- c) Battery earth fault locator
- d) Battery Health monitoring system
- e) Commissioning spares and consumables
- f) Mandatory spares
- g) Tools & tackles
- h) Any other equipment required for the system

3.0.0 CODES AND STANDARDS

The equipment to be furnished under this specification shall be in accordance with the applicable section of the latest version of the relevant Indian Standards, and IEC publications and any other standards, if any, except where modified and /or supplemented by this specification.

- a) IEEE: 485 Recommended practice for sizing for large lead storage batteries for generating stations and substations.
- b) IEEE: 484 IEEE Recommended Practice for Installation Design and Installation of Vented Lead-Acid Batteries for Stationary Applications
- c) IS : 14782 Code of practice for maintenance and testing of large lead- acid batteries for generating systems and substations
- d) IS: 1652 Specification for stationary cells and batteries, lead acid type with Plante positive plates).
- e) IS: 266 Specification for sulphuric acid.
- f) IS: 1146 Specification for rubber & plastic containers for lead acid storage batteries
- g) IS: 3116 Sealing compound for lead acid batteries.
- h) IS: 8320 General requirements and methods of tests for lead acid storage batteries.
- i) IS: 6071 Specification for synthetic separators for lead acid batteries.

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4.0.0 DESIGN REQUIREMENTS

- 4.1.0 Each battery shall be sized to cater to 100% load plus 10% design margin. The ageing factor and electrolyte temperature correction factors shall also be considered for the site ambient temperature.
- 4.2.0 Type of battery shall be Lead acid Plante type
- 4.3.0 DELETED
- 4.4.0 DELETED
- 4.5.0 DELETED
- 4.6.0 DELETED
- 4.7.0 Batteries shall normally be permanently connected to the load in parallel with a charger and shall supply the load during emergency conditions when AC supplies fail. Batteries shall be suitable for a long life under continuous float operations and occasional discharges.
- 4.8.0 The following items shall be provided for the Battery.
- Insulators (if applicable)
 - Long/short connectors with insulated cover
 - Inter row connectors with insulated cover (if applicable)
 - Interbank connectors with insulated cover (if applicable)
 - Vent plug
 - Level indicator and float guide
 - Battery take-off
 - Fasteners
 - Cell number plates
- 4.9.0 End take off connections from positive, negative and tap cell terminals of the battery shall be suitable for single core cables having XLPE insulated stranded aluminium conductors. Necessary supports for termination of these cables on the batteries shall be provided by the Contractor.
- 4.10.0 All the inter cell, inter row and interbank connectors supplied along with the battery shall be capable of continuously carrying the maximum discharge current of the respective batteries and through fault short circuit current which the battery can produce and withstand for the period declared.
- 4.11.0 Insulated mild steel racks suitably treated/coated with alkali /acid resistant compound mounted on the insulators shall be provided for the batteries.
- 4.12.0 Battery racks and other supporting/interconnecting accessories shall be as per layout arrangement to be approved by Owner during contract engineering stage. The cells shall be supported on insulator fixed on to the rack with adequate clearance.
- 4.13.0 Each battery bank shall be supplied with microprocessor base battery health monitoring system (BHMS). It shall be capable of calculating the net charge of Battery bank, deterioration of batteries in battery bank during the charge/discharge cycles and actual

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efficiency of the batteries. It shall continuously monitor each cell in the battery bank to identify deterioration in the cell prior to failure and Identify the net charge in the battery bank by monitoring charging and discharging currents. It shall identify the faulty cell by monitoring cell's parameters and create audio and visual alarms whenever battery fault occurs. Remote monitoring of battery health at DCS/SAS/EMS system through modem communication shall be provided.

4.14.0 Following accessories shall be provided for the Batteries as applicable.

- Electronic Syringe type Hydrometer with temperature measurement and with built in memory.
- Cell testing voltmeter with built in memory.
- Acid resistant funnel
- Acid resistant jug.
- Rubber apron and gloves
- Insulated Spanners
- Wall mounted teak wood rack/ Acid resistance rubber insulated Steel rack for above items
- Lifting device for cell

5.0.0 TECHNICAL REQUIREMENTS

5.1.0 Lead acid Plante Battery

5.1.1 The cell capacity shall be specified at 10 hour discharge rate. The nominal voltage per cell shall be 2.0 V and the end voltage of cell shall be not less than 1.85 V. AH efficiency of battery shall be not less than 90%. Battery sizing shall be carried out as per IEEE: 485.

5.1.2 Batteries shall be Lead-Acid Plante, Type F – HDP as per IS 1652.

5.1.3 Battery Containers shall be made of fire retardant polypropylene / fire retardant transparent styrene acrylo nitrile (SAN) polymer. Containers shall be robust, heat resistance, leak proof, non-absorbent, acid/alkaline resistant, non-bulging type and free from flaws such as wrinkles, cracks, blisters, pin holes etc. The electrolyte shall be prepared from battery grade sulphuric acid and distilled water

5.1.4 Batteries shall have thick plates designed for maximum durability during all service conditions including high rate of discharge and rapid fluctuations of load. Cells shall be fitted with electrolyte level indicator floats enclosed in transparent tub covers. Vent plug shall be provided which shall be anti-splash type.

5.1.5 The cells shall be supported on porcelain insulator fixed on to the rack with adequate clearance between adjacent cells.

6.0.0 TESTS

6.1.0 All type, routine and acceptance tests shall be conducted on the batteries as per applicable standard. Copies of certified reports of all type tests carried out on similar type and rating shall be furnished. The charges for carrying out all other routine/acceptance tests shall be deemed to be included in the Bid price.

6.2.0 Sampling scheme and criteria for acceptance shall be as per IS.

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6.3.0 Acceptance test shall be conducted at Site on completion of installation and commissioning and immediately prior to putting the battery in service.

6.4.0 Type tests shall comprise the following:

- Verification of constructional requirements.
- Dimensional check
- Test for capacity
- Retention of charge test
- Ampere - hour and watt-hour efficiency tests.
- Life & Endurance test.
- Short circuit current and internal resistance measurement test.
- Test for loss of capacity on storage
- Test for resistance to overcharge
- Test for voltages & specific gravity during discharge.
- Test for high rate discharge at normal temperature & at low temperature.
- Internal resistance measurement test.
- Accelerated aging test followed by Seismic test.

6.5.0 Acceptance tests shall comprise the following:

- Visual inspection.
- Dimensional check
- Test for capacity
- Test for voltages & specific gravity during discharge.
- Insulation resistance.
- Internal resistance of cells.

6.6.0 Site tests shall comprise the following:

- Check name plate details according to the specification
- Check for physical damage
- Check tightness of all bolts, clamps, joints and connecting terminals
- Check for electrolyte level
- Check for correct polarity
- Check charging and discharging cycle

9.0.0 DRAWINGS & DOCUMENTS

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

- Battery sizing calculation
- Technical data sheet
- General arrangement, layout drawing and section
- Battery room layout
- Rating factor & Battery selection table
- Erection and commissioning procedures
- Operation and maintenance manual
- Test reports
- Sub-vendor list
- Manufacturing quality plan
- Field quality plan

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SECTION: F

F.1.2 UNINTERRUPTED POWER SUPPLY SYSTEM (UPS) (SUB-SECTION: 3.15)

1.0.0 INTENT OF SPECIFICATION

This section covers the requirements of 230 V UPS system.

2.0.0 SCOPE OF WORK

The scope of work shall include supply, installation, testing and commissioning of the parallel redundant UPS with voltage stabilizer for the Electro chlorination plant.

3.0.0 CODES AND STANDARDS

The equipment to be furnished under this specification shall be in accordance with the applicable section of the latest version of the following Indian Standards, except where modified and /or supplemented by this specification.

- | | |
|----------------|---|
| a) IEC : 62040 | Uninterruptible Power Systems (UPS) |
| b) IS: 3895 | Mono crystalline semiconductor rectifier cells and stacks. |
| c) IS: 4540 | Mono crystalline semiconductor rectifier assemblies and equipment. |
| d) IS: 6619 | Safety code for semiconductor rectifier equipment. |
| e) IS 6297 | Transformer and inductors for electronic equipment |
| f) IS 13947 | LV switchgear and control gear |
| g) IS 6553 | Environmental requirements for semi-conductor devices and integrated circuits |
| h) IS 9000 | Basic Environmental Testing Procedures for Electronic and Electrical Items |

4.0.0 DESIGN REQUIREMENTS

- 4.1.0 UPS system shall be Digital type. It shall provide uninterrupted power supply to critical AC loads such as Control & Instrumentation system, DCS system, Respective control system, etc.
- 4.2.0 UPS shall be designed for design ambient temperature of 30°C. Other equipment shall be designed for design ambient temperature of 50°C.
- 4.3.0 Each UPS shall be parallel redundant UPS system consisting of 2X100% chargers, 2X100% inverters, 2X100% Battery, SMPS based voltage stabiliser, Static bypass and Maintenance bypass, UPS DB, MCCB box for battery, interconnecting cables among UPS & voltage stabiliser etc.
- 4.4.0 Single Line Diagram for UPS Distribution is enclosed in Section-G
- 4.5.0 UPS shall be located in Air conditioned room.

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- 4.6.0 Battery shall conform to the requirements stated in 'Battery section of this specification.
- 4.7.0 UPS battery shall be rated for 60 minutes back up
- 4.8.0 UPS shall have following features:
- Digital Technology
 - True on-line double conversion
 - High frequency PWM design
 - Programmable power walk-in
 - High efficiency
 - High input power factor
 - Constant voltage & frequency
 - Pure sine wave output power with no break output during normal to battery operation
 - Wide frequency synchronizing range
 - Wide input range
 - Soft start capability
 - 100% nonlinear load handling capability
 - LED mimic
 - LCD Display
 - RS 232 /RS 485 Interface complete with Communication software
 - Permissible harmonics at rated continuous load +/- 2% for linear loads & 3% for non-linear loads.
- 4.9.0 UPS shall be suitable for connecting to a 415 V, 3 phase, 4 wire, 50 Hz system with a symmetrical fault level of 50 kA rms. Nominal voltage output shall be 230 V, 50 Hz, Single phase with +/- 1% resolution.
- 4.10.0 Variation in inverter output voltage and frequency shall not exceed specified limits for the load variation between zero and the rated output of the UPS and also for the following input supply variation.
- For the input power supply condition of 415 V +/- 10% and 50 Hz +3%, -5%
 - For the DC input voltage over the range corresponding to battery float / boost charge operation and battery operation and battery discharge operation up to battery end cell voltage.
- 4.11.0 The changeover from inverter to by-pass transformer shall not be more than 5 m.second.
- 4.12.0 The design shall provide for high availability of equipment by ensuring high mean - time - between failures (MTBF) and low mean-time-to-repair (MTTR).
- 4.13.0 The UPS shall have an over load capacity of 125 % rated capacity for 10 minutes and 150 % rated capacity for 10 sec. The inverter shall have sufficient I²t capability to clear fault in the maximum rated branch circuit. The sizing of UPS shall be based on the power factor of the loads being fed subject to a maximum of 0.8.
- 4.14.0 On failure of one UPS, the other UPS shall take over the 100% load automatically without any interruption and on failure of both UPS, voltage stabiliser shall take over the power supply distribution and shall supply the power without any interruption.

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5.0.0 TECHNICAL REQUIREMENTS

- 5.1.0 The UPS system including the stabilized bypass shall be galvanically isolated from input power supply system by providing double wound Isolation transformers. A rectifier shall have a double wound transformer at its input.
- 5.2.0 Transient / surge protection circuit shall be provided in the input circuit to rectifiers to protect the UPS from surge & voltage spikes.
- 5.3.0 The UPS shall be provided with automatic sequence and power walk in circuits with adjustable time delay such that the rectifiers and inverters can start operating automatically when incoming AC power is restored allowing the UPS to be loaded automatically.
- 5.4.0 The inverters shall operate satisfactorily for variation of DC bus voltage from fully discharged condition of the battery to rapid charge voltage of the battery and inverter output load current waveform having a relative harmonic.
- 5.5.0 It shall be possible to vary the inverter output voltage steplessly within $\pm 5\%$ of the specified output voltage. This adjustment shall be possible to be made when the inverter is in operation.
- 5.6.0 UPS shall be provided with current limit circuit to avoid excessive loading beyond its permissible overload withstand capability. The UPS shall be designed to permit ready access to power switching and control modules and PCBs. The locations of components, test points and terminals shall be such that they are accessible for circuit checking adjustment, trouble shooting, and maintenance from the UPS without removal of any adjacent module or assembly.
- 5.7.0 The stabilized bypass supply shall have a continuous current rating equivalent to the rated output of the UPS unit and be capable of conducting a current ten times the rated output for the duration more than the fault clearing time of the type of fuse provided. The load transfer devices shall comprise of continuous rated elements in both inverter and stabilized bypass supply.
- 5.8.0 The inverters shall be phase locked to the stabilized bypass power supply as long as stabilized bypass supply frequency remain within $+ 3\%$ to $- 5\%$ of nominal. When bypass supply frequency variation exceeds the above limits, the inverters shall be delinked from mains. Free running frequency tolerance limit shall not exceed $\pm 1\%$. Facility shall also be provided for adjustment of synchronizing frequency from 1% to 5% in the steps of 0.5% .
- 5.9.0 All electronic power devices including thyristors, transistors, diodes etc., shall be rated under operating conditions for approximately 200% of the maximum current carried by the device. All other electrical components such as transformers, reactors, breakers, contactors, switches, bus bars etc., shall be rated for atleast 125% of the maximum

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required rating. No electronic device shall be subjected to PIV greater than 50% of the rated value.

5.10.0 All the thyristors, diodes and other electronic devices of UPS shall be protected with high speed semiconductor fuses. It co-ordination characteristics between fuse and semi-conducting power devices shall be furnished.

5.11.0 Radio Frequency Filters shall be provided at the input and output of UPS to reduce radio frequency interference.

5.12.0 All PCBs shall be provided with a transparent epoxy coating for environmental protection and tropicalisation. They shall be suitably located away from heat sources.

5.13.0 Maximum noise level from UPS system at 1 metre distance, under rated load with all normal cooling fans shall not exceed 65 dBA.

5.14.0 MCCB shall be TPN type for incoming supply to Rectifier circuit & Standby source, DP type for battery & ACDB incomer/outgoing. It shall be quick make, quick break, and independent manual type with trip free feature. All MCCB shall have the following :

- Short circuit release
- ON/OFF Trip position indicators
- Test trip push button

5.15.0 Copper cable shall be used for interconnection among UPS & voltage stabiliser.

6.0.0 MODE OF OPERATION**6.1.0 Normal Mode**

- a) During the normal operation the UPS shall be used to provide power to the critical loads. Under normal conditions, the loads shall be supplied by the inverters. The Rectifier shall derive power from normal/primary AC source and supply DC Power to the inverters. Two nos. Chargers shall feed regulated DC power to their individual inverter banks and simultaneously float charge the backup batteries.
- b) The individual inverters shall operate in parallel and shall share the load equally. The inverters shall be connected to load side through electronic switches. Outputs of the inverters are paralleled after the electronic switches and connected to load bus.

6.2.0 Emergency Mode

- a) Upon failure of the normal AC source, the loads shall continue to be supplied by inverters which, without any switching shall obtain their power from storage battery. In case of failure of the main supply, battery shall supply back up DC power to UPS system for duration of sixty (60) minutes.
- b) Upon restoration of the normal AC source, the rectifier/battery chargers shall power the inverters and simultaneously recharge the battery. This shall be automatic causing no interruption to critical loads.
- c) On failure of an inverter due to any one of the following faults the entire load shall be automatically transferred to the other inverter.
 - Excess inverter output voltage
 - Very low inverter output voltage

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- Failure of inverter.
- d) On failure of one inverter, the faulty one shall be isolated from load instantaneously and the other inverter shall continue to feed the load. In case, the other inverter also fails, automatic change over to standby transformer shall be effected through electronic switches.
- e) Parallel operation (load sharing) shall start automatically when the fault condition clears. If the transfer was due to the inverter failure the retransfer (parallel operation) shall be manually initiated.
- f) The entire load shall be automatically transferred to the alternate AC source through electronic switch within a maximum of four (5) milliseconds under the following conditions:
 - Battery discharged completely
 - Initiation of manual control switch.
 - Failures of both the inverters
 - Inverter output voltage is more than +/- 5 % of the rated value
 - The load current exceeds specified over load rating and time.
- g) In case of failure of both inverters, electronic transfer switch shall changeover within five (5) milliseconds to connect the alternate AC source to the load. On restoration, the retransfer shall be manually initiated.
- h) Retransfer of load shall be accomplished automatically by synchronizing the inverter to the alternate source and allowing the inverter to ramp into the load and then disconnecting the alternate source.
- i) Manual transfer facility through electronic transfer switches shall be provided in either direction.
- j) In case of maintenance requirement, it shall be possible to isolate inverters and electronic bypass switches from load and connect alternate AC source to the load through manually operated, make before break manual transfer switch.

7.0.0 EQUIPMENT DETAILS

7.1.0 Charger

7.1.1 Charger shall have following features:

- Switch mode rectifier/Phase controlled rectifier
- DC constant voltage, Constant current
- IGBT/SCR power device
- Advanced electronic protection device backed-up with MCCBs and fast acting fuses
- Soft start
- Built in Harmonic suppression
- Active power factor correction

7.1.2 These chargers shall be of static type and shall be provided with suitable full wave thyristorised rectifiers, transformers, filter circuits, DC & AC Switchgear. Chargers shall share automatically the load during parallel operation of the inverter system and shall maintain output voltage within plus or minus one percent of the nominal value from no load to full load.

7.1.3 The rectifiers / chargers shall be designed to completely charge the battery in a maximum time of 8 hours for lead acid batteries, after complete discharge. Facilities



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shall be provided to initiate battery rapid charge operation by Manual & Automatic means. An auto charging sequence should be provided for the boost and float charging based on current sensing. In addition to above, the charging shall be transferred from boost to float mode after preset time adjustable through 0-24 hour's timer. Rectifier shall have protection & interlocking against single phase input & reverse phase sequencing.

7.1.4 Facility shall be provided to enable testing of rectifier independently without disconnection of inverter.

7.1.5 Facility for initial charging of batteries shall also be provided. The inverters shall be disconnected during initial charging of the battery.

7.1.6 The rectifiers shall be sized based on the maximum inverter input load when inverter is delivering its rated output at 0.8 PF lagging and recharge the battery to nominal rated capacity

of the battery. The DC load imposed by the inverters shall be considered under the worst case where only one rectifier is operating but the UPS load is equally shared by all the inverters.

7.1.7 The DC rectifiers shall sense the battery charging current and adjust the DC bus voltage to maintain the charging current to preset level. A separate current limit circuit shall also be provided for adjustment of battery current. The rectifiers shall be protected against reverse battery connection at DC link voltage bus. Subsequent to a discharge cycle when battery is connected to rectifier, the battery current shall be monitored, controlled and limited to set value automatically irrespective of the inverter input current.

7.1.8 The battery may be taken out of service for maintenance, during which period it shall be possible for the inverter to continue operation by drawing power from the rectifier. Ripple content shall not exceed 1.5%. Ripple current relay shall be provided to indicate the charger capacity failure.

7.1.9 Battery shall be provided with a sensitive earth leakage protection.

7.1.10 The chargers shall be current limiting and shall be provided with surge suppression networks for both float and boost charging. All equipment and devices required to protect the chargers from short circuits e.g. fast acting semiconductor fuses, trip fuses and micro switch with alarm contacts etc., shall be provided. Rectifier shall have protection & interlocking against single phase input & reverse phase sequencing.

7.2.0 Inverter

7.2.1 Inverters shall have following features:

- Digital PWM IGBT design
- Advanced electronic protection device backed-up with MCCBs and fast acting fuses.
- High speed pulse balancing electronic over voltage/under voltage protection
- Electronic overcurrent trip with reset.

7.2.2 Inverters shall be PWM controlled IGBT (Insulated gate bipolar transistor), filters, necessary oscillators, voltage regulators, current limiting and surge suppression networks. Two nos. 100% capacity Inverters shall be provided. In addition the inverters shall have features of soft start, wave shaping, transient recovery etc. Any other

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equipment required for normal operation of the inverter shall be included irrespective of whether specified or not.

- 7.2.3** The inverter input voltage shall match with the battery and rectifier charger output voltages and shall be designed to operate over the entire range of variation of input DC voltage to accommodate decrease in battery voltage during discharge and to accept voltage increase under battery boost charge or equalizing charge conditions. The output from the inverter shall be 230 V AC, sine wave 1 phase.
- 7.2.4** The inverters shall always work on their internal oscillators or frequency variations with plant AC electrical system. Output voltage frequency shall be controlled simultaneously for both the inverters through common control bus. The plant AC electrical system shall provide a signal to each inverter to control the frequency and phase relationship of its output during normal operations. When this signal to an inverter deviates more than one hertz from the desired 50 Hz frequency, the inverter shall transfer automatically to its internal oscillator which shall maintain inverter frequency at 50 Hz. Within 0.5%. During operation on its internal frequency signal source, an inverter shall continuously monitor the frequency of the plant auxiliary AC electrical system.
- 7.2.5** Upon restoration of the plant auxiliary AC electrical system to 50 Hz. operations, inverter shall automatically adjust the phase relationship between its output and the plant auxiliary AC electrical system and return to the plant auxiliary AC electrical system as its output frequency and phase relationship signal source. During operation on its internal oscillator and inverter shall inhibit transfer of the electronic transfer switch to the alternate source. The automatic adjustment of the phase relationship between the inverter output and plant auxiliary AC system shall be accomplished at a controlled rate which shall not exceed one hertz per second. The inverters shall include a separate voltage distribution and voltage monitoring system for all command and interlock logic.
- 7.2.6** Selective protection shall be provided for each individual drive card and its associated interlock logic. The two inverters shall be designed for normal continuous parallel operation. To maintain specified output at maximum ambient temperature, inverters may be provided with cooling air fans as required. Fan cooling, if envisaged, shall be achieved with 2 x 100% cooling banks. One cooling fan bank shall be in operation while the other shall remain on standby. In case of failure of running bank / one fan, the standby bank shall start automatically. The power supply for the fans shall be tapped from the inverter output.
- 7.2.7** All the fuses used in inverter power and control circuits shall be fast acting semiconductor type, operating in less than 5 m.second. Indications and alarms shall be provided to enable fault to be located and rectified at the earliest. Lamps to indicate fault / trouble / failure of each sub group shall be provided on the cubicle front and lamps for each logic card shall be provided on the card itself.
- 7.3.0 Electronic Transfer Switch**
- 7.3.1** The electronic transfer switches shall use SCRs and other electronic devices, for automatic transfer of load from the Normal source to the Alternate source. The transition shall be “make before break” in both directions. The continuous capacity of each electronic switch shall be equal to the full load capacity of one inverter. Maximum



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transfer time including sensing shall not be more than $\frac{1}{4}$ cycle. The voltage failure shall be sensed at the output of the electronic switch. Failure shall cause the electronic switch to transfer. The load from the working inverter shall be transferred to the alternate source, i.e. second inverter or auxiliary power supply source by electronic switches, whenever the output voltage of the inverter deviates more than +10% from nominal. However, transfer shall not be made to the alternate source on over current conditions. Transfer shall be permitted only if voltage of the alternate source is within $\pm 2\%$ of nominal.

- 7.3.2** The electronic switch shall be provided with fuses in both 'normal' and 'alternate' power source. Provision for annunciation of failure of fuse or failure of alternate source shall be made. The switch shall be provided with surge suppression networks and shall also be rated to withstand transient voltages up to 150% of rated voltage. The short time rating of the switch shall be 150% of the rated full load current for two minutes.

7.4.0 Bypass Switch

Make before break type manually operated bypass switch of 100% UPS rated capacity shall be provided in the back up supply circuit to isolate electronic switch and inverter from its load and supply alternate power to load without interruption. Power supply to the loads is continuous during switch operations. Necessary isolators shall be provided to isolate both UPS system completely from back up supply circuit when the UPS loads are fed by back up source through by pass switch.

7.5.0 Transformer and Voltage Stabiliser

Transformers shall be provided at input and as well as output side of UPS.

The transformer shall be dry type, double wound, Class F insulated with copper conductor limiting temperature rise to class B limits, enclosed in CRCA sheet steel panel 2 mm thick. The cooling shall be by means of natural convection. Transformer connection shall also be considered, provided the connection has minimum unbalance on the primary side. The transformer shall be adequately rated for the duty involved. The actual value may be slightly increased to take care of any losses in the voltage stabilizer.

Voltage stabilizer shall employ SMPS controlled circuitry and shall maintain the specified output voltage for 0 to 100% load, with maximum input voltage variation.

7.6.0 UPS Enclosure & Accessories

UPS shall be metal enclosed, fixed type, suitable for indoor mounting on floor. Panel shall be fabricated using cold rolled sheet steel of thickness not less than 2.0 mm for load bearing members and 1.6 mm for non-load bearing members. Suitable synthetic rubber gaskets shall be provided to achieve a degree of protection of IP-31. At bottom removable gland plates of atleast 3 mm thick shall be provided. All incoming and outgoing cables shall be terminated on suitable terminal blocks.

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7.7.0 Metering & Protection

Voltage, current, frequency at input and output shall be measured either through LCD display or separate meters in UPS panel front. For remote metering of essential parameters, 4-20 mA transducer outputs shall be provided. For remote indication/annunciation, potential free contact shall be provided along with RS485 port. LED status indications and alarm indications shall be provided on the mimic on the panel. The following protections shall be provided.

- MCCB at each input supply
- DC MCCB at Battery supply
- Filter at input
- Surge suppressor across transformer secondary
- Semiconductor fuses for SCR bridges
- HRC fuses for filter capacitors
- DC over voltage protection
- Charger input current limit
- Battery current limit
- Under voltage on input side
- Negative sequence current protection on input side
- Overload on inverter
- DC ground fault protection
- HRC fuses in control circuit
- Under voltage / Over voltage protection
- Any other protection required for safe operation of the UPS.

Isolated 4-20 mA signals AC input voltage, current, AC output voltage, current, DC battery voltage, current and Alarms such as AC I/P supply failure, AC O/P (UPS output) supply failure, Inverter trouble etc., shall be considered for remote connection to DCS/EMS/SAS.

7.8.0 UPS AC Distribution Board

7.8.1 AC distribution board shall be metal enclosed, fixed type, suitable for indoor mounting on floor, bottom cable entry. The distribution board shall be single front having horizontal and vertical bus bars. All bus bars shall be PVC sleeved. Where specified, it shall be compartmentalized type.

7.8.2 The distribution board shall be fabricated using cold rolled sheet steel of thickness shall be 2.0 mm minimum for load bearing and 1.6 mm for other members and enclosure shall be IP 52. Earthing bus bar shall run in the bottom chamber through the length of the panel. Suitable synthetic rubber gaskets shall be provided to make boards completely dust and vermin proof. Two separate grounding pads shall be provided for each panel.

7.8.3 MCCBs shall be of triple pole construction for panel mounting, operating mechanism shall be trip free, quick make quick break type. MCCB should be current limiting type only. The MCCBs shall be provided with front operating handles & mechanical ON/OFF indicators. MCCBs shall be provided with overload releases setting range of 80% to 100% of rated current and adjustable short circuit magnetic releases from 5-10 times rated current. MCCBs shall have following accessories & features:

- Shunt trip release
- Auxiliary contact set of 1 NO + 1NC
- Fault signalling contact set of 1 NO + 1NC

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- Insulation shields to isolate the connection between each pole.
- Finger protection plate to prevent accidental contact.
- The compartment door shall be interlocked with handle of MCCB

7.8.4 MCB shall be rated for 10 kA short circuit rating. It shall be quick make, quick break, and independent manual type with trip free feature. MCB shall have the following :

- Over current protection
- ON/OFF Trip position indicators
- Auxiliary contact block

7.8.5 Painting

The fabricated parts shall undergo a treatment of degreasing, pickling and two coats of primer before being given the epoxy finish. Two coats of final paint shall be applied. The external and internal surface of the board shall be powder coated epoxy finish of gray shade RAL 7035. The final thickness of paint film on steel shall not be less than 50 microns.

8.0.0 TESTING & INSPECTION

8.1.0 Equipment offered shall be of type tested and proven type. Type test certificates for test conducted earlier on similar rating shall be furnished. The Owner shall review the type tests certificates furnished by the bidder at contract stage. Routine tests, functional tests and system tests shall be carried out as per applicable standard. Copies of certified reports of all tests carried out at the works shall be furnished.

8.2.0 Following tests shall constitute functional tests for the panel as per IS:4540 & IS:9000

- Voltage regulation
- Ripple content at different loads and noise measurement
- Insulation resistance test
- General operation
- Voltage/current stability test
- High voltage test
- Measurement of surface temperature of charger panel
- Current limiting features.
- Efficiency & PF measurement
- Temperature Rise test
- Short circuit at full load
- Short circuit at No load
- Connection checking of Rectifier assembly.

8.3.0 Following tests shall constitute type tests on the panel.

- Degree of protection Test for Panel
- Vibration Test of the Electronic Card Rack/Panel
- Environmental Tests on the Electronic Cards
- RFI Test
- Surge Withstand capability Test

8.4.0 System tests shall be performed on the completely assembled UPS system at Manufacturer's works. System tests shall include the following:

- Frequency regulation



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Part of ROS6282, REV:0

- Voltage regulation
- Current limiting feature
- Voltage & frequency control of inverters for synchronisation
- Harmonic content tests
- Transfer of load through electronic switch due to inverter failure
- Loss on inverter output
- Under voltage
- Load overcurrent
- Manual transfer/Retransfer
- Mains failure/restoration
- Tests on alarms/indications
- Availability test

8.5.0 Site tests shall include the following:

- a) Check name plate details according to the specification
- b) Check for physical damage
- c) Check tightness of all bolts, clamps, joints and connecting terminals
- d) Check earth connection and earth continuity
- e) Check for polarity
- f) Functionally check all control circuits
- g) Check connections and wiring
- h) Megger all terminals to body
- i) Test relay cards
- j) Test CTs and VTs
- k) Test rectifier transformer

9.0.0 DRAWINGS & DOCUMENTS

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

- UPS sizing calculation
- Technical data sheet
- Dimensional general arrangement drawing of UPS.
- Dimensional general arrangement for distribution board.
- Schematic & wiring diagram for UPS.
- Single line diagrams
- Sizing calculation for battery
- Cable schedule/ Interconnection diagram.
- Erection and commissioning procedures
- Operation and maintenance manual
- Test reports
- Sub-vendor list
- Manufacturing quality plan
- Field quality plan

	2 X 660 MW, UDANGUDI STPP (STAGE-1)	BAP-RANIPET
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SECTION: F

F.1.3 MOTORS (SUB-SECTION: 3.16)

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 |
| n) IS 60034-8 | Machines 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 |

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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.

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- 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

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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

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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 °C 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

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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



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- 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

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F.1.4 ELECTRICAL ACTUATORS (SUB-SECTION: 3.17)

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.

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- 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..

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- 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.

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- 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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**TECHNICAL SPECIFICATION FOR
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No: ROS: 4268, REV: 0

Part of ROS6282, REV:0

SECTION: F

F.1.5 CABLES (SUB-SECTION: 3.24)

1.0.0 INTENT OF SPECIFICATION

This section covers the requirements of cables.

2.0.0 SCOPE OF WORK

The scope of work shall include supply, installation, testing and commissioning of the following:

- a) 19/33 kV grade XLPE insulated armoured FRLS power cables
- b) 11/11 kV grade XLPE insulated armoured FRLS power cables
- c) 6.6/6.6 kV grade XLPE insulated armoured FRLS cables
- d) 1.1 kV grade XLPE insulated armoured FRLS cables
- e) 1.1 kV grade XLPE insulated armoured FRLS control cables
- f) Trailing cables
- g) Shielded cables
- h) Telephone cables
- i) Fiber optic cables

3.0.0 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: 3975 Mild steel wires formed wires and tapes for armouring of cables.
- b) IS: 4905 Methods for random sampling.
- c) IS: 5831 PVC insulation and sheath of electric cables.
- d) IS: 7098 Part-I Cross-linked polyethylene insulated PVC sheathed cables (LV)
- e) IS: 7098 Part-II Cross-linked polyethylene insulated PVC sheathed cables (HV)
- f) IS: 8130 Conductors for insulated electric cables and flexible cords.
- g) IS: 10418 Drums for electric cables.
- h) IS: 10810 Methods of tests for cables.
- i) IS: 3961 Recommended current ratings for cables

4.0.0 TECHNICAL REQUIREMENTS

4.1.0 Power cables shall be provided for the following systems:

- 33 kV earthed system having phase fault current and earth fault current of 25 kA.
- 11 kV unearthed system having phase fault current of 50 kA and earth fault current of 300 A.



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- 6.6 kV unearthed system having phase fault current of 31.5 kA and earth fault current of 300 A.
- 415 V earthed system having phase fault current and earth fault current of 65/50 kA.
- 220 V DC unearthed system having fault current of not less than 25 kA.

4.2.0 Power cables shall be sized to withstand the system fault current for the fault clearing time indicated below:

- Breaker operated Motor feeders and transformer feeders: 0.16 second.
- Breaker operated outgoing feeders: 0.5 second.
- Tie between two switchgear: 0.5 second.
- Incomers: 1 second.

4.3.0 Power cables shall be sized to satisfy the following Criteria:

- To withstand specified system short circuit current for the specified fault clearing time.
- To carry full load current under applicable installation conditions considering Site ambient temperature & site installation (Grouping) conditions based on Manufacturer's recommendation.
- To limit the voltage drop under steady state/transient state conditions to permissible values.

4.4.0 Cables shall be armoured type only.

4.5.0 Power cables shall be XLPE insulated. Control cables shall be PVC / XLPE insulated.

4.6.0 PVC insulation shall be suitable for continuous conductor temperature of 70 °C and short circuit conductor temperature of 160 °C. XLPE insulation shall be suitable for continuous conductor temperature of 90 °C and short circuit conductor temperature of 250 °C.

4.7.0 Cables for 33 kV system shall be rated for 19/33 kV earthed grade, cables for 11 kV system shall be rated for 11/11 kV unearthed grade and Cables for 6.6 kV system shall be rated for 6.6/6.6 kV unearthed grade. Cables for 415/230 V AC and 220 V DC shall be rated for 1.1 kV grade.

4.8.0 To minimize the damage that can be caused by a fire, conductors installed in electrical cable tray systems shall have jackets which have non-propagating, and self-extinguishing flame retardant, low smoke (FRLS) characteristics. Outer sheath shall be of PVC black in colour. These cables shall meet the following test requirements.

- Oxygen index of minimum 29 when tested as per IS 10810 Part-58
- Temperature index of minimum 250 °C when tested as per IS 10810 Part-64
- Acid gas emission of maximum 20% when tested as per IS 10810 Part-59 Average light transmission of 40% minimum when tested as per IS 10810 Part-63 (average smoke density is maximum 60%)
- Flame test requirements as per IS 10810 Parts-53 and 62
- Flame retardant test requirements as per IS 10810 Part-61

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- 4.9.0 For power cables, copper conductor shall be used for current rating of up to 10 A. For higher current rating, conductor can be aluminium/copper. Minimum size of copper conductor shall be 2.5 sq.mm and aluminium conductor shall be 6 sq.mm.
- 4.10.0 Conductor of control cables shall have plain annealed copper. The minimum size of control cable shall be of 1.5 sq.mm. For CT circuit minimum size shall be 2.5 sq.mm copper. Control cables shall have 20% spare cores.
- 4.11.0 Current transformers leads shall be checked for the lead burden vis-a-vis the current transformer VA capacity and knee point voltage. Minimum 2.5 sq.mm copper cables shall be used for connection of CT to load. In case 2.5 sq.mm size impose unacceptably high burden on CTs, 4 sq.mm copper shall be used. Voltage transformer leads shall be checked for voltage drop which shall be limited to within 1% for all cases other than tariff metering. For tariff metering the voltage drop shall be limited to 0.2%. In case the voltage drop with 2.5 sq.mm copper conductor exceeds this value, higher conductor sizes shall be used.
- 4.12.0 Power cables shall carry the full load current of the circuit continuously under site conditions considering the various derating factors like thermal resistivity of soil, ambient air/ground temperature, grouping, method of laying, etc.
- 4.13.0 Design ambient air temperature and ground temperature shall be considered at 50°C and 40°C respectively for cable sizing.
- 4.14.0 For 11 kV & 6.6 kV cables, screen of each core shall be sized to withstand 300 A for 1 sec. For 33 kV cables, screen of each core shall be sized to withstand system earth fault current for 0.16 sec.
- 4.15.0 For HT motors the voltage drop in the cable, during motor starting condition, shall be limited to 10% and during full load running condition, shall be limited to 2.5% of the rated voltage. However, the voltage drop from transformer secondary to motor terminals during full load running of motors shall be limited to 5% of rated voltage
- 4.16.0 For LT motors the voltage drop in the cable, during motor starting condition, shall be limited to 15% and during full load running condition, shall be limited to 3% of the rated voltage. However, the voltage drop from transformer secondary to motor terminals during full load running of motors shall be limited to 6% of rated voltage.
- 4.17.0 Cables for the following systems shall be fire survival type.
- DC emergency lube oil pumps
 - DC seal oil pump
 - DC emergency lighting cables for main building.
 - Batteries to chargers and DC distribution boards
 - Turbine lub oil pumps
 - Jacking oil pumps
 - Emergency turbine trip by push button in control room
 - Inter trip cables between Boiler master fuel trip and turbine trip relays

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- Inter trip cables between Generator trip relays and turbine trip relays/400 kV circuit breaker/generator field breaker/UT breakers

4.18.0 Method of curing for HT XLPE insulation shall be **gas/steam curing**.

4.19.0 Conductor screen and insulation screen shall both be of extruded semi-conducting compound and shall be applied with XLPE insulation in one operation through triple extrusion.

4.20.0 For armoured cables, armouring shall be of aluminium for single core cables. For multicore armoured cables, armouring shall be of galvanised steel.

4.21.0 All the cables shall be protected against rodent and termite attack. Necessary chemicals shall be added into the PVC compound of the outer sheath. The sheath shall be resistant to water, UV radiation, fungus, etc.

4.22.0 Multi-core cable color coding shall be as follows:

- Red, yellow, blue, black and gray for five core cables
- Outer sheath shall be of black in colour.
- For more than 5 cores, core identification shall be by alpha numerical numbering system at an interval of one meter.

4.23.0 Three core 19/33 kV earthed grade, 11/11 kV unearthed grade, 6.6/6.6 kV unearthed grade cables shall constitute the following:

- Circular stranded and compacted aluminium conductor
- Extruded semi conducting compound as conductor screen
- Extruded XLPE insulation
- Extruded semi conducting compound as insulation screen
- Copper tape as metallic screen for each core
- Extruded PVC inner sheath
- Galvanised steel formed wire/strip
- Extruded FRLS PVC outer sheath

4.24.0 Single core 19/33 kV earthed grade, 11/11 kV unearthed grade, 6.6/6.6 kV unearthed grade cables shall constitute the following:

- Circular stranded and compacted aluminium conductor
- Extruded Semi conducting compound as conductor screen
- Extruded XLPE insulation
- Extruded Semi conducting compound as insulation screen
- Copper tape as metallic screen
- Hard drawn aluminium wire armour
- Extruded FRLS PVC outer sheath

4.25.0 Multicore 1.1 kV earthed grade cables shall constitute the following:

- Circular / shaped, stranded aluminium conductor (compacted for >10 sq.mm)
- Extruded XLPE insulation
- Extruded PVC inner sheath
- Galvanised steel formed wire/strip
- Extruded FRLS PVC outer sheath

4.26.0 Single core 1.1 kV earthed grade cables shall constitute the following:

- Circular stranded and compacted aluminium conductor

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- Extruded XLPE insulation
- Hard drawn aluminium wire armour
- Extruded FRLS PVC outer sheath

4.27.0 Trailing power and control cables for mobile equipment shall constitute the following:

Unearthed grade HT power cables, earthed grade LV power cables and control cables shall be flexible trailing with annealed tinned copper conductor, EPR insulated, EPR inner sheathed, CSP outer sheathed. For HT cables, insulation screen shall be provided. Cables shall conform to applicable IS/IEC standard requirements.

4.28.0 Fire survival cables

Fire survival cable shall be of copper conductor and comply with IEC-60331 (withstanding 750 degree C temperature for 3 hours). Also the halogen acid contents in outer sheath shall not be more than 2% when tested as per IEC-60754 and the smoke density in percent light absorption shall not exceed 20% when tested as per ASTM-D-2843. 1.1 kV earthed grade fire survival cables shall constitute the following:

- Circular/shaped stranded and compacted annealed copper conductor
- Elastomeric materials (XLPE, EPR, SR, or LSOH) insulated
- Glass mica tapped
- Extruded FRLS compound or LSOH material as inner sheath
- Galvanised steel formed wire/strip
- Extruded FRLS compound or LSOH material as inner sheath

4.29.0 Multicore 1.1 kV earthed grade control cables shall constitute the following as per IS:1554-1 / 7098-1:

- Multi stranded annealed copper conductor
- Extruded PVC / XLPE insulation
- Extruded PVC inner sheath
- Galvanised steel formed wire/strip
- Extruded FRLS PVC outer sheath

4.30.0 Multi pair 1.1 kV earthed grade, overall screened signal cables shall constitute the following as per BS EN 50288-7:

- Multi stranded annealed copper conductor
- Extruded PVC insulation
- Twisted pair
- Overall polyester taped, Al-mylar screened with ATC drain wire
- Extruded PVC inner sheath
- Galvanised steel formed wire/strip
- Extruded FRLS PVC outer sheath

4.31.0 Multi pair 1.1 kV earthed grade, individual and overall screened signal cables shall constitute the following as per BS EN 50288-7:

- Multi stranded annealed copper conductor
- Extruded PVC insulation
- Twisted pair
- Individual polyester taped, Al-mylar screened with ATC drain wire
- Overall polyester taped, Al-mylar screened with ATC drain wire
- Extruded PVC inner sheath



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- Galvanised steel formed wire/strip
- Extruded FRLS PVC outer sheath

4.32.0 Cable drums

Cables shall be supplied in non-returnable wooden or steel drums of heavy construction. All ferrous parts shall be treated with suitable rust protective finish or coating to avoid rusting during transit and storage. All wooden parts shall be manufactured from durable quality wood duly seasoned and treated with copper nepthenates or zinc nepthenates for preserving the wood. The surface of the drum and the outer most cable layer shall be covered with waterproof layer. Both the ends of the cables shall be properly sealed with heat shrinkable PVC/rubber caps, secured by 'U' nails so as to eliminate ingress of water during transportation, storage and erection. Wood preservative anti-termite treatment shall be applied to the entire drum. Wooden drums shall comply with IS 10418.

4.33.0 Cable identification system

- In addition to manufacturer's identification on cables as per IS, following marking shall also be embossed/printed on the outer sheath at an interval of one metre throughout the length of cables.
 - BIS mark
 - Manufacturer's name and or trade mark.
 - Year of manufacture
 - Cable code
 - Type of cable and voltage class.
 - Nominal cross section area of conductor and no.of cores.
 - Progressive sequential length making.
- Cables shall be marked as having FRLS outer sheath at every 5 meters.
- The embossing/printing shall be progressive, automatic, in line and marking shall be legible and indelible.
- Multi-core cable color coding shall be as follows:
 - Red, yellow and blue for three core cables
 - Outer sheath shall be of black in colour.
 - For more than 5 cores, core identification shall be by alpha numerical numbering system at an interval of one meter.
 - For multi pair cables, each pair shall be coloured and numbered.

5.0.0 TESTS

Cables offered shall be type tested and proven type. Routine tests shall be carried out on 100% drums. Type tests, special tests and acceptance tests shall be carried out on 1 drum selected on random basis, out of every 10 or less number of drums of each type and size of cable of each lot. Size shall mean area of cross section in sq.mm read in conjunction with the number of cores. Type shall mean type of insulation, sheath, volt grade FRLS/FS etc.

5.1.0 Type Test



- a) Tests on conductor
 - i) Annealing Test (for copper)
 - ii) Tensile test (for aluminium)
 - iii) Wrapping test (for aluminium)
 - iv) Resistance test
- b) Tests for armour wires/strips
- c) Tests for thickness of insulation and sheath
- d) Physical tests for insulation
 - i) Tensile strength and elongation at break
 - ii) Ageing in air oven
 - iii) Shrinkage test
 - iv) Hot test
 - v) Water absorption (gravimetric)
- e) Physical test for outer sheath
 - i) Tensile strength and elongation at break
 - ii) Ageing in air oven
 - iii) Shrinkage test
 - iv) Hot deformation
 - v) Heat shock test
 - vi) Loss of mass test in air oven
 - vii) Thermal heat stability test (as per IS : 5831)
 - viii) Bleeding and blooming test
- f) Anti-termite and anti-rodent test (on outer sheath).
- g) Partial discharge test
- h) Bending test
- i) Dielectric power factor test
 - i) As a function of voltage
 - ii) As a function of temperature
- j) Insulation resistance (volume resistivity) test
- k) Heating cycle test
- l) Impulse withstand test
- m) High voltage test
- n) Flammability test
- o) Cold impact test

5.2.0 Acceptance Test

- a) Annealing test (for copper)
- b) Tensile test (for aluminium)
- c) Wrapping test (for aluminium)
- d) Conductor resistance test
- e) Test for thickness of insulation and sheath
- f) Hot set test for insulation
- g) Tensile strength and elongation at break test for insulation and outer sheath
- h) Partial discharge test (for screened cables)
- i) High voltage test
- j) Insulation resistance (volume resistivity) test

5.3.0 Routine Test



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- a) Conductor resistance test
- b) Partial discharge test
- c) High voltage test

5.4.0 Special Test

- a) Oxygen index test as per IS 10810 Part-58
- b) Temperature index test as per IS 10810 Part-64
- c) Acid gas generation test as per IS 10810 Part-59
- d) Smoke generation test as per IS 10810 Part-63
- e) Flammability tests as per IS 10810 Parts-53 and 62
- f) Flame retardant test as per IS 10810 Part-61

5.5.0 Site Test

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.

- a) Insulation resistance test
- b) High voltage test

6.0.0 DRAWINGS & DOCUMENTS

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

- Design basis report
- Cable sizing calculation
- General arrangement drawings
- Technical data sheet
- Test reports
- Catalogues
- Sub-vendor list
- Manufacturing quality plan
- Field quality plan

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SECTION: F

F.1.6 CABLE TRAYS, SUPPORTS & ACCESSORIES (SUB-SECTION: 3.25)

1.0.0 INTENT OF SPECIFICATION

This section covers the requirements of Cable trays & accessories.

2.0.0 SCOPE OF WORK

The scope of work shall include supply, installation, testing and commissioning of the following:

- a) Ladder type Cable trays
- b) Perforated type Cable trays
- c) Cable troughs
- d) Cable Tray bends, Tees, Cross, Coupler plates, etc.
- e) Cable tray covers
- f) Bolted (Unistrut type) cable tray support system
- g) Erection hardware
- h) Consumables
- i) Tools & tackles
- j) Any other equipment required for the system

3.0.0 CODES AND STANDARDS

The equipment to be furnished under this specification shall be in accordance with the applicable section of the latest version of the following Indian Standards, except where modified and /or supplemented by this specification.

- a) IEC: 61537 Cable traysystems.
- b) IS: 1079 Specification for hot rolled carbon steel sheet and strip.
- c) IS: 1730 Dimensions for steel plates, sheet strips and flats for general engineering purposes.
- d) IS: 1363 Hexagon head bolts, screws and nuts.
- e) IS: 6005 Code of practice for phosphating iron & steel.
- f) IS: 2629 Recommended practice for hot dip galvanising on iron and steel.
- g) IS: 2633 Methods for testing uniformity of coating on zinc coated articles.
- h) IS: 6745 Methods for determination of mass of zinc coating on zinc coated iron and steel articles.
- i) IS: 816 Code of practice for use of metal arc welding for general construction of mild steel.
- j) IS:4759 Specification for hot-dip zinc coatings on structural steel and allied products

4.0.0 TECHNICAL REQUIREMENTS

4.1.0 Cable Trays



- 4.1.1** Cable trays shall be ladder type for power and electrical control cables and perforated type for signal cables, prefabricated, made out of hot / cold rolled mild steel sheets complete with matching fittings, accessories and hardware as required. Cable trays shall be with standard width of 150 mm, 300 mm, 450 mm, 600 mm, 750 mm and 900 mm and standard lengths of 2.5 metre or more. Minimum thickness of mild steel sheets used for fabrication of cable trays and fittings shall be 2 mm. For ladder trays, rung spacing shall be 250 mm maximum. The thickness of side coupler plates shall be minimum 2 mm and of tray covers shall be minimum 1.6 mm.
- 4.1.2** In corrosive areas, FRP cable trays shall be provided in general.
- 4.1.3** FRP cable trays also shall be provided for the following areas
- Water Treatment Plant
 - Coal Handling Plant
 - Sea Water intake system
 - Interplant cable trays
- 4.1.4** Separate cable trays shall be provided for the following cables:
- HT Cables
 - LT power cables
 - Electrical Control cables
 - Signal cables
 - Fiber optic cables
- Cable trays shall be designed to cater to a load of minimum 75 kg/m.
- 4.1.5** Cable trays shall be complete with matching fittings and accessories (like elbows, bends, reducers, tees, crosses, side coupler plates, etc.) and hardware (like bolts, nuts, washers, etc.) as required. At both the ends of cable trays, four holes shall be provided for fixing side coupler plates. All the slots and coupler holes shall be machine punched.
- 4.1.6** Cable trays, fittings and accessories and covers shall be hot dip galvanized. Thickness of galvanizing shall be not less than 610 grams/sq.m. Fasteners like bolts, nuts; screws washers etc. shall also be hot dip galvanized.
- 4.1.7** For branch cabling routes involving fewer cables, sheet steel galvanized cable trough of size 50/75/100 mm shall be provided.
- 4.1.8** Cable tray covers shall be provided for horizontally laid outdoor trays, on top most trays. It shall be prefabricated made out of hot/cold rolled mild steel sheets, complete with hardware as required. Special clamps shall be provided for fixing tray covers without drilling holes on trays.
- 4.2.0 Cable Tray Support System**
- 4.2.1** Cable tray supports shall be of prefabricated preformed sections of sheet steel, bolted type and shall be hot dip galvanized.
- 4.2.2** Cable tray support system shall be similar or equivalent to "Unistrut make". Support system for cable trays shall essentially comprise of the two components i.e. main support channel and cantilever arms. The main support channel shall be of following two types:
- Single channel strut support for supporting cable trays on one side
 - Double channel strut support for supporting cable trays on both sides



- 4.2.3** Cable supporting steel work for cable racks/cables shall comprise of various channel sections, cantilever arms, various brackets, clamps, floor plates, all hardware such as lock washers, hexagon nuts, hexagon head bolt, support hooks, stud nuts, hexagon head screw, channel nut, channel nut with springs, fixing studs, etc.
- 4.2.4** The system shall be designed such that it allows easy assembly at site by using bolting. All cable supporting steel work, hardware fittings and accessories shall be prefabricated factory galvanised.
- 4.2.5** The main support and cantilever arms shall be fixed at site using necessary brackets, clamps, fittings, bolts, nuts and other hardware etc. of the components shall not be allowed.
- 4.2.6** All steel components, accessories, fittings and hardware shall be hot dip galvanised after completing welding, cutting, drilling and other machining operation.
- 4.2.7** The typical arrangement of flexible support system shall comprise the following:
- 4.2.8** The main support channel and cantilever arms shall be fabricated out of minimum 2.5 thick rolled steel sheets conforming to IS.
- Cantilever arms of required length to match cable tray width. The arm portion shall be suitable for assembling the complete arm assembly on to component constructed of standard channel section. The back plate shall allow sufficient clearance for fixing bolt to be tightened with tray in position.
 - The size of structural steel members or thickness of sheet steel of main support channel and cantilever arms and other accessories as indicated above or in the enclosed drawings are indicative only.
 - Main support channels may be supplied in any suitable lengths to minimize the wastage. Nevertheless, the support system shall be designed by the bidder to fully meet the requirements of type tests as specified.
- 4.2.9** Thickness of galvanizing on steel sections shall be not less than 610 gm/sq.m on all steel sections.
- 4.2.10** Horizontally running cable trays shall be clamped by bolting to cantilever arms at an interval of 1500 mm for outdoor and 2000 mm for indoor locations. Vertically running cable trays shall be bolted to main support channel by suitable bracket/clamps on both top and bottom side rails at an interval of 1500 mm. For vertical cable risers/shafts cable trays shall be supported at an interval of 1000 mm.
- 4.2.11** The cantilever arms shall be positioned on the main support channel with a minimum vertical spacing of 300 mm.

5.0.0 TESTS

Equipment offered shall be type tested and proven type. Tests shall be carried out for galvanizing thickness of trays and supports. Load test shall be carried out for trays and supports.



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Load Test for Cable trays shall be carried out as follows:

A 2.5 metre straight section of each type of cable tray shall be simply supported at the two ends. A uniformly distributed load of 100 kg per meter shall be applied along the length of tray. The maximum deflection at mid span shall not exceed 7 mm.

6.0.0 DRAWINGS & DOCUMENTS

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

- General arrangement drawings for trays and fittings
- General arrangement drawings for support system
- Technical data sheet
- Test reports
- Installation details
- Sub-vendor list
- Manufacturing quality plan
- Field quality plan

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SECTION: F

F.1.7 CABLE ACCESSORIES (SUB-SECTION: 3.26)

1.0.0 INTENT OF SPECIFICATION

This section covers the requirements of cabling accessories.

2.0.0 SCOPE OF WORK

The scope of work shall include supply, installation, testing and commissioning of the following:

- a) Cable joints & terminations
- b) Cable glands
- c) Cable lugs
- d) Camps
- e) Tags
- f) Conduits & Pipes
- g) Junction boxes
- h) Consumables
- i) Tools & tackles
- j) Any other equipment required for the system

3.0.0 CODES AND STANDARDS

The equipment to be furnished under this specification shall be in accordance with the applicable section of the latest version of the following Standards except where modified and/or supplemented by this specification.

- a) VDE 0278 Joints and Terminations
- b) IS: 13573 Joints and Terminations for polymeric cables for working voltages from 6.6 kV up to and including 33 kV-Performance requirements and type tests.
- c) BS:6121 Mechanical cable glands (Part 1 -Specification for metallic glands)
- d) IS: 12943 Brass Glands for PVC Cables
- e) IS: 8309 Specification for compression type tubular terminal ends for aluminium conductors of insulated cables.

4.0.0 TECHNICAL REQUIREMENTS

4.1.0 Joints & terminations

- 4.1.1** Termination and jointing kits shall be of proven design and make which have already been extensively used and fully type tested. Kits shall be complete with all accessories and consumables required for complete termination or jointing. Copper cable lugs & jointing ferrules for straight through joints shall form part of the kit.



- 4.1.2** Termination and jointing kits shall be suitable for the following types of cables as per IS.
- 19/33 kV earthed grade cable
 - 11/11 kV unearthed grade cable
 - 6.6/6.6 kV unearthed grade cable
 - 1.1 kV grade power cables
- 4.1.3** Termination kits shall be 'elastimold' or 'Push on type' or 'heat shrinkable type'.
- 4.1.4** Cable joints shall be avoided to the extent possible. If joints are unavoidable due to circuit length, in excess of permissible maximum drum length. Jointing kits shall be 'heat shrinkable type'.
- 4.1.5** Straight through joint and termination shall be capable of withstanding the fault level of 50 kA for 11/11 kV cables and 31.5 kA for 6.6/6.6 kV Cables and 25 kA for 33 kV cables.
- 4.1.6** Straight through joints shall be protected against mechanical damage, rodent and termite attack. It shall be suitable for directly buried cables.

4.2.0 Cable glands

Cables shall be terminated using cable glands suitable for the voltage grade of cables. Cable glands shall be heavy duty brass machine finished and tinned. Cable glands shall be supplied with neoprene seal and earth lugs suitable for the fault capacity of the armour of the installed cables. Cable glands shall be double compression, weather proof type for armoured cables. For flame proof equipment cable glands shall be of flame proof type

4.3.0 Cable lugs

- 4.3.1** Cable lugs shall be of aluminium for aluminium cables and tinned copper for copper cables. Thickness of tinning shall be not less than 10 microns Type of end connection shall be solder less crimping type.
- 4.3.2** Cable lugs for conductors of power cables shall be "heavy duty" long barrel type. The type & size of cable lugs for power cables shall be selected according to the number and sizes of strands of the cable.
- 4.3.3** Solder less crimping of terminals shall be done by using corrosion inhibiting compound. Cable lugs for control cable termination shall be insulated. These lugs shall be pin type/flat type/ ring type/U Type to suit the terminals provided in the panels.
- 4.3.4** Type of cable lugs shall be as follows:
- Power cables with aluminium conductor : Aluminium crimping type.
 - Power cables with copper conductor : Copper crimping type.
 - Control Cables : Copper pin type /Copper screw type
 - Special cables : pin type / maxi-termi type

4.4.0 Trefoil Cable Clamps

- Clamps required for single core cables carrying alternating current shall be suitable for holding three cables together in delta formation. Clamps shall be of FRP material.
- Clamps shall be of suitable sizes to firmly hold the cables of various outer



diameters including tolerance in OD.

- Clamps should have been type tested for Short Circuit Withstand Test.
- For Trefoil clamps run spacing shall be 2000 mm and axial spacing shall be double the diameter of larger adjacent trefoils cable or 150 mm whichever is less. Supports shall also be provided at each bend

4.5.0 Omega Cable clamps

- Omega clamps shall be of galvanized mild steel and shall be used to fasten the individual multi-core cables.
- Clamps shall be of simple construction, made of 2 mm thick, 25 mm wide strip of omega shape and suitable for clamping on the rungs / perforated sheet of tray with the help of two bolts.
- Clamps shall be of different sizes for different outer diameters of cables. Omega cable clamps shall be used for individual cables above 35 mm outer diameter.
- Steel clamps shall be hot dip galvanized. Weight of zinc not less than 610 grams. per sq. metre
- For cables of above 35 mm OD, cables shall be individually clamped at 5000 mm interval for Horizontal runs and shall be individually clamped at 1000 mm interval for Vertical runs. Supports shall also be provided at each bend.
- For cables of up to 35 mm OD, cables shall be collectively clamped at 5000 mm interval for Horizontal runs and shall be collectively clamped at 1000 mm interval for Vertical runs. Supports shall also be provided at each bend.
- For cables supported along structures/ceiling, clamp spacing shall be 750 mm. Supports shall also be provided at each bend.

4.6.0 Strip Cable Clamps

- Strip clamps shall be of galvanized mild steel and shall be used to fasten the group of multi- core cables up to 35 mm diameter only on a full or part of the tray width.
- Clamps shall be of simple construction, made of 3 mm thick Steel, 25 mm wide strip to cover the entire width up to 300 mm wide tray and part of the tray for more than 300 mm wide trays. Strip shall have two right angle bends at each end for fixing on to the rung/ perforated sheet of tray with the help of two bolts.
- Clamps shall be of different sizes for different sizes of tray width. However, the maximum size of clamp shall be 300 mm and for cable trays of greater width, two clamps shall be used.
- Clamps shall be hot dip galvanized. Weight of zinc not less than 610 grams. per sq. metre

4.7.0 Self-locking Clamps

- Clamps shall be of FRP material. Clamps shall have self-locking feature when the cord is looped. Clamps shall be provided with manual lock release.
- Clamp cord shall not move in the backward position once it has been locked, unless the lock release is applied.
- Type test certificates to ascertain the strength of clamps shall be submitted for Owner's approval.

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- Not more than four (4) cables shall be clamped together, wherever collective clamping is permitted.
- Clamp length shall be selected such that not more than 80% of lockable length is utilised for clamping.
- Nylon self-locking tie strips for collective clamping (up to 35 mm OD max. group of 4 cables) shall be 4 mm having Tensile strength 30 kg.
- Nylon self-locking tie strips for individual multicore clamping (above 35 mm OD up to 55 mm OD) shall be 4 mm having Tensile strength 20 kg.
- Nylon self-locking tie strips for individual multicore clamping (above 55 mm OD) shall be 7 mm having Tensile strength 60 kg.

4.8.0 Tags

- Cables shall be provided with cable number tags for identification.
- Cable tags shall be of aluminium.
- Cable numbers shall be engraved type
- Tags shall be of durable quality of size 60 mm x 12 mm with a tie hole at each end.
- Samples of tags shall be approved by the Owner before delivery.
- Tags shall be provided with non-corrosive wire of sufficient strength for tagging.

4.9.0 Junction Boxes

- 4.9.1** Junction box with IP 55 degree of protection shall comprise of a case with hinged door constructed from FRP material. The junction box shall be provided with canopy. The boxes shall include brackets, bolts, nuts, screws, glands, lugs, M8 earthing stud etc.
- 4.9.2** Terminal blocks shall be of 650 Volt grade, rated for 10 A and in one piece moulding. It shall be complete with insulating barriers, clip-on-type terminal numbering on wiring diagrams. Terminal block shall be suitable for terminating 2Cx2.5mm² cable on both sides and arranged to facilitate easy termination. Cable entry shall be from bottom.
- 4.9.3** The boxes shall have provision for wall, column, pole or structure mounting and shall be provided with cable / conduit entry knockouts and terminals.

5.0.0 TESTS

Equipment offered shall be type tested and proven type. Test reports shall be submitted for review. For junction boxes degree of protection test shall be carried out.

6.0.0 DRAWINGS & DOCUMENTS

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

- General arrangement drawings
- Technical data sheet
- Test reports
- Installation details for junction boxes
- Sub-vendor list
- Manufacturing quality plan
- Field quality plan

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SECTION: F

F.1.8 BUSDUCT (SUB-SECTION-3.6)

1.0.0 INTENT OF SPECIFICATION

This section covers the requirements of Isolated phase busduct, segregated phase busduct, Non segregated phase busduct associated equipment.

2.0.0 SCOPE OF WORK

The scope of work shall include supply, installation, testing and commissioning of the following:

- a) Isolated phase busduct (IPBD) between generator and generator circuit breaker.
- b) Isolated phase busduct (IPBD) between generator circuit breaker and generator transformer including delta connections and tap offs.
- c) Current transformers for IPBD
- d) Isolated phase busduct (IPBD) between generator and NGT including required CTs
- e) 11 kV Segregated phase busduct (SPBD) between Unit transformer / Station transformer and respective switchgear
- f) 11 kV Segregated phase busduct (SPBD) between standby maintenance transformer and respective switchgear
- g) 11 kV Segregated phase busduct (SPBD) between switchgears
- h) 6.6 kV Segregated phase busduct (SPBD) between Auxiliary transformer and respective Switchgear
- i) 415 V Non segregated phase busduct (NSPBD) between transformer and power control centres
- j) AC & DC busduct for Static excitation system (if applicable)
- k) Air pressurization equipment for IPBD
- l) Hot air blowing equipment for IPBD
- m) Galvanised steel support structures
- n) Shorting links for IPBD
- o) Commissioning spares and consumables
- p) Mandatory spares
- q) Tools & tackles
- r) Any other equipment required for the system

3.0.0 CODES AND STANDARDS

The equipment to be furnished under this specification shall be in accordance with the applicable section of the latest version of the following Indian Standards, IEC publications and any other standards of latest edition including amendments, except where modified and /or supplemented by this specification.

- a) IEC: 60529 Degree of protection provided by enclosures (IP code).



- b) IS: 2099 Bushings for alternating voltage above 1000 volts.
- c) IS: 2705 Current transformers.
- d) IS: 3156 Voltage transformers.
- e) IS: 4759 Hot-dip zinc coatings on structural steel and other allied products.
- f) IS: 5082 Wrought aluminum and aluminum alloy bars, rods, tubes and sections for electrical purposes.
- g) IS: 8084 Interconnecting bus bars for AC voltage above 1 kV up to and including 36 kV.
- h) IS: 9431 Indoor post insulators of organic material for systems with nominal voltages greater than 1000 volts up to and including 300 kV.
- i) IEEE: 32 Neutral grounding devices.
- j) IEC: 60076-11 Dry type power transformers.
- k) ANSI C37.20 Metal enclosed low voltage power circuit breaker switchgear.
- l) ANSI C37.23 Metal-enclosed bus and calculating losses in isolated phase bus.
- m) ANSI C37.24 Evaluating the effect of solar radiation on outdoor metal enclosed switchgear
- n) CBIP manual on busduct

4.0.0 TECHNICAL REQUIREMENTS

- 4.1.0 The bus ducts shall be installed partially indoor and partially outdoor in a hot, humid and tropical atmosphere.
- 4.2.0 All the equipment and its components shall be designed for design ambient temperature of 50°C.
- 4.3.0 The bus duct shall be natural air cooled. Degree of protection shall be IP-55 and shall be dust tight.
- 4.4.0 Positive air pressurization arrangement shall be provided for the isolated phase bus duct to prevent dust ingress.
- 4.5.0 For steam turbine generator, IPBD shall be sized to evacuate whole generated power at valve wide open (VWO) condition continuously, without exceeding the specified temperature limits. A design margin of 10% shall be considered further.
- 4.6.0 If Static excitation system is offered, Tapoff IPBD from Main IPBD for Excitation transformers, Non Segregated phase busduct (NPSBD) between Excitation Transformers and Exciter Panels, DC Busduct between Exciter Panels and generator Exciter shall be provided.

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4.7.0 SPBD and NSPBD busduct of transformers shall be rated to carry name plate power rating of the associated transformers continuously, without exceeding the specified temperature limits. A design margin of 10% shall be considered further.

4.8.0 SPBD busduct between the switchgear shall be sized to carry continuously for maximum power flow with 10% design margin, without exceeding the specified temperature limits.

4.9.0 The continuous rating of the busduct shall be such that the rated current can be delivered without exceeding the following temperature as per IS 8084, with no canopy for outdoor portion.

- Maximum temperature of bus conductor with silver plated /welded joint: 105°C
- Maximum temperature of bus conductor with plain bolted joint: 90°C
- Maximum temperature of bus enclosure: 80°C.

Losses in the conductor shall be limited to such a value that the temperature rise of the conductor does not exceed the specified values.

For the portion of the bus-duct installed outdoor and exposed to direct sun-rays, the effect of solar heat shall also be considered in the determination of temperature rise.

4.10.0 The busduct shall be suitable for continuous operation at maximum system voltage and shall be adequately sized to withstand short circuit current rating specified short circuit forces due to momentary current. Temperature of busduct shall not exceed 250 degree C, while carrying the specified short circuit current when fault occurs, at operating temperature.

4.11.0 The Busduct and auxiliary equipment shall be capable of withstanding the mechanical forces and thermal stresses of the short-circuit currents without any damage or deterioration of material. Bus conductor support insulator span shall be chosen considering minimum safety of 2.5 for cantilever strength under short circuit condition.

4.12.0 The busduct and supporting structures shall be designed and constructed so as to withstand without damage the horizontal/ vertical ground accelerations due to seismic. The outdoor section shall withstand the wind loading as indicated.

4.13.0 The bus conductors and inner surface of enclosure shall be coated with matte black paint to facilitate heat dissipation.

4.14.0 The portion of bus duct at the transformer end shall be subject to vibration. Suitable means shall be provided to isolate the transformer vibration from rest of the bus structure/busduct.

4.15.0 Bolted rigid joints provided as disconnecting links and to facilitate removal of CTs shall be of the same materials as the bus conductor.

4.16.0 Bus Conductor

- a) The Bus Conductor shall be of high conductivity, painted aluminum alloy, supported on insulators.



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- b) The bus conductor shall be designed for welded connections except at equipment terminations, bolted disconnect links, and bolted flexible. Flexible connections shall be provided between bus sections to allow for expansion and contraction of the conductor. Flexible connections shall also be provided at all equipment terminations.
- c) All connection hardware shall be nonmagnetic and shall have high corrosion resistance
- d) All busbar shall be colour coded as per IS. Phase identification painting shall be done at every joint.

4.17.0 Bus Enclosure

- a) Filtered drain tapping with dual stop cocks shall be provided for drainage of condensate at the lowest point and at such other locations where accumulation of condensate can be expected. In particular a drain valve shall be provided at the lowest point of transformer end termination.
- b) All outdoor bus-enclosures shall be so designed and constructed as to prevent accumulation of rain water on top sheet. Local rain hood shall be provided at all flanged joints coming in the outside portion of the busduct.
- c) Suitable inspection openings shall be provided for access to support insulators, bus joints, transformer terminals, equipment terminals etc. All inspection openings shall have reliable sealing arrangement with neoprene gaskets. Bolted type inspection covers shall be provided to provide access to the busbar joints and insulators.
- d) The enclosure cross section, connecting member between enclosure sections, flexible and rigid joints and shorting links between phase enclosures shall be adequate to allow the flow of longitudinal current required for the rated continuous current of the bus without overheating.

4.18.0 Insulators

- a) Insulator shall be interchangeable, high creep, high strength, wet process, fine glazed porcelain or good quality epoxy resin insulators.
- b) Insulator shall be mounted in such a way so as to permit easy removal or replacement without disassembly of the bus. The insulator mounting plate shall be designed for cantilever loading to withstand the short circuit force.
- c) The conductor shall be fastened on the insulator through fixed and sliding joints so as to allow conductor expansion or contraction without straining the insulator. Positive contact shall be made between end caps of the supporting insulators and the conductors.
- d) Additional support insulators shall be provided at bend and at tap offs for withstanding all possible forces.

4.19.0 Connections , Disconnecting links, Terminations and Shorting Link

- a) Expansion joints made of aluminium/copper laminated connections shall be provided wherever deemed necessary, to take care of thermal expansions and contractions of the bus bars under normal operating conditions.
- b) All matching flanges, gaskets, fittings, hardware vibration pads and supports required for termination of the bus duct at generator, transformers and other equipment shall be furnished. Flexible connections both for conductor and enclosure shall be furnished for the following:



- i. At all equipment termination to take care for misalignment up to 25 mm in all directions.
- ii. Between bus duct supported from building steel and that supported by turbine foundation to prevent transmission vibrations.
- c) The equipment terminal connections shall be readily accessible and shall provide sufficient air gap for safe isolation during electrical testing.
- d) If the material of bus conductor and that of the equipment terminal is different, then suitable bi-metallic connectors shall be provided by the bidder.

4.20.0 Supporting Structures

- a) Bus duct shall generally be supported from ground in outdoor areas and from ceiling/floor in indoor areas. However, same shall be firmed up as per the actual site conditions during detail engineering.
- b) All supporting structure required for hanging and/or supporting the complete bus duct shall be furnished. These shall include all members, indoor/outdoor posts, bolts, shims, base plates, hangers, brackets, bracings and hardware.
- c) For the design of structures, loads such as dead load due to equipment and structure, Wind load on structures, seismic loads, and short circuit forces shall be considered.
- d) All bus ducts shall be adequately supported and braced to successfully withstand normal operation, vibrations, thermal expansion, short circuit forces and all specified design loads.
- e) Supports shall be designed to provide tolerance of 12 mm in the horizontal and vertical directions.
- f) Arrangement of support steel work shall be such as to prevent heating of structures caused by circulating currents.
- g) Hinges of all inspection covers shall be strapped across with flexible earth connections.
- h) Support structure and busduct shall be designed in such a way that after opening the terminals, the transformer can be removed along the rail track without fouling/dismantling busduct support structure. It shall be ensured that No load is transferred on associated transformers and switchgear.
- i) All steel members shall be suitably surface treated and hot-dip galvanized after fabrication. All hardware shall be of high strength steel with weather resistant finish. Thickness of galvanizing shall be not less than 610gm/sq.m.

4.21.0 Isolated phase busduct

- 4.21.1 The IPBD shall serve as an interconnection between generator and its associated generator circuit breaker, generator transformer, Unit transformers, station transformer, NGT and SPVT cubicle. IPBD shall also cover the bushing CT's of the Generator.
- 4.21.2 The bus duct shall be isolated phase, continuous (bonded enclosure). IPBD shall be rated for short circuit duration of 3 seconds.
- 4.21.3 The material of the conductor shall be aluminium alloy. All contact surfaces shall be silver plated. The bus enclosure shall be made of non-magnetic material such as aluminium alloy. Each phase shall be enclosed in a weather proof, dust tight, non-magnetic metal (aluminum alloy) enclosure. The enclosure shall be designed for welded connection.



- 4.21.4 The portion of the bus duct at the generator end shall be subject to vibrations. Bus duct enclosure shall not be bolted with generator. A slit of 10–20 mm shall be kept between enclosure and generator flange. Suitable covering shall be provided on the slit to allow escape of hydrogen and avoid dust entry inside the common chamber.
- 4.21.5 Suitable wall frame assembly without seal-off bushing shall be provided for the busduct at locations where the busduct passes through building wall. The wall frame shall be fabricated out of aluminium.
- 4.21.6 Flexible laminated copper connections shall be provided at the terminals of Generator, generator circuit breaker, generator transformer, Unit transformers, station transformer, SPVT cubicle and neutral earthing cubicle.
- 4.21.7 Seal off bushings shall be provided at the generator end of the bus duct (to prevent migration of hydrogen into the bus duct) and tap off to transformers, SPVT cubicles and neutral grounding transformer (NGT) cubicle.
- 4.21.8 To prevent ingress of foreign matter into the bus duct enclosure during plant shut down or maintenance, aluminum end caps shall be provided for the following locations:
- Generator transformer end
 - Unit transformer end
 - Station transformer end
- 4.21.9 Apart from the disconnecting links at interconnection/equipment connections, bus duct shall be provided with pre-fabricated shorting link having rating equal to continuous rated current of busduct main run to for drying out / short circuit test. Shorting links shall be provided for the following locations:
- Generator end, as near to the generator terminals (It can be provided as part of GCB)
 - Generator transformer end, as near to the GT flange as possible
 - Unit transformer end and Station transformer end on-line side after 87T
 - Both sides of the neoprene or EPDM rubber or metallic expansion bellows
 - Any other section, where it is felt that it is not properly bonded and the induced currents may not have a continuous path
- 4.21.10 Pre-fabricated shorting links rated same as the continuous amperage of bus duct main run and shall be furnished complete with all hardware for connections. The links shall be suitable for shorting bus conductors/enclosures of three (3) phases. The links shall be so designed with flexible connections that the bus insulators shall not be unduly stressed due to expansion / contraction during dry out or short circuit tests.
- 4.21.11 Rubber bellows shall be provided at the bus duct terminations such as, SPVT, UAT, ST and GT.
- 4.21.12 The electrically continuous bus enclosure shall be used as the grounding bus. All parts of the bus enclosure, supporting structure and equipment frames shall be grounded to earthing mat. Duplicate bolted type ground pads shall be provided to accommodate adequately sized galvanized steel flats, wherever isolated phase bus duct terminates.
- 4.21.13 Air pressuring Equipment**
- a) Air pressurization of entire bus duct installation shall be provided to keep pressure inside the bus duct 20 to 100 mm water column above atmospheric pressure by clean dry air. To prevent condensation, the design shall be based on dew point of -25°C.
 - b) In order to avoid any accidental overpressure the unit shall be equipped with safety valves calibrated to open the circuit at about at about 2-3 times the design pressure.

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All materials shall be designed to withstand more than twice the safety valve set pressure.

- c) A tee-connection with non-return valve and isolation valve, pressure reducer shall be provided for a standby connection to station compressed air supply header.
- d) Complete arrangement for pressurization of bus duct shall be provided, located indoor, including compressor, drier, dust filters, safety valves, controls, indication and alarms for failure of pressurization and excessive leakage. Air drying plants shall have 2X100% redundancy. The degree of protection for control panel shall be IP-52. Control panel shall be provided accommodating starters and control systems for compressor and drier.
- e) Air leakage rate shall not exceed 3% of the total enclosure volume per hour.
- f) In addition to the above system, one additional inlet flange at air dryer unit for receiving instrument air from the 'main plant air compressor' as standby arrangement and suitable pressure reducer shall be provided by the Contractor.

4.21.14 Hot Air Blowing Equipment

- a) To avoid condensation of moisture inside busduct during shutdown of the generator, suitable facility for blowing hot air inside the bus enclosure shall be provided.
- b) Hot air blowing system shall be of open loop type, capable of blowing hot air simultaneously in the indoor and outdoor portions of the duct.
- c) One set of portable hot air blowing equipment mounted on trolley complete with motorized blowers, heaters, starters, thermostat, hose connections, piping, valves, control and instruments, control panel, cable tray / conduit, cable / cable accessories and all equipment and accessories as required for the system shall be provided for each Unit.
- d) A control cabinet shall be furnished with wired control and monitoring devices, indicating lights etc. Auxiliary contacts shall be provided for remote ON / OFF indication of hot air blowing operation.
- e) Ambient air shall be drawn in through inlet damper and dry air filter and forced through thermostat controllers. Hot air shall be distributed by a set of properly sized ducts and dampers to the indoor and outdoor portion of the busduct. Hot air shall be let from busduct through suitably directed outlet provided at each equipment termination.
- f) The system shall be put in operation only before start-up and shall be sized complete the drying operation in about 2 hours. Once the drying up is complete, the system shall be shut down. The dampers and hot air outlets are to be kept closed when the system is not in operation.
- g) Heaters shall be adequately rated to warm up the busduct from the specified minimum ambient temperature to temperature of 70 degree C in 2 hours' time.

4.21.15 Current Transformers (CTs)

- a) The current transformers shall be epoxy cast-resin, single core ring type conforming to IS:2705. It shall be mounted within the bus duct enclosure and suitable for operation at an ambient temperature existing within the bus duct enclosure which may be in range of 90 degree C to 100 degree C. Mounting arrangement of CT shall be so designed so as to avoid equalizing connections between live conductor and CT

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inner surface.

- b) CT secondary leads shall be brought out through non-magnetic metallic conduits to a marshaling box with degree of protection IP-55. The box shall be provided with removable aluminum gland plate. The facility for shorting and grounding shall be provided at the terminal blocks. CT terminal shall be stud type with shorting link.
- c) Bolted rigid joints provided as disconnecting links and to facilitate removal of CTs shall be of the aluminium alloy material.

4.22.0 Segregated phase busduct

- 4.22.1 11kV Segregated phase duct (SPB) shall serve as interconnection between the Unit switchgear / station switchgear / standby switchgear / Unit transformers / station transformers / standby transformer. The busduct shall have three phase conductors. The busduct shall be rated for ungrounded system.
- 4.22.2 6.6kV Segregated phase duct (SPB) shall serve as interconnection between the respective switchgear to Auxlairy Transformers. The busduct shall have three phase conductors. The busduct shall be rated for ungrounded system. In other locations, based on layout requirments busducts shall be provided which will be decided during detail engineering.
- 4.22.3 The busduct shall be natural air-cooled type. The enclosure shall have a degree of protection of IP 55 weather proof. The bus ducts shall be suitable for installation in outdoor in a hot, humid and tropical atmosphere.
- 4.22.4 Wall frame assembly with weather and fire proof seal-off bushing shall be provided for the busduct at locations where the busduct passes through building wall. The seal shall be such as to prevent interchange of air between either sides of busduct portions. Flexible connectors shall be provided on both sides of wall bushings. The wall frame shall be fabricated out of aluminium angles and sheet suitable for grouting in the wall. It shall be provided with flanges on both sides to receive the busduct flanges. Seal-off bushings shall be dry non-hygroscopic, porcelain/epoxy type. All plates, anchors and hardware required for fixing the frame, shall be furnished. The bushing shall withstand the maximum short circuit forces under short-circuit condition. Fireproof barrier/sealing shall have a minimum fire rating of three (3) hours.
- 4.22.5 The enclosure shall be of aluminum alloy. Minimum thickness of enclosure shall be 3 mm. Metallic barriers of minimum 2 mm thick aluminum sheet shall be provided to have complete phase segregation inside the enclosure. The aluminum sheet shall be welded on a frame work made up of aluminum angles.
- 4.22.6 The bus conductor shall be of high conductivity aluminum alloy.
- 4.22.7 All outdoor bus-enclosures shall be so designed and constructed as to prevent accumulation of rain water on top sheet. Local rain hood shall be provided at all flanged joints coming in the outside portion of the busduct.
- 4.22.8 Silicagel breathers shall be provided both in indoor and outdoor portions of bus duct for absorption of moisture. It shall be Perspex glass type. Number of silica gel breathers shall be provided based on the length of bus duct.
- 4.22.9 Filtered drains for drainage of condensate shall be provided at the lowest points and at such locations where accumulation of condensate can be expected.
- 4.22.10 Space heater shall be provided, preferably located near to each insulator at suitable

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intervals with thermostat control to avoid moisture condensation within bus-duct.

- 4.22.11 All matching flanges, seal-off bushings, gaskets, fittings, hardware and supports required for termination of the bus duct at the switchgear, transformers and other equipment shall be furnished.
- 4.22.12 Flexible connections both for conductor and enclosure shall be furnished to withstand vibration, expansion/ contraction at:
- At all equipment termination to provide for misalignment up to 25 mm in all directions.
 - Between the busduct portions supported from building steel to prevent transmission of vibration.
 - Between the bus sections to allow for expansion and contraction of the conductor and enclosure.
- 4.22.13 At transformer end flexible connections shall be of copper and at switchgear end it can be aluminium or copper flexible based on the busbar material at switchgear end which shall be firmed up during detail engineering.,
- 4.22.14 2 numbers 50 x 6 mm aluminium flat shall run as earthing conductor parallel to busduct, along the enclosure suitably clamped. This ground conductor shall be connected to plant earth grid at either end of busduct. Ground pad shall be bolted type complete with suitable tapped holes, bolts and washers. Bus enclosure, supporting structures and equipment frames shall be bonded to the above ground bus.

4.23.0 Non segregated phase busduct

- 4.23.1 Non phase segregated phase bus duct (NSPB) shall serve as interconnection between the 415 V switchgear and service transformers. The busduct shall have three phases and neutral conductor. Size of the neutral bus conductor shall be not less than 50% of size of the phase conductor. The busduct shall be rated for 415 V, grounded system.
- 4.23.2 The busduct shall be natural air-cooled type. The enclosure shall have a degree of protection of IP 55 weather proof. The bus ducts shall be suitable for installation in outdoor in a hot, humid and tropical atmosphere.
- 4.23.3 The portion of bus duct at the transformer end shall be subject to vibration. Suitable means shall be provided to isolate the transformer vibration from rest of the bus structure/bus duct.
- 4.23.4 Wall frame assembly with weather and fire proof seal-off bushing shall be provided for the busduct at locations where the busduct passes through building wall. The bushing shall withstand the maximum short circuit forces under short-circuit condition. Fireproof barrier/sealing shall have a minimum fire rating of three (3) hours.
- 4.23.5 The bus conductor shall be of high conductivity aluminum alloy.
- 4.23.6 The enclosure material for NSPBD shall be of non-magnetic material of aluminium alloy.
- 4.23.7 Phase to earth clearance shall be not less than 19 mm and phase to phase clearance shall be not less than 25 mm.
- 4.23.8 Silicagel breathers shall be provided both in indoor and outdoor portions of bus duct for absorption of moisture. It shall be perspex glass type.
- 4.23.9 Bus support insulators shall be of FRP sheet insulators. The support shall be designed for cantilever loading to withstand the short circuit force.
- 4.23.10 Space heater shall be provided at suitable intervals with thermostat control to avoid



moisture condensation within busduct.

- 4.23.11 2 numbers 50 x 10 mm aluminium flat shall run as earthing conductor parallel to busduct, along the enclosure suitably clamped. This ground conductor shall be connected to plant earth grid at either end of busduct.

4.24.0 Painting

- All the fabricated surfaces shall be pretreated by degreasing, de-rusting and chemically cleaned prior to application of epoxy resin red oxide primer to give a dry film thickness of 50 microns.
- The inside of busduct enclosure shall be treated with black matte paint. The inside of cubicles shall be off white.
- The finishing paint shall be half gloss based on an epoxy based. The paint shall be applied in two coats to give a minimum dry film thickness of not less than 50 microns.
- The final paint shade of external surface of busduct shall match with associated equipment.
- All the support structures shall be hot dip galvanized. All hardware shall be galvanized or cadmium plated.

5.0.0 TESTS

- 5.1.0 All components shall be tested as per applicable standard. Test reports shall be furnished for approval. All materials used in manufacture of various components shall be of tested quality and shall conform to relevant standards/specification.

- 5.2.0 Inspection and tests shall be performed in the field in accordance with the requirements and recommendations of respective standards and the local regulation. Testing shall include a comprehensive demonstration of all safety devices, interlocks and controls.

5.3.0 Following tests shall be conducted on busduct as per IS 8084.

5.3.1 Type Tests

- Impulse voltage test.
- Temperature rise test.
- Short time current test (Valid type test report carried out similar rating of busduct in the last 5 years shall be submitted for review).
- Power frequency voltage withstand test (wet).
- Degree of protection test (Water tightness test and air tightness test).
- Mill volt drop test as per IS 5561.

5.3.2 Routine Test

- Power frequency withstand voltage withstand test (dry).
- Insulation resistance test if applicable.
- Visual inspection and verification of dimensions.

5.3.3 Site tests

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.

- Power frequency voltage withstand test
- Air leakage test
- Water tightness test on outdoor portion of bus-duct
- Insulation resistant measurement of equipment and all wiring



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- Milli-volt drop

6.0.0 TECHNICAL PARAMETERS

6.1.0 IPBD

I. No.	Description	Unit	Data
1)	Type		Isolated Phase Busduct
2)	Service		Indoor/Outdoor
3)	Reference Standard		IS 8084
4)	Short circuit duration	kA/sec	3
5)	Material		
	a)Bus conductor		Aluminium alloy
	b)Bus enclosure		Aluminium alloy
6)	Degree of protection		IP 55
7)	Maximum Temperature of Bus bars at continuous full load rating for Silver plated bolted joints / welded joints		105°C
8)	Maximum temperature of enclosure		80°C

6.2.0 Segregated Phase Busduct

Sl. No.	Description	Unit	Data	Data
1)	Type		Segregated Phase Busduct	Segregated Phase Busduct
2)	Service		Indoor/Outdoor	Indoor/ Outdoor
3)	Rated Voltage	V	11000 V +/- 10%	6600V+/-10%
4)	Insulation level			
	a) 1 min dry power frequency withstand	kV(rms)	28	20
	b) Impulse withstand	kV(peak)	75	60
5)	Short circuit duration	sec	3	3
6)	Degree of protection		IP 55	IP 55
7)	Material			
	a)Bus conductor		Aluminium alloy	Aluminium alloy
	b)Bus enclosure		Aluminium alloy	Aluminium alloy
8)	Short-time current	kA rms	50	31.5
9)	Dynamic withstand current rating	kAp	125	80

6.3.0 Non phase segregated phase busduct

Sl. No.	Item Description	Units	Data
1.	Type of installation		Indoor
2.	Type of busduct		Non segregated bus duct, Three phase and Neutral.



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3.	Reference Standard		IS 8084
4.	Rated system voltage	V	415 +/-10%
5.	Short circuit rating and duration	kA / sec	65kA/1Sec 50kA/1 Sec
6.	Material of conductor		Aluminium
7.	Material of Enclosure		Aluminium
8.	Degree of Protection		IP:55
9.	Minimum clearance		
10.	Phase to Phase	mm	25
11.	Phase to Earth/Neutral	mm	19
12.	One minute power frequency withstand voltage	kV	2.5
13.	Short-time current for 1 sec.	kA rms	50/65
14.	Dynamic withstand current rating	kAp	105/137

7.0.0 DRAWINGS & DOCUMENTS

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

- Technical data sheets.
- Busduct sizing calculation
- GA and busduct layout and sectional details.
- Termination detail at equipment of both sides.
- Wall frame assembly drawing.
- Hot air blowing equipment drawing.
- Air pressurization equipment details.
- Particulars of CT.
- Scheme diagram and GA for space heater DB.
- Scheme for space heater circuit.
- Foundation plan and fixing details.
- Temperature rise calculation.
- Short circuit force withstand calculation.
- Structural calculations.
- GA and Fabrication drawings for supports.
- CT / VT sizing calculation
- Catalogues / drawings / leaflets for all items
- Erection and commissioning procedures
- Operation and maintenance manual
- Test reports
- Sub-vendor list
- Manufacturing quality plan
- Field quality plan

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SECTION: F

F.2 CONTROL AND INSTRUMENTATION (VOLUME-II, SECTION: 4)

F.2.1 DESIGN REQUIREMENT (SUB-SECTION 4.3)

3.1.2 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;

- Failure of sensor or transmitter,
- Failure of main and/or redundant controller, other electronic modules,
- Loss of motive power to final control element,
- Loss of control power.
- Loss of instrument air

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.

1.1.7 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

1.21.8 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.

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F.2.2 SPECIFICATION FOR DCS/PLC (SUB-SECTION: 4.6, 4.7)

- 1.0.0 The intent of the specification is to comply the requirement of the PLC/ Micro PLC proposed or supplied by the bidder for the equipment mounted or skid mounted items. The microprocessor based Programmable Logic Controllers (PLC) (Operator stations / Engineering stations shall be provided as specified in this section) shall consist of dual power supply modules, hot standby processor modules and communication modules with redundant communication link for communicating with remote Central control room DCS. The PLC shall be 100% modular and expandable. On-line replacement of all modules shall be possible.
- 2.0.0 PLC based systems of same make and same family of hardware shall be provided.
- 3.0.0 The system shall provide for sequencing of automatic start-up / shutdown bringing standby equipment into operation on failure of main equipment and manual intervention facility for all the equipment.
- 4.0.0 All the necessary hardware, licensed software, interfacing/driver cards, hubs/switches, cables and connectors for this purpose shall be supplied and installed and commissioned by the Bidder to make it full functional upto the full satisfaction of the Owner. 10% wired I/O spare upto the terminal blocks on each card shall be considered by the Bidder. 10% wired spare slots to accommodate electronic modules to be provided. And processor / communication loading should not be more than 60%.
- 5.0.0 The supplied PLC system shall have open system architecture to integrate/communicate with any third party system. It is the Bidder's sole responsibility of interfacing the PLC and SCADA system with central control room DCS and make this soft link communication fully functional upto the full satisfaction of the Owner. Programmable terminal with a laptop and software shall be provided for the PLC's.
- 6.0.0 The supplied PLC system shall be interfaced with DCS through OPC DA (data access) protocol. Since the PLC interface to DCS is used for monitoring purpose, the OPC on the PLC side shall act as server and OPC on the DCS shall act as client. The interface shall be used for monitoring purpose and control is not foreseen through serial link. Each PLC shall be interfaced independently with DCS.
- 7.0.0 The PLC system features shall include but not be limited to the following:
 - a) Scan time for digital and pulse inputs not greater than 100msec.
 - b) Scan time for all analog inputs not greater than 250 ms for non critical and 100 ms for a critical
 - c) Execution time not greater than 100msec.
 - d) Max. system loading of 60% under worst loading conditions.
 - e) Independent measurement circuit for each measurement.
 - f) Grouping of signals in each card is subject to approval at the time of detailed engineering.
 - g) Failure of one logic shall not result in failure of the other logics.
 - h) Overall accuracy of measurement signals shall be 0.5%.

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1.0.0 SYSTEM REQUIREMENTS

- 1.1.0 The following specification shall serve as a guideline to indicate the special requirements for the DCS. The plant control system configuration shall be as per Drawing in ANNEXURE-G.3.
- 1.2.0 The DCS must be capable of fulfilling all requirements of the plant in an optimal way. The offered system shall have been in satisfactory operation for at least three years in plant having capacity of 500MW or more and confirm guarantee against obsolescence for 15 years. The DCS offered shall be of the latest design. The operating system shall be based on windows platform (Windows XP or better) with latest service packs.
- 1.3.0 For designing the system all the specification requirements shall be considered, where applicable. All components and systems offered by the Bidder shall be of established reliability. The maximum reliability shall be achieved by the Bidder considering the meantime between failures (MTBF) and meantime to repair (MTTR) such that system will be available for 99.7% or better.
- 1.4.0 The operation of the plant DCS shall be based on simplicity and rapid access for monitoring and taking control actions.
- 1.5.0 Plant DCS to provide plant co-ordination for start-up, synchronization, normal load range, shut down and emergency operation of the plant in a coordinated sequence.
- 1.6.0 DCS will provide automatic supervisory control and pre-planned protective actions (run back, over-ride control, control mode transfer etc.) during upset conditions if the operator or normal modulating controls cannot be expected to provide a timely or adequate response.
- 1.7.0 The operation mode of the system must be conceived in such a manner that access to the process variables, motors and actuators shall be possible very quickly with only a few key strokes. In critical situations the switch from one display which supports operator control actions to another such display must be possible directly without the need to select additional intermediate displays. Systems are preferred which, in addition to the capability of taking control actions from dedicated displays; also provide the facility of taking such actions via graphic displays.
- 1.8.0 The operator station, LVS and other peripherals will perform control and monitoring functions including data archiving & alarm monitoring, dynamic graphic display for plant operation, Group display and trend group display, Real time and history trending of each loop, Alarm display and storing alarms for history, Multi window graphic display, Logging functions, Printing of system alarms, process alarms, graphics with dynamic reading and logging, operation of printing function will be continuous, scheduled and as well as on demand.
- 1.9.0 The following control system redundancy shall be considered,



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a) SG and TG integral

The control, protection, and monitoring system shall be implemented in a redundant fail safe & fault tolerant configuration. Power supply modules, communication & network interface cards, controllers, I/O modules for controls and interlocks shall be redundant.

b) Plant DCS

Power supply modules, communication & network interface cards, controllers and serial interface to other control systems shall be redundant. Redundant Input and output modules shall be provided for all the drive level interface (both OLCS/CLCS). For the inputs, 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's. Logics for the redundant drives shall not be in the same processor.

1.10.0 A functional group control hierarchy will be devised for all major plant equipment and their auxiliaries to allow operator to select a lower level of certain system or equipment during trial runs, testing etc.

DCS system will comply with following general failure criteria:-

- a) No single fault can cause the complete failure of the control system.
- b) No single fault can cause the Turbine/Boiler/Generator protection system control to malfunction or become inoperative.
- c) The grouping of control functions into system blocks will be arranged such that failure of any one block will only partly degrade the control of the overall system. Such degradation will always be manageable by operator intervention. Functional grouping of controllers shall be subject to approval by Owner.
- d) The control system will be structured to reflect the redundancy provisions of the plant so that no single fault within the control system can cause the failure of the duty equipment or make the standby equipment unavailable.
- e) As a result of a control system fault, a plant item or control function will always respond to its controls at the actuator level. That item or control function will be required to be isolated from automatic control system.

1.11.0 To meet the above failure criteria, the DCS system will incorporate diagnostic/self-checking facilities so that internal faults can be detected within the system itself prior to any resulting disturbance to the process. In addition, the protection and safety systems will incorporate channel redundancy or diversity of measurement as well as self-checking and adequate test facilities. For some important systems, "On line" test will be employed with no effect to the proper functioning of the protection system.

1.12.0 In order to achieve high plant safety and availability, the control systems shall be functionally distributed, highly modular and in a hierarchical configuration. This

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guarantees that any faults arising in the control system will always be confined to a limited section of the plant. The hierarchical configuration shall enhance the transparency of the plant for the operating personnel, in particular when faults arise.

1.13.0 Essentially, the configuration as defined shall have the result that in the event of a fault in the control system, manual operations will be required only at one or very few locations at the same time.

1.14.0 Controllers will be 100% hot standby.

1.15.0 Protection signals shall always intervene at the bottommost control level, and thus always have priority over automatic and manual interventions. Parallel wiring of protection, control signals is preferred over transmission of protection signals by way of a data bus.

Concept for I/O assignment shall be as follows:

- a) No two identical / similar equipment shall be grouped in the same I/O module and in the same rack.
- b) Any one card shall have I/O related to only one equipment and auxiliary. If, any equipment and auxiliary requires more than one card, I/Os for related auxiliaries (e.g. LOP-A, LOP-B) shall be in a different card.
- c) I/O assignment shall be identical for similar/redundant equipment. For example if BFP A run is assigned to channel 3 of a card, BFP-B run shall also be assigned channel 3 of another card.

1.16.0 In case of control power interruption for a short time (seconds) the Systems must maintain the plant in operation and after power restoration no false commands shall be issued.

1.17.0 To avoid damage to the plant equipment in the event of a major failure in the Systems, a safe shut-down of the plant must be guaranteed.

1.18.0 OPC servers provided shall be dual hot redundant and be of OPC UA or higher version. The OPC shall support data access, Alarm & event, Historical data access and the Bidder shall match the OPC protocol with the other systems for time stamped transfers.

1.19.0 The system will be provided with extensive diagnostic features so that a system failure can be diagnosed down to the module level giving location and nature of fault. Ease of maintenance and trouble shooting will be a primary consideration in equipment selection. The interposing relays provided shall be with minimum 2NO+ 2NC contacts.

1.20.0 DCS system shall have suitable interface arrangement so that pre-selected plant parameters and process mimics can be viewed at selected nodes on the plant's

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local areas network (LAN) or wide area network (WAN) or from remote locations via dial up or internet connection. Bidder shall provide two PC and A4 laser printer (B/W) along with necessary software & internet connection at Owner's corporate office for remote monitoring.

- 1.21.0 On unit tripping, alerting the maintenance Engineers/ Management/Corporate office via Email facility should also be provided in unit DCS. Unit trip and major equipment trip SMS in communication system. On unit tripping about hundred Engineers shall be informed through SMS automatically from DCS through communication system. In case of tripping of major fans/pumps/HT drive the concerned Engineer configured in such a way to get the SMS information

However to protect against unauthorized access to network, sufficient security arrangement in the form of firewall or any other suitable hardware / software keys etc., shall be deployed.

- 1.22.0 Network Monitoring device/software shall be provided as a in built feature of DCS for both the main plant and BOP.

- 1.23.0 The power supply for all the DCS panels of unit, common and BOP shall be fed from redundant feeders of plant UPS system.

- 1.24.0 UPS for the DCS of unit, common and BOP shall be redundant with redundant feeders for powering to the DCS panels located at different locations.

2.0.0 SYSTEM COMPONENTS

2.1.0 Controller Sub-System

- 2.1.1 The automatic control functions of the system shall be executed by microprocessor based controllers. The multi loop controller shall have 1:1 hot redundancy in each processor, power supply, and communication controller shall be redundant. To ensure that the above security aspects are met, the primary controller shall be backed-up by another controller that takes over automatically when the primary controller fails. The control output shall be fed back to both the controllers to allow bump-less transfer to be accomplished.

- 2.1.2 The time taken for stand-by controller to take over in the event of failure of primary controller shall not exceed one scan cycle of the controller. The transfer shall be bump-less and procedure less.

- 2.1.3 The controllers shall be capable of performing regulatory control, sequencing and interlocking.

- 2.1.4 The controller shall be capable of performing the following output processing functions.

- Output open check
- Output high/low alarm
- Output high/low limiter
- Output velocity limiter

- 2.1.5 The basic control functions shall include proportional, integral and derivative algorithms.



- 2.1.6** Advance control functions shall be inclusive of feed forward, Cascade control, high-low limit control, dead-time, lead lag, high-low signal selection, real-time computational capability etc. apart from other algorithms used in the plant DCS like feedback controls, Mean value and auto selection logic, bypass valve control, start-up/shut down curves.
- 2.1.7** The controller sub-system shall be capable of performing the following input signal processing functions like square root extraction, linearization for thermocouples, pulse train input function, line segment function, digital filtering, totalizer functions etc. as a minimum.
- 2.1.8** Controller shall be able to operate in either manual, auto, cascade mode. Mode change over in either direction shall be procedure less and bumpless.
- 2.1.9** Functional grouping of controllers shall be based on the Unit and Common DCS controller grouping. Conceptual drawing shall be referred for the grouping criteria and the number of controllers envisaged based on the density of I/Os for the plant capacity. Minimum number of redundant controllers for each unit DCS (excluding TMR system for BPS & TPS and the common DCS) shall be thirty five (35) numbers. (35 pair of controllers)
- Station electrical in common DCS shall be assigned with minimum of three (3) pair of controllers. And the BOP systems shall be assigned with the required number of redundant controllers in the Remote I/O units in accordance with the I/Os requirement.
- However the number of controllers and the grouping shall be as per the requirement evolving during detail engineering which shall be reviewed and approved by the Owner. No mixing of functional groups is allowed. If SG integral or TG integral controls are part of the plant DCS then separate controllers for each SG integral and TG integral to be envisaged.
- The Controller allocation criteria shall be as per the following guidelines as minimum
- The Boiler management system shall be assigned with separate controllers
 - The control logic of the mill shall be assigned in different controllers. Any one controller shall control maximum 2 mills.
 - The control logic of A or B side air and flue system of shall be assigned in a different controller.
 - The control logic of each BFPT pumps, forced draft fan, induced draft fan, primary air fan, condensate pump, circulating water pump, etc. shall be assigned in a different controller.
 - The same side of the equipment shall be assigned in the same controller as possible such as A-side induced draft fan and A side forced draft fan which can be configured in a controller. Similarly B-side induced draft fan and B-side forced draft fan can be configured in another controller. A-side forced draft fan and B-side induced draft fan does not allow to be assigned in a controller
 - Important auxiliary device shall be assigned in a different controller



- g. Left and right air-flue gas paths do not share the controller
- h. Left and right water paths do not share the controller.
- i. Those auxiliaries who are common to both paths will be resident in the controller other than those used for left/right paths so that both paths will not be lost due to the failure of a processor.
- j. The Air and Water paths do not share controllers
- k. Unit and station electrical shall be assigned in a separate controller.
- l. Redundant components and equipment within given systems shall be distributed among processors and I/O cards to the extent possible
- m. Critical inputs shall be supplied with redundant sensors/transmitters with each input connected to different input cards. Where redundant inputs exist, the DCS shall be configured to automatically reject erroneous data. Where required, one-of-two, two-of-two, two-of-three, or median select schemes shall be utilized to ensure the integrity of critical inputs.
- n. Wherever there is a process redundancy (Left/Right or Running/Standby) or transmitter/switched redundancy available, such inputs shall be routed through independent input cards.
- o. No two control loops/interlock loop shall share the inputs (either binary or analog) vide input cards if process signals are independently available. Protective inputs for two drives shall not be allotted to the same input card.
- p. In case inputs / outputs are required from one logic to another, they can be soft wired, provided if they are on same processor. For those inputs/outputs resident on other processors, the same shall be hardwired.
- q. Critical inputs and outputs in CLCS shall be connected to redundant AI/AO cards

- 2.1.10** The grouping of control loops in controllers shall be done based on the input / output (I/O) handling capacity of the individual controllers such that the system availability in the event of loss of one controller is more than 50% (i.e., whenever there is more than one similar equipment ex.: Feed water pump, necessarily the two shall be implemented in different controllers).
- 2.1.11** The controller shall be capable of carrying out following alarm check functions:
- a) Input open/output open check
 - b) High high, high, low and low low alarms
 - c) Velocity and deviation alarms
 - d) Alarm hysteresis
 - e) Alarm bypass
 - f) Alarm output off.
- 2.1.12** The system shall be capable of sending the following messages to the operator interface sub-system:
- a) Self-diagnostic alarms
 - b) Process alarms
 - c) Loop status changes
- 2.1.13** The controller shall have facility for slow and fast ramping of set point and output. Also all controllers shall have anti-reset wind up as a standard.
- 2.1.14** Two separate DO cards are to be used to de energies the solenoid coil by relatching for high reliability on safety of system.

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2.1.15 The remote I/O panel shall be provided with redundant processor, redundant power supply unit and redundant communication modules etc., on as required basis for the measurement of boiler metal temperature, flue gas temperature, air pre-heater grid temperature etc. The remote I/O panel shall be provided with I/O cards, redundant power supply unit and redundant communication modules etc. These parameters are brought to DCS via DCS I/O bus or via redundant soft link (either TCP/IP on OPC or MODBUS with RS485) to have real time data. This remote I/O panel shall be powered from redundant UPS or 24V DC source of respective unit of respective unit. The unit enclosure shall be of weather proof, dust tight and water proof. Bidder shall provide necessary air conditioning unit, if required for the system. This panel shall also accommodate 4-20 mA and RTD signals for monitoring parameter and not for control. The quantities of remote I/O panels shall be decided during detailed Engineering. For connecting remote I/O units with plant DCS and connecting BOP system to the plant DCS, Single mode fibre optical cable with converter, de-converter, termination etc shall be provided.

2.1.16 Remote I/O panel shall be provided with redundant processor, redundant power supply unit and redundant communication modules etc., on as required basis for the 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 remote I/O panel shall be provided with I/O cards, redundant power supply unit and redundant communication modules etc. These parameters are brought to DCS via DCS I/O bus or via redundant soft link (either TCP/IP on OPC or MODBUS with RS485) to have real time data. This remote I/O panel shall be powered from redundant UPS or 24V DC source of respective unit. The unit enclosure shall be of weather proof dust tight and water proof. Bidder shall provide necessary air conditioning unit, if required for the system. This panel shall also accommodate 4-20 mA and RTD signals for monitoring parameter and not for control. The quantities of remote I/O panels shall be decided during detailed Engineering. For connecting remote I/O units with plant DCS and connecting BOP system to the plant DCS, Single mode fibre optical cable with converter, de-converter, termination etc shall be provided.

2.2.0 Data Acquisition Sub-System

2.2.1 Data acquisition subsystem shall have dual redundant processors, power supplies and communication including cables. I/O redundancy is not envisaged. All other accessories as required to make the system complete shall be provided.

2.2.2 Data acquisition sub system shall cater to both analog and discrete inputs from open loops. The inputs shall include 4 20Ma DC, thermocouples, resistance temperature detectors (RTD), voltage signals, resistance signals and discrete contacts, as a minimum.

2.2.3 The data acquisition system shall be capable of performing the following alarm check functions as a minimum:
a) Input open check

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- b) Velocity alarm check
- c) Deviation alarm check
- d) High/low/high high/low low limit alarm check
- e) Alarm bypass

2.2.4 The sub-system shall be capable of processing linear and non-linear analog inputs, linearization for thermocouples and RTD inputs, square root extraction, totalizing of inputs and burn out protection for thermocouple inputs.

2.2.5 All open loops analog inputs used in DAS shall be scanned at a maximum of 250 ms interval.

2.2.6 It shall be possible to display all variables of the data acquisition sub system on the operator consoles by addressing from the keyboard.

a) Man Machine Interface

- i) Operator's interface sub-system shall have industrial type high resolution color LED flat panel of screen size 24". Resolution shall be minimum 1920 X 1200 resolution pixels. Each operator interface sub-system shall consist of electronics, Qwerty keyboard with special function keys, mouse or trackball, LED with antireflection features, offered with the latest configuration such that the system will not slow down while processing multiple tasks. The most current release of fully tested hardware shall be supplied. The features and the configuration for all the stations in the power project shall be reviewed and approved by the Owner.
- ii) Large video screen (LVS) shall ensure operation even if the operator stations fail. LVS shall consists of DLP REAR projection 84" displays suitable for 24/7 application with anti reflection feature and resolution of not less than SXGA, image processors, controllers with the plat form compatible with the DCS.
- iii) Commands through mouse operation on individual LVS by the operator to unit control systems shall be possible. Similarly for all other LVS of BOPs and CHP, commands to respective control system through mouse action on LVS by the respective operators shall be possible.
- iv) 21 Nos. of Digital display units are required to display Total MW and this will get the total MW data on modbus TCP/IP. The digit size of the display unit will be 300 mm for 6 Nos. and 200 mm for 15 Nos. The location shall be decided during detailed Engineering.

2.2.7 The operator, as a minimum, shall have access to all the displays, acknowledge alarm asand when they are annunciated on the operators' console, special function keys for single stroke operation to have direct access to any parameter assigned, Auto/manual/cascade/computer mode changeover of each controller with bump less transfer from one mode to another, facilities for slow and fast ramping of set point and output of each close loop parameter.

2.2.8 Access to changing control parameters, alarm limits and security level shall be through limited passwords or key lock system.

2.2.9 The sub-system shall be provided with highly reliable and field proven Hard Disks for storing of complete system software and operational data with minimum 30% spare capacity. Suitable battery back-up shall be provided for protection of volatile memory (for 72 hours).

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2.2.10 The system shall be also equipped with the external DVD/CD drive as a back-up device. The external DVD/CD drive shall have read/write capability and shall be provided with all required hardware interface including error detection and correction facilities.

Features shall include the following

- i. Supported Formats: DVD+R, DVD+RW, DVD-R, DVD-RW, DVD-ROM, DVD-video, CD-R/RW, CD-ROM/XA, CD-ROM, Audio CD, VCD, CD-I(FMV), Photo CD, CD- EXTRA, CD-TEXT
- ii. Write Speed: 8x DVD+R, 4x DVD+RW, 24x CD-R, 16x CD-RW
- iii. Read Speed: 24x CD-ROM, 8x DVD-ROM
- iv. Compliant with USB 2.0 High-Speed (480Mbps)
- v. Bootable on OWSs/Laptops
- vi. Memory buffer size: 2MB minimum.
- vii. Powered by an additional USB power cable for best speed. (Requires one more USB port available)
- viii. Can be powerless (only connected by the USB data cable).
- ix. Plug & Play and hot pluggable.
- x. Portable Design. .

2.2.11 In case the proprietary design/architecture of the manufacturer calls for separate Application/History processor for intensive computation, operation and bulk memory storage, the same shall be provided separately as application/history processor station with redundancy.

2.2.12 All the operator keyboards shall be interchangeable. All operator stations shall be identical and fully interchangeable. It shall be possible to carry out control/monitoring of total plant from any of the station and any station can be assigned for control/monitoring of any particular part of the plant. Any change made for any parameter for an input from any display shall be automatically updated on all displays configured for that input. Bidder to ensure that, any single failure in MMI hardware/software including controller, coupler, interfacing devices, cables etc. shall not lead to non availability of more than one operator station. The Operator station shall also include diagnostic functions that automatically detect process faults.

2.2.13 The Operator station must provide enough information under abnormal or hazardous conditions caused by failures in plant equipment or in the instrumentation and control system to allow the operator to identify the equipment causing the trouble, take measures to correct it, and move the process back to its normal operating state.

2.2.14 To determine whether it is the instrumentation and control equipment that is causing the problem, the Operator station should provide the following diagnostic features and make the results of diagnostic tests available to the operator:

- a) Ongoing tests and reasonable checks on the sensors and analyzers that measure the process variables of interest.
- b) Ongoing self-tests on the components and modules within the distributed control system itself: controllers, communication elements, computing



devices, and the human interface equipment itself.

c) Simulation of process variables shall be possible.

2.2.15 The engineering station configuration will be as same of that of the operator interface system except for the keyboard which shall be QWERTY type. The engineering station shall have provision for performing the following engineering functions.

- a) Database configuration including configuration of all displays and loops for various sub- systems.
- b) Automatic downloading of the configurations in each sub-system.
- c) Configuration of various control functions or control blocks to implement various control strategies and downloading the same into the respective control stations.
- d) Configuration/reconfiguration of alarm settings, their values, addition/deletion of alarm from groups, controller tuning like changing P,I,D values, dead time values etc.
- e) Defining the key lock functions or engineer keyboard functions.
- f) On-line compilation of all types of dynamic graphic displays.
- g) Setting of real time clock.
- h) Plant/group alarms inhibit function.
- i) Start/stop of each sub-system, including printers.
- j) Enabling/disabling of different instruments/ peripheral connected to the system.
- k) Scan-on /off-scan of different tags connected to the system.
- l) Preparation and compilation of logs/reports/ historical trend points.
- m) Calling of detailed self diagnostic displays for maintenance aid.
- n) Loading, editing, compiling and executing of all programs written using high level languages supported by the system.
- o) Performance calculation and load calculation using standard high level languages and using the real time data available on the DCS highway. It shall be possible to view the plant performance in any of the operator and MIS stations also.

2.2.16 Online configuration changes shall automatically update all modules, tags and subsystems affected by the change. Online configuration changes shall follow a prompt- validation sequence requiring a final acknowledgement step before the change is transmitted.

2.2.17 It shall be possible to save all database and configuration data on both removable and non- removable media for back up purposes without taking the system off line. It shall be possible to down load the data bases and configuration data to all modules from a single location.

2.2.18 Each analog input/output and analog control block shall be assigned an engineering unit. Engineering unit shall be a minimum of 6 free format alphanumeric characters. Engineering unit shall be automatically displayed along with the variable. System shall accommodate user configurable engineering units.

2.2.19 Printers shall be network printers and shall be freely assignable. All the printers shall be of heavy duty industrial grade. Printers shall be provided for printing of various

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events, shutdown reports etc. and making hard copies of various displays/ graphics, log reports, sequence of event recording etc. as given below:

- a) One Nos. Color laser A4 size printers for DCS alarm/etc
- b) One No. dedicated 132 column dot matrix printer for SOE
- c) One No. colour Laser printer A3 size for DCS graphics.
- d) One No. color Laser A4 size printer for Shift-in-charge.
- e) Two (2) nos of 132 column high speed line printers for post and pre trip logs, data base etc.
- f) One no. Engineering station with one no. color laser A3 size heavy duty printer for unit DCS. Another Engineering station with one no. A3 size scanner, copier cum heavy duty i printer shall be provided for unit DCS
- g) One no. Engineering station with one no. color laser A3 size heavy duty printer for common DCS. Another Engineering station with one no. A3 size scanner, copier cum heavy duty printer shall be provided for common DCS
- h) One no. monochrome laser A3 size heavy duty grade B/W printer for station in charge

2.2.20 Displays and Logs

Displays and logs related to the turbine-generator system are indicated as below:

- (1) Real Time Parameter/Status Display (default screen).
- (2) Real Time Trend/Historical Trend graph display, print out (on demand).
- (3) Alarm summary display/print out (on demand).
- (4) Alarm limit display / print out (ondemand).
- (5) Turbine Start-up log/print out (event actuated).
- (6) Shift Log/Daily Log/print out (on demand).
- (7) Generator trip log/print out (event actuated).
- (8) Turbine trip log/print out (event actuated).
- (9) Operator Control Screens.
- (10) Group Display screen (at least 8 loops).
- (11) Individual display screen (single parameter).
- (12) Flow chart/logic screens.
- (13) Operator's guidance message screen. Logs : (provisional)
- (14) Hourly Log : 250 plant data and 30 computed data.
- (15) Shift Review Log : 120 plant data and 20 computed data.
- (16) Daily Log : 120 plant data and 30 computed data.
- (17) Monthly Log : 120 plant data and 30 computed data.
- (18) Yearly Log : 120 plant data and 30 computed data.
- (19) Alarm Log : 1000 plant data and 15 computed data.
- (20) S.O.E. Log : 1024 Inputs.
- (21) Boiler Start-up Log (event based/manual) : 30 Analog, 60 Digital and 10 computed data (1 minute interval for 3 hours/ boilerstart-up).
- (22) Turbine Start-up Log (event based /manual) : 30 Analog, 60 Digital and 10 computed data (10 seconds interval for 1 hour / TurbineStartup).
- (23) Synchronization /Loading Log (event based /manual) : 40 Analog, 80 Digital and 15 computed data (10 seconds interval for 1 hour/synchronization).



- (24) Generator Trip Log (event based) : 40 Analog, 80 Digital and 15 computed data (15 second interval for 15 Minutes/GCB trip or GLR operated).
 - (25) Turbine Trip Log (event based) : 40 Analog, 80 Digital and 15 computed data (15 seconds interval, for 30 Minutes/Turbine trip).
 - (26) Boiler Trip Log(event based) : 60 Analog, 80 Digital and 15 computed data (15 second interval for 15 Minutes /Boiler trip).
 - (27) HP Bypass Log (event based) : 20 Analog, 15 Digital and 20 computed data (15 seconds interval, for 30 Minutes/Bypass open).
 - (28) Pre-Trip & Post Trip Log: 1 second interval for 3 minutes.
 - (29) Maintenance logs : For the equipment with motor rating 30 KW and above.
- Apart from the above logs, not less than ten other logs are anticipated. Such logs shall comprise of computed data typically like running hours of drive, fuel consumption, water consumption, auxiliary power consumption, maximum metal temperature (about 40 points), calculated values like efficiency & heat rate etc. Logs shall be configurable and reconfigurable at site.

2.3.0 Mass Storage Sub-System

2.3.1 Mass storage system shall be offered with necessary hard disks in RAID-5 or better configuration, controllers and back up devices. The mass storage system offered shall be capable of storing process events, alarm events, graphics, logs, reports in addition to the functional requirements of the system. It shall be possible to store the trend for at-least 1000process variables with one sample every 1 minute for a minimum of 15 days and 500 variables with ten second for a minimum of 7 days. In order to extend the limiting period the delta value technique for change in parameter value is to be adopted. Historical recording shall be possible for storing hourly, shift, weekly, monthly averages for at-least 1000 process variables. It shall also be possible to record the alarm events.

2.3.2 All events (such as changes in set-points, computer/auto/ manual mode changes, alarm inhibits, changing over from one key lock position to another etc.) alarms and messages shall all be stored as historical messages and presented to the operator as and when required. Important parameters trends etc related to plant efficiency and performance equipment history etc, shall be duly secured in the storage medium viz, optical disk drive unit for long time archival. Bidder to elaborate in his proposal, the memory capacity offered and the back-up in number of days stored considering the worst case loading. At least minimum one month storage is to be considered in the hard disk without back up. Sufficient back up storage medium Magnetic Optical disks shall be supplied for a storage period of 5 years of data. Historical Data Storage & Retrieval system shall be redundant (2x100%) and shall comprise one no. Engineering Station with one no. 132 Col Dot matrix printers for each unit and common DCS. Operator station based non-redundant distributed history data bases shall not be accepted.

This master storage system shall be capable of taking back up of third party systems like VMS,EMS etc.

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2.4.0 Plant Data Bus/Communication System

2.4.1 The communication sub-system shall be a digital communication bus, that provides a high- speed data transfer rapidly and reliably between the various sub-systems. The transmission rate shall be minimum 1 GBPS or better as per IEEE 802.3 / 802.4/ 802.5. Communication sub-system shall be dual redundant, consisting of two separate communication buses and two separate communication interfaces for each node. Both data highway subsystems shall be active at all times. Healthiness of each bus shall be automatically tested periodically at regular intervals without affecting system operation.

2.4.2 In case of main bus failure or any communication device failure, the transfer to the dual redundant back up device shall be automatic without interrupting the system operation and without any operator's intervention. Information about the failed bus/device shall be displayed on the operator / engineer station.

2.4.3 Failure of a particular node shall not be treated as failure of communication bus. Transceiver failure at a particular node shall not be displayed as data highway failure. Bus and node devices shall be suitably isolated against the surges and noise.

2.4.4 It shall be possible to switch over the communication from main bus to the dual redundant bus manually without disturbing the system operation.

2.4.5 It shall be possible to connect or disconnect any device from the system without disturbing the operation.

2.4.6 The mechanism used by the communication system for error checks and control shall be transparent. Error checking on all data transfer shall be done by cyclic redundancy check and / or any other advanced codes.

2.4.7 The data highway offered shall have 30% spare nodes without highway extender for future expansion. It shall be ensured that the bus loading does not exceed 60%.

2.5.0 Sequence of Events Recording (SER)

2.5.1 The Sequence of Event Recorder shall be integral to the DCS.

2.5.2 It shall be possible to perform the engineering function of the Sequence of Event Recorder from the engineering station offered for the DCS.

2.5.3 The Sequence of Event Recorder signals shall be time stamped with one milli second resolution at the I/O card level.

2.5.4 SER system shall be capable of presenting/aquiring 1024 events with a resolution of one milli second.

2.5.5 The SOE system shall be synchronized with station GPS

2.6.0 DCS Power Supply Modules

2.6.1 The system power supplies shall be suitable for 230 V AC 50 Hz, 1Ø UPS power.

2.6.2 HMI devices, all operator stations and engineering stations shall be operated with 230VAC.

2.6.3 The power supplies shall have a fuse rated suitably, according to the nominal current requirement.

2.6.4 The power supplies shall have built-in diagnostic circuitry, which checks for out-of-range voltages and over temperature conditions. Each power supply unit shall have pair of LEDs to indicate normal operation and alarm condition.

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- 2.6.5** The power supplies shall be provided with necessary cooling fans.
- 2.6.6** The power supplies shall be provided with galvanic isolation.
- 2.6.7** The power supply units shall be provided with miniature circuit breaker (MCB) of sufficient rating.
- 2.6.8** All power supply to cabinets shall be redundant & have auto change over facility or diode auctioneering. Power supply failure monitoring shall be provided in DCS for controller and I/O cards.
- 2.6.9** Power supply for operator stations and system peripherals shall be from UPS.
- 2.6.10** Redundant power supply modules shall be provided for operator stations. These shall be fed from two independent power supply feeders.

2.7.0 Main Controller Characteristics

Each controller envisaged for this project shall have following features as minimum:-

- i) Processing word length of 32/64 bit (Preferably 64 bits)
- ii) 16 Mbytes RAM
- iii) Redundant power supplies
- iv) Power fail/auto start feature
- v) Watch Dog timer
- vi) Memory protection
- vii) Direct Memory Access feature
- viii) Self monitoring & diagnostic feature
- ix) Easy modification of control functions
- x) RISC/CISC based
- xi) Real time data controller, Computer/PC based soft controller are not acceptable.

2.8.0 DCS Input / Output Modules

- 2.8.1** Input / Output (I/O) modules shall be modular plug-in-type suitable for mounting in racks. The multi-channel I/O cards for all AI cards shall have a maximum of 16 channels, AO card shall have maximum of 8 channel, DI/DO card shall have maximum of 32 channel. The analog input card shall capable of powering the transmitters with 24V DC and shall be capable of accepting the following signals. All process input / output card will have suitable isolation Galvanic / Optical for each channel at input / output respectively. Interrogation voltage for digital cards shall not be grouped and provided for each individual channels. A/D conversion of the measuring signals shall be such that the required data accuracy be guaranteed (minimum resolution 12 bits). Signal outputs shall be provided with protection against short-circuits. The principle of A/D converters shall be that of integration. 50 Hz noise shall be suppressed in a suitable way.
- 2.8.2** Analog Inputs : 4-20 Ma DC signals, RTD 3 wire & 4 wire and T/C signals
- Analog Outputs : 4-20 Ma DC, 1-5 V DC
- 2.8.4** Digital input modules (DIM) shall be provided with internal voltage source to convert contact state of potential free contacts, either change-over or ON-OFF into logic level signals. Possibility of surface film or contaminant on the contact shall be considered while selecting this source. Input interrogation voltage shall be 24V DC. Each module



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shall be provided with circuitry to detect card/channel failure and same shall be indicated. Couple of channel failure shall not result in total card failure. Each module shall be designed with self-checking features for detecting faulty operation. In case of individual card failure, on line replacement of the faulty module shall be possible.

2.8.5 Digital output modules shall be provided for controlling ON/OFF status of final control devices like motor starters, the outputs shall be 24 V DC direct driving or through interposing relays. All solenoid valve shall be rated for 24 VDC, 230V AC and 220 VDC. Interposing relays shall be accordingly provided for 230 VAC, 24VDC and 220 VDC rated solenoid valve for energizing these valves from the DOMs. Digital output modules (DOM) shall convert the internal level of the system into external binary signal levels required by the process. Digital output modules (DOM) shall be able to source / sink sufficient current while energizing field outputs. The outputs shall be able to drive breaker coils, contactors etc., directly.

2.8.6 All modules shall be provided with circuitry to detect card/channel failure and same shall be indicated. Couple of channel failure shall not result in total card failure. Each module shall be designed with self-checking features for detecting faulty operation. The input / output modules shall have SMART transmitter interfacing capability, detection of breakage in wire, out of range detection, contact bounce filtering, thermo-couple open circuit check features, RTD open circuit and closed circuit capabilities. Incase of individual card failure, on line replacement of the faulty module shall be possible. Output status simulation facility shall be possible, when the system is "ON-LINE".

2.8.7 All inputs / outputs (AI / AO / DO) shall have integral isolators and current limiting circuitry so that faults, short circuits, open circuits and overloads in one signal do not effect any other signal. Input / Output modules shall incorporate signal conditioning / filtering circuits to reduce the effects of electrical surges, noises and contact bounces.

2.8.8 Input / Output modules shall be designed to withstand vibration / EMI / RFI / Surges effects as per relevant standards.

2.8.9 Status indication of each input shall be available on the operator & engineering workstations.

2.8.10 It shall be possible to remove and insert the modules while the system is 'ON' (Hot swap of I/O modules)

2.8.11 Diagnostic LEDs shall be provided on the front plate of each module to indicate faults.

2.8.12 Identification labels (color-coded) to indicate one type of I/O card, signal level etc. shall be provided on the front plate for each I/O module.

2.9.0 Panels, Desks, Racks and Cubicles

2.9.1 In general in the following sections, panels shall mean marshalling panels, system cabinets, relay panels & power supply panels unless otherwise stated.

2.9.2 Unless otherwise specified, panels and cubicles shall be of floor mounted and free standing construction including those used for alarm and protection relays and the like. The electronic cubicles shall house rack mounted consisting of I/O, processor and power supply modules.

3.0.0 PANEL EARTHING

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- 3.1.0 Two separate earth circuits shall be provided for earthing, one as electronic earth (or instrument grounding) through separate group of pits for earthing of instruments & electronics and second safety earthing for earthing of system cabinets. These two earth circuits shall be electrically isolated from each other.
- 3.2.0 Each cabinet shall be provided with a copper bus-bar 25 mm wide, 6 mm thick and of suitable length with tapped holes to suite M6 bolts of brass. The copper bus shall be mounted suitably inside the cabinet and shall be electrically isolated from cabinet steel structures through insulated spacers.
- 3.3.0 All circuit grounds of electronic instruments, shields & drain wires of signal cables shall be connected to this ground bus.
- 3.4.0 All doors and removable covers shall be gasketed all around with neoprene gaskets. Ventilating louvers, if provided, shall have screens and filters. The screens shall be made of either brass or SS wire mesh.
- 3.5.0 Design, material selection and workmanship shall be such as to result in neat appearance inside and outside with no welds rivets or bolt heads apparent from outside, with all exterior surfaces true and smooth.
- 3.6.0 Cable entries to the cabinets shall be from the bottom, unless otherwise specified.
- 3.7.0 Equipment shall be mounted such that removal and replacement can be accomplished individually without interruption of service to adjacent equipment. Equipment mounted inside the cabinets shall be so located that terminals of adjacent devices are readily accessible without the use of special tools. Terminal markings shall be clearly visible.
- 3.8.0 Wherever required cabinets shall be matched with other cabinets in the control room with respect to dimensions, color and appearance.
- 3.9.0 Cabinets shall have double leaf door with lift off hinges at the front and at the back if the door width is greater than 800 mm. Doors shall have handles with built-locking facility. All door locks shall be provided with same lock and key combination unless otherwise specified. Keys shall be removable only with the doors locked and 2 keys per cabinet shall be provided.
- 3.10.0 DCS & PLC systems shall have their independent redundant Electronic Earth pits for system grounding. These earth pits shall be separate from the Electrical earth pits and located away from the HT equipments. Panel AC safety ground / Protection earth shall be connected to the Station Electrical earth Pit.
- 3.11.0 System cabinet AC and DC ground shall be electrically isolated from each other and also electrically isolated from the Instrumentation signal ground. All the above ground shall be individually connected to the single point on the ground pit. Dedicated redundant earth pit shall be provided which shall be way from the HV equipment. This earth pit shall not be shared with other electrical equipment



ground and shall also be insulated from other electrical system ground to ensure single point grounding of the system. Grounding resistance shall be better than 1.0 ohm. IEEE guideline shall be followed while designing the grounding system.

- 3.12.0 All panels and cabinets shall be provided with a continuous tinned copper ground bus bar of minimum 25 mm x 6 mm cross section, extending along the entire length of the panel / desk/ cabinet assembly. This signal ground bus shall be bolted to the panel structure on the insulated post. All shield wires shall be connected to this bus for onward connection to the earth pit. System DC power ground shall also be connected to the earth pit in similar way.
- 3.13.0 The panel /desk /enclosure ground shall have two (2) bolt drilling with GI bolts and nuts at each end to connect to GI / copper flat ground riser or by for protection ground. Each circuit requiring grounding shall be individually and directly connected to the panel ground bus.
- 3.14.0 Signal cable shields shall be grounded at the panel end only and shall never be left open. The ground in between panels of a shipping section shall be firmly looped.
- 3.15.0 Manufacturer recommendation and scheme shall be followed for all system panel grounding.
- 3.16.0 Electrical transmitters and switching devices, operating at a voltage less than 50V shall be grounded through the steel structure.
- 3.17.0 **Painting**

The Bidder shall submit a detailed paint procedure for all the panels and other equipment in his scope for the Owners for approval. The procedure shall include surface preparation, paint process and physical characteristics, application and type of paint to be used. All surfaces shall be properly cleaned and prepared to receive prime and finish coatings of epoxy paint. The finish shall be designed to minimize reflections from extraneous lighting sources.

3.18.0 Internal wiring

- 3.18.1 The wires shall be neatly looped and supported in non-flammable plastic wiring raceways. The wiring is to be of general-purpose classification for non-hazardous areas as per the applicable standards. Slotted wire-ways should be used and sized, such that no more than 50% of the cross sectional area of the wire –way is filled. All AC wiring in a cabinet should be routed in steel wire –way to reduce noise in instrument signal wiring. If this is not feasible, it should be physically separated from the DC signal wiring as much as possible. Parallel runs of AC and DC wiring closer than 300 mm should be avoided. Power supply to each instrument / equipment shall be through double pole miniature circuit breaker (MCB) of adequate rating. All these MCBs shall be housed in a separate switch box mounted inside the cabinet. All wiring shall be carried out with 600 V grade, single core, stranded copper conductor wires with PVC insulation. The minimum number of



strands per conductor shall be seven.

- 3.18.2 Terminal blocks of size suitable for 2.5-mm² cable shall be provided for all external wiring. Adequate space/ partitions shall be provided to prevent touching electronic hardware when working at terminal blocks.
- 3.18.3 Wire terminations shall be made with solderless crimping type of tinned copper lugs, which firmly grip the conductor. Insulated sleeves shall be provided at all the wire terminations.
- 3.18.4 Tag no. engraved identification markers made of PVC, plastic or suitable material shall be fitted at both ends of each wire. The marker shall not fall off when the wire is disconnected from terminal blocks. Single lettered ferrules are not acceptable. 'Cross ferruling' method shall be used for identification i.e. ferrule shall identify the terminal nos to which both ends of the wire is connected.
- 3.18.5 Terminal blocks shall be shrouded 600V grade clip-on type, complete with identification strips. A minimum clearance of 100 mm shall be provided between blocks of terminals. Not more than two wires shall be connected to a single terminal.
- 3.18.6 Each row or column of terminal blocks shall be identified with a unique identification and the terminals in a block shall be sequentially numbered.
- 3.18.7 Necessary cable glands shall be provided for glanding all incoming and outgoing cables. All cable glands shall be of nickel-plated brass and double compression type. At least 20% glands of each size shall be supplied as spare.
- 3.18.8 All the signals connected to a module shall be grouped and wired to a single terminal block in the marshalling/IO and system cabinets. The field cables shall not be directly wired to the I/O modules. Marshalling cabinets shall be provided such that DCS system wiring shall be done independent of field cable grouping. The terminal blocks shall be suitably tagged for easy identification.
- 3.18.9 The following colour code shall be used for cabinet wiring.

230 V AC wiring	Phase	-	Black
	Neutral	-	Red
D.C. wiring	Positive	-	Blue
	Negative	-	Grey

Interlock wiring powered by external sources – Yellow Earthing – Green or Green with yellow stripes

3.19.0 Interior lighting and receptacles

- 3.19.1 Each cabinet shall be provided with a LED lighting fixture rated for 230V, 1 phase, 50 Hz supply for the interior illumination of the cabinet during maintenance. The fitting shall be complete with MCB and the respective cabinet door switch shall control the switching of the fitting.
- 3.19.2 Each cabinet shall be provided with a 230 V AC, 1 phase, 50 Hz, 5 Amps, 3 pin receptacle switch mounted inside, at a convenient location.

3.20.0 Name Plates

- 3.20.1 All components mounted inside the cabinet shall be provided with individual nameplates with the tag no. and service engraved. The nameplates shall be



mounted directly below the respective component. Also the cabinet shall be provided at the top with a nameplate engraved with cabinet designation. Nameplates shall be made of anodized aluminum engraved with white letters on black background.

- 3.20.2 Enclosure Protection class for the DCS panels shall be minimum IP-32 as per IEC 60529.

4.0.0 SOFTWARE PACKAGES

4.1.0 Standard software modules shall be available for performing the required control and monitoring tasks. Implementation of the control functions shall be easily possible using readily understandable configuration procedures.

4.2.0 The offered system shall include the display of a number of mechanical flow diagrams or electrical single line diagrams by means of dynamically updated displays.

4.3.0 The software shall be user friendly and flexible so as to enable the user to modify the content to their requirements. Multiple windowing in a single LED monitor or in a LVS shall be provided.

4.4.0 The software shall give the following displays as a minimum.

a) Plant overview displays

These displays shall summarize the key information needed to provide the operator with an overall picture of current plant conditions. The display shall also identify key problem areas.

A summary of the names of various areas in the plant shall serve as a menu to the next level of displays.

b) Area level displays

The displays at this level shall provide information concerning a portion of the plant equipment like Boiler, turbine generator etc. After obtaining a summary of the plant status from the plant level displays the operator shall be able to move down the next lower level to look at the situation in a selected plant area.

c) Absolute value displays

These displays shall show the absolute value of the process variable in bar graph form. The displays shall also show the set point, high and low alarm limits, set points, control outputs, man, auto, cas mode indications. When any of these limits is exceeded the bar graph shall change color. Open loop displays shall mimic the indicator stations and push button stations; indicator displays shall include bar graphs for selected process variable with alarm set points. Push button station displays shall allow the operator to perform logic operations such as opening and closing of valves or starting and stopping of motors and shall include feedback indications like open and close position indications for the valves and running/stopped indications for the motors.

d) Parameter Displays



These displays shall display the tag number and the current value of the process variable in engineering units. If the process variable is in alarm condition the corresponding tag number shall change colour and start flashing. In all these level displays the top line of the display shall display the date, time and alarm status. These displays in addition to graphic displays shall be used to perform control operations.

e) Loop level displays

The displays at this level deal with individual control loops, control sequences and data points. These displays shall be used by the operator for control and analysis purposes

f) Tuning displays

These displays shall help the operating personnel and instrument engineers to tune the control loops. These displays shall include trend plotting capability, necessary functions to allow the operator to control the loop, a list of the tuning parameters (e.g. proportional band, reset rate and derivative rate) associated with the loop.

g) Trend display, historic trend display for various timings.

It must be possible to group the trended variables by related process functions as well as by similarities of time scale of interest. The trend graph must clearly label the tag no, service, engineering units, time increments, and absolute time of day of the trended variables. The operator must be able to obtain a precise reading (in engineering units) of both the current value as well as past values of the trended variable. The same graph displaying the trend should also show auxiliary information that would help the operator evaluate the status of the trended variable. This information includes the nominal value of the variable, the set point of the associated control loop, the allowed range of the variable and the allowed rate of change. Up to 10 trends in trend windows may be displayed on a operating screen, ZOOM and PAN function must be available to facilitate operator analysis of process condition over varied time span.

The system should be able to trend PV, SV, MV of all closed loops and PV and any system calculated values of all open loops connected to the system with a scan rate of 10 seconds.

The historical trend should be able to trend PV, SV, MV, loop status, calculated variables etc. of all the signals connected to the system with a sampling time of 1 min for a period of atleast 24 hours

h) Graphic displays.

Static fields – to provide a background for the dynamic position of the display. They include labels, symbols and other elements that do not change.

Data fields (in engineering units) – Process information that is updated automatically.

Dynamic display elements – These change size, color or shape as a function of changing process conditions (e.g. line drawings, process equipment symbols, bar graphs, or pie charts). They can include both user-defined elements as well as standard library

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symbols. Process mimics shall be in 3D in nature and dynamic on operation console for unit and common DCS

For improved operator efficiency, windowing (picture in picture) capabilities for graphic display will be preferred. The capabilities shall be powerful enough to allow the operator to control / monitor additional information such as trends, loop face plate, operator guide messages etc., by calling up these information as windows within the same graphic page without the need for switching between graphic pages and other information displays. It shall be possible to have more than one trend or more than one loop faceplate display at configurable locations on the graphic page to provide better informative displays for improved efficiency of operation. Bidder shall furnish a write-up about these capabilities in the offered system with supporting documents.

The number of graphic pages per process unit shall be 40 as a minimum.

i) Self diagnostics displays

Card level failure, bus failure or any other failure at any part of the integrated system should be displayed on the VDU as system alarm. An overview of the entire process information network (PIN) showing the various nodes on the network should form the self-diagnostic overview displays. Any malfunction at any sub-system shall be indicated by change of color. By a single keystroke, the operator should be able to go to the sub-system level diagnostic display, which shall show all the cards interconnected by different internal buses. Again, malfunction of a particular card/bus shall be shown by a change of color. In addition, diagnostics feature shall be available at the local level also, by means of LED indicators, at the different cards of the sub-systems. It shall be possible to print detailed diagnostic displays on the printer.

j) Alarm display.

It shall have an ability to handle process alarms as well as system alarms on the operators` stations for operators` attention. First-out alarming function, which enables the operator to know which alarm in a sequence, occurred first. Priority alarming functions, which rank the current alarms by their importance to process operation. Alarms shall be prioritized based on the color codes and categorized accordingly.

Alarms with brief comments shall appear immediately on top section of the operator stations` screen with different kinds of sound depending on priority alarm without any inconvenience to the operator while viewing other important displays of the plant. The process alarm and system alarm shall be displayed separately on the operators` consoles.

All alarms shall be displayed as they occur with change in colour of display in the following sequence, activating an audio signal:

Continuous flashing : unacknowledged
alarm Steady display : acknowledged alarm

Alarm monitoring and reporting shall be based on priority levels



In addition to alarms appearing on different displays, the system shall also be able to display alarm summary and alarm history, listing the date and time occurrence, tag no, point description, type of alarm (absolute value or deviation), serial number of alarm in the sequence of occurrence etc.

Alarms shall disappear from display only when they are acknowledged and cleared. Any abnormal condition in any sub-system or any other function devices shall be displayed as system alarm message on the Operator's/Engineer's console, irrespective of display selected.

The following alarm classification applies to alarms with DCS:-

- k) **Stability alarm**
Stability alarm indicating a disturbance or deviation in normal process operation. These alarms are generally software configured within DCS.
- l) **Bad Input alarm**
When an input signal to the DCS falls outside the range of prescribed limits, the system shall generate an alarm to indicate a faulty instrument signal. It shall be possible to suppress these alarms selectively on a per loop basis.
- m) **System alarm**
These alarms shall be generated by the system diagnostic features to indicate faults within the DCS. Also alarms to be included in this category are system status, power supply failure, fan failure and abnormal system environments. These alarms shall be printed separately from operational alarms.
- n) **Alarm Discrimination**
The DCS shall permit operators to completely discriminate between all alarm categories. This discrimination can be both via colour or priority.
- o) **Alarm Summary Display**
It shall be possible to display summary of alarms in chronological order and shall disappear from display only when they are acknowledged and condition of alarm status returns to normal. The alarm display shall list the following for each alarm as a minimum:
The date and time of occurrence Point identification (i.e. tag no.) Point description
- p) **Type of alarm**
The system shall be able to display on alarm summary a minimum of the latest 100 alarms. When all the alarms cannot be displayed on one screen area, operator shall be able to monitor the hidden alarms by scrolling the display. From the alarm summary display, operator can call any pre-defined display stored in DAS.
 - a) Plant start-up, shutdown messages.
 - b) X-Y plot
 - c) Logs, pre & post trip logs, trend logs, hourly/shift/daily logs.
 - d) Control group display.
 - e) Operator guide messages display as per the results from "What if analysis".

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f) Equipment operating history

Facility to accumulate running hours for all the cycles of start and stop from initial commissioning and last overhaul of the equipment.

Important parameters related to plant efficiency and performance, equipment history etc. shall be duly secured in the storage medium viz. Optical disk drive unit for long time archival. The number of signals shall be decided during detailed engineering.

Others – to be listed by the Bidder.

Software packages such as Life evaluation software, Asset management system, Equipment capability curves to be included.

5.0.0 CLOSED LOOP CONTROLS

5.1.0 All control loops shall be stable for all operating conditions and in all load ranges, and shall have optimum performance in compliance with the latest standards.

5.2.0 They shall be matched in such a way that optimal control is accomplished in compliance with the requirements.

5.3.0 As far as possible, the design shall be so decentralized that in the main control loop, one failure will not lead to an outage of more than one control loop.

5.4.0 Interlocking/protection shall be independent of the control loop or alarm annunciations, i.e. separate measuring points or independent analog transmitters shall be provided. Apart from these wherever signal multiplications are required, it shall be suitably taken care by the Bidder.

5.5.0 In the case of failures, e.g. interruption of power supplies, in the event of switch tripping, etc., the control circuit shall automatically be transferred to a safe condition. In the event of failure of auxiliary power, the actuators shall remain in their position or if this is not possible they shall take over a position which is safe for the process. Similarly, power supply failures shall not result in any undesired or dangerous control actions.

5.6.0 The control system shall have advanced control algorithms like adaptive control, self tuning control etc. Availability of advance control techniques/Algorithms ensuring process optimization. Availability of Predictive control techniques. System shall have the feasibility of auto changing of PID constants in micro-processor for different loads. Hunting of control valve at different loads is to be avoided.

5.7.0 Bias adjustment with indication where a single controller is controlling more than one final control element (control valve, control damper, speed drive etc.) to maintain the same process variable. Auto and manual control facility shall be transferable in both directions without bump of the value of the process variable to control the parameter during manual operation. Both master Auto Manual station and Auto / Manual station for individual control element shall be provided in OWS.

5.8.0 Characterization of final control element to suit the various applications with respect to load or otherwise as dictated by the process. Function generator to provide necessary

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characterization or variation of set points with respect to load, speed or any other requirement. Blocking/Interlocking function as dictated by Process/equipment. Monitoring of loop failures or any hardware failure in the loops.

Fail safe operation of final control elements in case of failure of motive power or Signal.

6.0.0 OPEN LOOP CONTROLS

Sequential start-up and interlock protection system shall be provided for all major critical auxiliaries of the plant. The system structure will provide for control from the highest level of unit operation down to the individual drive level.

6.1.0 The design of the Open-loop Control shall be implemented in the DCS.

6.2.0 The interposing relays shall be housed in the Motor Control Centers (MCC) of the switchgear.

6.3.0 All main system drives shall be provided with individual remote stop / start capability. Additional local start / stop push-buttons shall be provided in cases where local operation of the plant is necessary. In all such cases the local controls shall act only if selected by a group or individual selector in the central control room/MCC. Group selector shall be provided where a large number of local start / stop push buttons are required.

6.4.0 Local push buttons shall be connected to their associated command logic in order to ensure that the same starting conditions are achieved before an item of plant can be started from either the local or the remote position.

6.5.0 In cases where it is necessary for safety reasons to provide a local emergency off push buttons, the push button shall interact directly with the MCC/switchgear. The push button shall be provided with suitable mechanical interlocking device in order to avoid restarting. It shall be protected against malfunction by a cover or similar protection. Another contact of stop push button shall be wired to DCS for annunciation. Start push button shall be wired to DCS so as to run the equipments on checking necessary process interlocks & protections.

6.6.0 After a voltage failure in the electronic equipment and upon restoration of this voltage the system shall not cause unintended orders to the breakers concerned.

6.7.0 In the event of On/Off commands arising simultaneously or commands repeating alternately, provision shall be made to lock out these commands.

6.8.0 Subgroup controls are to be provided for start-up, operation and shutdown of associated functional units and drive groups, i.e. it shall be possible to start or stop main aggregates with all associated equipment by pressing one push-button. These controls may be designed either in the form of combinational controls or in the form of sequential controls. In the case of combinational controls the issue of commands depends solely on the interlinking of certain process criteria ; in the case of sequential controls the command sequence takes place in steps and is monitored for time, taking into account incoming process criteria in a predetermined sequence and in at fixed scanning time.



6.9.0 The steps of the individual programs and missing criteria shall be displayed on the VDU. Subgroup controls must be capable of being switched On and Off and must have defined manual commands for 'operation' and 'stop'. Any faults in the control system which could cause blockage of the control sequence must be confined to one control sequence. For this reason, an autonomous design is required for each subgroup control.

6.10.0 All functions performed by automatic systems must be capable of being implemented as individually remote-controlled operations via command modules.

6.11.0 Any faults in the control system or in the plant must lead to an automatic changeover from a faulty unit to an appropriate stand-by unit.

7.0.0 INTERLOCK, PROTECTION

7.1.0 To protect individual units or parts of the plant, interlocks are to be formed in accordance with process criteria, which can be either active or passive depending on their functions.

7.2.0 Active interlocks will automatically disconnect units or parts of the plant before they reach a critical operating condition. In addition, such dangerous conditions must be immediately indicated to the operating personnel by means of the alarm annunciation and shall lead to a print-out by the event recorder.

7.3.0 Passive interlocks are intended to prevent operational errors or wrong commands from being carried out in the event of selective faults in the automatic control.

7.4.0 For that reason active and passive interlocks must not be capable of being switched off operationally from the CCR.

7.5.0 Protection signals must be hardwired and interference free. The use of scanning devices or multiplexers shall not be allowed.

8.0.0 PERFORMANCE REQUIREMENTS

a) Loop execution time for CLCS Loops)	Maximum 250 ms (For all non critical Loops)
b) Loop execution time for CLCS	Maximum 100 ms (For all critical Loops)
c) Loop execution time for OLCS	Maximum 100 ms (For all Loops)
d) Loop execution time for protection Controls	Maximum 20 ms and governing
e) Updating rate of Analog display	Max. 500 ms (for measurement)
f) Updating rate of Analog display	Max. 500 ms for OLCS/CLCS
g) Updating rate of Digital value display	Max. 500 ms (for measurement)
h) Updating rate of Digital value	Max. 500 ms for OLCS/CLCS
i) Updating rate of pulse signal	Max. 500 ms
j) Change over to back up controller	less than 20ms (bump-less)



- | | |
|------------------------------------|---------------------------------|
| k) Time for display on screen | Max 1 seconds on demand |
| l) Keyboard command execution time | Max. 2 sec (max) |
| m) Controller Loading conditions | Max. 60 % under worst loading |
| n) Data Bus Loading conditions | Max. 60 % under worst loading |
| o) Overall system availability | 99.7 % |
| p) Speed of communication Bus | 1 GBps Worst Loading Conditions |

For DCS the worst loading condition shall include the following tasks:

- a) All process inputs scanning and processing is in progress and all the data is transmitted over the main data bus every one-second
- b) All closed loop controls in operation
- c) All open loop controls in operation
- d) All output devices are in operation with rated performance/speed
- e) Control/information request is initiated on control
- f) All the spare I/O's are connected to the DCS

9.0.0 PERFORMANCE REQUIREMENTS FOR CLOSED LOOP CONTROL SYSTEM

- a) The DCS shall permit the performance of the following dynamic load tests while maintaining safe furnace conditions, major process parameters and without endangering other equipment. All tests shall be performed with the system in automatic mode :
 - i) Drop 50 percent of maximum load capability from approximately full load at a rate of 10 percent per minute.
 - ii) Drop load from full rated output to the lowest runback limit, at a rate corresponding to the fastest run back rate
 - iii) Pick up 50 percent of the maximum load capability from approximately 50 percent load at a rate of 10 percent per minute.
- b) During transient conditions causing deviation of process variables, the control system furnished under the specification shall not permit deviations which exceed those permitted by the manufacturers of the controlled process equipment, for load changes as indicated above. The exact parameters to be monitored for this test are given in the following table.

		MAXIMUM DEVIATION OF PARAMETERS FROM SET POINT
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Sl. No.	Load/ Rate of Load Change (% of MCR per min.)	Throttle Pressure Deviation (Kg/cm)	Flue Gas Oxygen (Kg/cm)	Furnace Pressure Deviation	S.H. steam Temperature Deviation	R.H. Steam Temperature Deviation
A Steady State Condition						
1	60% to 100%	±3.0	±0.5	±3.0	±4.0	±6.0
B. Ramp Test (Change for max. duration of five minutes)						
1.	±3%	±3.0	±0.6 / - 0.4	±7.0	±10.0	±10.0
2.	±5%	±5.0	±0.8 / - 0.4	±12.0	±10.0	±14.0
3.	±10%	±7.0	±1.0 / - 0.5	±12.0	±10.0	±14.0
C. Step Load Changes						
1.	From 100% to 80% at the rate of 10% per minute	±7.0	±1.5 / - 0.5	±20.0	±15.0	±20.0

The control loops shall perform to return the controlled variable to the set point in a stable manner without cycling in the shortest possible time and without any loop interactions for cycling of generation when generation matches unit load demand. The Bidder shall guarantee that the control system provided by him shall be responsive and stable and shall maintain the deviation of controlled variables from set point within the limits specified so that the equipment being controlled shall operate as specified over the range required. The controls shall operate automatically, with no assistance from the operator. The Bidder shall successfully demonstrate the performance of Closed Loop Control Systems before acceptance and taking over of this system by the Owner. Bidder shall furnish his best achievable deviation figure for each of the above mentioned parameters in the bid.

10.0.0 DCS PARAMETRIC TESTS

The following parametric tests shall also be conducted under worst case loading conditions

01 Processor Spare Duty Cycle (Free Time)

(a) For Control System:-

CPU loading, cycle time/controller reaction time and memory spare capacity

(b) For MMIPIS:-

CPU loading, spare duty cycle, spare memory capacity

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02 Spare duty cycle for system bus

03 Various display response time

04 System accuracy

05 Monitor update time

b) For the parametric test, the following requirements shall be met

01 Processor Spare Duty Cycle (Free Time)

Under worst case loading of MMIPIS and system bus, each MMIPIS processor shall have 40% free time when measured over any two second period and 50% free time when measured over any one-minute period.

Under worst case loading conditions of control system control system processor shall have 20% free time when measured over any one-minute period. The Bidder shall furnish all necessary data to fully satisfy the Owner that the processor spare duty cycle figures quoted by the Bidder are realistic and based on configuration and computation capability of the offered system and these shall be actually achieved in the fully implemented system as commissioned at project site. The spare capacity of working and bulk memory shall meet the specification requirements.

02 System Bus Spare Duty Cycle (Free Time)

The system bus shall have min. 50% free time during the worst case loading conditions of control system, MMIPIS and the system bus, measured over any 2 seconds interval.

03 Display Response Time

The system shall acknowledge all operator requests in one of the following manners within one second of pressing of the last button: Commencement of the requested display or Acknowledgment of operator request in a suitable manner.

The display response time as defined above, under the worst case loading conditions shall not be worse than the following:

- | | | |
|--|---|-----------|
| 01 All control related displays | : | 1 sec |
| 02 Control command execution time | : | 1 sec |
| 03 Point details display (single point) | : | 1-2 secs |
| 04 Bar chart display (20 points, current data) | : | 2-3 secs |
| Operator guide / plant start-up guide message display (full screen of alphanumeric information and a maximum of ten numbers of dynamic data items) | : | 1-2 secs. |
| 06 Plant mimic display of fair complexity with a minimum of 120 numbers of dynamic data items e.g., values, macros, line segment, etc. | : | 2-3 secs |
| 07 Group review display (current values of twenty points) | : | 2-3 secs. |
| 08 X-Y plot display (2 X-Y- plots and a single display requiring | | |



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- both historical as well as current data) : 3-4 secs.
- 09 X-T plot display (trend of 6 analog points and a single display
requiring both historical as well as current data) : 3-4 secs.
- 10 Plant summary display (e.g., bad point summary, limit check removed point
summary. Assume the whole data base search is required and the summary
display contains ten
points only). : 3-4 secs.

The response time for screen update after the execution of the control command from the time the command is issued (for example command to start a motor to the time the screen is updated) shall be two seconds (excluding the drive actuation time).

04 System Accuracy Requirements

The overall system accuracy from signal input terminals to output presentation on monitor display and printers for the least accurate input range and maximum scan rate shall be not worse than +/- 0.2% of full scale of the process range.

05 Screen updated rates

All monitor & LVS displays shall be updated at least every two seconds.

11.0.0 AVAILABILITY TESTS

DCS availability tests shall be performed to establish the system availability guarantee of 99.7%. Bidder shall submit the availability test procedure for Owner's approval.

- a) Bidder shall guarantee 99.7 percent system availability for a period of 365 days. An Availability Guarantee Test shall be conducted to assure this level of availability. If the accrued down time exceeds 0.3 percent of 365 days, during availability test run, a new 365 days test run shall start at the time when the system becomes available again. Loss of availability shall be defined as the loss of the system's guaranteed accuracy and repeatability or of any system function; except, however, that the loss of a function for not more than five percent of the I/O points shall not be considered as complete loss of availability. Loss of a function for more not more than five percent of the points shall be treated as partial unavailability and the corresponding outage time shall be weighted with respect to function and the percentage of the points for which the function is unavailable. Loss of each function shall have one weighing factor and unavailability of each equipment, peripheral device or process I/O card etc. shall have another weighing factor. The guaranteed accuracy and repeatability and system parametric requirements specified elsewhere shall be maintained for the entire 365 days run without any manual recalibration or any other changes made to the system.
- b) Downtime shall start upon loss of a system function and shall end upon full restoration of the affected system function.



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- c) If availability is lost due to Owner, down time shall not be charged to Bidder.
- d) Test Dates Starting date of the test shall be decided based on mutual consent of both Bidder and Owner.
- e) Test Duration and Definition
 - 1) The availability test duration shall be 365 days of accumulated test duration time. Such duration time shall be continuous from the start of test, except as defined hereinafter.
 - 2) The availability shall be expressed by a percentage which shall be calculated as $100 \times \frac{\text{Test Duration Time} - \text{Accumulated System Outage Time}}{\text{Test Duration Time}}$
 - 3) The accumulated system outage time shall be a total of time in which the system functions are not available. A weighing factor shall be used to determine the amount of outage time assessed due to partial failures. System outage time shall be calculated as : (Outage time) x (Weighing factors)
 - 4) System outage time shall be accumulated over the test duration and shall be the accumulated system outage time.
 - 5) A minimum of one hour's down time shall be charged for each loss of availability in determining system availability.
- f) Outage Time and Weighing Factors
 - 1) Bidder shall submit a list of weightage factors for all system elements / components of the DCS which shall be agreed upon by the Owner before award of Contract.
 - 2) Outage time shall be assessed for the length of time in which all or any part of any of the functions are either continuously available or not available to the operator.

<u>System Element</u>	<u>Weighting Factor</u>
Data acquisition and Validation	1.00
Control Function	1.00
Historical Storage Function	0.30
Operator guides (OWS)	0.50
System summaries	0.30
Alarming, displays and logs	0.90
Other displays	0.30
Logs (except SOE)	0.30
Report	0.30
Sequence of events log	0.30
OWS Graphic	0.30
Each Bulk Memory	0.50



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Each utility OWS and alarm OWS	0.33
Display / KBD	
Each Control OWS	0.50
Each Keyboard	0.50
Each printer	0.30
Cartridge Tape	0.40
Data Highway	0.75
Each Programmer's OWS/KBD	0.30
Engineer's Workstation	0.30
5% I/O Points	1.00
5% Controllers	1.00

Weighting factors for other system elements shall be defined and agreed upon after contract award.

The loss of functions based on the weighting factors above shall be limited to 1.00 maximum.

g) Conditions

- 1) Downtime shall start at the time of notification exclusive of actual travel time required by Bidder's specialist (wherever required) but not in excess of 48 hours.
- 2) Bidder shall include commissioning spares for performing the above tests.
- 3) The Bidder shall include in his proposal the price and quantity of any spare parts necessary for his performance of the availability test
- 3) Failure of peripheral output devices shall be counted as outage time if failure of the device affects any or part of any function as per clause.
- 4) Any degradation of function shall accrues to outage time regardless of system configuration.
- 5) During a period of partial system outage, Owner shall be permitted to use other operable functions of the system if such use does not interfere with maintenance of the inoperable functions or hardware as determined by the Bidder. Should Bidder determine that partial use of the system by Owner shall interfere with Bidder's maintenance procedures, system outage time shall accumulate with a weighing factor of 1.0 since no functions are available to Owner. This shall include off-line servicing.
- 6) All costs associated with maintaining 99.7 percent availability for a continuous period of 365 days shall be borne by the Bidder. This includes hardware, software, spares and services.
- 7) The 99.7 per cent availability shall exclude downtime required for scheduled maintenance and service. The Bidder's proposal shall list maintenance and service requirement for all applicable equipment. If these requirements are not listed, it shall be understood that no downtime is required.

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12.0.0 GENERAL I/O REQUIREMENTS AND SPARE CAPACITY

- (i) The DCS shall be provided with the capacity and capability to handle either 20% additional modules for each type of modules or 20% over and above the specified number of modules connected to the system bus without any additional hardware or software requirements. These additions shall not result in decrease in system response time (i.e. control response time, display response time, SOE resolutions etc.).
- (ii) 20% spare relays of each type and rating, mounted and wired in relays cabinets. All contacts of relays shall be terminated in terminal blocks of relay cabinets, Additionally in each of the relay cabinets, 20% spare terminal blocks shall be provided so that additional relays can be mounted and wired. In case bidder's system employs marshalling cabinet for all inputs, the spare terminals, fully wired up to marshalling cabinets are also to be provided. Above criteria shall also be applicable for PLC based controls system.
- (iii) Separate DI, DO, AI & AO shall be considered by bidder for HW Annunciation windows, Mimic, ILPB, PBs, Indicators, recorders, A/M stations & other HW etc mounted on back up control desk/panel & UCP
- (iv) Wired-in "usable" space for 20% modules in each of the system cabinets for mounting electronic modules shall be provided by the bidder. Empty slots between individual modules/group of modules, kept for ease in maintenance or for heat dissipation requirement as per standard practice of Bidder shall not be considered as wired-in "usable" space for I/O modules. Field Terminal assemblies, PCB/ Connectors (if any in the offered system), corresponding to the I/O modules shall be provided for above-mentioned 20% blank space.
- (v) 20% spare fully wired I/O channels shall be provided in each I/O module. In addition to this 10% or minimum one no. extra assigned complete spare cards (which ever is more) fully wired mounted in the cabinets for each type of I/O modules shall also to be provided.
- (vi) Electrical I/Os required as per Energy Distribution Management System (EDMS), Energy Management System (EMS) and any other electrical system shall also be considered/included by bidder in respective package I/O list.
- (vii) The spare capacity as specified above shall be uniformly distributed throughout all controller systems. The system design shall ensure that above-mentioned additions shall not require any additional controller/processor/Peripheral drivers in the system delivered at site. Further, these additions shall not deteriorate the system response time/ duty cycle, etc. from those stipulated under this specification and shall meet other redundancy / functional requirement. Above criteria shall be applicable for DCS, PLC & any other microprocessor based control system.

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SECTION: F

F.2.3 PLANT AUX. & OFFSITE PLANT CONTROL SYSTEM (SUB-SECTION: 4.10)

9.0.0 ELECTRO-CHLORINATION SYSTEM

9.1.0 Control Philosophy

Electro chlorination system shall be controlled and monitored from the Electro chlorination system local control room, through the DCS remote I/Os, Redundant Processor, power supply, communication module, redundant communication link all hardware, software, other interfaces, cables and field sensors / instruments / erection hardware envisaged to control and monitor it.

Electro chlorination system local control room shall be provided with Two (2) no. 24" LED type Operator station for control and monitoring the Electro chlorination system locally in addition to remote monitoring from the central control room in the main plant DCS. Local annunciation panel with minimum amount of conventional hardwired pushbutton stations and indicators shall be provided for the safe shutdown of the plant.

Operator station in the Electro chlorination system local control room shall be provided with the access to monitor the main plant operations

Operational requirement

- Operation of the pumps, Transformer Rectifier, Electrolyser and other equipments shall be performed from the operator station located at the Electro Chlorination Building (air conditioned area) as well as remote monitoring in central control room of the main plant.
- All conditions used for tripping the Transformer Rectifier, Electrolyser and pumps etc., shall be provided with pre-trip annunciation in the operator station
- All initiating devices, relays and other hardware required to achieve annunciation, control and interlock system shall be provided by the bidder.

Important safety interlocks

The safety interlocks shall be furnished by the vendor during detail engineering and will be reviewed and approved by owner.

Special Instrument requirement

Sea water booster pump suction pressure low trip (2 out of 3).

Sea water Booster pump discharge header pressure transmitter (1 out of 2) for monitoring and Auto cut in stand by pump and pressure gauges

Differential Pressure Transmitter and local gauge across the suction strainer of Booster pump

Booster Pump by pass valve shall be motorised



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Differential Pressure Transmitters and gauges across each electrolyser.

Flow transmitter along with flow control valve shall be provided at the inlet of each electrolyser to regulate the flow of sea water according to generation rate of hypochlorite.

Level transmitters shall be provided in the hypochlorite degassing tank for controlling level in the tank.

Hypochlorite pump discharge header pressure transmitters and gauges at each header (For monitoring and Auto cut in stand by pump)

5% HCL tank Level transmitter and Local level Indicator

Air Dilution Blower fan discharge header pressure switch at each header (For monitoring and Auto cut in stand by pump)

Flow transmitter along with flow control valve shall be provided at the outlet of each Hypochlorite pump discharge header to regulate the dosing rate of hypochlorite

All pumps and fan status (Run / Stop / Trip) and their MCC status (ON , OFF) etc shall be indicated in the OWS.

All electrical parameters of Transformer Rectifier such as Input Voltage, current and output voltage and current shall be displayed at Operator station

The necessary protection and control for Transformer Rectifiers and Electrolysers as per the recommendation of OEM shall be provided.

Process instruments & logic control connected with heater circuit

Multiple online chlorine leak detectors in chlorine storage tank area, chlorine producing unit area, chlorine pumping room, chlorine processing zone areas inside the building.

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F.2.4 FIELD INSTRUMENTS SPECIFICATION (SUB-SECTION -4.12)

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 °C change. Stability 0.15% for five years.
- f) The plant instrument air supply pressure shall be:
 1. Maximum supply pressure 7 kg/cm²
 2. Minimum supply pressure 4.5 kg/cm²
- 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

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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. Hastelloy 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/cm²g
 - 2. Temperature - °C
 - 3. Steam flow – kg/hr / T/hr
 - 4. Liquid flow – m³/hr (Feed Water flow (in kg/hr or T/hr)
 - 5. Distance – meters (m) or millimeters (mm)
 - 6. Differential pressure – mmH₂O
- 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.

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- 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°C 3-wire RTD duplex type, PT 100 type shall be used. For temperature beyond 300°C 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°C ≤ T < 850°C. R or S type for T > 850°C.
- b) The Mv signal of thermocouple shall be used as input to the DCS. Cold junction

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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/°C). 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

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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 $\pm 1\%$ accuracy and overage protection of 125%.
- p) Switches shall have the following:
 - Max. contact rating : 230V AC, 5A
 - Repeatability : $\pm 0.5\%$ 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 $\pm 1\%$. Ultrasonic type flow meter shall be used for cooling water flow application with an accuracy of minimum $\pm 0.4\%$ 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.

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- 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 $\pm 1\%$.
- 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) Algebraic 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 $\frac{1}{2}$ inch outlet and a $\frac{1}{2}$ 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**.

1.1.5 Control Valves

- a) Control Valves are defined as Pneumatic operated modulating valves.
- b) Control valves for regulating service will be pneumatically operated and provided with characterized plugs. In general, equal percentage characteristics will be provided for throttling service; linear characteristics for pressure reducing applications and quick opening characteristics for On/Off service.
- c) Control valves will be designed to prevent cavitation, flashing on the downstream side of valve or piping. For cavitation /flashing services, valves with anti-cavitation trims will be provided. Hardened trim material shall be provided for control valves subjected to DP > 7

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Kg/cm² and for flashing applications 17 – 4 PH material is recommended.

- d) The control valves will be of straight through globe body double port balanced type or of Angle body except for large cooling water lines.
- e) Instrument air shutoff valve shall be provided on each control valve assembly.
- f) The following end connections shall be used when weld type connections are specified in the piping line specification :
 - g) Socket weld end connections : 2 inch and under control valve bodies.
 - h) Butt weld end connection : 2-1/2 inch and over control valve bodies.
- i) Valve bodies shall be Globe, single – port unless otherwise required and shall be not more than two nominal sizes smaller than the line in which they are installed.
- j) Valve body material shall be as specified in the piping line specifications.
- k) All integrally mounted instrumentation (controllers, positioners, regulators, etc.) to be designed for a maximum instrument air supply pressure of 7kg/cm²g. Minimum instrument air supply pressure is 4.5kg/cm²g. Separate air filter regulators with inlet and outlet gauges shall be provided for each control valve.
- l) SMART positioners with HART compatibility shall be provided for all the control valves.
- m) Necessary diagnostics software along with SMART positioners shall be provided.
- n) Color of the control valve shall be identified based on the fail safe position of the valve.
- o) All the control valve shall be provided with block and bypass valves. The bypass valves shall be automatic inching valve for critical applications only.
- p) It is the intent that the valves shall fail either open or closed or fail lock in the event of failure of air signal or electric signal from any valve component (controller or positioner), as well as failure of the main control air supply or voltage to the solenoid.
- q) Position transmitters of non-contact, 2-wire 4-20Ma DC type shall be provided for modulating control valves. Also in general limit switches shall be provided for control valves wherever applicable.
- r) Pilot solenoid valves for on-off service control valves are to be designed for 24 Vdc with a minimum orifice size of ¼ inch. Limit switches (open and close) to be provided for all on-off valves.
- s) Instrument tubing is to be stainless steel, in accordance with the tubing line specifications. Minimum tubing size is ¼ inch, SS-316.
- t) Control valve limit switches to be designed to operate at 24 VDC.
- u) The control valves shall generally have the max. flow handling capacity of 120% and the limit of valve travel shall generally be between 10% and 80%. The trim characteristics shall be so selected that the control valve is operated in the controlled flow range of 20– 75 %.
- v) The following shall be specified for control valves.

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Max. noise – 85 Dba from 1m. distance from the equipment.

The max. permissible outlet velocity shall be as per ISA-S75.01 based on service (liquid, steam or flashing services). The control valve sizing shall be as per ANSI / ISA: S75.01.

Leakage class will be class V as per ANSI FCI 70.2 or better.

For fuel gas applications the valve leakage class shall be minimum class VI.

1.1.6 DELETED

1.1.7 DELETED

1.1.8 DELETED

1.1.9 DELETED

1.1.10 DELETED

1.1.11 DELETED

1.1.12 DELETED

1.1.13 Chlorine Analyzer

The chlorine analyzer shall be Micro processor based and the analyser shall be continuous flow through type with accuracy of minimum +/-1% of span with automatic temperature compensation.

Self diagnostic features shall include alarm for transmitter fault, no reagent, calibration fault as a minimum. Analyzer housing shall be weather and water proof. Output shall be isolated 4-20 Ma DC linear signal.

The field mounted cabinets for Chlorine analyzer system shall have the following:

- a) Auto zeroing and calibration facility
- b) Manual overriding
- c) Liquid handling unit comprising of valves, manifolds, thermometers, power supply unit, pressure reducer etc.

1.1.14 DELETED

1.1.15 H₂ Gas Analyser (Microprocessor based):

H₂ Gas analysers shall be provided with the following features

Type	: Conductivity type or multimode oscillation type
Case Purity shall	: 0 to 100% H ₂ in Air.
Purge	: 0 to 100% H ₂ in CO ₂ 0 to 100% air in CO ₂
Hydrogen Flow rate	: 100 to 700 CC/min.
Output Signal	: 4-20 m Amp.
Display	: Digital with Gas Purity in realtime.
Power Supply	: (90-250) V, 50 Hz, 1 Phase Sample gas flow
control	: Required
Reference gas flow	: Required Reference gas pressure
regulator	: Required
Cell response	: 95% of change in 30 Sec.(Appox.)
Accuracy	: 2% of full scale
Repeatability	: 1% of full scale
Local Indicator	: Indicating meter of 1% accuracy
Alarm facility	: Dual (High & Low) independently adjustable.
Contact rating	: 0.5A at 220 V AC
Accessories	: As required i.e Flow meter, flow control valve, pump with complete software.
Hazardous duty Version	: FM Standards.

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Calibration gas cylinders and installation accessories such as tubings and fittings for connecting calibration gas cylinders and auto calibration units.

Cylinder ownership certificates, pressure test and explosion proof certificates to be given for refilling the gases by owner for future calibration.

1.1.16 DELETED

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



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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 1/2" 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

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F.2.5 INSTRUMENTATION & CONTROL CABLES (SUB-SECTION: 4.20)

1.0.0 GENERAL

All Instrumentation Cables shall be of 600V grades and Control cables shall be of 1100V FRLS, PVC insulated, armoured 7-stranded copper conductor cable to be provided as per the latest IS/IEC standards.

Signal cable : 600V, 0.5 Sq.mm for single pair, screened
600V, 0.5 Sq mm for multipair, individual pair and overall shielded.

Control Cable : 1100V Screened with overall screen
1100V 1.0 Sq mm for 2 Cores 1100V 1.0 Sq mm for multi core

Power cable : 2.5 Sq.mm for 2/3 Cores

Wiring within desks and panels shall be supported on trays and shall be segregated according to voltage level. Wire carrying AC and DC voltage shall also be segregated.

All desks, panels, cubicles and racks shall be factory-wired. Where desks or panels shall be supplied in more than one section, electrical connections between the sections shall be via terminal strips provided for this purpose.

Spare cores shall be terminated at terminal strips and shall be ferruled in such a way as to indicate that they are spare cores.

After commissioning 20% of the conductors of multi core cables shall be available as spare.

All instrument cables shall be laid on cable trays. Cable trays shall be sized to have 20% spare space as a minimum.

Junction boxes for alarm, signal, T/C, interlocks etc shall be separate. All the shield wires shall be terminated in the JB as per Cable Schedule. Separate JB shall be used for inputs and outputs. JB shall be earthed through GI flat. Separate JB shall be provided for intrinsic safe circuits. Fiber optic cables shall be routed in GI conduits.

All panel wiring shall have sufficient spares for future expandability.

Individual pair shielded & overall shield twisted pair copper cables shall be used for analog signals & overall shielded cables shall be used for digital signals. All these cables shall be armoured. The insulation of outer sheath shall be FRLS quality. The wire size shall be 0.5 sq.mm. Ferruling indicating terminal numbers on termination side shall be followed. Colour coding shall be as per Purchaser's standard.

2.0.0 INSTRUMENTATION CABLES



2 X 660 MW, UDANGUDI STPP (STAGE-1)

BAP-RANIPET

**TECHNICAL SPECIFICATION FOR
ELECTRO CHLORINATION PLANT (E, C & I)**

No: ROS: 4268, REV: 0

Part of ROS6282, REV:0

Instrumentation cables shall be 600VAC grade, stranded high conductivity annealed, tinned copper, twisted pair (with min. 20 twists for meter) extruded PVC insulated with overall and / or individual screening, extruded PVC inner sheathed, galvanized steel wire armoured, only extruded outer sheathed with FRLS PVC compound. The conductor size shall be 0.5 sq.mm. Pair cables can be used for RTDs. Instrumentation cables carrying digital signals shall have overall screening along with drain wire and analogue signal carrying cables shall have each pair screening and overall screening along with each pair drain wire and overall drain wire. Colour coding for the identification of pairs shall be as per BS-5308 Part-2.

3.0.0 CONTROL CABLES

Control cables shall be 1100V AC grade, multicore, minimum 1.0 sq.mm cross section, stranded copper conductor having 7 strands, PVC insulated, inner PVC sheathed of type ST- 1, galvanized steel wire armoured and outer sheath made of FRLS PVC compound of type ST-1. In situations where accuracy of measurement or voltage drop in control circuit, warrant, higher cross sections as required shall be used. Colour coding for the identification of pairs shall be as per BS-5308 Part-2.

4.0.0 FIBRE OPTIC CABLES

Mono mode type fibre optic cable with following parameters shall be provided.

- Cable Type: Mono-mode with minimum 4 fibres
- Wavelength band optimized : 850nm / 1300nm / 1550nm
- Mode field diameter : 9-10 μ m $\pm$ 10% of nominal value
- Cladding diameter : 125 μ m $\pm$ 3
- Non-concentricity core/cladding : not more than 2 μ m
- Non-circularity of cladding : not more than 3 μ m
- Cut-off wavelength : 1200nm
- Attenuation : less than 0.3-0.4 dB/km at 1300nm
less than 0.15-0.25 dB/km at 1550nm

Multi mode type fibre optic cable with following parameters shall be provided.

- Cable Type: Multi-mode with minimum 4 fibres
- Core / cladding diameter: 62.5 / 125 μ m
- Jacketing Material: Halogen Free, Flame Retardant, Low Toxicity
- Attenuation @ 850 nm: Length (m) x 0.0035 db/m+2db maximum
- Outside Diameter: 8.10 mm (0.324 in)
- Minimum Bend Radius: 12.5 cm (5 in)
- Minimum Bend Radius (Long term): 7.5 cm (3 in)
- Cable Assembly: Tensile Load for attenuation increase <0.5 db: 300 N (66 lb) maximum
- Tensile Load at Installation: 1776 N (400 lb) max.
- Connector Tensile Load MIC : 133 N (30lb)
- Minimum Crush Resistance: 46 N /cm (250 lb /in)
- Maximum Cable Weight : 46 kg/1 km (31 lb/1000ft)
- Maximum Cable length: 2 km (6560 ft)

	2 X 660 MW, UDANGUDI STPP (STAGE-1)	BAP-RANIPET
	TECHNICAL SPECIFICATION FOR ELECTRO CHLORINATION PLANT (E, C & I)	No: ROS: 4268, REV: 0 Part of ROS6282, REV:0

HDPE insulation shall be suitable for continuous conductor temperature of 85°C. The insulation material shall be resistant to oil, acid and alkali and shall be tough enough to withstand mechanical stresses during handling.

The cables shall have HDPE primary insulation suitable for FRLS. Inner and outer jacket shall be made of extruded flame retardant HDPE.

The cables shall be armoured. Armour shall be of galvanised steel wire / flat as per IS 3975.

The cables shall be protected against termite and rodent attack. Necessary chemicals shall be added into the compound of the outer sheath.

The material used in the construction of fibre optic cables shall be compatible with the properties of the cables and shall be in accordance with the relevant IS and IEC standards as stated above.

5.0.0 Design requirements

All cables shall be suitable for laying on racks, in ducts, trenches with chances of flooding by water and shall also be suitable for directly buried installation. All the cables shall be FRLS type designed to withstand mechanical, electrical and thermal stresses developed under steady state and transient operating conditions.

The cables shall be capable of operating satisfactorily under the power supply and frequency variations, high ambient, high humid tropical climatic conditions as specified in project information.

The cables are proposed to be laid in multi-tier overhead cable racks, in concrete cable trenches. Derating factors for grouping and ambient temperature shall be furnished by successful bidder along with filled up datasheets during contract engineering stage.

PVC insulation shall be suitable for continuous conductor temperature of 85°C and short circuit conductor temperature of 160 °C. The insulation material shall be resistant to oil, acid and alkali and shall be tough enough to withstand mechanical stresses during handling.

All the cables shall be protected against termite and rodent attack. Necessary chemicals shall be added into the PVC compound of the outer sheath.

All cables shall have PVC primary insulation as per IS 5831 Type C / IEC 502 suitable for FRLS. Inner and outer jacket shall be made of extruded flame retardant 90°C PVC to IS 5831 Type ST2 / IEC 502. Oxygen Index of PVC shall be over 29% and temperature index shall be over 250°C.

The cable cores shall be laid up with fillers between the cores wherever necessary. All the cables shall have distinct extruded PVC inner sheath.

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The cables shall be armoured. Armour over inner jacket shall be of galvanised steel wire / flat as per IS 3975.

All the cores of single pair or multipair shall be twisted and twists shall not be less than 20 per metre.

The outer sheath for analog and digital cables the colour shall be light blue and black respectively.

Running length of cable shall be printed atleast every 5m interval. For multipair cables, pair identification shall be provided with numbers at interval of not more than 250mm or as per vendor's standard.

6.0.0 Construction

The insulation shall be applied directly over the conductor by extrusion method. in such a way that it fits closely on the conductor and it shall be possible to remove it easily without damage to the conductor. Two cores shall be twisted to form a pair and four such pairs shall be twisted together to form a unit.

Every pair shall be twisted with a lay of 40 to 50 mm and to be wrapped with polyester tape. Individual pair screening with edges free poly aluminium tape with continuous drain wire of minimum overlap of 30%.

Required number of pairs to be laid up to form the cable and overall shielded with edge free Poly- aluminium tape with continuous drain wire of minimum overlap of 30%.

The cable shall be then sheathed with FRLS PVC by extrusion method. The shielding and sheathing shall be so done that it fits firmly on to the cable and are easily removable without damage to the cores.

7.0.0 Packing and Marking

Packing

The tolerance on the dispatched cable length on each drum verified and accepted by Inspector shall be limited to +/-5% of standard drum length. However the overall tolerance of the total dispatched quantity of each size shall be +2%. Short lengths of individual length not less than 200m shall be acceptable only in the final drum lengths to meet the overall tolerance limits stipulated above. Cable consumed for testing and inspection will be to bidder's account.

Cable Reeling Drums

The Cable drums shall be non returnable wooden or steel drums of sturdy construction

The wood used for the construction of the drums shall be of durable quality, properly seasoned and treated with Copper Nephthenates or Zinc Nephthenates for

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preserving the wood (Refer IS 401). Wood preservatives anti-termite treatment shall be applied to the entire drum. Wooden drums shall comply with IS 10418. All ferrous parts shall be treated with suitable rust preventive coating to avoid rusting during transit and storage.

The surface of the drum and the outermost cable shall be covered with waterproof layer. Both the ends of the cable shall be properly secured with heat shrinkable PVC / Rubber caps, secured by 'U' nails so as to eliminate ingress of water during transportation, storage and erection.

Each drum shall carry the manufacturer's name, purchaser's name, address and contract no., item no. and type, size and length of the cable and net and gross weight stenciled on both sides of the drum. A tag containing the same information shall be attached to the leading end of the cable.

An arrow accompanied by suitable wording shall be stenciled on the ends of the drums to indicate which way it should be rolled. The number of each drum shall be either branded at the end of the drum or stamped on the metal disc attached to one end of the drum.

Marking

Marking on outer sheath:

In addition to manufacturer's identification on cables as per IS, the following shall be embossed on the outer sheath at every 1m throughout the length of the cable:

- (i) Manufacturer's Name & Trade Name :
- (ii) Year of Manufacture :
- (iii) User's Name :
- (iv) Voltage grade :
- (v) Type of outer sheath :
- (vi) Type of inner sheath :

The label which is securely attached to the reel or drum or coil shall have the following information:

- Purchaser's name and address :
- Purchase Order No. and item no. :
- Manufacturer's /Supplier Name :
- Length in meters :
- Gross Weight :
- Item code number and cable drum number :
- Direction of rotation of drum for unwinding by means of an arrow

**SECTION: F****F.2.6 C&I ERECTION (SUB-SECTION: 4.21)****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.

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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



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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°C. To dissipate the excess heat, a minimum of 1 meter of tubing for each 30°C 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	Seamless Alloy Steel Piping to ASTM A335
	(Medium: Steam & Water and furnace region)	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 ≥ 40 bar.

- | | | |
|------|---|--|
| 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 316SS | Globe valves with FAS body/FCS body, stellited internals, SW ends for 2500 lb/1500 lb/ 600 lb ASA ratings. |
| c) | Condensation vessels connection | FAS/FCS body with NPT (F) SCRD and vent plugs for 2500/600 lb ASA ratings. |
| d) | Dust separating chambers Class | ERW carbon steel pipe to IS-1239 Heavy |
| e) | Racks and Associated Equipment | ANSI C83.9-1972 |
| f) | Code for pressure piping, testing | ANSI B-31.1 welding and Hydrostatic |
| g) | Flexible conduits with fittings resistant | 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.

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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

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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 mm² 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.



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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:



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Single Tubing / Pipe Maximum distance between Supports 3/8" OD and less Continuous to 3/4" Nom. size 2 Meters (6 ft.) 3/4" 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 45° 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. Of 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 AND 425 degree C
B. Level Measurement			
B1-Level Gauge and Switch			
(i)	2	25	≥62 bar OR 425 degree C
(ii)	1	15	< 62 bar AND 425 degree C
B2-Level Transmitter (Displacement Type)			
	2	25	≥62 bar OR 425 degree C
	1	15	< 62 bar AND 425 degree C
B3-Standpipe For Level Measuring Instrument			



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2	25	≥ 62 bar OR 425 degree C
1	15	< 62 bar AND 425 degree C
C-Flow Measurement		
2	25	≥ 62 bar OR 425 degree C
1	15	< 62 bar AND 425 degree C
D. Sampling System Measurement (Steam & Water Service)		
2	25	≥ 62 bar OR 425 degree C
1	15	< 62 bar AND 425 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/pair cables 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.



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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 JB/cabinets shall run through flexible PVC conduits for approximately 500mm.

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F.2.7 C&I TESTING AND COMMISSIONING (SUB-SECTION: 4.22)

1.0.0 ERECTION, FIELD TESTING AND COMMISSIONING

- 1.1.0 The Bidder shall select and adopt methods and procedures for equipment erection to suit the nature of equipment and erection, involved according to the best modern industrial practice and his own experience.
- 1.2.0 The Bidder shall arrange for the transportation and handling of cabinets and desks from stores to work site suitably without any damage. If any damage is observed before handling, this shall be brought to the notice of the OWNER
- 1.3.0 Before installation of cabinets and desks, the necessary openings and inserts required to be made on the floor by the Bidder shall be checked and then after proper alignment, the cabinets and desks shall be installed on the floor by the Bidder. All necessary civil work to be carried out for this shall be in Bidder's scope of supply. The cabinets and desks shall be cleaned by blowing air to remove dust or foreign particles.
- 1.4.0 Nameplates shall be installed for all the I&C equipments bearing the service description, instrument number and calibrated range.
- 1.5.0 The data base covering the instrument No. type, application, process parameters, range, set point, calibrated/feasible range & span, maximum admissible value, recommended periodicity of calibration, other information for all the instruments, final control elements etc., for the unit, BOP, etc., shall be given in soft form.
- 1.6.0 All cables shall be tested for insulation level. Cable ends shall be properly cleaned. The entry to and exit from pipes shall be smooth and free from burr where cables are run through pipes. Cable shall be pulled into the pipes in such a way that there shall be no damage to the cables. Flexible conduits shall be provided wherever necessary. Cable in hot areas shall have proper heat protection. A minimum distance of 300 mm shall be kept between instrument / signal cables and power cables. Each tray shall be filled with a maximum of two layers for instrument and control cables and one layer for power cables providing 20% spare space in the number of layers specified. Instrument Cable Trays, shall be erected vertically as far as possible to avoid dust accumulation. All the cables laid shall be tied individually to the Tray. Thermocouple cables shall be run completely independent of all other cables with minimum separation as per relevant standard and with cross over at right angles. The cabling accessories shall include terminal blocks, splicing materials, crimping tools, cable support grips, insulating tapes, GI flexible conduits, conduit fittings, GI perforated covered trays, supports, accessories, and cadmium plated trays & cable glands.

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- 1.7.0 The Bidder shall get prior approval as per approved quality assurance plan of the Owner Representative before any installation work starts. If any work is carried out by the Bidder before prior approval from Owner Representative and modification is sought by Owner Representative later, then the work shall be redone by Bidder without any cost / material implications to the Owner Representative. Impulse / sample piping, air supply and pneumatic tubing, cable trays and equipment shall be supported rigid enough to prevent vibration and anchored sufficiently to prevent strains on equipment installed. Supporting clamps shall be provided at least at every one meter distance for better rigidity. Impulse / sampling piping shall be provided with adequate slope, (preferably 1:10). Hanger and supports shall be so installed as not to interfere with free expansion and contraction of the piping and tubing between anchors. Suitable vibration dampeners, etc., shall be provided wherever necessary. In addition, care shall be taken that the arrangement of impulse / sampling piping, air supply and pneumatic tubing from detrimental sagging, mechanical injury, abuse due to unusual service conditions from sources other than those due to pressure, temperature and vibrations. All impulse lines of joints shall be welded type unless otherwise specified.
- 1.8.0 The Bidder shall set up his own instrument laboratory. The calibration equipment shall cover complete range and shall have the desired accuracy of less than 0.1% or better. The Bidder shall follow the standard procedures for calibration of various instruments and as set by the manufacturer of instruments and as instructed by the Owner including any requirements of field calibration. First, the calibrations shall be carried out independently by the Bidder and later in the presence of Owner who shall certify the same. Proper documentation in this regard shall be maintained and handed over to the Owner
- 1.9.0 All the instruments shall be calibrated for the entire range of the instrument for which it is designed. Calibration shall include test for repeatability. After first commissioning, the instruments shall be tested for calibration again to check whether the instrument maintains its zero and maximum of the range. All instruments and control equipment shall be calibrated to read correctly to the satisfaction of Owner. All switches shall be tested for the actuation of both normally open and normally closed contacts at the desired set points and also for the fixed / differential settings. All the float / displacer operated level switches shall be tested for the movement of the float and linkages to make to break the switch contacts by filling up with water before installation. For such tests, necessary testing set up required shall be arranged by the Bidder. Air leak tests shall be performed on all flue gas impulse / sample lines, air supply and pneumatic lines. Necessary equipment such as portable compressor, connecting pipes, materials, cables and test gauges shall be provided by the Bidder. All the welding shall be carried out as per the relevant codes with electrodes approved by the Engineer-in-Charge. Only qualified welders approved by the

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Engineer-in-charge shall carry out the welding. IBR grade of welder will be required wherever IBR grade welding is involved. After IBR welding, radiography as per the required standard to be done by qualified welder. All threaded joints shall be jointed using teflon tapes and no other pipe 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 whenever 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. 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. Pipes or tubes installed but not connected, shall have the ends closed in an approved fashion to prevent the entry of foreign material such as caps or plugs. All cables finally entering JB's / cabinets shall run through flexible PVC conduits for approximately 500mm. 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 (4' 6") above the platform or floor in an accessible position. When an instrument is located at a distance of 2.5 meters or more from its pressure connection, an additional block valve and a vent valve shall be provided adjacent to the instrument. Vent valves shall be arranged, if necessary, with drain lines to ensure that operation of these valves does not create a hazard. 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, i.e. 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 45° from the bottom of the main pipe and these are to be sloped downwards from the sensing point. An exception is made in the case of the tapping point for fuel oil or corrosive fluid in which the pressure instrument shall not have direct contact with the process fluid. Glycerine or other suitable liquid shall be used as a medium to separate the fuel oil from the pressure instrument. 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 unit.

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- 1.10.0 Pipes shall be bent using pipe benders and any hot bending will be totally rejected. Pipe shall be cut, using pipe-cutting devices. Hot cutting will not be allowed.
- 1.11.0 Hydro test shall be performed for all other impulse lines / sampling lines / sensors. Necessary equipment such as hydro test pumps and temporary piping to the required point, fill pump etc., materials such as temporary gaskets, miscellaneous fasteners, etc. tools and tackles including test pressure gauges, etc. are to be provided by the Bidder. For all electrical actuators of the valves, functioning, setting and performance of limit switches / torque switches of various positions shall be checked before and after installation of the actuators. The position transmitters for inching applications shall also be calibrated. Pneumatic actuators shall be calibrated at site. PG test points shall be provided on the process line at various location by the Bidder.
- 1.12.0 Chipping of foundations, alignment, as required for instrumentation installations.
- 1.13.0 Fabrication and erection of stanchions/supports for all local instruments, junction boxes, etc. Fabrication and erection of suitable supports for surface mounted instruments.
- 1.14.0 Fabrication and erection of structural steel plates, angles, pipes, required for supporting ducts, trays, local instruments, etc., complete with bolts and nuts. (GI bolts and nuts shall be used wherever applicable or directed).
- 1.15.0 Painting of all stanchion/structures meant for instrumentation work (ducts, trays, pipe/ angle, supports, etc. as per specification). Colour and codes shall be strictly followed as per guidelines/ specifications as per direction of the Engineer-in-charge.
- 1.16.0 Earthing of the Instrumentation panels on the separate earthing pits (by others).
- 1.17.0 Double compression cable glands, cable lug, ferrules, cable identification tags, trefoil clamps for single core cables, cable dressing materials etc.
- 1.18.0 Cable sealing compound to prevent water entry wherever cables enters from outdoor to indoor areas.
- 1.19.0 Supporting structures for cable trays, cable racks, etc. using mild steel sections like channels, angles, flats, chequered plates etc. shall be in bidder's scope
- 1.20.0 Excavation & refilling of soil for buried cable trench / earthing with necessary materials.
- 1.21.0 GI Cable tray with all accessories and its MS supports.
- 1.22.0 Minor civil works like drilling, chipping and punching holes and openings in concrete floors, slabs, brick walls, fabrication of supporting structures, drainage of water from cable trenches and cleaning of all debris due to instrumentation installation.
- 1.23.0 Primary impulse tubing, laying of all types of cables, glanding and wiring and all kinds of pipe/tube fittings.

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- 1.24.0 Fabrication and installation of primary tubing for pressure and differential pressure instruments complete with manifolds as per standards.
- 1.25.0 Erection & supply of the PVC instrument ducts(if required for the internal wiring of GCP cables), and perforated cable trays generally as per drawing including bends, tees, supports and opening wherever required, including provision of covers wherever required. No jumping of cables will be allowed.
- 1.26.0 Laying of multi-core / pair cables for all applications on perforated trays with proper tagging, dressing clamping, glanding and terminations (including proper termination of shields) at both the ends.
- 1.27.0 Laying of multi/single pair cables in trenches wherever required.
- 1.28.0 Interconnection wiring/tubing of various field mounted instruments, viz., transmitters, transducers, positioners etc.
- 1.29.0 Identification of each cable by proper tags at every 10 meters on the main tray as per cable schedule.
- 1.30.0 Fabrication of nipples from pipes and threading of the same wherever required.
- 1.31.0 Tapping/threading of coupling wherever required for special instruments.
- 1.32.0 Welding electrodes required for the complete of the job shall be in bidder's scope..
- 1.33.0 Completion/updating of Owner's drawings/documents as per the work done at site. This should be done before applying for completion certificate.
- 1.34.0 Pre-commissioning service and commissioning assistance during start-up of plant, wherever required.
- 1.35.0 Provision of copper wire, GI wires to panel earth bus, laying and grounding of the same to the system earth pits.
- 1.36.0 Fabrication and erection of canopy (single) for instruments, wherever required.
- 1.37.0 Minor modifications/repairs required to be done on the existing instruments namely, replacement of damaged signal tubes, tapping of damaged threads on couplings, tees and other fittings.
- 1.38.0 Identification of each cable by proper tag plate/ferrules at instrument ends, inside junction boxes and inside control room outside JB's by tagging the cables with SS tags as per the cable schedule.
- 1.39.0 Drilling holes on all Panels etc. for cables/ glands/ grommets, if required, after obtaining approval from the owner. Unused holes to be plugged after completion of job.
- 1.40.0 Grounding of shield for all shielded cables to respective instrument earth bus provided in the thermocouple head/junction boxes.

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1.41.0 Sealing of switches with standard lead seals after final setting in the presence of Engineer-in- charge.

1.42.0 Painting of welded joints etc. as per the engineer in charge's instruction.

1.43.0 Excavating roads, laying cable road crossing sleeves and refilling and finishing wherever required.

2.0.0 LOOP TESTING

2.1.0 The action of the controller is set as prescribed. Controller settings for various modes of operation (Proportional band, reset and rate action) are at nominal value. For current signals, 4 – 20 mA shall be injected and checked the loop for 0%, 25%, 50%, 75% and 100% of full- scale inputs. For temperature loops with thermocouples, a known milli volt signal shall be injected and the output display shall be checked for input signals of 0%, 25%, 50%, 75% and 100%. For temperature loops with RTDs, a known resistance shall be injected in the control cable through decade resistance box and Output display shall be checked for 0%, 25%, 50%, 75% and 100%. For field mounted switches for alarms / interlocks, the action shall be simulated by disconnecting the wires / shorting the terminals and the function of the associated system shall be checked. Any equipment required by the Bidder for testing, calibration and commissioning shall be brought by the Bidder at site. The list of such equipment shall be furnished along with the offer

2.2.0 Prior to taking the instruments in service, all impulse lines, sampling lines and air supply lines shall be blown as required with the establishment of adequate line pressure and temperature conditions to keep the lines thoroughly clean. On-line i.e., without removing control valves from the pipe, calibration of the positioners and stroking of control valves / control dampers shall be carried out as required during control system tuning. Pre-commissioning checks, individuals loop checks, power initialisation, verification of system functioning, trouble shooting final solutions to application and / or instrument problems, etc., is Bidder's responsibility. All the required software and hardware changes shall be incorporated as required for successful commissioning to Owner satisfaction. Any other tests as may be directed by the Owner Representative. After delivery of the equipment, the Bidder shall locate all the equipment including electronic cards in its final position, check all the power wiring, grounding and interconnection cables, all in accordance with manufacturer's recommendations. The Bidder shall perform initialisation of system power, field loading of system configuration / software and data base, demonstration of system functionality to verify conformance with manufacturer's instructions and specifications, tuning of control loops, implementation of any configuration changes including hardware, software and additional tapping's / instruments, cabinets as required and providing general trouble shooting and final solutions to application and / or instrument problems.

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2.3.0 The Bidder shall take care to complete all pre-commissioning activities and simulation tests after erection to suit the over all start up of respective plant equipment. The controllers shall be tuned as per the process requirement. The list of set points, alarms / Interlocks, settings for the controllers shall be furnished in the standard format and handed over to the Owner.. Control loops shall be put in auto mode as per the operational requirement of different phases. Processor, Bus Worst loading conditions calculation and other control system performance requirements shall be proved at the time of commissioning. Before taking over of the plant by the OWNER , all the system and auto control loops shall run satisfactorily for at least one month at varying loads without disturbing any adjustment. During this period, supervision and maintenance of the system shall be the scope and responsibility of the Bidder. The performance test shall be carried out for the system offered and certificates to these effects shall be approved by the OWNER .

3.0.0 INSPECTION, TESTING, GUARANTEE & SPECIAL TOOLS / TACKLES

3.1.0 After manufacturing all the I&C equipments / instruments shall be factory tested and calibrated. All the required test certificates, calibration certificates for the I & C equipments / instruments to be submitted to the Owner for approval before the dispatch of the same is allowed from the factory. As a minimum hydro-test, accuracy & repeatability test, over-range test, leak test, HV test, insulation test, functional tests, temperature rise test shall be conducted as applicable for the instruments and the control system. The electronic equipments shall be subjected to burn in test and tests as per IEC 68. The details of the test to be carried out for the I & C equipment shall be submitted for the Owner consent/approval before proceeding with the test. Bidder shall submit a detailed quality assurance program for individual I & C equipments / instruments for Owners for approval.

3.2.0 Tests for DCS / SG control / STG control / PLC system will include the following:

3.2.1 Factory Acceptance Test (FAT):

To be carried out at BIDDER's / Sub-Vendor's works and witnessed by Owner/Engineer, successful completion of which will be the basis for 'Authorization for Shipment to Site'. FAT shall be a complete integrated test of the system and carried out at BIDDER's / Sub-Vendor's works on completion of manufacturing of the system. The test shall be performed with the completely assembled system and performing all the functions, it is expected to perform while in actual service. The BIDDER shall submit a detailed "Factory Acceptance Test Procedure" in line with the above specified guidelines for Owner approval. The FAT shall be conducted as an integrated test of plant I&C system integrating the control system supplied by Other Vendors.

FAT shall be preceded by a 'Pre- FAT Inspection/ Test' to be carried out by Bidder/Vendor. Pre-FAT inspection / test shall be carried out as per approved FAT procedure detailed above and shall submit 'Pre- FAT Inspection/ Test' report for

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Owners review and approval. Owner shall witness the actual FAT on the basis of successful completion of 'Pre- FAT Inspection/ Test'.

3.2.2 Site Test (SAT):

Involves tests for site commissioning, calibration of monitoring and control equipment, Integrated loop test wiring, Trial Operation of the system functioning. Site guarantee tests for system performance & availability to be conducted in the presence of Owner. The reliability run shall be conducted for one month period. During the reliability run if the I&C system fails to meet the specific requirements, then the Bidder shall take immediate remedial actions and the procedure shall be restarted again for the reliability run. After the completion of the reliability run with full satisfaction of the Owner, the system shall be deemed for take over and this shall mark the commencement of warranty period.

Special tools and equipment for the maintenance, inspection and repair of the individual main equipment and auxiliary equipment shall be supplied by the Bidders in sufficient quantity to equip the shift personnel, maintenance personnel and workshop craftsman.

The special tools and equipment for maintenance and repair shall be delivered by the bidder in lockable steel boxes and they shall be marked in an approved manner for identification purposes and a corresponding tool chart shall be supplied with the steel boxes

The I&C systems offered by the Bidder shall be provided with guarantee period which will start from the date of handing over to the owner and Bidder to indicate the same in his offer.

Latest version of hardware and software available at the time of system designing shall be provided. In case of future up-gradation of software, Bidder shall remain committed to upgrade the supplied system with the new version within the warranty period. Beyond the warranty period and during the remaining life of the plant, any up gradation in hardware and software shall be brought to the notice of Buyer. Bidder shall ensure that supplied controls & instruments should be supported by the supplier such that spare parts are guaranteed to be available for purchase for a period of 15 (Fifteen) years. Similarly the service shall also be guaranteed for a period of 15 (Fifteen) years.

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F.2.8 C&I DATA SHEET (SUB-SECTION - 4.23)

9 SPECIFICATION FOR INSTRUMENTS EQUIPMENT TO BE SUPPLIED ARE AS FOLLOWS:

A MAN MACHINE INTERFACE AND PERIPHERALS

1. OPERATOR'S & ENGINEERING WORK STATION

The operator's & Engineering station shall be Workstation based with suitable networking capability to interface with the real-time data bus as well as the MIS bus. The following general specification shall apply, but the latest version available with better configurations to suit the applications shall be furnished. Bidder shall be responsible to get the approval from the owner for the selection of systems and peripherals during detail engineering stage.

The most current release of fully tested hardware shall be supplied. The features and the configuration for all the stations in the power project shall be reviewed and approved by the Owner.

S.N. FEATURES

QUALIFYING MINIMUM REQUIREMENTS

1. Processor	Intel Dual Core Xeon 5160 / latest / equivalent
2. Chipset & mother board	Intel original board, (suitable for above processor) /latest / equivalent
3. RAM	2 X 16 GB DDR @ 800MHz & expandable up to 64 GB / higher
4. HDD	500 GB SCSI 10000 RPM / higher
5. Optical drive	16 X DVD – R / RW / Blue Ray disc
6. Monitor	24" LED Type with minimum 1920 X 1200 resolution, MRP II, Energy Star Complaint, Asset Controlled (same make of workstation manufacturer preferable)
7. Graphics	High end 3 D
8. Type	DDC MIS / PLC work station, industrial application
9. Mouse	OEM optical mouse
10. Audio	Integrated based on Intel chipset / equivalent
11. Ethernet	Integrated 10 / 100 / 1000 with RJ45 port with ASF, WOL & PXE or latest
12.Bays, Slots and Chassis Design	Minimum 6 bays, 3 PCI (with option to expand to 5) +1 AGP slot. Chassis should be toll free design. (Tool less cover removal, Hard disk, CD, system board and PCI card removal)
14. Ports	Minimum 1 parallel, 1 serial, 6USB (Ver 2.0), VGA, Audio.
15. Operating system and DVDs	Latest windows 7 or latest with restore / recovery DVD and OS DVD to be supplied with every PC.
16. Thermal Design	Minimum 3 fans. ATX chassis with tool less opening features.
17. Power supply	Minimum 230 V AC
18. Manageability features:	Pre installed OEM's management agent with the following



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19. Security	Asset tag, DIMM Serial Presence detect, Serial number, Model and Manufacturer for system, monitor and HDD, ROM and system board revision levels Removable media boot control, Serial, parallel and USB interface control, power-on password, setup password, and Memory change alert (through BIOS, in windows environment & on management console). Internal smart cover lock & sensor for securing internal components. Kensington slot on chassis for physically securing the chassis.
20. Compliances	For OEM: ISO 9001:2000, 14001 For Desktop: OS certification (WLP 2.0 from Microsoft website), DMI 2.0 certification (from DMTF website) , EMI / FCC compliance, energy star compliance & UL compliance For Monitor: EMI / FCC compliance, Energy star compliance, MPR II Compliance
21. OS Certification	MS Windows 7/64 bit or higher (Latest)
22. Onsite Warranty	3 years comprehensive on – site, backed by manufacturer support, with OEM certified spare parts.
23. Software required	MS (Professional) office latest (English) license with media & documentation / multi user shall be separate one. Anti Virus & fire wall Norton / McAfee / Trend Micro corporate for PC's Laptop supplied through this P.O MATLAB, AUTO CAD, ORACLE, Photo shop (all latest with their individual license and products)
Edition	
24 Software updates	Shall be given for not less than 3 years, at no extra cost from the owner
25 Preferable Make	HP/DELL /IBM-Lenova (Work Stations)

2. LAPTOP COMPUTER FOR MOBILE COMPUTING

S.NO. FEATURES	QUALIFYING MINIMUM REQUIREMENTS
1. Processor	Intel Core I-7 processor or latest at the ordering
2. Installed memory	4 GB or (latest configuration)
3. Display	15.0 LED based latest
4. Operating System	Microsoft Windows 7/64 bit latest at the through of supply
5. Processor manufacturer	Intel
6. Processor type	Pentium mobile
7. Display size	15.6"
10. Display Tech	LED based
11. Display Max. Resolution	1280X1024 or better
12. Hard Drive Capacity	SATA II – 500 GB or solid state drive or latest
13. Storage Controller type	EIDE
14. Installed RAM	4 GB upgraded up to 16 GB or higher
15. RAM technology	DDR SDRAM



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|--------------------------------|--|
| 16. Max Supported RAM | 16 GB or Higher |
| 17. Installed Cache memory | 1024 KB |
| 18. CD / DVD type | DVD + RW (Combo) or Blue ray |
| 19. Optical drive Read system | 16 X (DVD – R/RW) |
| 20. USB Ports | 3, 1 S Video |
| 21. Installed Video Memory | 128 MB sharable with RAM |
| 22. Audio output type | Integrated sound card with internal speakers |
| 23. Modem type | 56 Kbps |
| 24. Analog Modulation protocol | ITU V.90, ITU V.92 |
| 25. Networking type | Integrated 10 / 100 Eth, wireless access point |
| 26. Data link protocol | IEEE 1394 / 802.11b wireless, Ethernet, fast Ethernet. |
| 27. Battery Technology | Lithium Ion |
| 28. Carry bag | Leather, shoulder carry type |
| 29. Warranty | Three yr on site |
| 30 Preferable Make | HP/DELL /IBM/SONY |

3. MONITOR

S.NO. FEATURES

QUALIFYING MINIMUM REQUIREMENTS

- | | |
|--------------------------|---|
| 01. Type | : LED Monitor |
| 02. Sync. | : Multisync. |
| 03. Screen diagonal | : 24" flat |
| 04. Display | : Super Video Graphic Array |
| 05. Resolution | : 1600 x 1200 |
| 06. Degree of protection | : IP-30 |
| 07. Brightness | : 300cd/m ² |
| 08. Contrast | : 800: 1 |
| 09. External Controls | : Brightness, contrast, Horizontal / Vertical amplification & shift |
| 10. Power supply | : 240 V, 50 Hz, 1 phase |
| 11. Ambient temperature | : 0-50 O C |
| 12. Humidity | : 95% non-condensing. |
| 13. Version | : To suit industrial application. |

4. KEY BOARD

S.NO. FEATURES

QUALIFYING MINIMUM REQUIREMENTS

- | | |
|--------------------|---|
| 01. Type | : Flat, spill proof membrane type or positive depression type. |
| 02. Different keys | : a) Soft and user defined function keys for software/ programming including text correction, scan rate alteration, zooming/ flashing color selection etc.
b) Panel select keys for alarm summary, control loop display, overview, trend, graphic, operator guide message etc.
c) Standard Alphanumeric keys
d) Alarm acknowledge keys
e) Cursor keys
f) Mode loop mode / loop status switching keys |



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- g) Multiple loop setting change keys
- h) Print-out command keys
- i) Other keys as required to operate the system
- j) Multiple loop output change keys
- k) Soft and user defined function keys for process mimics
- 03. Key lock : Lockable type push button mounted on keyboard
- 04. Life Expectancy : 50 million cycles per key
- 05. Version : To suit industrial application

5. LASER PRINTER

S.NO. FEATURES

QUALIFYING MINIMUM REQUIREMENTS

- 01. Type : Electro-photographic laser, tabletop / latest
- 02. Printer Memory : 256 MB (min.)
- 03. Speed : Monochrome 24 ppm - A4 Color 20 ppm - A4
- 04. Resolution : 1200 x 1200 DPI in color
- 05. No. of color (Basic) : 4 (four) minimum
- 06. Duty cycle : Monochrome 75000 pages / month
- 07. Power supply : 240 V, 50 Hz, 1 phase
- 08. Ambient temperature : 0-50° C
- 09. Humidity : 95% non-condensing.
- 10. Size of paper : Letter, A4 (25 Reams of paper), Legal, Ledger, A3 (20 Reams of paper)
- 11. Print media : Plain paper, transparencies, thick stock, glossy stock, envelopes
- 12. Accessories : i) Adapters
ii) Connector Cable
iii) Multiplexer switch (4 point)

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



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- 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

B. 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 without : 150 % of maximum span continuously, affecting the calibration.
- 08. Turn-down ratio : 100 : 1 minimum.



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- | | | | |
|-----|---|---|---|
| 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 Division 1 | : | IP-65 (Explosion proof for NEC Class-1, area) |
| 11. | Output Indicator unit and LCD (Digital display) transmitter | : | LCD type in % and engineering failure shall not affect the 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 °C |
| 17. | Performance: | : | |
| | i) Accuracy package, + | : | + 0.04% or better of FSR for BTG

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 suitable fill | : | 10 meters SS armoured capillary with

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, |



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bolts and gaskets.

- g) Hand held configuration kit for diagnostics and calibration of Smart Transmitter locally or in remote.
- h) $\frac{3}{4}$ " 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 °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.



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20. Accessories :
- a) Flange size and pressure rating as per application.
 - 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).



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- | | | |
|--------------------------------|---|---|
| 11. Sealing Ring | : | Viton, Buna-N |
| 12. Terminal Block connection. | : | Suitable for full ring lugs for cable |
| 13. Cable connection | : | 3/4" ET compression gland. |
| 14. Enclosure Class Division 1 | : | IP-65 (Explosion proof for NEC Class-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) 3/4" 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 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 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 |



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- 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: $\pm 1.0\%$ of span.
b) Accuracy of set point Indication: $\pm 1.5\%$
 14. Operating Ambient Temperature : 0 - 50 ° 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 pressure : Free floating bellows attached to high-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)



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- | | | | |
|-----|---------------------------|---|--|
| 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 $\pm$ 1.0 % of span or better for Pressure gauge |
| | Temperature | : | 0 - 50 °C |
| 14. | Safety Feature | : | Blow out disc. /diaphragm at the back |
| 15. | Accessories | : | <ul style="list-style-type: none"> 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. |
| 16. | Applicable standard | : | IS-3624 / 1996 |
| 17. | Electrical Contact rating | : | 240V, 5A AC/ 220V, 0.5A DC (for gauges with alarm contact). Number of Contacts:2 SPDT |
| 18. | Nameplate | : | Tag number, service engraved in stainless steel tag plate |

II. LEVEL



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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 | : | $\pm 0.03\%$ of measure distance or ± 3 mm |
| 10. | Stability | : | Contractor specify |
| 11. | Communication possible | : | Communication / configuration shall be 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 |
| 12. | Load limitation | : | max 600 ohm at 24V |
| 13. | Span & zero | : | adjustable |
| 14. | Flange mounting | : | yes |
| 15. | Environmental protection | : | IP 66 or better |
| 16. | Process connection with | : | traditional flange with $\frac{1}{4}$ " – 18 NPT on flange
process adapters (Flange & drain vent- 316SST) |
| 17. | Electronic housing | : | Aluminium alloy |
| 18. | Electrical connection | : | Preferably $\frac{1}{2}$ " – 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 / $\frac{3}{4}$ " NPT (M) |
| 04. | Material of construction | : | 316 SS |



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|-------------------------|---|---|
| 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 °C. |
| 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 |



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|----------------------------|---|--|
| 12. False signal tolerance | : | application
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 pervendor 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 coupled. | : | External cage float operated. Magnetically |
| 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) $\frac{3}{4}$ " 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 |



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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 °C. |
| 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)



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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 $\pm 0.25\%$; Resolution 1mm; Repeatability

$\pm 0.1\%$; Linearity $\pm 1\%$; Response time 150ms; Beam angle $< 12^\circ$; 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 $\pm 1\%$; Resolution 0.04"; Repeatability $\pm 0.04\%$; Linearity $\pm 0.01\%$; Beam angle $< 20^\circ$; 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



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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 ° 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

FLOW INSTRUMENTS

1. DELETED

2. DELETED

3. DELETED

1. Electro-Magnetic Flow Meter

A. Sensor



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- | | | |
|-------------------------|---|--|
| 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°C |
| 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 |

2. 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



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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.

1. 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 |



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12. Flow & Scale length : To be decided by Contractor.

2. Orifice Plate

- 01. Type : Ring joint / Flange type or other required type (To be decided by Contractor)
- 02. Material : 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.

3. Flow Nozzle

- 01. Application : flow element shall have 3 pair of differential pressure tapping
- 02. Design Standard : High fluid velocity flow measurement
- 03. Number of Tapings : ASME PTC 19.5
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)

4. 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
- 01. Hydraulic Test Pressure : 1.5 times maximum working pressure
- 02. Accessories : As required

3. Gauge Glass

- 01. Type : flow element shall have 3 pair of differential pressure tapping
- 02. Glass : Reflex
- 03. Body material : Toughened borosilicate. Resistant to mechanical and thermal shocks.
SS-304 / 316 / Carbon steel – As per



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- | | | |
|------------------------|---|---|
| 04. Pressure rating | : | process requirements (Flanged Connection) |
| 05. Temperature rating | : | Twice the maximum working pressure |
| 06. Bolts and nuts | : | 300 °C |
| 07. Accessories | : | Rust proof alloy steel |
| | : | Suitable ball check valves of SS- |
| | : | 304/316 body, gaskets, companion |
| | : | flange etc. |

4. 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 |



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- 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.: Value) 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°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 ± 0.06 Ohm
 - @ 100 Deg C ± 0.13 Ohm
 - @ 200 Deg C ± 0.20 Ohm
 - @ 300 Deg C ± 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



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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" ET cable gland |

6. Temperature Gauge

- | | |
|----------|--|
| 01. Type | : Mercury filled-in remote mounting system |
|----------|--|



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- 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

F. ANALYSERS

1. Chloride Analyser

- i. Type : Continuous flow through sample type-
Microprocessor based
- ii. Analyser power supply : 240V AC, 50 Hz
- iii. Analyser output : a) 4-20mA DC spare output.
b) 4-20mA DC isolated output for DCS.
- iv. Accuracy : Better than + 5 microgram/litre of full scale.
- v. Sensitivity : 0.1 ppm.
- vi. Range : Contractor to specify for process



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requirement & rerangable.

- vi. Annunciation contacts:
 - a) Number : 2 SPDT
 - b) Type : Snap action micro switch.
 - c) Rating : 5A, 240V, AC,
 - 0.2A, 220V DC. d) Mounting : Flush.
- vii. Terminal points : All component piped & wired.
- viii. Accessories
 - a) Flow regulator.
 - b) Flow gauges.
 - c) Sample rate set valves.
 - d) Other accessories as required to make the system complete

C. 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.)



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- | | | |
|-------------------------------|---|--------------------------------|
| 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 Hz
2.5 Hz for voltage measurement |



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- 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



2 X 660 MW, UDANGUDI STPP (STAGE-1)

BAP-RANIPET

TECHNICAL SPECIFICATION FOR ELECTRO CHLORINATION PLANT (E, C & I)

No: ROS: 4268, REV: 0

Part of ROS6282, REV:0

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.
- 2. Tag Plate : a) JB Number
b) Cable Numbers on top
c) Cable numbers with ferrules (side)
- 3. 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. DELETED

N. DELETED

O. Interposing Relays (IPR)



2 X 660 MW, UDANGUDI STPP (STAGE-1)

BAP-RANIPET

**TECHNICAL SPECIFICATION FOR
ELECTRO CHLORINATION PLANT (E, C & I)**

No: ROS: 4268, REV: 0

Part of ROS6282, REV:0

Electro magnetic type 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 type status 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 for 0.5 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

16. Instrument Manifolds

Technical Particulars

- | | | |
|---------------------------|---|---|
| 01. Type | : | a) Two valve manifold
b) Five valve manifold Remote 2" Pipe Mounting |
| 02. 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 |

I. CONTROL AND INSTRUMENT CABLE

1. DELETED

2. Instrumentation Pair Signal Cable

- | | | |
|--------------------------|---|--|
| 01. Conductor type | : | Stranded (7) annealed tinned copper |
| 02. Conductor size | : | 0.5 Sq.mm |
| 03. Resistance | : | 39 Ohms / Km (max.) at 20 °C |
| 04. Conductor Insulation | : | HRPVC Type-C (IS-5831,1984) 0.6 mm thick |
| 05. Voltage grade | : | 600V (peak value.) |
| 06. Twisting | : | Twin twisted with lay of 75 mm |
| 07. Twisting Direction | : | All pairs in the same direction. Lapped to |



2 X 660 MW, UDANGUDI STPP (STAGE-1)

BAP-RANIPET

TECHNICAL SPECIFICATION FOR ELECTRO CHLORINATION PLANT (E, C & I)

No: ROS: 4268, REV: 0

Part of ROS6282, REV:0

- form
bunch with mylar tape.
08. Individual Pair & Overall Shield : Aluminium mylar tape with a thickness of 2.35MIL and 25% overlapped edges.
 09. Drain wire : Annealed Tinned copper wire, Stranded. Size 0.5 Sq. mm. (No. of strands / size:- 7 / 0.3mm)
 10. Inner Sheath : Extruded FRLS PVC
Type ST2 of IS-5831,1984
Thickness as per IS-1554 Part-I 1976
 11. Armoring : G.I. Wire/Strip as per IS-3975
 12. Outer Sheath : Extruded FRLS PVC (anti rodent, anti termite & moisture resistant properties)
Type ST2 of IS-5831, 1984
Thickness as per IS-1554, Part-I 1976
 13. Rip Cord : Yes
 14. Temperature Range : 85 °C
 15. Insulation at 20 Deg.C : 100 MOhms/Km [Min]
 16. Capacitance at 800 Hz : 70 nf/km [Typical]
 17. Codes & Standards : a) IPCEA-S-61-402
b) IEC 332-1
c) ASTM-B-33
d) IS-8130-1984
 18. Tests : a) Oxygen Index: Min.29 at room temp. (ASTM-D-2863)
c) Acid Gas Gen.: Max.20% by weight as per IEC 754 Part-I
d) Temp Index: Min 250 ° C at 21Oxy. Ind. (ASTM-D-2863)
e) Smoke Density Rating: Max.60% (ASTM-D- 2843).
f) Flammability Test: as per IEC 332 Part-I
g) Swedish Chimney Test-S-424-1475
h) Insulation Test Core to core: 1.0 KVr.m.s for1 Min
i) Insulation Test Core to armour: 1.0 KV r.m.s for1 Min
j) Insulation Resistance 100 M Ohm / Km Min
k) Type test for material
l) Fire resistance test to IS 5831 for 20 Minute CPVC insulation & sheath of electrical cable.
m) Rodent & termite proof
n) Thermal Stability of 200 OYC to IEC 540 for 100 Nos.



2 X 660 MW, UDANGUDI STPP (STAGE-1)

BAP-RANIPET

**TECHNICAL SPECIFICATION FOR
ELECTRO CHLORINATION PLANT (E, C & I)**

No: ROS: 4268, REV: 0

Part of ROS6282, REV:0

3. Fiber Optic Cable

A Fiber:

1	Type	Multile single mode/Multi-Mode Fiber to avoid usage of any repeaters.
2	Core Diameter	62.5 ± 3 microns
3	Cladding Diameter	125 ± 2 microns
4	Fiber Proof test	As per Manufacturer"s standard
5	Coating Diameter	As per Manufacturer"s standard
6	Number of Fibers/core	Four OR Six (Colour Coded) with min. 100% spare core (Fibers)
7	Standard	As per Manufacturer"s standard

B Numerical Aperture 0.275

C Bandwidth & Attenuation:

1	Bandwidth @ 850 nm	160 MHz-Km min
2	Attenuation @ 850 nm	4.0 dB/Km max

D Cable Construction: Optic Fibre cable shall be galvanised corrugated steel taped armoured, fully water blocked with central dielectric material

1	Outer Colour	Black
2	Outer Jacket	Polyethylene 1.0 to 1.5mm thick, Flame retardant & UV resistant.
3	Inner Jacket	Core-locked flame retardant polyethylene
4	Filler / Strength member	As per Manufacturer"s standard
5	Central Strength member	Glass reinforced plastic (GRP) and Buckle resistant

E Stripping Ability All layers easily removed with Commercially available tools

F Installation:

1	Minimum bending radius	As per IEC/EIA & other international standard
2	Maximum Tensile Load	As per IEC/EIA & other international standard
3	Method of laying	Directly laid in cable trays / duct bank / clamped with available structure
4	Pulling	Ordinary cable grips

G Storage Temperature - 20⁰ C to 60⁰ C



2 X 660 MW, UDANGUDI STPP (STAGE-1)

BAP-RANIPET

**TECHNICAL SPECIFICATION FOR
ELECTRO CHLORINATION PLANT (E, C & I)**

No: ROS: 4268, REV: 0

Part of ROS6282, REV:0

H	Operating Temperature	- 20⁰ C to 65⁰ C
I	Test Specification (EIA – STD – RS - 445 or Equivalent):	
1	Impact Resistance	50 impacts
2	Crush	440 N/Cm
J	Moisture Resistance	Water blocking layer
K	F.O. Cable Testing	All Fiber Optic Cables shall be Tested as per IEC/EIA & other international standard using Optical Time Domain Reflector (OTDR meter)

J. Miscellaneous Instruments

07. 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



2 X 660 MW, UDANGUDI STPP (STAGE-1)

BAP-RANIPET

**TECHNICAL SPECIFICATION FOR
ELECTRO CHLORINATION PLANT (E, C & I)**

**No: ROS: 4268, REV: 0
Part of ROS6282, REV:0**

SECTION: G

ANNEXURES



2 X 660 MW, UDANGUDI STPP (STAGE-1)

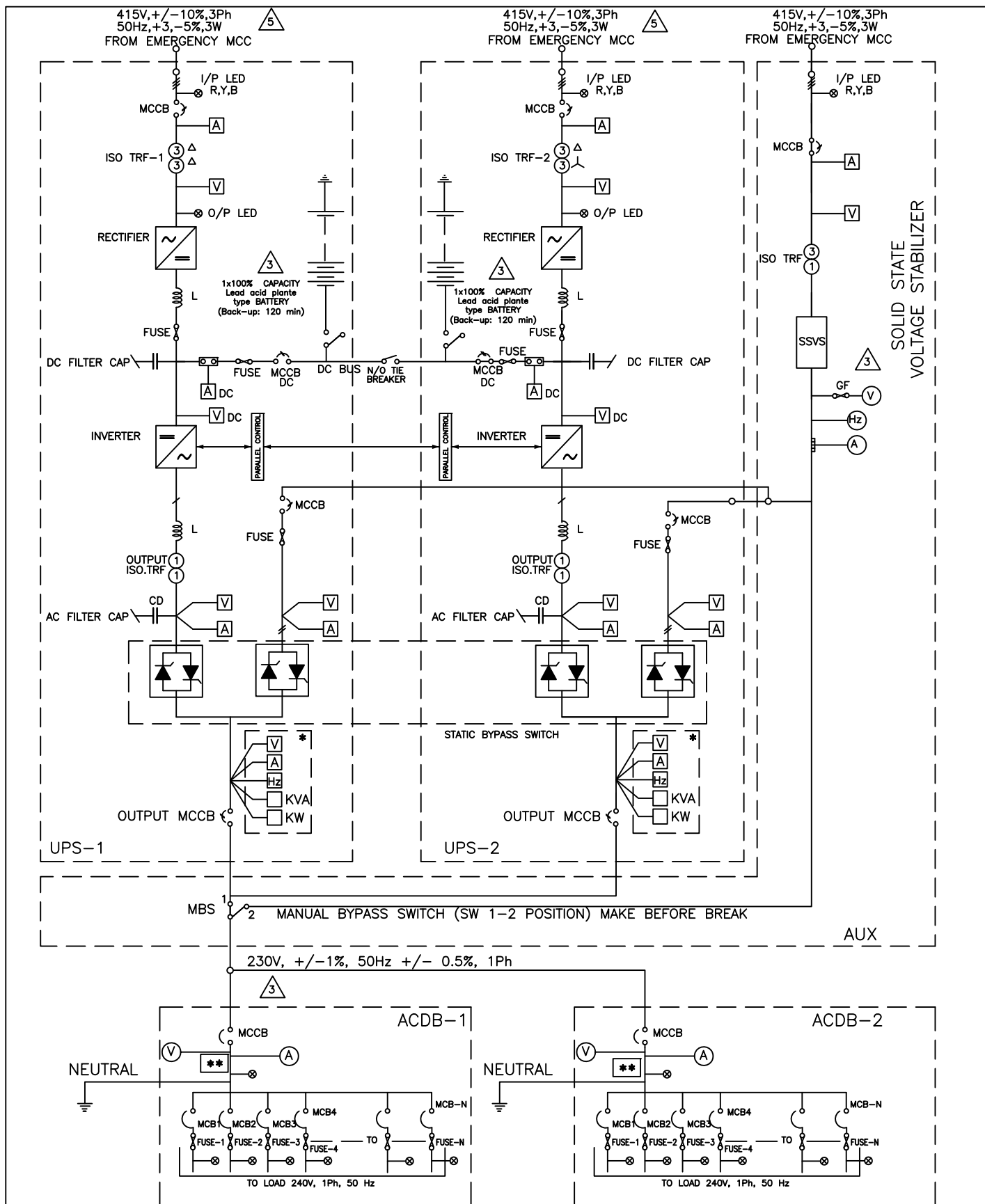
BAP-RANIPET

**TECHNICAL SPECIFICATION FOR
ELECTRO CHLORINATION PLANT (E, C & I)**

**No: ROS: 4268, REV: 0
Part of ROS6282, REV:0**

ANNEXURE: G.1

SINGLE LINE DIAGRAM FOR UPS



* V, A, Hz, KVA, KW READINGS/VALUES SHALL BE READY ON THE MIMIC DISPLAY PROVIDED ON THE UPS PANEL FRONT DOOR.
 **MFM (MULTI-FUNCTIONAL METER) SHALL BE PROVIDED AT EACH ACDB.



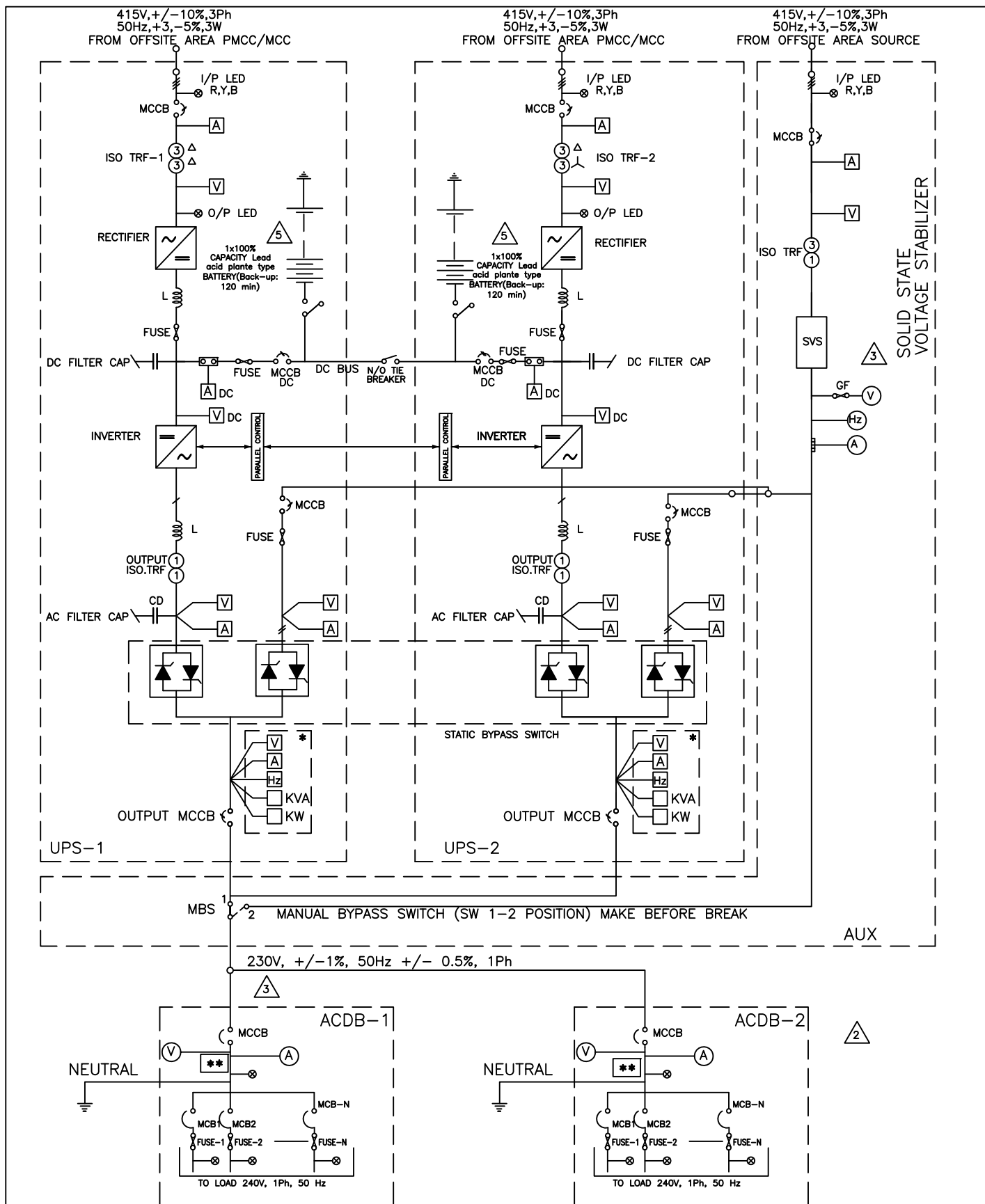
PROJECT:- 2X660 MW UDANGUDI TPP-STAGE I

TITLE:- UPS SCHEME
FOR MAIN PLANT

DRG. No. PE-DG-435-145-I004

REV. No. 00 DATE 24.03.2018

SHEET 2 OF 5



* V, A, Hz, KVA, KW READINGS/VALUES SHALL BE READY ON THE MIMIC DISPLAY PROVIDED ON THE UPS PANEL FRONT DOOR.

**MFM (MULTI-FUNCTIONAL METER) SHALL BE PROVIDED AT EACH ACDB.



PROJECT:- 2X660 MW UDANGUDI TPP-STAGE I

TITLE:- UPS SCHEME
FOR OFFSITE

DRG.
No.

PE-DG-435-145-1004

REV.
No.

00

DATE

24.03.2018

SHEET

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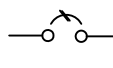
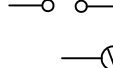
OF

5

GENERAL NOTES:

1. ACDB-1&2 NEUTRAL TO BE GROUNDED TO A DEDICATED GROUND.
2. ALL OUTPUT FEEDERS OF ACDB SHALL BE PROVIDED WITH AN LED AFTER THE FUSE FOR 'FEEDER ON' INDICATION WITH FEEDER DESCRIPTION.
3. ONLINE BATTERY HEALTH MONITORING SYSTEM SHALL BE PROVIDED FOR MAIN PLANT & OFFSITE UPS.
4. SINCE, THIS DIAGRAM IS AN SLD FOR UPS, DETAILS REGARDING SIZING HAVE NOT BEEN SHOWN. BHEL-EDN SHALL DO THE SIZING AND PREPARE TECHNICAL SPECIFICATION FOR PROCURING THE UPS.
5. FILTER CIRCUITS SHALL BE PROVIDED ON AC & DC SIDE AS REQUIRED.
6. UPS DB SHALL HAVE 1Ø240V MCB OUTGOING FEEDER.
7. RECTIFIER SHALL HAVE FACILITY FOR BOOST CHARGING THE BATTERY.
8. BOTH STATIC TRANSFER SWITCHES SHALL BE SELECTED ON AUTO MODE FOR AUTOMATIC TRANSFER TO BACKUP SUPPLY.
9. ACDB's PROVIDED ARE NON-COMPARTMENTALIZED TYPE.
10. ELECTRONIC TRANSFER SWITCHES SHALL BE PROVIDED AS PER CUSTOMER SPECIFICATION. 2
11. TRANSIENT/SURGE PROTECTION CIRCUIT SHALL BE PROVIDED IN THE INPUT CIRCUIT AS PER CUSTOMER SPECIFICATION. 2
12. RADIO FREQUENCY FILTERS SHALL BE PROVIDED AT THE INPUT AND OUTPUT OF UPS AS PER CUSTOMER SPECIFICATION. 2
13. TRANSDUCERS SHALL BE PROVIDED AT AC INPUT AND BATTERY SUPPLY DC MCCB FOR GIVING 4-20 mA ISOLATED SIGNALS FOR DDCMIS AND PLC 2
14. TRANSDUCERS SHALL BE PROVIDED AT SVS OUTPUT FOR GIVING 4-20 mA ISOLATED SIGNALS FOR DDCMIS AND PLC 2
15. NOMINAL VOLTAGE OUTPUT SHALL BE 230 V, 50 HZ, SINGLE PHASE WITH +/- 1% RESOLUTION. 2
16. MCCB AND MCB SHALL BE PROVIDED WITH ON, OFF, TRIP POSITION INDICATOR. 3
17. ACDBs SHALL HAVE FAULT LEVEL OF 10KA. 4
18. UPS SHALL BE CONNECTED TO EMS 7
19. MCB SHALL BE PROVIDED FOR OUTGOING FEEDERS RATINGS <= 16A AND MCCB FOR >16A. 8

LEGEND:

	ISO. TRF		INDUCTOR
	CAPACITOR		FUSE
	INVERTER		MCCB
	STATIC BYPASS SWITCH		SELECTOR SWITCH
	RECTIFIER		VOLTMETER
	INDICATING LAMP		FREQUENCY METER
	AMMETER		GROUNDING



PROJECT:- **2X660 MW UDANGUDI TPP-STAGE I**

DRG.
No.

PE-DG-435-145-I004

TITLE:-
UPS SCHEME
NOTES & LEGEND

REV.
No.

00

DATE

24.03.2018

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UPS SIGNAL INTERFACING WITH DDCMIS/DCS & PLC

1. ALARMS AND STATUS INDICATIONS, CURRENT, VOLTAGE ,FREQUENCY, PF ETC SHALL BE PROVIDED THROUGH SERIAL LINK WITH MODBUS OR ANOTHER COMPATIBLE PROTOCOL .
2. LIST OF 4–20 mA SIGNALS TO DDCMIS/PLC :
 - I) INVERTER A & B OUTPUT VOLTAGES
 - II) INVERTER A & B OUTPUT CURRENTS
 - III) INVERTER A&B OUTPUT FREQUENCY
 - IV) RECTIFIER A & B INPUT VOLTAGES
 - V) RECTIFIER A & B INPUT CURRENTS
 - VI) BATTERY A & B DC VOLTAGES
 - VII) BATTERY A & B DC CURRENTS
3. LIST OF ALARMS (MIN.) TO DDCMIS THROUGH POTENTIAL FREE CONTACTS :-
 - I) RECTIFIER – 1 TRIP.
 - II) INVERTER – 1 TRIP.
 - III) UPS BATTERY–1 LOW.
 - IV) UPS BATTERY–2 LOW.
 - V) RECTIFIER – 2 TRIP.
 - VI) INVERTER – 2 TRIP.
 - VII) LOAD ON STATIC BYPASS.
 - VIII) STATIC BYPASS FAILURE
 - IX) ACDB – 1 INCOMER TRIPPED.
 - X) ACDB – 2 INCOMER TRIPPED.
 - XI) UPS – 1 FAN TRIPPED.
 - XII) UPS – 2 FAN TRIPPED.



PROJECT:- 2X660 MW UDANGUDI TPP-STAGE I

DRG.
No.

PE-DG-435-145-I004

TITLE:- UPS SCHEME

REV.
No.

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DATE

24.03.2018

SHEET

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OF

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2 X 660 MW, UDANGUDI STPP (STAGE-1)

BAP-RANIPET

TECHNICAL SPECIFICATION FOR
ELECTRO CHLORINATION PLANT (E, C & I)

No: ROS: 4268, REV: 0
Part of ROS6282, REV:0

ANNEXURE: G.2

DRIVE CONTROL PHILOSOPHY

TATA CONSULTING ENGINEERS LIMITED

VENDOR DRAWING STATUS

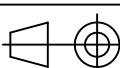
	CATEGORY	DESCRIPTION
☒	CAT-1	Drawing/drawing set to be cleared for approval/contract/contract.
☐	CAT-2	Drawing/drawing set cleared for approval/contract/contract. BHEL to receive the drawing for Approval Category - 1. Contract cleared for the drawing/drawing set.
☐	CAT-3	Drawing/drawing set cleared for approval/contract/contract. BHEL to receive the drawing for Approval Category - 1. Contract cleared for the drawing/drawing set.
☐	CAT-4	Drawing/drawing set cleared for approval/contract/contract. BHEL to receive the drawing for Approval Category - 1. Contract cleared for the drawing/drawing set.

Note:

1.	It is a drawing set to be cleared for approval/contract/contract. BHEL to receive the drawing for Approval Category - 1. Contract cleared for the drawing/drawing set.
2.	Approval/contract/contract cleared for approval/contract/contract. BHEL to receive the drawing for Approval Category - 1. Contract cleared for the drawing/drawing set.

Approval/contract/contract cleared for approval/contract/contract. BHEL to receive the drawing for Approval Category - 1. Contract cleared for the drawing/drawing set.

Reviewed by TKJ Date 29-01-2020

JOB NO. 435		REV. 06	DATED. 18.06.2019	ALTD. -sd-	CHD. -sd-	APPD. -sd-	DH-APP. -sd-	REV. 07	DATED. 05.11.2019	ALTD. PJ	CHD. MK	APPD. BS	DH-APP. SM
STATUS CONTRACT		A) REVISED IN LINE WITH CUSTOMER COMMENTS RCD VIDE LETTER REF # TCE. TCE.11403A-IC-VDT-043 Dated 28.05.2019				A) REVISED IN LINE WITH CUSTOMER COMMENTS RCD VIDE LETTER REF # TCE.11403A-IC-VDT-084 Dated 05.07.19							
REV. 05		DATED. 09.05.2019	ALTD. PJ	CHD. MK	APPD. BS	DH-APP. SM							
A) REVISED IN LINE WITH CUSTOMER COMMENTS RCD VIDE LETTER REF # TCE. 11403A-IC-VDT-023 DATED: 02.05.19		CUSTOMER TAMILNADU GENERATION & DISTRIBUTION CORPORATION LIMITED 5TH Floor, Western Wing, NPKRR Maaligai 144, Anna Salai, Chennai - 600002. 											
REV. 04		DATED. 29.04.2019	ALTD. PJ	CHD. MK	APPD. BS	DH-APP. SM							
A) REVISED IN LINE WITH CUSTOMER COMMENTS RCD VIDE EMAIL DATED 08.04.2019		CONSULTANT TATA CONSULTING ENGINEERS LIMITED BENGALURU 											
REV. 03		DATED. 01.12.2018	ALTD. PJ	CHD. MK	APPD. BS	DH-APP. SM							
A) REVISED IN LINE WITH RESOLUTION IN MEETING WITH TANGEDCO & DESEIN AT BHEL - PSSR - CHENNAI ON 23.10.2018		PROJECT 2X660 MW UDANGUDI TPP - UNIT # 1&2 											
REV. 02		DATED. 10.10.18	ALTD. PJ	CHD. MK	APPD. BS	DH-APP. SM							
A) REVISED IN LINE WITH RESOLUTION IN MEETING WITH TANGEDCO & DESEIN AT BHEL - PEM - NOIDA DATED: 20.09.2018		PROJECT BHARAT HEAVY ELECTRICALS LTD POWER SECTOR PROJECTS ENGINEERING MANAGEMENT NOIDA 											
REV. 01		DATED. 07.08.18	ALTD. PJ	CHD. MK	APPD. BS	DH-APP. SM							
A) REVISED IN LINE WITH CUSTOMER/CONSULTANT COMMENTS RCD VIDE LR.NO.SE /C /UP /EE /E / F. 2X660 MW UTTP /D. 87 /18, DT. 05.06.2018, RECEIVED VIDE EMAIL DATED 29.06.2018		TITLE DRIVE CONTROL PHILOSOPHY (STATION C&I) COPY RIGHT AND CONFIDENTIAL The information on this document is the property of BHARAT HEAVY ELECTRICALS LIMITED it must not be used directly or indirectly in any way detrimental to the interest of the company. DEPT CODE DESIGN PJ CHD MK APPD BS NAME SIGN DATE											
A) REVISED IN LINE WITH CUSTOMER/CONSULTANT COMMENTS RCD VIDE LR.NO.SE /C /UP /EE /E / F. 2X660 MW UTTP /D. 87 /18, DT. 05.06.2018, RECEIVED VIDE EMAIL DATED 29.06.2018		DEPT. SCALE 1:100 SIGN  DRAWING NO. PE-DM-435-145-I002											
		SHEET 1 OF 11 REV. 07											

	DOCUMENT TITLE	DOCUMENT NUMBER	PE-DM-435-145-I002
	DRIVE CONTROL PHILOSOPHY (STATION C&I)	REVISION NUMBER	07 DATE 05.11.2019
	2X660 MW TANGEDCO UDANGUDI STAGE I STPP	SHEET	2 OF 11

A. DRIVE CONTROL PHILOSOPHY

The control philosophy for different type of Drives is detailed below:

1 Bi-directional drives with Integral Starter (Open/Close duty and inching / regulating duty)



- a) All bi-directional drives shall have integral starter. These drives shall be operable from Remote i.e. from Central Control Room (CCR). **Local operation facility is provided for initial / commissioning only.**
- b) Remote manual operation of all drives shall be done from Operator Works Station (OWS/LVS).
- c) Remote control commands i.e. open/close generated from DDCMIS/PLC shall be issued to Integral Starter through interposing relays, mounted in Integral Starter. For open/close duty bi-directional drives DDCMIS/PLC Output command shall be latched at integral starter end, except for inching duty bi-directional drives where latching is not required.
- d) Necessary electrical protections shall be realized at Integral Starter, whereas process interlocks and protection shall be realized in DDCMIS/PLC.
- e) Following signal exchange shall take place between Integral Starter & DDCMIS/PLC.
 - Open & Close command
 - Actuator Disturbed (Loss of power supply/Loss of control supply/ Motor thermostat trip/ Thermal O/L /Local/off/Remote S/S in Local or off mode/ Torque open/close cutoff/ Stop PB operated).
 - Valve status feedback by means of limit switches (open/close).
 - Valve position feedback (4-20mA) for inching duty drives.
 - **Actuator in Remote mode.**
- f) **Automatic phase correction facility and potential free contact for annunciation of power failure shall be provided.**
- g) **Inching/pulse type command to control the inching type motorized valves shall be taken care in DDCMIS/PLC**



The above signal exchanges are diagrammatically represented in sheet no. 7.

2 Unidirectional LT Drives (Contactor Operated)

- a. Unidirectional LT drives shall be operable from Remote only i.e. from Central Control Room (CCR). Drives shall be provided with Local Emergency Stop Push Button (EPB).
- b. Remote manual operation of all drives shall be done from OWS and Local/remote selection of drives shall be done in DDCMIS/PLC. Back

	DOCUMENT TITLE	DOCUMENT NUMBER	PE-DM-435-145-I002
	DRIVE CONTROL PHILOSOPHY (STATION C&I)	REVISION NUMBER	07 DATE 05.11.2019
	2X660 MW TANGEDCO UDANGUDI STAGE I STPP	SHEET	3 OF 11

up remote operation from PB station mounted on UCP is provided for some essential drives for safe shutdown of plant.

- c. Control commands i.e. start/stop, shall be generated from DDCMIS/PLC and shall be issued to MCC through interposing relays located in respective MCC. DDCMIS/PLC output command shall be latched in MCC. EPB (stay put type), in MCC supplier's scope, shall be wired directly to MCC to stop the motor irrespective of motor being in remote/local mode. The EPB shall be provided with press to lock and turn to release type, keyless mechanism. Under its locked position, the drive operation shall be inhibited. The local start push button shall be wired to the DDCMIS/PLC to ensure interlock/protection requirement.
- d. Necessary electrical protections for the drives shall be realised at MCC, whereas process interlocks and protections shall be realized in DDCMIS/PLC.
- e. Following signal exchange shall take place between MCC & DDCMIS/PLC

- i. Drive Start & Stop commands.
 - ii. Drive ON & OFF feedback.
 - iii. MCC disturbed (Thermal O/L /Control supply fail/ MCC switched off / EPB operated
 - iv. Local Start to DDCMIS/PLC
 - v. **MCC Available (MCC in Remote)**
- f. Current transducers, 4-20mA types (in MCC suppliers scope), shall be mounted in the MCC for monitoring the current in DDCMIS/PLC for all drives ≥ 30 KW and for critical drives <30 KW. Auxiliary power supply to these transducers shall be provided from the control power supply of the respective MCC.



The above signal exchanges are diagrammatically represented in sheet no. 8.

3 Solenoid Operated Drives (24V DC/220V DC/240V AC)

- a. Solenoid operated drives shall be operable from remote i.e. CCR only.
- b. Remote manual operation of all drives shall be done from OWS.
- c. Remote control commands i.e. open/close shall be generated from DDCMIS/PLC and shall be issued to the respective solenoid through interposing relays located in Interposing Relay panels.
- d. Necessary process interlocks shall be realized in DDCMIS/PLC.
- e. Following signal exchange shall take place between solenoid operated drive & DDCMIS/PLC

	DOCUMENT TITLE	DOCUMENT NUMBER	PE-DM-435-145-I002
	DRIVE CONTROL PHILOSOPHY (STATION C&I)	REVISION NUMBER	07 DATE 05.11.2019
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- i. Valve open & close command.
- ii. Valve status feedback by means of limit switches (open/close), wherever available or from relay contact of interposing relays if limit switches are not provided. 1No. contact for single coil & 2 No. contact for dual coil (open Limit switch & closed limit switch) shall be provided.
- f. BHEL will take care of de-energize to trip philosophy for fail safe control system (wherever required).

The above signal exchanges are diagrammatically represented in sh. no. 9.

4 HT/LT (Breaker operated) Unidirectional Drives



- a. Remote manual operation of Breaker operated drives shall be normally from remote i.e. Station DDCMIS/**PLC** in main Control Room through OWS. Back up remote operation from PB station mounted on UCP is provided for some essential drives for safe shutdown of plant.
- b. Remote/Switchgear (SWGR) selection shall be realized from SWGR mounted R/S selector switch.
- c. Following are the operational combinations for breaker operated drives:
 - SERVICE POSITION – Drive Operation (Start/Stop) shall be from CCR with R/S (Remote/SWGR) selector switch in Remote position.
 - TEST POSITION – SWGR Testing (Start/Stop) from SWGR.

Switchgear mounted 'Trip/Neutral/Close' switch shall be provided for testing of switchgear when 'R/S' selector switch is selected as 'SWGR' and SWGR is in test position.
- d. Remote control commands i.e. start/stop, pulse type, shall be generated from DDCMIS/**PLC** and shall be issued to Switchgear through interposing relays located in respective Switchgear. Further there is Local/remote selection in DDCMIS/**PLC**. Local selection in DDCMIS/**PLC** means, command from local PB, provided near the drive, will be executed through DDCMIS/**PLC** whereas in case of remote mode of selection in DDCMIS/**PLC**, the command from OWS will be processed, not through local PB.
- e. The EPB shall be wired directly to switchgear to stop the motor irrespective of motor being in remote/local mode. The EPB (stay put type), in SWGR supplier's scope, shall be provided with press to lock and turn to release type, keyless mechanism. Under its locked position, the drive operation shall be inhibited. The local **start** push

	DOCUMENT TITLE	DOCUMENT NUMBER	PE-DM-435-145-I002
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button shall be wired to the DDCMIS/PLC to ensure interlock/protection requirement.

f. Necessary electrical protections for the drive shall be realised at Switchgear, whereas process interlocks and protections are realized in DDCMIS/PLC.

g. Following signal exchange shall take place between switchgear and DDCMIS/PLC: -

- i. Drive Start & Stop commands.
- ii. Drive ON & OFF status feedback.
- iii. Switchgear Disturbed (Control power supply failure / Trip coil unhealthy / LPB Operated).
- iv. Switchgear Available (Breaker in Service & Trip ckt Healthy & Master Trip Relay Reset & Spring Charged / SWGR in remote)
- v. Master Trip Relay (86 Relay) operated.
- vi. **Local Start to DDCMIS/PLC**



h. Current transducers, 4-20mA types (in SWGR suppliers scope), shall be mounted in the SWGR for monitoring the current in DDCMIS/PLC. Auxiliary power supply to these transducers shall be provided from the control power supply of the respective switchgear.

The above signal exchanges are diagrammatically represented in sh. no. 10.

B. ANALOG DRIVE CONTROL PHILOSOPHY

Analog Drives Control

- 1.1 A drive control function residing in Distributed Processing Units (DPUs) is used to position the pneumatically operated control valves/Dampers through SMART positioner. Interlock and protection Open/Close Commands, originating from field or generated internally in Control Logics (ACS), are interfaced with the drive control function residing in processors.
- 1.2 Control Valve actuator design shall take care of fail safe condition i.e. bringing valve to full open/full close or stay put mode, on signal (pneumatic/electric) failure.
- 1.3 Auto/Manual operator control and display for various control loops shall be provided through OWS, using Analog Displays.
- 1.4 Analog Displays have following functionality:
 - Auto/Manual selection with control device “Raise/Lower Buttons”

	DOCUMENT TITLE	DOCUMENT NUMBER	PE-DM-435-145-I002
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- Set point indication with “Raise/Lower Buttons”
- Indication for deviation between set point and measured value
- Measured value indication
- Final control element position feedback indication.

The above signal exchanges with DDCMIS/PLC are diagrammatically represented in sh.no. 11.



Note:

- 1) G-Type cable (Overall Shielded) shall be used for binary signals whereas F-Type cable (Individual pair and overall shielded) shall be used for analog signals.



- 2) This document (Drive Control Philosophy - Station C&I) will be used for total project in general, except for TG & SG integral. Same shall be submitted separately for approval. TANGEDCO & DESEIN noted.



- 3) Please refer PEM-Electrical drawing / documents for HT Breaker operated electrical feeders (other than motors), BTS, Sync panel, EDG, DC system, sync panel, EMS-electrical interface, LT feeder

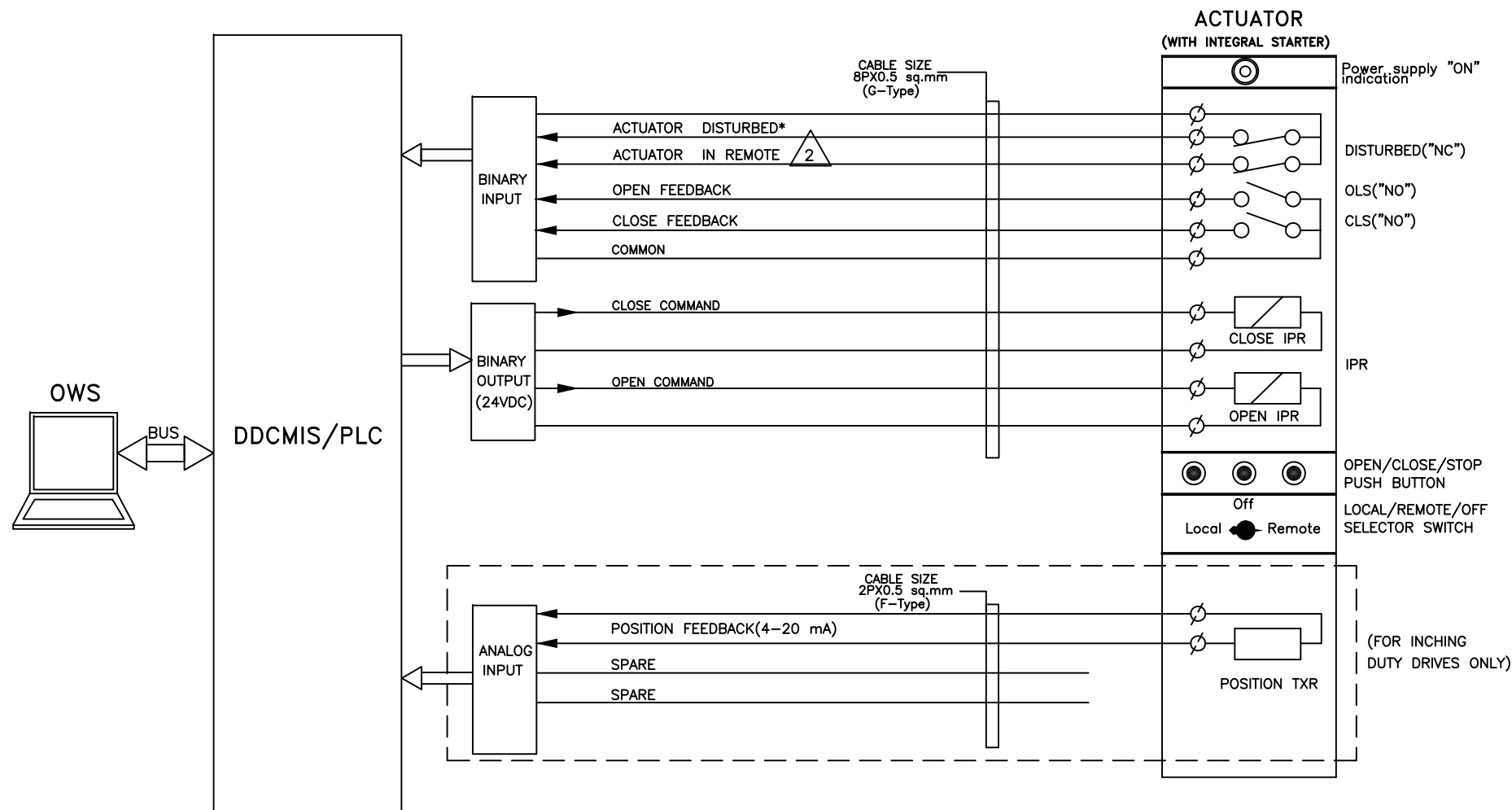
- 4) Please refer BHEL-TBG drawing / documents for switchyard and protection system control philosophy.



- 5) Meters are connected to EMS through data concentrators. Further the meter data will be communicated to DCS from EMS.

- 6) Signals used for critical interlocks (electrical) shall be hardwired to DCS.

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.

3) Two Nos of 9 pin plug in connectors, type connection shall be provided for interfacing with DDCMIS.

* 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.



PROJECT: 2X660 MW TANGEDCO UDANGUDI
STAGE I STPP

TITLE DDCMIS INTERFACE FOR
BIDIRECTIONAL DRIVE

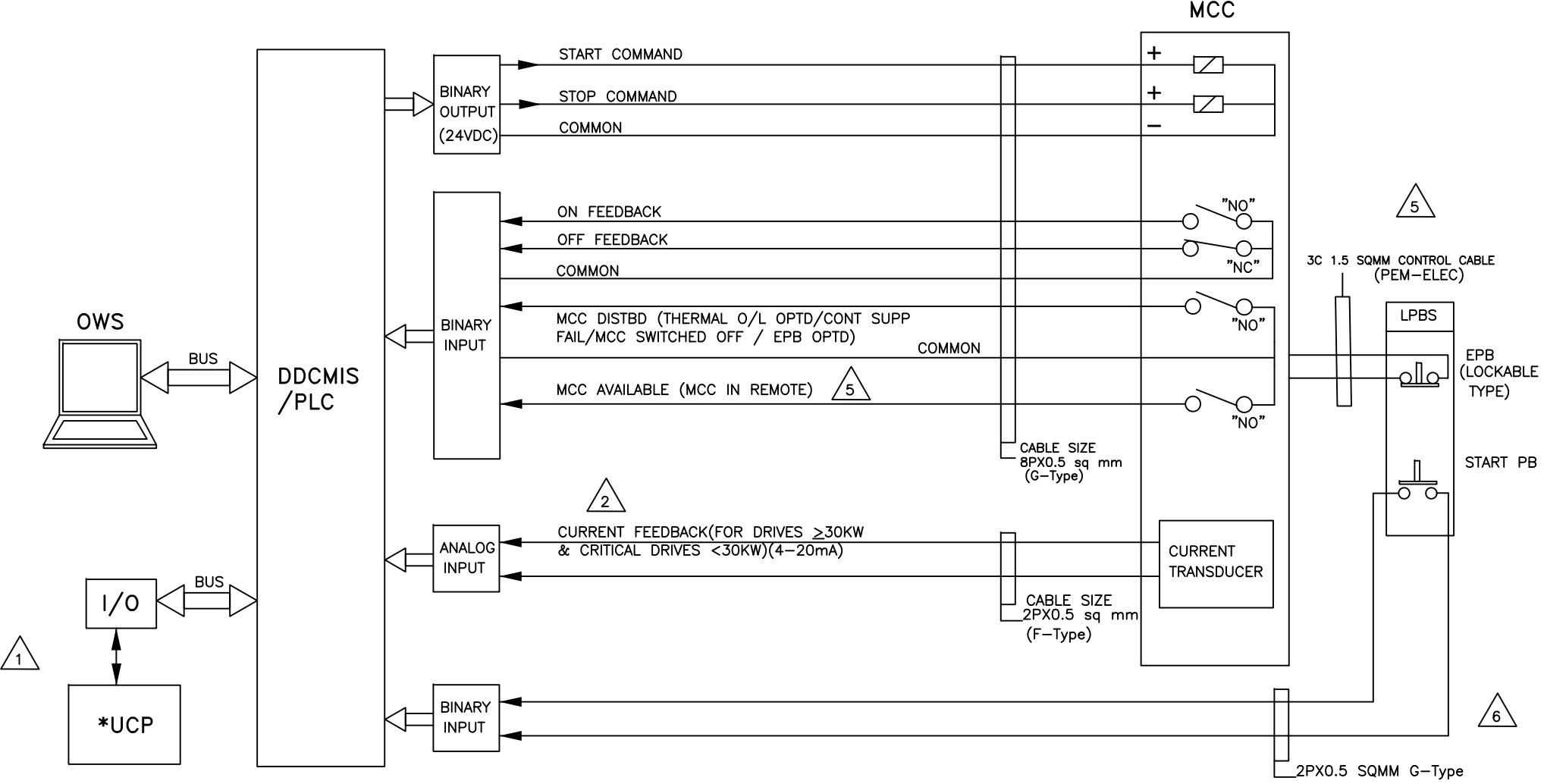
DRG.NO. PE-DM-435-145-I002

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DCS INTERFACE FOR UNIDIRECTIONAL LT DRIVE



* As Applicable

NOTE:
1) Redundancy of I/Os shall be as per contract specification requirement.

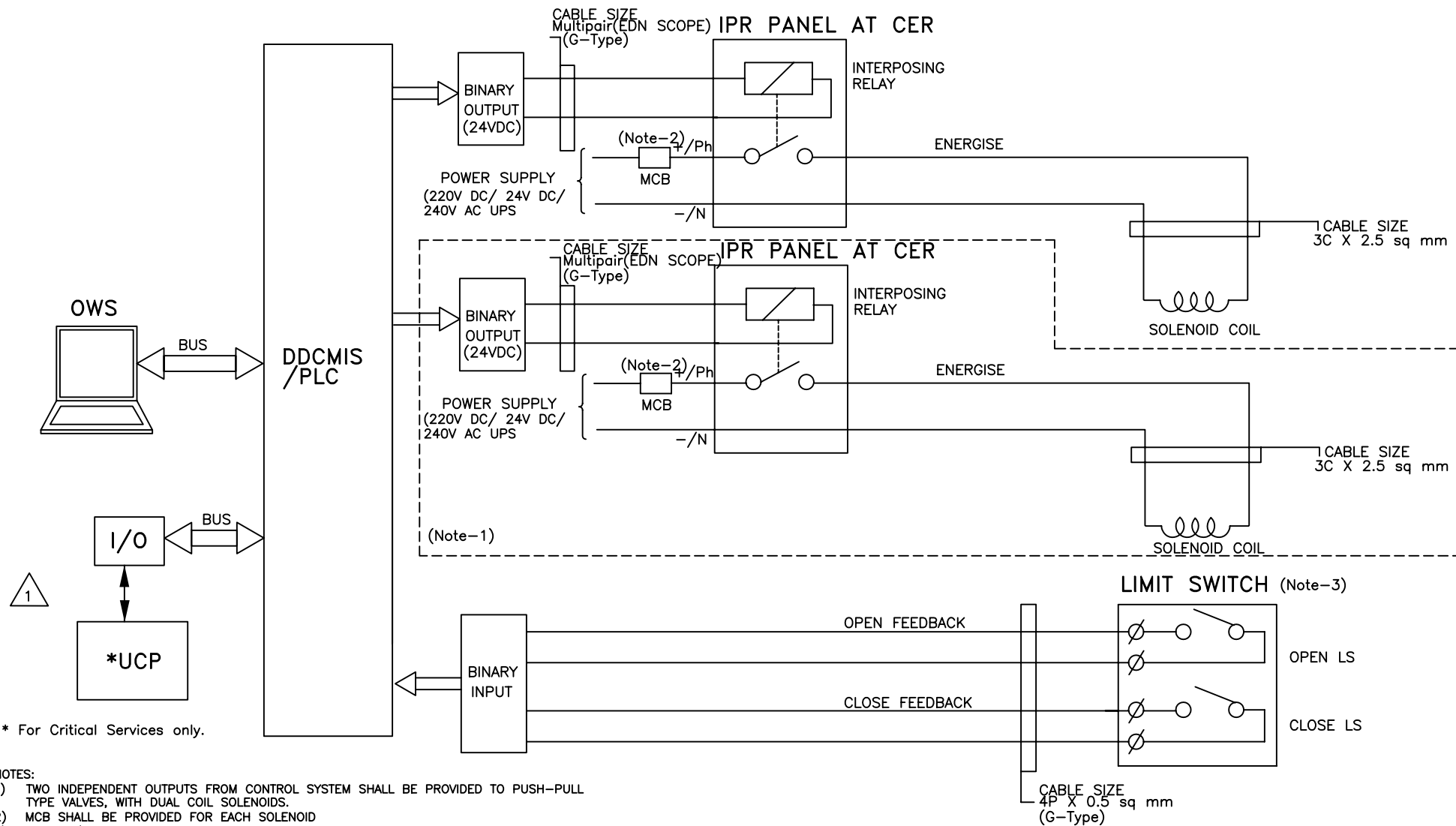


PROJECT: 2X660 MW TANGEDCO UDANGUDI
STAGE I STPP

TITLE DDCMIS INTERFACE FOR
UNIDIRECTIONAL LT DRIVE

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DCS INTERFACE FOR SOLENOID DRIVE (220V DC/ 24V DC / 240V AC UPS)



* For Critical Services only.

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.



PROJECT: 2X660 MW TANGEDCO UDANGUDI
STAGE I STPP

TITLE DDCMIS INTERFACE FOR
SOLENOID DRIVE

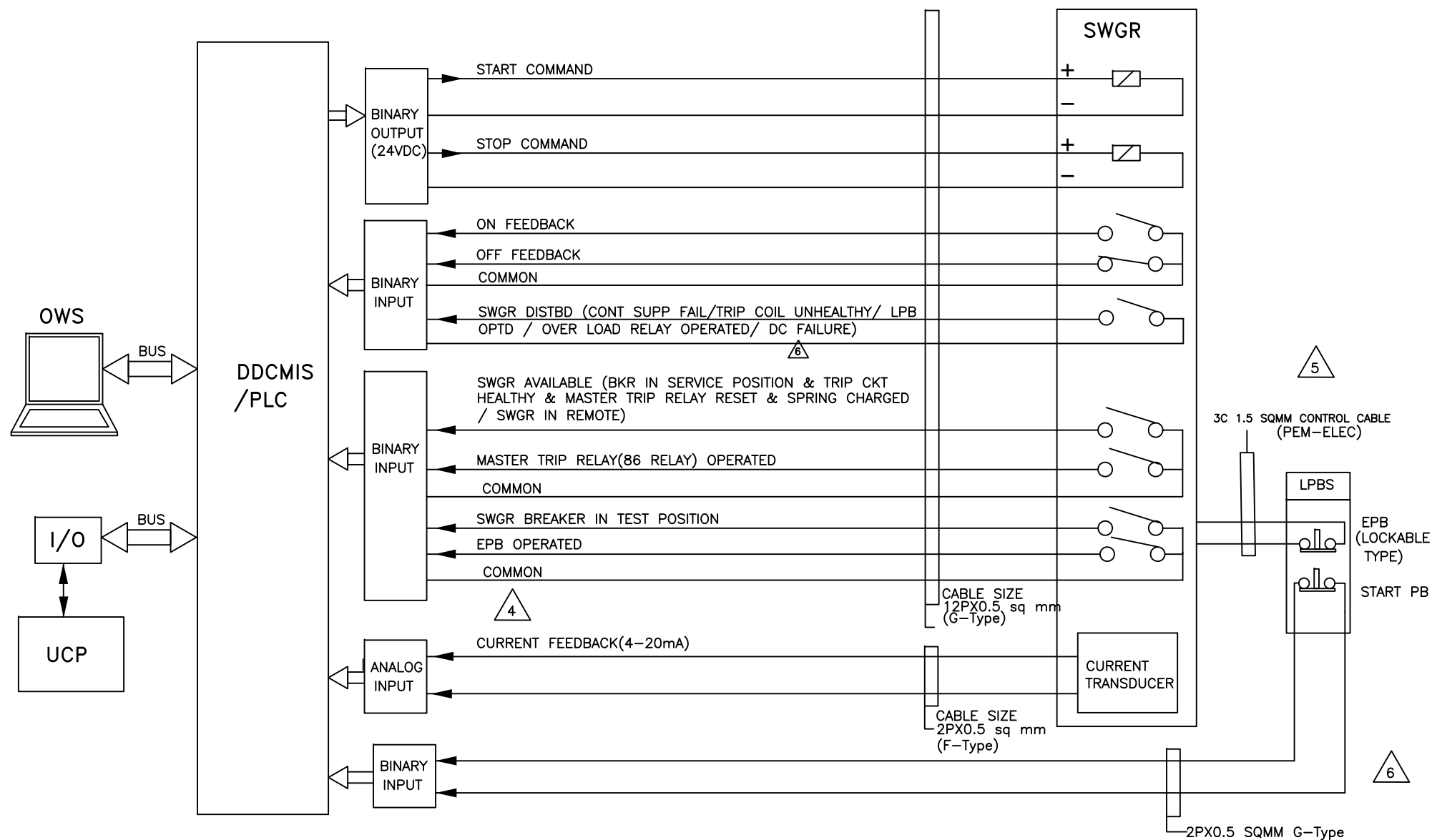
DRG.NO. PE-DM-435-145-I002

DATE 05.11.2019

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DCS INTERFACE FOR HT/LT(BREAKER OPERATED) UNIDIRECTIONAL DRIVES



NOTE:

- Redundancy of I/Os shall be as per contract specification requirement.
- Winding, Bearing and Vibration signals shall be interfaced with DDCMIS.



PROJECT: 2X660 MW TANGEDCO UDANGUDI
STAGE I STPP

TITLE DDCMIS INTERFACE FOR
UNIDIRECTIONAL HT DRIVE

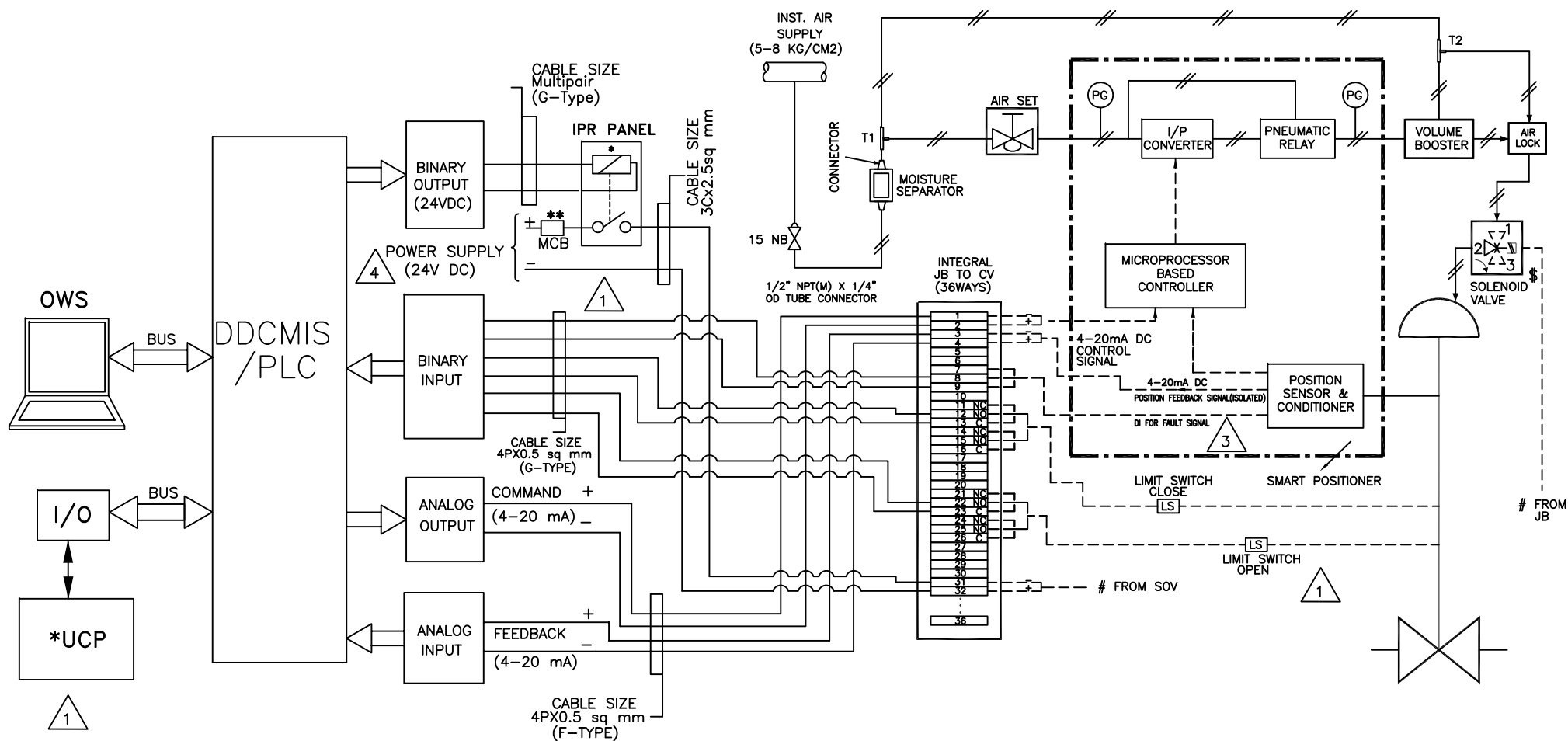
DRG.NO. PE-DM-435-145-I002

DATE 05.11.2019

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DCS INTERFACE FOR ANALOG DRIVE (WITH SMART POSITIONER)



* As Applicable

NOTES:

- 1) REDUNDANCY OF I/O'S SHALL BE AS PER CONTRACT SPECIFICATION 1
REQUIREMENT.
- 2) \$ APPLICABLE TO VALVES WHERE PROTECTION OPEN/CLOSE ACTION FOR
CONTROL DEMAND OVERRIDING IS REQUIRED.
- 3) DI FOR FAULT SIGNAL OF THE SMART POSITIONER SHALL BE PROVIDED.
- 4) ** MCB SHALL BE PROVIDED FOR EACH SOLENOID



PROJECT: 2X660 MW TANGEDCO UDANGUDI
STAGE I STPP

TITLE TYPICAL HOOK-UP DIAGRAM
 ANALOG DRIVE (WITH SMART POSITIONER)

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2 X 660 MW, UDANGUDI STPP (STAGE-1)

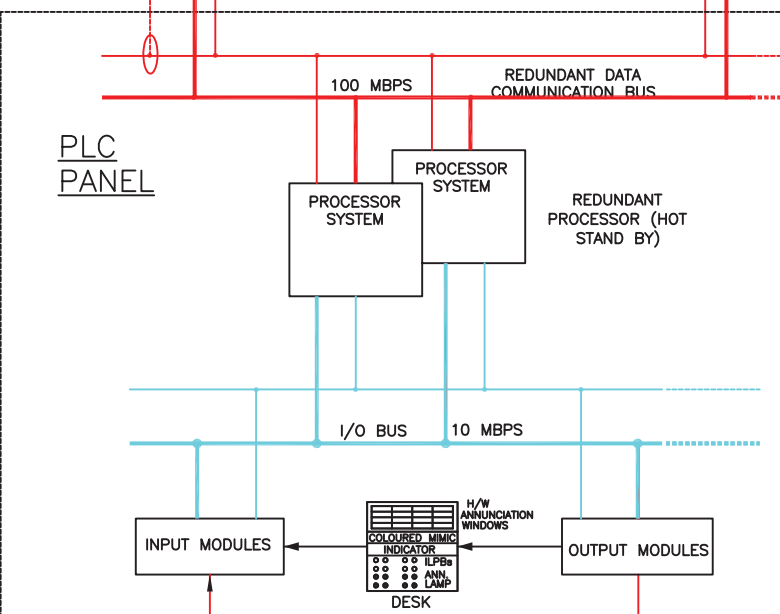
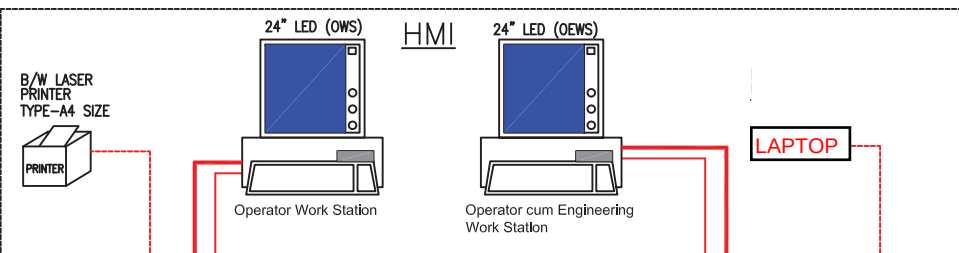
BAP-RANIPET

TECHNICAL SPECIFICATION FOR
ELECTRO CHLORINATION PLANT (E, C & I)

No: ROS: 4268, REV: 0
Part of ROS6282, REV:0

ANNEXURE: G.3

PLC CONFIGURATION DIAGRAM

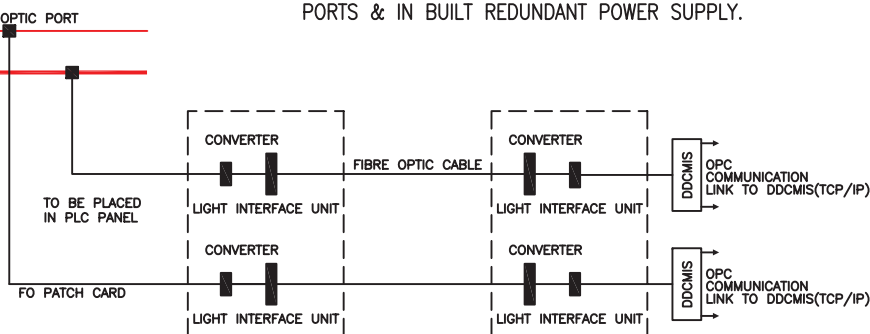


LEGEND:-

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

NOTES:

- 1) TABLE TOP OWS/OEWS SHALL BE OF LED 24" AS PER TECHNICAL SPECIFICATION.
- 2) PLC SYSTEM SHALL HAVE HOT REDUNDANCY IN PROCESSOR, COMMUNICATION SYSTEM AND POWER SUPPLY.
- 3) PARALLEL REDUNDANT UPS POWER SUPPLY SHALL BE PROVIDED FOR PLC PANEL(S), OWS/OEWS AND NETWORK COMPONENTS.
- 4) POWER SUPPLY ARRANGEMENT FOR PLC SYSTEM SHALL BE AS PER THE UPS SCHEME FOR OFFSITE, DOCUMENT No. PE-DG-435-145-I004.
- 5) PLC PANEL SHALL HAVE PROVISION TO ACCEPT REDUNDANT TIME SYNC. SIGNAL (IRIG-B) FROM MASTER CLOCK SYSTEM (PLANT AREA).
- 6) PLC PANEL SHALL HAVE PROVISION FOR REDUNDANT DATA EXCHANGE (OPC) WITH PLANT DCS.
- 7) PLC SHALL BE PROVIDED WITH NECESSARY REDUNDANT PORTS & COMPLETE HARDWARE FOR AUTO TIME SYNCHRONISATION FROM MASTER CLOCK TIME.
- 8) EACH COMMUNICATION NETWORK SHALL BE INDUSTRIAL GRADE AND SHALL BE PROVIDED WITH INDUSTRIAL GRADE MANAGED TYPE ETHERNET SWITCHES, EXTERNAL SURGE PROTECTION SYSTEM/DEVICES AND INDUSTRIAL FIREWALL. INDUSTRIAL GRADE MANAGED TYPE ETHERNET SWITCHES SHALL BE PROVIDED WITH IN BUILT DIAGNOSTIC FEATURES, 20% SPARE PORTS & IN BUILT REDUNDANT POWER SUPPLY.



	TITLE:- PLC SYSTEM CONFIGURATION ELETROLYTIC CHLORINATION PLANT (FOR CW & PRETREATMENT PLANT)		DRG. NO.	
			REV. No.	1
			DATE	
SHEET		1	OF	1



2 X 660 MW, UDANGUDI STPP (STAGE-1)

BAP-RANIPET

**TECHNICAL SPECIFICATION FOR
ELECTRO CHLORINATION PLANT (E, C & I)**

**No: ROS: 4268, REV: 0
Part of ROS6282, REV:0**

ANNEXURE: G.4

ELECTRICAL LOAD FORMAT



2 X 660 MW, UDANGUDI STPP (STAGE-1)

BAP-RANIPET

TECHNICAL SPECIFICATION FOR
ELECTRO CHLORINATION PLANT (E, C & I)

No: ROS: 4268, REV: 0
Part of ROS6282, REV:0

ANNEXURE: G.5

CABLE SCHEDULE FORMAT

**2 X 660 MW, UDANGUDI STPP (STAGE-1)****BAP-RANIPET****TECHNICAL SPECIFICATION FOR
ELECTRO CHLORINATION PLANT (E, C & I)****No: ROS: 4268, REV: 0
Part of ROS6282, REV:0**

Annexure-G.5

CABLE SCHEDULE FORMAT

S no.	Instrument & device no.	Cable Number	Number of Cables	Cable Size & Type	From Equipment	From Equipment Description	To Equipment	To Equipment Description	Routed Length (Mtrs.)	Ref Drawing no.	Rev No

Instrument cables finalised for the project

INSTRUMENT CABLE OF 1100V, HR PVC INSULATED, FRLS ST-2 PVC INNER & OUTER SHEATHED, ARMoured

S.No	Item Description
1	2P X 0.5 SQ. MM, CU CABLE (G-TYPE)
2	4P X 0.5 SQ. MM, CU CABLE (F-TYPE)
3	8P X 0.5 SQ. MM, CU CABLE (F-TYPE)
4	12P X 0.5 SQ. MM, CU CABLE (F-TYPE)
5	4P X 0.5 SQ. MM, CU CABLE (G-TYPE)
6	8P X 0.5 SQ. MM, CU CABLE (G-TYPE)
7	12P X 0.5 SQ. MM, CU CABLE (G-TYPE)

	Design Calculations For LT Cable Selection & Sizing		Doc. No. PE-DC-435-507-E002
	2 X 660MW UDANGUDI STPP- STAGE-1		Rev No. 06
			Date: 06.04.2020

CABLE SIZES FINALISED FOR THE PROJECT

1.1 kV, XLPE INSULATED POWER CABLES		1.1 kV, CONTROL CABLES	1.1 kV, EPR INSULATED FIRE SURVIVAL CONTROL CABLES	1.1 kV, EPR INSULATED FIRE SURVIVAL POWER CABLES
ARMOURED, AL CONDUCTOR	ARMOURED, CU CONDUCTOR	COPPER CONDUCTOR PVC INSULATED ARMOURED CONTROL CABLES	ARMOURED, Cu CONDUCTOR	ARMOURED, Cu CONDUCTOR
1C-400	2C-2.5	3C-1.5	3C-1.5	1C-400
1C-630	3C-2.5	5C-1.5	5C-1.5	2C-50
2C-10		5C-2.5		2C-95
2C-25		7C-1.5		3C-50
2C-50		9C-1.5		3C-150
2C-95		12C-1.5		
3C-10		5C-4		
3C-25				
3C-50				
3C-95				
3C-150				
3C-240				
3C-300				
3.5C-25				
3.5C-50				
3.5C-95				
3.5C-185				

NOTES:

1. For CT/PT Connection, minimum 2.5 sq.mm. copper control cable shall be used. However higher size of 4.0 sq. mm. will also be provided, if required.
2. Cable sizes shall be selected from above as per requirement. All sizes may not be used.



2 X 660 MW, UDANGUDI STPP (STAGE-1)

BAP-RANIPET

TECHNICAL SPECIFICATION FOR
ELECTRO CHLORINATION PLANT (E, C & I)

No: ROS: 4268, REV: 0
Part of ROS6282, REV:0

ANNEXURE: G.6

INSTRUMENT SCHEDULE FORMAT

ANNEXURE-G.6

Project :2 X 660 MW UDANGUDI STPP (STAGE-1)

PID Drg. No & Name:

S. No	Tag No.	Description	Legend/ TYPE	Qty	Scope	Drg. Reference	Medium	OPERATION			DESIGN			Instrument			Set Point	Alarm	Process		Electrical connection	Make	Model	Remarks
								Pressure (Kg/cm2)	Temp. (deg. C)	Flow (m3/hr)	Pressure (Kg/cm2)	Temp. (deg. C)	Flow (m3/hr)	Min.	Max	Unit			Inst.	Piping				

Mandatory spares

S. No.	Description	Quantity
1	FOR HORIZONTAL CENTRIFUGAL PUMPS	
1.1	Impeller with shaft	1 set for each type of pump
1.2	Bearings (for pump)	1 set for each type of pump
1.3	Shaft Sleeves	1 set for each type of pump
1.4	Mechanical seal/ Gland packing	1 set for each type of pump
2	Mimic & Control Panel	
2.1	Annunciator	
a.	Hooter	Two (2) Nos. for each size.
b.	Lamps	Twenty Four (24) Nos. for each size.
c.	Flasher cord	Two (2) Nos. for each size.
2.2	Control Panel	
a.	Indicating lamps	Twenty Four (24) Nos. for each size.
b.	Switches rotating	Two (2) Nos. for each size.
c.	Fuses with fuse holder	Twelve (12) Nos. fuse for each rating
d.	Terminal Block	Two (2) Nos.
e.	Mimic Lamps	Twelve (12) Nos. for each color
f.	Push Button	One (1) set.
3	PLC	
a.	Processor card	One (1) No.
b.	Input / Output card	Two (2) Nos. of each type or model (DI, DO, AI, AO, RTD and any other I/O card)
c.	Communication card	One (1) No.
d.	Power Supply card	One (1) No.
4	Dry type Transformer of each rating	
a)	HV Bushings with metal parts for each rating	3 Nos.
b)	Winding Temperature Indicator with all accessories	2 Nos.
c)	Limit Switches	2 Nos.
d)	Temperature scanner	2 Nos.
5	For Battery of each type and rating	
a)	Inter cell connectors with insulated cover	10 Nos.
b)	Inter row connectors with insulated cover	10 Nos.
c)	Battery stand insulators	10 Nos.
d)	Cell insulators	10 Nos.
e)	Nuts, bolts & washers-each type	1 Set
f)	Vent plugs	10 Nos.
g)	Spare dry cell	10 Nos.
6	UPS of each rating	
a)	HRC Fuses of each type and rating	5 Nos.
b)	Semiconductor fuses of each rating	5 Nos.
c)	Electronic cards and modules of each type	2 Nos.
d)	Thyristors /Power transistors / power diodes of each rating	5 Nos.
e)	Filter capacitors & Chokes of each rating	5 Nos.
f)	Static transfer switch	5 Nos.
g)	Maintenance by pass switch for each type and rating	2 Nos.
h)	MCCB for each type and rating	10 % of total population
i)	CTs of each type and rating	1 Set
j)	Rectifier cards	1 Set
k)	MFMM for each type and rating	1 No.
l)	Rectifier transformer for each type and rating	1 No.
7	LT Motors of each type and rating	
	Driving end bearing	1 set
	Non driving end bearing	1 set
	Terminal block for motors up to 30 Kw each rating	10 Nos.
	Terminal block for motors above 30 Kw each rating	5 Nos.
	Motors of each type & rating	10% of installed quantity or 1 –no whichever is higher
8	Electrical actuator, complete assembly, of each rating	2 nos.
9	HMI, Network	
	Keyboard	10% or 1 no. of each type.
	Mouse	10% or 1 no. of each type.
	24" Monitor	10% or 1 no. of each type.
	Printer toner for all printers	10% or 1 no. of each type.

Mandatory spares

S. No.	Description	Quantity
	Ethernet switches, Routers	10% or 1 no. of each type.
	Graphical Interface Unit	1 no. of each type & model
	Network Cables and Connectors.	10% or 3 nos of each length & each type
	Cat6 cable	200 mtr
	RJ 45 connector with box	20% or 2 nos. of each type
	Portable hard disk Drive 1TB	1 No.
	Prefab interconnecting cables with connectors	2 nos. of each type and length
	System bus cable with connectors	2 nos. of each type and length
	I/O bus cable with connectors for remote I/O units	3 nos. of each type and length.
	Power Supply Modules & Power Packs for control system	20 % or 4 nos. of each type, model and rating, whichever is more.
	Bus coupler/Interface hardware and other communication devices (If applicable)	10% of each type and model
10	Temperature elements	
	RTD's of each type and length(with head assembly, terminal block & nipple)	10% or 2 nos. of each type and length, whichever is more
	Thermocouples of each type like K-type, R-type, metal etc. (with head assembly, terminal block & nipple)	10% or 2 nos. of each type and length which ever is more
	Thermowell for application like mill outlet temperature and SH/RH/Eco/ flue gas temp. in furnace	10% or 2 nos. of each type and length whichever is more
	Temperature transmitters	10% of each type and model
11	Local Indicators like temperature gauges, pressure gauges, differential pressure gauges, flow gauges, flow meters etc.,	10% or 2 no. of each make, model and type whichever is more and for each plant (to be divided to various ranges in proportion to main of all make, model, type population)
12	Process Actuated Switch Devices Includes all types of Pressure, differential pressure, flow, temperature, differential temperature, level switch Devices	5% or 1 no. of each type and model whichever is more
13	PD Type Flow Transmitters	1 no. of each type and model
14	POWER SUPPLY SYSTEM – 24 VDC (To be provided for each system)	
	Silicon controlled thyristors, diodes, power transistors	100%(1 Lot)
	Capacitors	1 set
	Filter regulators	20% of each model or 2 nos. whichever is more.
15	INSTRUMENTATION CABLE, INTERNAL WIRING & ELECTRICAL FIELD	
	Pre fabricated cable of each type.	10% of installed quantity
	Pre fabricated cable connector of each type	10% or 1 no. of each type and model, whichever is more.
	Other cables	5% of each type, pair and size of actual installed quantity
16	MICROPROCESSOR BASED/PLC BASED CONTROL SYSTEM FOR ESP/CAS etc	
	Complete set including integral microprocessor based control system alongwith system & application software and special cables	10% or 1 set whichever is more
	UPS	
	Electronic cards	
	IGBT Modules of each type	
	MCBs of each type	10% or 2 nos. min. whichever is more
	Digital Indicators of each model, type & range (including relevant digital indicators of electrical system)	10% or 2 nos. min. whichever is more
	Card Reader	10% or 2 nos. min. whichever is more
	Cooling fans in control panels	10% or 2 nos. min. whichever is more
	LVS Lamps	24 Nos.

Note: Only applicable items shall be considered. Applicable items are those which are installed in the system.

LIST OF INDICATIVE SUB-VENDORS

FOR ELECTRO MECHANICAL ITEMS			
SR No.	Items	Vendor	Place / Location
1.0	Horzional/Vertical Centrifugal Pump	KBL	Kirolskarwadi
		M&P	Pune
		Flowmore	Ghaziabad
		Sulzer pumps india ltd.	Navi mumbai
		Worthington	Ghaziabad
		Bharat pumps & compressors ltd	Allahabad
		Flowserve India Controls Pvt. Ltd.	Coimbatore
		Jyoti ltd.	Vadodara
2.0	Vertical Centrifugal Pump	Kishore Pump	Pune
		Sam Turbo	Coimbatore
		KSB	Pune
		Best and Crompton	Chennai
		Voltas	Mumbai
		V-Flo Pumps & Systems Co. Ltd.,	Beijing, China
		Kishore Pump	Pune
3.0	Strainers (Y-Type & Basket Type)	Multitex Filtration Engg Ltd.	Noida
		Sarojini Enterprises	Kolkata
		Otoklin Filters	Mumbai
		BHATIA ENGINEERING CO.	Delhi
		JAYPEE INDUSTRIES PVT. LTD.	Delhi
		FILTRATION ENGINEERS (I) PVT. LTD.	MUMBAI
		OTOKLIN GLOBAL BUSINESS LIMITED	Mumbai
		SUNGOV Engg. PVT. LTD.	Delhi
		Grand Prix	Faridabad
4.0	Fittings (metallic)	M.S. Fittings	Kolkata
		Metal lloyds	Mumbai
		True Forge	Faridabad
		Tube Products	Baroda
		NL Hazra	Kolkata
		Gujrat Infra Pipes	Baroda
		Edwards	USA
		Pipefit Engineers	Baroda
		Siddarth & Gautam	Faridabad
		EBY	Mumbai
		Reliance Forge	Mumbai
5.0	MS/GI ERW Pipes	SAIL	Rourkela
		Jindal	Ghaziabad/ 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	Sikandrabad
		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
6.0	Seamless Pipes	ISMT	Ahmednagar/Baramati
		Maharashtra Seamless	Raigad
7.0	S.S. Pipes	REMI	Mumbai

	(For small Quantity 500 m)		
		Ratmani	Ahmedabad
		Apex Tubes	Behror
		Choksi	Ahmedabad
8.0	CI Gate/ Globe/NRV/ SRV (Manual and motorized)	H.Sarkar	Howrah
		A.V. VALVES LTD	Agra
		Leader	Jalandhar
		SURYA VALVES AND INSTRUMENTS MFG CO.	Chennai
		ATAM VALVES PVT. LTD.	JALANDHAR
		FLUIDLINE VALVES COMPANY PVT.LTD.	Mumbai
		G.M. DALUI AND SONS PVT.LTD.	Howrah
		KBL	Kondhapuri
		Bankim	Kolkata
		VENUS PUMPS AND ENGG. WORKS	Kolkata
9.0	GM valve	A.V. VALVES LTD	Agra
		ATAM VALVES PVT. LTD.	Mumbai
		Leader	Jalandhar
		VALTECH INDUSTRIES	
		SANT VALVES PVT. LTD.	Jalandhar
13.0	Motor	Marathon,	kolkata
		Crompton Greaves	Ahmednagar
		NGEF	Bangalore
		ABB	Bangalore/Faridabad
		Siemens	Mumbai
		Jyoti	Baroda
		LHP	Solapur
		BHEL	Bhopal
		Bharat Electric (BHEL)	
		Bharat Bijlee	Mumbai
		KEC	Bangalore/Hubli
15.0	Steel Plate, Structural Steel tank	SAIL	
		Essar Steel	
		TISCO	
		RINL	
		Jindal	
		Lloyd	
		Ispat	
		Indian Iron & Steel Co. Ltd	
16.0	Control / Power 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	Khushkhhera
		SRI Ram Cables	Bhiwadi
		Thermocables	Hyderabad
		Torrent cable	Nadiad
		Universal Cables	SATNA
		Gemscab	Bhiwadi
		Delton	Faridabad
17.0	AGITATOR	REMI	MUMBAI
		FIBRE & FIBRE PRODUTS	
		STANDARD ENGINEERS	MUMBAI
		CROMPTON GREAVES	AHAMADNAGAR
18.0	ORIFICE PLATE	MICRO PRECISION	FARIDABAD
		INSTRUMENTAION LTD	PALGHAT
		CARLO DYNAMICS	HYDRABAD
19.0	BUTTERFLY VALVE	ADVANCE VALVES PVT. LTD.	NOIDA
		FLUIDLINE VALVES COMPANY PVT.LTD.	GHAZIABAD
		INSTRUMENTATION LTD.	PALAKKAD-KERALA
		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
20.0	DUAL PLATE CHECK VALVE	ADVANCE VALVES PVT. LTD.	NOIDA
		ASIAN INDUSTRIAL VALVES & INSTRUMENTS.	CHENAI
		FLUIDLINE VALVES COMPANY PVT.LTD.	GHAZIABAD
		R AND D MULTIPLES (METAL CAST) PVT LTD	MUMBAI
		VENUS PUMPS AND ENGG. WORKS	KOLKATA
21.0	ELECTRICAL HOIST	ARMSEL MHE PVT. LTD	BANGALORE
		ALPHA SERVICES	NEW DELHI
		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	NEW DELHI
		MANGLA HOISTS PVT LTD	NEW DELHI
		REVA INDUSTRIES LTD.	FARIDABAD
		ROCKWELL HOISTO CRANES PVT. LTD.	JHAJJAR-HARYANA
		SAFEX ENERGY PVT. LTD.	AHMEDABAD
		TUOBRO FURGUSON (INDIA) PVT LTD	KOLKATA-
22.0	BALL VALVE	BDK	HUBLI
		LEADER	JALANDHAR
		BANKIM	KOLKATA
		H SARKAR	KOLKATA
		AV VALVES	AGRA
		HAWA VALVES	MUMBAI
		FLOW CHEM	AHMEDABAD
		STEEL STRON VALVES	MUMBAI
		AKAY VALVES LTD.	MUMBAI
		AQUA VALVES PVT.LTD.	KARNATAKA
		CRESCENT VALVES	MUMBAI
		FISHER SANMAR LIMITED	CHENNAI
		HABONIM VAAS AUTOMATION PVT LTD.,CHENNAI	CHENNAI
		KIRLOSKAR BROTHERS LTD.	PUNE
		KSB PUMPS LTD.	MUMBAI
		MICROFINISH VALVES PVT LTD.	HUBLI
		MICON VALVES (INDIA) PVT.LTD	MUMBAI
		PEC VALVES	MUMBAI
23.0	SLUICE GATE	H SARKAR	KOLKATA
		JASH ENGINEERING	INDORE
		YASHWANT	MIRAJ
		GLOBETECH	HOWRAH
24.0	DIAPHRAGM VALVE	PROCON ENGINEERES	MUMBAI
		HAWA VALVES	MUMBAI
		BDK VALVES	HUBLI
		FOURESS	BANALORE
		INERVALVE	GUJRAT
25.0	3 WAY VALVE	HI TECH	AHMEDABAD
		ADVANCE VALVES PVT.LTD	NOIDA
		BDK	HUBLI
		FOURESS ENGG.INDIA LTD.	MUMBAI
		FLUIDLINEVALVES COMPANY PRIVATE LTD.,	MUMBAI
		INSTRUMENTATION LTD.	PALAKAD
		KIRLOSKAR BROTHERS LTD.	PUNE

		VENUS PUMP & ENGG. WORKS	KOLKATA
		SURYA VALVES AND INSTRUMENTS MANUFACTURING COMPANY	CHENNAI
		STAFFORD CONTROLS LIMITED	PUNE
		MICON VALVES (INDIA) PVT.LTD	MUMBAI
26.0	PLUG VALVE	FISHER SANMAR LIMITED	CHENNAI
		BDK	HUBLI
		LARSEN & TOUBRO LTD.	MUMBAI
		LEADER	JALANDHAR
		MICON VALVES (INDIA) PVT.LTD	MUMBAI
27.0	FLANGES (SS/CS)	BHARAT FORGE	PUNE
		RELIANCE FORGE	MUMBAI
		MS FITTINGS	KOLKATA
28.0	POSITIVE DISPLACEMENT PUMP	MILTON ROY INIDA	CHENNAI
		SWELLORE	AHMEDABAD
		VK PUMP	NASIK
		DENCIL PUMP	MUMBAI
29.0	VALVES (GATE/GLOBE/NRV/ BALL)- CPVC/PVC/PP/ HDPE/PVDF	GEROGE FISHCHER IPING SYSTEMS PVT LTD	DELHI
		ASTROL PLYTECHINC LTD	AHMEDABAD
30.0	PIPE/FITTINGS/ FLANGES CPVC/PVC/ PP/HDPE/PFDF	GEROGE FISHCHER IPING SYSTEMS PVT LTD	DELHI
		ASTROL PLYTECHINC LTD	AHMEDABAD
31.0	RUBBER LINING FOR PIPES/TANK	RISHI INDUSTRIES	SONEPET
		INDUSTRIAL LINING LTD	BARODA
		MIL	CHENNAI
32.0	NON METALIC PUMP (CENTRIFUGAL)	Anticorrosive Pumps	Mumbai
		Rajedia Pumps	Gujrat
		Price Pumps	Mumbai
33.0	Blower	Everest	Delhi
		Kay International	Haryana
		Swam Pneumatics	Delhi
		Kulkarni brothers	Mumbai
34.0	HDPE TANK	SINTEX	
35.0	PRP TANK	TIANODE	CHENNAI
		BHAVI PLAST	MUMBAI
36.0	HYDROGEN DETECTOR	Detection Instruments	INDIA
		HACH	USA
		HONEYWELL	UK
		ORBIT	INDIA
37.0	PAINT	BERGER	
		ASIAN PAINTS	
		SHALIMAR	
		J&N	
38.0	TRANSFORMER RECTIFIER	RAYCHEM RPG	PUNE
		Associated Powercon	PUNE
		HIND RECTIFIER	NASIK
39.0	SELF CLEANING STRAINER	OTOKLIN	MUMBAI
		AMIAD FILTRATION SYSTEMS LTD	ISAREL
		GEA BGR ENERGY SYSTEM INDIA LTD	Chennai
		MULTITEX FILTRATION ENGINEERS LIMITED,	Delhi
		FILTRATION ENGINEERS (I) PVT. LTD.	mumbai
40.0	Chain pulley block	INDEF	
		BRADY	
		Lifting Equipment	
		GRIP ENGG	
		Tractel tirfor	
		REVA	
		TECHNO INDUSTRIES	

FOR C&I ITEMS			
SR No.	Items	Vendor	Place / Location
1.0	CONTROL VALVE	DEZURIK-COPES VULCAN LTD	UK
		CONTROL COMPONENT INC	USA
		DRESSER VALVE INDIA PVT LTD	
		FISHER SANMAR LIMITED	
		INSTRUMENTATION LTD	
		FORBES MARSHALL ARCA PVT LTE	
2.0	FLOW ELEMENT	BRISTOL BABCOCK LTD	UK
		BALIGA LIGHTING EQUIPMENTS PVT LTD	CHENNAI
		ENGINEERING SPECIALITIES PVT LTD	
		INSTRUMENTATION LTD	
		MICRO PRECISION PRODUCTS	
		STAR MECH CONTROLS PVT LTD	
3.0	ANUBAR (DELTA TUBE)	STAR MECH CONTROLS (I) PVT LTD	
		SWITZER INSTRUMENT LTD	
4.0	CONTROL VALVE	CONTROL COMPONENT INC.	
		INSTRUMENTATION LTD	
		WEIR VALVES AND CONTROLS UK LTD	
		FORBES MARSHAL ARCA PVT LTD	
		RK CONTROLS INSTRUMENTS PVT LTD	
		EMERSON	CHENNAI
		MIL CONTROLS	
		METSO SINGAPORE PTE LTD	
5.0	FLOW ELEMENT NOZZLE	HYDROPNEUMATICS PVT. LTD.	
		INSTRUMENTATION LTD.	
		MICRO PRECISION PRODUCTS PVT. LTD.	
		STAR-MECH CONTROLS (I) PVT.LTD.	
		SEIKO FLOW CONTROL GMBH	
6.0	FLOW ELEMENT ORIFICE	MICRO PRECISION PRODUCTS PVT. LTD.	
		INSTRUMENTATION LTD.	
		HYDROPNEUMATICS PVT. LTD.	
		Flow Star Engineering Pvt. Ltd.,	
		STAR-MECH CONTROLS (I) PVT.LTD.	
		MINCO (INDIA) PRIVATE LIMITED	
		INSTRUMENTATION ENGINEERS PVT LTD	
7.0	PLC	GE Intelligent Platforms Private Limited	
		SIEMENS LIMITED	
		ROCKWELL AUTOMATION INDIA LTD	
		SCHNEIDER ELECTRIC INDIA PVT.LTD.	
		Honeywell Automation India Limited	
8.0	ROTAMETER	FLOWTECH INSTRUMENTS SERVICES	
		Flow Star Engineering Pvt. Ltd.,	
		EUREKA INDUSTRIAL EQUIPMENTS PVT.LTD.	
		SCIENTIFIC DEVICES (BOMBAY) PVT LTD,	
		INSTRUMENTATION ENGINEERS PVT LTD	
9.0	SIGHT FLOW INDICATORS	BLISS ANAND PVT. LTD.	
		B.K.EQUIPMENTS PVT.LTD.	
		SIGMA INSTRUMENTS CO.	
		FLOWTECH INSTRUMENTS SERVICES	
		INSTRUMENTATION ENGINEERS PVT LTD	
		SCIENTIFIC DEVICES (BOMBAY) PVT LTD,	
		BLISS ANAND PVT. LTD.	
		B.K.EQUIPMENTS PVT.LTD.	
		SIGMA INSTRUMENTS CO.	

FOR C&I ITEMS			
SR No.	Items	Vendor	Place / Location
1.0	ANALYTICAL INSTS.SAMPLE COOLER	FORBES MARSHAL PVT. LTD.	PUNE
		EMERSON PROCESS MANAGEMENT (INDIA) PVT.LTD.	MUMBAI
		SIEMENS LIMITED	MUMBAI
2.0	ANUBAR (DELTA TUBE)	MICRO PRECISION PRODUCTS PVT LTD	FARIDABAD
		DYNAFLUID VALVES AND FLOW CONTROLS	BELGAUM
		TM TECNOMATIC SPA	ITALY
3.0	COL JUNCTION COMPENSATION BOX (CJCB)	CREATIVE INSTRUMENTS AND CONTROLS	BANGALORE
4.0	CONTROL VALVE	SPX FLOW TECHNOLOGIY	AHMEDABAD
		DRESSER VALVE INDIA PVT LTD	COIMBATORE
		DAUME REGELARMATUREN GMBH	GERMANY
		HOLTER REFELARMATUREN GMBH & CO.KG	GERMANY
		KOSO INDIA PVT LTED	NASHIK
		PARCOL SPA	ITALY
		SUZHOU DELAN ENERGY SCIENCE & TECH CO LTD	CHINA
		VALVITALIA SPA	ITALY
		WALDEMAR PRUSS ARMATURENFABRIK GMBH	GERMANY
5.0	ELECTRO MAGNETIC FLOW METER	ELECTRONET EQUIPMENT	PUNE
		ADEPT FLUIDYNE PVT LTD	PUNE
6.0	FLOW ELEMENT	STAR-MECH CONTROLS (I) PVT LTED	PUNE
		INSTRUMENTATION LTD	PALAKKAD
		MICRO PRECISION PRODUCTS PVT LTD	FARIDABAD
		TM TECNOMATIC SPA	ITALY
7.0	FLOW ELEMENT NOZZLE	MINCO (INDIA) FLOW ELEMENTS PVT LTD	GOA
		DYNAFLUID VALVES AND FLOW CONTROLS (P) LTD	BELGAUM
8.0	FLOW ELEMENT ORIFICE	HYDROPNEUMATICS PVT LTD	GOA
		DYNAFLUID VALVES AND FLOW CONTROLS (P) LTD	BELGAUM
9.0	INSTRUMENT FITTINGS	PRECISION ENGG INDUSTIES	MUMBAI
		PANAM ENGINEERS	MUMBAI
		PERFECT INSTRUMENTATION COTROL (INDIA) PVT LTD	MUMBAI
		COMFIT AND VALVES PVT LTD	AHMEDABAD
		AURA INCORPORATED	NEW DELHI
		ARYA CRAFTS AND ENGG PVT LTD	MUMBAI
		FLUIDFIT ENGINEERS PVT LTD	MUMBAI
		HP VALVES AND FITTINGS INDIA PVT LTD	CHENNAI.
		FLUID CONTROLS PVT LTD	MUMBAI
		VIKAS INDUSTRIAL PRODUCTS	NOIDA
10.0	INSTRUMENT PIPE FITTINGS	VIKAS INDUSTRIAL PRODUCTS	NOIDA
		FLUID CONTROLS PVT LTD	MUMBAI
		AURA INCORPORATED	NEW DELHI
		PRECISION ENGG INDUSTIES	MUMBAI
11.0	INSTRUMENT TUBE FITTINGS	PRECISION ENGG INDUSTIES	MUMBAI
		AURA INCORPORATED	NEW DELHI
		FLUID CONTROLS PVT LTD	MUMBAI
		VIKAS INDUSTRIAL PRODUCTS	NOIDA
12.0	JUNCTION BOX	SHRENIK & COMPANY	AHMEDABAD
		FLEXPRO ELECTRICALS PVT LTD	KABILPORE
		AJMERIA INDUSTRIAL & ENGG WORKS	MUMBAI
		KS INSTRUMENTS PVT LTD	BANGALORE
		SUCHITRA INDUSTRIES	BANGAORE
13.0	LEVEL GAUGE	SIGMA INSTRUMENTS	MUMBAI
		BLISS ANAND PVT LTD	HARYANA
		TOSHNIWAL BROTHERS PVT LTD	AJMER
14.0	LEVEL SWITCH (CAPACITANCE TYPE)	SAPCON INSTRUMENT PVT LTD	Indore
		BAUMER TECH INDIA PVT LTD	MUMBAI
		V AUTAMAT	NEW DELHI
		BLISS ANAND	HARYANA

		FLOW STAR ENGG PVT LTD	FARIDABAD
		SIGMA INSTRUMENT	MUMBAI
		SOR INC	USA
		LEVCON INSTRUEMENTS PVT LTD	KOLKATA
		PUNE TECHTROL	PUNE
		NIVO CONTROLS PVT LTD	INDORE
15.0	LEVEL SWITCH (CONDUCTIVITY TYPE)	LEVCON INSTRUEMENTS PVT LTD	KOLKATA
		SOR INC	USA
		SIGMA INSTRUMENT	MUMBAI
		RAMAN INSTRUEMENTS PVT LTD	MUMBAI
		HI-TECH SYSTM AND SERVICES LTD	KOLKATA
		BLISS ANAND	HARYANA
		V AUTAMAT	NEW DELHI
		SAPCON INSTRUMENT PVT LTD	Indore
16.0	LEVEL SWITCH (FLOAT TYPE)	V AUTAMAT	NEW DELHI
		BAUMER TECH INDIA PVT LTD	MUMBAI
		BLISS ANAND	HARYANA
		DK INSTRUMENTS	KOLKATA
		GENERAL INSTRUMENT	MUMBAI
		SIGMA INSTRUMENT	MUMBAI
		SOR INC	USA
		SBEM PVT LTD	PUNE
		LEVCON INSTRUEMENTS PVT LTD	KOLKATA
		PUNE TECHTROL	PUNE
17.0	PRESSRUE GAUGE AND DIFF PRESSURE GAUGE	FORBES MARSHALL (HYD) LTD	HYDERABAD
		H GURU	BANGALORE
		H GURU	KOLKATA
		GAUGE BOUDRON INDIA PVT LTD	MUMBAI
		BOSE PANDA	KOLKATA
		PRECISION MASS PRODUCTS PVT LTD	GUJRAT
		AN INSTRUMENT	KOLKATA
		BAUMER	MUMBAI
18.0	PRESSRUE SWITCH AND DIFF PRESSURE SWITCH	PRECISION MASS PRODUCTS	GUJARAT
		BARKSDALE GMBH	GERMANY
		DRESSER INDUSTRIES INC	GUJARAT
		INDOFS (INDIA) LTD	CHENNAI
		GENERAL INSTRUMENT CONSORTIUM	MUMBAI
		KAUSTUBH UDYOG	PUNE
		INDFOS INDUSTRIES LIMITED	GHAZIABAD
		SOR INC	USA
		SWITZER PROCESS INSTRUMENTS PVT LTD	CHENNAI
19.0	PLC	mitsubishi electric india pvt ltd	MUMBAI
20.0	TEMP ELEMENT	GOA INSTRUMENTS	GOA
		GAUGE BOURDON INDIA	MUMBAI
		DETRIVE INSTRUMENTATION AND ELECTRONICS LTD	MUMBAI
		PYRO ELECTRIC INSTRUMENTS	GOA
		TECHNO INSTRUMENTS	GANDHINAGAR
		TEMPSENS INSTRUMENT (I) PVT	UDAIPUR
		TM TECNOMATIC SPA	ITALY
		THERMAL INSTRUMENT INDIA PVT LTD	MUMBAI
		TOSHNIWAL INDUSTRIES	AJMER
		BAUMER	MUMBAI
21.0	TEMPERATUR GAUGE	BAUMER	MUMBAI
		GAUGE BOURDON INDIA PVT. LTD.	MUMBAI
		H.GURU INDUSTRIES	KOLKATA
		H.GURU INSTRUMENTS (SOUTH INDIA) P. LTD	BANGALORE
		GOA INSTRUMENTS INDUSTRIES PVT LTD.,	GOA
		GOA THERMOSTATIC INSTRUMENTS PVT.LTD.	GOA
		FORBES MARSHALL (HYD) LTD.	HYDERABAD
		PRECISION MASS PRODUCTS PVT. LTD.	GUJARAT

		BUDENBERG GUAGE CO.LTD.	UK
		A.N. INSTRUMENTS PVT. LTD.	KOLKATA
22.0	TEMPERATURE SWITCH	INDFOS (INDIA) LIMITED	CHENNAI
		DRESSER INDUSTRIES INC.	GUJARAT
		SWITZER PROCESS INSTRUMENTS PVT. LTD.	CHENNI
		SOR INC.	USA
		TOSHNIWAL BROTHERS PVT.LTD.	AJMER
23.0	TRANSMITTER	Honeywell Automation India Limited	NEW DELHI
		YOKOGAWA INDIA LIMITED,	BANGALORE
		TOSHNIWAL INDUSTRIES PVT. LTD.,	AJMER
		V. AUTOMAT & INSTRUMENTS (P) LTD.	NEW DELHI
		SMART INSTRUMENTS LTD, BRAZIL	MUMBAI
		SBEM PVT. LTD.	PUNE
		SIEMENS LIMITED	MUMBAI
		EMERSON PROCESS MANAGEMENT (INDIA) PVT.LTD.	MUMBAI
		Pune Techtrol Pvt. Ltd.	PUNE
		PANAM ENGINEERS	MUMBAI
		NIVO CONTROLS PVT. LTD.	INDORE
		Moore Industries International Inc.	CALIFORNIA
		Endress + Hauser (India) Pvt. Ltd.,	NEW DELHI
		ABB LTD	FARIDABAD
24.0	ULTRASONIC FLOW METER	NIVUS GMBH	GERMANY
25.0	VENTURI METER	MICRO PRECISION PRODUCTS PVT LTD	FARIDABAD
		STAR-MECH CONTROLS (I) PVT LTD	PUNE
		TM TECNOMATIC SPA	ITALY
26.0	VIBRATION MONITORING SYSTEM	SKF INDIA LIMITED	PUNE
		ROCKWELL AUTOMATION INDIA PVT LTD	NOIDA.
		MEGGITT INDIA PVT LTD	BANGALORE
		FORBES MARSHALL (HYD) LTD.	PUNE
		GE INDIA INDUSTIRAL PVT LTD	HARYANA

NOTE: - 1: Any other sub-vendor not specified in above sub-vendor list shall be subject to approval of BHEL/TANGEDCO/TCE during detailed engineering.

NOTE:- 2: The above list is subject to approval of M/s TANGEDCO/ TCE during detailed engineering.

TYPICAL QUALITY PLAN

SERIAL NUMBERS	DESCRIPTION	VISUAL EXAMINATION	DIMENSIONS	MATERIAL TEST CERT.	IDENT. & CORRELATION	UT FOR HEAVY PLATES & BARS	WELDING QUALIFICATIONS	PT / MT	RADIOGRAPHY	STAGE INSPECTIONS	BALANCING	BODY LEAK TEST	SEAT LEAK TEST	OPERATION / NO LOAD TEST	PERF. / FULL LOAD TEST	MAKE & RATING OF PARTS	FUNCTIONAL & INTERLOCK TEST	TYPE TEST	ROUTINE TEST	LINING TESTS - THICKNESS, HARDNESS, SPARK, ADHESION	CALIBRATION	MFRS. PRODUCT CERT.	DEGREE OF PROTECTION	STATUTORY APPROVAL / CERTIFICATE
1	PRESSURE VESSELS	A	A	C	D	D	C/A	C	B	C		A								B				
2	PLASTIC TANKS	A	A	C								A								B				
3	AGITATORS	A	A	C	D	D	C/A	C			D			A ^x	A ^x					B				
4	PIPES	A	A	C	D		C/A					D								B				
5	FITTINGS, FLANGES	A	A	C	D	D	C/A													B				
6	VALVES	A	A	C		D						A	A							B				
7	PUMPS	A	A	C		D		C			D	A			A					B				
8	BLOWERS	A	A	C		D					D	A			A									
9	ELECTROLYZER	A	A	C											A									
10	CHILLER	A	A	C											A									
11	SOFTENER	A	A	C											A									
12	RECTIFIER	A	A	C											A									
LEGEND A - WITNESSED BY BHEL. B - WITNESSED BY BHEL IF REQUIREMENT IS SPECIFIED. C - RECORDS VERIFIED BY BHEL WHEREVER APPLICABLE. D - A OR C, AT BHEL'S DISCRETION WHEREVER APPLICABLE. X - INCLUDING RUN OUT CHECK.		NOTES 1 - ALL STAGES SHALL BE CHECKED 100 % BY VENDOR AND RECORDS THEREOF SHOWN TO BHEL. 2 - WITNESSING BY BHEL MAY BE 100 % OR ON RANDOM SAMPLES. 3 - THE PRESSURE GAUGES AND INSTRUMENTS FOR MEASURING CRITICAL PARAMETERS SHALL HAVE VALID CALIBRATION CERTIFICATE TRACEABLE TO NATIONAL LABORATORY.																						

INDICATIVE MASTER DRAWINGS LIST (ELECTRO CHLORINATION PLANT)					
PROJECT : YADADRI 5X800MW					
PACKAGE : BOP - WATER SYSTEM					
CLIENT :					
Sr. No.	BHEL_DRG_NO	VENDOR_DRG_NO.	DRAWING TITLE	SCH DATE OF SUBMISSION	CAT
1			EQPT SIZING CALCULATION OF ELECTRO-CHLORINATION PLANT		A
2			P&I DIAGRAM FOR ELECTRO CHLORINATION PLANT		A
3			EQUIPMENT LAYOUT FOR ELECTRO CHLORINATION PLANT		A
4			PROCESS SIZING CALCULATION FOR ELECTRO CHLORINATION PLANT		A
5			DATA SHEET OF SAFETY ITEMS		A
6			PIPING LAYOUT OF CW CHLORINATION DOSING & DISTRIBUTION		A
7			PIPING LAYOUT OF INTAKE PUMP HOUSE CHLORINATION SYSTEM DOSING & DISTRIBUTION		A
8			PIPING LAYOUT OF CHLORINATION AT STILLING CHAMBER OF PT PLANT		A
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PERFORMANCE GUARANTEE

The system performance guarantees applicable are detailed in this section.

PERFORMANCE GUARANTEE

The bidder shall guarantee all equipment for workmanship, materials and satisfactory performance. The guarantee for performance will cover individual items and systems including electrical for their ratings / outputs as well as for the integrated operation of equipment and its auxiliaries as a whole. On completion of satisfactory commissioning, the supplier shall conduct performance / acceptance tests on the equipment and system as a whole for demonstrating the guaranteed performance parameters specified.

- a. Capacity of Electrochlorination plant & dosing rates at various locations are indicated in Design memorandum
- b. Power consumption for continuous operating equipment as per Section-3, Cl.11
- c. Vibration and noise level of rotating equipment

Minimum 72 hrs performance test run shall be conducted for the guaranteed values of quality, quantity and other performance parameters.

General

In addition to the guarantees mentioned above, the requirements of specifications on all guarantees as elaborated under relevant clauses of Technical Specifications should be met.

The guarantee for the equipment shall start after 18 months from the date of supply (or) 12 months from the date of commissioning, whichever is earlier.

Any part which proves to be defective either in design, materials / and / or manufacture within the above guarantee period shall be replaced free of cost to the owner at site and the provision of this clause shall apply to the portions of the plant so replaced or renewed until the expiration of the guarantee period or from the date of replacement whichever is later. (Replacement work / activity of failed part shall be in the scope of Bidder at No cost to Customer)

BIDDER SHALL SUBMIT THE PERFORMANCE GUARANTEE TEST PROCEDURE TO BHEL FOR APPROVAL.

DRAWINGS & DOCUMENTS ATTACHED

The following drawing/document are enclosed as a part of the specification

1. Design Memorandum: 4-WT-040-01234
2. P&ID for Electrochlorination system: 1-WT-040-01694
3. Equipment Layout of Electrochlorination system: 1-WT-040-01386
4. MECHANICAL GA of Sea water intake pump house: PE-DG-435-172-N004
5. Mechanical GA of CW & ACW Pump house: PE-DG-435-165-N004
6. PT plant layout: 1-WT-220-01806
7. GRP piping layout with terminal points: 1-WT-040-01850

01	11.09.19	Sd/- SS	Sd/- IMRL	Sd/- MSM	Fresh Issue	
00	27.02.19	Sd/- SS	Sd/- IMRL	Sd/- MSM	Fresh Issue	
Rev.No	Date	Prepared	Checked	Approved	Remarks	
	Owner: TAMIL NADU GENERATION AND DISTRIBUTION CORPORATION LIMITED: UDANGUDI -2 X 660 MW STPP STAGE-1					
	Owner's Consultant: TATA CONSULTING ENGINEERS LIMITED, BENGALURU					
	EPC Contractor: BHARAT HEAVY ELECTRICALS LTD BOILER AUXILIARIES PLANT RANIPET – 632 406.					
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		876	DESN	SS	Sd/-	27.02.19
			CHD	IMRL	Sd/-	27.02.19
			APPD	MSM	Sd/-	27.02.19
TITLE DESIGN MEMORANDUM FOR ELECTROCHLORINATION PLANT		DOCUMENT NO. 4-WT-040-01234				REV.NO 01

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1.0 INTRODUCTION

The purpose of the system is to generate the onsite Sodium Hypochlorite by using sea water and dosing of Sodium Hypochlorite to prevent bio fouling in water used in different areas of 2X660 MW UDANGUDI STPP under the scope of BHEL.

2.0 PROCESS DESCRIPTION ELECTRO CHLORINATION PLANT

The function of the Electro-chlorination system is to generate Sodium Hypochlorite (NaOCl) which will be effective in preventing fouling thereby creating hostile environment by continuous chlorination of the cooling water circuits and PT Plant. Sea water will be delivered to the Electro-chlorination plant by sea water booster pumps which takes suction from CT make up pump discharge. Sea water will be strained to remove solid particles by sea water strainers with automatic backwash facility for cleaning of filtering element. To generate available chlorine, sea water will be passed through electrolyser cells in Hypochlorite generator powered by Transformer rectifiers.

Sea water containing the product of electrolysis which is essentially, sodium hypochlorite solution and hydrogen gas is transferred from the generating module to Degassifier cum Hypochlorite storage unit. The unit equipped with air blowers will dilute the hydrogen to non-explosive concentrations. The hypochlorite solution will be dosed to the sea water by means of dosing pumps. The deposits caused by the sea water hardness inside the generators shall be periodically removed by dissolving them in a diluted solution of Hydrochloric acid circulated through generators by centrifugal pumps. At the end of cleaning cycle, the acid solution is diverted to DM Plant's N-pit.

Electrolysis of a dilute brine solution in an electrolytic cell is carried out to produce NaOCl as per the overall reaction:

TABLE-1

Anode	Cathode
$2\text{Cl}^{-1} - 2\text{e}^{-1} \rightarrow \text{Cl}_2$	$2\text{Na}^{+1} + 2\text{H}_2\text{O} + 2\text{e}^{-1} \rightarrow 2\text{NaOH} + \text{H}_2$
Combined reaction: $2\text{NaCl} + 2\text{H}_2\text{O} \rightarrow 2\text{NaOCl} + 2\text{H}_2$	

3.0 PLANT DESCRIPTION ELECTRO CHLORINATION PLANT

Electro chlorination system shall be sized considering sea water intake system (shock and continuous), Desalination feed system & CW system (shock and continuous) for all the 2 x 660 MW units. Each electro chlorination system is designed to meet the station chlorination requirement. 

~~Hypo chlorite required for potable water disinfection and treated sewage disinfection shall be procured separately and hypo chlorite generated from electro chlorination system shall not be used for potable water disinfection.~~

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~~1 Please refer to Design memorandum for STP (Drg.:4-WT-055-01272) and P&ID diagram for STP (Drg.: 1-WT-055-01401) for treated sewage disinfection system.~~

~~1 Please refer to P&ID diagram for Chemical dosing system (Drg :1-WT-220-01577) for Potable water disinfection dosing system.~~

Chlorine will be dosed to remove organic matter present in the Circulating Water (CW) and to minimize biological growth on the piping as such since biological growth could promote corrosion, impair heat transfer and impair water distribution throughout the circulating water system

The seawater is fed to the electro chlorination plant from taking suction from the CT make up pumps discharge line near plant boundary and by means of Electro Chlorination system booster pumps.

Sizing criteria

1. For sea water intake system: 1 ppm continuous dosing at intake well & 3ppm, shock dosing (once in a shift of 30mins) at velocity cap
2. Desalination feed system – 2 ppm continuous dosing
3. Circulating water system – 1 ppm continuous dosing & 3ppm shock dosing (once in a shift of 30mins.) in CW forebay

~~1 4. Sewage treatment plant – 2 ppm continuous dosing~~

The filtered seawater is fed to the Electrolyser unit. The Capacity of the chlorine Generator shall be sized as per sizing criteria above. These generators units connected hydraulically in parallel with each other, having chlorine production to meet the system requirements.

The Electrolyser will generate hypochlorite and hydrogen consuming the sodium chloride present in the seawater.

The active hypochlorite solution is collected in the 2 Nos. NaOCl storage tank for CW system where the liberated hydrogen gets vented out with air dilution for CW dosing.

This solution is pumped to the CW system in each pumping chamber by continuous centrifugal pumps. Each unit cooling water system has a dedicated continuous dosing pump and there will be one standby pump common for both units. There are two dosing pumps (1 operating + 1 standby) dedicated for shock dosing in CW system. Shock Dosing shall be done for one unit at a time. The Hypo shall be dosed upstream of Screens in each pumping chamber.

The active hypochlorite solution is collected in the 1 Nos. NaOCl storage tank for Intake system where the liberated hydrogen gets vented out with air dilution for CW dosing.

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In sea water intake system, 3 x 50% hypo dosing pumps shall be provided for continuous dosing at the intake forebay and 2 x 100% dosing pumps shall be provided for shock dosing at velocity cap.

In the Desalination Plant, Hypo shall be dosed in the Stilling chamber. There are 2 x 100% PT & Desal plant NaOCl dosing pumps for Hypo dosing to Water Treatment Plant.

The hydrogen generated with the hypochlorite gets separated in the NaOCl storage tank. Air dilution blowers (1 Duty + 1 Standby) for each NaOCl storage tanks are provided in order to dilute the hydrogen stream with air, so as to get a non-flammable mixture (25% of LEL).

In case of failure of one blower, the other one will start automatically. An automatic interlock will shut down the rectifier if both the blowers fail.

The transformer-rectifier unit provides the Electrolyser with direct current. Each Electro chlorinator unit will have individual transformer-rectifier. The current from the transformer - rectifier is transferred through Bus bars to the Electro chlorinators.

Sampling valves will be provided at the outlet of the cell drain to monitor the cell performance.

The side reaction products of the electrolysis process after long periods of operation can accumulate on the electrodes. They shall be removed by dissolving them in a solution of diluted hydrochloric acid that shall be circulated through the Electro chlorinator units.

The acid cleaning system consists of 1 x 100% Acid day tank and two Acid circulation pumps (1 operating + 1 standby), which are hooked up to the Electro chlorinator units for cleaning.

The Electro chlorinator units & transformer rectifiers will be located indoors.

MCC & Control panel will be located indoor.

Acid day tank, Hypo storage tanks & Hydrogen dilution blowers shall all be located outdoor.

Bulk acid storage tank will be placed in PT-RO-DM plant Bulk storage area.

All cleaning waste from Electro chlorinators will be terminated in DM plant neutralization pit and neutralized for further disposal to ETP.

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4.0 DESIGN INPUT/ CRITERIA

1. Customer specification No. SE/C/UP/EE/E/OT No. 01/2015-16
2. P & I Diagram for Electro chlorination plant: 1-WT-040-01694
3. Sea water analysis (Table 2)
4. ~~P & ID CW & ACW system PE DG 435 165 N001~~
5. ~~P & ID for Plant water system: PE DG 435 172 N001~~

Sea water analysis (TABLE-2)

Refer to Annexure-12 for Raw sea water analysis

S.No	Description	Unit	Value
1.	General		
a)	pH	---	7.98 - 8.1
b)	Conductivity	μS / cm	53700
c)	Temperature range/ design	Deg C	(25 – 33) / 29
d)	Turbidity	NTU	12.5 – 14.8
e)	Total Suspended Solids (TSS)	mg/l	11
f)	Total Dissolved Solids (TDS)	mg/l	38000
g)	BOD @ 27 Deg C for 3 days	mg/l	11*
h)	COD	mg/l	62*
i)	Oil and Grease (free)	mg/l	< 1**
j)	Phenols	mg/l	Nil
k)	Free residual chlorine	mg/l	< 0.2
2.	Cations		
a)	Calcium	mg/l	409
b)	Magnesium	mg/l	1274
c)	Sodium	mg/l	12600
d)	Potassium	mg/l	380
e)	Ammonia	mg/l	Nil
f)	Strontium	mg/l	2.37
g)	Barium	mg/l	Nil
h)	Zinc	mg/l	0.1
i)	Nickel	mg/l	Nil
j)	Copper as Cu	mg/l	Nil
k)	Cadmium as Cd	mg/l	Nil
l)	Lead as Pb	mg/l	Nil
m)	Mercury as Hg	mg/l	Nil

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S.No	Description	Unit	Value
n)	Aluminium Total	mg/l	Nil
o)	Aluminium Dissolved	mg/l	Nil
p)	Manganese Total	mg/l	Nil
q)	Manganese Dissolved	µg/l	Nil
r)	Iron Total	mg/l	0.49
s)	Iron Dissolved	mg/l	0.25
3.	Anions		
a)	Chloride	mg/l	21088
b)	Sulphate	mg/l	3396
c)	Nitrate	mg/l	1.62
d)	Nitrite	mg/l	0.04
e)	Bicarbonate as HCO ₃	mg/l	140
f)	Carbonate	mg/l	Nil
g)	Fluoride	mg/l	1.4
h)	Boron	mg/l	1.38
i)	Phosphate	mg/l	0.16
j)	Sulphide as H ₂ S	mg/l	Nil
k)	Silica Dissolved	mg/l	0.25
4.	Density of Sea water	Kg /m ³	1030

Note:

- 1) Any other feed parameter not listed above shall be assumed as "Nil".
- 2) * - All BOD and COD in suspended form
- 3) **- 1 mg/l free oil & grease.

5.0 SYSTEM DESCRIPTION AND SIZING

5.1 Chlorination requirement for Sea Water Intake system

S.no	Description	Value
1.	Flow at raw water intake (max.)	30000 m ³ /h (as per tender)
2.	Chlorine dosing rate (continuous and shock)	1ppm (cont.) & 3ppm (shock)
3.	Dosing period	22.5 hr cont. & 1.5 hr shock
4.	Chlorine consumption rate (Cont.)	30000 x (1/1000) x 22.5 = 675 kg/day

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5.	Chlorine consumption rate (Shock))	$30000 \times (3/1000) \times 1.5 = 135 \text{ kg/day}$
6.	Total chlorine consumption rate	$675 + 135 = 810 \text{ kg/day} = 33.75 \text{ kg/hr}$

5.2 Chlorination requirement for Desalination plant

S.no	Description	Value
1.	Flow for Desalination plant	$3632 \text{ m}^3/\text{h}$ 
2.	Chlorine dosing rate (continuous)	2ppm (cont.)
3.	Dosing period	24 hrs. 
4.	Chlorine consumption rate (Cont.)	$3632 \times (2/1000) \times 24 = 174.34 \text{ kg/day}$
5.	Total chlorine consumption rate	$174.34 \text{ kg/day} = 7.26 \text{ kg/hr}$ 

5.3 Chlorination requirement for Circulating water system

S.no	Description	Value
1.	Circulating water flow for 2 Units	$85500 \times 2 \text{ m}^3/\text{h} = 171000 \text{ m}^3/\text{h}$
2.	Chlorine dosing rate (continuous and shock)	1ppm (cont.) & 3ppm (shock)
3.	Dosing period	22.5 hr cont. & 1.5 hr shock
4.	Chlorine consumption rate (Cont.)	$171000 \times (1/1000) \times 22.5 = 3847.5 \text{ kg/day}$
5.	Chlorine consumption rate (Shock))	$171000 \times (3/1000) \times 1.5 = 769.5 \text{ kg/day}$
6.	Total chlorine consumption rate	$3847.5 + 769.5 = 4617 \text{ kg/day} = 192.38 \text{ kg/hr}$

5.4 Electro Chlorination Plant Capacity

S.no	Chlorination requirement	Value
1.	Sea Water Intake system	33.75 kg/hr
2.	Desalination plant	7.26 kg/hr 
3.	Circulating water system	192.38 kg/hr
4.	Total capacity 	233.39 kg/hr (Selected 234 kg/hr)

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1 5.5 Sea Water requirement

S.no	Description	Value
1.	Design NaOCl concentration for Sea water Electro-chlorination plant	1500ppm(approx) = 1.5 kg/m ³
2.	Water required for NaOCl production	234kg/hr/1.5 kg/m ³
		= 156 m ³ /hr
3.	Sea water booster pump capacity	each 78 m ³ /hr. Considering 10% flow margin, 78 x 1.1 = 85.8 3Nos. (2W+1S), 86m ³ /hr

1 5.6 Pump sizing calculation

S.no	Description	Value
1.	Intake dosing	
a.	Continuous dosing	675kg/day/ 22.5 hr = 30kg/hr = 30/ 1.5 m ³ /hr = 20 m ³ /hr
	Continuous dosing pump capacity	Each 10m ³ /hr Considering 10% flow margin 10 x 1.1 = 11 m ³ /hr 3Nos. (2W+1S), 11m ³ /hr
b.	Shock dosing	135kg/day/ 1.5 hr = 90kg/hr = 90/ 1.5 m ³ /hr = 60 m ³ /hr
	Shock dosing pump capacity	Each 60m ³ /hr Considering 10% flow margin 60 x 1.1 = 66 m ³ /hr 2Nos. (1W+1S), each 66m ³ /hr
2.	Desalination plant dosing	
a.	Continuous dosing	7.26 kg/hr = 7.26/ 1.5 m ³ /hr = 4.84 m ³ /hr

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S.no	Description	Value
	Continuous dosing pump capacity	Each 4.84 m ³ /hr Considering 10% flow margin 4.84 x 1.1 = 5.32 m ³ /hr 2Nos. (1W+1S), each 5.5 m ³ /hr
3.	Circulating water dosing	
a.	Continuous dosing	3847.5 kg/day/ 22.5 hr = 171 kg/hr = 171/ 1.5 m ³ /hr = 114 m ³ /hr
	Continuous dosing pump capacity	Each 57 m ³ /hr Considering 10% flow margin 57 x 1.1 = 62.7 m ³ /hr 3Nos. (2W+1S), each 63 m ³ /hr
b.	Shock dosing	769.5kg/day/ 1.5 hr = 513kg/hr = 513/ 1.5 m ³ /hr = 342 m ³ /hr
	Shock dosing pump capacity	Each 342 m ³ /hr Considering 10% flow margin 342 x 1.1 = 376.2 m ³ /hr 2Nos. (1W+1S), each 377m ³ /hr

6.0 LIST OF MANDATORY SPARES Refer Annexure-1

S. No.	Equipment / Package name	Qty.
1.0	HORIZONTAL CENTRIFUGAL PUMP	QTY/TYPE
1.1	Bearing	2 sets
1.2	Thrust Pads	1 set
1.3	Shaft Sleeves	1 set
1.4	Fasteners	1 set (complete to assemble each pump)

Note: Only applicable items shall be considered. Applicable items are those which are installed in the system.

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7.0 DATA SHEET (Refer PID for minimum capacities of equipment)

Sl.No.	Item	Description
1.0	Automatic Self Cleaning filters	
a)	Number required	3 x 50%
b)	Type	Self-cleaning type
c)	Service	Sea water application
d)	Capacity	As per system requirement
e)	Mesh Screen Size	500 μ
f)	Material of Construction	
g)	Body	MSRL/ FRP
h)	Screen	SS 316L
2.0	Booster Pumps	
a)	Number required	3 x 50%
b)	Type	Vertical/ Horizontal
c)	Service	Sea water application
d)	Capacity	As per system requirement
e)	TDH	As per system requirement
f)	Location	Indoor
g)	Suction condition	Flooded
h)	Lubrication type	Self-lubricated
i)	Materials of construction:	
j)	Casing	Duplex SS UNS 31803, PREN>38
k)	Impeller	Duplex SS UNS 31803, PREN>38
l)	Shaft	Duplex SS ASTM A 890 CD4MCU
m)	Base Plate	MS with Epoxy Paint.
n)	Bolts & Nuts	SS 316L
3.0	Electrochlorinators	
a)	Number required	2 x 100%
b)	Capacity	234 kg/hr
4.0	Electrolysers	
a)	Number required	(minimum 4 nos./ stream). As per system requirement
b)	Capacity	As per system requirement
c)	Available Cl ₂ content @ outlet	1500 ppm (approx)
d)	Life of electrodes	> 5 years
e)	Range of operation	10% to 100%
f)	Material of construction	

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Sl.No.	Item	Description
g)	Anode	Titanium as per ASTM B265 Grade-II with MMO coating.
h)	Cathode	Titanium as per ASTM B265 Grade- II
i)	Shell	PVC lined with FRP, To be designed to withstand 1.5 times of booster pumps shut off pressure.
j)	Gaskets	Titanium impregnated with ebonite
k)	Design pressure	1.5 times of sea water booster pump shut of head
5.0	NaOCl storage tank	
a)	NaOCl storage tanks for CW system	2 Nos., in electro chlorination system area. Total capacity to meet 1 shock dosing requirement.
b)	NaOCl storage tank for In-take system	1 No., in electro chlorination system area. Total capacity to meet 1 shock dosing requirement.
c)	MOC	FRP/ suitable material for the application.
6.0	CW NaOCl Continuous dosing pumps	Cooling water Continuous dosing
a)	Number required	3 x 50%
b)	Type	Horizontal centrifugal with closed impeller.
c)	Capacity	By Bidder
d)	Location	Indoor
e)	Lubrication system	Self-lubricated
f)	TDH	By Bidder
g)	Material of Construction	PP/ Suitable for the application
7.0	CW NaOCl Shock dosing pumps	Cooling water shock dosing
a)	Number required	2 x 100%
b)	Type	Horizontal centrifugal with closed impeller.
c)	Capacity	By Bidder
d)	Location	Indoor
e)	Lubrication system	Self-lubricated
f)	TDH	By Bidder
g)	Material of Construction	PP/ Suitable for the application
8.0	PT & Desal plant NaOCl	Continuous dosing



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Sl.No.	Item	Description
	dosing pumps	
a)	Number required	2 x 100%
b)	Type	Horizontal centrifugal with closed impeller.
c)	Capacity	By Bidder
d)	Location	Indoor
e)	Lubrication system	Self-lubricated
f)	TDH	By Bidder
g)	Material of Construction	PP/ Suitable for the application
9.0	NaOCl Dosing skid for potable water	
a)	Dosing tank	1 x 100%
i.	Capacity	500litres (to meet 24hr requirement.)
ii.	MOC	FRP
b)	Dosing pumps	2 x 100%
i.	Capacity	50 lph
ii.	MOC	PP
10.0	Intake NaOCl Continuous dosing pumps	Cooling water Continuous dosing
a)	Number required	3 x 50%
b)	Type	Horizontal centrifugal with closed impeller.
c)	Capacity	By Bidder
d)	Location	Indoor
e)	Lubrication system	Self-lubricated
f)	TDH	By Bidder
g)	Material of Construction	PP/ Suitable for the application
11.0	Intake NaOCl Shock dosing pumps	Cooling water shock dosing
a)	Number required	2 x 100%
b)	Type	Horizontal centrifugal with closed impeller.
c)	Capacity	By Bidder
d)	Location	Indoor
e)	Lubrication system	Self-lubricated
f)	TDH	By Bidder
12.0	H2 Dilution blowers for NaOCl Storage tank for CW system	
a)	Number required	2nos. (1W+1S) for each NaOCl storage

	DOCUMENT TITLE:		BHEL DOCUMENT NO.: 4-WT-040-01234	
	DESIGN MEMORANDUM FOR		DEPARTMENT: WATER SYSTEM	
	ELECTROCHLORINATION PLANT		REV. NO. 01	DATE: 11.09.19
	2 X 660 MW UDANGUDI STPP STAGE-1		Page: 14 of 15	

Sl.No.	Item	Description
		tank
b)	Capacity & head	As per system requirement
c)	MOC of casing, Impeller & shaft	CS
d)	Type	Horizontal Centrifugal blowers
13.0	H2 Dilution blowers for NaOCl Storage tank for Intake system	
a)	Number required	2nos. (1W+1S) for each NaOCl storage tank
b)	Capacity & head	As per system requirement
c)	MOC of casing, Impeller & shaft	CS
d)	Type	Horizontal Centrifugal blowers
14.0	Bulk Hydrochloric Acid Tank	
a)	Number required	One (1)
b)	Capacity of each tank	20m ³ or 30 days stock whichever is high.
c)	Type	Cylindrical Horizontal
d)	Location	Outdoor
e)	Material of Construction	FRP
f)	Accessories	As per P&ID. Access ladder and platform shall be provided.
15.0	Acid Circulation Pumps	
a)	Number required	2 x 100%
b)	Capacity	As per requirement
c)	Type	Centrifugal.
d)	Location	Outdoor
e)	Lubrication type	Self-lubricated
f)	Material of Construction	
	Casing, Impeller & shaft	PP
16.0	Acid measuring tank	
a)	Number required	1
b)	Capacity	To store 120% of one cleaning requirement
c)	MOC	FRP
17.0	Transformer – rectifiers	
a)	Number required	One dedicated for each Electro chlorinator unit



DOCUMENT TITLE:

**DESIGN MEMORANDUM FOR
ELECTROCHLORINATION PLANT**

2 X 660 MW UDANGUDI STPP STAGE-1

BHEL DOCUMENT NO.: 4-WT-040-01234

DEPARTMENT: WATER SYSTEM

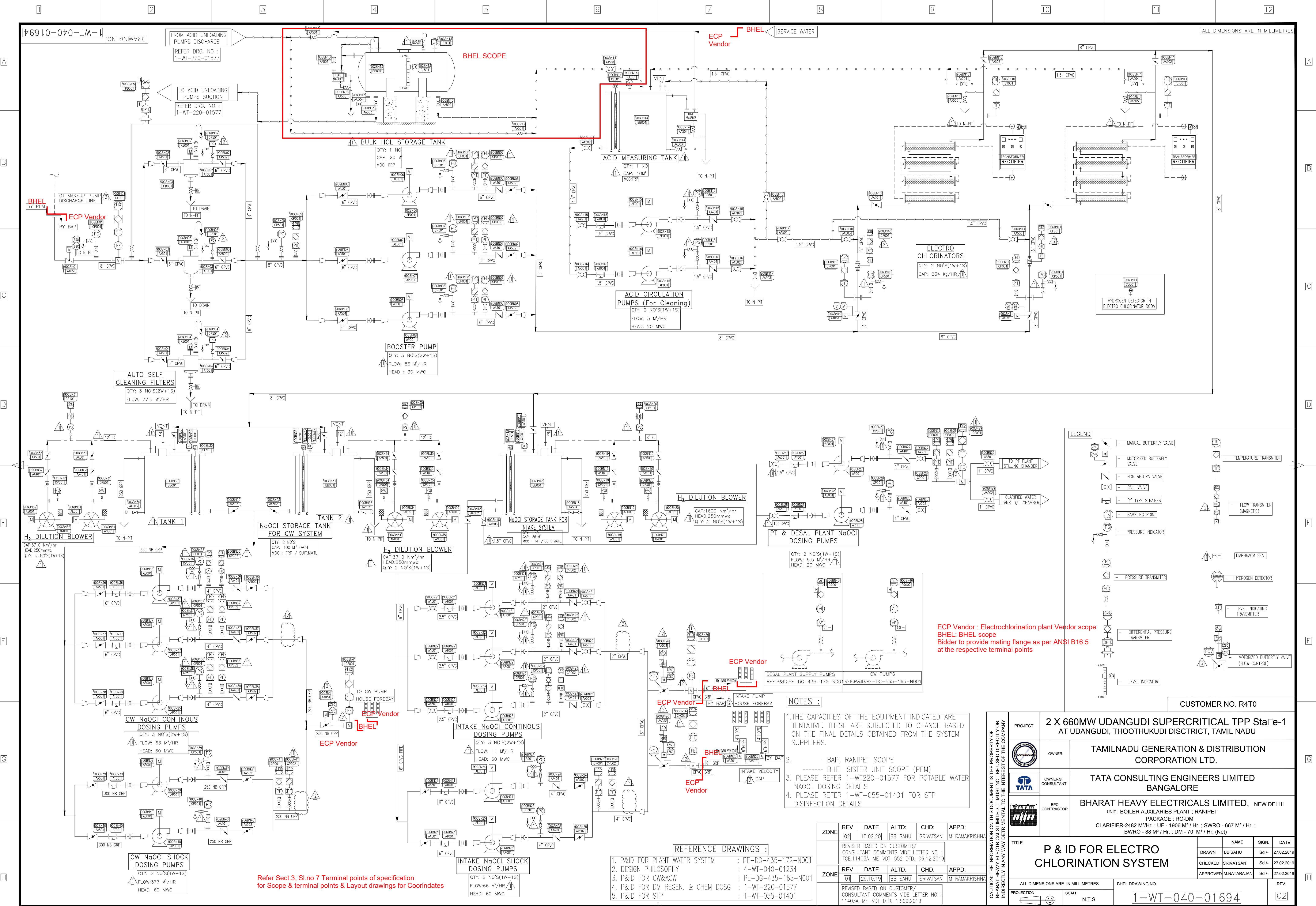
REV. NO. 01

DATE: 11.09.19

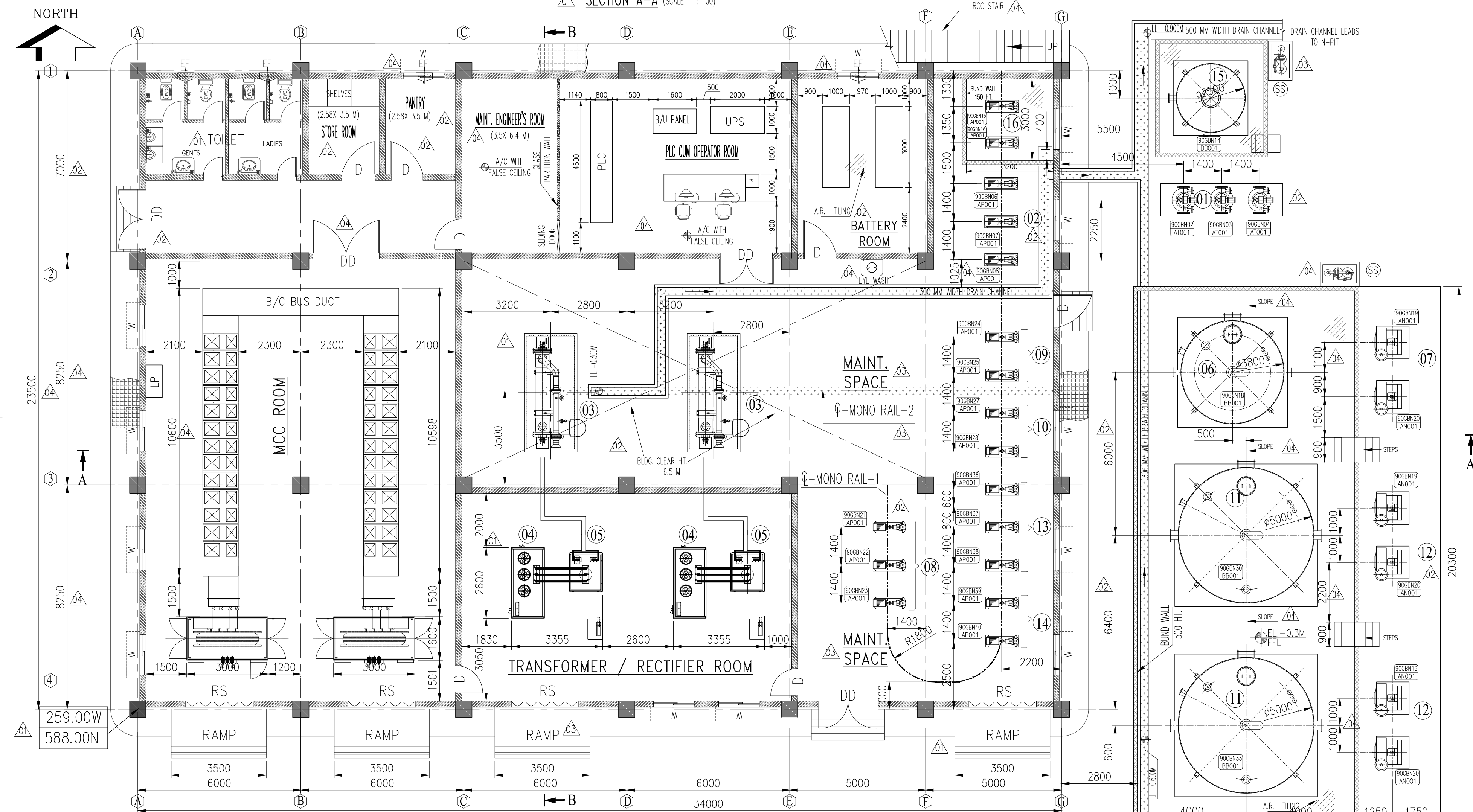
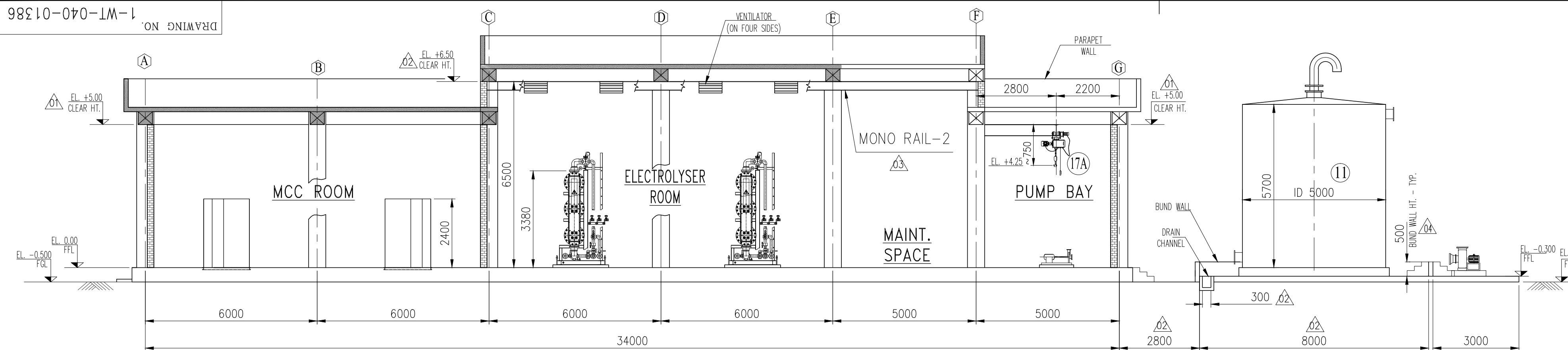
Page: 15 of 15

Sl.No.	Item	Description
b)	Method of control	Thyristor
c)	Output DC current	As per system requirement
d)	Output DC voltage	As per system requirement
e)	Cooling type	Air cooled
f)	Location	Indoor
18.0	Diffuser assemblies	
a)	MOC	FRP/ HDPE
b)	Capacity	As per system requirement with a minimum of one diffuser set per CW pump chamber, one no. in stilling chamber & one no. for Intake well.
c)	Neutralization pit	Neutralization pit in DM plant will be used for neutralization of cleaning effluents from Electro chlorinators
d)	Neutralization pit disposal pumps	Neutralization pit disposal pumps in DM plant will be used.
19.0	Chlorination piping system	For intake well
a)	Pipe MOC	CPVC/ HDPE/ GRP Refer PID for MOC
20.0	Chlorination piping system	For Desalination plant stilling chamber, CW pump chamber
a)	Pipe MOC	CPVC/ HDPE/ GRP Refer PID for MOC
21.0	Material handling arrangement	
a)	<u>Manual hoist</u> 2Nos. Each <u>Electric hoist</u>	1MT for handling & maintenance of pumps in Electro chlorination building

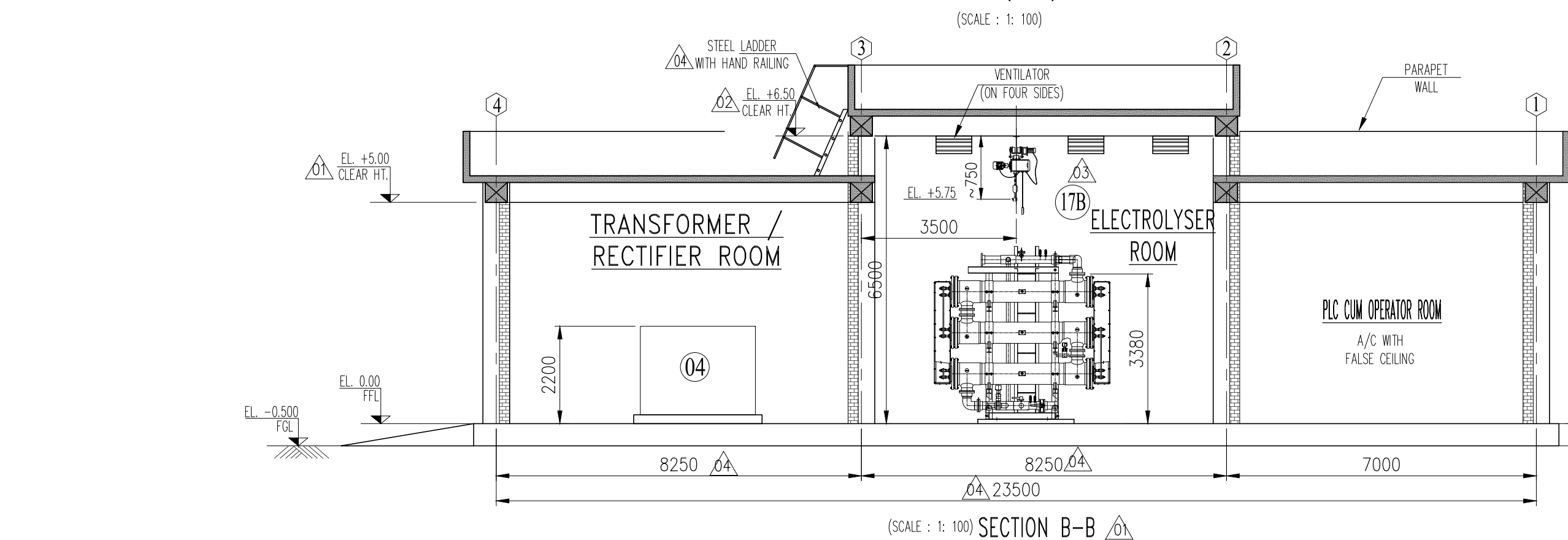
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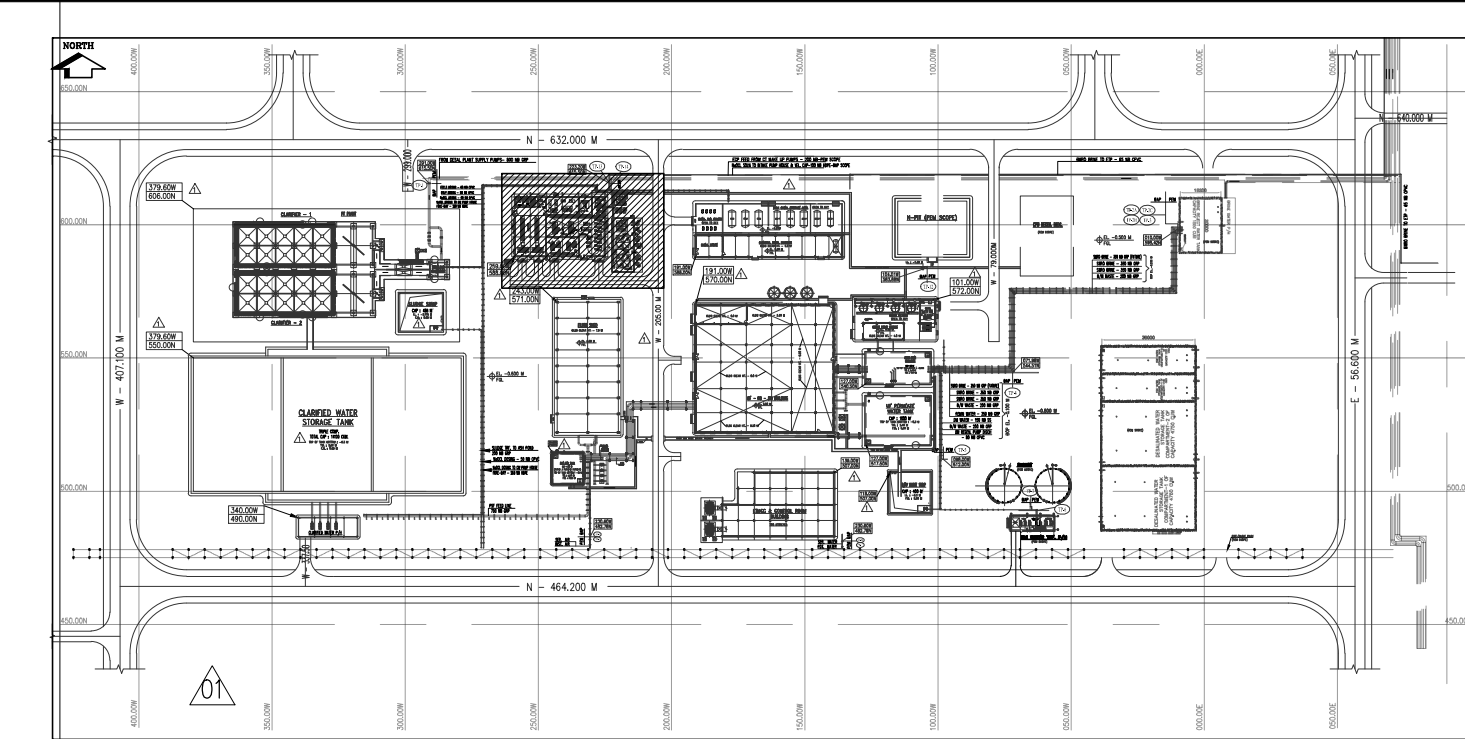
1-WT-040-01386



ELECTRO CHLORINATION PLANT (ECP)- PLAN @+5.50 M EL.



SECTION B-B



EQUIPMENT LIST:-

EQPT. NO	DESCRIPTION	QUANTITY	EQPT. DIMENSION IN MTR.(Aprox.)	EQUIPMENT TAG NO	ZONE
01	SELF CLEANING STRAINER	2W+1S	Ø0.60 X 1.5 L (CYL)	90GBN02-04 AT001	C-6
02	BOOSTER PUMP	2W+1S	1.2 M LX0.50 M WX0.6 M H	90GBN06-08 AP001	D-5
03	ELECTROLYSER	1W+1S	4.4 M LX2.0 M WX3.5 M H	---	E-4/B-4
04	TRANSFORMER PANEL	1W+1S	2.6 M LX2.0 M WX2.2 M H	---	F-4/H-5
05	RECTIFIER PANEL	1W+1S	1.4 M LX1.4 M WX2.2 M H	---	F-4
06	BULK NaOCL TANK FOR INTAKE-35 M³	1W	Ø3.5 X 3.84 H (CYL)	90GBN18 BB001	D-7
07	H2 DILUTION BLOWER	1W+1S	1.2 M LX1.2 M WX0.9 M H	90GBN19-20 AN001	D-8
08	NaOCL DOSING PUMPS (INTAKE-CONT)	2W+1S	1.2 M LX0.50 M WX0.6 M H	90GBN21-23 AP001	D-6
09	NaOCL DOSING PUMPS (INTAKE-SHOCK)	1W+1S	1.2 M LX0.50 M WX0.6 M H	90GB24-25 AP001	E-6
10	NaOCL DOSING PUMPS (PT & DESAL)	1W+1S	1.2 M LX0.50 M WX0.6 M H	90GB27-28 AP001	E-6
11	BULK NaOCL TANK FOR CW-100 M³	2W	Ø5.0 X 5.7 H (CYL)	90GBN30,33 BB001	E-7
12	H2 DILUTION BLOWER	2W+2S	1.2 M LX1.2 M WX0.9 M H	90GBN31,32,34,35 AN001	F-8
13	NaOCL DOSING PUMPS (CW-CONT)	2W+1S	1.2 M LX0.50 M WX0.6 M H	90GBN36-38 AP001	E-6
14	NaOCL DOSING PUMPS (CW-SHOCK)	1W+1S	1.2 M LX0.50 M WX0.6 M H	90GBN39-40 AP001	F-6
15	ACID DAY TANK - 10 M³	1W	Ø2.5 X 2.0H (CYL)	90GBN14 BB001	C-7
16	ACID CLEANING PUMP	1W+1S	1.2 M LX0.50 M WX0.6 M H	90GBN15,16 AP001	D-6
17A	HOIST-1 (1 MT ELECT.)	1W	---	---	B-6
17B	HOIST-2 (1 MT ELECT.)	1W	---	---	B-6
SS	SAFETY SHOWER	2W	---	---	D-7

NOTES :

- FINISHED GRADED LEVEL (FGL) ELEVATION IS -0.500 M.
- ECP BUILDING FINISHED FLOOR LEVEL (FFL) EL. IS (±)0.00M WHICH CORRESPONDS TO RL (+)3.80 FROM MSL.
- ECP BUILDING IS RCC STRUCTURE WITH SIDE BRICK WALL.
- EQUIPMENT LOCATION DIMENSION & PIPE LINE ROUTING ARE FOR INFORMATION. FINAL DIMENSION WILL BE UPDATED AFTER VENDOR FINALIZATION.
- DRAIN CHANNEL, TRENCH AND PIPE LINE SHOWN ARE TENTATIVE AND THESE SHALL BE UPDATED AFTER DETAILED ENGINEERING.
- PLINTH PROTECTION OF 1.0 M WIDTH SHALL BE PROVIDED AROUND RCC BUILDING.
- ALL RAMP SLOPE SHALL BE MAINTAINED IN 1:6.
- ADEQUATE EXHAUST FANS IN ECP BUILDING SHALL BE PROVIDED IN SUITABLE LOCATION.
- HEAVIEST LOADS TO BE HANDLED BY HOIST IN PUMP BAY AND ELECTROLYSER HOIST IS APPROX. 600 Kg.
- ALL THE DRAINS INSIDE THE BUILDING SHALL BE COVERED WITH PRE-CAST RCC SLAB.

REFERENCE DRGS :

- KEY PLAN : 1-WT-220-01377 LAT. REV.
- P&ID FOR ECP : 1-WT-040-01694

LEGEND :

- FGL - FINISHED GRADED LEVEL
FFL - FINISHED FLOOR LEVEL
RS - ROLLING SHUTTER
DD - DOUBLE DOOR
D - SINGLE DOOR
- PLINTH PROTECTION OF 1.0M WIDTH ALL AROUND BUILDING
AR TILED DRAIN TENCH
AR TILED FLOOR
BUND /DYKE WALL

ROLLING SHUTTER & DOOR SIZES

TAG	WIDTH IN M X HT. IN M	QTY
RS	3.0 X 3.5	03
DD	2.2 X 2.1	04
D	1.2 X 2.1	09

CUSTOMER NO. R4T0

CUSTOMER	TAMIL NADU GENERATION AND DISTRIBUTION CORPORATION LIMITED, TANGEDCO HEAD HEADQUARTERS, 1ST FLOOR, NEW EB QTRS., 144,ANNASALAI, CHENNAI 600002.
CONSULTANT NAME	TATA CONSULTING ENGINEERS LIMITED BENGALURU
PROJECT NAME	2 X 660 MW UDANGUDI STPP STAGE - I
	BHARAT HEAVY ELECTRICALS LIMITED, NEW DELHI UNIT: BOILER AUXILIARIES PLANT, RANIPET PACKAGE : PT-RO-DN & ECP CLARIFIER - 3523 M³ / Hr.; UF - 1906 M³ / Hr.; SWRO - 667 M³ / Hr.; BWRO - 88 M³ / Hr.; DM - 70 M³ / Hr. (Net)
TITLE	ELECTRO CHLORINATION PLANT EQPT. LAYOUT
ALL DIMENSIONS ARE IN MILLIMETRES	BHEL DRAWING NO.
PROJECTION	SCALE 1:100 AS PER PLAN & SEC
1 - WT - 040 - 01386	04A

REV 04A	DATE 18.05.20	ALTERED: BB SAHU CHECKED: G.RAJENDIRAN	REV 02	DATE 28.12.19	ALTERED: BB SAHU CHECKED: G.RAJENDIRAN
ZONE	REVISED BASED ON CUSTOMER/ CONSULTANT COMMENTS VIDE LETTER NO : TCE.11403A-ME-VDT-770 DTD. 14.04.2020		ZONE	REVISED BASED ON CUSTOMER/ CONSULTANT COMMENTS VIDE LETTER NO : 11403A-ME-VDT-550 DTD. 29.10.2019	
REV 03	DATE 24.02.20	ALTERED: BB SAHU CHECKED: G.RAJENDIRAN	REV 01	DATE 29.10.19	ALTERED: BB SAHU CHECKED: G.RAJENDIRAN
ZONE	REVISED BASED ON CUSTOMER/ CONSULTANT COMMENTS VIDE LETTER NO : TCE.11403A-ME-VDT-669 DTD. 10.02.2020		ZONE	REVISED BASED ON CUSTOMER/ CONSULTANT COMMENTS VIDE LETTER NO : 11403A-ME-VDT DTD. 13.09.2019	