2X660 MW ENNORE SEZ STPP, CHENNAI.

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VOLUME: IIB & III.

TECHNICAL SPECIFICATION
FOR
ELECTRO CHLORINATION PLANT.

SPECIFICATION NO.: PE-TS-412-174-A102

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

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VOLUME-IIB & III

VOLUME-III

SECTION – A
SCOPE OF ENQUIRY

1. SCOPE OF INQUIRY/ INTENT OF SPECIFICATION

1.1 The specification is intended to cover design, engineering, manufacture, supply (**Except already supplied items**), fabrication, assembly, inspection/testing at vendor's & sub-vendor's works, painting, maintenance/special tools & tackles, mandatory spares, startup and commissioning spares as required, forwarding, proper packing, shipment and delivery at site, unloading, handling, transportation & storage at site, in site transportation, assembly, erection & commissioning, trial run at site, preparation and submission of drawing/documents including "As built" drawings and carrying out performance guarantee test (PG Test) at site & equipment/system guarantee, etc., handover in flawless condition of the **ELECTRO CHLORINATION PLANT** for **2X660 MW ENNORE SEZ STPP, CHENNAI** to the end customer complete with all accessories for the total scope defined as per BHEL NIT and tender technical specification, amendment & agreement till placement of order.

Bidders to please note that originally the plant was Designed and Engineered by M/s DeNora India Ltd, Goa, India, however, only partial supply of few items were completed (Refer Specific "Technical Requirements for Mechanical") and no Erection work has been completed. The supplied items area available at site. The Civil front has already prepared at site based on the Detailed Engineering Documents submitted by M/s DeNora and approved by M/s BHEL/Customer/Consultant. Bidder to visit site for readiness of Civil Fronts in totality. The items to be supplied by Bidder should be able to integrate/hook with the existing/under construction Civil Work/Foundation. Bidder shall carryout rectification in existing civil work if any, before erection & commissioning of the plant.

1.2 While all efforts have been made to make the specification requirement complete & unambiguous, it shall be bidders' responsibility to ask for missing information, ensure completeness of specification, to bring out any contradictory / conflicting requirement in different sections of the specification and within a section itself to the notice of BHEL and to seek any clarification on specification requirement in the format enclosed under Vol-III of the specification as **"PRE BID CLARIFICATION SCHEDULE"**. 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.

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

SECTION - B

(PROJECT INFORMATION)

Project Title : 2 x 660 MW Ennore SEZ Coal Based Supercritical Thermal Power Project at Ash Dyke of NCTPS.

OWNER : TAMIL NADU GENERATION AND DISTRIBUTION CORPORATION (TANGEDCO).

LOCATION : The site is located near Vayalur Village, Ennore
Latitude : 13°17' N to 13°18' N
Longitude : 80°18' E to 80°19' E
Distance from Chennai City : 35 km
Nearest Airport is at Chennai at a Distance of : 60 km

Meteorological Condition

Climate : Tropical ,very dry and hot summer, dry and cold winter and good rain-fall in monsoon accompanied with strong wind.

Climatological data	:	Ambient temp. (°C)
Annual Maximum Mean Temp	:	41.5(°C)
Annual Minimum Mean Temp	:	24(°C)
Design Ambient temperature	:	35(°C)
Relative Humidity	:	In Percentage
Maximum	:	100%
Minimum	:	36%
Design	:	75%
Annual Rainfall	:	In MM
Maximum	:	2540 mm
Average	:	1600 mm
Minimum	:	1175 mm

Seismic Zone III as per IS:1893-2002

SECTION – C

(SPECIFIC TECHNICAL REQUIREMENTS)

SECTION – C1

(SPECIFIC TECHNICAL REQUIREMENTS FOR MECHANICAL)

1.0 GENERAL

The **Electro Chlorination Plant** and associated accessories shall conform to the technical specification.

2.0 SCOPE OF SUPPLY

Scope of work of this package includes all equipment and accessories as per The Technical Specification. Please also refer Electrical (Section-C1) & C&I (Section-C2) for respective scopes.

a) Broad Supply Scope (Refer P&ID (**Ref. No. PE-V11-412-174-A101**) **and Data Sheet-A for clarity)**:

1) Two numbers (1W+1S) Seawater booster pumps.
2) Two numbers (1W+1S) self-cleaning type seawater strainers with accessories.
3) Two numbers (1W+1S) Electrolyzers **(Already Supplied by M/s DeNora, Shall be free issue by BHEL to bidder).**
4) Two numbers (1W+1S) transformer rectifiers and accessories as per system requirement.
5) Two numbers (1W+1S) Hypochlorite storage tank **(Already Supplied by M/s DeNora, Shall be free issue by BHEL to bidder).**
6) One number (1x100%) Hypochlorite Storage tank for 2X600 MW NCTPS Stage-II (Loose supply) **(Already Supplied by M/s DeNora, Shall be free issue by BHEL to bidder).**
7) Air dilution blower four numbers (2W+2S).
8) Two numbers (1W+1S) hypo dosing pumps for PT Plant.
9) Two numbers (1W+1S) hypo dosing pumps for Common channel of CW Sump.
10) Three numbers (1W+2S During Continuous dosing and 2W+1S during Shock Dosing) hypo dosing pumps for CW Pump Pit.
11) Two numbers (1W+1S) hypo dosing pump for Sea water intake channel (Located at 2X600 MW NCTPS Stage-II).
12) One number (1x100%) HCl preparation tank **(Already Supplied by M/s DeNora, Shall be free issue by BHEL to bidder).**
13) Two numbers (1W+1S) acid cleaning pumps.
14) One number (1x100%) HCl storage tank **(Already Supplied by M/s DeNora, Shall be free issue by BHEL to bidder).**
15) Two numbers (1W+1S) HCl unloading pumps.
16) Hydrogen detector two numbers.
17) Chain pulley block of minimum 2 Ton capacity (manual) two numbers (one for Hypo dosing pump handling and one for blower).
18) Crane of minimum 3 Ton capacity one number for handling Electrolyzers.
19) Two numbers (1W+1S) N-pit disposal pumps.
20) NaOH dosing Drum one number (1x100%).
21) Pipes and valves as indicated in P&ID (as minimum).
22) Electrical motors as per requirement.
23) Control panel (PLC based).
24) All tanks complete with inlet and outlet connections, all fittings and appurtenances etc. as specified and as required.
25) All necessary valves and fittings for the installations with the actuators necessary for their remote operation.
26) All necessary drains, vents and sampling points, with valves, as specified and as required.
27) Hangers and supports as per the requirement.
28) Safety requirement as per Data Sheet-A.
29) Start-up and commissioning spares as required.
30) Mandatory spares as enclosed.
31) Necessary flanges and counter flanges as applicable for interconnection.
32) All special tools necessary for proper maintenance.
33) 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.
34) Finish paints for touch up painting of equipments after erection at site in sealed container.
35) Permanent ladder (not rungs) for approaching the top of tanks, valves for opening/maintenance purpose.

36) All steel inserts with lugs, plates, bolts, nuts, sleeves, edge angles and all other embedding components etc as required to grout in civil works and to support/hold the equipments being supplied under this specification. All nuts, bolts, etc shall be of SS 316L.
37) All auxiliary steel structures (U-clamps, nuts, bolts, channels etc.) for fixing the pipe on the pedestal or trestles.
38) Hume pipe for road crossing. Consider 15 nos 150 NB IS 1239 H pipe and 3 nos 300 NB IS 3589 (min 6 mm thick) each of 6 meter with wrapping and coating.
39) Electrical scope shall be as per "Electrical scope between BHEL and Vendor".
40) Instrumentation (minimum) as per the enclosed P&ID (**Ref. No. PE-V11-412-174-A101**).
41) Air conditioner for PLC room and ventilation fan for electrolyzer area and Transformer rectifier area.
42) Special tools and tackles as required.
43) All the first fill and one Year's topping requirements of consumable such as greases, oil, lubricants, servo fluids/control fluids etc. which will be required to put the equipment covered under the scope of specifications, into successful commissioning / initial operation and to establish completion of facilities shall be in bidder's scope. Suitable standard lubricants as available in India are desired. Efforts should be made to limit the variety of lubricants to minimum.
44) All Chemical for Trial Run (Minimum 15 Days) and for PG Test+First fill of all chemical tanks.

Note: The mechanical Documents/Drawings already approved as per ANNEXURE-C to be followed by bidder and for that no drawing/documents to be submitted by Bidder. In addition to above the engineering documents which are not approved as per Annexure-C shall be part of Bidder scope.

3.0 SCOPE OF SERVICES

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

1) Erection and commissioning, unloading, storage and handling at site.
2) Arrangement of all instruments and lab facilities as required to carry out trial run/commissioning and PG test.
3) Complete grouting for equipment, fixing and any concreting inside the vessels and lining as required.
4) All personnel required during commissioning, Trial Run and PG Test.
5) Trial run and Performance testing (PG Test).
6) Painting as per enclosed painting schedule.

Note: The above services shall be applicable for already supplied items also.

4.0 CIVIL SCOPE

Total Civil construction work along with material (RCC and Reinforcement Steel) at site is in BHEL's Scope of work, however complete grouting for equipment, pumps, blowers etc. as required shall be in bidder's scope.

Note: The Civil Input Documents/Drawings already approved as per ANNEXURE-C to be followed by bidder and for that no drawing/documents to be submitted by Bidder. Only those documents not approved or under approval or commented or pending for submission as per ANNEXURE-C shall be submitted by bidder.

5.0 ELECTRICAL SCOPE

Complete electrical as per specification / details indicated in Section IB (Specific Technical Requirement Electrical) and IIB (General Technical Requirement Electrical).

Note-1: The Electrical Documents/Drawings already approved as per ANNEXURE-C to be followed by bidder and for that no drawing/documents to be submitted by Bidder. In addition to above the engineering documents which are not approved as per Annexure-C shall be part of Bidder scope.

Note-2: Please note that MCC/Switchgear already supplied by BHEL, bidder to follow the already approved load list (Ref. PE-V11-412-174-A107). In case any minor changes is needed, the same shall be part of bidder scope.

6.0 C&I SCOPE

Complete C&I as per specification / details indicated in Section IC (Specific Technical Requirement C&I) and IIC (General Technical Requirement C&I).

Note: The C&I Documents/Drawings already approved as per ANNEXURE-C to be followed by bidder and for that no drawing/documents to be submitted by Bidder. In addition to above the engineering documents which are not approved as per Annexure-C shall be part of Bidder scope.

7.0 TERMINAL POINT

- **a.** Inlet water line: At Terminal Point At Terminal Point 10 meter from ECP building (Refer Plot plan for details) at flooded suction.
- **b.** Service water and portable water: At Terminal Point 10 meter from ECP building (Refer Plot plan for details).
- **c.** Instrument Air/Service Air: At Terminal Point 10 meter from ECP building (Refer Plot plan for details) at 5-7 kg/cm2 (g) pressure.
- **d.** Dosing point- Upto Common channel and CW Pump Pit (Consider Piping Distance=350 Meter each) and upto PT plant stilling chamber (Consider 2000 meter piping distance).
- **e.** Neutralization Pit Waste: Upto CW Forebay (consider 100 meter Piping distance).
- **f.** All drains: To be terminated at Common drain.
- **g.** Dosing point at Sea water intake channel at 2X600 MW NCTPS Stage-II: Consider piping distance 1000 meter.

Note: For Size of the pipe refer enclosed P&ID (**Ref. No. PE-V11-412-174-A101**) and Pump head shall be as per **PE-V11-412-174-A102 (PROCESS SIZING CALCULATION).**

8.0 EXCLUSIONS

a) Service air, Instrument air, upto the terminal point.
b) Fire fighting facilities.
c) Drinking water and service water.
d) All Civil works at site including Acid/Alkali resistant tiling/lining, excavation, backfilling, cement and steel.
e) M.C.C. / Switch fuse feeder panels for the power plant and control cabling up to & beyond the battery limit (Refer electrical section for scope).
f) Monorail for hoist/crane movement is excluded from bidder scope.

9.0 QP AND SUBVENDOR APPROVAL

a) Approved subvendor list is enclosed elsewhere of this specification. However, any additional sub-vendor shall be subject to BHEL and Customer approval.

Note: The QAP already approved as per ANNEXURE-C to be followed by bidder and for that no documents to be submitted by Bidder. In addition to above the engineering documents which are not approved as per Annexure-C shall be part of Bidder scope.

10.0 FUNCTIONAL GUARANTEES (REFER APPROVED PG TEST PROCEDURE ENCLOSED, REF. PE-V11-174-A132).

11.0 DRAWING/DOCUEMNTS REQUIREMENT (FOR MECHANICAL/ELECTRICAL/C&I/ETC)

The Documents/Drawings already approved as per ANNEXURE-C to be followed by bidder and for that no drawing/documents to be submitted by Bidder. In addition to above the engineering documents which are not approved as per Annexure-C shall be part of Bidder scope.

12.0 DRAWING/DOCUEMNTS REQUIRED ALONG WITH THE BID .

- Compliance certificate.(Stamped & Signed)
- Un Price Schedule duly filled in. (Stamped & Signed)

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

Note-2: Bidder to note that BHEL reserve the right for drg/doc submission through web based Document Management System. Bidder would be provided access to the DMS for drg/doc approval and adequate training for the same. Detailed methodology would be finalized during the kick-off meeting. Bidder to ensure following at their end.
• Internet explorer version – Minimum Internet Explorer 7

• Internet speed – 2 mbps (Minimum preferred)
• Pop ups from our external DMS IP (124.124.36.198) should not be blocked
• Vendor's Internal proxy setting should not block DMS application's link
(http://124.124.36.198/wrenchwebaccess/login.aspx)

Note-3: The above Note-1 and 2 shall be applicable for Electrical and C&I also.

TABLE - A

SEA WATER ANALYSIS (Quality of Sea Water using for Preparation of NaOCl):

S.No.	Parameter	Unit	Value (Range)
1	**General**		
a	pH		7.94-8
b	Conductivity	millisiemens/cm	43.8-44.1
c	Temperature	Deg C	25-32
d	Turbidity	NTU	20-40
e	Total Organic carbon (total/ dissolved)	PPM of C	2.4-2.84
f	CO2	Mg/l	<2
g	TDS	Mg/l	39600-39740
h	BOD	Mg/l	10-12
i	COD	Mg/l	88-96
j	Oil & Grease	Mg/l	<10
k	Phenols	Mg/l	0.08-0.09
l	Free Residual Chlorine	Mg/l	<0.2
2	**Cations**		
a	Cacium	Mg/l	459-478
b	Magnesium	Mg/l	1510-1516
c	Sodium	Mg/l	10100-12000
d	Potassium	Mg/l	358-450
e	Ammonia	Mg/l	4.43-5.42
f	Stontium	Mg/l	12.9-12.4
g	Barium	Mg/l	1.55-1.58
h	Aluminum Total	Mg/l	1-1.8
i	Aluminum Dossolved	Mg/l	0.8-1.0
j	Manganese Total	Micro g/l	0.2-0.6
k	Manganese Dissolved	Micro g/l	0.1-0.2
l	Iron total	Micro g/l	220-260
m	Iron Dissolved	Micro g/l	Below detectable limit (detectable Limit : 10)
3	**Anions**		
a	Chloride	Mg/l	18994-19194
b	Sulphate	Mg/l	3710-3949

c	Nitrate	Mg/l	136-152
d	Nitrite	Mg/l	0.46-0.62
e	Bicarbonate	Mg/l	144-148
f	Carbonate	Mg/l	Nil
g	Fluoride	Mg/l	2.64-2.8
h	Boron	Mg/l	0.14-0.17
i	Phosphate	Micro g/l	240-380
j	Sulphide	Micro g/l	Below detectable limit (detectable Limit : 100)
k	Silica Dissolved	Micro g/l as SiO2	200-250
4	**Heavy Metals**		
A	Arsenic	Micro g/l	Below detectable limit (detectable Limit : 2)
B	Mercury	Micro g/l	Below detectable limit (detectable Limit : 1)
C	Cadmium	Micro g/l	120-130
D	Copper	Micro g/l	200-220
E	Nickel	Micro g/l	470-490
F	Molybdenum	Micro g/l	Below detectable limit (detectable Limit : 100)
5	**Suspended Particle Size Range**		
A	10 micron & above	Mg/l	Below detectable limit(detectable Limit : 10)
B	5 micron to 10 micron	Mg/l	Below detectable limit(detectable Limit : 10)
C	1 micron to 5 micron	Mg/l	Below detectable limit(detectable Limit : 10)
D	0.1 micron to 1 micron	Mg/l	20-26
6	**Colloidal Particle Size Range**		
A	SDI (10 Minutes)	-	10-20
B	SDI (5 Minutes)	-	20-40
7	Density of sea water	Kg/ cum	1030

TABLE-B

MANDATORY SPARES

SL. No.	Equipment / Package name	Qty.	Remarks (BHEL)
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)	
2.0	**Each type of lamps, PBs, ILPBs, fuse, MCB, MCCB used in the equipment/system.**	20 % of Installed of each type.	
3.0	**Measuring Instruments**		
3.1	**Indicators, Recorders, Electrical Metering and Skid Mounted Instruments**		
(i)	Indicators, recorders and meters offered from each model for the project. These instruments shall be supplied with three sets of blank scales.	10 % of Installed of each type/Model or a minimum of one number for each model and type, whichever is more	
(ii)	For skid mounted instruments	10% of total number of instruments for each Type and model or a minimum of one number for each model and type, whichever is more	
3.2	**Temperature Elements and Thermowells**		
(i)	Thermocouple/RTD elements	10% spare for each type and length of element furnished with thermocouple/RTD assemblies, or a minimum of one number of each type & length, whichever is more.	
(ii)	Thermowells	10% for each type of temperature sensors or a minimum of one for each type, whichever is more	
3.3	**Temperature Transmitters and Electronic Transmitters (For Pressure, DP, Temp, Flow, Level), Temperature, Pressure, Flow & Level Switch, safety switches, Gauges, meters, Transducer or any other instrument etc.**	10% of total number of Instruments/transducers offered for each model and type for the project or a minimum of one number, whichever is more.	
4.0	**DDCMIS/PLC system, Master slave clock system, Hart Management System, Vibration Monitoring system, CAAQMS, ERP/MIS/LAN/Simulator/ WAN, CCTV, Microprocessor based control system, and other Control System/Sub-systems/electronic.**		
4.1	**I/O cards**		
a.	Analog Input module	10% of qty Installed of each category/model or at least 2 No. of each type/model (Whichever is more)	
b.	Analog output module	10% of qty Installed of each category/ model or at least 2 No. of each type/model (Whichever is more)	
c.	RTD/TC cards/modules	10% of qty Installed of each category/model or at least 2 No. of each type/model (Whichever is more)	
d	Digital input module	10% of qty Installed of each category/model or at least 2 No. of each type/model (Whichever is more)	
e.	Digital output module	10% of qty Installed of each category/model or at least 2 No. of each type/model (Whichever is	

		more)	
4.2	All types of electronic modules, controllers, function modules, cards, terminal boards, relay boards, power supply cards etc for above mentioned system and other Control System/Sub- systems and any other type of PCB not covered above	10% of qty Installed of each category/model or at least 2 No. of each type/model (Whichever is more)	
4.3	Electronic Cards/modules	10% of number for each type or minimum of 2 number for each type whichever is high.	
4.4	Auto/Manual stations, set-point/bias stations etc	10% of the number of stations offered for the project from each type or a minimum of 2 number from each model, whichever is more.	
4.5	Control logic power supply fuses, MCB, MCCB, at each current rating required for the project.	20% spare for each type/Model	
4.6	Electronic cards of each type used for each type of Servers supplied with any control system	Ten (10) percent or 2 no. (Whichever is more)	
4.7	Electric to pneumatic each type utilized with automatic control system using pneumatic drives converters.	Ten (10) percent of each type or a minimum of one of each type, whichever is more.	
4.8	Data highway cable with adequate connectors of each type **(sets)**	200 mts. each	
4.9	Prefab cable connectors	10% or 5 nos (whichever is more) of each type of Installed	
4.10	Cubicle power supply power supply modules	Ten (10) percent or 5 nos (whichever is more) of Installed of each type and rating	
4.11	Interposing/coupling relays.	Ten (10) percent Installed of each type and rating	
4.12	Ethernet Switches, Routers & other communication hardware.	10% of qty Installed of each type or a minimum of 2 numbers from each model, whichever is more.	
4.13	Sensors with special cables, Power supply modules, Relay, Interface Module, and electronic modules used for vibration monitoring system.	10% of qty installed or Five no. (Whichever is more) of each type)	
4.14	RJ 45 connector with box of each type	Twenty (20) percent or 2 no. (Whichever is more)	
4.15	Hooters, Buzzers, Cooling fans of each type.	Ten (10) percent or 2 no. (Whichever is more)	
4.16	Interface cables	2 sets of each type/model	
4.17	Power supply modules (AC to DC convertors)	10% or Five no. (Whichever is more) of each type/model	
5.0	**Relay based Control Panels**		
5.1	LEDs for indicating lights	10% of qty installed.	
5.2	Control circuit fuses/MCB/MCCB/Semiconductor Fuses	300% of installed of each type, current rating	
5.3	Relays modules & contactors.	20% spare of qty Installed of each type and rating.	
6.0	**Alarm Annunciation System**		
6.1	Logic modules, group card modules, power supply modules, Hooters and any other electronic module.	20% spares of each type installed	
6.2	un-engraved window boxes complete with LED etc.	5% spares of each size installed	
6.3	LEDs for annunciation facia windows and LEDs box assemblies offered for the project	20% of qty installed	
6.4	Annunciator hooter	One (1) No. of each type	
7.0	**Un-interrupted Power Supply System and DC Control Power Supply System**		
7.1	As per Manufacturer's Recommendation for Three Years Continuous Operation or minimum quantities indicated as below		

	(whichever is more)		
7.2	Fuses/Semiconductor Fuses	300% of installed of each type, current rating with each panel /board	
7.3	Miscellaneous parts for the power supplies such as SCRS, transistors, resistors, diodes, light bulbs, static switches , blocking diodes etc	Minimum of 10% or atleast two (which ever is more) of each type	
7.4	Battery cells complete with contactor,cover plates etc	10% of qty installed	
7.5	Electronic Modules like Rectifier control card, inverter control card, Driver card, IGBT Module, DC-DC converter card or any other card as listed in approved BOM for UPS, AC supply & 24 V DC supply etc.	1 Set of each type & rating	
7.6	Miniature Circuit breakers for AC and DC supply.	20 % of installed or 10 Nos of each type (which ever is more) for ACDB and DCDB.	
7.7	Digital/analog panel meters/indicators	5% or 2 no. of each type (whichever is more)	
7.8	CT's, CVT's VT's chokes, AC/DC isolators, contactors, timers, relays.	10% or 2 nos. of each type and rating, (whichever is more)	
7.9	Cooling Fans in UPS & 24 V DC charger panels	10% or 2 nos. of each type and rating, (whichever is more)	
7.10	following accessory equipment for the battery shall be furnished (sets) : a) Cell lifting facilities b) Assembly wrenches c) Vent plug hydrometer d) Vent plug thermometer. e) Supply of corrosion-preventive grease. f) 10% spare cells.	Two sets	
7.11	Electronic modules of each type & rating for UPS and DC control power supply system (sets)	One set of with each set consisting of at least one number of each type of electronic module for inverters, chargers, static switch, stabilizer etc. as per approved BOM.	
7.12	MCCB for UPS & 24 V DC charger panels, ACDB, DCDB.	20 % of installed or 5 Nos of each type (which ever is more)	
8.0	**Erection hardware**		
8.1	Instrument valves	Ten (10) percent of each type & Size installed	
8.2	Condensate pots of each type & Size installed	Ten (10) percent of total number of Installed or four numbers whichever is higher .	
8.3	Manifold	Ten (10) percent of each type & Size installed	
8.4	Fittings	Ten (10) percent of each type & Size installed	
9.0	**Control valves, Power Cylinder, Control Dampers, Actuators and Accessories**		
9.1	Following spares shall be provided for control valves, Power Cylinder, Control Dampers as applicable.		
a	One set of spare control valve stem packing for each control valve.		
b	Two moulded rubber diaphragms for each control valve.		
c	One sets of each of O-rings and rubber gaskets for each control valve.		
d	100 percent qty. of lubricants for gaskets for each control valve on one year consumption basis.		
e	2 sets of limit switches and 1 set of valve positioner for each control valve.		
f	20 percent of position transmitter (4-20mA) for total qty. of control valve.		

g	One (1) set of valve trims (such as plug, stem, seat ring /cage, guide bushing, stem lock pin, packing retaining ring, etc) for each control valve.		
h	One completes actuator of each type or min 10% for each type and size whichever is more.		
I	20 percent of Solenoid valves or min 2 no. of each type for total qty. of control valves.		
j	20% of I to P converters, Pressure regulators.		
10.0	10% or 1 no. (Whichever is more) of each type of sensor/instrument, instrumentation/mechanical fittings etc for any other electronic system.		
11.0	**Motors (HV/LV/DC)**		
11.1	**11 KV & 3.3 KV Motors**		
a	Termination kits (if elastimold type)	2 Nos. of each type	
b	Termination kits (end connection)	20 Nos.	
c	Temp. indicators	10 Nos.	
d	Vibration indicators	10 Nos.	
e	Terminal box teflon glands	20 Nos.	
f	Phase segregated terminal boxes	2 Nos.	
g	Heaters	4 sets	
h	Couplings	2 Nos. each	
I	Bearings (DE and NDE) for each type and rating of motors	4 sets	
j	Motor of each type and rating	10% of the installed quantity or minimum 1 number whichever be higher	
10.2	**415 V Motors**		
a	Terminal plates	10 Nos. each for small motors upto 30 kW & 4 Nos. each for more than 30 kW	
b	Heaters	2 sets	
c	Greasing arrangements	4 sets each type of motor	
d	Motor of each type and rating	10% of the installed quantity or minimum 1 number whichever be higher	
e	Bearings (DE and NDE) for each type and rating of motor	4 sets	
11.3	**D C Motors**		
a	Carbon brushes	10 sets each type	
b	Brush assemblies	2 sets each type	
c	Terminal blocks	2 sets each type	
d	Heaters	2 sets each type	
e	Pulleys	2 sets each type	
f	Motor of each type and rating	10% of the installed quantity or minimum 1 number whichever be higher	
g	Bearings (DE and NDE) for each type and rating of motor	4 sets	

Note: Only applicable items shall be considered. Applicable items are those which are installed in the system.

PAINTING SCHEDULE

CHAPTER - 6

PAINTING

1.0 SCOPE

This section defines the technical requirements for surface preparation, selection and application of paints on equipment, vessels, machinery, piping, ducts etc. However, manufacturers shall follow their standard procedures for painting their equipment. The bidder shall submit a detailed painting procedure for approval of owner/ owner's representative after the award of contract.

The following surface and material shall require painting:

a. All un-insulated carbon steel and alloy steel equipment like columns, vessels, storage tanks, pumps, heat exchangers etc.
b. All un-insulated carbon steel and low alloy piping, fitting and valves (including painting of identification marks).
c. All pipe structural steel supports, walkways, platforms, handrails, ladders etc.

The following surfaces and materials shall not require painting :

a. Non-ferrous materials
b. Austentic stainless steel
c. Plastic and / or plastic coated materials
d. Insulated surface of equipment and pipes except color coating wherever required.
e. Painted equipment like blowers, pumps, valves etc. with finishing coats in good condition and with matching color code.

2.0 CODES AND STANDARDS

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

The following Indian Standards may be referred to for carrying out the painting job :

IS:5	:	Colours for ready mixed paints and enamels
IS:1303	:	Glossary of terms relating to paints
IS:2379	:	Colour code for identification of pipelines
IS:1477	:	Code of practice for painting of ferrous metals in buildings (Parts I & II)
IS:2524	:	Code of practice for painting of non-ferrous metals in buildings (Parts I & II)
IS:2395	:	Code of practice for painting of concrete, masonry and plaster surfaces (Parts I & II)

IS:2338	:	Code of practice for finishing of wood and wood based materials (Parts I & II)
IS:158	:	Ready mixed paint, brushing, bituminous, black, lead free, acid, alkali, water and heat resisting.
IS:2074	:	Ready mixed paint, air drying, red Oxide Zinc Chrome, priming
IS:104	:	Ready mixed paint, brushing, Zinc Chrome, priming
IS:2932	:	Enamel Synthetic exterior (a) Undercoating (b) finishing
IS:4682	:	Code of practice for lining of vessels & equipment
SIS 559000	:	Swedish standard for blasting
ISO 8504-2	:	Preparation of steel substrates before application of paints and related products. Surface preparation methods Part 2 Abrasive blast cleaning
ISO 8501-1	:	Preparation of steel substrates before application of paints and related products. Visual assessment of surface cleanliness. Part 1 : Rust grades and preparation grades of uncoated steel substrates and of steel substrates after overall removal of previous coatings.
SIS 05 5800	:	Surface preparation by acid pickling
SSPC SP08	:	Surface preparation by acid pickling
IS 2629	:	Recommended practice for hot dip galvanizing of iron and steel
ASTM A780	:	Standard practice for repair of damaged galvanized coatings
SSPC	:	Steel structures painting council
NACE	:	National association of Corrosion Engineers
DIN	:	Deutsehes Institute for Normung
BS	:	British Standard
ASTM	:	American Society for Testing material
AWWA	:	American Water works association

3.0 SURFACE PREPARATION

The surface shall be prepared in a manner suitable for coatings. Chemical derusters or rust converters shall not be applied. Acid cleaning is subject to approval of Purchaser/ Purchaser's representative.

3.1 BLASTING

The surface of the part/ component shall be blasted before the coating material is applied.
Compressed air supply for blast cleaning shall be free of water and oil. Air compressors shall not be allowed to deliver air above 1100C. Blasting activity shall be performed at temperatures 30C above due point and substrata temperature between 50C & 500C and relative humidity not exceeding 85% shall be maintained during painting. Necessary safety precautions for equipment and operator shall be adhered to and shall comply with applicable laws, regulations, ordinances etc., of the local authority, state or the nation pertains to the work.

Abrasive used for blast cleaning carbon steel and alloy steel shall be as per ISO 8504-2 and SSPC painting manual. Suggested abrasives are chilled iron grit, shot steel, malleable iron grit and shots of non metallic abrasive (aluminum oxide, copper slag, garnet etc.).
The grade of blasting shall be performed in line with the approved painting scheme.
The nature, quality and grain size of abrasives and the parameter of their use are to be chosen to obtain the required surface profile depth and cleanliness.
Surfaces prepared for coating shall be coated the same day and before any visible rusting occurs (the time elapsed between blast cleaning and commencement pf painting shall under no circumstances exceed 4 hours, but in any case must commence before signs of degradation occur).

The grades of surface finish

	ISO 8501-1	SIS 055900	SSPC	NACE
White metal	Sa3	Sa3	SP5	1
Near White metal	Sa 2½	Sa 2½	SP10	2
Commercial Blast	Sa2	Sa2	SP6	3
Brush off blast	Sa1	Sa1	SP7	4

Unless otherwise specified in the documents, the surface shall satisfy the following requirements after blasting
(a) Blasting according to SIS 055900, Grade Sa 2½

Primer paint shall be Zinc Silicate of approved brand. Dry film thickness of each primer coat shall be 15-25 µm.

3.2 Manual Rust Removal

Manual rust removal shall be allowed for welded zones and for touching up installed components.

3.3 Cleaning

Removal of impurity

	Impurity	Removal
a)	Dust, Loose deposits	Vacuum cleaning, brushing
b)	Adhesive deposits	Power brushing
c)	Oils, greasy impurities	Wet Blasting, Use of Detergent Additives by agreement
d)	Salt deposits	Rinsing
e)	Markings (eg felt up pen)	Organic solvents to manufacturer's specifications eg Trichloro trifluoro ethane and solvents containing acetone (renew solvent and rag frequently)

3.4 Acid Pickling

Prior to galvanizing the surface preparation shall be done by acid pickling as per SSPC-SP-08.

4.0 PROCESSING

4.1 General
Application Conditions

The primer shall be applied to properly prepared surfaces only. The specifications of the coating material manufacturers shall be observed. The minimum temperature shall be + 5^0C and the relative humidity shall not exceed 80%. The temperature of the work piece shall be at least 3^0C above dew point.

4.2 Application Procedure

The primer shall be applied by means of brush or by spary. The top coats shall be applied by means of brush, roller or spray.

At points where coating application is interrupted, the individual layers shall be adequately stepped to ensure proper layer sequence when coating operations are resumed.

4.3 Touching Up

Before each layer is applied, previous coating shall be touched up where necessary by way of rust removal and cleaning according coating manufacturers specification. The final top shall be reapplies completely.

4.4 Uncoated Surfaces

Moving parts of machines (e.g stems, shafts, sliding and locating bearings), nameplates, instruments and sealing surface shall not be coated. Welds shall be left free of coating upto a distance of 30 mm on each side of the weld edge until erection and weld examinations, if any, have been completed.

4.5 Bond Strength

The pill off stress determined using the pull off test method for adhesion shall not be less than 1.5 N/mm2, according to ISO 4624.

5.0 SURFACE CONDITIONS OF COATING SURFACES

The coating surface shall have a uniform film thickness, shade and gloss and shall be free from inclusions, sags and wrinkles.

6.0 COATING SYSTEMS

6.1 General Requirements for Coating Systems

Coating materials according to SSPC, BS 5493 or DIN 55 928 shall be used. Intermediate coats are to be pigmented with micaceous iron oxide. The materials shall be matched with each other so that they are compatible. Coatings deviating this

specification shall be subject to approval. Standards of surface preparation and painting shall give a time to first maintenance of 10 years.

The colour and gloss of top coats shall be in accordance with sub clause suggested colour codes for painting (Sub Clause 6.8)

6.2 Standard Coating System (External Coatings)

(a) Steel Surfaces

(i) All steel structures shall receive two primer coats and two sandwich coat of MIO Epoxy paint and one finish coat of painting. First coat of primer shall be given in shop after fabrication before dispatch to erection site after surface preparation as described below. The second coat of primer shall be applied after erection and final alignment of the erected structures. Two intermediate coats and one finished coat shall also be applied after erection.

(ii) Steel surface which is to be painted shall be cleaned of dust and grease and the heavier layers of rust shall be removed by chipping prior to actual surface preparation. The surface shall be abrasive blasted as explained in clause 3.1 to Sa 2½ finish as per SIS05-5900. Primer paint shall be Zinc Silicate of approved brand. Dry film thickness of each primer shall be 60 microns.

(iii) Two intermediate MIO Epoxy paint, and one top polyurethane coating of approved brand shall be applied. Dry film thickness of each intermediate coat shall be 90 microns and top polyurethane coating shall be 30 microns. The under coat and finish coat shall be of different tint to distinguish the same from finish paint. The total dry film thickness shall be 330 microns. All paints shall be of approved brand and shade as per owner's requirement.

(iv) Joints to be site welded shall have weldable primer applied within 100 mm of welding zone. Similarly where friction grip fasteners are to be used removable anti corrosive coating shall be provided. On completion of the joint the surfaces shall receive the paint as specified.

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

(b) Gratings and Step Threads

(i) Surface Preparation

Gratings and step threads shall be cleared by acid pickling as per SSPC-SP-08

(ii) Hot Dip galvanizing

The hot dip galvanizing shall be done as per IS 2629. The average mass of coating shall be 610 gm/m2.

(iii) Post Treatment

Immediately after galvanizing post treatment such as chromating shall be applied to retard white rust attack.

(iv) Touch up mechanical damages

The repair of damages coatings shall be done as per the recommended practice ASTM A780.

6.3 Painting of Indoor components such as valves, pumps, motors, electrical parts, tanks etc.

At Works

Surface Preparation

Blasting according to SIS 055900 grade Sa 2½. Depending on production flow, a weldable, inorganic ethyl zinc silicate shop primer of minimum dry film thickness 25 µm may be used.

Prime Coat

Two (2) layers of Zinc phosphate epoxy, total dry fim thickness 75µm.

At Site

Thorough cleaning to remove oil, grease, dirt and any other contaminants. Derusting of all mechanical damages according to SIS 055900 Grade ST3. Touch up with dry film thickness 50 µm.

Finish Coat

Application of two (2) finishing coats of chlorinated rubber paint in approved shades at 30-40 microns DFT each coat in approved shades.

Remarks

Equipment coated with a standard application system can be accepted if the quality of this application system is corresponding with the quality of the above mentioned system.

6.4 Painting of Outdoor equipment (external surfaces) such as piping, valves, pumps, motors, electrical parts, tanks etc.

Weather exposure, weather resistance, temperature upto 120^0C as per clause 6.1 & 6.3. However

Surface Preparation

Blasting according to SIS 055900 grade Sa 2½. Depending on production flow, a weldable, inorganic ethyl zinc silicate shop primer of minimum dry film thickness 15-25 µm may be used.

Prime Coat

Two (2) layers of Zinc phosphate epoxy, total dry fim thickness 75µm.

Intermediate Coat

One (1) layer 2 pack high build epoxy polyamide MIO, DFT 100µm.

Finish Coat

Application of two (2) finishing coats of chlorinated rubber paint in approved shades at 50 microns DFT each coat in approved shades.

6.5 Special Coating

(a) Parts exposed to temperatures above 120^{0}C, upto 200^{0}C, not insulated

(i) At Works

Surface Preparation

Blasting according to SIS 055900 grade Sa 2½ and ISO 8501-1:1958. Depending on production flow, a weldable, inorganic ethyl zinc silicate shop primer of minimum dry film thickness 15-25 µm may be used.

Prime Coat

Inorganic ethyl Zinc silicate, total dry fim thickness 75µm.

(ii) At Site

Pretreatment

Dersuting of all mechanical damages, according to ISO 8501-1:1989, grade St 3 touch up with 1 pack inorganic ethyl zinc silicate, dry film thickness 50µm.

Intermediate Coat

I pack silicon acrylic dry film thickness 35 µm.

Final Coat

1 pack silicon acrylic, dry film thickness as 35µm.
Total system dry film thickness 145µm.
Final coat according to colour code.

(b) **Parts exposed to temperatures above 200^{0}C, upto 400^{0}C, not insulated**

(i) At Works

Surface Preparation

Blasting according to ISO 8501-1:1958 grade Sa-2½. Depending on production flow, a weldable, inorganic ethyl zinc silicate shop primer of minimum dry film thickness 15-25 µm may be used.

Prime Coat

Inorganic ethyl Zinc silicate, total dry film thickness 75µm.

(ii) At Site

Pretreatment

Derusting of all mechanical damages, according to standard Sa 2½ to ISO 8501-1:1988. Touch up with coating system according to manufacturer's recommendations.

(c) **Insulated parts continuously exposed to condensing water or parts exposed to temperatures**

For parts that are provided with insulation on site.

(i) **Insulated parts exposed to condensing water**

At Works

Surface Preparation

Blasting according to Sa 2½ to ISO 8501-1:1988. Depending on production flow, a weldable, inorganic ethyl zinc silicate shop primer of minimum dry film thickness 15-25 µm shall be used.

Prime Coat

Inorganic ethyl Zinc silicate, total dry film thickness 75µm

(ii) **Insulated parts exposed to temperatures**

Parts exposed to temperatures upto < 400^{0}C

Surface Preparation

Blasting according to Sa 2½ to ISO 8501-1:1988. Depending on production flow, a weldable, inorganic ethyl zinc silicate shop primer of minimum dry film thickness 15-25 µm shall be used.

Parts exposed to temperature above 400^0C at works (Steam pipes, pressure tubes and parts for the HRSG, such as heating surfaces, heaters and superheaters, reheaters etc)

Temporary Primer

Varnish

(d) **Intermittent exposure due to condensing water/ chemicals (Indoors)**

(i) At Works

Surface Preparation

Blasting according to Sa 2½ and ISO 8501-1:1988. Depending on production flow, a weldable, inorganic ethyl zinc silicate shop primer of minimum dry film thickness 15-25 µm may be used.

Prime Coat

Two layers of Zinc phosphate primer, total dry fim thickness 75µm.

(ii) At Site

Pretreatment

Dersuting of all mechanical damages, according to standard Sa3 to ISO 8501-1:1988, touch up with 2 pack high build epoxy with volume solid content of more than 85%, 75µm.

Intermediate Coat

2 pack high build epoxy, dry film thickness 80 µm.

Finish Coat

2 pack silicon acrylic, dry film thickness of 50µm.

Total system dry film thickness 205µm.

When exposed o weathering, weather resistance finish coat shall be applied.

(e) **Water Exposure**

(i) At Site/ Works

Pretreatment

Removal of all welding pearls.

Blasting according to Sa 3 to ISO 8501-1:1988

Coat
4 coats 2 pack coal tar epoxy, dry film thickness 125 µm each.

Total system dry film thickness 500µm
Touch up after erection as required.

6.6 Painting of Pipes

6.6.1 Buried Piping

Internal surfaces

(i) Surface cleaning by sand blasting.

(ii) Two (2) coats of epoxy primer coats. The minimum DFT of each coat shall be 35 microns.

(iii) Finish coat-Two (2) coats of high build epoxy paint. The minimum DFT of each coat shall be 35 microns.

The total dry film thickness of 150 microns.

Note : All steel pipes carrying sea water shall be internally coated with corrocoat/ polyurea coating having thickness 1500 DFT.

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

External surfaces

(i) Surface cleaning by Sand Blasting.

(ii) Coal tar primer compatible with coal tar enamel grade. The number of coats shall be two with a DFT of 35 microns each.

(iii) Coal tar enamel shall be applied. A single spiral inner wrap of glass fibre tissues shall be applied overlapping at least 25 mm ensuring impregnation of glass fibre tissues in the first coat. The second coat of enamel and second outer wrap of glass fibre felt, Type – I to IS: 7193-1974 will be applied in the same way confirming to Table – 10 of IS – 10221 – 1982.

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

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

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

6.6.2 Overground Piping

Internal surfaces

(i) Surface cleaning by sand blasting.

(ii) Two (2) coats of epoxy primer coats. The minimum DFT of each coat shall be 35 microns.

(iii) Finish coat-Two (2) coats of high build epoxy paint. The minimum DFT of each coat shall be 35 microns.

The total dry film thickness of 150 microns.

Note : All steel pipes carrying sea water shall be internally coated with corrocoat/ polyurea coating having thickness 1500 DFT.

External surfaces

(i) Surface cleaning by Sand Blasting.

(ii) Two (2) coats of epoxy primer coats. The minimum DFT of each coat shall be 35 microns.

(iii) Finish coat-Two (2) coats of high build epoxy paint. The minimum DFT of each coat shall be 35 microns.

6.7 Internal Coatings

6.7.1 Tanks (Internal surfaces) as specified in relevant sections of specification

Industrial deionised, demineralised and potable water upto 60^0C pH range 4.5-9.5

Blasting according to Sa 2½ and ISO 8501-1:1988.

Prime Coat

Two layers of Zinc phosphate epoxy primer, total dry fim thickness >75µm.

Pretreatment

Dersuting of all mechanical damages, according to standard Sa3 to ISO 8501-1:1988, touch up with 2 pack high build epoxy with volume solid content of more than 85%, 75µm.

Intermediate Coat

2 pack high build epoxy, dry film thickness 80 µm.

Finish Coat

2 pack silicon acrylic, dry film thickness of 150µm per coat.

In case of service or potable water tanks, the coating material selected shall not taint the water. The paint system shall confirm to regulations issued by Food & drug administration/ National Public Health service/ AWWA/ OSHA and comply with applicable laws, regulations, ordinances etc. of the local authority, state or the nation pertains to work.

QA/ QC Procedure including pinhole inspection, shall be submitted for approval by Owner/ Owner's representative.

6.6.2 Rubber Lining of Pipes, Valves and Tanks for DM Water

Pretreatment

Blasting according to Sa 2½ and ISO 8501-1:1988

Rubber Lining

Hard rubber 5 mm for DM water applications as IS – 4682

6.7 Painting for Electrical items

6.7.1 All the steel work shall be thoroughly cleaned of rust, scale, oil, grease, dirt and swarf by pickling, emulsion cleaning etc. The sheet steel shall be phosphate/ oven dried and then painted with two coats of zinc rich primer paint. After application of the primer, two coats of finishing epoxy paint shall be applied. The colour of the finishing coats inside shall be glossy white and exterior of the treated sheet steel shall be shade 631 of IS-5/ RAL 7032 for all switchboard/ MCC/ Distribution boards, control panels etc.

6.7.2 All electrical equipment shall be given tropical and fungicidal treatment and outdoor equipment shall be provided with rain hood to prevent entry of rain water into the equipment.

6.7.3 Painting of I & C equipment : Epoxy coating required for all I & C equipment.

6.8 SUGGESTED COLOUR CODES FOR PAINTING

SL. NO.	ITEM/SERVICE	COLOUR	IS-5	COLOUR (BAND)	IS-5
1.	Structures, platforms, galleries, ladders and handrails	Dark Admirality Grey	632	-	-
2.	Boiler casing, ducting	Nut Brown	413	-	-

SL. NO.	ITEM/SERVICE	COLOUR	IS-5	COLOUR (BAND)	IS-5
3.	Crane				
3.1	Crane structure	Golden Yellow	356	Black	-
3.2	Trolley & hook	Crimson	540	-	-
4.	Fans, pumps, motors, compressors	Light Grey	631	-	-
5.	Tanks (without insulation and cladding)				
5.1	Outdoor	Aluminium	-	-	-
5.2	Indoor	Light grey	631	-	-
6.	Vessels & all other proprietary equipment (without insulation & cladding)	Light grey	631	-	-
7.	Switchgear	Light grey (Powder coated)		-	-
8.	Control & relay panels	Light grey (Powder coated)	631/70 78 of IS 1650	-	-
9.	Turbines	Light Grey	631	-	-
10.	Generators & Exciter	Light Grey	631	-	-
11.	Transformers	Aluminum	-	-	-
12.	Machinery guards	Signal red	537	-	-
13.	Piping (without insulation and cladding)				
13.1	Water System				
a	Boiler feed	Sea Green	217	-	-

SL. NO.	ITEM/SERVICE	COLOUR	IS-5	COLOUR (BAND)	IS-5
b	Condenstae	Sea Green	217	Light Brown	410
c	DM Water	Sea Green	217	Light Orange	557
d	Soft Water	Sea Green	217	French Blue	166
e	Bearing Cooling Water	Sea Green	217	French Blue	166
f	Potable & filtered Water	Sea Green	217	French Blue	166
g	Service and clarified water	Sea Green	217	French Blue	166
h	Cooling water	Sea Green	217	French Blue	166
I	Sea Water	Sea Green	217	White	-
14.	Ash Transmitting Vessels and pipe lines	Aluminium	-	-	
15.	**Air System**				
15.1	Station air	Sky blue	101	-	-
15.2	Control air	Sky blue	101	White	-
16.	**Oil system**				
16.1	Fuel oil	Light brown	410	French	166
16.2	Light oil (HSD)	Light Brown	410	Brilliant green	221
16.3	Lubricating oil	Light brown	410	Light grey	631
16.4	Transformer oil	Light brown	410	Light orange	557
17.	Gas System				
17.1	Carbon dioxide	Canary yellow	309	Light grey	631
17.2	Hydrogen	Canary yellow	309	Signal red	537
18.	Fire services	Fire red	536	-	-
19.	Effluent pipes	Black	-	-	-
20.	Vacuum pipes	Sky blue	101	Black	-

Notes :

1. This colour code basically refers to IS:2379 for piping with necessary modifications

2. Where band colour is specified, same shall be provided at 30 meter intervals on long uninterrupted lines and also adjacent to valves and junctions.

   Bidder shall furnish his painting specification to suit corrosive atmosphere of coastal area along with the bid. The specification shall in general be in line with the above requirements.

SECTION – C2

(SPECIFIC TECHNICAL REQUIREMENTS FOR ELECTRICAL)

ELECTRICAL EQUIPMENT SPECIFICATION

TECHNICAL SPECIFICATION

FOR

(ELECTRICAL PORTION)

1.0 EQUIPMENT & SERVICES TO BE PROVIDED BY BIDDER:

a) Services and equipment as per "Electrical Scope between BHEL and Vendor".
b) Any item/work either supply of 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 same shall be provided by the bidder without any extra charge.
c) Supply of mandatory spares as specified in the specifications of mechanical equipments.
d) Electrical load requirement for Condensate Poilishing Unit
e) All equipment shall be suitable for the power supply fault levels and other climatic conditions mentioned in the enclosed project information.
f) Bidder to furnish list of makes for each equipment at contract stage, which shall be subject to customer/BHEL approval without any commercial and delivery implications to BHEL
g) Various drawings, data sheets as per required format, Quality plans, calculations, test reports, test certificates, operation and maintenance manuals etc shall be furnished as specified at contract stage. All documents shall be subject to customer/BHEL approval without any commercial implication to BHEL.
h) Motor shall meet minimum requirement of motor specification.
i) Vendor to clearly indicate equipment locations and local routing lengths in their cable listing furnished to BHEL.
j) Cable BOQ worked out based on routing of cable listing provided by the vendor for " both end equipment in vendor's scope"shall be binding to the vendor with +10 % margin to take care of slight variation in routing length & wastages.

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

Refer "Electrical Scope between BHEL and Vendor".

3.0 DOCUMENTS TO BE SUBMITTED ALONG WITH BID

3.1 The electrical specification without any deviation from the technical/quality assurance requirements stipulated shall be deemed to be complied by the bidder in case bidder furnishes the overall compliance of package technical specification in the form of compliance certificate.

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

4.0 List of enclosures :

a) Electrical scope between BHEL & vendor.
b) Electrical Load data format.
c) BHEL cable listing formt.

ELECTRICAL LOAD FORMAT

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

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

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

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

	LOAD DATA (ELECTRICAL)	JOB NO.	412	ORIGINATING AGENCY		PEM (ELECTRICAL)
		PROJECT TITLE	2X660 MW ENNORE SEZ STPP	NAME		DATA FILLED UP ON
		SYSTEM	ELECTRO CHLORINATION PLANT	SIGN.		DATA ENTERED ON
		DEPTT. / SECTION	ELECTRICAL	SHEET 1 OF 1	REV. 00	DE'S SIGN. & DATE

ELECTRICAL SCOPE FOR VENDOR AND BHEL

ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR (FOR EPC PROJECTS)

PACKAGES: ELECTRO CHLORINATION PLANT
SCOPE OF VENDOR: SUPPLY, ERECTION & COMMISSIONING OF VENDOR'S EQUIPMENT
PROJECT: 2X660 MW ENNORE SEZ STPP, CHENNAI

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

ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR (FOR EPC PROJECTS)

PACKAGES: ELECTRO CHLORINATION PLANT
SCOPE OF VENDOR: SUPPLY, ERECTION & COMMISSIONING OF VENDOR'S EQUIPMENT
PROJECT: 2X660 MW ENNORE SEZ STPP, CHENNAI

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

NOTES:

1. Make of all electrical equipment/ items supplied shall be reputed make & shall be subject to approval of BHEL/customer after award of contract.
2. All QPs shall be subject to approval of BHEL/customer after award of contract without any commercial implication.
3. In case the requirement of Junction Box arises on account of Power Cable size mis-match due to vendor engineering at later stage, vendor shall supply the Junction Box for suitable termination.
4. Vendor shall indicate location of Electronic Earth pit in their Civil assignment drawing.

SECTION – C3

(SPECIFIC TECHNICAL REQUIREMENTS FOR C&I)

1. SCOPE OF SUPPLY

Instrumentation (Minimum) as shown in the **P&ID (Ref. No. PE-V11-412-174-A101),** however any additional instrumentation required to complete the system will be in bidder's scope. All required piping, tubing and wiring for instrumentation including fittings, support and other accessories.

- One number PLC based control panel (kept in the Electro Chlorination Plant Building) for the control of complete Electro Chlorination Plant, UPS, BATTERY, PRINTER, SCANNER, COMPUTER, FURNITURE FOR PLC ROOM.
- Level transmitters, Level Switches, level Gauges as per Flow Diagram.
- Pressure transmitters, Pressure Switches, Pressure Gauges as per Flow Diagram.
- Flow transmitters and Flow switch as per Flow Diagram.
- Hydrogen Detector 2 numbers.
- Chlorine analyzer-1 No.
- UPS and Battery as required.
- Differential Pressure Transmitter and Differential pressure Gauge as per Flow Diagram
- Any other instrument not listed but required to complete the system.

2.0 CONTROL PHILOSOPHY (PROCESS INSTRUMENTATION, CONTROL AND INTERLOCKS) [FOR DETAILS REFER : PE-V11-412-174-A105 (CONTROL PHILOSOPHY):

A) Control for Electro Chlorination plant for CW System and PT Plant:

The electro chlorination plant shall be controlled from PLC based system (with Redundant Hot standby processor) shall be provided/located at Control room of electro Chlorination plant building.

The control system shall be fully automatic control. Fully automatic control shall mean that sending a start signal shall initiate a start sequence within the control system to start pumps, motors, Rectifier units and Electrolyser.

The control system shall monitor safety interlocks for flow, level control etc. and allow the necessary time delay to establish system equilibrium before moving to the next step in the start sequence.

On/Off/Trip status of all motors shall be indicated in LCP.

Open and Close limit switch feed backs of valves are to be connected to PLC for remote viewing and for interlocks and protection.

All drive motors shall be provided with arrangement of local starting and stopping. Local starting shall be possible through remote/local selector switch in control panel (LCP).

The unit will have Flow meter with manual throttling valve to ensure the required Sea Water is fed to the unit.

a) The following trip conditions are incorporated toward automatic shutdown of the package:
   i) High voltage/current/temperature from the Transformer-Rectifier.
   ii) Loss of power, Transformer trip, Rectifier Failure.
   iii) Both the air dilution Blowers trip.
   iv) High alarm at Hydrogen Detector.
   v) Both NaOCl storage tanks level high.

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 OWS.

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

All conditions used for tripping the Transformer Rectifier, Electrolyser and pumps etc., shall be provided with pre-trip annunciation in the remote control desk/panel.

Operation of the pumps, Transformer Rectifier, Electrolyser and other equipment shall be performed from local control panel / OWS to be located at the Electro Chlorination Building (air conditioned area). The Control panel shall house PLC Hardware,

Alarm Annunciator driven by PLC programmed sequence, Indicators, Indication lamps, Switches, local / remote selector switch, Start / Stop push buttons, Auxiliary Relays, Motor current meter etc.. Selector switch shall be provided in the control panel to achieve three positions for “Base duty”, “Stand by duty” and “Stop”.

The latest proven PLC system shall be provided. PLC should be sourced from original manufacturers; PLC from system house shall not be acceptable. PLC system shall be complete with hot standby redundant CPU of word length of 32bits minimum, Input / Output modules, dual serial link interface module for connecting Input / Output Modules, dual Communication Processors, dual Memory modules and redundant Power supply units. Power supply unit shall be redundant for each CPU & I/O rack. PLC system will be interfaced with DDCMIS through OPC dual redundant communication interfacing (to be provided at PLC & DDCMIS end) for important process parameters. PLC shall confirm to IEC – 61131.

PLC with one no. OWS & one no. Operating cum engineering station [24” sized (Industrial type) LED monitor] and with Redundant hot standby processor with one no. A4 size B/W LJP & 1 No A3 sized DMP. Back up Control desk with colour Mimic, H.W. Annunciator, P.B. parameters indicators and indication Lamps shall also be provided.

PLC shall be provided with necessary redundant ports & complete hardware for Auto time synchronization from Master clock time.

UPS shall be Parallel Redundant UPS with battery & ACDB.

Each communication Network shall be commercial grade and shall be provided with commercial grade managed type Ethernet switches, external surge protection system/devices and industrial firewall. Commercial grade managed type Ethernet switches shall be provided with in built diagnostic features, 20% spare ports & in built redundant power supply. BIDDER shall provide only commercial grade network components/switches.
However in case of availability of industrial grade PCs from reputed vendors at the time of execution stage the same shall be provided.

Valve end position (Open & Close) shall be monitored for the manual critical valves, wherever provided.

Specifications for Operator Station, Engineering Work Stations:

Each operating station & Engineering work stations and any other work stations/PC envisaged in plant shall meet following minimum requirements & as per latest trends at the time of supply:
- On board Intel – Xeon quad core, 3.46 GHz processor with 1066 MHz bus with Hyper threading or higher.
- 4GB DDR3 RAM (min.)
- 1 x 1000 GB IDE Hard Disc Drive of 7200 RPM or higher
- 1024 MB Graphic Accelerator
- System chipset: Intel Express
- 2 x RS – 232 ports
- 1 x parallel port
- 4 nos. USB ports. (2 nos. on front side)
- 1 x 52X DVD/CD Read Drive
- 16 X DVD R/W Drive
- 2 x Ethernet (10 / 100 / 1000MB) cards (Industrial Grade)
- UXGA graphics and monitor 1920 X 1080, 256 colours with MRPII compliant, viewing angle 178° vertical & Horizontal and fastest response time.
- 1 x windows XP/7 Professional or latest & proven version of Windows OS professional with Multimedia
- Ethernet adapter
- Third party operating system, graphical users interface and software, if required.
- 2 nos. graphic output crads minimum
-Optical mouse
- Sound card
- Internal speakers
- Wireless internet & Blue tooth Interface
- Redundant power supply (In built)
- General MS Windows latest, MS-Office Professional, Adobe Acrobat, anti-virus McAfee or equivalent, AutoCAD etc.
- Application engineering & HMI software - to suit project Specific requirement
- All OWS shall be interchangeable

Makes of OWS/EWS/PC’s are DELL, HPCOMPAQ, NEC & IBM.

SPECIFICATION FOR PRINTERS:

Line Impact Heavy Duty Dot Matrix Printers
All printers shall be low noise (less than 60dB) type with a minimum of 136 columns. Printing speed shall be a minimum of 300 characters per second. Since the control room printers are high-speed printers, the system shall output to these printers at the rate of 1000 lines of printout per minute as a minimum. This rate shall be independent of the number of printers in simultaneous operation. Style of printing available shall be indicated by the Bidder. The printers shall have graphic capability and any OPERATING STATION display may be printed on the printer. The printing shall be bi-directional and in two colours black and red for sequence of event recording. Paper input capacity shall be with continuous paper feed.
Printers shall accept and print all ASCII characters via an E.I.A. RS-232 C or twenty milliamp current loop interface. Parity checking shall be utilized.
All printers mounted shall be provided with a separate printer enclosure each. The enclosures shall be designed to permit full enclosure of the printers at a convenient level. Plexiglas windows shall be used to provide visual inspection of the printers and ease of reading.
Printer enclosures shall be designed to protect the printers from accidental external contact and each should be removable from hinges at the back and shall be provided with a lock at the front.
If one of the printers fails to operate, it's functions shall automatically be transferred to the other printer. Failure of the printer shall be indicated on all OPERATING STATION's. Printer shall be offered and supplied from reputed manufacturer with latest proven technology. 5 Rims of papers shall be provided by bidder for each printer provided with subject plant.

Laser Jet printer (B & W)
Printing Speed 30 ppm (min.)
Resolution 1200 X 1200 dpi
Memory 128 MB (min.)
External Port 1 no. USB 2.0 port, and TCP/IP 10/100
Ethernet, Blue tooth interface
Duty Cycle 15,000 pages per month
Pages size A4, A3, and Transparency etc. with automatic duplex printing facility. Paper tray – 2

Makes of printers are HP, Canon, Fuji Xerox, & Epson.

B) Control for Electro Chlorination at Sea Water Intake [Located near Electro chlorination plant building for 2x600 MW NCTPS]:

Control of sea water intake hypo chlorite dosing system shall be envisaged in standalone DDCMIS panel placed in sea water intake pump house control room to start/stop the pump w.r.t duty and Hypo Chlorite Storage Tank level (w.r.t available suction pressure of pump). Monitoring and control of chlorine dosing to sea water intake along with a chlorine analyser shall be provided.

On/Off/Trip status of all motors shall be indicated in DDCMIS Panel.

All drive motors shall be provided with arrangement of local starting and stopping.

The following trip conditions are incorporated toward automatic trip of the pump:

i. Pump Suction pressure low.

Junction Boxes details used in Electro Chlorination plant:

i) Type : Flame proof/weather proof
ii) Enclosure: IP-65/Explosion/Flame Proof as per area classification.
iii) Material : FRP with protective Coating
iv) Cable entry : Bottom or Side
v) Cable glands : Double compression type – Nickel plated
vi) Brass with PVC hoods.
vii) Mounting : Indoor/Outdoor
viii) No. of terminals: As required with standardization with 20% spare of each size & type.
ix) Terminals : Phoenix/Wago (screw less cage clamp type spring loaded)
x) Grounding : Two terminals for body and shield ground
xi) Door: Hinged, lockable type.
xii) Suitable mounting clamps and other accessories shall be provided.
xiii) 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.
xiv) M6 Ni plated Brass earthing stud shall be provided.

DATA SHEET-A

SL NO.	PARTICULARS	PARAMETERS/DETAILS
1.0	**SEA WATER STRAINERS**	
a.	Number	2 Nos (1W+1S/Under Cleaning).
b.	Type	Self-cleaning type (Auto Backwash Type).
c.	Service	Sea water application
d.	Capacity (each)	As per system requirement.
e.	Mesh size of screen	100 micron
f.	Material of Construction	Body and Screen-Duplex stainless steels
2.0	**SEA WATER BOOSTER PUMPS**	
a.	Number	2 Nos (1W+1S).
b.	Type	Horizontal-Centrifugal with open impeller.
c.	Service	Sea water application
d.	Location	Indoor.
e.	Capacity (each) and Head (each).	As per system requirement+10% margin
f.	Suction condition	Flooded
g.	Lubrication type	Self-lubricated
h.	Head	As required.
i.	Material of Construction	Casing – Duplex SS 2205 UNS S31803. Impeller – Duplex SS 2205 UNS S31803. Shaft – Duplex SS 2205 UNS S31803. Shaft Sleeves- Duplex SS 2205 UNS S31803. Base Plate-MS with Epoxy Paint. Fastener- SS 316L.
3.0	**ELECTROLYTIC GENERATOR (ELECTROLYSER)** **[Already Supplied by M/s DeNora, Shall be free issue by BHEL to bidder]**	
a.	Number of Electrolyser	2 Nos (1W+1S).
b.	Active chlorine production rate (each)	200 Kg/Hr
c.	Type	Tubular shells arranged electrically in series
d.	Range of generation control	10 to 100 %.
e.	Strength of Hypo to be generated	1500 ppm to 2000 ppm.
f.	Cathode material	Titanium
g.	Anode material	Titanium with Mixed metal oxide.
h.	Shell	PVC lined with FRP
i.	Life of electrode	5 years
j.	Gasket	Titanium Impregnated Ebonite or equivalent.
k.	Design pressure	Shall be 1.5 times of shutoff head of booster pump.
4.0	**TRANSFORMER RECTIFIER**	
a.	Quantity	2 Nos (1 W+1S).
b.	Type	Transformer- Cast resin dry type. Rectifier- Silicon controlled diode type.
c.	Capacity	As per system requirement.
d.	Location	Indoor.
e.	Cooling	Forced Air cooled
f.	Method of Control	Thyristor
g.	Output DC current and voltage	As per system requirement.
5.0	**HYPOCHLORITE STORAGE CUM DEGASSING TANK** **[Already Supplied by M/s DeNora, Shall be free issue by BHEL to bidder]**	
a.	Quantity	2 Nos (1W+1S)
b.	Capacity	To store required NaOCl for one shock dose for Unit #1 in one tank and Unit # 2 for other tank or 70 CuM (effective) each.
c.	Type	Cylindrical vertical
d.	MOC	MS-FRP.
e.	Accessories	As per P&ID. Manhole, Access ladder and platform shall be provided.

6.0	**HYPOCHLORITE STORAGE CUM DEGASSING TANK FOR SEA WATER INTAKE (LOCATED AT 2X600 MW NCTPS). [Already Supplied by M/s DeNora, Shall be free issue by BHEL to bidder]**	
a.	Quantity	1 No Tank (Loose supply)
b.	Capacity	15 CuM
c.	Type	Cylindrical vertical
d.	MOC	MS-FRP.
e.	Accessories	As per P&ID. Manhole, Access ladder and platform shall be provided.
7.0	**AIR DILUTION BLOWERS**	
a.	Quantity (per tank)	2 Nos (1W+1S).
b.	Capacity	Vendor design specific.
c.	Location	Outdoor.
d.	Type	Horizontal centrifugal
e.	Motor rating	Vendor design specific
f.	MOC	Casing, shaft and Impeller-SS 316.
8.0	**HYPOCHLORITE DOSING PUMPS FOR CW FOREBAY**	
a.	Quantity	2 Nos (1W+1S) for Continuous dosing. 3 Nos (2W+1S) for Shock dosing.
b.	Type	Horizontal centrifugal with closed impeller.
c.	Capacity (each) & Head (each)	120 m^3/hr and as per requirement+12 Meter static head.
d.	Location	Indoor.
e.	Lubrication type	Self-lubricated
f.	Suction condition	Flooded.
g.	MOC	Casing – ASTM B367 Ti Grade C3. Impeller – ASTM B367 Ti Grade C3. Shaft – Duplex SS 2205 UNS S31803. Shaft Sleeves- ASTM B367 Ti Grade C3. Base Plate-MS with Epoxy Paint. Fastener- SS 316L.
9.0	**HYPOCHLORITE DOSING PUMPS FOR PT PLANT STILLING CHAMBER**	
a.	Quantity	2 Nos (1W+1S)
b.	Type	Horizontal centrifugal with closed impeller.
c.	Capacity (each) & Head (each)	8 m^3/hr and as per requirement+12 Meter static head..
d.	Location	Indoor
e.	Lubrication type	Self-lubricated
f.	Suction condition	Flooded.
g.	MOC	Casing – ASTM B367 Ti Grade C3. Impeller – ASTM B367 Ti Grade C3. Shaft – Duplex SS 2205 UNS S31803. Shaft Sleeves- ASTM B367 Ti Grade C3. Base Plate-MS with Epoxy Paint. Fastener- SS 316L.
10.0	**STRAINER FOR DOSING PUMP FOR CW FOREBAY AND PT PLANT**	
a.	Quantity	2 Nos (1W+1S).
b.	Type	Simplex Basket Strainer.
c.	Mesh size	500 micron.
d.	Capacity	220 m^3/hr.
e.	MOC	Body and Mesh-Duplex Stainless Steel.
f.	Location	Indoor.
11.0	**ACID CLEANING TANK FOR ELECTROLYSER**	
a.	Quantity	One (1) No.
b.	Capacity	1000 Ltrs or one electrolyzer cleaning requirement with 5% HCl whichever is higher.
c.	Type	Cylindrical vertical
d.	MOC	FRP/HDPE.
e.	Location	Outdoor.

12.0	**ACID CLEANING PUMPS FOR ELECTROLYSER**	
a.	Quantity	2 Nos (1W+1S).
b.	Capacity	Shall be provided to meet the requirement +10% margin.
c.	Type	Horizontal Centrifugal.
d.	Location	Outdoor.
e.	Suction condition	Flooded.
f.	Lubrication type	Self-lubricated
g.	Motor rating	Vendor Design specific.
h.	MOC	Casing, shaft and Impeller-PP.
i.	Strainer	2X100% (MOC: Body and Mesh-PP)
13.0	**BULK ACID STORAGE TANK** **[Already Supplied by M/s DeNora, Shall be free issue by BHEL to bidder]**	
a.	Quantity	One (1) No.
b.	Capacity	20 CuM or 15 days requirement; whichever is higher.
c.	Type	Cylindrical Horizontal.
d.	MOC	FRP (Minimum 12 mm thick)
e.	Accessories	As per P&ID. Access ladder and platform shall be provided.
f.	Location	Outdoor.
14.0	**ACID TRANSFER PUMP**	
a.	Quantity	2 Nos (1W+1S).
b.	Capacity	10 Cum/Hr.
c.	Type	Centrifugal.
d.	Motor rating	Vendor Design specific.
e.	MOC	Casing and Impeller-PP, Shaft-SS 316L.
f.	Location	Outdoor.
g.	Lubrication type	Self-lubricated
15.0	**NEUTRALIZATION PIT (N-PIT)**	
a.	Quantity	One number.
b.	Capacity	20 CuM.
c.	MOC	RCC with acid alkali protection.
d.	NaOH tank (for neutralization)	1 No @ 500 Ltrs of HDPE.
16.0	**N-PIT DEWATERING PUMP**	
a.	Quantity	Two (2) nos. (1W+1S).
b.	Capacity and head	2 Cum/Hr and as per requirement+12 Meter static head.
c.	Type	Centrifugal.
d.	Motor rating	Vendor Design specific.
e.	MOC	Casing and Impeller-PP.
f.	Lubrication type	Self-lubricated
17.0	**LIFTING ARRANGEMENT FOR MAINTANANCE PURPOSE**	
a.	Chain pulley block	Two number
b.	Capacity	2 Ton (min)
c.	Purpose	For lifting Blowers and pumps
d.	EOT Crane	One number
e.	Capacity	3 Ton (min)
f.	Purpose	For lifting electrolyzer
18.0	**HYPOCHLORITE DOSING PUMPS FOR SEA WATER INTAKE (LOCATED AT 2X600 MW NCTPS)**	
a.	Quantity	2 Nos (1W+1S)
b.	Type	Horizontal centrifugal with closed impeller.
c.	Capacity (each) & Head (each)	12 m^3/hr and as per requirement+12 Meter static head.
d.	Location	Outdoor (Under canopy) [at 2x600 MW NCTPS].
e.	Lubrication type	Self-water lubricated.
f.	Suction condition	Flooded.
g.	MOC	Casing – ASTM B367 Ti Grade C3. Impeller – ASTM B367 Ti Grade C3. Shaft – Duplex SS 2205 UNS S31803. Shaft Sleeves- ASTM B367 Ti Grade C3.

		Base Plate-MS with Epoxy Paint. Fastener- SS 316L.
h.	Strainer	'Y' Type, 1 no per each pump, MOC: CPVC
19.0	**PIPES AND VALVES**	
a.	MOC	CPVC SCH-80 (except service water line. Service water line shall be of CS as per IS 1239 H and for Potable water shall be as per IS 1239 H with galvanized as per IS 4736).
b.	Type	As per Flow diagram.
20.0	**SAFETY EQIPMENTS**	a) Two sets of safety equipment comprising PVC protection suits with hoods, rubber boots, face visors and thick PVC gauntlets shall also be provided. One number Hydrogen detector shall be installed in Electro chlorination Building and one number near the hypo chlorite storage tanks for safety. b) An eyewash and one safety shower shall be provided near acid handling area.

SECTION-D

(GENERAL TECHNICAL REQUIREMENT)

SECTION-D1

(GENERAL TECHNICAL REQUIREMENT FOR MECHANICAL)

1.0 SYSTEM 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 hostie 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. 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 electrolysis 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 recovered again in a tank. Hypochlorite dosing is done at forebay, travelling water screens and water box of the condenser.

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
$2Cl^{-1}$ - $2e^{-1}$ ---------- Cl_2	$2Na^{+1}$ + $2H_2O$ + $2e^{-1}$-------$2NaOH+H_2$
Combined reaction: $2NaCl + 2H_2O \rightarrow 2NaOCl + 2H_2$	

Sodium Hypochlorite (NaOCl) preparation and dosing system has been designed for **continuous dosing** of Hypochlorite solution (@1 ppm chlorine) for 22.5 hrs at common channel of CW Sump for both units and shock dosing of Hypochlorite Solution (@2 ppm chlorine) for 30 minutes in a shift of 8 hours at the working CW pump Pits for one unit only at a time. The dosing shall be done sequentially in the CW pump pits for one unit at a time, from Hypochlorite Storage cum Degassing tank.

Sodium Hypochlorite (NaOCl) also to be dosed at PT plant Stilling chamber on continuous basis @ 5 ppm.

For sea water intake the dosing rate is 1 ppm continuous and the required hypochlorite shall be taken from existing Electro Chlorination plant for 2X660 MW North Chennai TPS.

Commercial grade Sodium Hypochlorite (NaOCl) also to be dosed at potable water on continuous basis @ 2 ppm. The system for this (Tank, Pumps, etc) shall be located at PT Plant Chemical House. The dosing system shall be taken care by PT Plant package supplier separately.

Commercial grade Sodium Hypochlorite (NaOCl) also to be dosed at Sewage Treatment Plant on continuous basis @ 2 ppm. The system for this (Tank, Pumps, etc) shall be located at Sewage Treatment Plant. The dosing system shall be taken care by Sewage Treatment Plant package supplier separately.

NOTE: FOR DETAIL REFER "PE-V11-412-174-A102 (PROCESS SIZING CALCULATION)-REV-2".

SECTION-D2

(GENERAL TECHNICAL REQUIREMENT FOR ELECTRICAL)

CABLE SCHEDULE FORMAT

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

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

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

(A) SYSTEM VOLTAGE CODES:

(ac) A = 11KV, B = 6.6KV, C = 3.3KV, D = 415V, E = 240V, F = 110V

(dc) G = 220V, H = 110V, J = 48V, K = +24V, L = -24V

(B) CABLE VOLTAGE CODES:

A = 11KV (Power cables)

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

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

(C) CABLE CODES

PVC Copper

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

PVC Aluminium

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

XLPE Copper

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

XLPE Aluminium

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

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

CABLE SCHEDULE FORMAT **ANNEXURE III**

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

SECTION-D3

(GENERAL TECHNICAL REQUIREMENT FOR C&I)

GENERAL TECHNICAL REQUIREMENT

GENERAL REQUIREMENT

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 The customer specification attached as Specific Technical Requirement will supercede the Data sheets, if there is any mismatch.

Specific Technical Requirements (C&I):

The control of Electro chlorination Plant shall be through PLC based control system having hot redundant Central Processing Unit. 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 & A3 sized Dot Matrix 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.

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) 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 PLC Configuration Diagram.

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. All motorised valves of 200NB or more than 200NB size shall be provided with integral motorized bypass valves on all process lines.

6. All electrical actuators shall be convention al type of integral starter.

7. Components of instruments, control devices, accessories, piping etc. which contact with steam, condensate or boiler feed water shall be manufactured from copper free materials which do not react with media at operating parameters.

8. Valve end position (Open & Close) shall be monitored for the manual critical valves, wherever provided.

9. 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.

10. All the instruments/drives shall be terminated on JBs/Panels in field. JBs/Panels shall be in Bidder's scope.

11. Scope of Instrumentation cables (Screened Control Cables), Fibre Optic cable & Control cables shall be as per Electrical Cable scope matrix in Electrical portion of specification.

12. UPS for PLC & OWS shall be in bidder’s scope with 2X100% configuration. UPS shall have 2X100%, Ni-Cd type battery bank with 60 min back up.

13. Bidder shall provide Customer training on the proper application and maintenance on PLC Hardware & Software at Vendor’s work or at Ennore SEZ site. Duration of the training, number of persons & the topics to be covered shall be discussed & mutually agreed during contract finalization stage.

14. 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.

15. 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.

16. Bidder to comply with codes and standards as mentioned in the specification.

17. 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.

18. Bidder shall provide an unlimited warranty on all equipment and software for three years after the start of the warranty period, i.e. after satisfactory completion of initial operations. This warranty shall include repair, replacement or correction of identified software or hardware discrepancies at no cost to OWNER.

19. 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, the
recommended IDS/IPS should contain the following combined features. Any feature can be selected depending on whether it is to be configured as IPS or IDS.

20. All local gauges, transmitters and switches shall be mounted on suitable enclosures, racks subject to owner’s approval. All transmitters shall be HART compatible.

21. Bidder to delegate /depute their persons/experts as per owner/consultants’ requirement.

22. Bidder must offer general tools and tackles and special calibration instruments required during start-up, trial run, operation and maintenance of the system.

23. 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.

24. Bidder shall provide Cable Schedule in BHEL excel format provided in Electrical portion of the specification. Also, Cable Interconnections details for Complete System shall be in Bidder's scope.

25. All the instruments/equipment/electrical items shall be provided & designed with maximum star rating as available in line with energy conservation policies notified by BEE, GOI at the time of supply.

26. 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.

27. All approval/Inspection are to be carried out by Owner or owner appointed agency only.

28. 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.

29. 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 and repetition of clauses in the specification, the more stringent requirements among them are to be complied with.

GENERAL

1. The specification hereunder provides a general guideline for Control & Instrumentations to be provided for the Plant auxiliary systems and Off Site Plants. Bidder shall provide functionally independent & geographically distributed PLC (Programmable Logic Control) based control & Instrumentation system with all control equipment, instruments, accessories, cables and erection hardware for safe, efficient and reliable operation of the plant.

2. Each of the Plant Auxiliaries & off site systems shall be provided with annunciation system. It shall be an integral part of the control system. All the field contact for this purpose shall be acquired through control system. The annunciation sequence/logic shall conform to ISA sequence ISA-2A. The window lamps for the system shall be driven through output modules of the control system.

4. The instrumentation to be provided for each of the plant auxiliary & Off Site Plant systems shall be as per the technical specification document / drawings wherever provided for the respective systems as a minimum requirement for bidding purpose. However, for completeness of each of the plant auxiliary & Off Site system and its associated equipment, Bidder shall also provide all the necessary instruments to the process requirement even if it is not specifically indicated in the given technical Specfication document / drawings.

5. The instrumentation, operation and control philosophy proposed is specific to the plant design. Any improvement over the proposed typical Control & Instrumentation scheme shall be accepted so long as it does not deviate from the basic intent and general philosophy enumerated herein and elsewhere in this specification.

6. Plant auxiliaries / Off Site Plants shall be operated from their respective local control panels or Operating work stations located in the local area control rooms. Some of the auxiliaries will have operational facility from central control room as well as from local panels. All the PLC's of Ash Handling, DM-RO plant, Service water pump house, Compressor Plant, Condensate polishing unit, Fire Water Pump house etc., shall have digital data communication connectivity with DDCMIS already detailed/discussed in chapter 4. The control system for each of the Plant auxiliaries, Off Site Plant and their Man machine interface requirement and DDC MIS interfaces in the central control room shall be as follows:

   i. Considering the high ambient noise and electromagnetic interference prevailing in power plant, it is recommended that all links between off-site controls and plant DDC MIS shall be based on Dual Optical Fiber Communication (OFC) medium. Necessary ports / converters shall be provided at both ends.

   ii. PLC and RTU shall be designed for operating in a non air-conditioned harsh environment also. Communication media shall be optical fiber cable with MODBUS / OPC protocol between DDCMIS and PLC as per requirements. Optical cable, PLC end Modem/Converter and DDCMIS end Modem/Converter shall be supplied by bidder at both end. Optical cables shall be routed through GI conduit pipes. Communication protocol between the Modems shall be RS485/Modbus and the maximum communication time for receipt of signal at DDCMIS end should not exceed 2 seconds. The Communication links shall be as per chapter 4.

iii. In addition Hard wired signal interfacing shall also be provided for any signal required for interlock, control & protection. Similarly cable for hard ware signal transfer between DDCMIS and PLC/relay based control system shall be supplied, laid terminated by the bidder including preparation of cable schedule. Quantum of hard wired signals for linking each PLC based system and DDCMIS shall be decided during detailed engineering,.

7. Bidder will provide necessary separate industrial grade parallel redundant UPS power supply with 60 minutes battery backup for each PLC, Operating station & printer etc. Bidder shall provide necessary separate industrial grade parallel redundant 24 volts DC charger with 60 minutes battery backup for each PLC without Operating station . Bidder shall have to provide necessary cabling for redundant power supply to UPS / charger.

8. Whenever control system is PLC based, annunciation system shall be driven by PLC via Digital output. Mimic LED shall also be driven from PLC digital output. For other relay based control systems, solid-state annunciation system shall be provided. Mimic acrylic sheet thickness shall be min 6-7 mm.

9. For each PLC system, without OEWS (Operating Engineering Work Station), Laptop along with software shall be provided for engineering (Laptop shall be separate for each PLC with out OWES).

10. PLC system without OEWS (Operating & Engineering Work Station) shall have panel mounted push buttons, lamps, H.W. annunciation, indicators, Ammeters and MIMIC etc for operation & control purpose except specifically requirements of control desk mentioned for any package listed above.

11. All the PLC control system shall be of same make, model & same family and shall be supplied directly from manufacturer/vendors. PLC system supplied /engineered by system houses shall not be acceptable. It is preferred to have same family of Plant DDCMIS .

12. All remote I/O cards shall be with IP-65 protection class and should withstand upto 70 deg.C temperature.

13. All cables terminated in the terminal block, power distribution scheme instruments shall be ferruled. Ferruling shall be double cross ferruling (i.e.) source and destination addresses shall be marked on both sides of the tube ferruling.

14. Any Package not listed above shall be PLC (redundant hot standby controllers) controlled with one no. OWS, one no. OEWS (Operating & Engineering Work Station) and one no. A4 B/W LJP.

15. Bidder shall provide local panel for local start/ stop monitoring of auxiliaries and equipment as per requirement .The requirement shall be decided during detailed engineering. All local panel shall be NEMA 4X with canopy.

16. Bidder shall provide ammeters, voltmeters, PB indicating lamp, mimic, electrical scheme, indicators, chartless recorders and HW annunciations on the desk/ panels as requirement and shall be decided in detailed engineering.

17. PLC supplier shall prepare graphic for the complete plant with proper tag nos. for drives, binary inputs, analogue inputs, status of drives etc for the soft link for DDCMIS as per format of DDCMIS.

18. Each PLC/Microprocessor based system/electrical system shall be time synchronized with master clock system. Redundant Time synchronisation signals shall be provided for each control system, wherever redundant controllers/processors are provided.

19. Each subsystem PLC shall be provided with HW interfacing with main system PLC for signals used for command, interlocks, protections and other importants process parameters.

20. Control, operation & monitoring of electrical distribution system, namely PCC, Bus coupler, Incomer, breakers etc. for respective plant BOP package shall be controlled & operated from its respective PLC operating station/ backup control desk as well as from respective switchgear unit. Control system for the same shall be implemented in the respective PLC envisaged in the local control room. Bidder shall consider all transducers for monitoring of voltage, current, Kwh, power factor at respective PLC operating station and backup control desk. All signals shall be hardwired only.

21. The technical particulars & requirements of PLC, OWS, Printers, LVS and all other related hardwares/softwares shall be as per Vol. V, Chapter 4.

22. The technical particulars & requirements of UPS & 24 V DC systems shall be as per Vol. V, Chapter 7.

(Refer PLC System Configuration Drawings, # 114 -01-0000, 0101, 0105, 0107, 0111, 0113, 0114 & 0116, In case any ambiguity between System Configuration Drawings & above Annexure A, Annexure A shall prevail for finalizing the PLC configuration).

11.00.00 ELECTRO-CHLORINATION SYSTEM

11.00.01 CONTROL PHILOSOPHY

For automation of the Electro Chlorination Plant, PROGRAMMABLE LOGIC CONTROL system has been envisaged. The control system together with the power supplies and other accessories will be located within the local panel. The system shall include Binary Logic (interlocks, protection and sequential logic control). The control system shall be capable of communicating with the central control room through PLC gateway for the purpose of achieving functions of remote control & monitoring.

The PLC shall be preferably from plant DDCMIS family.

The PLC system shall be provided as detailed in chapter 4 of this specification..

Open and Close limit switch feed backs of valves are to be connected to PLC for remote viewing and for interlocks and protection.

Remote and local indications of various parameters to the process requirement shall be provided. (The same can be decided during detailed engineering)

The OLCs and CLCS philosophy shall be as per the section V of this volume.

The one no's of Operator work station and one no. of Engineering work station with 24 " LED Monitor and printers as defined in the Vol. V, Annexure A shall have to be complied.. In addition to OWS operation, Backup control desk with coloured Process Mimics, Hard wired Annunciation system, required Push .Button arrangements in Back Panel for complete operation of the systems, Ammeters, Parameter Indicators, LED Based indication Lamps etc., shall also be provided.

11.00.02 OPERATIONAL REQUIREMENT

a. Operation of the pumps , Transformer Rectifier, Electrolyser and other equipments shall be performed from local control panel / OWS to be located at the Electro Chlorination Building (air conditioned area). The Control panel shall house PLC Hardware, Alarm Annunciator driven by PLC programmed sequence, Indicators, Indication lamps, Switches, local / remote selector switch, Start / Stop push buttons, Auxiliary Relays, Motor current meter etc.. Selector switch shall be provided in the control panel to achieve three positions for "Base duty", "Stand by duty" and "Stop".

b. All conditions used for tripping the Transformer Rectifier, Electrolyser and pumps etc., shall be provided with pre-trip annunciation in the remote control desk/panel.

c. All initiating devices, relays and other hardware required to achieve annunciation, control and interlock system shall be provided by the bidder.

11.00.03 IMPORTANT SAFETY INTERLOCKS

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

11.00.04 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

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 as specified in section V

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

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 and

Hydrogen detection System

Chlorine Leak detection system shall be provided in all the rooms where chlorine contents are available. (Example chlorine storage tank, chlorine producing unit, chlorine pumping room etc.)

The PLC panel and control panels shall be provided in an air conditioned room.

DATA SHEET FOR MOTORIZED VALVE

FORM NO. PEM-6666-0

	Data Sheet FOR MOTORISED VALVE ACTUATOR	SPECIFICATION NO.: PE-ID-412-145-I902
		VOLUME II B
		SECTION D
		REV. NO. 01 DATE: 04.07.15
		SHEET 1 OF 3

Data Sheet A & B

		DATA SHEET-A (TO BE FILLED BY PURCHASER)	DATA SHEET-B (TO BE FILLED-UP BY BIDDER)
GENERAL*	* PROJECT	2x 660 MW ENNORE STP	
	OFFER REFERENCE		
	* TAG NO. SERVICE		
	* DUTY	☐ ON / OFF ☐ INCHING	
	* LINE SIZE (inlet/outlet): MATERIAL		
	* VALVE TYPE	☐ GLOBE ☐ GATE ☐ REG. GLOBE ☐ BUTTERFLY	
	* OPENING / CLOSING TIME		
	* WORKING PRESSURE		
	AMBIENT CONDITION	SHALL BE SUITABLE FOR CONTINUOUS OPERATION UNDER AN AMBIENT TEMP. OF 0-55 DEG C AND RELATIVE HUMIDITY OF 0-95%	
	VALVE SEAT TEST PRESS	BIDDER TO SPECIFY	
	REQUIRED VALVE TORQUE	BIDDER TO SPECIFY	
	ACTUATOR RATED TORQUE	BIDDER TO SPECIFY	
CONSTRUCTION AND SIZING	CONSTRUCTION	TOTALLY ENCLOSED, WEATHER PROOF, IP:68	
	MECHANICAL POSITION INDICATOR	TO BE PROVIDED FOR 0-100% TRAVEL	
	BEARINGS	DOUBLE SHIELDED, GREASE LUBRICATED ANTI-FRICTION.	
	GEAR TRAIN FOR LIMIT SWITCH/TORQUE SWITCH OPERATION	METAL (NOT FIBRE GEARS). SELF-LOCKING TO PREVENT DRIFT UNDER TORQUE SWITCH SPRING PRESSURE WHEN MOTOR IS DE-ENERGIZED.	
	SIZING	OPEN/CLOSE AT RATED SPEED AGAINST DESIGNED DIFFERENTIAL PRESSURE AT 85% OF RATED VOLTAGE. FOR ISOLATING SERVICE THREE SUCCESSIVE OPEN-CLOSE OPERATIONS OR 15 MINS. WHICHEVER IS HIGHER. **FOR INCHING SERVICE - 150 STARTS/HR MINIMUM & FOR REGULATING SERVICE - 600 STARTS/HR MINIMUM.**	
HANDWHEEL	* REQUIRED	■ YES ☐ NO	
	* ORIENTATION	☐ TOP MOUNTED ☐ SIDE MOUNTED	
	*TO DISENGAGE AUTOMATICALLY DURING MOTOR OPERATION.		
ELECTRIC ACTUATOR	ACTUATOR MAKE/MODEL	BIDDER TO SPECIFY	
	MOTOR MAKE / MODEL / TYPE / RATING (KW)	BIDDER TO SPECIFY	
	@ MOTOR TYPE	SQUIRREL CAGE INDUCTION MOTOR, STARTING CURRENT LIMITED TO SIX TIMES THE RATED CURRENT-INCLUSIVE OF **I.S.** TOLERANCE	
	ACTUATOR APPLICABLE WIRING DIAGRAM	☐ ENCLOSED (BIDDER TO CONFIRM) A: ☐ DRG. NO. 3-V-MISC-24227 R00 B: ☐ DRG. NO. 3-V-MISC-24550 R00 C: ☐ DRG. NO. 3-V-MISC-24283 R00 D: ☐ DRG. NO. 4-V-MISC-90271 R11 E: ☐ For Thyristor based Integral starter, Bidder/Vendor to furnish wiring diagram	
	COLOUR SHADE	☐ BLUE (RAL 5012) ☐ DURING DETAIL ENGG.	
	PAINT TYPE **(## Refer Notes)**	☐ ENAMEL ■ ☐ EPOXY ☐	
	SHAFT RPM	BIDDER TO SPECIFY	
	OLR SET VALUE	BIDDER TO SPECIFY	
	@ STARTING / FULL LOAD CURRENT	BIDDER TO SPECIFY	
	NO. OF REV FOR FULL TRAVEL	BIDDER TO SPECIFY	
	@ PWR SUPP TO MTR / STARTER	415V, 3PH, AC	
	@ CONTROL VOLTAGE REQUIREMENT	TO BE DERIVED FROM THE POWER SUPPLY TO THE STARTER ☐ 230 V ☐ 110 V	

	SPECIFICATION FOR MOTORISED VALVE ACTUATOR	SPECIFICATION NO.: PE-ID-412-145-I902	
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Data Sheet A & B

		DATA SHEET-A (TO BE FILLED BY PURCHASER)	DATA SHEET-B (TO BE FILLED-UP BY BIDDER)
	@ ENCLOSURE CLASS OF MOTOR	☐ IP 67 ☐ FLAME PROOF	
	@ INSULATION CLASS	CLASS-F TEMP. RISE LIMITED TO CLASS-B	
	@ WINDING TEMP PROTECTION	■ THERMOSTAT (3 Nos.,1 IN EACH PHASE) ☐ ----------	
	SINGLE PHASE / WRONG PHASE SEQUENCE PROTECTION	REQUIRED	
INTEGRAL STARTER	INTEGRAL STARTER	■ REQUIRED ☐ NOT REQUIRED	
	TYPE OF SWITCHING DEVICE	■ CONTACTORS ☐ THYRISTORS	
	TYPE	■ CONVENTIONAL ☐ SMART (NON-INTRUSIVE)	
	STEP DOWN CONT. TRANSFORMER	■ REQUIRED	
	OPEN / CLOSE PB	■ REQUIRED ☐ NOT REQUIRED	
	STOP PB	■ REQUIRED ☐ NOT REQUIRED	
	INDICATING LAMPS	■ REQUIRED ☐ NOT REQUIRED	
	LOCAL REMOTE S/S	■REQUIRED ☐ NOT REQUIRED	
	STATUS CONTACTS FOR MONITORING	■ REQUIRED ☐ NOT REQUIRED	
	INTEGRAL STARTER DISTURBED SIGNAL	REQUIRED (MOTOR THERMOSTST TRIP,O/L RELAY OPERATED, CONT./POWER SUPPLY FAILED, PHASE LOSS, S/S IN LOCAL/OFF MODE, STOP PB OPTD, TORQUE OPEN/CLOSE CUTOFF) 1	
INTERPOSING RELAY/OPTO COUPLER (Applicable for integral Starter)	TYPE OF ISOLATING DEVICE	☐ INTERPOSING RELAY ☐ OPTO COUPLER ☐ EITHER	
	QUANTITY	■ 2 NOs. ☐ 3 NOs.	
	DRIVING VOLTAGE	■ 20.5 – 24V DC ☐ _____V DC	
	DRIVING CURRENT	■ 125mA MAX ☐ _____mA MAX	
	LOAD RESISTANCE	■ > 192 ohms - <25 k ohms ☐ > _____ohms - < _____ohms	
TORQUE SWITCH (Not Applicable for Smart Actuator) **($$ Refer Notes)**	MFR & MODEL NO.	BIDDER TO SPECIFY	
	OPEN / CLOSE	■1 No. ☐2Nos. / ■1 No. ☐2Nos	
	CONTACT TYPE	2 NO + 2 NC	
	RATING	5A 240V AC AND 0.5A 220V DC	
	CALIBRATED KNOBS(OPEN&CLOSE TS)	REQUIRED FOR SETTING DESIRED TORQUE	
	ACCURACY	+3% OF SET VALUE	
LIMIT SWITCH (Not Applicable for Smart Actuator) **($$ Refer Notes)**	MFR & MODEL NO.	BIDDER TO SPECIFY	
	OPEN : INT : CLOSE	☐1 No ■2 Nos. / 2 Nos. (ADJ.) / ☐1 No. ■2Nos.	
	CONTACT TYPE	2 NO + 2 NC	
	RATING (AC / DC)	5A 240V AC AND 0.5A 220V DC	

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	Data Sheet FOR MOTORISED VALVE ACTUATOR	SPECIFICATION NO.: PE-ID-412-145-I902	
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		SHEET 3 OF 3	

Data Sheet A & B

		DATA SHEET-A (TO BE FILLED BY PURCHASER)	DATA SHEET-B (TO BE FILLED-UP BY BIDDER)
POSITION TRANSMITTER	POSITION TRANSMITTER (For inching duty & other specific applications)	■ REQUIRED ☐ NOT REQUIRED	
	MFR & MODEL NO.	BIDDER TO SPECIFY	
	TYPE	☐ ELECTRONIC (2 WIRE) R/I CONVERTER ■ ELECTRONIC (2 WIRE) CONTACTLESS	
	SUPPLY	■ 24V DC ☐	
	OUTPUT	■ 4-20mA	
	ACCURACY	± 1% FS	
SPACE HEATER	@SPACE HEATER	REQUIRED	
	@ POWER SUPPLY (NON INTEGRAL)	230V AC,1 PH.,50 Hz	
	@ POWER SUPPLY (INTEGRAL)	BIDDER TO SPECIFY	
	@ RATING		
TERMINAL BOX	ACTUATOR/MOTOR TERMINAL BOX	REQUIRED	
	ENCL CLASS ACTUATOR/MOTOR T.B.	@■ IP 68 @☐.....	
	@ EARTHING TERMINAL	REQUIRED	
	PLUG & SOCKET(9 PIN) (FOR COMMD, LS/TS FEED BACK, PoT)	☐REQUIRED ■ NOT REQUIRED☐ ☐ 2 NOS. ☐ ----------	
CABLE GLANDS	@ POWER CABLE GLAND	SIZE:----------	
	@ SPACE HEATER CABLE GLAND	SIZE:----------	
	OTHER CONTROL CABLE GLANDS	QUANTITY & SIZE :Cable gland suitable for 8Px0.5 sq mm & 2P x 0.5 sq mm Cable.	
WEIGHT	TOTAL WEIGHT (ACTUATOR + ACCESSORIES)	BIDDER TO SPECIFY	_____ Kg.

NOTES:

1. **SCOPE**: DESIGN, MANUFACTURE, INSPECTION, TESTING AND DELIVERY TO SITE OF ELECTRIC ACTUATOR FOR INCHING OR OPEN / CLOSE DUTY.
2. **CODES & STANDARDS**: DESIGN AND MATERIALS USED SHALL COMPLY WITH THE RELEVANT LATEST NATIONAL AND INTERNATION STANDARD. AS A MINIMUM, THE FOLLOWING STANDARDS SHALL BE COMPLIED WITH:
   IS-9334, IS-2147, IS-2148, IS-325, IS-2959, IS-4691 AND IS-4722
3. ACTUATOR SHALL HAVE HARDWIRED CONTACTS FOR FOLLOWING SIGNALS (a) ACTUATOR IN LOCAL MODE (b) ACTUATOR IN REMOTE MODE.
4. BIDDER TO ENSURE AVAILABILITY OF SPARE 1NO + 1NC LIMIT SWITCH & TORQUE SWITCH. 1
5. SS TAG NAME PLATE SHALL BE PROVIDED.
6. TEMPERATURE RISE SHALL BE RESTRICTED TO 70 DEG. C FOR AMBIENT TEMPERATURE OF 50 DEG C.
7. CABLE GLANDS OF DOUBLE COMPRESSION TYPE, Ni PLATED BRASS MATERIAL SHALL BE PROVIDED.
8. THE TORQUE SWITCHES SHALL BE PROVIDED WITH MECHANICAL LATCHING DEVICE TO PREVENT OPERATION WHEN UNSEATING FROM THE END POSITIONS. THE LATCHING DEVICE SHALL UNLATCH AS SOON AS THE VALVE LEAVES THE END POSITION. IF SUCH PROVISION IS NOT POSSIBLE, THE TORQUE SWITCHES SHALL BE BYPASSED BY END-POSITION LIMIT SWITCHES WHICH OPENS ON VALVE LEAVING END POSITION.THESE LIMIT SWITCHES ARE ADDITIONAL TO THE NUMBER OF LIMIT SWITCHES SPECIFIED ELSEWHERE.
9. THE MOTOR SHALL OPERATE SATISFACTORILY UNDER THE +/- 10% SUPPLY VOLTAGE VARIATION AT RATED FREQUENCY, -5% TO +3% VARIATION IN FREQUENCY AT RATED SUPPLY VOLTAGE, SIMULTANEOUS VARIATION IN VOLTAGE & FREQUENCY THE SUM OF ABSOLUTE PERCENTAGE NOT EXCEEDING 10%.
10. THE MOTOR SHALL BE SUITABLE FOR DIRECT ON LINE STARTING.

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

EPOXY PAINT IS RECOMMENDED FOR COASTAL AREAS.

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

DATA SHEET FOR MEASURING INSTRUMENT

CHAPTER-3

FIELD AND MEASURING INSTRUMENTS

3.00.00 FIELD & MEASURING INSTRUMENTS (PRIMARY & SECONDARY INSTRUMENTS)

3.01.00 GENERAL REQUIREMENTS

3.01.01 Instruments, control devices and other equipment accessories covered under this specification shall be furnished in accordance with I&C specification sheets and drawings enclosed herewith and the requirements of all applicable clauses of this specification.

3.01.02 The instrumentation and control equipment shall conform to all applicable codes and standards including those referred in Cl. no. 1.08.00 in this Volume. All equipment and systems shall also fully comply with the design criteria stated in chapter-2 of this part.

3.01.03 The instrumentation/control equipment and accessories shall be from the latest proven design for which the performance and high availability have been demonstrated by a considerable record of successful operation in power station service for similar applications. The bidder shall furnish sufficient evidence to fully satisfy the Owner in this regard.

3.01.04 For plug in type instruments, The plug & sockets shall be polarized to prevent wrong connections and have facility for secure coupling in plug-in position to prevent loose connections.
Signal/Electrical connection shall be screwed connection with double compression type Nickel-plated brass cable glands for Explosion proof area, Flame proof area and high vibration prone area.

3.01.05 Every instrument requiring power supply shall be provided with a pair of easily replaceable glass cartridge fuse of suitable rating. Every instrument shall be provided with a grounding terminal and shall be suitably connected to the panel grounding bus.

3.01.06 All field instruments shall be weatherproof, drip tight, dust tight and splash proof suitable for use under outdoor ambient conditions prevalent in the subject plant. All field-mounted instruments shall be mounted in suitable locations where maximum accessibility for maintenance is achieved. The enclosures of all electronic instruments shall conform to IP-65 unless otherwise specified (Explosion proof for NEC article 500, class 1, Division 1 area & flame proof) and an anti corrosive paint shall be applied to the field mounted enclosures / instruments. All the field instruments shall also be provided with SS tag nameplate and double compression type Nickel-plated brass cable gland. Gaskets, Fasteners, Counter and mating flange shall also be included wherever required with the field instruments.

3.02.00 Following minimum requirement of field instruments shall be fulfilled by Bidder (In addition, Redundancy criteria for field instruments shall be as specified elsewhere in specification): -

i. Level switches / pressure switches / flow switches/any other process switches etc. for OLCS / Alarms / Interlocks / Protection. Pressure switches at inlet, outlet

of individual pumps and discharge header of pumps for protection and auto start / stop & alarms.

ii. Level switches for sump/tank level high/normal/ low/very low interlocks.

iii. Level Transmitters (Type as per Owner approval) for open sump/ tank/bunker/vessel/heaters.

iv. Stand pipes on both side of tank for all level instruments (LT, LS & LG).

v. Flow elements with flow transmitter & Flow meter for flow measurement of process medium like Steam, Water, Air, Flue Gas, Fuel oil, open channel liquid, solid fuel, ash flow, DM water, Raw water, Instrument and Service air etc. as decided by owner.

vi. Pressure gauges and temp. Gauges at inlet and outlet of each heat exchanger and cooler.

vii. DPG, DPT & DPS across the filters/strainers.

viii. Tapping points/test points shall be provided.

ix. All primary Instruments, hardwares & JBs etc used for measurement for HFO, LDO & Turbine Lube Oil system shall be flame proof (IEC-79.1, Part I). All primary Instruments, hardwares & JBs etc used for measurement for Hydrogen shall be intrinsically safe and explosion proof as per NEC article 500, class 1, Division 1 area I.

x. All Thermocouples & RTDs shall be Duplex.

xi. All Field Instruments used in acid or alkaline atmosphere shall be with standard Anti corrosion coating i.e. the combination of Polyurethane and epoxy resin baked coating (ANSI/ISA-71.04).

xii. All primary instruments installed at “Minus level or Floor” shall be with protection class of IP 68.

xiii. Transmitters (all type) for monitoring & controls purpose.

xiv Pull cord, belt sway, zero speed switches, emergency stop PB for conveyers, other limit switches, cable gland etc. of CHP which produce spark shall be provided with dust and flame proof enclosure conforming to IS-2148.

xv Lockable Deinterlock switches shall be provided for CHP as per requirement.

xvi Bidder shall provide electronics weighing in motion system as per IS-11547, hermitically sealed load cell of precision strain gauge type,100% over load protection of cell and 250% overload protection for the construction; one calibrator attachment with two weighers.

xvii All field mounted push button, selector switch etc. shall be as per IEC or NEMA 4X protection.

xviii All limit switch shall be conform to IEC-60947-5-1.

xix At APH, **temperature measuring device of different lengths forming grid** shall be provided to have average temperature for variable flow of flue gas, secondary air and primary air. These temperatures may be connected to nearest remote I/O panel.

xx. On both left and right sides of furnace, separate lines shall be laid and provided with **furnace pressure transmitters having wider range** than the furnace pressure transmitter.

xxi. Temp. Transmitters are envisaged with RTD & Thermocouples for monitoring services/application only. However any RTD & Thermocouples are used for control, interlock & protection application, same shall be directly wired to DDCMIS/DCS/PLC using instrumentation & Extension cables respectively.

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

xxiii. Contacts less, electronic 2-wire position transmitters shall be provided for all inching type motorised valve and dampers.

xxiv. 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 Acoustic, Ultrasonic, Radar based shall be provided by bidders as specified in NIT and as approved by owner.

xxv. Considering the type of application, wireless technology to bring signals to DDCMIS may be adopted by interfacing with OPC gateway to avoid cabling for smart level transmitters specified above at sr. no. xxiv. However Wireless technology as adopted by Bidder shall be reliable and field proven in power plants and same shall be approved by Owner.

xxvi. For Turbine oil, HFO/LDO applications & H2 Gas application, zener protection on power supplies shall be included.

xxvii. Where the process fluids are corrosive, viscous, solid bearing or slurry type, diaphragm seals shall be provided. Parts below the diaphragm shall be removable for cleaning. The entire volume above the diaphragm shall be completely filled with an inert liquid suitable for the application. For HFO, LFO Applications, SS capillary with thin wafer element with ANSI RF flanged ends are to be provided. For hazardous area, explosions proof enclosure as described in NEC article 500 shall be provided.

FIELD INSTRUMENTS SHALL BE SUPPLIED & OFFERED AS PER DATA SHEETS SPECIFIED BELOW:

3.03.00 TRANSMITTERS, SWITCHES, GAUGES AND PANEL MOUNTED INSTRUMENTS

3.03.01 Pressure, Differential Pressure, DP type Level and Flow Transmitters (PT, DPT, LT & FT)

Smart Transmitters of the electronic type shall be furnished.

All Transmitter shall be installed in closed LIE in the boiler area. Similarly transmitter for TG shall also be in LIE except the transmitters located in covered area on TG floor and these shall be mounted in LIR.

Transmitters shall be equipped with mounting brackets suitable for a mounting in transmitter enclosures.

In general, Transmitters are envisaged to be grouped at several places as to be decided during detailed engg. stage. For this purpose, suitable enclosures complete with all tubing, fittings, purge meters, loop cable trays etc. shall be provided.

Type/Construction	:	Sealed capacitance/ Inductance/ Silicon resonance type
Material		
- Body	:	Die cast Aluminum with epoxy coating for air & flue gas SS316 for other services
- Diaphragm	:	316 SS
- Measurement element	:	Teflon seal
- Valves	:	Carbon steel for non-corrosive Applications SS316 for corrosive applications.
Output signal	:	4 to 20 m Amp. DC (Two wires) HART Compatible
Local Indicator	:	LCD indicator (5 digit) with scale of Engg. unit
Overall Accuracy	:	± 0.04% or better of Span for BTG package ± 0.065% or better of Span for BOP packages ± 0.2% or better of span for remote seal type transmitter.
Turn down ratio	:	100:1 in general
Stability	:	± 0.15% of URL for 5 years.
Response time	:	150 msec.
Power supply	:	24V DC nominal
Drive capability	:	600 Ohms nominal
Enclosure Class	:	IP-65 (Explosion proof for NEC Class-1, Division 1 area)
Span and Zero	:	Locally adjustable, non-interacting

Zero suppression / elevation	:	At least 100% of Span
Connection		
- Process	:	1. Half (1/2) inch NPT (F) Quarter (1/4) inch NPT with/without oval flanges
- Electrical	:	Suitable for Plug in type connection (Both side of transmitter), unused entry with blind plug.
Accessories	:	
- For Absolute Pressure Transmitters:		Two (2) valve SS316 manifold
- For Gauge & Vacuum pressure transmitter	:	Three (3) valve SS316 manifold
- For DP, level & flow transmitter	:	Five (5) valve SS316 manifold
- For oil and corrosive liquids	:	Separator diaphragm seals
- For all transmitters	:	Mounting bracket

Manifold should not be mounted on the transmitter, Manifold shall be non integral and standalone type. Snubbers/Pulsation dampners shall be used where the process media is unstable for measurement such as the discharge of a pump. Over range protection shall be used where necessary. The coil syphons & condensate pots shall be used for steam services. Transmitters shall be provided with suitable drain & vent points.

3.03.01.01 Transmitters & other HART based instruments shall be supplied along with 3 Nos. of universal type hand held/portable pressure calibrators. Temperature transmitters shall be supplied along with 3 Nos. of hand held/portable mV source generators.

3.03.02 PRESSURE SWITCHES (PS) & DIFFERENTIAL PRESSURE SWITCHES (DPS)

Applicable Standards	:	IS3624 - 1966/ISA-RP-8.1 except as modified in spec.
Type/Construction	:	Bourdon/Sealed Diaphragm Piston Actuated preferable. Indicators with contacts are not acceptable.
Materials		
- Bellows	:	316 SS
- Bourdon tube	:	316 SS
- Movement	:	316 SS
- Enclouser	:	Die-cast aluminum with stoved enamel black finish. Epoxy coating shall be provided for corrosive atmosphere.
- Protective Diaphragm	:	Teflon

Accuracy	:	± One (1) percent or better
Repeatability	:	± 0.5(half) percent or better
Setting & Differential	:	Adjustable
Contact		
- Number	:	DPDT /2 SPDT
- Type	:	Auto reset with internal Adjustable snap action micro switch
- Rating	:	5 Amp, 240V AC / 0.2 Amp, 220V DC
Connection - instrument	:	Half (1/2) inch NPT Male Process
Electrical	:	Suitable for Plug in type connection. All the switches are internally connected and brought to the surface with Amphenol male/female connection. Cabling need not terminated inside the switch. Cable ends are to be soldiered in connector and to be inserted for easy maintenance.
- Over range protection	:	One Fifty (150) percent of full scale
Enclosure Class	:	IP-65 or better (Explosion/Flame proof for NEC Class-1, Division 1 area)
Accessories		
- 3 / 5 valve manifold	:	As applicable for all switches
- Self cleaning type pulsation dampners/Snubber (Material SS316)	:	Pump and compressor discharge lines
- Syphon	:	For all steam lines
- Protective separating diaphragm	:	For fuel oil & corrosive liquid lines.
Mounting	:	Local (in LIE/LIR for BTG package).

3.03.03 PRESSURE & DIFFERENTIAL PRESSURE GAUGES (PG & DPG)

Applicable standard	:	IS:3602-1966, IS/3624, ASME B 40.1
Type/Construction		
-760 mm to 1.0Kg/cm2	:	Bellows/Diaphragm
-Above1.0Kg/cm2	:	Bourdon Tube
- Suction side of pumps	:	Compound gauge
Materials		
- Bourdon tube	:	316 SS
- Bellows	:	316 SS
- Movement	:	316 SS
- Case	:	SS 316/ Die-cast aluminum with stoved enamel black finish. Epoxy coating

		shall be provided for corrosive atmosphere.
- Protective Diaphragm	:	Teflon
Dial size	:	150mm with shatter proof glass
Scale Details	:	Graduations in black lines on white dial, on white dial, 270 Deg. pointer deflection scale provided with glass cover. Smallest scale division shall be one (1) percent of full scale value or smaller. Pointer stop for all gauges.
Accuracy	:	± One (1) percent or better
Connection - Instrument Process	:	1/2 inch NPT Male Bottom
Mounting	:	Local
	:	1/2 inch NPT Male (Back entry) mounted on local gauge board.
Enclosure Class	:	IP-65 or better (Explosion/Flame proof for NEC Class-1, Division 1 area)

Accessories

- 3 way needle valve/manifolds	:	For all gauges
- Self cleaning type Pulsation dampener/snubber (S316)	:	Pump and compressor discharge lines
- Syphon	:	For all steam lines
- Protective separating	:	For fuel oil and corrosive liquid lines

Other particulars

- External Zero adjustment	:	For all gauges
- Safety device		
Ranges 5 to 20 Kg/cm2	:	Rubber blow out disc with open front construction.
Ranges above 20 Kg/cm2	:	Neoprene safety diaphragm at the back with solid front construction.
- Over range protection	:	One Fifty (150) percent of full scale
Other Requirments	:	Movement mechanism shall be glycerin filled for oil services & vibration prone area.
	:	For Fuel oil & corrosive liquid lines diaphragm type sensors required. Armored capillary of 10 M for Fuel oil & Corrosive liquid service.

: Contact type pressure gauges are not acceptable for interlock & protection.

: For condensate storage tank the pressure gauge in terms of0-10000 mm wc or suitable range having **dial size of 300mm or bigger size** shall be provided.

3.03.04 **TEMERATURE TRANSMITTERS**

Type	:	SMART type configurable from control room through HART protocol (HMS System).
Display type	:	Indicating type (5 digit LCD Display),
Accuracy	:	±0.10%,
Ambient temperature error	:	0.1% per 10°C change
Output	:	4-20 mA DC (2 wire system) HART compatible signals for analogue monitoring inputs to the distributed control system (DDCMIS), DCS & PLC.
Protection class	:	NEMA 4/IP66 or equivalent degree of protection for enclosure)/ (Explosion/Flame proof for NEC Class-1, Division 1 area)/ flame proof (IEC-79.1, Part I). As applicable).
Material of accessories	:	SS316.
Stability	:	± 0.1 % or ± 0.1 deg C of reading (whichever is great) for 2 years in case of RTD inputs and for 1 year in case of Thermocouples inputs.
Operating Voltage	:	16 – 48 V DC
Calibration	:	as per NIST monograph 125 for T/C & European Curve Alpha = 0.00385 for RTD .
Ref. Junction compensation	:	Provided
Span/zero adjustment	:	Locally adjustable, Non interacting
Auto calibration	:	Provided
Burn out protection upscale	:	Provided
Input - output isolation	:	Provided
Circuit ungrounded	:	Provided

Any RTD & Thermocouples shall be directly wired to DDCMIS/DCS/PLC for metal temperature application, bearing & winding temp application only.

The Temperature transmitter shall accept Universal dual inputs of all types of thermocouples & RTD, 0-5V input signals etc.

Temp., Fuel oil temp. measurement as per IBR rules and regulations

3.03.10 TEST THERMOWELLS (TW)

Applicable Standard	:	ASME PTC 19.3 TW - 2010
Type/Construction	:	Machined from Bar Stock
Material	:	316 SS/F11/F22/F91
Connection		
- Pipe	:	M33 x 2
- Test Instrument	:	To suit test instruments
Accessories	:	Plug with chain
IBR Certification	:	For high pressure service, Steam Temp., Fuel oil temp. measurement as per IBR rules and regulations Bidder shall provide calculation for thermowell as per ASME – PTC-19.3 TW - 2010.

Test wells shall be provided on main steam, reheat steam, extraction steam, feed water, condensate, spray water lines and other piping as required to meet ASME test requirements.

3.03.11 DIRECT MOUNTED LEVEL TRANSMITTERS (LT)

Displacer type level transmitter shall not be used in the process anywhere in the plant.

3.03.12 Ultrasonic Level Transmitter (for Water sump/Tank level, Raw water reservoir level, Cooling water fore bay level measurements)

Principle of Operation	:	Detection of reflected ultrasonic pulse
Measuring Ranges	:	Up to 30 meters (typical)
Signal Processing	:	Microprocessor Controlled Signal Processing
Operating Freq.	:	10 KHz to 50 KHz (typical)
Display	:	Head mounted alpha-numeric back lit LCD/LED
Calibration & Configuration	:	Accessible from front of panel & HART calibrator.
Diagnosis	:	On-line
Status	:	For power, Hi / Lo / V. Hi / V. Lo-level indication, fault etc.
Construction	:	Plug-on board
Power supply	:	240 V AC 50 Hz / 24V DC
Signal Output	:	4-20 mA DC with HART (isolated) - 600 Ohm load.
Hysteresis	:	Fully adjustable preferred
Output contacts	:	2SPDT Potential free changeover contacts @ 8A 230V AC.
Accuracy & Repeatability	:	± 0.25% of span or better
Resolution	:	± 0.1% of span

Temperature Compensation: To be provided with Transducer.

Operating temp.	:	Transmitter-50 deg C and Sensor – 80 deg C
MOC Sensor	:	Body- PVDF and Face – Polyurethene
Humidity	:	1% to 95% non condensing.
Enclosure	:	IP-67 Epoxy painted die cast Aluminum or SS316L housing.
Cable Connection	:	3/4" ET
Mounting	:	2" – 4" NPT or flanged
Accessories	:	Cable gland, prefab cable, mounting accessories like EPDM seal, SS316 flanged etc. Additional separate local display unit with large Alphanumeric back light LCD/LED & to be provided for the applications which will be decided during detailed engineering.

3.03.13 CAPACITANCE TYPE LEVEL TRANSMITTER

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

Type	:	Capacitance type
Probe	:	a) Rod or suspended electrode. b) Rope type probes may be used only where required probe length is greater than 3 meters
Probe Mounting	:	Stainless steel 1-1/2 ANSI RF Flange / ¾" NPT (M)
Material of construction	:	316 SS
Insulation	:	PTFE Part/Full as per service.
Transmitter	:	The transmitter shall receive output of the preamplifier and convert it into 4-20 mA DC output signal.
Accuracy	:	± 1% of Full scale
Repeatability	:	± 0.5 % of Full scale
Load	:	Min 600 Ohms
Enclosure	:	Powder/Epoxy coated Die cast aluminum. with neoprene gasket conforming to IP 65. (Explosion proof for NEC Class-1, Division 1 area).
Ambient temperature	:	0-60 ºC.
Mounting	:	Wall / Surface
Supply voltage	:	240V AC, 50Hz / 24V DC
Response time	:	100 m sec or better
Cable connection	:	¾" ET
Accessories	:	Counter flange, Cable gland, prefab cable if any
Preferable features	:	Alarm output contacts with adjustable set point facility

3.03.14 GUIDED WAVE RADAR/RADAR LEVEL TRANSMITTER

Type	:	Guided wave Radar (Contact type)/Radar (Non contact type) as finalized by owner.
Application	:	For Turbine Lube oil tank, HFO & LDO tank level,

~~Output Signal~~	~~:~~	~~Pulse~~
~~Material of Construction~~	~~:~~	~~AISI 316~~
~~Sensor Seal~~	~~:~~	~~PTFE / higher based on temperature~~
~~Flow range~~	~~:~~	~~As required.~~
~~Linearity~~	~~:~~	~~0.25% or better.~~
~~Repeatability~~	~~:~~	~~0.02% or better.~~
~~Ambient temperature~~	~~:~~	~~50 deg C~~
~~Mounting~~	~~:~~	~~On-Line mounting with flanges of stainless steel.~~
~~Enclosure~~	~~:~~	~~IP 65~~
~~Accessories~~	~~:~~	~~Nuts, bolts, gaskets etc.~~

~~**Transmitter**~~

~~Electronics~~	~~:~~	~~Solid State~~
~~Power Supply~~	~~:~~	~~240V AC, 50Hz. UPS~~
~~Input~~	~~:~~	~~Input from Sensor~~
~~Display~~	~~:~~	~~4 1/2 digit LCD~~
~~Output~~	~~:~~	~~Isolated 4-20mA DC HART~~
~~Measuring Accuracy~~	~~:~~	~~0.5% of full scale range~~
~~Totalized Value~~	~~:~~	~~Required~~
~~Housing~~	~~:~~	~~IP 65 (Explosion proof for NEC Class 1, Division 1 area)~~
~~Nameplate~~	~~:~~	~~Tag number, service engraved in stainless steel tag plate~~
~~Accessories~~	~~:~~	~~Clamping strip, bracket, prefab cable etc. Special tool kit for calibration/ configuration .~~

3.03.23 Flow Transmitter (Ultrasonic)

Type	:	ULTRA SONIC, 2-wired
Sensing element	:	Non-contact
Output	:	4-20mA with HART Protocol
Accuracy	:	± 0.1% FS
Supply	:	24 V DC
Enclosure class	:	IP-65

Transmitter

Mounting	:	On Nozzle
Mounting position	:	Top mounted
Housing	:	Plastic
Display	:	Head mounted LCD Display and remote LCD display
Process connection	:	NPT/Flanged
Electrical connection	:	NPT
Turn Down ratio	:	1:100
Measuring range	:	Adjustable (as per process requirement)
Totaliser	:	Required
Accessories	:	As per process requirement Additional separate local display unit with large Alphanumeric back light LCD/LED & to be provided for the applications which will be decided during

Nuts, bolts, gaskets, mesh etc.

b) Special tool kit for calibration/configuration.

3.03.25 Electromagnetic Flow meter

Electromagnetic flow meters shall have separate transmitter having accuracy ±0.2% with zero stability feature, suitable for process medium with <= 5 micron Siemens conductivity, flanges material SS-316, electrode & measuring tube material SS-316, liner material Teflon and enclosure IP-66, local digital display configurable as totaliser, 4-20 mA output signal HART compatible with zero and span field adjustable. Application – DM Water and for other application as decided by owner.

3.03.26 FLOW GAUGES (FG)

Type/Construction	:	a) On-line type Rotameter for 50 Nb and below lines b) Bypass type Rotameter for above 50 Nb lines.

Material

- For On-line type

Metering Tube	:	Borosilicate glass
Float	:	316 SS
Packing	:	Teflon
End fittings	:	304 SS

-For Bypass type

Metering Tube	:	Borosilicate glass
Float	:	316 SS
Packing	:	Teflon
End Fittings	:	304 SS
Orifice Plate	:	316 SS
Carrier ring	:	304 SS
Flanges & Mating flanges	:	Same as pipe material, 200 lbs ANSI - RF
Impulse pipe	:	Same as pipe material
Fittings	:	2000 ANSI, SW ends to match with pipe material.
Dial Size/Scale length	:	250 mm
Scale Details	:	Direct reading type engraved on detachable Aluminum scale
Accuracy	:	± Two (2) percent
Reproducibility	:	Half (1/2) percent
Rangeability	:	1:10
Connection	:	SCRD NPT

Accessories	:	a)	Isolating valves (for Bypass type only)
		b)	Bolts, Nuts and Gaskets as required
Tests	:	Shall be tested at two hundred (200) percent of the maximum process pressure	

3.03.27 SIGHT FLOW GLASS INDICATORS

Type/Construction	:	Flapper type.
Materials	:	
Body	:	Carbon steel/SS316 as per process requirement
Glass	:	Toughened Borosilicate
Gaskets	:	Neoprene
Bolts & nuts	:	SS
Flappers / Rotating Wheel	:	316 SS
Flappers / Rotating Wheel holder	:	304 SS
Process Connection	:	SW (Socket Welded)
Accessories	:	Scale, Bolts, Nuts, Cover plates and Gaskets as required
Tests	:	Tested at two hundred (200) percent of the maximum process pressure.

3.03.28 **SOLID FLOWMETER**

Type	:	Online Impact type Microprocessor Based
Measuring Principle	:	The system measurement is basically pertains to the measurement of horizontal deflection using LVDT, created by the impact of solid flow up on online sensing plate. The horizontal deflection being proportional to the impact forces, LVDT convert this horizontal movement into electrical signal. The inbuilt integrator convert this signal into time based flow rate indication & provide totalized flow also.
Sensing plate	:	316 SS
Sensing head	:	Sensing mechanism shall be mounted outside the process flow line.
Enclosure	:	316 SS
Enclosure protection	:	IP 67 class
Accuracy	:	+/-1%
Repeatability	:	+/- 0.2%
Drift	:	Both zero & span $\pm$ 2% / month
Output	:	4-20mA DC isolated, load 600 ohm (min)
Digital communication	:	yes, (HART) facility
Power supply	:	240 V AC, 50Hz. UPS
Ambient condition	:	Temperature -60^0 C, RH-95% Environment – Highly Dusty

Accessories	:	Shall be complete with all the accessories including digital display for flow rate, integral vents, baffles for air separation, etc. which ever required for satisfactory operation.

Note:-

1. The above on line flow meter shall not create any obstruction on flow.

2. User's list shall be submitted to support on proven satisfactory performance for similar process application.

3.03.29 **Instrument Air System**

The instrument Air Supply System for various pneumatic Control & Instrumentation devices like pneumatic actuators, power cylinders, I/P converters, pneumatically operated valves etc. shall be complete in all respect with necessary Air Filter Regulators, valves, piping/tubing etc.. Each pneumatic instrument shall have an individual air shut off valve. The pressure-regulating valve shall be equipped with an internal filter, a 50 mm pressure gauge and a built in filter-housing blow down valve.

Filter shall be of minimum 5-micron size & sintered bronze material.

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.

Bulk header nearby the crowded applications shall be provided and from this bulk header individual air lines with necessary isolation values are laid to the application.

These bulk header are to be provided with **mechanical / electronic based automatic Drains.**

Individual moisture separator for O_2 analyzer or vital application shall be provided nearby the instrument so as to enhance the cell life or the performance of vital final control elements.

3.03.30 **Air Filter Regulator (AFR)**

Constant bleed type AFR with an accuracy of $\pm$ 1.0 % inlet pressure range of 5-8 kg/ cm2 and suitable spring ranges (AFR) for use with positioners in control valves, control damper, E/P convertors and shut off valves for phosphor bronze filter element; Filtering particles above five microns. Weather and water proof enclosure. Material of accessories will be SS316.

Air filter regulators shall be provided in the :

(a) Air supply line to valve positioners / power cylinders
(b) Air supply line to electric to pneumatic converters.

(c) Air supply line to pneumatic interlocked block valves.
(d) For each instrument rack, field instruments enclosure for purging.

3.03.31 **Electro-Pneumatic Convertors (E/P)**

Two wire type E/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 S S. E/P convertors shall have fail freeze (stay put) feature also. Process connection shall be 1/4" NPT (F) and Electrical connection shall be ½" NPT (F). Zero/span adjustment facility shall be provided. The E 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.

3.03.32 **Solenoid Valves**

Solenoid valves shall be provided with control valves / pneumatic control valves hooked up with process interlock requirements and where direct tripping is involved. The number of ways for solenoid valve shall be provided as indicated below:

(a) Two (2) way solenoid valves shall be provided, where process line of less than 50 mm with low pressure and temperature application.
(b) Three (3) way solenoid valve shall be provided commonly, where the pressure is admitted or exhausted from a diaphragm valve or single acting cylinder, e.g, Pneumatic operated spray water block valve.
(c) Four (4) way solenoid valve shall be provided for operating double acting cylinders, e.g, Pneumatically operated on-off type dampers.
(d) 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.
(e) Solenoid Valve coils shall be Class-H high-temperature or Class-F construction as applicable and shall be designed for continuous duty. Three-way solenoid valves shall be designed for universal operation so that the supply air may be connected to any port. Solenoid enclosures shall be NEMA-4)/ (Explosion proof for NEC Class-1, Division 1 area)/ flame proof (IEC-79.1, Part I) As applicable). Body material of solenoid valve shall be Die Cast Aluminum or SS316.

.
(f) All solenoid shall be with varister, LED indication, surge suppress diode and circuits.

3.03.33 Power Cylinders (Pneumatic)

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

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

- Local LCD Display for Dew Point

3.03.42 **Junction Boxes**

v.	Type	:	Flame proof/weather proof
vi.	Enclosure	:	IP-65/Explosion/Flame Proof as per area classification.
vii.	Material	:	FRP with protective Coating
viii.	Cable entry	:	Bottom or Side
ix.	Cable glands	:	Double compression type – Nickel plated brass with PVC hoods.
x.	Mounting	:	Indoor/Outdoor
xi.	No. of terminals	:	As required with standardization with 20% spare of each size & type.
xii.	Terminals	:	Phoenix/Wago (screw less cage clamp type spring loaded)
xiii.	Grounding	:	Two terminals for body and shield ground
xiv.	Door	:	Hinged, lockable type.

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

xii 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.

Xiii M6 Ni plated Brass earthing stud shall be provided (external 2 nos. internal 1 no.)

xiv Gasket (Normal)- Neoprene thickness 6.0 mm

3.03.43 **Interposing Relays (IPR)**

Electro magnetic type IPRs with modular design, plug-in type connections, suitable for channel/DIN rail mounting in cabinets; coil rating 24V D.C; 2 set of silver plated change over contacts rated for 0.5A 220 V DC/8 A 240 V AC. Free wheeling diode across relay copper coil and self reset type status LED indicator flag (electronic) shall be provided. Manual forcing/override facility is required. The test voltage for relay shall not be less than 4 KV with operating temperature from –20 deg. C to 60 deg. C. The relay shall have the necessary approvals like V 0 inflammability class in accordance with UL94", IEC60664/IEC60664A/DIN VDE 0110. Facility to stimulate IPR manually shall be provided.The VA burden of relays shall be suitable to match the capacity of output modules. Interposing relay & sockets for mounting the interposing relay shall be of same make only.

3.03.44 RECORDERS (CHARTLESS)

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

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

Input Signal	:	Fully configurable multi range (Programmable) universal (input)
Recording method	:	Continuous with different colour, for each channel
Display colour	:	Selectable from 30 Colours
Bar graph facility	:	To be provided
Digital indication	:	To be provided
Accuracy	:	+/- 0.1 % for reading for DC V Input And 0.1 Deg for TC/RTD input
Programmability	:	Front key board
Data Storage	:	hard disk/ Flash Memory
Data Retrieval	:	Compact 4 GB flash Memory card and USB port with 8 GB USB drive.
Scan rate	:	≤ 20 m **second** for individual channel. **Selection of scan time for individual channel is required.**
Power Supply	:	240 VAC 1 Phase UPS
Ambient Temperature	:	0-50 Degrees
Mounting	:	Front panel mounted weather & Dust proof IP 65
Application software	:	Yes, To be provided
Internal Memory	:	400 MB or more
Screen	:	≥ 10.5" colour LCD TFT
Resolution	:	≥ 640 X 480 Pixels
Type of Display	:	i) Trends ii) Bar Graph iii)Digital display/ values
Event Sampling	:	1/2/5/10/30/60/120 sec.
Zoom & Scroll Facility	:	Required
OWS and printer connectivity port	:	Required
	:	Necessary software shall be supplied for uploading the data.
Communication	:	Additional MODBUS/PROFIBUS ports connectivity between recorder and third party systems.

3.03.45 DIGITAL INDICATOR

Type	:	**Programmable electronic digital indicator** with floating point decimal.
Input	:	4-20 mA DC/1-5V DC/RTD/T/C.
Number of inputs	:	One
Range	:	As per requirement/adjustable by end user

through key pad available on the indicator.

Number of digits	:	Four plus sign
Digit height	:	20 mm or larger
Display	:	Fluorescent red
Input over range/open sensor (T/C)	:	All digits to flash
Input hold time	:	0.7 seconds max.
Accuracy	:	±0.25% of span
Power supply	:	240V AC, 50Hz
Mounting	:	Flush panel, compatible for mounting on mosaic grid panel
Size	:	96x48 mm
Other Particular	:	Indicator receiving thermocouple signal shall have automatic cold junction compensation.
	:	Retransmission Output 4 -20 mA isolated required.
	:	24 V DC inbuilt power supply
	:	Alarm contact with 2 NO/NC contact (rating 5A/230 V AC)

3.03.46 RECEIVER INDICATORS (SINGLE/DUAL CHANNEL)

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

3.03.47 Temperature Scanner

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

Input over range/open sensor	:	All digits to flash
Mounting	:	Panel mounting
Zero and Span	:	Adjustable by digital calibration
Serial communication communication	:	Isolated RS232/485 for modbus-RTU
Memory Capacity	:	5MB Flash
Alarm output	:	Required
Contact rating	:	2A at 220 V AC
Power supply	:	240 V AC/24 V DC
Properties	:	i. Any channel shall be configured for Data Logging ii. Channel to Channel online Isolation shall be provided iii. Real Time RTC Interface for Printer shall be provided
Operation Modes	:	Auto/manual mode, Run mode, Verify mode, Calibration Mode, Program mode.

3.03.48 AMMETERS (AMM)

Input	:	4-20 mA DC
Mounting	:	Flush panel, compatible for mounting on mosaic grid panel
Face Dimensions	:	96 x 96 mm
Scale/Type	:	Moving coil, circular, FSD 240 deg. With six times suppression scale
Zero adjustment	:	Screw on meter face
Accuracy	:	$\pm$ 1 percent (class 1)
Indication	:	Pointer with scale
Magnetic Shield	:	Shielded Case
Quantities	:	For all HT Motors & LT motor with rating $\geq$ 30 KW and other critical application motors/drives.

3.03.49 VOLTMETER:

Input	:	4 - 20 mA DC
Mounting	:	Flush Panel, compatible for mounting on mosaic grid panel
Face Dimension	:	96x96 mm
Range	:	As per requirement
Accuracy	:	$\pm$ < 0.5 %
Indication	:	Digital type 4 1/2 digit
Magnetic Shield	:	Shielded Case
Connection	:	Plug in type
Quantities	:	For 230 V AC input power supply, UPS power supply, 24 V DC interrogation voltage & 220 V DC.

3.03.50 FREQUENCY METER/MW METER (DIGITAL)

Type	:	Electronic digital 7- segment with fluorescent display
Input	:	4 - 20 mA DC
Mounting	:	Flush Panel compatible for mounting On mosaic grid panel
Number of digits	:	41/2 digit
Face Dimension	:	192X192 mm
Digit size	:	Approximately 40 mm
Range	:	As per requirements
Accuracy	:	± 0.2 Hz
Display	:	Red LED display.
Connection	:	Plug in type
Magnetic Shield	:	Shielded Case

3.03.51 AC CURRENT TRANSDUCERS

Input	:	0 - 1 A CT current
Output	:	Dual 4-20 mA with 500 impedance
Mounting	:	Back rail
Accuracy	:	± 0.25%

3.03.52 DC CURRENT TRANSDUCERS

Input	:	0 - 75 mV
Output	:	Dual 4-20 mA with 500 impedance
Mounting	:	Back rail
Accuracy	:	± 0.25%

3.03.53 AC VOLTAGE TRANSDUCERS

Input	:	0 - 110 V PT, Volts
Output	:	4-20 mA with 500 impedance
Mounting	:	Back rail
Accuracy	:	+ 0.25%

3.03.54 DC VOLT TRANSDUCERS

Input	:	System Voltage
Output	:	4-20 mA with 500 impedance
Mounting	:	Back rail
Accuracy	:	± 0.25%

3.03.55 TRANSDUCERS FOR POWER

Input	:	CT and PT (1A) (110V)
Output	:	4-20 mA with 500 impedance
Mounting	:	Back rail
Accuracy	:	± 0.25%

3.03.56 TRANSDUCERS FOR FREQUENCY

Input	:	110 V PT Volts
Output	:	4-20 mA with 500 impedance
Mounting	:	Back rail
Accuracy	:	± 0.25%

3.03.57 TRANSDUCERS FOR POWER FACTOR

Input	:	PT (110V)
Output	:	4-20 mA with 500 impedance
Mounting	:	Back rail
Accuracy	:	± 0.25%

3.03.58 TRANSDUCERS FOR MVAR

Input	:	CT & PT (110V/1A)
Output	:	4-20 mA with 500 impedance
Mounting	:	Back rail
Accuracy	:	± 0.25%

3.03.59 DIFFERENTIAL FREQUENCY TRANSDUCERS (FOR SYNCHRONIZATION)

Input	:	110 V PT
Output	:	4-20 mA with 500 impedance
Mounting	:	Back rail
Accuracy	:	± 0.25%

3.03.60 DIFFERENTIAL VOLT TRANSDUCERS (FOR SYNCHRONIZATION)

Input	:	System voltage
Output	:	4-20 mA with 500 impedance
Mounting	:	Back rail
Accuracy	:	± 0.25%

3.03.61 PUSH BUTTONS (PB)/ ILPBs FOR ON/OFF, OPEN/CLOSE, START/STOP

Type	:	Momentary/Miniaturised Suitable for mosaic grid 24x48 Mm with 2 PB and 3 coloured LED.
Contact Configuration	:	2 NO + 2 NC
Contact Material	:	Hard Silver Alloy
Contact Rating	:	500V / 10 A
Insulation Voltage terminals and earth	:	2 KV for 1 minute between
Lamp Rating :-		
a) Voltage	:	240 V AC
b) Watt	:	2 Watt (approx.)

Colour

5.19.00 Technical Specification of Chlorine Analyzer

i)	Type	Microprocessor based Continuous flow through sample type with automatic temperature compensation.
ii)	Analyzer power supply	240V AC, 50 Hz, Single Phase from UPS
iii)	Analyzer output	i) 4-20 mA, DC spare output ii) 4-20 mA, DC isolated output for DDCMIS
iv)	Accuracy	0.005 mg/ltr. or 1% of range.
v)	Sensitivity	0.001 mg/ltr. (1 ppb)
vi)	Range	As per schedule.
vii)	Annunciation contacts:	
	- Number	As per schedule, 2 SPDT

	-	Type	Snap action micro switch
	-	Rating	5A, 240V AC, 0.2A, 220V DC
	-	Mounting	Flush
viii)	Terminal points		All components piped & wired to terminal points
ix)	Accessories	i)	Flow regulator
		ii)	Flow gauges
		iii)	Sample rate set valves
		iv)	Other accessories as required to make the system complete

5.20.00 Technical Specification of Residual Chlorine Analyser

SENSOR

Method	:	Amperometric
Electrodes	:	Gold Cathode/Silver Anode
Cell Material	:	PVC
Electrolyte	:	Potassium Bromide

TRANSMITTER

Type	:	Microprocessor Based with self diagnostic features
Transmitter Output	:	4 – 20 mA
Enclosure Protection	:	IP65
Enclosure Material	:	Polyester coated Al.
Electrical Connection	:	½" NPT (F)
Mounting	:	FIELD
Display Type	:	LCD
Display Details	:	4 digit backlit LCD matrix
Diagnostics	:	Required
Meter Range	:	0-1 mg/l
Resolution	:	0.01 ppm
Area Classification	:	SAFE
Electromagnetic Compatibility	:	BUILT – IN
Temp. Compensator	:	AUTO – BUILT – IN
Temp. Compensating element	:	PT100

DOCUMENT FOR PLC

Bidder's equipment which are vulnerable to electrical noise shall be hardened to eliminate possible problems.

The Bidder shall be fully responsible for detailed recommendations on the type, size, shielding, input balancing, ripple amplitude and frequency, isolation and grounding for field inputs and for equipment furnished by the Bidder to achieve an installation with minimum noise from all sources.

The Bidder shall carefully review the Electrical Field Construction and cabling specifications given in Section-9 of this volume. If the performance of the equipment furnished by the Bidder is likely to be adversely affected in any manner because of these cabling and electrical field construction practices, the Bidder shall bring this to the attention of the Owner along with his proposal.

Any additional equipment, services required for effectively eliminating the noise problems shall be identified by the Bidder and shall be included in his lump sum proposal.

The Bidder shall be fully responsible for satisfactory elimination of any noise problems that evidence themselves following the installation of the equipment. All expenses incurred in the elimination of noise problems shall be borne by the Bidder.

2.14.00 SURGE-PROTECTION DESIGN CRITERIA FOR SOLID STATE/MICRO PROCESSOR BASED EQUIPMENTS/DCS/DDCMIS/PLC/UPS etc.

i. All solid-state equipment shall be able to withstand the noise and surges inherent in a powerhouse. The equipment shall be designed to successfully withstand without damage to components and/or wiring, application of surge withstand capability (SWC) wave whose shape and characteristics are defined in ANSI publication C37.90a - 1974 entitled "Guide for surge withstand capability (SWC) Tests".

ii. All solid state equipments, power supply to electronic cards, power supply to controllers, PLC panels, DDCMIS panels, SMPS power supply, UPS, battery chargers etc shall have external surge protection device with Plug ability and life indication as per IEC 61643-1:1998-02 and E DIN VDE 0675 part 6:1996-03/A2: 1996-10, to withstand max. 40 kA, 8/20 u Sec of Surge. The connection of the devices should be made as per TT configuration wherever applicable.

iii. Signal lines shall have surge protection devices with pluggability and testability as per IEC 61643-21:2000-09 and E VDE 0845 part 3-1:1999-07, to withstand max. 20 kA, 8/20 u Sec of surges.

iv. For data lines, communication lines, Ethernet/Can networks/LAN, Coaxial lines modular surge protection device should be used as per IEC 61643- 21:2000-09 to withstand a min of 2.5 kA, 8/20 u Sec of surges. The surge protection device should be used with the corresponding connector as being used for the lines i.e. RJ45, D-Sub, BNC, N-Type etc.

"The Bus systems (like Profibus/ Modbus etc) or the Serial Port Systems (like RS-232/ RS-485 etc) shall be protected with suitable surge protection devices, confirming to the latest IEC-61643-21 guidelines. The surge handling capacity of

device shall at least be 10 KA, 8/20 µSec between core-core and 20 KA, 8/20 µSec between core-ground. The device shall be pluggable & on-site testable".

v. All electronic cards/modules shall also be protected from failure against accidental/inadvertent application of high voltage upto 500V DC (common mode) even though these modules may be designed to operate at lower voltage levels such as 24V/48V.

vi. In the case of DC powered system/subsystem/instrument, the design shall ensure protection against reverse polarity.

iv. The Bidder shall provide details of production tests being carried out to fully satisfy the Owner that the proposed equipment meets the above requirements and to assure that the products furnished shall be of the desired grade.

2.15.00 General Tools and Tackles, Special Calibration Instruments:

Bidder must offer general tools & tackles and special calibration instruments required during start-up, trial run, operation and maintenance of the plant.

2.16.00 PG TEST POINTS

2.16.01 Pressure, temperature and flow test points shall be provided in line with latest performance test code requirements.

2.16.02 In addition, pressure and temperature test points shall be provided for the following services:

(a) At the discharge of all pumps and fans

(b) At the inlet and outlet of the heat exchangers for the fluid media involved

(c) Adequate number at the Combustor at different zones

(d) At the inlet and outlet of each control valve

2.16.03 Pressure test points shall be complete with root valves and shall terminate with a nipple.

2.16.04 Temperature test points shall be provided with thermowell with a cap and chain.

4.02.00 Control System Basic Features/Design Requirements

4.02.01 Design Requirements

1. The instrumentation and controls shall be designed for maximum availability, reliability, operability and maintainability.

   All components shall function in a satisfactory manner within their rated capacity under the specified conditions during the continuous service life of the plant.

2. All like instrumentation, control hardware, control and protective system should be of same make and model no. in order to achieve the goal of consistent control philosophy and to minimize the diversity of I&C equipment & spares.

3. Control system shall 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 boiler or turbine/generator protection system to malfunction or become inoperative.

c. The grouping of control functions into system blocks shall be arranged such that failure of any one block will only partly degrade the control of the overall system. Such degradation shall always be manageable by operator intervention.

d. The control system shall 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. Start command or stop command/trip command towards safety of process or process equipment shall be hardwired parallel from the **two different DO cards.**

e. As a result of a control system fault, a plant item or control function shall always respond to its controls at the actuator level (i.e., remote manual control). That item or control function shall be required to be isolated from automatic control system.

f. No single random fault in the entire automation and control system will cause a load loss, forced outage or unit trip.

g No two simultaneous faults shall lead to or potentially cause damage to plant

h Safety related instrumentation and control shall be designed with a fail-safe mode.

i No single fault shall jeopardise the functioning of the entire system.

j The control and automation system and the field instruments and actuators as well as it's support systems, power supplies and data networks shall be immune to the electromagnetic interference and shall conform to the internationally accepted standards.

k To meet the operational and safety requirements, the control system hardware and software shall conform to a modular, hierarchical architecture.

l When more than one device utilizes the same measurement or control signal, the transmitter and other components shall be fully equipped to provide all signal requirements without overloading and with proper isolation. Transmitters required to serve multiple receivers shall be arranged so that disconnecting, shorting or grounding of one receiver device shall not have any perceptible influence on any other consumer point of the same signal nor shall change the transmitter calibration.

4. Distributed control equipment shall employ modern distributed microprocessor based technology, as required to comply with the project specification and the DDCMIS system should not be more than 5 year old. A truly integrated DCS is envisaged with all the self sustaining subsystems communicating with each other over the bus network and thus ensuring that the system has a truly global data base.

5. The active control system including the plant protection system is the heart of the DCS system and therefore most stringent safety, availability and reliability

requirements have to be fulfilled by this subsystem. The bidder must bring out very clearly in his proposal how he intends to satisfy these requirements.

6. The control system shall be functionally distributed, (For Boiler, TG and BOP and similarly the control for 2 similar equipments like ID Fan A, B and C should be in different co ntrollers & I/ O cards) hi ghly m odular and a rranged t o r eflect the functional grouping plant equipment and systems to be controlled. This functional group control strategy shall also form the basis for the partitioning of the controller to enhance the system reliability and flexibility. I n case of redundant Analogue and B inary S ignals, t hese w ill be co nnected t o di fferent i nput m odules and different C PU. Similarly whenever inputs are more than one and needs temperature and pr essure co rrection, the sa me shall be ca rried out i n di fferent CPU.

   In ca se o f r edundant/multi P umps/Drives for sa me se rvice, al l r elated Inputs & outputs of main pump/drive shall be in separate I/O cards and similarly all related Inputs & outputs of respective standby pump/drive shall be in separate I/O cards. Inputs/outputs of any two same services pumps/drives shall not be mixed in one common I/O card.

7. To meet the above failure criteria at sr. no. 3, the I&C system shall incorporate self-checking facilities so that internal faults can be det ected within the system itself prior to any resulting disturbance to the process. In addition, the protection and sa fety sy stems shall i ncorporate ch annel r edundancy or di versity o f measurement as well a s self-checking and ad equate t est facilities. F or so me important systems, “on l ine” t est sh all be em ployed with no ef fect t o the pr oper functioning of the protection system.

8. In order to m ake su re that the D DCMIS is an extremely use r friendly sy stem a centralized engineering subsystem is envisaged. An integrated subsystem has to be pr ovided w hich t akes over t he co mplete task of pl anning, I/O al location, generation of function schemes and wiring documentation (in design stage) and finally t he aut omatic linking and l oading o f the pl anned f unctions in t he t arget hardware.

   The complete en gineering o f al l the au tomation and da ta ac quisition functions should be possible from this central tool. This shall included all m odulating and sequence control functions as far as the automation is concerned, generation of plant graphics, logs and other MMI functions. I n addition the central engineering system must support all service, maintenance and commissioning assistance functions.

9. For pr otection appl ications, multi-channel m easurements shall be provided incorporating 2 out o f 3 t rip act ion. Faci lities for t he on -line t esting of each independent ch annel shall be pr ovided w ithout l oss of pr otection. E ach measurement channel shall include discrete transmitters and instrument loops, i.e. multi channel measurement of the same process variable shall not be derived from common instrument. As per NFPA, Triple supply viz.240VAC UPS, 24 V DC and 220 V DC shall be ensured for critical Boiler and Turbine protection.
   Both redundancy and diversity of trip criteria shall be considered to achieve sufficient guarantee a gainst non oper ability or unnece ssary oper ation of the

protection system. The principle of de energized to trip (Fail safe logic) shall be adopted.

10. Individual control elements shall be equipped with permissive to prevent the inappropriate operation of the item and "active interlocks" to trip the item in case of dangerous operation conditions.

11. Each of the multifunction controller together with its I/O and drive level control modules is to be understood as a self sustaining automation island, which executes the function allocated to it independently and is not affected by a disturbance in the adjacent island. For the purpose of lateral communication between the automation islands, a high speed redundant bus (the so-called control bus) should be provided which should be solely responsible for the automation (control) signal exchanges.

12. Alarms shall be provided for all abnormal conditions over which the operator has control in the control room, plus those abnormal conditions which are of interest to the operator because they may affect plant operation or security.

13. The following colors shall be selected for equipment status indicating lights:
- Red----energized, running, valve open
- Green----de-energized, stopped, valve closed
- Light yellow ----abnormal, discrepancy
- White----control power available

14. The functions of DDCMIS System are achieved through bus communication units, bus interfaces, process controllers, I/O modules and computers. The system shall be versatile and provide the user, the flexibility to freely choose configuration and redundancy. The system shall ensure very high reliability and safety through complete distribution and decentralization which goes right down to the individual I/O level.

15. Interposing relays with suitable contact rating shall be provided between DCS/PLC and MCC/Swgr in Interposing relay panels for giving command signals ON/OFF or OPEN/CLOSE. Interposing relays shall have minimum 2 NO and 2 NC contacts.

16. All parameters on which protection is achieved through pressure/ temperature/ flow switches; the measurement shall also be made available through transmitters. " **Provision of transmitter/remote sensor will be applicable for 70% of total protection signals for such important services which will be decided during detailed engineering"**

17. Also the system shall have the flexibility to easily reconfigure any controller at any time, without requiring additional hardware or system wiring changes and without disabling the devices from their normal operating mode.

18. The system shall execute all control functions with the help of a set of pre-programmed functions resident in controllers.

The offered system shall have provision for open system architecture to establish communication to any other system using open system standards such as UNIX, WINDOWS NT, WINDOW XP/7, TCP/IP, OSF, MOTIF, SQL Access etc.

19. The system shall 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 shall be a primary consideration in equipment selection.

20. The system shall provide inherent safe operation under all plant disturbances and component failures so that under no circumstance safety of the plant personnel or equipment is jeopardized.

21. The design of the control system and related equipment shall adhere to the principle of "fail safe" operation at all system levels and provide reliable and efficient operation of the plant under dynamic conditions and attainment of maximum station availability.

22. The DDCMIS shall be fully capable to operate plant in all regimes of plant operating conditions, including emergency operation/trip conditions, black out conditions etc. without resorting to manual control. The DDCMIS shall be capable of bringing the plant to safety state automatically without operator interventions.

23. All process input/output cards shall have built in galvanic/optical/electronic isolation for each input and output channel.

24. The failure of controller module and each I/O module shall be indicated on control cubicles and all operator stations.

25. For all the trip signals (very high/very low) employed for the boiler/Turbine Control System, **the alarms (High/Low) shall appear for correcting the process by the operators**.

26. For measurement of boiler metal temperature flue gas temperature, air pre-heater grid temperature etc., The bidder shall provide permanent/removable duplex type mineral insulated thermo-couples terminated in junction boxes at boiler platforms. Remote I/O unit has been envisaged for these inputs. 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 DDCMIS via DDCMIS 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 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 require for the system. This panel shall also be accommodate able for 4-20 mA and RTD signals of monitoring parameter and not for control parameters. The quantities **of remote I/O panels** shall be decided during detailed Engineering.

27. For measurement of turbine metal temperature turbine casing temperatures, stator winding temperature, Generator seal oil system, Turbine bearing temperature, Turbine oil temperature, Turbine bearing drain oil temperature, BFP turbine measurement parameters, MDBFP measurement parameters etc., The

bidder sh all pr ovide p ermanent/ r emovable dupl ex t ype m ineral i nsulated thermocouple/ RTD terminated in junction boxes at respective turbine side floors. Remote I/O unit has been envisaged for these inputs. The remote I/O panel shall be pr ovided w ith I /O cards, r edundant pow er su pply uni t and r edundant communication m odules et c. These par ameters are br ought t o D DCMIS via DDCMIS 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 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 require for the system. This panel shall also be accommodate able for 4-20 mA and RTD signals of monitoring parameter and not for control parameters. The quantities **of remote I/O panels** shall be decided during detailed Engineering.

28. **8 Nos. temperature elements/sensors in each units control room** shall be provided for monitoring the room temperature.

29. On unit tripping, about hundred Engineers shall be informed through SMS automatically from DDCMIS. Incase of tripping of major fans/pumps/HT drive the concerned Engineer configured in such a way shall get the SMS information.

    To ach ieve t he au tomatic SMS f acility, G SM (global sy stem for m obile Communication) with redundant Ethernet connectivity shall be provided by bidder for SMS facility. Same shall be co nnected with DDCMIS/OPC server/MIS server as decided during detailed engineering.

30. For A uto g eneration o f t rip m essage o f uni t & m ajor fans/pumps/HT dr ive t hru Email, Email facility in DDCMIS/OPC server shall be provided by bidder.

31. All the 4 nos. 40” LED TV monitors per unit and 2 nos. 40” LED TV monitors for common system at CCR shall be erected at the false roof top of central control room.

4.02.02 CONTROL SYSTEM PHILOSOPHY

4.02.02.1 In order to minimise the burden on the unit operator, all control functions within the operational load range shall be fully automated. The control system shall be structured in acco rdance w ith a well-defined control hi erarchy t o permit operator intervention at appropriate levels during abnormal modes of operation.

4.02.02.2 The automation shall meet the following objectives as minimum:

(a) Consistent start-up, shut down and running of the plant under all operational condition

(b) Achieve minimum run-up and loading time

(c) Maximize fuel economy during start-up, shut down and normal on load operation cycle

(d) Maximize plant life expectancy

(e) Contribute to power grid during normal and disturbance condition

(f) To meet the operational and safety requirements, the control system hardware and software shall conform to a modular, hierarchical architecture. The system hierarchy shall be at four levels.

4.02.03 Different Level of Controls

4.02.03.1 Drive Level

4.02.03.1.1 The first and lowest level shall cover all the modulating, sequence and protection control functions directly associated with all remotely controlled plant items. It shall also incorporate all necessary interlocks, initiations and trip functions for starting and stopping a main drive motor.

4.02.03.1.2 Control at this level shall either be initiated directly from the remote manual control interface or automatically by the next hierarchical level.

4.02.03.2 Subgroup Level

4.02.03.2.1 The second level shall coordinate the control of all first level drives, both closed loop and open loop, associated with a particular functional subgroup. In the case of a pump subgroup, for instance, the permissive checks, the coordination of the operation of the suction and discharge valves, the main drive initiations and the basic modulating control loops shall be executed at this control level. The major monitoring functions (e.g. turbine supervisory measurements) shall also be identified with this level.

4.02.03.2.2 Typical control functions associated with this level are:

i. Auto- Start and stop initiation or set point guidance from the next higher control level
ii. Start-stop- Normal initiation of the auxiliary start and stop sequence.
iii. Auto Standby-Start initiation in the event of duty item failure.

4.02.03.2.3 A functional group consists of different units, which individually represent and control a part of the complete plant and can be divided into two or more groups. Every sub group is controlled by an independent sub group control, which controls the operation of various drives. Once a start signal issued by a functional group, the sub group control brings the sub group from one state into another operating condition by issuing command signals in a programmed sequence. It brings the sub group from a shut down state into a working condition and vice-versa. The functional group instrumentation and control system co-ordinates the entire sub group controls belonging to one functional group.

4.02.03.2.4 Group Level

4.02.03.2.4.1 The third and penultimate level shall coordinate the individual subgroup control function (both modulating and sequence controls) within the main functional groups of the system.

4.02.03.2.4.2 The group co-ordinate the sub group of a functional group. Its main function is to

deliver start-up or shutdown command signals to the sub-group and change over from a faulty subgroup to the reserve sub group, the group co-ordination control supervises. the actual and the required position of the switchgear in the sub group and then decides whether the sub group shall be switched “ON” or “OFF”..

4.02.03.2.4.3 The aforesaid concept of functional group control is independent of the control techniques-freely programmable.

4.02.03.2.5 Unit Co-Ordination Level

4.02.03.2.5.1 The fourth level, which stands at the apex of the hierarchical triangle, shall perform the overall unit coordination. It shall incorporate, for example, the master load control function which should regulate the load generated by the generator to the demand set point value. In general for automatic start-up and shutdown control, the sequential initiations of the functional group sequences should be generated at this level.

4.02.03.2.5.2 The typical sequence control functions to be implemented at this level would include:

i. The sequential initiation of the subordinate functional group sequences for automatic start up and shutdown.

ii. The sequential initiation of the subordinate functional group sequences for automatic start up and shutdown of a part/full.

iii. The sequential transition to the various combination of subordinate functional Groups.

4.02.03.2.5.3 The modulating control functions to be implemented at this level would include the following:

i. Unit load control with frequency regulation incorporating load balancing (remote set point adjustment from the CCR /LCR shall be provided).
ii. Station load demand and demand rate limiting

4.02.03.2.5.4 In general the operator shall have direct access to all four control levels where these are identified, through the operator control interface located in the CCR.

4.02.03.2.5.5 Communication links shall be provided between the various control systems to allow for access to the system from any of the operator’s interface stations.

4.02.04 CONTROL SYSTEM - LEVEL OF AUTOMATION

4.02.04.1 The unit control and monitoring shall be performed from control room by means of OWS/KB operation interface mounted on unit control desk, through a microprocessor based distributed Digital control monitoring and information system.

4.02.04.2 The unit shall be remotely controlled, but a fully automatic system of the plant shall be provided, i.e. all valves, motors, final control elements and other equipment that have to be operated during start up, operation and shut down, belonging to the Main Systems, shall be remotely controllable from unit control room by the operator through Distributed digital control monitoring and Information system.

4.02.04.3 Subordinated drives belonging to one main aggregate shall be managed by means by sub group control systems. Automatic open/closed loop controls shall be installed wherever it is possible to lighten the work of the operation.

4.02.05 CLOSED LOOP CONTROL SYSTEM (CLCS)

4.02.05.1 The CLCS shall control the process variables automatically both under steady state and dynamic conditions with in the limits specified under guarantee clauses over the entire operational range of the equipment/system.

4.02.05.2 The CLCS shall have the following features:

(a) Provision of predictive and/or adaptive controls in addition to PID controls as required by the system. Availability of **advance control techniques/Algorithms** ensuring process optimization.

(b) Set point adjustments and indication from operating work stations/ KBs for process variables which need to be changed during load changes, start-up, shutdown, normal or under any other emergency conditions.

(c) Fixed set point at the software level/hardware level (only changeable by the maintenance engineer) and indication for those process variables which need not be changed with respect to load or otherwise.

(d) 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.

(e) 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. Auto tuning facility shall be an inherent feature of the DDCMIS. Availability of control loop of process parameters in auto for different loads. If required, the system shall have the feasibility of **auto changing of PID constants (K constants)** in micro-processor/controller for different loads so as to avoid hunting of control valve.

(f) Characterization of final control element to suit the various applications with respect to load or otherwise as dictated by the process.

(g) Function generator to provide necessary characterization or variation of set points with respect to load, speed or any other requirement.

(h) Soft Auto /Manual station interlocks to drive the final control elements to a suitable position for safe plant operation in the event of process/equipment abnormal conditions.

(i) Blocking/Interlocking function as dictated by process/equipment.

(j) Monitoring of loop failures or any hardware failure in the loops.

(k) Fail safe operation of final control elements in case of failure of motive power or

Signal.

(l) Redundancy criteria of sensors for CLCS shall be dictated as per NIT, Vol. V, Cl. No. 2.05.05.

(m) Redundancy criteria of I/O cards and Wiring for redundant or non redundant signals from field to control system (I/O cards & controllers) shall be dictated as per NIT, Vol. V, Cl. No. 4.02.08.02 and 4.02.08.02.1 respectively.

4.02.06 OPEN LOOP CONTROL SYSTEM (OLCS)

4.02.06.1 Protection, interlock and sequence controls constitute OLCS. This system shall enable the operator for safe start up and shutdown and carryout normal operation both from control room and local areas. Protection and Interlock shall be provided for all the equipment and system to safeguard the equipment against abnormal conditions which may result in the failure and less utility of the equipment and protect the operating personnel. Controls shall be provided to start/shutdown various systems and/or any equipment with associated auxiliaries and to operate the Unit on line with optimum number of operations and higher safety.

4.02.06.2 The OLCS shall have the following features as a minimum:

Features-General Requirements

(a) The logic and sequence control shall be Digital distributed microprocessor based and programmable.

(b) Enable the operator to start/stop various unidirectional motors, to open/close various valves and dampers and carry out inching operation of bypass valves or any other similar equipment both from control room and local areas.

(c) The system shall be designed based on the philosophy of command to energise a relay or solenoid valve.

(d) Where there is more than one pump or fan for the same service (say 2 pumps), auto standby features shall be provided to select the standby unit and this standby unit shall start automatically on failure of running pump or on applicable process criteria (say low discharge pressure) with an annunciation.

(e) All the contacts of the sensors used in protection circuit shall be monitored.

(f) Triple redundant sensors shall be provided when used in protection circuits for major critical equipment and 2 out of 3 logic shall be derived for further use in protection circuit

4.02.06.3 Features-Interlock Requirements

(a) Permissive conditions for a equipment start shall be provided. The permissive conditions within the equipment are bearing temperature normal, winding temperature normal, adequate suction pressure, bearing vibrations normal, bearing lubrication oil pressure normal, switchgear in service, switchgear not in test, no protection trip command persisting (as applicable) etc.

(b) The permissive conditions from a process system related equipment are

establishment of free path for the flowing medium under all start-up, emergency and shutdown conditions, closure of discharge valve for the starting of first of the identical pumps/fans and then opening the valve after the operating condition is established etc.

(c) Selection of standby equipment and starting the equipment automatically on the tripping of running equipment and/or desired process parameter conditions (say loss of discharge pressure or low level in the discharge tank etc.)

(d) Isolation of the tripped equipment from the main process.

(e) Any other conditions for safe starting and shutting down the equipment.

4.02.06.4 Features-Sequence Control Requirements

Sequence control shall be provided to start and stop the equipment and the associated auxiliaries. The sequence control shall have the following features:

(a) Once the start-up or shutdown of an equipment is initiated either manually or automatically from the system, the control of associated auxiliaries shall be automatic with facility for manual operation at each stage (step).

(b) Criteria check up for each stage of operation with monitoring and displaying.

(c) Bypass facility for each criteria when only the feedback signal/display is incorrect but the actual condition is fulfilled. This activity shall be logged and annunciated in control system (DCS / PLC).

(d) Adequate time delay between the steps as dictated by the process to establish an operating parameter or healthiness of an equipment.

(e) Normally, the auxiliaries of the standby equipment should be running (as applicable) so that the standby equipment is started without loss of time.

4.02.06.5 Features-Protection Control Requirements

The following minimum protection shall be provided for the various equipment/system as applicable to trip the equipment.

(a) Any condition which endangers the safety of the plant personnel

(b) Any of the permissive conditions becoming abnormal thereby producing a dangerous condition in operating the equipment.

(c) The conditions from process such as dry flow conditions, flashing conditions or any other conditions that may create cavitation.

4.02.06.6 Redundancy criteria of sensors for OLCS shall be dictated as per NIT, Vol. V, Cl. No. 2.05.05.

4.02.06.7 Redundancy criteria of I/O cards and Wiring for redundant or non redundant signals from field to control system (I/O cards & controllers) shall be dictated as per NIT, Vol. V, Cl. No. 4.02.08.02 and 4.02.08.02.1 respectively.

4.02.07 System Architecture for Main Plant Control System (unit wise)

Following Operating work stations & Engineering work stations per unit except wherever specifically asked for both unit, are envisaged for control & operation of main power plant from Unified Distributed Digital Control, Monitoring and Information System (DDCMIS) (Refer System Configuration Drawing, # 114-01-0100).

4.02.07.01 Option 1 – For Unified DDCMIS

4.02.07.01.01 Operating Work stations:-

i. 6 nos of Operating Stations (one no. of boiler control system like MFT, two nos., for BMS (FSSS), Boiler auxiliaries, two nos. for Turbine auxiliaries and one no. for electrical system & BOP) shall be connected directly on Proprietary/ preferably Industrial Data Highway/higher level network of DDCMIS with 2 LJP A4 B/W and 1 LJP A4 Color.

ii. 2 nos. of Operating Stations for Turbine Control System (governing system), like DEHGC, ATRS, ATT, ETS from the respective system shall be connected directly on Proprietary/ preferably Industrial Data Highway/higher level network of DDCMIS with 1 LJP A4 B/W & 1 LJP A4 Color.

iii. 1 no. of Operating Station for TSE for Unit incharge (shift supervisor) with 1 LJP A4 Color (if this is not integral of DDCMIS, TSE shall be connected with DDC MIS through redundant OPC connection).

iv. 1 no. of Operating Station for Unit incharge (shift supervisor) - Printer not required

v. 1 no. of Operating Station for Station incharge (in the cadre of Executive Engineer) with 1 LJP A4 B/W.

vi. 1 no of Operating Station for performance calculations & optimization for Unit incharge (shift supervisor) shall be provided with 1 LJP A4 B/W.

vii 1 no. of Operating Station for performance calculations & optimization at the Office of Executive Engineer/Efficiency shall be provided with 1 LJP A3 B/W.

viii. 1 no. of Operating Station for water chemistry parameters connected with performance calculations & optimization at the SWAS / Chemical Express lab shall be provided with 1 LJP A4 B/W.

ix. 1 no. common Operating Stations at Factory manager, and 1 no. common Operating Stations at Electrical System incharge room shall be provided for both units, operation/ command shall not be executed from these three consoles to start/stop the equipments. Software and hardware security lock shall be provided not to use these controls for any operations. 1 LJP A4 Color with each Operating station shall be provided.

x. 2 nos. of common Operating Stations for both units at common DDCMIS network in CCR with A3 sized color LJP.

4.02.07.01.02 Engineering Work stations & Servers:-

i. 2 nos. of Engineering Stations for system maintenance Engineer for unit DDC MIS system with 2 LJP A4 Color, 1 No. A3 sized Scanner, copier cum printer, 1 LJP Heavy Duty Industrial grade A3 Color.

ii. 1 no. Engineering Station for system maintenance Engineer for Turbine Control System with 1 LJP Heavy Duty Industrial grade A3 Color.

iii. 1 no Engineering Station for Turbine Stress Evaluation with 1 LJP A4 Color (if this is not integral of DDCMIS, TSE shall be connected with DDC MIS through redundant OPC connection).

iv. 1 no. of Engineering Station for Sequential Event Recording with 1 no. A3 sized DMP

v. Redundant Historian server (Historical Data Storage & Retrieval system) with Work station and 2 no. A3 sized DMP.

vi. 1 no. redundant server system for performance calculation & optimization (PADO) with Engineering work Station and Heavy Duty Industrial grade A3 Color printer.

vii. Redundant OPC server for OPC connections with DDCMIS from other systems with Work station & 1 LJP A4 B/W.

viii. Redundant MIS server with one no. MIS work station, and 1 no. LJP A4 B/W.

ix. Common Redundant OPC server for OPC connections with both units DDCMIS from other common systems with Work station & 1 LJP A4 B/W.

4.02.07.01.03 "The local operating stations 6 nos. per unit namely at locations like ESP, Zero M Elev. Turbine building, Boiler - A Elevation, HT Switchgear room, SWAS / Chemical Express lab room & CWPH (with 1 no. A4 sized B/W LJP) and 1 nos. namely at common locations like FOPH shall be provided with 24" LED color screen/OWS, with minimum configuration connected to DDCMIS on redundant connection to show the status/ conditions of various process parameters/equipments in process mimics, trends, logs etc with real time data.

Operation/command shall not be executed from these local operators' consoles to start/stop the equipments. Software and Hardware security lock shall be provided for not using these consoles for any control/operations. Specification of these local stations shall be same as specified at cl. no. 4.03.03.04 respectively.

All the locations/rooms availing the operating stations namely FOPH, CWPH, Boiler A elevation, Turbine 0 meter, ESP, Ash handling Control room, HT Switchgear room, 400 KV switchyard control room and SWAS / Chemical Express lab, DM Plant are to be air conditioned.

4.02.07.01.04 All operating stations connected on redundant data highway shall be interchangeable and operation of the plant shall be possible from Engg. station after security check. All operator stations shall have full access to the entire plant data base and shall have identical functionalities. The system shall have full data base redundancy. The data base shall be independent and shall reside separate from the operator stations.

4.02.07.02 Option – 2

i. Separate DCS based control system is provided for Turbine integral control and DEHGC, ATT, same shall be provided with complete configuration (OWS & EWS with printers) as specified above at cl. No. 4.02.07.01.01 (ii) & 4.02.07.01.02 (ii) and TSE's work stations & TSE's Engineering stations with printers & TSI work station with printers as specified else where in the specification.

ii. Separate DCS based control system is provided for Turbine protection (ETS – Emergency trip system), same shall be provided with one no. operating station and one no. operating cum engineering station and one no. A4 sized B/W LJP.

iii. Separate DCS based control system is provided for MFT & Boiler protection controls, same shall be provided with one no. operating station, one no. operating cum engineering station and one no. A4 sized B/W LJP and one no. A4 sized color LJP.

iv. For option 2, Qunatities of OWS & EWS shall remain same with DDCMIS as specified above at cl. No. 4.02.07.01.01 (i & iv to viii), 4.02.07.01.02 (i & iv to vii) & 4.02.07.01.03 irrespective of separate control systems (DCS) for Boiler integral controls and Turbine integral control respectively.

v. In case bidder provide separate Turbine control system & Boiler control system from DDCMIS. Then configuration of LVS shall be 4 no. LVS with Display controller as part of DDCMIS package, 1 no. LVS with display controller as part of Turbine control system and 1 no. LVS with display controller as part of Boiler MFT control system.

4.02.07.03 Option – 3

i. Separate DCS based control system is provided for DEHGC, TSC, ATT & Turbine protection (ETS – Emergency trip system), same shall be provided with complete configuration (OWS & EWS with printers) as specified above at cl. No. 4.02.07.01.01 (ii) & 4.02.07.01.02 (ii), one no. OWS for ETS/Turbine protection, and TSE's work stations & TSE's Engineering stations with printers & TSI work station with printers as specified else where in the specification.

ii. MFT & Boiler protection controls shall be part of DDCMIS.

iii. For option 3, Qunatities of OWS & EWS shall remain same with DDCMIS as specified above at cl. No. 4.02.07.01.01 (i & iv to viii), 4.02.07.01.02 (i & iv to vii) & 4.02.07.01.03, irrespective of separate control systems (DCS) for Turbine integral control system.

iv. In case bidder provide separate Turbine control system from DDCMIS. Then configuration of LVS shall be 5 no. LVS with Display controller as part of DDCMIS package and 1 no. LVS with display controller as part of Turbine control system.

4.02.07.04 Total 6 No. 80/84" diagonal sized LVS per unit shall also be provided for monitoring, operation and control of power plant as per details specified elsewhere in the specification.

2 no. common 80/84" diagonal sized **LVS** with their own display controller connected to both unit DDCMIS on common redundant OPC network to show the status/ conditions of various process parameters/equipments in process mimics, trends, logs etc of common BOP/Offsite packages with real time data shall be provided by bidder. These two nos, LVS are common to both 2 X 660 MW units and shall be located in CCR. Operation/command shall not be executed from these LVS to start/stop the equipments. Software and Hardware security lock shall be provided for not using these local LVS for any control/operations.

4.02.07.05 Modulating Controls (CLCS) and Discrete Open Loop Control (OLCS) shall be designed to eliminate the necessity of operator action except manual / auto selection, set point changes, biasing and similar actions during normal operation. Bumpless and balance less transfers between automatic and manual operation modes and vice-versa shall be provided automatically without need of operator action. Complete backup shall also be provided for safe shutdown operation of plant.

The system shall have built in redundancies for all system functions both at the processor and device level. No failure of any single device or processor shall lead to any system function being lost. It shall have redundant data highway on a "master less" principle.

Redundant equipment wherever provided shall be powered from redundant power supply units in order to improve system availability and reliability.

The system shall have the capability and facility for expansion through addition of station/drops, controllers, processors, process I/O cards etc., while the existing system is fully operational. The system shall have the capability to add any new control loop in CLCS and new group, sub group, drive functions in OLCS while existing system is fully operational. Intelligent I/O cards will be preferred.

All the basic systems shall be connected through redundant data high way/bus system. The local bus system with associated bus couplers shall be provided for communication between different I/O modules and processors. The communication system shall be designed keeping in view the integrity & security aspects for the control system. In case the system employs master communication controllers, facility for 100 % hot back up controllers with automatic switch over shall be provided and it shall be ensured that no loss of data takes place during failure of communication controller.

The DDCMIS shall be fully capable to operate plant in all regimes of plant operating conditions, including emergency operation/trip conditions, black out conditions etc. without resorting to manual control. The DDCMIS shall be capable of bringing the plant to safety state automatically without operator interventions.

The application programmes for the functional controllers shall reside in EPROMS or in non volatile RAMS. The application programme shall be alterable by access through programmer's console. Parts replacement or parts removal shall not be required for accomplishing changes in application programmes including control loop tuning. Each controller shall be equipped with the amount of functional capacity required to perform its specified functions and still have an overall spare capacity of 40%.

4.02.08 Redundancy & Availability Requirements

The CPU / Controllers, communication modules, data highway, power supply modules, etc for all DDCMIS/DCS/PLC shall be 100% hot standby redundant. I/O cards redundancy shall be as per cl. No. 4.02.08.02.

4.02.08.01 Controller Redundancy

All functional controllers for sequence control, functional controllers for closed loop control and functional controller for DAS & monitoring shall be provided with hundred percent hot standby controllers. However controller redundancy is not mandatory, where controller is purely executing data acquisition & monitoring functions. DAS function can also be integrated within CLCS/OLCS controller. All processors for modulating controls shall have self-tuning facility.

All the 100% hot back up controllers shall be identical in hardware and software to their corresponding main controllers. Further, each of the 100% hot back up controller shall be able to perform all the tasks of their corresponding main controller. The 100% hot back up controller shall continuously track/update its data corresponding to its main controller. There shall be an automatic and bumpless switchover from the main controller to its corresponding back-up controller in case of main controller failure and vice versa. The changeover shall take place within 50 msec. Engineered solution for redundancy in CPU are not acceptable. Dual redundant controllers shall be placed separately and shall not share the same motherboard or shall not have any other common sharing point.

Any switchover from main controller to 100 % hot back up controller and vice versa, whether automatic or manual shall not result in any process upset or any change in control status. The transfer from main controller to the back-up & vice-versa shall be indicated as alarm on all operator station OSs.

In case of switchover from main controller to back up controller, the back-up controller shall be designated as the main controller.

All the input variables shall be available to the main controller as well as its 100% hot back up controller so that any failure within the main controller shall not degrade the input data being used by the 100% hot back-up controller and vice-versa.

Each controller shall have 40% spare functional capacity to implement additional function blocks, over and above implemented logic/ loops under worst load conditions. Each controller shall have battery backup or EEPROM/NVRAM for program memory.

Parts replacement or parts removal shall not be required for accomplishing changes in application programmes including control loop tuning.

Each of the corresponding communication controllers shall also have same spare capacity as that of controller.

For controller, 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 (1) 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 all control Operating stations.
(f) In burst mode operation (in case of major equipment trip), 100 digital alarms are generated per second for a period of 10 seconds.

4.02.08.02 Redundancy in Input/output Modules

Hot standby 100% redundancy shall be provided for all input/output cards where inputs/outputs are used for CLCS and OLCS. All input/output of SCADA from/ to breaker & isolators shall be redundant. No redundancy at I/O card level is required which are executing purely data acquisition/monitoring functions. I/O card shall have 16 channels per AI/RTD/TC/AO card and 32 channels for DI/DO card. No. of channels per I/O card indicated are maximum, which may also further reduced to meet the I/O cards features specified elsewhere in specification.

Wherever redundant I/O modules/cards are used as per specification requirement, both (1:1 redundant) input or output modules shall execute the designated functions parallelly. The offered system shall have facility to enable final output from any of redundant input/output module, in case both modules are healthy. In case one of redundant card/module is unhealthy, the system shall detect the same and the output to and from system shall be given from the healthier card. I/O card redundancy shall not be achieved through relays, diodes or any other additional hardware or software, Engineered solution for redundancy in I/O cards are not acceptable.

Wherever redundant sensors are employed each sensor shall be wired to both input modules of redundant modules so that even if one input module fails, the both signals will be available from the other input module. This arrangement is necessary to avoid loss of both input signals due to failure of one input module where both the signals are connected.

In addition to above, 20 % fully wired input/output spare channel should be provided for each I/O modules.

Bidder to note that all type of hardwares & electronic modules like controllers, I/O cards, communication modules and interface modules etc used in DDCMIS/DCS/PLC shall be sourced/supplied from their Principal's works.

4.02.08.02.1 Wiring Scheme for inputs/outputs to/from control system shall be as follows:

i. Each of the triple redundant binary & analog inputs shall be wired to separate input modules. In addition, for functions employing 2V3 controllers (eg. Turbine protection, MFT, Boiler protection, DEHGC etc.), each of the triple redundant binary & analog signals shall be wired to separate input modules associated with each controller, so that even if one input module fails, the signal will be available from the other input module.

In case of dual redundant binary & analog inputs, each of the signal shall be wired to both input modules of redundant modules, so that even if one input module fails, the both signals will be available from the other input module. These redundant modules shall be placed in different racks, which will have separately fused power supply distribution. Implementation of multiple measurement schemes of these inputs will be performed in the redundant hardware. Loss of one input module shall not affect the signal to other modules. Other channels of these modules can be used by other inputs of the same functional group.

ii. The single (i.e. non-redundant) binary & analog signal required for control purposes shall be wired as follows:

All single analog & binary inputs (used for OLCS & CLCS) including the limit switches of valves/dampers MCC/SWGR check-backs of all drives, SOE & information related signals shall be wired to redundant input modules.

The binary and analog outputs from one subsystem of the Control System to other which are required in these systems for control & protection purposes, shall be made available from triple/dual redundant binary and analog output modules. Other binary & analog outputs used for DAS shall be non-redundant only. Failure of any single module shall not affect operation of more than one single drive.

4.02.09 DDCMIS/DCS Controller Grouping/Partitioning

All controllers shall be dual redundant except Triple modular redundant controllers for Turbine DEHC, Turbine protection & Boiler MFT/protection. Following tentative segregation for controls (OLCS, CLCS) & DAS is proposed, however final segregation shall be subject to Owner's approval during detailed engineering:-

a) Coordinated master controls, FTP, Oil System, Misc. Drives, Burner Tilt
b) IDF A, FDF A, Air flow and excess air correction, PA fan –A/AH – A/SCAPH-A/PA header Pr. Control.
c) IDF B, FDF B, Furnace draft, PA fan –B/AH – B/SCAPH-B
d) Mill related controls such as air flow/feeder rate/outlet temperature, Mill Lube oil controls; Two mills per redundant processor
   i. AB
   ii. CD
   iii. EF
   iv. GH
   v. JK
   vi. MN

e) Feed water/BFP Scoop control/CBD

f) TDBFP - A integral controls per redundant processor
   i. ATRS 1 SGC & Turbine Protection
   ii. ATRS 2 SGC, TSI & CLCS
   iii. DEHC (Digital Electro Hydraulic Governing System)

g) TDBFP - B integral controls per redundant processor
   i. ATRS 1 SGC & Turbine Protection
   ii. ATRS 2 SGC, TSI & CLCS
   iii. DEHC (Digital Electro Hydraulic Governing System)

h) MDBFP – C & Aux and Boiler fill up Pumps
i) Deaerator (three element controls), CEP, hot well, & Hot well makeup Pumps.
j) HP heaters 5, 6, 7 & 8.
k) LP Heaters 1, 2, & 3.
l) SH steam temperature control (multi variable control) & RH steam temperature control (multi variable control), Metal Temp.
m) DMCW Pumps & DMCW system for SG & TG and CPU* (* CPU incase DDCMIS controlled) .
n) COLTCS, HP & LP Dosing System and Cooling Tower & Aux.
o) Electrical system 1
p) Electrical system 2
q) Electrical system 3
r) **Remote I /O panel** with r edundant pr ocessor f rom D DCMIS f amily is to be implemented with following grouping for CW & ACW system

   i. CW Pump – A, CW Pump – C, ACW Pump A & CW lines to/from unit # 1 Condenser/Hotwell.
   ii. CW Pump – B, ACW Pump B, CW makeup system & CW lines to/from unit # 2 Condenser/Hotwell.

s) Turbine integral controls per redundant processor

   i. ATRS SGC Oil Supply, Turbine & Drains
   ii. ATRS SGC Condensate & Evacuation System
   iii. GSPC (Gland Steam Pressure Control), LP Bypass
   iv. GAMP (Generator Aux. Monitoring)
   v. TSC (Turbine Stress Evaluation Control System) & TSI
   vi. ATT (Automatic Turbine Tester)

t) SG integral controls per redundant processor

   i. Oil A B & Oil CD
   ii. Oil E F & Oil G H
   iii. Oil J K & Oil M N
   iv. Coal A B
   v. Coal C D
   vi. Coal E F
   vii. Coal GH
   viii. Coal JK
   ix. Coal MN

x. SADC & APRDS
xi. SBC controls, SBC PR & Drain Temp. controls.
xii. HPBP

u) Steam Turbine controls like DEHGC (TMR – Triple modular Redundant philosophy) and Turbine Protection (TMR – Triple modular redundant philosophy) with fail safe design cards can be Integral or separate stand-alone.

v) Triple Modular Redundant (TMR) processors for MFT & Boiler protection with fail safe design cards can be Integral or separate stand-alone.

All controllers at "sr. no. a to t shall be dual redundant (92 Nos. total)" and at "sr. no. u to v shall be triple redundant (9 Nos)" for each unit. Hence, altogether minimum 101 processors are envisaged for each unit. During detailed engineering, processor task allocation will be done amongst these processors (and shall be subject to owner's approval) taking into consideration the turbine control, boiler control and the station C&I portion altogether. In addition, loading of signal interfacing from other BOP packages, Aux. & control/monitoring system shall be considered for finalization of quantity of controllers.

For common system between two units, following redundant controller grouping shall be provided with unit 1 DDCMIS, which shall also be interfaced with unit - 2 DDCMIS for control & operation. **Remote I/O panel** with processor from DDCMIS family is to be implemented because of the long distance. Controllers shall be 1 no. dual redundant (2 Nos. total).

i) BTG (FOPH) Fuel Oil System

Above quantity of controllers is minimum, indicative and tentative only. However final quantities of processors in addition to above quantities shall be finalized depending upon I/O handling capacity of the processor and design parameters like response time, communication bus speeds etc. Overcrowding of control loops in controllers shall be avoided.

Each group has sufficient spare capacity of at least 25% to meet modification/extension of the system. Multi-function processors can incorporate the corresponding interlocks (open loop control tasks of the system). Interlock and modulating controls are to be so assigned to the processors in such a way that failure of any processor does not lead to shut down of the entire unit. In no case CPU loading should exceed 60% of its capacity. Bidder to submit calculation of CPU loading along with his bid.

4.02.10 Response Times

The system shall have adequate speed of response through all regimes of system loadings. The minimum criteria to be ensured are as follows:-

a) Key board command to field equipment shall be executed and its confirmation shall be displayed on the screen within1 second.

b) The response for operator requested display (time between pressing of last key and appearance of last character on screen) shall be of the order of one to two seconds under all loading conditions.

c) Dynamic parameters in the OS displays shall be updated in one second interval.

d) The cycle time for open loop and closed loop controls shall be as follows:-

i) For critical closed loops like Steam Separator level control, main steam temp. control, feed water flow control, HRH steam temp. control, HP/LP bypass control, furnace draft control & combustion control, the loop cycle time shall be max. 100 milli seconds preferably 50 milli seconds.

ii) For non-critical closed loops it shall be max. 250 milli seconds (preferably 150 milli seconds).

iii) For all open loops, sequential interlocks & protection it shall be max. 100 milli seconds.

(The loop cycle time is defined as the time taken from change at input module to change in output module for command).

e) All analog inputs to CLCS shall be acquired and data base updated within an interval of 50 milli seconds. Data for critical loops shall be acquired & data base updated at a faster rate to suit the requirements of (d) above.

f) The digital inputs for SOE shall be monitored at 1 milli second resolution.

g) The system shall acquire & check all inputs at the input scan rate. If the input is in alarm state (i.e. the input is in an off normal condition) the alarm status shall be annunciated, printed out and displayed within 1 second after the input is scanned.

4.02.11 Established Reliability

i) All components and systems offered by the Bidder shall be of established reliability. The minimum target reliability of each component shall be established by the Bidder, considering its failure rate/meantime between failures (MTBF) & meantime to repair (MTTR), such that the availability of the complete system is assured for 8700 hours / year (99.7%) or better.

ii) In order to ensure the target reliability the bidder shall perform necessary availability tests and burn in tests for major systems. Surge protection for electronic control systems, annunciation system and other solid state systems conforming to SWC test per ANSI C 37.90a (IEEE standard 472) and selection of proper materials, manufacturing processes, quality controlled components and parts, adequate derating of electronic components and parts shall be ensured by the Bidder to meet the reliability and life expectancy goals.

iii) Continuous self checking features shall be incorporated in system design with automatic transfer to healthy/redundant circuits to enhance the reliability of the complete system.

iv) In general, failure of equipment used for alarm purpose will cause switching to the alarm state.

4.03.03.04 Specifications for Operator Station, Engineering Work Stations

Each operating station & Engineering work stations and any other work stations/PC envisaged in plant shall meet following minimum requirements & as per latest trends at the time of supply:

- On board Intel – Xeon quad core, 3.46 GHz processor with 1066 MHz bus with Hyper threading or higher.
- 4GB DDR3 RAM (min.)
- 1 x 1000 GB IDE Hard Disc Drive of 7200 RPM or higher
- 1024 MB Graphic Accelerator
- System chipset: Intel Express
- 2 x RS – 232 ports
- 1 x parallel port
- 4 nos. USB ports. (2 nos. on front side)
- 1 x 52X DVD/CD Read Drive
- 16 X DVD R/W Drive
- 2 x Ethernet (10 / 100 / 1000MB) cards (Industrial Grade)
- UXGA graphics and monitor 1920 X 1080, 256 colours with MRPII compliant, viewing angle 178° vertical & Horizontal and fastest response time.
- 1 x windows XP/7 Professional or latest & proven version of Windows OS professional with Multimedia
- Ethernet adapter
- Third party operating system, graphical users interface and software, if required.
- 2 nos. graphic output crads minimum

- Optical mouse
- Sound card
- Internal speakers
- Wireless internet & Blue tooth Interface
- Redundant power supply (In built)
- General MS Windows latest, MS-Office Professional, Adobe Acrobat, anti-virus McAfee or equivalent, AutoCAD etc.
- Application engineering & HMI software - to suit project Specific requirement
- All OWS shall be interchangeable

Preferred makes of OWS/EWS/PC's are DELL, HPCOMPAQ, NEC & IBM.

4.03.03.04.01 Peripherals for Operator Station, Engineering Work Stations & Server System

4.03.03.04.02 Full flat Monitors with LED back lighting

The bidder shall furnish OWS/EWS/Servers/PC with coloured **Full flat Monitors with LED back lighting**. OWS/EWS/Servers/PC with **Monitors** shall have a fast cursor control device like a track ball/optical mouse. All **Monitors** shall be of high resolution colour graphics type and with not less than 32 colours. The picture frequency shall not exceed 85 Hz. The resolution required is 1920 X 1080 pixel or better. The picture shall be stable and completely free of any flickering. The screen illumination shall be enough to give good readability. The screen dimensions shall not be less than 24" screen diagonal.

Antiglare hard coating shall be provided. High reliability and long life 24" (Industrial type) or better size monitors shall be supplied by the bidder. **Monitors** shall be equipped with all adjusting elements accessible on the front plate. Monitors with 3D capabilities for graphics shall be provided by bidder.

Monitors along with keyboard & optical mouse shall be mounted on supervisory control console specified elsewhere in the specification.

4.03.03.04.03 Key Board:

Functional key boards for plant operator station shall be of special type adopted to operation tasks and monitor functions. It shall contain all keys necessary for plant operation arranged in an ergonomically manner. Multi function keys shall be provided with automatic display for modified functions. Freely programmable keys (Minimum 101) shall be available for special user application.

Key Board shall be integrated into supervisors control consoles horizontal part.

Provision of functional keyboard shall be in addition to facility for operator control through mouse/track ball.

Membrane type keyboard shall be provided for operator interface with process for plant control and display functions to access plant data in conjunction with control OPERATING STATIONs. Membrane keypad shall be assignable with LED alarms, dedicated display selection keys with spare provision, hardware locking facility to set OPERATING STATION in engineer, supervisor or operator mode. The keyboard

shall have a minimum of 101 configurable keys for assigning most frequently used displays. A minimum of forty of those keys shall have two independently lit LED's used for event-specific alarm annunciation.

Keyboard shall be provided to enable the shift supervisor to develop graphic displays, control system software and system configuration for the DDCMIS. It shall be possible to perform operating interface functions from engineering OPERATING STATION. Assignable function keys shall be provided for execution of command, program etc. Hardware facility shall be provided to set OPERATING STATION in engineer or operator mode. QWERTY type keyboard shall be provided for engineer's functions. QWETRY type Key Board may be offered alternatively for OWS.

4.03.03.04.04 PRINTERS

Line Impact Heavy Duty Dot Matrix Printers

All printers shall be low noise (less than 60dB) type with a minimum of 136 columns. Printing speed shall be a minimum of 300 characters per second. Since the control room printers are high-speed printers, the system shall output to these printers at the rate of 1000 lines of printout per minute as a minimum. This rate shall be independent of the number of printers in simultaneous operation. Style of printing available shall be indicated by the Bidder. The printers shall have graphic capability and any OPERATING STATION display may be printed on the printer. The printing shall be bi-directional and in two colours black and red for sequence of event recording. Paper input capacity shall be with continuous paper feed.

Printers shall accept and print all ASCII characters via an E.I.A. RS-232 C or twenty milliamp current loop interface. Parity checking shall be utilized.

All printers mounted shall be provided with a separate printer enclosure each. The enclosures shall be designed to permit full enclosure of the printers at a convenient level. Plexiglas windows shall be used to provide visual inspection of the printers and ease of reading.

Printer enclosures shall be designed to protect the printers from accidental external contact and each should be removable from hinges at the back and shall be provided with a lock at the front.

If one of the printers fails to operate, it's functions shall automatically be transferred to the other printer. Failure of the printer shall be indicated on all OPERATING STATION's. Printer shall be offered and supplied from reputed manufacturer with latest proven technology. 5 Rims of papers shall be provided by bidder for each printer provided with subject plant.

Coloured Laser Jet printer

Printing Speed	20 ppm (min.)
Resolution	1200 X 600 dpi
Memory	128 MB (min.)
External Port	1 no. USB 2.0 port, and TCP/IP 10/100 Ethernet, Blue tooth interface

Duty Cycle	40,000 pages per month
Pages size	A3, A4, and Transparency etc. with automatic duplex printing facility.

Laser Jet printer (B & W)

Printing Speed	30 ppm (min.)
Resolution	1200 X 1200 dpi
Memory	128 MB (min.)
External Port	1 no. USB 2.0 port, and TCP/IP 10/100 Ethernet, Blue tooth interface
Duty Cycle	15,000 pages per month
Pages size	A4, A3, and Transparency etc. with automatic duplex printing facility. Paper tray - 2

Ink Jet Printers (Coloured)

Printing Speed	30 ppm (min.)
Resolution	1200 X 1200 dpi
Memory	64 MB (min.)
External Port	1 no. USB 2.0 port, and TCP/IP 10/100 Ethernet, Blue tooth interface
Duty Cycle	5,000 pages per month
Pages size	A4, Transparency etc.
Duplex printing	Automatic

Five sets of print cartridges and Five rims of papers shall be provided with each printer provided anywhere in the plant by bidder with each DDCMIS, DCS & PLC system and any other system specified elsewhere in specification.

Preferred makes of printers are HP, Canon, Fuji Xerox, & Epson.

4.03.03.04.05 External DAT Drive

The DAT drive is a serial back-up device. The DAT drive shall have read/write capability and shall be provided with all required hardware interface including error detection and correction facilities in each control room. The tape (total 10 nos.) of Sony make shall have the capacity of 12/24 GB min. The tape drive shall be specified as follows:-

- DC drive
- Tape format - QIC-80
- Data Transfer Rate – 5MB/minute.
- Seek time – 22 milli second

4.03.03.04.06 Hard Copy Facilities

The system shall be capable of copying hard copy of OPERATING STATION graphics through a video colour copier switch able to any OPERATING STATION.

The printer/copier offered shall be capable of copying OPERATING STATION image in 20 seconds.

4.03.03.04.07 USB Port Pen Drive

Twenty Five (25) no. USB Port pen drive per unit having 32 GB memory with read/write facility shall be provided.
Preferred makes of USB pen Drive are HP, Sandisk, Kingston, Strontium.

4.03.03.04.08 Scanner, Copier cum Printer (A3 size)

Resolution	:	1200 x600 dpi (optical) (min) for Printer 600 x600 dpi (optical) (min) for Scanner
Colour Depth	:	48 bit
Scaling	:	10 to 2000% in 1% increments
USB interface	:	required.
Memory	:	1 GB
Printing Speed	:	30 ppm (min.) for A4 size 20 ppm (min) for A3 size
Duplex printing		Automatic

4.03.03.04.09 DVD Writer

The DVD writer should be capable to read and write any DVDs as well as CDs. and shall be provided with all required hardware interface including error detection and correction. The DVD writer shall meet following minimum requirements:

- DVD write speed - 16x
- CD write speed - 52x
- Cache / Buffer size - 2MB
- Buffer under protection technology

Five nos of DVD (Re-writeable) shall be provided with each OWS/server provided anywhere in the plant by bidder with each DDCMIS, DCS & PLC system and any other system specified elsewhere in specification.

4.03.03.04.10 Digital B/W Copier cum Printer (A3 size)

01.	Type	:	Laser, tabletop / latest
02.	Printer Memory	:	512 MB (min.)
03.	Speed	:	Monochrome 30 ppm - A4 20 ppm – A3
04.	Resolution	:	600 x 600 DPI
05.	No. of color (Basic)	:	Monochrome
06.	Duty cycle	:	Monochrome more than 75000 pages / month
07.	Power supply	:	240 V, 50 Hz, 1 phase UPS
08.	Ambient temperature	:	0-50° C
09.	Humidity	:	95% non-condensing.
10.	Size of paper	:	Paper weight of 45 to 165 g/M^2

11.	Networking Capability	:	USB / Ethernet
12.	Coping	:	Max Original Size – A3, Continuous Coping (1-999)
13.	Accessories	:	i) Adapters
			ii) Connector Cable
			iii) Duplex Unit. Automatic
			iv) Optional Paper feeder- 2 Nos

4.03.03.05 Lap Top

The LapTop shall meet following minimum requirements:

a) Intel Centrino™ Mobile Technology.
b) Intel Core – i7 Processor with 3.46 GHz, 4 MB L2 cache, 1066MHz FSB.
c) 14" WXGA LED Screen with wide angle viewing.
d) 500 GB 7200 rpm HDD with shock absorber.
e) 4 GB 800 MHz DDR3 SDRAM (slot for 1no. additional RAM slot should be provided)
f) 1 x windows XP Professional or latest & proven version o f Windows O S with Multimedia
g) Slim type DVD-RW/DVD ROM combo drive.
h) Internal 10/100/1000Mbps Ethernet card
i) IEEE 802.11B connectivity port
j) IR port
- Optical mouse
k) 2Nos. USB ports & Wireless INTERNET & blue tooth interface
l) External mouse connectivity and optical mouse
m) Minimum 8 hrs battery backup.
n) Recovery software tools.
o) Sound cards
p) Internal speakers
- General MS Windows latest, MS-Office Professional, Microsoft Visual Studio, Adobe Acrobat, anti-virus McAfee or equivalent, etc.
q) Application engineering & HMI software - to suit project specific requirement

Preferred makes of Laptop are DELL, HPCOMPAQ, VAIO (Sony), Lenovo.

4.03.03.06 General Specification of the server:

Enclosure	:	6U Rack Mountable server / Tower type Sever
Processor	:	Intel Xeon Quad (4) Core 64 bit Processor capable 3.6 GHz with 16MB L3 cache memory per processor, Dual independent 1333 MHz system bus (2 way SMF) or better.
Memory	:	64GB ECC DDR – 3, 800 SDRAM

Video	:	Integrated with 64MB SDRAM
Resolution	:	1920 x 1080
Drives	:	HDD – RAID 5 (1000 GB) Ultra 320 SCSI adaptors with internal storage capacity 3.6 TB DVD/CDROM – 24X CD – RW/DVD IDE combo USB – 4 ports DAT – 36 / 72 GB
Peripherals	:	PS/2 keyboard Optical Mouse
Operating system	:	Windows 2008 server version standard / latest Enterprise Edition or latest & proven version of Windows Operating system
Backup & Disaster Recovery	:	VERITAS \ CA \ Tivoli \ any other
Environmental	:	Operating Temp range - 10°C to 35°C Humidity range - 8 to 80% (Non-Condensing) Vibration 0.25 G at 3 to 300 Hz for 15 Minutes.
Software	-	General MS Windows latest, MS-Office Professional, Adobe Acrobat, anti-virus McAfee or equivalent, etc. Application eng ineering & H MI so ftware - to su it project Specific requirement
Miscellaneous	:	i. 1 Parallel port ii. 1 Serial port iii. 4 – 10/100/1000 MB/1GB network ports iv. Two non-boards and two added v. External SCSI port vi. Dual hot plug power supplies vii. Dual Hot plug fans viii. 2 PCI Express slots (1x4 lane and 1x8 lane) ix. 2 PCI X slots (64bit/100MHz) x. 2 PCI slots (one 32bit/33MHz, 5V & one 64bit/66Mz) xi Redundant Server shall be provided, wherever required. xii. LED based 24” sized Monitors.

Preferred makes of OWS & Servers are DELL, HPCOMPAQ, Lenovo.

4.03.03.07 Industrial grade managed type Ethernet switches

Industrial grade managed type Ethernet switches shall be provided with in built diagnostic features, 20% spare ports & inbuilt redundant 24 V DC power supply features and Integrated Security features (IPS, ACL, Firewall). Industrial grade managed type Ethernet switch sh all be r ack m ounted and co mply with the I EC 61850 (3) a nd I EEE 1613 requirements. Switches shall have 10 GB module support for future upgradeability

4.03.03.08 **The Firewall shall meet following minimum requirements:**

Industrial grade Firewall appliance should facilitate multi-vendor, m ulti-application environment and should support third-party products on open al liance. It should support Active-Active configuration.

i. The firewall should contain following features:

   (a) Stateful inspection of packets.

   (b) NAT functionality, including dynamic and static NAT translations

   (c) Latest version of SNMP

ii. The firewall must send log information to a se parate log server via an encr ypted connection. Firewall logging must not impact firewall performance.

iii. Remote ne twork acce ss to t he firewall sh ould onl y be possible through t he administration interface.

iv. The firewall administration station m ust be capable of pushing firewall se curity policies and co nfigurations to i ndividual or m ultiple firewalls through a secure, encrypted connection to the firewall administration interfaces.

v. Graphical User Interface (GUI) and a Command Line Interface (CLI) for making changes to the firewall rules set should be provided. (Access to the firewalls via the GUI or the CLI must be through an secure encrypted channel).

vi. Any changes or commands issued by an authenticated user should be logged to a dat abase co nfigured on any of t he machines i n t he LA N. The adm inistration station must allow for a hierarchical architecture for rules set administration and viewing of firewall configurations Management.

vii. The firewall must not support any unencrypted means of access to the firewall.

viii. It should Monitors ALL network traffic-traffic at Firewalls (Internet and external networks), in the DMZ and detect known threat through deep packet inspection.

ix. Detects unknown threats via anomaly scanning.

x. Detect unknown threats via behavior pattern to protect from zero day attacks.

xi. Keeps up-to-date on new threats and vulnerabilities.

4.03.03.09 **Software License**:

The B idder sh all pr ovide so ftware l icense for al l so ftware being use d i n DDCMIS/PLC/simulator/any other electronic/microprocessor based system. The software licenses shall be pr ovided for the project (e.g. organisation or site license) and sh all not be hardware/machine-specific. That is, if any hardware/machine is upgraded or changed, the same license shall hold good and it shall not be nece ssary for Owner to seek a new license/renew license due to upgradation/change of hardware/machine in

DDCMIS/PLC/simulator/any other electronic/microprocessor based system at site. All licenses shall be valid for the continuous service life of the plant.

In case the s/w license is dependent on no of points, then quantity to be considered is 30% above the finally implemented points.

Software Upgrades

As a customer/owner support, the Bidder shall periodically inform the designated officer of the Owner about the software upgrades/new releases that would be taking place after the each system is commissioned and handing over to owner, so that same can be procured & implemented by bidder at site.

The future updated version of any type of software shall be supplied free of cost as and when such software is upgraded, on request by owner until 5 years from the date of commissioning of the unit.

4.03.03.10 Separate Laptops shall also be provided with all master software loaded and engineering of DDCMIS, DCS, simulator & any other control system individually. Similarly additional Laptops shall be provided with all master software loaded and engineering of PLC system individually.

As explained above, One No. Laptop with necessary master software loaded and engineering of each control System shall **be** supplied individually.

4.03.03.11 **SOFTWARE DOCUMENTATION AND SOFTWARE LISTINGS**

All technical manuals, reference manuals, user's guide etc., in English required for modification/editing/addition/deletion of features in the software of the DDCMIS, DCS & PLC / any other microprocessor based control system/simulator etc shall be furnished. The Bidder shall furnish a comprehensive list of all system/application software documentation after system finalisation for Owner's review and approval.

The software listings shall be submitted by the Bidder for source code of application software and all special-to-project data files.

4.03.04 Programming, Diagnostic and Engineering Work Station

There shall be Two (2) no. work station with 24" sized (Industrial type) LED monitor, associated hard disk 3½", Two color laser jet printer and associated peripherals, as like 52X CD drive, DVD Drive, DVD/CD writer, 1 No. A3 sized Scanner copier cum laserjet printer, and A3 heavy duty industrial grade Coloured LJP with DDCMIS.

For PLC based control system, same shall be provided as listed in Annexure A.

The Engineering stations provided wth DDCMIS, DCS & PLC shall have all the function of programming/ configuration/modification/ reconfiguration and documentation. The features and facilities to be included are as under:-

a) Configuration or re-configuration of a system.
b) Possibility to introduce or modify parameters.
c) Documentation of system configuration.

4.05.00 Design Criteria for BOP packages' Control System

4.05.01 Design Criteria for Programmable Logic Controller (PLC) System

The PLC for BOP packages shall have following features:

i. The PLC system shall fulfill and demands emanating from the domains

- Automation
- Monitoring
- Process control
- Management
- Engineering

ii. Uniform operator machine interface

iii. Reliable user guidance

iv. Comprehensive redundancy concept

v. Modern object oriented software structure

vi. Shall be able to communicate with external system and intelligent field equipment

vii. Simple central project planning and configuration aids

viii. Integrated documentation system

ix. Integrated diagnosis and service

x. Commissioning support
The Control System shall have on-line simulation & testing facility.

xii. The system shall have the flexibility to easily reconfigure any controller at any time without requiring additional hardware or system wiring changes and without disabling other devices from their normal operation mode. Modifications shall not require switching *off* power to any part of the system.

xiii. Fault Diagnostics
Complete software for microprocessor based system including the communication software between systems, MIS system etc., shall be supplied and implemented. The software shall be also included for equipment performance test, life evaluation, equipment capability curve and alarm analysis, Management information system, etc.

xiv General I/O requirements of PLC based system shall be as per cl. No. 4.02.08.02, 4.03.11 and Annexure B.

xv Bidder to note that all PLC system shall be from same manufacturer only. PLC system supplied & engineered through system house shall not be acceptable. It should be supplied & engineered directly from PLC manufacturer only. It is preferred to have each PLC system with hardwares from same family of Plant DDCMIS.

xvi. Design & Functional Requirements as per the cl. No. 4. 02.00 detailed for DDCMIS/DCS system shall be applicable for each PLC based control systems.

xvii. PLC shall be provided with necessary redundant ports & complete hardwares for Auto time synchronization from Master clock time by bidder.

4.05.02 Technical specification for PLC

4.05.02.1 The latest proven PLC system shall be provided. PLC should be sourced from original manufacturers; PLC from system house shall not be acceptable. PLC system shall be complete with hot standby redundant CPU of word length of 32bits minimum, Input /

Output modules, dual serial link interface module for connecting Input / Output Modules, dual Communication Processors, dual Memory modules and redundant Power supply units. Power supply unit shall be redundant for each CPU & I/O rack. PLC system will be interfaced with DDCMIS through OPC dual redundant communication interfacing (to be provided at PLC & DDCMIS end) for important process parameters. PLC shall confirm to IEC – 61131.

4.05.02.2 Redundant CPUs in hot standby mode shall operate on fault tolerant mode with continuous self and cross monitoring facility. Redundant CPU/controllers shall be placed separately and shall not share the same motherboard.
Failure of the active CPU shall not adversely affect the operation of the plant in any perceptible way. Failure of the active CPU will lead to transfer of the tasks being performed to the other healthy CPU within fastest possible transfer time (i.e. ≤ 50 m sec.) without causing any output to drop during the Transfer period. In the Event of the both the CPU failure, the system shall revert to the Fail-safe mode. The CPUs shall not be loaded over 60% of the Individual capacity even under worst data loading conditions. It shall be possible to switch from the active to the back-up CPU and vice versa from Operating station as well from the CPU front panel. (The worst data condition of PLC means all modules in active mode, printer in operation, OLCS&CLCS logics active and process in running condition). Data bus loading shall not be more than 50%. This configuration shall be applicable for each type of PLC based control system. Engineered solutions for redundancy in CPU & I/O cards are not acceptable.

4.05.02.3 The system shall be of modular construction and expandable by adding hardware modules and incorporating them in the address register. Bidder shall provide at least 20% overall with minimum two no. spare channels as hot-on-rail spares in each configured cards / Modules. In addition to this 10% or minimum one no. extra assigned complete spare cards mounted on rails in sub-racks for each type of I/O modules shall also to be provided. The spare channel and cards shall be fully wired up to termination cabinets. Spare Philosophy as detailed in cl. No. 4.03.11 for DDCMIS/DCS system shall be applicable for each PLC based control systems.

4.05.02.4 The memory unit of the CPU shall be field expandable. The memory capacity shall be sufficient (min. 8 MB per CPU) for system operation and shall have the capability for future expansion at least to the tune of 40%. The application program / sequence logic etc. shall be stored in non-volatile memory (EPROM). However all the dynamic memories shall be provided with battery back up with at least for 96 hours. Lithium or Ni-cd battery shall be used. The quantities of Hot standby redundant CPU/controllers for each PLC system shall be finalized during detailed engineering by owner depending upon CPU/controller's worst data loading conditions and CPU/controller's functional distribution.

4.05.02.5 The max number of Input / Output points per card shall be 32 for digital and 16 for Analog / Thermocouple / RTD. No. of channels may also reduced to meet the I/O cards feature specified in NIT. Individual input channels shall have galvanic isolation. Output points shall also have optical / galvanic isolation. Merely fusing of individual or a group of channels is not acceptable. The I/O cards shall be rack mounted. Failure of Analogue I/O cards, binary cards / modules shall also be displayed on the Engineering cum diagnostic station.

4.05.02.6 The data communication system of the PLC including that of its redundant system bus with hot back up and other allied buses such us I/O bus, local bus etc., shall fulfill the following minimum features. The bidder shall furnish all the calculation details of CPU utilization and Bus loading. Bidder shall also furnish communication protocol used for the offered PLC.

i. Communication links (I/O bus) between CPU and individual Input & Output (I/O) modules rack shall be dual redundant with 10 Mbps speed and 16 bit CRC data protection feature. In no case failure of a link shall affect the control of the plant.

ii. The communication system design shall ensure that any single point failure on the system bus / media shall not disrupt not more than single message and disrupted message shall be automatically retransmitted after the standby communication link takes over control.

iii. Failure of physical removal of any station / modules connected on the system bus shall not lead to any loss of communication.

iv. Diagnostics display both at operating workstation and module front end shall be provided for easy fault detection.

v. Bus change over from active bus to stand by bus, during failure of active bus shall be performed automatically and bumpless. Such event shall be suitably logged or alarmed.

vi. The system communication between PLC controllers and the operators stations shall be conducted at high speed minimum 100 Mbps with Ethernet based open protocol with no collision feature to avoid data jamming / overloading of the system. The communication bus, serial link etc. shall have adequate protection against electrical noise and mechanical damage.

vii. System should have open bus structure and should allow further extension facility and connection with any third party system.

h. PLC Network shall also be provided with external surge protection system and industrial firewall.

4.05.02.7 Man Machine Interface (MMI) shall be industrially ruggedised Operator's station based on latest window based market available software along with its peripherals like LED monitor, printer, mouse. Engineering functions shall normally be carried out from dedicated workstation or operating station as per annexure-A "control system for BOP". In case a dedicated engineering station is provided, EWS shall also be worked as operating station through password / Hardware lock. The monitor refresh time i.e. latency time should be $\leq$ 2 second.

4.05.02.8 The Operator's station shall perform the following minimum requirements.

a. Selection of Auto / Manual, Open / Close operation, sequence auto, start / stop operation etc.
b. Dynamic Mimic display detecting the entire process for control monitoring purpose.

c. Alarm monitoring, report generation, logs, calculations and printing of logs, reports, trends etc.
d. Online / historical trending, historical storage and retrieval of data.

4.05.02.9 Software provided shall be latest, modular, upgradable and industrially proven. It shall have capability for multi tasking, multi programming, multi user operation in real time environment and support for third party system. Bidder shall provide the following minimum requirements:

1. Required software for fulfilling the complete implementation of the control logics, operation displays, logs, data storage, retrieval, diagnostic and other functional requirements as indicated in this specification.
2. Detail documentation on all programming software's and this shall be part of the O & M manual.
3. Supply of Licensed version of all software both in edit and run mode with multi – user license. All the third party softwares should be latest and market available.

4.05.02.10 a. Bidder shall provide and connect suitable communication hardware / software/ cables and other accessories required for connecting all numerical relays as per IEC – 61850 of auxiliary in PLC / SCADA where PLC with OWS.

b. Bidder shall provide firewall (hardware) in various layers to protect PLC from other network as per ISA – SP – 99. Communication to any third party system shall be via industrial grade anti spam, anti virus Firewall only.

c. Bidder shall provide redundant software/hardware link with "online" in Motion Bridge computer and other belt weight system with CHP PLC system to calculate coal flow to indicate following status:

i. Daily and cumulative coal unloaded by track hopper.
ii. Daily and cumulative coal sent to stockpile.
iii. Daily and cumulative coal sent to boiler bunker.
iv. Amount of coal available in stockpile.

d. Remote indication in centralized control room (DDCMIS) for total coal unloaded in 24 hours from ECHS shall be provided.

e. A pneumatic control valve shall be provided at the interconnection line between service air header and instrument air header before air dryer unit. When instrument air header pressure falls below set value, the control valve will start opening and maintain the instrument header pressure at specified level in line with plant requirement. Again when instrument air header pressure goes above specified level in line with plant requirement the control valve will fully close automatically. Complete system shall be in bidder scope.

4.05.02.11 PLC shall specifically meet the following requirements:

(a) PLC shall have extensive self-diagnostic capability. Self diagnostics shall include both module level diagnostics as well as channel level diagnostics

(b) PLC shall have hot standby redundant processors/controllers. This shall mean the fulfillment of the following requirements:

(i) Automatic synchronisation of primary processor/controller of PLC with secondary processor/controller

(ii) Bumpless switchover to secondary processor/controller of PLC when the primary fails.

(c) Automatic program and data equalisation in the event of any on-line program / edit executed in the primary processor/controller of PLC.

(d) Automatic "Forcing Bit" update in the secondary processor/ controller of PLC when any " Forcing is applied in the primary processor/controller of PLC.

4.05.03 **SYSTEM REQUIREMENT & SPECIFICATION**

4.05.03.1 The system shall have high MTBF and shall be hot maintainable. The system hardware shall be designed to be fault avoidant by selecting high grade components of proven quality and properly thermally de-rated design. The system shall have extensive fault monitoring, self surveillance & on-line self diagnostic capability so that failure upto module / card level is immediately detected. Each of the modules shall have its self – diagnostic system. The operator station located at the area control room shall be used for fault data presentation and monitoring purpose.

4.05.03.2 The system shall have capability to automatically check & correct gain & drift for ADCs on-line.

4.05.03.3 All data exchanged in a bus shall be fully monitored & checked for validity.

4.05.03.4 Loop Cycle time in PLC shall be equal to or less than.

a. OLCS : 100 ms or less
b. CLCS : 250ms or less

4.05.03.5 Following operations will be performed on I/Os, as required:

1. Square root extraction
2. Pressure & Temperature compensation
3. Responsibility check of all inputs (analog specially), validate and quality tagging like good, bad, suspects etc
4. Channel wise engineering unit conversion.
5. Contact bounce filtering with adjustable time constant.

4.05.03.6 All controllers shall be freely configurable with respect to requisite control algorithms. An extensive library of macros shall be included for the purpose adequate software capability shall be provided to implement closed loop control functions as follows:

i) P, PI, PD and PID control and their variations.
ii) Open loop (On- Off, sequence control)
iii) Cascade control
iv) Ratio control

4.05.03.7 For open Loop Controls, the system shall have, as a minimum, the following features:

a) Logic functions like AND/OR/NOT gates, timers (on-delay, off-delay), shift registers, counters, latches, flip-flops, mono – shots, tantalizers etc.

b) The automatic sequence control to ensure sequential start up and shut down of auxiliaries / equipment. Sequence control shall be performed in groups initiated by command from operator's console. A sequence shall be made of steps executed in predetermined order according to logic criteria. For each step there shall be a provision for 'waiting time' and 'monitoring time', and it shall output an action on the process. System shall have the capability to by pass one step if desired by the operating personnel by forcing an input or output from the operator's station. Such action however will be registered as an exception or alarm.

c) Increase the reliability and availability of the plant as a whole, for example, by timely and correct switchover to standby drives etc.

d) Basic interlock and protection logic related to safety of individual drive and plant equipment. All inputs required for protection system shall be on high priority basis. In the event of either loss of control power or control signal input to the drive, the drive shall remain in its last position unless specifically required otherwise. The system shall be designed such that no upset occurs either to process or to the drive when the power is restored.

4.05.03.8 Interface of the PLC system with AC Solenoids & DC Solenoids shall be in the form of potential free contacts via interposing relay modules mounted in the interposing relay cabinet. 20% additional interposing relay modules shall be provided as installed spare. For AC solenoids and contactors directly driven from output cards, arc suppressors & MCB shall be provide across the coil.

4.05.03.9 **Displays**

4.05.03.9.1 The operator's station shall be responsible for handling all commands as well as in generating desired displays, logs, reports, alarms and printouts. Security in different levels shall be provided to prevent unauthorized access to the system.

4.05.03.9.2 Programming shall also be permissible by drawing Ladder or Boolean diagram or through any easily understandable language. Single programming instruction / command shall be sufficient to delete a program rung from memory. Similarly, any rung can be inserted into the existing program. The active and the standby CPU programs shall equalize automatically, once the new program is permitted to 'RUN'.

4.05.03.9.3 Updating time and reaction time (system's response to an operator's command) shall be provided for operator station as follows:

a. Calling up a mimic : 1 sec or better

b. Updating status signal in mimic : 1 sec or better

c. Updating variables in a mimic : 1 sec or better.

d. Issuance of command to output : 2 sec. or better

(without considering travel time and process lag)

4.05.03.9.4 Programmable Controller shall be responsible for real time process Parameter monitoring, storage and display. Basic requirements are (i) Operator Interface, (ii) Basic

Calculation, (iii) A larm Monitoring & R eporting, (iv) D isplay g eneration, (v) Lo gs, (vi) Trend Recording & (vii) Historical Storage & Retrieval.

4.05.03.9.5 The di splays at the op erator co nsole sh all be cl assified i nto ov erview D isplay, g roup display, point display, alarm display and trend display.

a) Overview display – This display is to enable the operator to set an overview of the entire plant section.

b) Group di splay – The gr oup di splay page sh all di splay se veral su b-sections & present status information.

c) Point di splay – Along w ith t he s pecified pa rameter v alue, t his page sh ould indicate historical trend of the parameter.

d) Trend di splay – This display include r eal t ime/historical trend di splay facility including Dynamic Graphic Display & Bar Graph Display.

e) Alarm Message Display – It shall be possible to display process as well as system and di agnostic alarms for oper ator's attention a nd act ion. A larm shall appear immediately on t he operator station as and when they occur on pr iority basis. I n addition to alarms appearing on displays, the system shall also be able to display alarm summary and alarm history listing the date and time of occurrence, tag number, poi nt descr iption, t ype of al arm (absolute v alue or de viation), se rial number of alarm in the sequence of occurrence etc. A larm shall disappear from display on ly when they are acknowledged and cl eared. Any abnormal condition in any sub-system or any ot her function devices shall be displayed as system alarm message on the operator console irrespective of display selected.

4.05.03.9.6 The system shall print the following logs as minimum as defined in the Following clauses. The printing of these l ogs shall be i nitiated automatically at prescribed time intervals, or initiated on demand by the occurrence of predefined events.

Shift/Daily Log

A S hift/daily l og shall be pr ovided t o furnish dat a for routine a nalysis of pl ant performance. This log shall be aut omatically printed at specified time each day and on demand at any time.

4.05.04 **Salient hardware / software features of the PLC system**

The salient hardware / software features of the PLC system for I/O handling shall be as follows.

1. Input filters to attenuate noise.
2. SWC of 500v DC common mode and 500V AC peak to peak
3. Comm. Mode Noise rejection for analog inputs of 120dB at 50 HZ
4. Normal mode noise rejection for analog inputs of 60 dB at 50 HZ
5. LED indicators on each card to show status of input
6. All the outputs shall be with individual fuse.
7. K type thermocouple mV input where applicable.
8. Pt-100 three wire resistance thermometer input where applicable.

9. 24 V DC power supply to field mounted two wires transmitters.

4.05.04.1 The salient hardware / software features of the CPUs as follows:

a)	Watch dog timer	:	Periodical reset, Alarm and interruption, if not reset within stipulated time.
b)	Max. Scan time for I/Ps	:	1 sec. max. for measurments
c)	Maximum Scan Rate	:	2.5 ms (per k word)
d)	Memory Capacity	:	40% spare capacity after full utilization Expandable in multiples of 16K.
e)	Comm. Processor	:	Integral / Separate
f)	Power Supply	:	Dual redundant at each CPU rack
g)	Control Processor	:	32 bit processor , RISC based.
h)	Battery back up for RAM	:	Ni-Cd / lithium type, at least for 96 hrs continuous Operations during power failure.
i)	Diagnostic feature	:	Periodic, automatic, self-diagnostic. Result available at the Operator's Station.

4.05.04.2 **Input / Output Modules:**

Bidder to note that All I/O cards shall be sourced from their original manufacturers/Principal. Indigenous cards shall not be accepted. No. of channels per I/O card may reduced to meet the I/O cards features specified in NIT. The salient features of the Input / Output modules are as follows:

a) All I/O Cards

1.	Ambient temp.	: 0-50 degree C
2.	Surge withstand capability	: IEC-255.4
3.	Power Supply	: Dual redundant at each I/O rack

b) Digital General

1.	No. of channels / card	: 32 max
2.	Interrogation voltage	: 24/48 VDC
3.	Status Indicator	: LED Type./channel
4.	Isolation	: Optical (channel to channel)
5.	Electrical Isolation	: between system and field

c) Digital Input Module

1.	Contact bounces filtering	: Adjustable time constant of 15m.sec.
2.	Self Diagnostic	: Wire break, Short Circuit

d) Digital Output Module

1.	Output protection	: Short ckt protected and individual fuse

e) Analog General

1.	No. of channels/card	:	Input /output – 16 channel
2.	Isolation	:	Galvanic/Optical (channel to channel)
3.	Status Indicator	:	LED Type./channel
4.	Fuse protection for failure	:	Individual for each signal

f) Hi-Level Analog Input Module

1.	Type of input	:	4-20mA DC & 1-5VDC
2.	A/D Converter	:	14 bits + Sign (or better)
3.	Accuracy	:	0.1% or better
4.	Diagnostic	:	A to D / Channel fault, Short circuit, wire break
5.	Power of transmitter	:	24 V DC 2W type

g) Low Level Analog input Module

1.	Type of output	:	PT-100; T/C (As required)
2.	C-J-C	:	On Module
3.	Accuracy	:	0.1% or better
4.	A/D converter	:	14 bits + sign (or better)
5.	Diagnostic	:	A to D / Channel fault, short circuit, wire break

h) Analog Output Module

1.	Type of output	:	4-20mA DC
2.	Accuracy	:	±0.1% or better
3.	Load	:	600 OHM
4.	Diagnostic	:	Channel fault

i) The maximum number of channels with LEDs indications that can be provided in a single module shall be:

(i) Digital input module/ Digital output module - 32
(ii) 4-20mA input/output modules - 16
(iii) Thermocouple / RTD input module - 16

j. Input/Output modules shall have the following features:

The functions performed on digital inputs shall include:

(i) Signal isolation (optical)
(ii) Fuse protection & monitoring
(iii) Short circuit protection
(iii) Contact bounce protection
(iv) Contact monitoring for trip and causes of trip inputs
(v) Contact interrogation at 24/48 V DC
(vi) Configurable as status input, latched input or pulse input
(vii) Direct or reverse sense
(viii) Alarming of abnormal state

k. Digital outputs shall have the following characteristics:

i) Individually fused
ii) Individual contact suppression
iii) Configurable as momentary, latched or pulse- width modulated Outputs
iv) Individually definable default state
v) Output read back verification
vi) Short circuit protection

l. Analog inputs can be 4-20 mA DC, RTD, thermocouple. A/D converter shall have a minimum resolution of 14 bits. Functions performed on analog inputs shall include

i) Signal isolation (Galvanic/opto coupling)
ii) Fuse protection and fuse failure detection
iii) Transmitter power supply at 24 V DC
iv) Input filtering for noise level
v) Cold junction compensation for thermocouples
vi) Transmitter monitoring for parity, wire break, live zero and end limit values
vii) Monitoring of A/D conversion
viii) Test for substituted value
ix) Conversion to engineering units
x) Test for normal or extended range
xi) Detection of open circuit for thermocouples
xii) Alarm limit testing for high, low, high high and low low substituted values
xiii) Rate of change - positive and negative dead band
xiv) All analog signals fed to the control system shall be acquired and validated.

m. Analog outputs shall be 4-20 mA DC with the following characteristics:

i) Direct or reverse operation
ii) D/A per output and power regulator per output
iii) Loop check back of output
iv) Default options upon failure
v) 5-segment output characterization
vi) Go to zero current

4.05.05 **PLC Configuration**:

The PLC configuration will have a hierarchy of industrial grade open system architecture for management information system (MIS) and closed system architecture for plant operation and control system.

The specification of Peripherals for Operator Station, Engg Station & printers for PLC/microprocessor based system shall be as same as specified at cl. no. 4.03.03.04.

The complete MIS system including hardware, software, cables etc, as required shall be provided. This shall acquire dynamic pre configured points and mimics as required by Owner.

The closed system architecture for plant operation and control system is secure and deterministic system for real time operations of the plant.

Industrial grade managed type Ethernet switches shall be provided with features as same as specified at cl. no. 4.03.03.07.

PLC Network shall also be provided with external surge protection system and firewall.

"The Bus systems (like Profibus/ Modbus etc) or the Serial Port Systems (like RS-232/ RS-485 etc) shall be protected with suitable surge protection devices, confirming to the latest IEC-61643-21 guidelines. The surge handling capacity of device shall at least be 10 KA, 8/20 µSec between core-core and 20 KA, 8/20 µSec between core-ground. The device shall be pluggable & on-site testable".

All the operator stations will be 'work stations grade' as same as specified at cl. no. 4.03.03.04 and are required to reside on the main redundant bus running on IEEE 802.4 or IEEE 802.5 to facilitate determinism.

4.05.06 Redundancy Criteria (For details also refer chapter no. 2)

i. Redundancy of components and systems shall be dictated by availability criteria to ensure the system availability target as well as safety considerations in critical applications.
ii. Dual/Triple redundancy for sensors and transmitters will be used for critical and semi critical applications i.e for interlocks/trip/protection conditions (as decided by Owner).
iii. The Wiring Scheme for inputs/outputs to/from PLC control system shall be as same specified at Vol. V, cl. No. 4.02.08.02.1.
iv. Sensor redundancy (1 out of 2 or 2 out of 3) requirement shall be indicated in the respective control system.
v. The CPU / Controllers, communication modules, data highway, power supply modules, etc for all PLCs shall be 100% hot standby redundant.
vi. All drive input/output modules redundancy shall be as per Annexure – B.
vii. All input/output of SCADA from/ to breaker & isolators shall be redundant.
viii. Redundant Cooling fans with fire retarded filter for panels/cabinets

4.05.07 CONTROL PANEL AND OPERATOR INTERFACE (For details also refer chapter no. 6)

i. Operating console desks for OPERATING STATION's and KB shall be provided by bidder along with their printers in AC control room.

ii. OPERATING STATION/KBD shall generally be used for control and monitoring.

iii. Complete industrial grade Furniture for mounting Operating stations, Swivel Chairs, Printers, Keyboards, Computer etc. shall be furnished by bidder.

iv. In the Back up Control desk and relay based system following operator interface devices shall be provided as per Annexure A.

a) Control station (illuminated P.B. stations, Desk P.B., control switches etc).
b) Hardwired Annunciator with push buttons.
c) Coloured Mimic with LEDs for Drive status (ON, OFF, & trip) and level (Low & High) of tanks.
d) Process recorders, indicators & A mmeters as deci ded dur ing det ailed engineering.

v. Control panels housing the control cards/equipment marshalling cabinets shall be located in a co ntrol room; and sh all have IP-32 m in. degree of p rotection as per IS-13947 offering dust and vermin protections, 2 mm thick steel sheets (CRCA) shall be adopt ed for fabrication, co nsistent with w eight o f dev ices, co ntrol equipment t o be m ounted. U PS panel s shall b e w ith 2 m m t hick st eel sh eet (CRCA). Cable gland plate thickness size shall be 3mm. Mimic shall be made of Acrylic sheet with thickness of minimum 6/7 mm.

vi. Panels shall be furnished co mplete w ith requisite acce ssories such as transformers, regulators, switch fuse units, MCB, MCCB and ot her power supply equipment to adopt the sources of power supply to requirements of panel mounted instruments and devices.

vii. All panels, cabinets and enclosures shall be furnished, fully, wired with necessary provisions for convenience outlets, internal lighting, grounding, ventilation, space heating, and vibration isolation pads, double compression cable glands, integral piping and other accessories as per IS: 5039- 1969.

viii. The sealing o f panel s/cabinets/enclosures bottom w ith bot tom plate. Double compression cable glands and suitable sealing material to prevent entry of dust shall be in t he B idder's scope. S uitable ar rangement for pr eventing fire propagation through cable entry points like fire seals etc. shall also be provided at cable entry points.

xi. Fire/Smoke D etector, N eoprene/silicon G asket, E xhaust Fans with l ouvers & filters shall be provided in all consoles and panels.

x. All the panels shall be equipped with Anti vibration pad of 15 mm size.

xi. PLC with OWS –

a. All winding/Bearing Thermocouple/ RTD shall be connected to PLC.
b. All anal og i nputs i.e. Temperature, P ressure, flow, l evel, v ibration et c. shall be connected to PLC.
c. Only important parameters shall be display on desk / Panel.
d. Bidder shall provide Ammeter on panel for all HT Motor current & $\geq$ 15 KW LT Motor and very important LT drives as decided during detail engineering.

Checklist for Serial Communication between maxDNA Systems and Foreign Device :BHEL

A Device Specific :

SN	Parameters	Options available	Remarks if any
1	Modle No.& Make of Device		
2	Communications Link Options	☐ Multidrop ☐ Peer to Peer ☐ N/w topology attached	
3	Protocol Mode (Device is a)	☐ Master ☐ Slave ☐ Master/Slave	
4	Protocol	☐ RTU ☐ ASCII ☐ Other ----------	
5	Master	☐ System maxDNA ☐ Other ----------	
6	Dist.bet.maxDNA System & Device*	☐ ---------- Feet ☐ ---------- Meters	

B Electrical Spcific :

1	Interface Type	☐ RS232 ☐ RS422 ☐ RS485	
2	Wiring at Device end	☐ 2 Wire ☐ 4 Wire	
3	Transmission Channel	☐ Half Duplex ☐ Full Duplex	
4	Baud Rates (bps)	☐ 1200 ☐ 2400 ☐ 4800 ☐ 9600 ☐ 19200	
5	Databits	☐ 8 ☐ 7	
6	Stopbits	☐ 1 ☐ 2	
7	Parity	☐ None ☐ Odd ☐ Even	
8	H/w & Software Handshake	☐ Yes ☐ No	
9	Response Timeout time (Sec)	☐ ---------- ☐ Configurable timeout	
10	Data Formats Supported	☐ Boolean ☐ Real ☐ Char ☐ Sn.Int ☐ UnSn.Int	
11	Transmission mode	☐ Asynchronous ☐ Synchronous	

C Application Specific : *

1	Primary Function*	☐ Data Acquisition ☐ Data Acquisition & Control	
		☐ Download parameter sets	
2	Analog Points to read	--------Nos. ☐ Details attached ☐ Details not attached	
3	Analog Points to write	--------Nos. ☐ Details attached ☐ Details not attached	
4	Digital Points to read	--------Nos. ☐ Details attached ☐ Details not attached	
5	Digital Points to write	--------Nos. ☐ Details attached ☐ Details not attached	
6	Memory / Flag Points to read	--------Nos. ☐ Details attached ☐ Details not attached	
7	Memory / Flag Points to write	--------Nos. ☐ Details attached ☐ Details not attached	

D Hardware Specific :

1	Cable type	☐ Boolean cable ☐ Twisted pair cable	
2	Cable Details Enclosed	☐ Yes ☐ No	
3	Any specific Converter required	☐ Yes ☐ No ☐ Details enclosed	

E Device Documents :

1	Manufacturer's Documents*	☐ Tech., Spec. ☐ Operating Manual	

***Notes:**

A6 To identify converter requirement and cable length.

C The sr.no.1 to 7 are reqd.to be furnished for interface impl. :such as Tagname,Description,point type, modbus(Register) address,EU,range & device (dlave) address

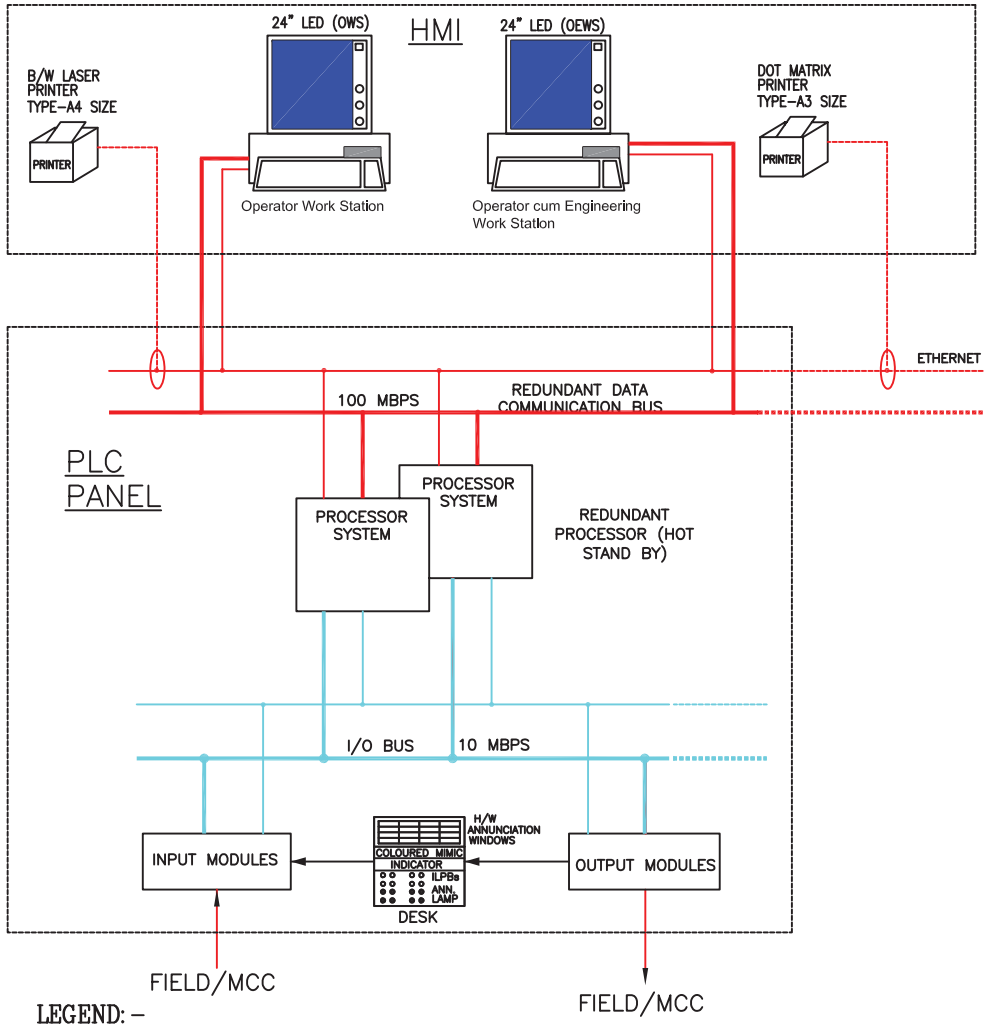
C1 What is the primary purpose of the communications link?

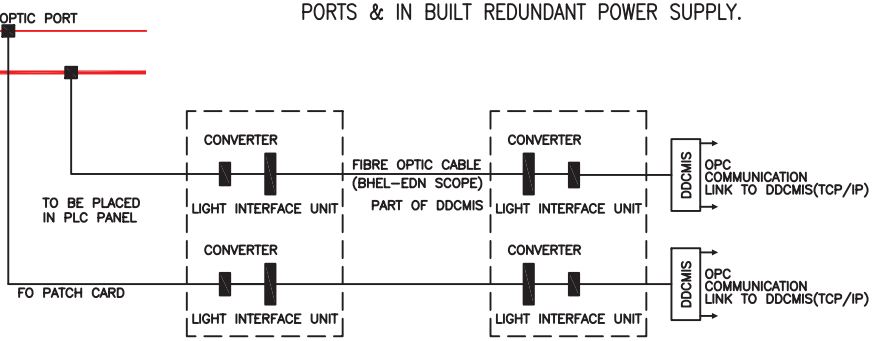
E1 Reqd. Contents : This document must provide an overview of the device including its intended use(a general technical,communication & electrical details)

Format for vendor to furnish signal
Exchange list between DCS-PLC

Tag Name	Tag Description	Modbus address	Point type	Range	Alarm Setpoint	Alarm priority	History reqd	Function code	

SYSTEM CONFIGURATION DIAGRAM





NOTES:

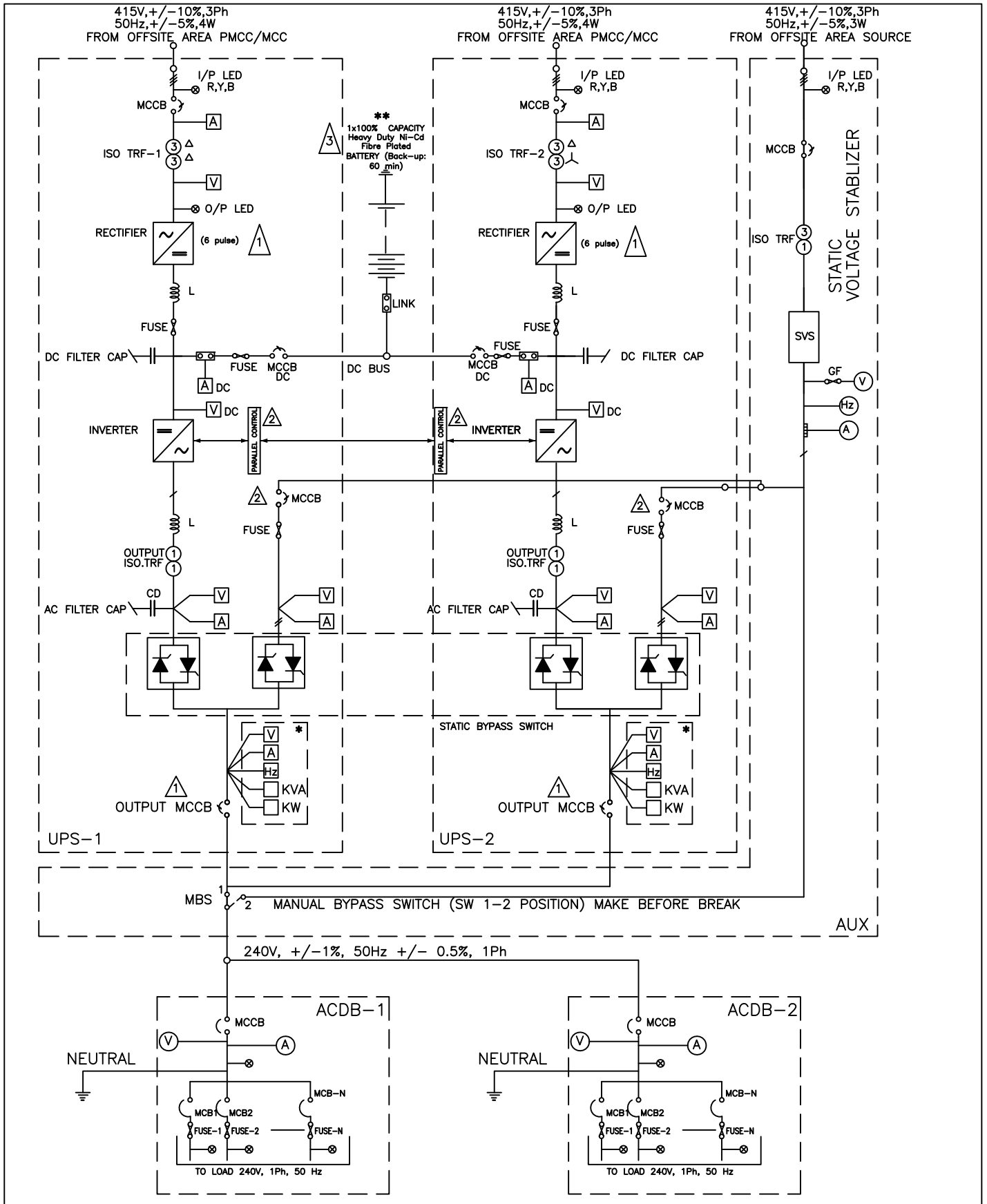
1) TABLE TOP OWS/OEWS SHALL BE OF LED 24" AS PER TECHNICAL SPECIFICATION.
2) PLC SYSTEM SHALL HAVE HOT REDUNDANCY IN PROCESSOR, COMMUNICATION SYSTEM AND POWER SUPPLY.
3) PARALLEL REDUNDANT UPS POWER SUPPLY SHALL BE PROVIDED FOR PLC PANEL(S), OWS/OEWS AND NETWORK COMPONENTS.
4) POWER SUPPLY ARRANGEMENT FOR PLC SYSTEM SHALL BE AS PER THE UPS SCHEME FOR OFFSITE, DOCUMENT No. PE-DG-412-145-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.

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

TITLE:– PLC SYSTEM CONFIGURATION ELETROLYTIC CHLORINATION PLANT (FOR CW & PRETREATMENT PLANT)	DRG. NO.		
	REV. No.	1	DATE
	SHEET	1 OF 1	

DOCUMENT FOR UPS



* V, A, Hz, KVA, KW READINGS/VALUES SHALL BE READY ON THE MIMIC DISPLAY PROVIDED ON THE UPS PANEL FRONT DOOR.
** SINGAL SET OF BATTERY FOR LOAD < 15KVA & 2-SETS OF BATTERY FOR UPS RATING > 15KVA SHALL BE PROVIDED. 2

BHEL	PROJECT:- 2 X 660 MW ENNORE SEZ STPP	DRG. No.	PE-DG-412-145-I004		
	TITLE:- UPS SCHEME FOR OFFSITE	REV. No.	03	DATE	31.07.2015
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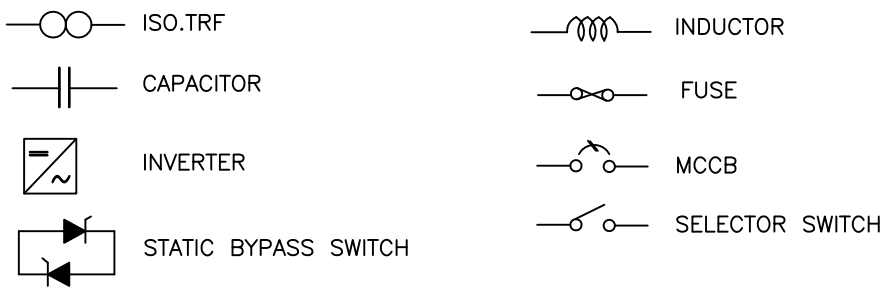
GENERAL NOTES:

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. REDUNDANT FEEDERS SHALL BE PROVIDED FOR EACH LOAD. △3
4. △2 ONLINE BATTERY HEALTH MONITORING SYSTEM SHALL BE PROVIDED FOR MAIN PLANT & OFFSITE UPS.
5. 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.
6. FILTER CIRCUITS SHALL BE PROVIDED ON AC & DC SIDE AS REQUIRED.
7. UPS DB SHALL HAVE 1$\varnothing$240V MCB OUTGOING FEEDER.
8. RECTIFIER SHALL HAVE FACILITY FOR BOOST CHARGING THE BATTERY.
9. △1 TRANSDUCERS SHALL BE PROVIDED FOR GIVING 4–20mA ISOLATED SIGNALS FOR DDCMIS & PLC.
10. POTENTIAL FREE CONTACTS FOR ALARMS/FAULTS SHALL BE PROVIDED FOR USE IN DDCMIS & PLC.
11. BOTH STATIC TRANSFER SWITCHES SHALL BE SELECTED ON AUTO MODE FOR AUTOMATIC TRANSFER TO BACKUP SUPPLY.
12. △2 UPS SYSTEM SHALL WORK IN "CRISS –CROSS REDUNDANCY" CONFIGURATION. HENCE THE UPS SYSTEM DESIGN SHALL ENSURE THAT IN CASE OF ONE OF THE CHARGER FAILURE, THE OTHER HEALTHY CHARGER, SHALL FEED TO ONE OF OR BOTH THE INVERTORS AS THE CASE MAY BE AND CONTINUE TO CHARGE THE COMMON/INDIVIDUAL DC BATTERY BANKS AT ALL LOAD CONDITIONS.
13. △2 SURGE PROTECTION DEVICE (SPD) SHALL BE PROVIDED AT INPUT SIDE OF EACH UPS & STATIC VOLTAGE STABILIZER.
14. △2 BATTERY JUNCTION BOXES SHALL BE AS PER CUSTOMER SPECIFICATION REQUIREMENT.
15. △2 THE REQUIREMENT OF INDICATION OF ON, OFF & TRIP SHALL BE AS PER CUSTOMER SPECIFICATION.
16. △3 FOR A.C. POWER DISTRIBUTION PANELS(INCLUDING 20% SPARE FEEDERS ON EACH PANEL WITH 2 Nos. MINIMUM SPARE FEEDER OF EACH RATING) AND DIGITAL TYPE AMMETER, VOLTMETER, FREQUENCY METER, PF METER, WATT METER & VA METER QTY OF UPS FOR BTG & FOR EACH INDIVIDUAL BOP PKG IS 2 SETS QTY OF FEEDERS SHALL BE AS ON REQUIRED BASIS.

LEGEND:



BHEL	PROJECT:– 2 X 660 MW ENNORE SEZ STPP	DRG. No.	PE–DG–412–145–I004		
	TITLE:– UPS SCHEME NOTES & LEGEND	REV. No.	03	DATE	31.07.2015
		SHEET	4 OF 5		

⚠2 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

3. LIST OF ALARMS (MIN.) TO DDCMIS THROUGH POTENTIAL FREE CONTACTS :–
   - I) RECTIFIER – 1 TRIP.
   - II) INVERTER – 1 TRIP.
   - III) UPS BATTERY LOW.
   - IV) RECTIFIER – 2 TRIP.
   - V) INVERTER – 2 TRIP.
   - VI) LOAD ON STATIC BYPASS.
   - VII) STATIC BYPASS FAILURE
   - VIII) ACDB – 1 INCOMER TRIPPED.
   - IX) ACDB – 2 INCOMER TRIPPED.
   - X) UPS – 1 FAN TRIPPED.
   - XI) UPS – 2 FAN TRIPPED.

CHAPTER-7

UNINTERRUPTIBLE POWER SUPPLY SYSTEM & 24 V DC SYSTEMS

7.01.00 GENERAL REQUIREMENTS

7.01.01 This subsection covers design, construction and performance requirements of parallel redundant industrial grade Uninterruptible Power Supply (UPS) System & parallel redundant 24 V DC System to be furnished by the Bidder for BTG, Station C & I Package & BOP/offsite packages & any other control system/sub system specified elsewhere in the specification. The Bidder shall furnish separate parallel redundant industrial grade UPS System for each unit DDCMIS/DCS Package and separate parallel redundant industrial grade UPS System for each BOP package including static inverters, static switches, manual bypass switch, chargers, A.C. Power distribution panels and Batteries with all required isolating and protecting devices and all other equipment and accessories required for completeness of this system. Bidder to note that there will be no common component like in phase transformer (IPT), common power supply to any redundant component and common point of failure in the UPS & 24 V DC system.

7.01.02 The requirements of UPS system & 24 V DC system are specified herein on system basis. The Bidder shall be responsible for engineering and furnishing a complete and operational system fully meeting the intent and requirements of this specification and Owner approved drawings.

7.01.03 The equipment furnished under this subsection shall meet the requirements of all applicable codes and standards including ANSI, NEMA, TEEE, NEC and IS.

7.01.04 The UPS System & 24 V DC system hardware shall be from the latest established product range of a qualified manufacturer. The Bidder shall furnish documents to satisfy the owner that the design, performance and high availability of the proposed UPS System, 24 V DC system and all system components have been established by a considerable record of successful operation in utility power station for similar application. All UPS system & 24 V DC system cabinets, enclosures and distribution boards shall be manufactured, assembled, wired and fully tested as a complete assembly as per the requirements of this specification in the manufacturing works of a qualified manufacturer prior to shipment to the project site. Class of insulation of wound components (All transformers, chokes/inductances etc.) shall be class H with temp rating up to class B.

7.01.05 The UPS, 24 V DC system equipment and the complete system shall have surge withstanding capability (SWC) to meet the requirements of ANSI C 37.90a – IEEE Standard 472 –1974. UPS & 24 V DC charger system should be provided with Class C type surge protection device. The Class C type surge arrester should be single MOV type, pluggable, should have fault indication and should be tested as per IEC 61643-1 to withstand 40KA 8/20 µs pulse. The arresters should have potential free contact to ensure maintainability.

7.01.06 All non-interrupting components of UPS system & 24 V DC systems shall be capable of withstanding all available short circuit current without damage. Additionally, all circuit interrupting components shall be capable of withstanding and interrupting all encountered short circuit currents without damage.

7.01.07 All control and instrument circuits shall be fused. Fuses shall be mounted inside the enclosures and shall have easy accessibility. Fuses shall be Buss man low-peak type or Owner approved equivalent. All load fuses shall be to Owner's approval equal. The Bidder shall co-ordinate all load and line fuses applications to ensure that load fuses operate properly.

7.01.08 The bidder shall be responsible for ensuring that UPS System, 24 V DC system and the downstream power distribution system for equipment to be serviced by are coordinated such that UPS loads continue to operate without interruption and in accordance with the power supply tolerance requirements (both voltage and frequency) for these UPS loads as long as at least one source is within the limits of voltage and frequency as specified herein. The Bidder shall furnish single line diagrams with his proposal to demonstrate how this requirement is met for all equipment and system covered under Bidders scope.

7.01.09 The UPS system & 24 V DC System shall be installed in AC room.

7.01.10 Acoustic noise at rated linear load shall be < 75 dBA at 1 meter distance from UPS as per ISO 3746.

7.02.00 <u>FUNCTIONAL REQUIREMENTS OF UPS</u>

7.02.01 CAPACITY OF UPS SYSTEM FOR main plant PACKAGE, remote I/O panels and BOP/OFF-SITE PACKAGES

Parallel redundant UPS shall be sized by the bidder to cater to power for the bidder furnished loads such as plant control, monitoring system. Min. capacity shall be considered as 150 KVA (or as per system requirement in case capacity is higher than 150 KVA) at 50 deg. C ambient. All microprocessor based system, I/o cards, digital equipments, operating stations, printers, peripherals, receiver instruments, SWAS, CEMS, LVS, HMS, TSI, VMS, PADO, C&I Lab, Operator training Simulator system and other devices mounted in supervisory control desk, control panels and other microprocessor based system for BTG shall be operated on UPS power.

Each Individual parallel redundant UPS shall be designed considering 20 % design margin over and above any capacity mentioned in specification; UPS sizing calculation shall be submitted for approval. While computing the base capacity of the UPS, inrush requirements of connected loads shall be duly considered. The inrush shall be taken as 300% of steady state load lasting for 100 milli seconds. The base capacity shall be computed by bidder on above basis and to provide for at least 10% variation to cater to changed load requirements during detailed engineering stage. Bidder shall detail in the technical bid, the steady state as well as inrush requirements of each of the loads furnished by him and justify the selection of UPS capacity duly satisfying the requirement of 20% design margin.

This base capacity shall be guaranteed at 240 V AC, 50 Hz single phase output at 50 deg. C & 95 % RH – non condensing at ambient conditions. Ratings other than standard ratings of the manufacture shall not be acceptable. Number of distribution feeders in completely redundant configuration shall be offered to suit the load distribution as decided during engineering. Spare feeders of at least 20% of the total number of feeders with 2 nos. minimum spare feeder of each rating shall be built in.

Separate industrial grade parallel redudnat UPS system for each set of Remote I/Os cum processor panel of DDCMIS and each BOP/Offsite package & any other control system/sub system specified elsewhere in the specification, shall be provided of suitable capacity with similar features as of main plant UPS by the bidder. UPS system for remote I/Os panels and BOP/Offsite package & any other control system/sub system specified elsewhere in the specification shall be kept in the respective package UPS rooms.

UPS sizing calculation shall also be submitted for approval for each system/package. Diversity factor shall be considered as 1 for calculating the UPS capacity.

7.02.02 The parallel redundant Uninterruptible Power Supply (UPS) system of continuous duty shall supply, regulated, filtered and uninterrupted 240 V, 50 Hz, single phase power, within specified tolerances, to system AC loads, UCB mounted monitoring system, and other critical loads. Each of these critical loads shall receive one feeder from the AC Distribution Board of Inverter-"A" and another feeder from the AC Distribution Board of Inverter-"B". However, each inverter shall supply only 50% loads under normal conditions as indicated below. SLD of UPS as per NIT drawing # 114-17-0100 shall also be referred by bidder.

7.02.03 All necessary equipment required for protecting UPS equipment and connected inputs and outputs shall be furnished by the Bidder as an integral part of this system. Complete UPS system shall be automatic without any manual interference at any time of operation.

7.02.04 True, 100 % parallel redundant configuration also means availability of " Criss-Cross Redundancy". Hence The UPS system design shall ensure that in case of one of the charger failure, the other healthy charger, shall feed to one of or both the invertors as the case may be and continue to charge the common/individual DC battery banks at all load conditions. UPS system shall work in "Criss-Cross Redundancy" configuration to safeguard the battery bank from unnecessary drainage. The bidder should note that this situation should not in any way lead to the discharge of the DC battery and maintain the UPS power supply to all loads.

7.02.05 The industrial grade UPS system for BTG & for each individual BOP package shall include the following equipment:

Sr. No.	Descriptions	Quantities for UPS of main plant Package	Quantities for UPS for each remote I/O panel & BOP package
1.	100% capacity of IGBT based PWM Inverter with output Voltage, current, frequency, KVA & KW digital display/meter.	2 nos.	2 nos.
2.	100% capacity static switches with input Voltage, current, frequency digital display/meter at bypass line.	(As required) 2 no. (Min)	(As required) 2 no .(Min)
3.	Manual by-pass switch	1 no.	1no.
4.	100% capacity of 12	2 nos.	-

	pulse controlled f loats-cum-boast Chargers		
5.	100% ca pacity of 6 pulse controlled floats-cum-boast Chargers	-	2 nos.
6.	100% Battery Set each	2 set (each For 2 hour back-up)	1 set (For 1 hour back-up) in case of UPS rating less than 15 KVA. 2 sets (For 1 hour back-up) in case of UPS rating more than 15 KVA.
7.	Step-down transformer (415 V, three phase , to 240V, single phase) of required capacity)	1 no.	1 no.
8.	Static Votage S tabilizer with i nput & out put O N Red i ndication and i nput & output Voltage, current, frequency di gital display/meter.	1 set	1set
9.	Input isolation transformer with input & output ON red indication and input Voltage, current, frequency di gital display/meter. Out put isolation transformer	1 no. each	1 no. each
10.	A.C. P ower D istribution Panels (including 20 % spare feeders on eac h panel with 2 no s. minimum spare f eeder of each rating) and digital type A mmeter, V oltmeter, Frequency m eter, P F meter, Watt meter & VA meter	2 s ets (Quantities of feeders shall be as on required basis).	2 s ets (Quantities of feeders sh all be as on required basis).
11.	Interconnecting A rmored FRLS ST2 (inner & outer sheath), PVC type C insulated stranded Copper co nductor power Cable between UPS eq uipment & ba ttery, UPS & ACDB, AC DB & loads. For em ergency t rip pu sh	As required	As required

	buttons, Fire alarm system, safety critical circuit, trip protection circuit and for other services specified elsewhere in the specification shall be fire survival power cable conforming to IEC 60331, BS6387 (CWZ), BS6207 standard and this specification.		
12.	MCCB (At input, out put, battery side, Bypass side, ACDB side etc) and tie breaker with ON, OFF & Trip indication.	1 no. each	1 no. each
13.	Online Battery Health Monitoring System	1 set	1 set
14.	Battery Junction Boxes with MCCB, Voltmeter & Current meter.	1 set each	1 set each
Any other equipment necessary for completion of the system shall be provided by bidder.			

All equipment, enclosures and accessories for UPS system shall be designed, arranged assembled and connected in accordance with the requirements of this specification.

7.02.06 NORMAL OPERATION

Two inverters each of 100% capacity, two battery packs of 100% capacity and two 100% battery chargers are used for main plant UPS. Two inverters each of 100% capacity, one battery packs of 100% capacity and two 100% battery chargers are used for BOP packages UPS.

1. During normal operation, UPS loads shall be supplied by both 100% capacity inverters each working at 50% load. The inverters shall receive power from DC source (Charger / Battery), their static switches shall be in the respective "Inverter" position and the manual by-pass switch shall be in "Position-2". In this mode the two inverters shall act as standby for each other.

   Necessary paralleling networks shall be included to ensure equal load sharing by both inverters. Load sharing network details shall be detailed to establish all functionalities including fuse clearance. Capabilities of the UPS System as well as each 100% rated inverters are fully satisfied. In addition to UPS output paralleling, Rectifier DC outputs shall also be properly paralleled.

2. One inverter will act as "Master", working on its internal oscillator and the other inverter will follow by using the synchronizing signal from master inverter for automatic control of its output frequency.

7.02.07 EMERGENCY OPERATION

The static transfer switches and the manual by-pass switch shall provides witching means during emergency operation as follows:

1. In case of failure of any inverter the static switch shall automatically transfer the UPS Loads of faulty inverter (say Inverter – "A") to the healthy Inverter-"B" which will start working at 100% capacity. Thus the feeding of UPS power is continued automatically to all load connected to both inverters despite power supply to all UPS loads connected to both inverters shall be maintained without interruption. Isolation of faulty inverter shall be automatic and achieved in less than 4 milli seconds.

2. Based on inverter failure alarm, the operator will transfer manual by-pass switch to "Position-1" bringing in the plant AC source as the standby source to healthy Inverter –"B" now working at 100% capacity. In this mode the healthy Inverter-"B" shall get the synchronizing signal from the stand by-AC source and automatic synchronization, operation on internal oscillator and transfer / retransfer to standby source shall be as follows:

   i) The output frequency of the concerned inverter shall be automatically synchronized with the plant stand-by source by using synchronizing signal from the standby source. The frequency limits for this synchronism are specified in clause 7.03.05. If the frequency of the standby source is beyond these limits, the Inverter frequency control shall be automatically disconnected from stand-by synchronizing signal and the inverter shall maintain the output frequency at 50 Hz within $\pm$ 0.1 per cent under all conditions of load and input voltage by working on their own internal oscillators.

   ii) During operation on its own internal oscillator, the inverters shall continuously monitor the frequency of standby source. Upon restoration of proper frequency conditions of stand-by source, the inverter shall automatically start using stand-by source frequency as the synchronizing signal for inverter output frequency control.

   iii) During the operation of any inverter on its internal oscillator due to synchronising frequency being beyond the specified limits, the transfer of static switch from "Inverter" to "Standby" shall be inhibited.

3. During any fault in the branch circuit feeders or inverter output bus, the inverter shall be capable of clearing a fast acting fuse of largest rating in 4 milliseconds and simultaneously provide UPS power to all connected loads (i.e. 50% capacity). In view of the above fault clearing capability of each inverter and due to availability of plant AC source as standby source for inverters the static switches shall not transfer the loads to the other inverter for fault clearing purposes.

4. Retransfer of static switch shall be manual in all cases and shall be accomplished only after synchronism of the inverter output with the stand-by source has been automatically accomplished.

5. The manual by pass switch shall have the provision (position –4) for fully by-passing the UPS system and connecting all UPS loads to the standby AC source. This provision may be used during start up to limit the inrush current and at other occasions at the option of the operator.

7.03.00 STATIC INVERTERS AND AUXILIARY EQUIPMENT

7.03.01 The static inverters shall be solid state type using proven IGBT based pulse width modulation (PWM) to convert direct current power to essentially sinusoidal alternating current power as per this specification. The inverter equipment shall include all necessary circuitry and devices to conform to requirements like voltage regulation, current limiting, wave shaping, transient recovery, surge suppression network, automatic synchronization etc. as specified herein.

7.03.02 INVERTER CAPACITY

Each static inverter shall have the following minimum capabilities without causing any damage to the components and with current limit not operation :-

1) Continuous full load rating

2) Over load capacity: 125% of full load rating as above for 10 minutes, 150% for 1 minute, 200% for 10 seconds minimum & 300% for 4 msec for all specified input voltages.

3) Fuse clearing capacity : Upon a fault in any branch circuit lateral feeder, the inverter shall have the capacity to carry a load equal to one half of its full load rating plus it shall clear the largest rated fast acting fuse in 4 milliseconds or less. All fuses used in inverter power and control circuit shall be fast acting type operating in less than 5 millisecond and each of these fuses shall be provided with kick fuse and alarm contact. Indication and alarm shall be provided to enable fault location.

4) Step load pick up: Upon transfer of full load, the inverter output voltage shall not drop below 85% of nominal voltage during the first half cycle after transfer and 90% of nominal voltage in the next half cycle. The recovery to within $\pm$ 1% of voltage shall be in less than 50 milliseconds.

5) The inverter shall have sufficient I2t capacity to clear a slow acting HRC fuse having a continuous current rating equal to at lease 20% of the continuous full load current rating of the inveter, while feeding 100% rated loads of the inverter.

7.03.03 INPUT VOLTAGE

The inverters shall be fed from a DC Battery and chargers which do not feed any other loads. Input voltage shall be nominal DC output voltage of battery and charger of range from final voltage after discharge of battery to maximum DC bus voltage during equalize charging of battery. The inverter shall also be capable of working satisfactorily meeting the specification requirements with only the chargers connected to its input without battery in circuit. DC input window of each inverter shall be either 315-434 or 320-450 V

DC. Filtering on the input of the inverters shall be furnished is required to operate within the output ripple of the chargers furnished by the Bidder. Each inverter shall include equipment necessary to protect itself from damage resulting from excursios, loss, or restoration of DC input voltage and synchrnising voltage. The inverter output voltage shall be 230 V AC , 50 Hz, Single phase.

7.03.04 OVER LOADS, SHORT CIRCUITS AND LOAD LOSS PROECTION

1. The inverters shall be provided with suitable fuses at the input and output which will permit proper co-ordination with other protective devices and at the same time protect the inverter against damage due to internal faults. All necessary equipment shall be provided to protect the inverters against over loads, short circuits and 100% loss of load. The inverter shall be self protecting against damage if energized with full load connected.

2. The inverter shall be provided with current limiting circuitry which will limit the output current to a value which will not damage the inverter or blow its fuses.

3. The inverter shall have sufficient $I^2 t$ capability to prevent damage to itself until short circuit conditions on the output are cleared.

4. Each inverter shall be capable of operation with nonlinear loads. For bidders loads bidder shall detail the nature of non linearity. For loads provided by owner, bidder may assure a non linear wave form with a current crest factor of 3.0 occuring coincident with voltage peak. With nonlinearity consisting of third, fifth and seventh order harmonics. Output waveform of the inverter(s) shall remain within specified limits when operating with nonlinear loads at 100 per cent rated load.

5. The inverters shall be self protecting against all AC and DC transients, voltage surges and steady state abnormal voltages and current likely to be encountered in utility power station.

7.03.05 Automatic Synchronisation

Inverter equipment shall include stable solid state oscillator devices designed to automatically maintain the inverter output in phase and in synchronization with the standby AC source. The frequency regulation shall be automatic within $\pm$ 0.1 Hz of all conditions of inputs, loads and temperature occurring simultaneously or in any combination.

Facility shall be provided for automatic transfer to internal oscillator operation when the standby source frequency is not within the synchronization limits.

Provision shall be made for step less adjustment of synch disconnect frequency range from 50 Hz +/- 0.5 Hz to 50 Hz +/- 2 Hz.

Automatic adjustment of phase relationship between inverter output and standby AC source shall be gradual, at a controlled slew rate, which shall not exceed 0.1 Hz per second.

The inverter shall normally work on the internal oscillator with either of the two inverters as master synchronizer and the other following it. Suitable selector facility shall be provided to select the master. When any one inverter fails the healthy inverter gets the synchronizing signal from the standby AC source.

The DC inputcurrent shall never exceed the full load current except for a short circuit within the inverter. The limitation applies to transient as well as steady state currents and includes in rush currents upto initial energisation of the UPS, load energisation, short circuits external to the inverter etc. For any value of the load and load power factor drawn by the equipment served, the inverter shall not impose on DC source any voltage oscillations in excess of 5 volts (RMS total, all frequencies) or any current oscillations in excess of 3 %(RMS total, all frequencies) of the DC current at full load.

7.03.06 The inverter shall meet the following specifications in addition to other requirements stated herein :-

1.	Voltage input (Battery output)	:	As per system requirement
2.	Nominal voltage output:		240V, 50Hz, single phase
3.	Inverter capacity (output KVA)	:	As per clause 7.03.02
4.	Voltage regulation	:	
	a) Steady state (0-100% load at all input voltages & all power factors)	:	± 1 %
	b) Transient voltage regulation (on application or removal of 100% load)	:	± 5%
	c) Time to recover from transient to normal voltage with ± 1% of steady state (on application or removal of 100% load)	:	<50 milli second
5.	Wave Form		
	a) Nominal Frequency	:	50 Hz
	b) Frequency regulation for all conditions of input supplies, loads and temperature occurring simultaneously or in any combination (automatically controlled)	:	± 0.1Hz

c)	Synchronization limits (for maintenance & synchronism between the inverter and standby AC source).	:	48 Hz to 52 Hz (factory test)
d)	Field adjustment range for (c) above	:	50 ± 0.5 Hz to 50 ± 2 Hz
e)	Total harmonic content	:	<4% max.
f)	Harmonic content max.for any single harmonic	:	<2.5%

6. Rated output current at rated output voltage with current limit not operating :

a)	Current	:	200%
b)	Duration	:	10 seconds

7. Overload capacity at 100% voltage :

a)	For 4 ms (fuse clearing):		App. 300%
b)	For 10 seconds	:	200%
c)	For 10 minutes	:	125%
d)	The proposed inverter has the capacity to clear largest acting fuse in 5 milli second & without entering into current limiting mode	:	---

8. Efficiency (watt output/watt input)

a)	at 100% load 1.0 P.F. / 0.8 P.F:		>91%/ 91%
b)	at 75% load 1.0. P.F. / 0.8 P.F.	:	>90% / 90%
c)	at 50% load 1.0 P.F. / 0.8 P.F.	:	>89% /89 %

9. Duty : Continuous

10. Cooling : Natural convection or forced cooling using redundant fans.

Equipment to be designed for operation with full load even without cooling availability.

11. Ambient temperature : 50 deg C, maximum

12. SCR derating from : 50%

peak voltage and peak ratings.

7.03.06 STATIC INVERTER AUXILIARY EQUIPMENT

In addition to the inverter equipment specified above, auxiliary equipment shall be furnished with each static inverter as follows:

1) Equipment and material furnished, mounted and wired on the front panel of the inverter enclosures :

ITEM	QUANTITY
Output ammeter, AC, indicating, Scale-0 to 150 percent of rated continuous full load inverter output current, 1 percent accuracy.	1
Output voltmeter, AC, indicating 0-300 volt scale, 1 percent accuracy.	1
Output KVA, AC indicating scale 0-150 percent of Rated capacity, 1 percent accuracy.	1
Input voltmeter DC, indicating 0-300 volts scale, 1 percent accuracy.	1
Frequency meter, 45-55 hertz, 1 percent accuracy.	1
Power factor meter, (0-1. 0-0), 1 percent accuracy	
Inverter ON-OFF switch	1
Alarm Reset Push Button	1

2) Indicating lights listed below with proper actuating devices, circuitry and legend shall be furnished on front of the Ups panels. For these abnormal conditions which could be of a momentary nature, the indicating lights shall remain energized and the contract remain closed until cleared by a reset push button furnished on the panel. The indicating lights shall be of make subject to Owner's approval.

The following indications shall be provided as a minimum :

a) DC voltage to the Inverter - Low
b) DC voltage to the Inverter - High
c) Loss of DC input to the inverter
d) Inverter output voltage - High
e) Inverter output voltage – Low (after a time delay to avoid unnecessary alarm due to low voltage on load in rush etc.)
f) Inverter A failure / Inverter B failure
g) Standby AC source failure
h) Inverter A / Inverter B not synchronized with AC source
i) Automatic transfer to AC source. Blown Fuse or Tripped Breaker.
j) Inverter A/ Inverter B feeding 100% UPS Load
k) Standby source feeding 100% UPS loads
l) Redundant fan failure and temperature high (if provided)

7.04.00 STATIC TRANSFER SWITCHES AND AUXILIARY EQUIPMENT

7.04.01 The static transfer switches shall be provided to perform the following functions

1) To transfer the load automatically without any break between the inverter to the standby inverter as required to maintain the continuity of power supply to UPS connection loads. The load shall be automatically transferred from "Inverter" to the inverter source upon any malfunction of one inverter.

2) To transfer UPS load under manual control from standby AC source to inverter when placing the UPS System in service and from inverter to standby AC source when taking the UPS out of service.

7.04.02 The static transfer switches shall have two modes of operation namely automatic and manual.

7.04.03 The static transfer switches shall use silicon controlled rectifiers and other static devices required for automatic transfer of load from "Inverter" to Standby" source and vice versa.

The static switches shall conform to the requirements specified herein including the following:

1. Capacity (continuous) : Equal to the continuous full load capacity of the inverter.
2. Capacity (overload) : 200% for 10 seconds, 150% of continuous for 60 seconds and 125% of continuous rating for 10 minutes and 300% of continuous rating for 4 msec.
3. Capacity (Peak) : 1000 % of continuous rating for 5 cycles.
4. Transfer Time : < 4 msec. The transition shall be "make before break", voltage failure shall be sensed at the output of the static switch.
5. Voltage Rating (Nominal) : 240 Volts, 50 Hz. Single phase.
6. Transient Voltage Tolerance : 340 Volts peak above the normal line voltage.
7. Ambient temperature : 50 deg C max.
8. Cooling : Natural or forced circulation , using redundant fans.
9. Duty : Continuous

7.04.05 **<u>TRANSFER INITIATION</u>**

1) The transfer of static switch from normal "Inverter" position to "Stand-by" position shall be initiated by one of the following causes :

   a) Inverter failure and UPS System trouble
   b) Inverter output voltage failure
   c) Over current
   d) Manual push button operation
   e) Static Output voltage failure.

2) The UPS bus shall be monitored by two voltage detectors. One fast acting circuit shall be used for detecting a complete and instantaneous, voltage loss while the other slower acting averaging circuit with adjustable trip level shall be employed to detect voltage deviation beyond selected limits. Both voltage detector circuits shall automatically initiate operation of static transfer switch.

3) The static switch shall automatically transfer the load from inverter to stand-by AC source when the maximum I^2t capability of the inverter is reached when the inverter output voltage drops below 90%.

4) UPS bus current shall be continuously monitored by a current monitoring detector. This detector shall operate the static transfer switch when the load current exceeds the overload rating of any inverter. The detector shall rest when the load current falls below the rated current of the inverter resulting in retransfer of static switch with inverter position.

5) Over current transfer limit shall be continuously adjustable from inverter continuous rating to inverter current limit rating.

7.04.06 TRANSFER INHIBIT

The transfer of static switch shall be inhibited under the following conditions:

1) Automatic or manual transfer of load from inverter to stand-by AC source or vice versa, shall be inhibited when the inverter frequency is not synchronized to the alternative source.

2) Transfer resulting from overload shall be inhibited when the standby AC source is not available. In this case the load fed by the inverter shall be automatically disconnected

7.04.07 RETRANSFER TO NORMAL

1) The retransfer to normal shall be manual in all cases.

2) Manual transfers shall be initiated by push button actuation.

7.04.08 Static transfer switches shall be provided with necessary protective devices (circuit breakers / current limiting fuses) both in “Normal” as well as “Stand-by” position.

7.04.09 The static transfer switches shall be provided duly mounted and wired in enclosures furnished by the bidder.

7.04.10 The static switches shall be furnished with contacts to alarm failure of the alternate source or opening of any fuse protecting the static switches.

7.05.00 MANUAL BY-PASS SWITCH

7.05.01 The manual by-pass switch will be used to isolate any static switch from its load and stand-by power supply and to take the static switch out of service without power interruption to the load. In doing so the manual by-pass switch shall connect both load buses to a single inverter. The manual by-pass switch shall also provide the facility for by- passing the entire UPS system during start up at the option of the operator.

7.05.02 The manual bypass switch shall have make before break contacts to ensure continuous supply to UPS loads during the operation of this by-pass switch.

7.05.03 The manual by-pass switch shall be rated for 600 Volts, 50 Hz, single phase operation. It shall have continuous load carrying capacity equal to full load inverter current and necessary short term load carrying and interrupting capacity to meet the requirements of the UPS system.

7.05.04 All other by-pass and disconnect devices shall be provided by the Bidder as required for orderly start up and shut down and maintenance of UPS system and system components.

7.05.05 The Bidder shall provide potential free contacts, one closed in each position, for use in DDCMIS & PLC system.

7.05.06 The manual by-pass switch and required disconnect devices shall be furnished duly mounted and wired in enclosure, furnished by the Bidder.

7.06.00 FLOAT-CUM-BOOST CHARGERS AND AUXILIARY EQUIPMENT

Two no. 100% capacity SCR based fully controlled 12 pulse float cum boost chargers shall be furnished for main BTG UPS system and Two no. 100% capacity SCR based fully controlled 6 pulse float cum boost chargers shall be furnished for BOP packages UPS system. Each charger shall confirm to the following requirements.

7.06.01 CHARGER CAPACITY

Each charger furnished for UPS system shall be adequately rated to ensure that any one shall meet full DC load of UP system operating at 100% rating plus recharge the fully discharged UPS battery within 8 hours.

The Bidder shall furnish the charger rating calculations to the Owner to satisfy that this requirement is met. The charger shall be furnished as per rating approved by the Owner during engineering stage.

7.06.02 The chargers shall be supplied from a 415 volt, 50 Hz. 3 phase system. The chargers shall maintain the output voltage within plus and minus 0.5 percent from no load to full load with an input power supply deviation in voltage level of plus or minus 10 percent and input power supply deviation in frequency of plus or minus 5 per cent and with both deviations present in any combination.

7.06.03 In addition to supplying DC power for inverters, the chargers shall be designed to charge a fully discharged battery without over loading or causing over voltage or without causing interrupting operation of AC or DC circuit breakers for the entire range of intended operating regimes. Suitable solid state electronic circuits shall be provided to ensure that the charging current is voltage regulated and current limited. After the battery is recharged the charger shall maintain the battery at full charge until the next emergency operation when the UPS battery is again required to provide DC power.

7.06.04 Float and equalizing controls shall have an adjustment range of ± 5% continuous (without steps).

7.06.05 The chargers shall be self-regulating, solid state, silicon controlled, full-wave rectifier type designed for single and parallel operation with the battery specified under clause 7.07.00. The chargers shall be designed for automatic load sharing during parallel operation.

7.06.06 The charger shall be current limited at 125% of full load to reduce output voltage for charger circuit protection and for protection of battery from overcharge. The current limit shall be continuously adjustable from 80% to 125%.

7.06.07 All necessary equipment and devices shall be provided to protect the charger from short circuits, transient voltage surges, load and supply fluctuation including sudden loss of input or load.

7.06.08 The charger shall have a slow walk-in circuit which shall prevent application of full load DC current in less than 10 seconds after AC power is energized.

7.06.09 The minimum full load efficiency at nominal input and float output shall be 96 %.The output regulation, ripple content and power factor shall meet the requirements of UPS system as well as the inverters furnished by the Bidder as per clause 7.03.00.

7.06.10 Chargers and auxiliary equipment shall be mounted in free standing cabinets furnished by the Bidder. Charger cabinets shall be folded steel construction with top, front, back and sides fabricated from not less than 3 mm thick sheet steel. The cabinet front, back, end sides shall extend to the floor to present a finished appearance. Cabinet door shall be provided to permit easy access to all components for maintenance or replacement. Doors shall have concealed hinges and three-point latches. Louvers shall be provided for ventilation as required for operation at the specified ambient but the cabinet top shall be solid. All louver openings shall be covered with corrosion resistant fine screen coverings.

7.06.11 **GROUND DETECTOR SYSTEM**

a) Each charger shall be furnished with a ground detector system consisting of a relay and a center tapped resistor. The resistor shall be connected between the positive bus and the negative bus.

The relay coil shall be connected between the centre tap of the resistor and ground. The relay shall be furnished with one normally open and one normally closed contact wired to terminal blocks for connection to external circuits.

7.06.12 **UPS Signal interfacing with DDCMIS/DCS & PLC**

a) The bidder shall provide alarms and status indications, current, voltage ,frequency, PF etc through serial link with MODBUS or another compatible protocol .

b) The Bidder shall furnish 4-20 mA signals to DDCMIS/PLC for the following:

i) Inverter A & B output voltages
ii) Inverter A & B output currents
iii) Inverter A&B output frequency

c) List of alarms (min.) to DDCMIS through potential free contacts shall be as follows:-

i. Rectifier – 1 Trip.
ii. Inverter – 1 Trip.
iii. UPS battery low.
iv. Rectifier – 2 Trip.
v. Inverter – 2 Trip.
vi. Load on static Bypass.
vii. Static Bypass failure
viii. ACDB – 1 Incomer Tripped.
ix. ACDB – 2 Incomer Tripped.
x. UPS – 1 Fan Tripped.
xi. UPS – 2 Fan Tripped.

7.07.00 UPS/24 V DC System BATTERY AND ACCESSORIES

The UPS/24 V DC system batteries shall be heavy duty *Ni-Cd type* as specified below:

i. Expected service life is greater than 20 years when operated on float or trickle charge.
ii. Low maintenance – minimal topping up frequency and self - discharge.
iii. Capable of rapid recharging.
iv. Transparent containers for ease of inspection and maintenance.
v. Battery racks provided for battery shall be 2 tier made from heavy teak wood to bear 150% over load, anti acid paint etc.
vi. One no. 2 sided Folding Aluminium ladder (height 180 cm) for maintenance & removal of battery cells and mounting bracket for ladder shall be provided by bidder with each battery set.

The batteries shall be **heavy duty Nickel-cadmium Fiber plated type** and shall be sized for an hour of full load operation during non-availability of AC supply / chargers. The Ni-Cd batteries shall conform to IS:10918. For sizing calculation, design margin of 120%, an aging factor of 0.8 and a temperature correction factor (Based on temperature characteristics curve to be submitted by the Bidder and at a temperature of 4 deg. C). Capacity factor shall be taken into consideration, and ambient temperature shall be considered as the electrolytic temperature. The sizing of the battery shall be as approved by Owner during detailed engineering. However, Bidder shall consider a suitable voltage drop from battery room to UPS and UPS to load, while sizing the battery. The system shall also be suitably designed to overcome any over voltage that may arise during low-load operation of the charger. The bidder shall clearly bring out in his offer how the same is being implemented.

The battery size shall be calculated taking UPS/24 V DC system capacities as base load. Bidder shall also consider voltage drop from battery room to UPS/24 V DC systems, while sizing the battery. For Plant UPS & plant 24 V DC system, battery back up time shall be 2 hours and for BOP packages UPS & BOP 24 V DC system, the back up time shall be for 1 hour.

For Fire alarm panels, batteries shall be provided with min. 10 hours backup.

7.07.01 In order to monitor the batteries, **online battery health monitoring system** shall be employed. It is a battery management system based on monitoring the voltage of individual battery cell, which provide the information/details about battery health status to end user/owner. Complete hardware like detector units, Battery clips, cables, monitor (power control unit) and other accessories etc as required to complete the system shall be provided by bidder. LED indication shall be provided on detector units for power, alarm and RUN indication etc. Data from Online Battery Health Monitoring System shall be communicate/transferred to DDCMIS for Monitoring and analysis using different protocol like RS485 Modbus/OPC etc.

7.07.02 One complete set of all accessories and devices required for maintenance and testing of batteries shall be supplied for each set of the batteries of each unit/plant auxiliary system. Each set include at least the following:

a)	Hydrometer	5 Nos
b)	Set of hydrometer syringes suitable for the vent holes in different cells	5 Nos
c)	Thermometer for measuring electrolyte temperature	5 Nos
d)	Specific gravity correction chart	5 Nos
e)	Wall mounting type holder made of teak woodfor hydrometer & thermometer	5 Nos
f)	cell testing voltmeter(3-0-3 V)	5 Nos
g)	Alkali mixing jar	5 Nos
h)	Rubber aprons	5 Nos
i)	Pair of rubber gloves	5 Nos
j)	Set of spanners	5 Nos
k)	No smoking notice for each battery room	2 Nos
l)	Goggles (industrial)	5 Nos
m)	Instruction card	10 Nos
n)	Minimum and maximum temperature indicator for battery room	1 No.
o)	Cell lifting facility	1 Set
p)	Vent Caps	2 set
q)	Terminal Bolts & Washers	1 Set
r)	Plastic Filling Bottles	10 Nos.
s)	Alkali resistant funnel & Mugs	10 Nos.

7.07.03 Cell booster charger shall be provided with main plant UPS & 24 V DC batteries set to charge the new & sick cell for revival of cell. The cell booster shall be built in separate portable panel. Resistive load discharge bank shall also be provided with main plant UPS & 24 V DC batteries set to discharge the batteries in case of over charged batteries.

7.08.00 VOLTAGE STATIC STABILISER

7.08.01 One 415 Volt, 3 phase to 240 Volt, single phase transformer along with associated static voltage stabilizer shall be furnished with each UPS set.

This transformer and stabilizer combination shall convert 415 Volt ± 10% plant auxiliary AC supply to 240V ± 1% single phase standby AC Power which will serve as UPS system back up supply source.

7.08.02 The transformer and stabilizer shall be sized for 100 percent UPS load and shall coordinate with the largest branch circuit protection device for feeder short circuit current without sacrificing voltage regulation. The voltage stabilizer shall employ silicon solid state circuitry and shall maintain the specified output voltage for 0-100% load with input voltage variations as indicated above. Class of insulation of wound components like transformers etc shall be class H with temp rating up to class B.

7.08.03 The stabilizer shall meet the following characteristics as a minimum
- Fast rate of correction - within 5 cycles
- Output distortion - less than 5% under worst conditions
- Efficiency - better than 95%
- Overload Capacity – 300% for 200 mSec.

The make and rating shall be subjected to Owners approval.

7.09.00 24 V DC CONTROL POWER SUPPLY SYSTEM FOR MAIN PLANT

7.09.01 The bidder shall offer a completely separate parallel redundant system with 50 % load sharing on each charger to cater to 24 V DC requirements for control, protection interlock & sequencing systems for BTG (Turbine protection, MFT & solenoid valves etc.). 24V DC system shall consist of

1.	100% capacity 12 Pulse float cum booster charger	2 nos. charger in parallel redundant configuration
2.	Battery Bank for 100 % load	2 Bank (100% capacity) each for 120 minutes back up
3.	DCDB (including 20 % spare feeders on each panel with 2 nos. minimum spare feeder of each rating)	2 set, (Quantities of feeders shall be as on required basis).
4.	Armored FR LS S T2 (inner & outer sheath), PVC type Cu insulated stranded copper conductor Cables. For emergency trip push buttons, Fire alarm system, safety critical circuit, trip protection circuit and for other services specified elsewhere in the specification shall be fire survival power cable conforming to IEC 60331, BS 6387 (CWZ), BS 6207 standard and this specification.	Complete power cables for 24 V DC system with battery, DCDB and loads.
5.	MCCB (At input, output, battery side, & DCDB side etc) with ON, OFF & Trip indication.	1 no. each

Input for 24 V DC systems shall be from 3 phase MCC system. 24VDC power supply to load will be through MCCB, MCB, and redundant feeders DCDB – 1 and DCDB – 2. Grounding cubicle for 24 V DC system shall be included in scope of supply.

SLD of 24 V DC charger system as per NIT drawing # 114-17-0200 shall also be referred by bidder.

7.09.03.06 The charger shall be current limited at 125% of full load to reduce output voltage for charger circuit protection and for protection of battery from overcharge. The current limit shall be continuously adjustable from 80% to 125%.

7.09.03.07 The chargers shall have a slow walk-in circuit which shall prevent application of full load DC current in less than 10 seconds after AC power is energised.

7.09.03.08 The chargers shall be fed from 415V AC, 50 HZ, 3 phase. The Bidder shall provide all required power cables from 415 V AC power supply system to his power supply system.

7.09.03.09 The minimum full load efficiency at nominal input and output shall be 70%.

7.09.03.10 Charger design shall ensure that there is no component failure due to fluctuations of input supply or loss of supply and restoration. This feature shall be demonstrated during factory testing at various loads.

7.09.03.11 Bidder shall furnish the equipment complete in all respects along with charger rating & voltage drop calculations, supporting curves/data etc.

7.09.03.12 24 V DC Charger sizing calculation shall be submitted for approval) at 50 deg. C ambient. Each Individual parallel redundant 24 V DC charger system shall be designed considering 20% design margin.

7.09.04 Batteries And Accessories

The 24 V DC system batteries shall be Two (2) set of **heavy duty Nickel-cadmium Fiber plated type** as specified at clause no. 7.07.00. Battery sizing calculation shall also be submitted for approval as per factors specified at clause no. 7.07.00. All other items shall also be furnished by bidder as specified at clause no. 7.07.01 & 7.07.02, 7.07.03.

In order to monitor the batteries, **online battery health monitoring system** shall be employed.

7.10.00 AC & DC Power supply for BOP packages

7.10.01 The UPS system shall be separate for each BoP/offsie package. The UPS shall be designed as specified at clause no. 7.02.00 to 7.08.00.

7.10.02 Parallel redundant 240 V AC to 24 V DC convertor with 50% sharing & 125 % capacity shall be provided for 24 V DC power supply in each cubicle separately as per requirements for BOP/Offsite package's PLC control system and microprocessor based control system.
The UPS power supply shall be extended to Parallel redundant 240 V AC to 24 V DC convertor thru redundant UPS feeders.

AC to DC convertor shall be SMPS based and shall have wide range of AC/DC input voltage (85-264 V AC & 90-350 VDC). It shall have the necessary diagnostic functions like indications for DC OK, automatic overload monitoring etc. The MTBF for the power supplies shall not be less than 500,000 hours (in Accordance with (IEC – 1709) with operating temp. from –25deg. C to 70 deg. C.

7.11.00 CONSTRUCTIONAL FEATURES FOR CABINETS/ENCLOSURES

The Construction details for UPS & 24 V DC charger system cabinets/enclosure shall conform to the requirements indicated in chapter 6.

7.11.01 Grounding

Normal, AC power supply will be grounded at the source. For grounding other than this, I/P and O/P isolation transformers shall be furnished with the UPS.

7.11.02 All the transformers used any where in UPS & 24 V DC charger circuitry shall be copper wire winded with class H insulation.

7.12.00 DC DISTRIBUTION BOARD PANEL

7.12.01 Distribution board shall be furnished with components, devices and materials meeting the requirements specified herein.

7.12.02 Each DC distribution board shall be constructed for 2 wire DC distribution .All bus bars shall be of solid copper. Each panel shall have four double pole 800 amps MCCB and properly sized fuses for three incoming feeders (two from chargers and one from battery) and two double pole 800 amps Moulded case circuit breakers with thermal over current relays and electromagnetic over current relays for two out going feeders to inverters. Isolators and circuit breakers shall open and close with snap action. Fuses of appropriate capacity shall be provided for incoming feeder from battery. All switches, fuses, circuit breakers and buses shall be rated for DC system fault level, which shall be indicated by the bidder in his proposal. Circuit identification cards mounted in card holders shall be provided on the hinged panel board front. The number of feeders (WITH 20% spare feeders) and rating of each feeder shall be to suit the individual load keeping in view the fuse clearance capability of UPS system already stipulated and shall be as finalised during engineering. No price implication is admissible for the number ratings of feeders as decided during engineering and owners decision in this shall be final. Each feeder shall have fast acting semi conductor fuse, MCB & LED indication for ON status.

7.13.00 AC DISTRIBUTION BOARDS PANEL

7.13.01 Panel boards for distribution of continuous AC power to essential loads shall be dead - front type panel boards rated for 600/1100 V, AC service. The hinged panel board front shall cover the fuses and wiring gutter but not the switch handles. The hinged front and switch handles shall be covered by the enclosure door.

7.13.02 Each panel board shall be constructed for 2 wire, single- phase distribution with a solid neutral bar. Phase and neutral bars shall be of copper. Rating of the main lugs shall be equal to the rated continuous full load current of each inverter.

7.13.03 Each panel board shall have one fused disconnect switch & MCCB of adequate rating for incoming feeder for A C Bus and requisite double pole, suitably rated ampere fused, disconnect switch branch circuit devices (MCB). Fused switches shall be equipped with arc quenchers, visible blades, and quick-make quick-break operating mechanisms. Maximum size fuse which branch circuit fuse holders will accept shall be rated at 60 amperes. As each UPS fed load will be provided with two hot

redundant 100% rated feeders. Main feeders to ACDB shall be provided with digital type Ammeter, Voltmeter, Frequency meter, PF meter, Watt meter & VA meter. One from ACDB-A and other from ACDB-B, boards with feeders shall be constructed in line. The number of feeders (WITH 20% spare feeders) and rating of each feeder shall be to suit the individual load keeping in view the fuse clearance capability of UPS system already stipulated and shall be as finalised during engineering. No price implication is admissible for the number ratings of feeders as decided during engineering and owners decision in this shall be final. Each feeder shall have fast acting semi conductor fuse, MCB & LED indication for ON status.

~~**7.14.00 FACTORY TESTS**~~

~~**7.14.01** The UPS system & 24 V DC system shall be factory tested under various stages of manufacture and upon full completion as per Owner approved quality Assurance plan, the tests shall include, but shall not be limited to the following:~~

~~**7.14.02** Type and Routine Tests~~

~~Type and routine tests for various components and sub assemblies in accordance with IS and/or NEMA, TEE Test Standards.~~

~~**7.14.03** Functional Tests~~

~~Functional tests to demonstrate compliance with all specified requirements and published specifications, such as frequency regulation, voltage regulation, current limiting, fuse clearing capability of inverters, demonstration of phase and frequency control of inverters for synchronisation with range of adjustments; transfer and retransfer of static switches under influence of under voltage and over current, tests on charges, batteries and other system components to confirm compliance with specification.~~

~~**7.14.03.1 UPS (Factory Acceptance Test)**~~

~~i) Power Efficiency (IEC 146-2, IEC 146) at 100% load, 50% load.~~
~~ii) Load test (Approved Procedure) load regulation test~~
~~iii) Audible noise test (IEC 146-2)~~
~~iv) Fuse clearing capability (Approved Procedure)~~
~~v) Relative harmonic content (IEC 146-2)~~
~~vi) Synchronous transfer & synchronization test (IEC 146-4)~~
~~vii) Temperature rise test without redundant fans (IEC 146-2)~~
~~viii) Input voltage variation test (Approved Procedure)~~
~~ix) Overload test on inverter & charger (Approved Procedure)~~
~~x) Insulation test (IEC 146)~~
~~xi) Restart test (IEC 146-2)~~
~~xii) Short circuit current capability (IEC 146-2 clause 5.10)~~
~~xiii) Output voltage & frequency tolerance (IEC 146-2)~~
~~xiv) Voltage current division (IEC 146-2)~~
~~xv) Relative harmonic content (IEC 146-2)~~
~~xvi) Parallel redundancy (* Simulation of Parallel redundant fault (IEC 146-4)~~
~~xvii) Overload test (final acceptance test)~~
~~xviii) Any other required as per national international standard or QAP~~

DRIVE CONTROL PHILOSOPHY

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 testing/commissioning only. 1

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 shall be issued to Integral Starter through interposing relays, mounted in Integral Starter. For open/close duty bi-directional drives Start & stop command shall be latched at integral starter end, except for inching duty bi-directional drives where latching is not required. 4

d) Necessary electrical protections shall be realized at Integral Starter, whereas process interlocks and protection shall be realised in DDCMIS.

e) Following signal exchange shall take place between Integral Starter & DDCMIS.

- Open & close command
- Integral Starter 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/Stop PB optd/Torque open/close cutoff). 4
- Actuator in Remote Mode.
- Valve status feedback by means of limit switches (open/close).
- Valve position feedback (4-20mA) for inching duty drives.

f) The Control & Operation from Backup Control Desk/UCP shall be envisaged for critical Drives. 3

g) For Bidirectional drives of >=15 KW, CURRENT TRANSDUCER shall be located in MCC. 4

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 i.e. from Central Control Room (CCR). Drives shall be provided with Local Emergency Stop Push Button (EPB). Local start operation of the drive can also be done through the start push button provided near the drive when the drive is in local mode.

b. Remote manual operation of all drives shall be done from OWS/LVS and Local/remote selection of drives shall be done in DDCMIS. Back 1

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 and shall be issued to MCC through interposing relays located in respective MCC. DDCMIS 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 to ensure interlock/protection requirement. 1

d. Necessary electrical protections for the drives shall be realised at MCC, whereas process interlocks and protections shall be realised in DDCMIS.

e. Following signal exchange shall take place between MCC & DDCMIS

i. Drive Start & Stop commands.
ii. Drive ON & OFF feedback.
iii. MCC disturbed (Thermal O/L /Control supply fail/ MCC switched off).
iv. MCC available(In Remote)
v. EPB operated 3

f. Current transducers, 4-20mA types (in MCC suppliers scope), shall be mounted in the MCC for monitoring the current in DDCMIS for all drives ≥ 15 KW and for important drives <15 KW. Auxiliary power supply to these transducers shall be provided from the control power supply of the respective MCC. 1

g. The Control & Operation from Backup Control Desk/UCP shall be envisaged for critical Drives. 3

h. Start & Stop command shall be latched at MCC end.

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

3 <u>Solenoid Operated Drives (24V DC/220V DC/240V AC)</u> 2

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 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.

1 e. Following signal exchange shall take place between solenoid operated drive & DDCMIS

i. Valve open & close command.

2 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.

3

f. BHEL will take care of de-energize to trip philosophy for fail safe control system (wherever required).

4 g. UCP/backup interface shall be provided for critical solenoid drives.

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

4 HT/LT Unidirectional Drives (Breaker operated)

1 a. Remote manual operation of Breaker operated drives shall be normally from remote i.e. Station DDCMIS in main Control Room through OWS/LVS and Local/remote selection of drives shall also be done in DDCMIS. 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 and shall be issued to Switchgear through interposing relays located in respective Switchgear. Further there is Local/remote selection in DDCMIS. Local selection in DDCMIS means, command from local PB, provided near the drive, will be executed through DDCMIS whereas in case of remote mode of selection in DDCMIS, 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 button shall be wired to the DDCMIS to ensure interlock/protection requirement.

1

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

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

i. Drive Start & Stop commands.
ii. Drive ON & OFF status feedback.
iii. Switchgear Disturbed (Control power supply fail/Trip coil Unhealthy/Master trip relay operated).
iv. Switchgear Available (Breaker in Service & Trip ckt Healthy & Master Trip Relay Reset & Spring Charged)
v. Master Trip Relay (86 Relay) operated.
vi. Emergency Stop PB operated.
vii. Local start Push Button shall be wired to DCS from LPBS near Drive.

2

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

3

i. The Control & Operation from Backup Control Desk/UCP shall be envisaged for critical Drives.

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 (conventional positioner for Burner Tilt). 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”
- Set point indication with “Raise/Lower Buttons”
- Indication for deviation between set point and measured value
- Measured value indication
- Final control element portion indicators

3 1.5 The Control & Operation from Backup Control Desk/UCP shall be envisaged for critical Drives.

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

C. CABLE

3 For interconnection of analog signals (4-20mA) to DDCMIS, in general “armoured” 0.5sq mm color coded individually and over all screened twisted pair shall be used (F Type). However for position feedback signals of bidirectional drives and current feedback signals of HT/LT drives 2P, F type cable shall be used.

For interconnection of binary signals (24V DC) to DDCMIS, “armoured” 0.5sq mm color coded over all screened twisted pair cable shall be used (G Type).

2 **D.IO REDUNDANCY**

(1) IO redundancy shall be as per specification requirement.
(2) Start command/stop command/trip command towards safety of process or process equipment shall be hardwired parallel from two different cards.
3 (3) In case of redundant/multi Pumps/Drives for same service, all related Inputs & outputs of main pump/drive shall be in separate I/O cards and similarly all related Inputs & outputs of respective standby pump/drive shall be in separate I/O cards. Inputs/outputs of any two same services pumps/drives shall not be mixed in one common I/O car

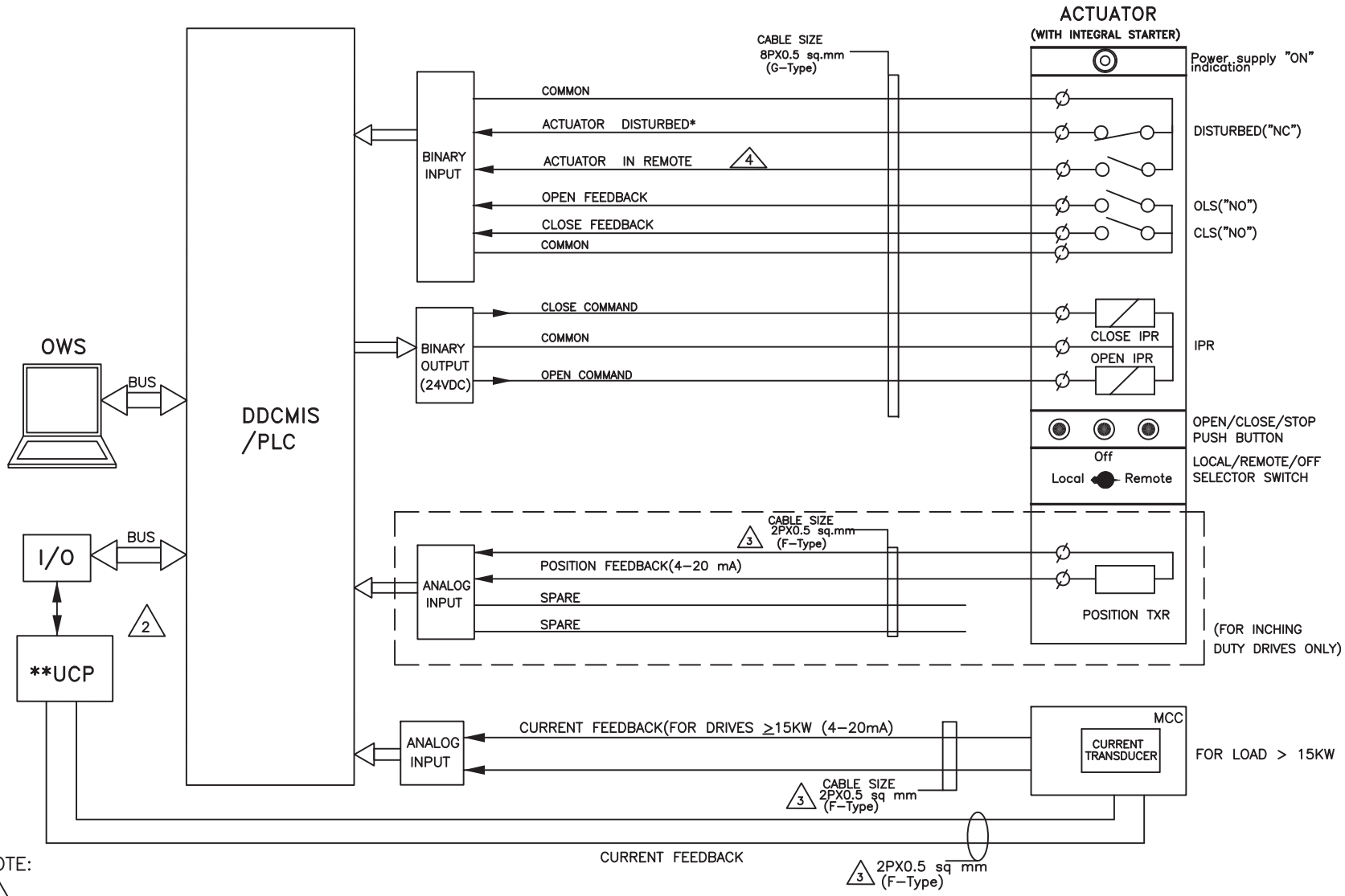
3 **Notes**: **1) (a)** Drive Control Philosophy will be generally used for total project except for few cases where OEM recommendations prevail.
(b) This scheme shall be applicable for PLC as well as DDCMIS based Offsite packages.
4 **2) Email/Message alert**
Intimation through message/E-mail shall be provided for tripping for all HT drives & critical LT drives.

3) Drives with VFD will have the following signal exchange:-

4

a) Speed Input AI
b) Speed Output AO
c) VFD Mode/Bypass Mode selection DI
d) VFD Mode/Bypass Mode command DO

DCS INTERFACE FOR BIDIRECTIONAL DRIVE(WITH INTEGRAL STARTER)



NOTE:

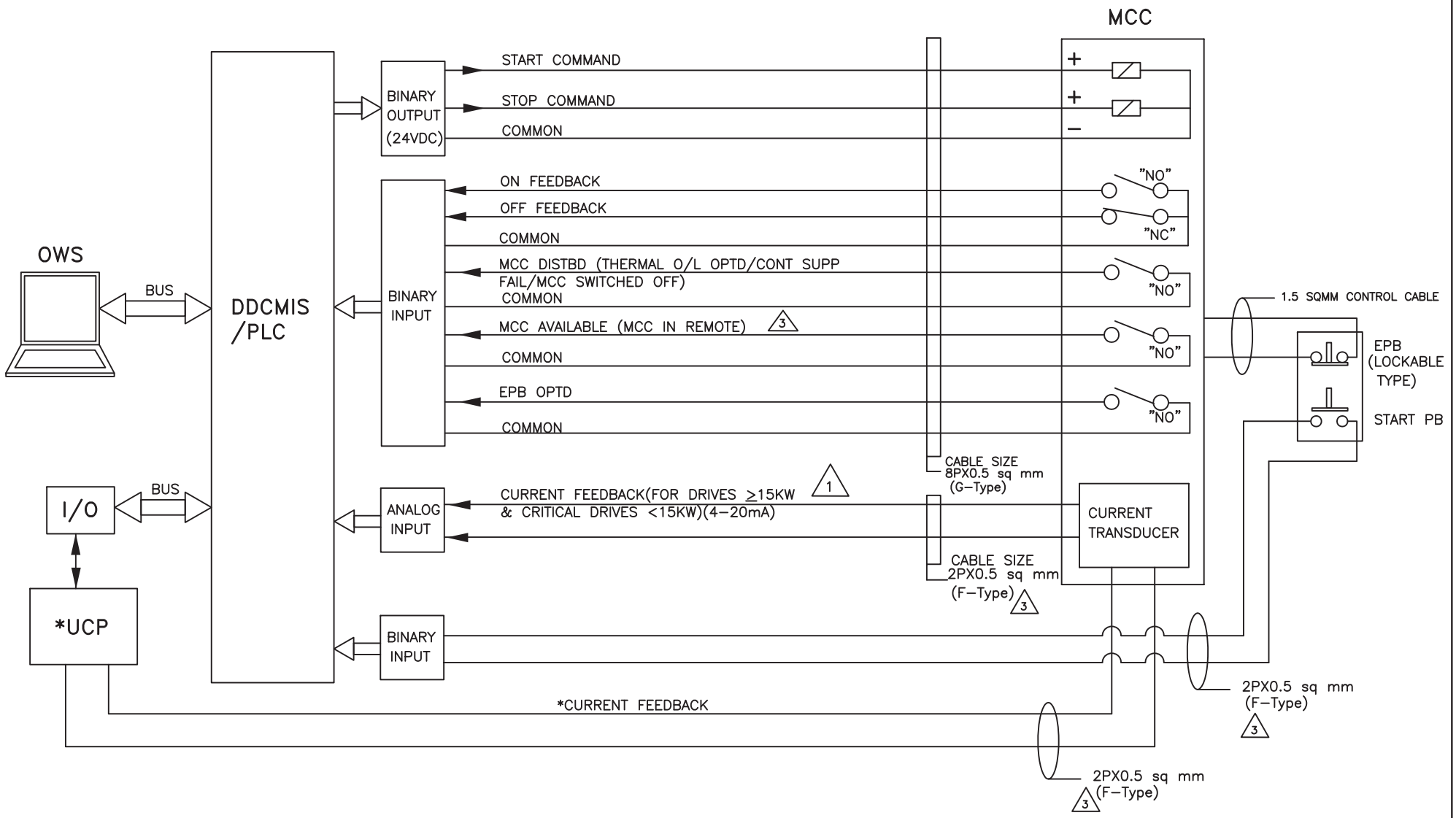
4 REDUNDANCY OF IO SHALL BE AS PER CUSTOMER SPECIFICATION.

* DISTURBED= Loss of Power supply (1 Phase/3 Phase)/ Loss of control supply/ Motor thermostat trip/Thermal over load/Torque open/close cutoff Local/Off/Remote Sel. switch in local or off mode/Stop PB optd.

2 ** AS APPLICABLE.

BHEL	PROJECT: 2X660 MW ENNORE SEZ STPP	DRG.NO.	PE-DM-412-145-I002
		DATE	10.08.2015
	TITLE DDCMIS INTERFACE FOR BIDIRECTIONAL DRIVE	REV.NO.	04
		SHT	8 OF 12

DCS INTERFACE FOR UNIDIRECTIONAL LT DRIVE



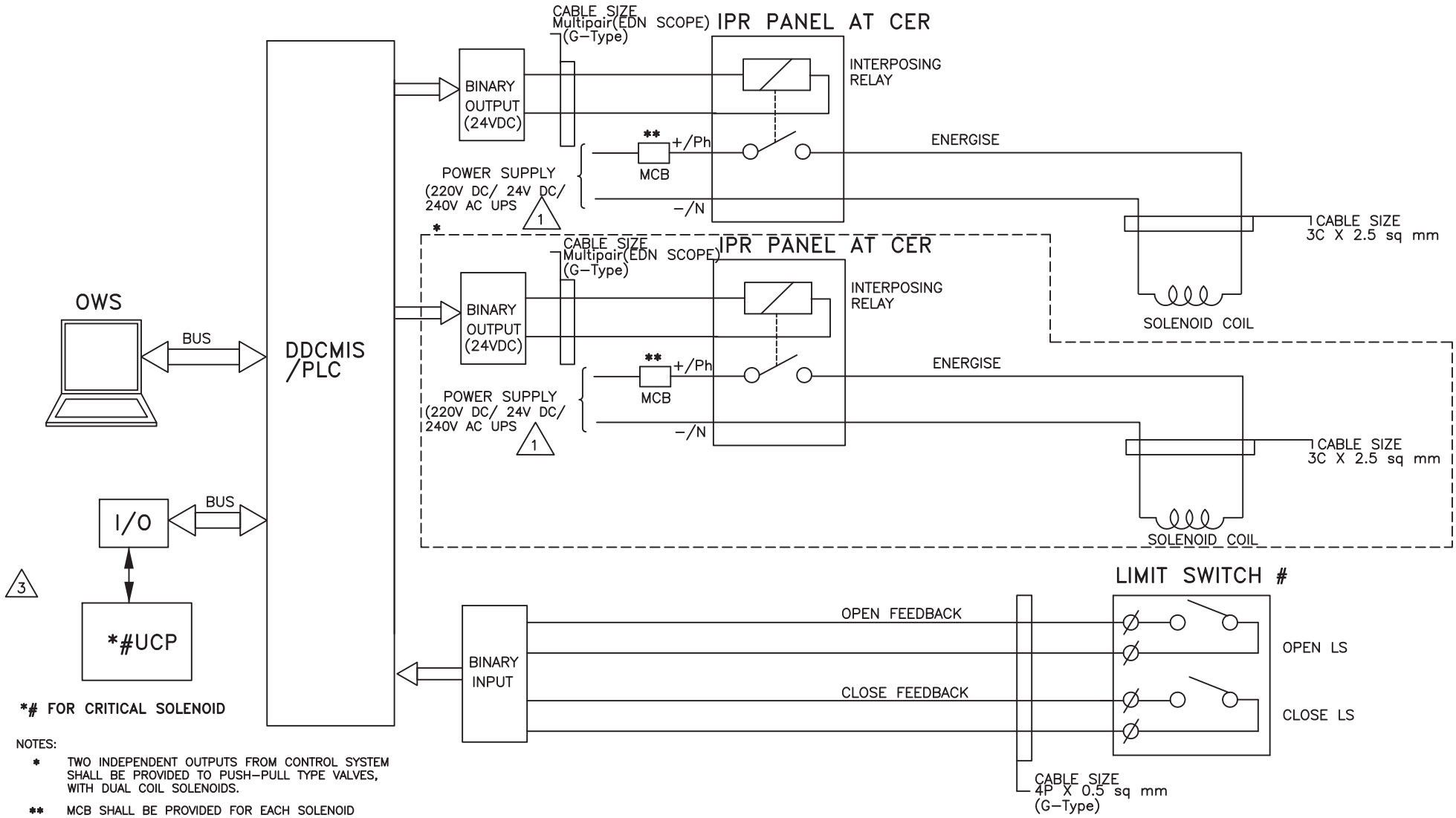
NOTE:

* CURRENT FEEDBACK IN DDCMIS SHALL BE PROVIDED FOR ALL DRIVES > 15 KW AND FOR IMPORTANT DRIVES <15 KW. 4

I/O REDUNDANCY SHALL BE AS PER SPECIFICATION REQUIREMENTS.

BHEL	PROJECT: 2X660 MW ENNORE SEZ STPP	DRG.NO. PE–DM–412–145–I002
		DATE 10.08.2015
	TITLE DDCMIS INTERFACE FOR UNIDIRECTIONAL LT DRIVE	REV.NO. 04
		SHT 9 OF 12

DCS INTERFACE FOR SOLENOID DRIVE
△1 (220V DC/ 24V DC / 240V AC UPS)



NOTES:

* TWO INDEPENDENT OUTPUTS FROM CONTROL SYSTEM SHALL BE PROVIDED TO PUSH-PULL TYPE VALVES, WITH DUAL COIL SOLENOIDS.

** MCB SHALL BE PROVIDED FOR EACH SOLENOID

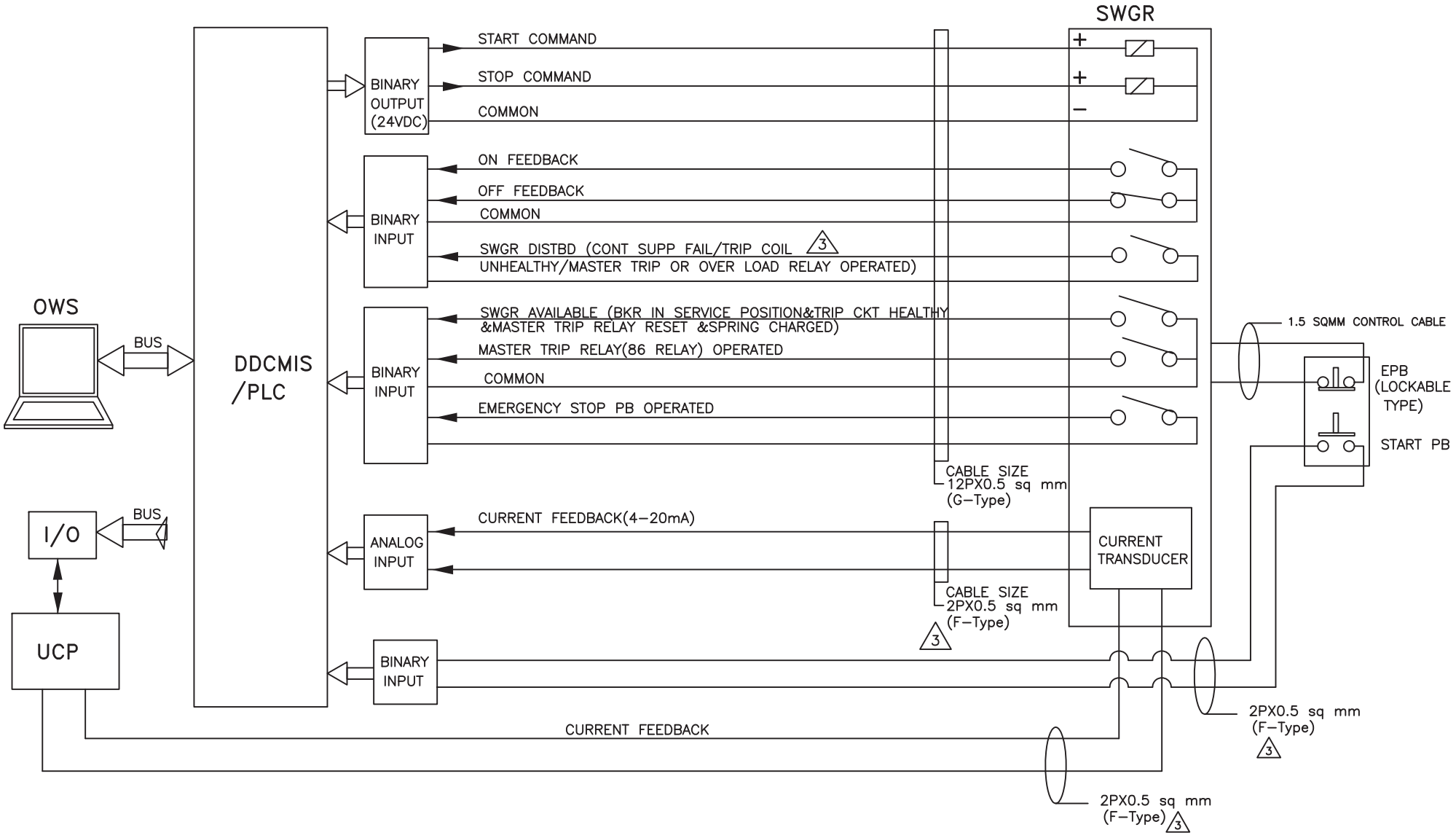
△1 # FOR ON/OFF TYPE, SOLENOID ACTUATED VALVE. RELAY CONTACTS SHALL BE WIRED AS FEEDBACK WHEREVER LIMIT SWITCH FEEDBACKS ARE NOT AVAILABLE. 1 CONTACT FOR SINGLE COIL & 2 CONTACT FOR DUAL COIL (OPEN LIMIT SWITCH & CLOSED LIMIT SWITCH. △2

△1 *** BHEL WILL TAKE CARE OF DE-ENERGISE TO TRIP PHILOSOPHY FOR FAIL SAFE CONTROL SYSTEM (WHEREVER REQUIRED)

I/O REDUNDANCY SHALL BE AS PER SPECIFICATION REQUIREMENTS. △3

BHEL	PROJECT: 2X660 MW ENNORE SEZ STPP	DRG.NO.	PE-DM-412-145-I002
		DATE	10.08.2015
	TITLE: DDCMIS INTERFACE FOR SOLENOID DRIVE	REV.NO.	04
		SHT	10 OF 12

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



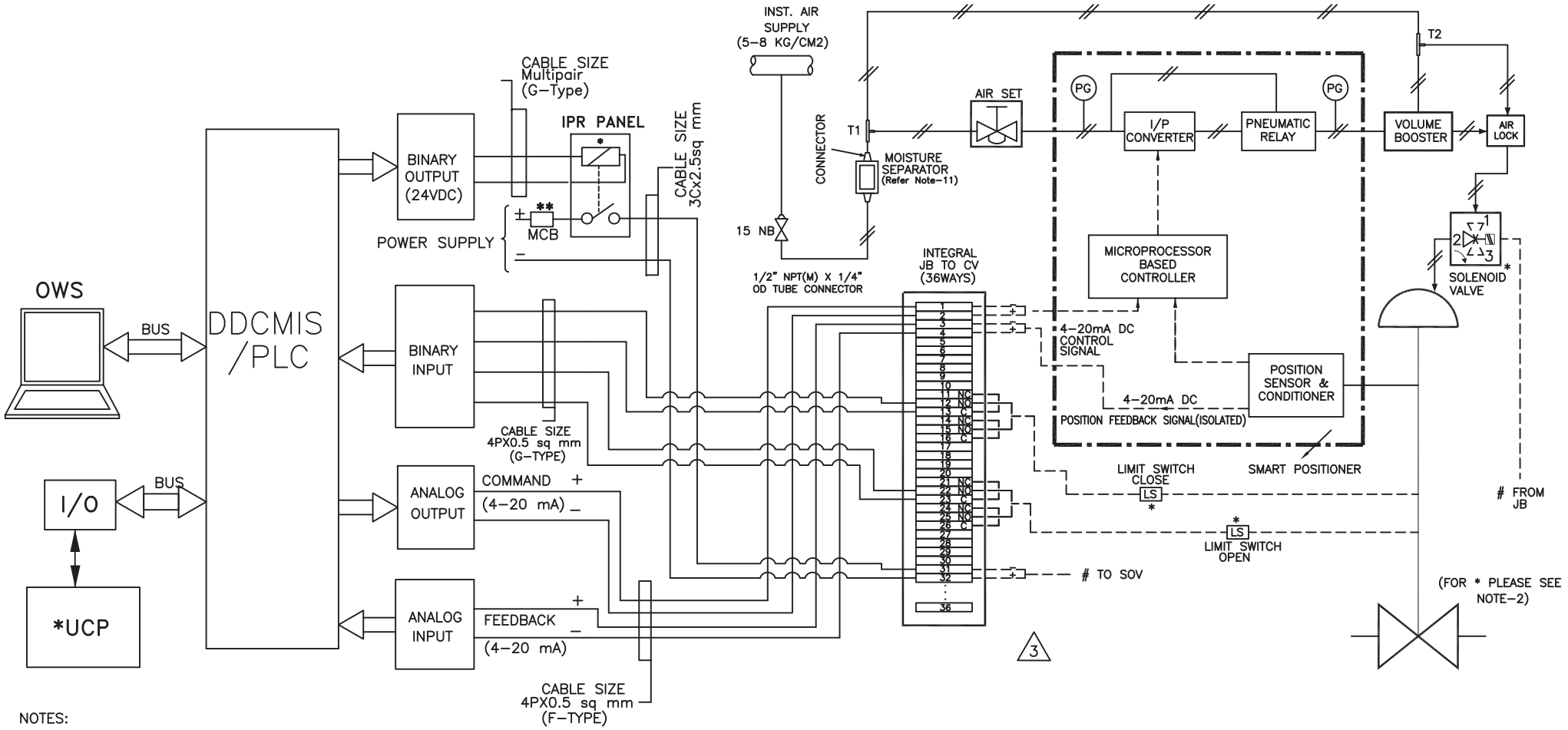
NOTE:

VIBRATION, WINDING & BEARING SIGNALS SHALL BE INTERFACED WITH DDCMIS AND INCLUDED IN EDN'S DOCUMENT.

I/O REDUNDANCY SHALL BE AS PER SPECIFICATION REQUIREMENTS. 3

BHEL	PROJECT: 2X660 MW ENNORE SEZ STPP	DRG.NO.	PE–DM–412–145–I002
		DATE	10.08.2015
	TITLE: DDCMIS INTERFACE FOR UNIDIRECTIONAL HT DRIVE	REV.NO.	04
		SHT	11 OF 12

DCS INTERFACE FOR ANALOG DRIVE (WITH SMART POSITIONER)



NOTES:

* WHEREVER APPLICABLE.

** APPLICABLE TO VALVES WHERE PROTECTION OPEN/CLOSE ACTION FOR CONTROL DEMAND OVERRIDING IS REQUIRED.

3 I/O REDUNDANCY SHALL BE AS PER SPECIFICATION REQUIREMENTS.

4 ALL REQUIRED ACCESSORIES i.e. SOLENOID OR ANY OTHER HARDWARE REQUIRED TO ACHIEVE THE STAYPUT POSITION AT CONTROLLER SIGNAL FAILURE SHALL BE PROVIDED.

DI FOR FAULT SIGNAL OF THE SMART POSITIONER SHALL BE PROVIDED.

BHEL	PROJECT: 2X660 MW ENNORE SEZ STPP	DRG.NO.	PE-DM-412-145-I002
		DATE	10.08.2015
	TITLE: TYPICAL HOOK-UP DIAGRAM ANALOG DRIVE (WITH SMART POSITIONER)	REV.NO.	04
		SHT	12 OF 12

QAP FOR C&I ITEMS AND FAT

CHAPTER-14

QUALITY ASSURANCE AND TESTING AND GUARANTEES

14.01.00 GENERAL REQUIREMENT

14.01.01 All equipment furnished under this specification shall be subject to test by authorized quality assurance personnel of the Bidder, representatives of the Owner during manufacture, erection and on completion. Bidder'' quality assurance personnel for these shop and site tests shall be identified in advance and shall be acceptable to the Owner. The approval of the Owner or passing of such inspection of tests will not, however, prejudice the right of the owner to reject the equipment if it does not comply with the specifications when erected or fails to give complete satisfaction in service.

14.01.02 The Bidder shall furnish details of shop and site tests proposed to be conducted by him at various stages to meet the specification requirements for each type of instrument/system along with his proposal. Bidder shall also furnish details of his proposed shop and site quality assurance organization for this contract

14.01.03 Bidder shall prepare a detailed shop and site 'Quality Assurance Programme' to meet the requirements of these specifications for Owner's approval. This document shall also contain the formats for reports and maintenance of test records specification of test equipment to be used for site tests.

14.01.04 All equipment and systems furnished under this specification shall be subjected to shop & site tests in accordance with the Quality Assurance Program approved by the Owner and shall be adequate to ensure full compliance with these specification, all applicable codes & standards and detailed engineering drawings and documents approved by the Owner.

14.01.05 The Bidder shall provide all required test equipment and simulation devices for performing all shop and site tests. All tests equipment shall be of reputed make, required accuracy class and shall be recently calibrated. The record of calibration of test equipment shall be made available to the Owner on demand.

14.01.06 The cost of all tests as per the requirements of this specification and approved quality assurance programme shall be included in Bidder's lump sum price for this package and no extra price shall be payable by the Owner for conducting any test as per the intent and requirements of this specification.

14.01.07 All approval/Inspection are to be carried out by the Owner only.

14.02.00 SHOP TESTS

14.02.01 General Requirement

14.02.01.00 Shop tests shall include all tests to be carried out at Bidder's works at of this sub-bidder and at works where raw materials used for manufacture of equipment is produced.

14.02.01.01 Individual components, instruments and devices furnished in accordance with specification sheets, and I&C device list enclosed with these specifications shall be shop tested by manufacturer prior to shipment. The manufacturer shall conduct these tests for certifying compliance with published specifications for the equipment and provide test results to the Owner in writing. These tests and test certificates shall be in accordance with the agreed 'QA' programme for major systems/equipments. However, manufacturer's standard methods shall be followed if details of tests for any equipment are not covered under this agreed 'QA Programme'.

14.02.01.02 Whenever tested quality material is specified and wherever called upon by Indian Boilers Regulations or by the design code, the test pieces are to be prepared and tested to Owner's satisfaction.

14.02.01.03 In the event of Owner being furnished with certified particulars of tests, which have been carried out by the suppliers of material, the Owner may, at his discretion, dispense with these tests.

14.02.02 Material Tests

14.02.02.01 Whenever tested quality material specified and whenever called upon by Indian Boilers Regulations or by design code, the test pieces, are to be prepared and tested to Owner's satisfaction.

14.02.02.02 In the event of Owner being furnished with certified particulars of tests, which have been carried out by the suppliers of material, the Owner may, at his discretion, dispense with these tests.

14.02.03 Test at Manufacturer's Works

14.02.03.01 Works tests are to include electrical, mechanical performance and hydraulic tests in accordance with relevant IS, IBR or any other approved standard or any other tests called for by the Owner under these specifications to ensure that the equipment being supplied fulfills the requirements of these specifications. For equipments not covered by any IS or other approved standards, the tests to be carried out shall be in accordance with Bidders' quality assurance programme approved by the Owner.

14.02.03.02 Control systems, monitoring systems ,control panels instrument enclosures ,and power supply systems shall be shop tested according to unique requirements specified in the applicable section of these specifications for each item and quality assurance program approved by the owner.

14.02.03.03 All shop tests shall be performed prior to shipment and the Owner shall be given the opportunity to witness these tests. The Bidder shall notify the Owner regarding readiness for shop test at least 10 days before the scheduled date if the tests to be conducted within Indian and at least 60 days before the schedule date if the test is to be conducted abroad.

14.02.04 Factory Tests

14.02.04.01 Automatic Control and Monitoring system (DDCMIS, PLC & any other microprocessor based control system) including alarm annunciation system furnished as per this specification shall be subject to shop and site tests as per the requirements of this specification, applicable codes and Owner approved Quantity Assurance Program so as to demonstrate to the Owner that the equipment furnished by the Bidder meets the intent and requirement of this specification. These tests shall include but shall not be limited to the tests indicated in the subsequent clauses.

14.02.04.02 **Surge Protection Test for Solid State Equipment**

All solid state equipment shall be able to withstand the noise and surge inherent in a Power House, and shall strictly comply with SWC tests ANSI C 37.90A, 1974 for IEEE-472 (1974). Complete details of the features incorporated in electronic system to meet this requirement, the relevant test carried out, and the test certificates shall be submitted along with the proposal.

14.02.04.03 **Burn-in and Elevated Temperature Test**

All solid state electronic equipment shall be tested as a complete system/equipment with all devices connected for a minimum of 168 hours continuously under energized conditions prior to shipment from manufacturer's works, as per the following cycle :-

During the first 48 hours of testing the ambient temperature shall be maintained at 50 deg.C and relative humidity at 95%. The equipment shall be interconnected with all devices, which will cause it to repeatedly perform all operations; it is supposed to perform in actual service, with load on various components being equal to those, which will be experienced in actual service.

The 48 hours tests period shall be continuous but shall be divided into four 12 hours segments. The input voltage during each 12-hour segment shall be nominal voltage for 11 hours, followed by 110% of normal voltage for 30 minutes followed by 90 percent of nominal voltage for 30 minutes.

The 48 hours elevated temp test shall be followed by 120 hours of burn in test as specified in the above paragraphs except that the temperature is reduced to ambient temperature prevalent at that time. Alternatively copy of type test certificate for burn-in test shall be submitted.

14.02.04.04 The Bidder shall furnish full details regarding shop tests and site tests, as per good engineering practices. The Owner shall approve all such tests and the supplier shall conduct all such tests without calling for additional price.

The tests shall cover factory tests, burn-in and elevated temperature tests, simulation and functional tests, insulation tests as applicable, the rating of the contact devices and components, surge withstand capability test, conformity of interconnection cables, testing and checking of other conditions deemed to be necessary with the system/equipment items.

14.02.04.05 All instruments and control equipment supplied against this contract shall be factory calibrated at least at five (5) points throughout the range and checked for their

functional/performance requirements. The instruments shall also be calibrated at site prior to commissioning.

14.02.04.06 All panels, instruments enclosures, junction boxes, etc. shall be type tested for degree of protection and applicable in accordance with IS: 2147. 8.02.04

14.02.04.07 Type, routine and acceptance testing of all equipments, supplied under this contract, shall be in accordance with relevant NEEA/IS/IEC/ANSI/BS/ISA standards, in addition to the requirements of Owner approved Quality Plans. Six (6) copies of test reports shall be submitted to the Owner for approval prior to dispatch of respective equipment

14.02.04.08 The representative of Owner shall be given opportunity to witness the factory tests which shall be mutually finalized during the progress of the contract.

14.02.04.09 All control systems to be furnished for this project, shall be factory tested for circuit continuity and direction of response. The Components to be tested shall include all controllers, HAND/AUTO station, other system modules, alarm contactors and multi-conductor interconnecting cables. The tests shall be performed with all of the system components supplied by the Bidder connected to form a complete system with the sole exception of transmitters. The tests shall include a means of confirming the mathematical design response of the control system by simulating changes in system input. The tests shall be a qualitative functional test of each component of control system, which simulates dynamic inputs and monitors system outputs.

14.02.04.10 Certain control loops shall be factory tested using closed loop mathematical simulation techniques. Control loops to be tested by closed loop methods are broadly as under. However, owner has discretion to test and all control loops during simulation testing.

ii) Firing rate control (fuel and air flow control)
iii) Furnace draft control
iv) Boiler separator level control

(d) **Response time for Turbine Control System.**

The input simulation equipment shall be designed to produce effects from control system outputs based on mathematical model of the predicted performance and process dynamics of the main unit equipment. The control constants of various control loop components shall be adjusted to produce a stable and optimum control adjusted to produce a stable and optimum control when connected to the simulation equipment.

14.02.04.11 Simulation data including factory adjustment of control system constants, and simulation equations shall be tabulated and shall be made available by the Bidder for owner's use during field check out and the start up of the control system.

14.02.04.12 Availability of a simulated type test for automatic control loops specified with a detailed description of testing methods utilized, shall be indicated.

14.02.04.13 The availability of facilities for carrying out the model test for the control systems shall be indicated by the bidder. Also details of test procedures and copies of test results conducted for a similar fossil fuel fired unit shall be furnished. The data required from Boiler and Turbo generator supplies shall also be furnished by the Bidder.

14.02.04.14 Brief description of all tests proposed to be conducted on each control system components during various stages of manufacture, installation and commissioning shall be f urnished. C opies of t est dat a acc umulated dur ing t he t ests shall be submitted to the mutually agreed formats.

14.02.04.15 The owner shall witness the factory tests which shall be performed at a time mutually agreeable to the Bidder and the owner.

14.02.04.16 **Factory Acceptance Tests for DDCMIS, DCS, Simulator & PLC**

GENERAL	1	FACTORY ACCEPTENCE TEST (FAT): REF NOTE-1	✓
	2	FACTORY ACCEPTENCE TEST (FAT) PROCEDURE: REF.NOTE -2	✓
	3		
	4		
	5		
TEST REQUIREMENTS	6	TEST SHALL BE PERFORMED WITH THE COMPLETELY ASSEMBLED SYSTEM AND ALSO WITH COMPLETE	✓
	7	I&C SOFTWARE AND PERFORMING ALL FUNCTIONS EXPECTED OUT WHILE IN ACTUAL SERVICE AND	
	8	WITH STSTEM CONFIGURATION AS FINALISED.	
	9	PROCESS INPUT/OUTPUT CONDITIONS AND OTHER LOAD ON THE SYSTEM TO BE STIMULATED	✓
	10	EITHER BY HARDWARE/SOFTWARE.	
	11	ALL SYSTEM SOFTWARE and APPLICATION SOFTWARE TO BE LOADED AND OPERATIONAL ON THE	✓
	12	SYSTEM PRIOR TO FAT	
	13	FAT TO BE CONDUCTED AT ELEVATED TEMP. OF 45 DEG C FOR MINIMUM 48 HOURES	✓
	14	FAT UNDER FOUR CYLES OF VOLTAGE FLUCATIONS VIZ NOMINAL AT 110 % OF RATED VOLTAGE	✓
	15	PERFORMANCE TEST:	✓
	16	-	
	17	-	
TEST DOCUMENTS DRAWINGS	18	TOTAL SYSTEM CONFIGARATION DRAWINGS	
	19	FAT PROCEDURE CONSITING OF:	
	20	(i) TEST EQUIPMENT	
	21	(ii) TEST ENVIRONMENT	
	22	(iii) TEST CONFIGURATION	✓
	23	(iv) TEST PROCEDURE	
	24	(v) TEST SCHEDULE	
	25	(vi) TEST VENUE	
	26	(vii) TEST REPORTS- SPECIMEN COPIES	
	27	FUNCTION DESIGN SPECIFICATION FOR EACH EQIPMENT / SYSTEM	
	28	-	
	29	-	
PRELIMINARY CHECKS	30	GENERAL APPEARENCE CHECK and BILL OF MATERIALS CHECK	✓
	31	CONSTRUCTION CHECK AS PER OVER ALL GENERAL ARRANGEMENT DRAWINGS	✓
	32	DIMENSIONAL CHECK	✓
	33	LABELLING, TERMINAL ARRANGEMENT AND EQUIPMENT IDENTIFICATION CHECK	✓
	34	POWER SUPPLY VOLTAGE LEVEL CHECK and POWER 'LEDs -ON CHECK	✓
	35	COOLING FAN OPERATION CHECK	✓
	36	GROUNDING NETWORK CHECK	✓
TEM	1	POWER SUPPLY UNDER VOLTAGE AND OVER VOLTAGE CHECK (± 10%)	✓
	2	PROCESSOR and MAIN DATA BUS NETWORK REDUNDANCY CHECK, IF APPLICABLE	✓
	3	COMMUNICATION COUPLER IF APPLICABLE REDUNDANCY CHECK	✓
	4	COMMUNICATION MODULE OF THE CONTROLLER TO NETWORK REDUNDANCY CHECK, IF APPLICABLE	✓
	5	POWER SUPPLY REDUNDANCY CHECK	✓
	6	HARDWARE ON-LINE MAINTAINABILITY CHECK,	✓
	7	-	
	8	-	
CONTROLLER ENGINEERING	9	CLOSED LOOP CONTROL SIMULATION CHECK	✓
	10	OPEN LOOP CONTROL SIMULATION CHECK	✓
	11	CONTROL LOOP RESPONSE CHECK	✓
	12	BUMPLESS AUTO MANUAL TRANSFER CHECK	✓
	13	OPERATING STATION – GRAPHIC OVERVIEW CHECK	✓
	14	OPERATING STATION- TREND CHECK	✓
	15	OPERATING STATION- REAL TIME TREND CHECK	✓
	16	OPERATING STATION- MIMICS CHECK	✓
	17	OPERATING STATION- CHECK FOR OPERATING CONTROL DIRECTLY FROM MIMICS	✓
	18	OPERATING STATION- FUNCTION KEYS CHECK	✓
	19	OPERATING STATION- TOUCH SCREEN FUNCTION CHECK	✓
	20	OPERATING STATION- ANALOG CONTROL DISPLAY CHECK	✓
	21	OPERATING STATION- SEQUENCE CONTROL DISPLAY CHECK	✓
	22	OPERATING STATION- OPERATOR GUIDENCE MESSAGE CHECK	✓
	23	OPERATING STATION- ALARM MANAGEMENT FUNCTION CHECK	✓

	24	OPERATING STATION LOGGING FUNCTION CHECK	✓
	25	OPERATING STATION / RESPONSE / UPDATING CHECK	✓
	26	KEYBOARD LOCK FUNCTION CHECK	✓
	27	OPERATING STATION INTERCHANGEBILITY and ASSIGNABILITY CHECK	✓
	28	PRINTER ASSIGNABILITY and BACK-UP FUNCTION CHECK	✓
	29	FLOPPY DISK/ STD / OPTICAL DISK UNIT STORAGE and RETRIEVAL CHECK	✓
	30	OPERATING STATION ASSIGNABILITY CHECK FOR HARD COPIER FUNCTION	✓
	31	PLANT PERFORMANCE CALCULATION CHECK	✓
	32	COMMUNICATION INTERFACE TO OTHER'S SYSTEM SIMULATION CHECK	✓
	33	-	
	34	DATA BUS DISTANCE BUILDING CHECK (REFER NOTE- 3)	✓
	35	GRAPHIC DISPLAY BUILDING FUNCTION CHECK	✓
MAINTENANCE	36	CLOSED LOOP CONTROL SYSTEM MODIFICATION CHECK	✓
	37	OPEN LOOP CONTROL SYSTEM MODIFICATION CHECK	✓
	38	ALARM DISPLAY PRIORITISATION CHECK	✓
	39	SYSTEM SECURITY CHECK	✓
	40	SYSTEM ALARM CHECK	✓
	41	SYSTEM DIAGNOSTIC FUNCTION CHECK	✓
	42	POINT DETAIL CONFIGURATION CHECK	✓
	43	CONTROL LOOP TUNING CHECK	✓
	44	SYSTEM SELF DOCUMENTATION CHECK	✓
NOTES	1. THE INTENT OF THE FAT IS TO DEMONSTRATE AND ENSURE THAT THE I&C SYSTEM MEETS ALL THE FUNCTIONAL REQUIREMENTS AS INTENDED IN THE SPECIFICATION / CONTRACT. A COMPLETED INTEGRATED TEST OF THE SYSTEM SHALL BE CARRIED OUT AT VENDOR'S WORKS IN THE PRESENCE OF OWNER, ON COMPLETION OF INTEGRATION/MANUFACTURING OF THE SYSTEM. THE SHIPMENT OF I&C EQUIPMENT TO SITE WILL BE EFFECTED ONLY AFTER THE FAT HAS BEEN ACCEPTED BY THE OWNER.		
	2. FAT PROCEDURE SHALL BE PREPARED BY VENDOR AND TO BE SUBMITTED FOR OWNER'S/ APPROVAL WELL IN ADVANCE PRIOR TO THE COMMENCEMENT OF FAT		
	3. FAT SHALL BE CONDUCTED WITH THE DISTANCE BETWEEN THE PROCESSOR AND OTHER SUPPORTING PERIPHERIALS AS PER THE FINAL LAYOUT IN THE CONTROL ROOM.		
	4. ALL THE RELEVANT APPROVED DOCUMENTS REQUIRED FOR FAT SHALL BE SUBMITTED BY THE BIDDER IN ADVANCE PRIOR TO COMMENCEMENT OF FAT.		

14.02.04.17 **Tests to be performed during FAT of PLC system**

Following minimum tests shall be performed during FAT at manufacturer's place of PLC system:

1) Hardware Inspection of PLC Sub System
   - i) Heat run test
   - ii) Hardware check / physical software package check
   - iii) I/O loading specification
   - iv) PLC start-up and power fail restart
   - v) PLC processor back-up function
   - vi) Communication redundancy

2) Application Inspection for Logic Functions
   - i) Ladder logic functional check and graphic screen check

3) Application Inspection for PLC Panels
   - i) General arrangement
   - ii) Appearance and construction
   - iii) Panel wiring
   - iv) Panel functional check
   - v) Power supply redundancy check

4) PLC System Checks

i) PLC Scan time functional test
ii) PLC/IO panel/Engineering station functions
iii) Diagnostic and process alarm test
iv) Controller redundancy test
v. I/O cards redundancy test.
vi) Controller loading test

In addition to above test, Bidder shall also perform other tests as per approved QAP & FAT procedure. Also bidder shall submit "Type Test" report as per IEC – 61131.2 along with FAT report for PLC.

14.02.04.19 FACTORY ACCEPTANCE TEST FOR SIMULATOR

Factory Acceptance Test (FAT) shall include all required tests to fully demonstrate to Owner's satisfaction that each equipment/sub-system/system software modules etc. furnished as per this specification, as well as Simulator as a whole, fully meets the functional, parametric and other requirements of this specification and Owner's approved drawings/documents under all operating regimes.

Bidder to note that FAT procedure given below in subsequent clauses are only indicative in order to help the Bidder in understanding the requirements and help him in submitting a detailed procedure based on these guidelines meeting all the specification requirements.

The Bidder shall also carry out the tests included in subsequent clause as pre FAT and submit its results before inviting Owner for FAT.

The Factory Acceptance Test (FAT) shall include all reasonable exercises, which the combination of equipment and software can be expected to perform. These tests shall be divided into, as a minimum, but not limited to the following categories:

i. Pre power on checks
ii. Power on check
iii. Hardware tests
iv. Functional tests
v. Parametric tests
vi. Specific tests on Electronic hardware

14.02.04.19.1 The major Functional Tests shall include but not limited to the following:

a) Verification of individual modules in line with approved documents.

b) Verification of adherence to parameters for various plant configurations at different initial conditions.

c) **Functional test for C&I Model**

Verification of proper realization of Control and Logic functions as per input documents and approved functional design specification (FDS).

d) **Functional tests for HMIPIS**

i. Verification of all types of displays, logs including their formats, bar graphs, X-Y plots etc. Verification of all function keys on keyboards and availability of all operator functions.

ii. Verification of event generation and handling capabilities of HMIPIS processors by simulating various types of events / data and observing associated event sequence display and alarm signaling boxes.

iii. Calculations:

All calculations shall be tested to demonstrate that these are in accordance with the specification and I/O schedule. The Bidder shall prepare all tests cases for calculations (3 for each calculation at low, mid and upper ranges of inputs) and submit them for the owner's approval. Test cases shall include performance calculations, flow and level calculations, pressure and temperature compensations, etc.

iv. Checking historical storage and retrieval functions including long-term storage.

v. Checking healthiness of processor, main memory. Testing of initialization and loading of configuration data, etc.

vi. Verification of all programmers' stations functions for HMIPIS and Control System, as well as for documentation facility as specified.

vii. Various display response time / System accuracy etc.

viii. Display update time on OWS

e) Functional test for networking & communication devices

i. Verification of various features as per approved documents.

ii. Verification of throughput after creating high communication traffic.

f) Instructor's workstation Functions

Verification of all features of instructor functions like malfunction, initial conditions, snapshots, trainee exercises etc. in line with specification & approved documentation.

g) Programming and Documentation functions

i. Verification of all programming function like, modification of application software, da tabase, a dministrator's function et c. i n l ine w ith specification and approved documents.

ii. Verification of all documentation functions in line with specification and approved documents.

14.02.04.19.2 FAT Procedure

The B idder shall su bmit a de tailed FA T p rocedure for ow ner's approval dur ing detailed engineering stage based on the above guidelines. The FAT procedure to be submitted by the Bidder shall be det ailed and exh austive enough such that owner is satisfied t hat al l t he S imulator S ystem sp ecification r equirements and f eatures are being tested and the system meets these requirements.

14.02.04.20 **Tests to be performed during FAT of Peripherals & other control system**

1. Colour Graphic Video Display Unit (OWS)

   i. Functional tests (As per FAT procedure. Note-1)
   ii. Test for capabilities of OWS including error detection for the complete system (Both hardware & software) simulating worst conditions
   iii. Noise test
   iv. Surge withstanding capacity as per IEEE or equivalent
   v. Quality assurance as governed by BS 5750 or equivalent
   vi. Design, construction, components, finishes and testing of electronic equipment as per EES-1980 (General specification of electronic equipment) or equivalent

   Note-1: Test to be witnessed by Owner.

2. Keyboard

   i. Test for satisfactory operation of keyboard controls, push buttons and all associated functions (As per FAT procedure. Note-1)
   ii. Quality assu rance as governed by BS 5750 or e quivalent for functional test for the complete system simulating worst conditions
   iii. Design, construction, components, finishes and testing of electronic equipment as per EES-1980 (General specification of electronic equipment) or equivalent

   Note-1: Test to be witnessed by Owner.

3. Printers

   i. Noise level test for the printer
   ii. Test of interlock performance and error detection feature.
   iii. Quality assurance as governed by BS 5750 or equivalent
   iv. Design, construction, components, finishes and testing of electronic equipment as per E ES-1980 (General sp ecification o f el ectronic equipment) or equivalent

4. Floppy / Tape Drive Unit / Bulk Memory Unit / DVD, CD drive Unit / DAT Drive

   i. Noise test
   ii. Surge withstanding capacity as per IEEE or equivalent
   iii. Quality assurance as governed by BS 5750 or equivalent
   iv. Design, construction, components, finishes and testing of electronic equipment as per EES-1980 (General specification of electronic equipment) or equivalent
   v. Test of Control unit and drive for all features, date checking features.

5. Vibration Monitoring & Analysis System

   i. Simulated functional test (Note-1)
   ii. Tests for server, LED monitor, Printer, Keyboard

   Note-1: Test to be witnessed by Owner.

6. PADO (Performance & Optimization System)

   i. Simulated functional test (Note-1)
   ii. Tests for server, LED monitor, Printer, Keyboard

   Note-1: Test to be witnessed by Owner.

7. ERP System

   i. Simulated functional test (Note-1)
   ii. Tests for server, LED monitor, Printer, Keyboard

   Note-1: Test to be witnessed by Owner.

8. MIS System

   i. Simulated functional test (Note-1)
   ii. Tests for server, LED monitor, Printer, Keyboard

   Note-1: Test to be witnessed by Owner.

9. HMS System

   i. Simulated functional test (Note-1)
   ii. Tests for server, LED monitor, Printer, Keyboard

   Note-1: Test to be witnessed by Owner.

NOTES:

1. The intent of the FAT is to demonstrate and ensure that the I&C system meets all the functional requirements as intended in the specification / contract. A completed integrated test of the system shall be carried out at vendor's works in the presence of Owner or Owner's representative, on

completion of integration / manufacturing of the system. The shipment of I&C equipment to site will be effected only after the FAT has been accepted by Owner.

2. FAT procedure shall be prepared by vendor and to be submitted for Owners approval well in advance prior to the commencement of FAT.

14.02.04.21 **Calibration of Instruments**

The Bidder shall carry out the calibration of instruments as indicated below by submitting the test procedure and quality assurance plan for the Owner's approval. Bidder shall also prepare detailed checklist/calibration sheets for each of the systems/equipment clearly indicating the step-by-step procedures to be carried out for calibration pre commissioning, loop checking, powering and commissioning.
The calibration of all instruments shall be checked and calibration records prepared for the Owner's use. If the instruments require recalibration, Bidder shall recalibrate the instruments and revise the calibration records and submit to the Owner.

i TESTS TO BE PERFORMED FOR FIELD INSTRUMENTS

1.	Pressure Gauges
	Calibration Hydro test (1.5 times max. pr.)
2.	Pressure switches
	Calibration test / Hydro test / Contact rating test / Accuracy test / Repeatability
3.	Differential Pressure Gauges
	Calibration test / Hydro test / Leak test / Over range test / Accuracy test / Repeatability test.
4.	Differential Pressure Switches
	Calibration test / Hydro test / Contact rating test / Leak test / Accuracy test / Repeatability test.
5.	Thermometers
	Calibration / Material test / Accuracy test / Bore concentricity : $\pm$ 5% of wall thickness / Hydrostatic test for TW (1.5 times max. pr.)
6.	Temperature switch
	Calibration / Material test / Accuracy test / Bore concentricity : 1.5% of wall thickness / Hydrostatic test for TW (1.5 times max. pr.) / Contact rating test.
7.	Resistance temperature detector assembly.
	Calibration / Material test / Bore concentricity test / Insulation test ($\leq$ 500 MΩ at 500V DC) as per ISA, Hydro test for TW. Bore concentricity: $\pm$ 5% of wall thickness, Accuracy test.
8.	Thermocouple assembly
	Calibration / Material test, Insulation test ($\geq$ 500 Ω at 500 V, DC) as per ISA, Hydro static test (1.5 times max. pr.), Bore concentricity : $\pm$ 5% of wall thickness.
9.	Thermowells
	Material test / Bore concentricity : $\pm$ 5% of wall thickness / Hydrostatic test for TW (1.5 times max. pr.)

10.	Level Guages
	Hydrostatic test / Material test / Seat leakage test / Ball check test.
11.	Level switches (Magnetic)
	Material test / Contact rating test / Hydro test / Calibration test.
12.	Flow Switch
	Material test / Hydro static test (1.5 times max. pr.) / function test.
13.	Flow glasses
	Material test / Hydrostatic test (1.5 times max. pr.) / function test.
14.	Variable area flow meters
	Calibration test / Material test / Hydrostatic test (1.5 times max. pr.)
15.	Flow element
	100% Radiography test / Hydro test / Calibration test, IBR Certificate.
	Calibration test for flow element shall be witnessed by Owner.
16.	Control valves/Pneumatic block valve/Pressure regulating valve – Refer chapter 11.
17.	Position transmitters
	Calibration / hysteresis and Accuracy test
18.	Electro Pneumatic Convertors
	Calibration test / Accuracy test
19.	Solenoid valves
	Hydrotest / Seat leakage test / CV test / Coil insulation test
20.	Air filter regulators
	Calibration test / Accuracy test
21.	Junction Boxes
	Test for degree of protection / Material test
22.	Tests for terminal blocks
	Test for moulding for flame resistant, Non-hygroscopic and Decarbonised / Insulation test between terminals / Insulation between terminal block and frame.
23.	Thermocouple extension cable
	Thermo-emf characteristic / Continuity test / Measurement on capacitance, inductance and loop resistance / Insulation resistance / High voltage test as per latest IS / Tensile and elongation test / Oxygen index test / Any other test applicable.
24.	Mass flow meter
	Performance test / Calibration test / Hydrostatic test.
25.	Boiler Level Gauge
	Hydrostatic test / Material test / Seat leakage test / IBR Certificate
26.	pH/Conductivity measurement / Silica / Dissolved oxygen analysers:
	Calibration test, Accuracy test
27.	Sample cooler :

	Hydro test, IBR Certificate
28.	Sampling racks :
	Hydro test, IBR Certificate for tubes and fittings.
29.	S02 / Nox analyser / SPM analyser:
	Calibration test, accuracy test
30.	Interposing relay
	Functional test, temperature rise test, H.V test, Insulation test
31.	Transmitter Racks :
	Hydro test, air leak test for piping / tubing and fittings. IBR certification as required for tubing / piping and fittings.
32.	Pressure Transmitter
	Calibration test / Hydro test / Leak test / Over range test / Accuracy test / Repeatability test.
33.	Differential pressure transmitter
	Calibration test / Hydro test / Leak test / Over range test / Accuracy test / Repeatability test.
34.	Temperature Transmitter
	Calibration test / Accuracy test /Ambient temperature error test
35	Pneumatic Block Valves
	a) IBR certificate form III C b) Hydrostatic test : ANSI B 16.34 c) Seat leakage test : As per ANSI B 16-104 d) CV test: As per ISA procedure e) Magnetic particle test ANSI B 16.34 special class (applicable for pr.>70 bar & temp< 400 DegC) f) Liquid penetration test: ANSI B 16.34 special class (applicable for pr.>70 bar & temp< 400 DegC) g) Radiography test: ANSI B 16.34 special class h) Calibration and Hysteresis test i) Actuator leakage test
36.	Pressure Regulating Valve

	a) IBR certificate form III C b) Hydrostatic test : ANSI B 16.34 c) Seat leakage test : As per ANSI B 16-104 d) CV test: As per ISA procedure e) Magnetic particle test ANSI B 16.34 special class (applicable for pr.>70 bar & temp< 400 DegC) f) Liquid penetration test: ANSI B 16.34 special class (applicable for pr.>70 bar & temp< 400 DegC) g) Radiography test: ANSI B 16.34 special class h) Calibration and Hysteresis test i) Actuator leakage test
37.	Local Panels : Visual inspection, wiring & continuity check, H.V. and I.R. tests on panels, checking of bill of materials, functional tests.
38	Wiring Termination & Accessories
	Routine test: Conductor resistance test/High voltage test/Impulse dielectric test/insulation test/Humidity test/Temperature rise test on power circuits/short time current test on power circuits.
	Type test:Annealing test/Test for insulation and sheath/ Flame retardance test - a) Oxygen index, b) Flammability / Test for acid gas generation/test for water absorption/wet dielectric test
39	Marshalling/System cabinets
	Verification of degree of protection/Electrical tests as detailed under wiring Termination& accessories/Type test and routine test as per relevant Indian standards.
	Notes:
	1. Test Certificates in addition to inspection at manufacturers works shall be furnished for all the instruments for Owner's review. 2. Above Test to be witnessed shall be finalized by Owner.
	3. In addition to above test, test as per approved QAP shall also be witnessed by owner.

17.02.05 TYPE TESTING

The BIDDER shall furnish the Type test reports of all type tests as per relevant standards and codes. As well as other specifics test indicated in the specification. A list of such test are given for various equipment in table titled, TYPE TEST REQUIREMENT FOR C&I SYSTEM and under the item special requirement for solid state requirements/systems. For the balance equipments/instruments. type test may be conducted as per manufacturer standards or if required by relevant standards.

A. Out of these test listed , the bidder /subvendor/manufacturer is required

to conduct certain type test specifically for this contract (and witnessed by employer or his authorized representative). Even if the same have been conducted earlier as clearly indicated subsequently such tests.

B. For the rest, submission of type test, results, and certificates shall be acceptable provided following points

i. The same have been carried out by the bidder/ subvendor on exactly the same model/rating of equipment. (For control valves this shall be same size, type & design).
ii. There has been no change in the components from the offered equipments and tested equipments.
iii. The test has been carried out as per the latest standards along with amendemends as on the date of bid opening.

C. In case the approved equipment is different from the one on which the type test had been conducted earlier or any of the above grounds, then the tests have to be repeated and the cost of such tests shall be borne by the bidder/sub-vendor within the quoted price and no extra cost will be payable by the owner on this account.

17.02.05.1 As mentioned against certain items, the test certificates for some of the items shall be reviewed and approved by the main bidder or his authorized representative and balanced have to be approved by the employer.

The schedule of conduction of type test/submission of reports shall be submitted and finalized during pre award discussion.

17.02.05.2 For the type test to be conducted, bidder shall submit detailed test procedure for approval by owner. This shall clearly specify test setup, instruments to be used, procedure, acceptance norms (wherever applicable)., recording of different parameters, intervals of recording precaution to be taken etc. for the test to be carried out.

17.02.05.3 **SPECIAL REQUIREMENTS FOR SOLID STATE EQUIPEMNTS /SYSTEMS**

The minimum type test report, over and above the requirements of above clause which are to be submitted for each of the major C&I systems like DDCMIS, DCS, PLC etc shall be as indicated below:

i. Surge Withstand Capability (SWC) for solid state equipments/equipments

All solid state systems/equipments shall be able to withstand the electrical noise and the surges as encountered in actual service conditions and inherent in the power plant . All the solid states systems /equipments shall be provided with all required protection that needs the surge withstand capability as defined in ANSI 37. 90.1/IEEE 472. Hence, all front end cards which receive external signals like analog input and output modules, Binary input and output modules etc including power supply , data highway, data links shall be provided with protection that meets the surge withstand capability as

defined in ANSI 37.90.1/IEEE 472. Complete details of the features incorporated in the electronic system to meet this requirement the relevant test carried out, the test certificates ,etc shall be submitted along with the proposal. As an alternative to the above, suitable class of EN 61000-4-12 which is equivalent to ANSI 37.90.1/IEEE 472 may also be adapted for SWC test.

ii. The dry heat test as per IEC-68-2-2 or equivalent
iii. Damp heat test as per IEC 68-2-3 or equivalent
iv. Vibration test as per IEC 68-2-6 or equivalent
v. Electrostatic Discharge test as per EN 61000-4-2 or equivalent
vi. Radio frequency immunity test as per EN 61000-4-6 or equivalent
vii. Electromagnetic Field Immunity test as per EN 61000-4-3 or equivalent

Test listed at Item no v , vi, vii above are applicable for electronic cards only as defined under item no. (i) above

17.02.05.4 TYPE TEST REQUIREMENTS FOR C&I SYSTEMS

S.No.	Item	Test requirement	Standard	Test to be specifically conducted	Owner's Approval required on Test Certificate
1	Electrical metering instruments	As per standards	IS 1248	No	Yes
2	Thermocouple	Degree of Protection Test	IS - 13947	No	No.
3	Junction Box	Degree of Protection Test	IS - 13947	Yes	Yes
4	RTD	As per standards	IEC-60751	No	No
5	Electronic Transmitter	As per standards	BS 6447/ IEC 60770	No	Yes
6	E/P convertor	As per standards	Manufacturing standard	No	Yes
7	Instrumentation cable (Twisted and shielded) (Refer Vol. V, Chapter 9)				
8	Battery	As per standard	IS 10918	Yes	YES
9.	Voltage stabiliser	Over load test	Approved procedure	No	YES
		Temp. rise test without redundant fans	Approved procedure	No	YES
		Input voltage variation test	Approved procedure	No	YES
10	**DDCMIS**				
	CLCS	Model Test	Approved	No	No

	system		procedure		
	BMS & MFT	Safety requirement	VDE 0116, SEC 8.7	No	YES
11	Conductivity type level switch	Degree of protection test	IS 13947	No	No
12	Local gauges	Degree of protection test	IS 13947	No	No
13	Process actuated switches	Degree of protection test	IS 13947	No	No
14	Control valves	CV test	ISA 75.02	No	YES
15	PLCs	As per Standard	IEC 1131	No	YES
16	LIE/LIR	Degree of protection test	IS 13947	YES	YES
17	Flue gas O2 analyser, other Fl ue gas Analysers	Degree of protection test	IS 13947	No	YES
18	Flow nozz les & O rifice plates	calibration	ASME PT C BS 1042	YES	YES

Note:
Type test are to be conducted only for the items, which are being supplied as part of this package.

A. For batteries with electric power supply system of main plant C&I, the bidder shall submit for owner's approval the reports of all the type tests as per IS-10918 carried out within last 5 years from the date of bid opening and the test should have been either conducted at an i ndependent l aboratory or sh ould hav e b een w itnessed by a o wner/client. The complete type test report shall be for any rating of battery in a particular group, based on plate dimensions being manufactured by supplier.

For batteries with electric power system of auxiliary plants, type test reports for batteries shall be as per standard –practice of manufacturer.

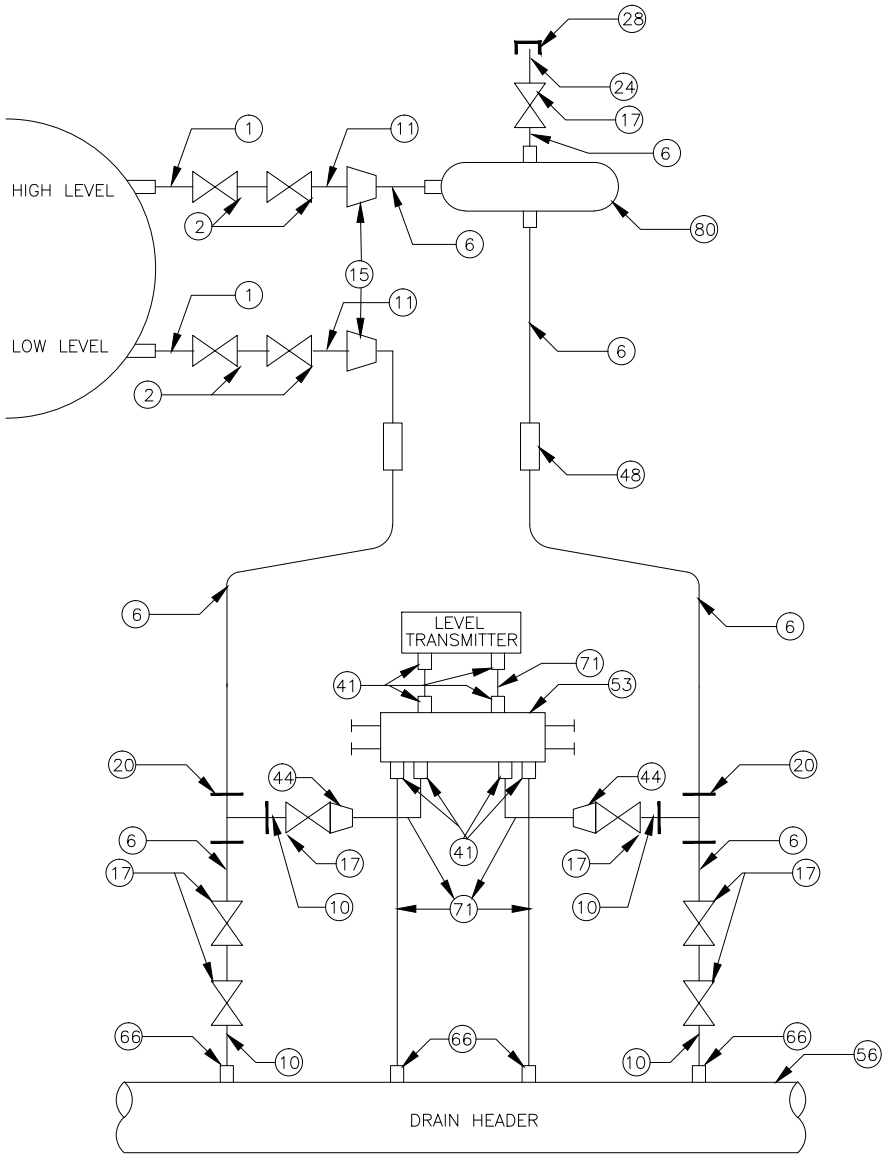
14.02.06 Testing at Site [Prior to commercial operation]

a. All equipment shall be checked thoroughly in respect of the following:

i. Visual and mechanical testing

ii. Complete system configuration loading functions; system diagnostics; system proper operation specified power supply specifications.

HOOK UP DRAWING



TRANSMITTER MOUNTED BELOW INST. SOURCE POINT

TAG NO.	DESCRIPTION	BOM
80	CONDENSATION CHAMBER	1
71	1/2"OD IMPULSE TUBE, SS-316	AS REQD.
66	1/2" GI SOCKET / FUNNEL	4
56	2"NB GI DRAIN HEADER	AS REQD.
53	5-VALVE MANIFOLD, SS-316	1
48	1/2" SW, CS/AS BULK HEAD PIPE UNION	2
44	1/2"BWX1/2"OD COMPRESSION TUBE FITTING,SS-316	2
41	1/2"NPT(M)X1/2"OD TUBE COMPRESSION FITTING,SS-316	8
28	1/2" NPT (F) CS CAP	1
24	1/2" NPS SCH-80/160X1/2"NPT(M) CS/AS NIPPLE	1
20	1/2" SOCKET WELDED EQUAL TEE CS/AS	2
17	1/2" SOCKET WELDED CS GLOBE VALVE	7
15	1"TO 1/2" SOCKET WELD REDUCER	2
11	1" NPS SCH 80/160 CS/AS NIPPLE	2
10	1/2" NPS SCH 80/160,CS/AS NIPPLE	4
6	1/2" NPS SCH 80/160 CS/AS PIPE	AS REQD.
2	1/2"/3/4"/1" SOCKET WELDED GLOBE VLV/ROOT VLV.	4
1	1/2" NPS SCH 80 NIPPLES OF MATERIAL SAME AS MAIN PIPE WITH NECESSARY ATTACH TO FLANGES	AS REQD.

NOTE:-
1. FOR HIGH TEMP. SERVICE (MORE THAN 80°C) A 'U' TUBE(REF. DWG NO. 114-04-0100) SHALL BE PROVIDED BETWEEN THE MANIFOLD AND THE TRANSMITTER
2. FOR HIGH PR.(MORE THAN 40kg/sqcm) ONE NO. OF ISOLATING VLV. IS PROVIDED IN EACH LINE BETWEEN VLV. MANIFOLD AND 1/2"SW EQUAL TEE AND 2NO. DRAIN VLV. ARE ALSO

REFERENCE DRAWINGS.

NOTES

1. DO NOT SCALE, ASK WHEN IN DOUBT.
2. ALL DIMENSIONS ARE IN MILIMETRES UNLESS NOTED OTHERWISE.
3. BULK HEAD FITTING SW TYPE SHALL BE PROVIDED AT LIE/LIR
4. ABOVE DRWING IS FOR BASIC GUIDE LINE TO BE MEET BY BIDDER, ANY FURTHER IMPROVEMENT DURING DETAILED ENGINEERING SHALL ALSO BE CONFIRMED/PROVIDED BY CONTRACTOR.
5. QUANTITIES OF INSTRUMENTS/ ERECTION HARDWARE SHALL BE AS PER NIT AND AS FINALISED DURING DETAIL ENGINEERING
6. FOR DM PLANT MATERIAL OF ERECTION HARDWARE SHALL BE SS 316 ONLY.

NOTICE

ZONE	MARK	REVISIONS	DATE	CIVIL	MECH.	ELEC.	C&I	H.O.D.
	A	PRELIMINARY	25.04.13				SLN	

APPROVED

DESEIN
CONSULTING ENGINEERS
NEW DELHI - INDIA

CLIENT: TAMILNADU GEN. & DIST. CORPORATION
PROJECT: 2x660MW ENNORE SEZ COAL BASED SUPERCRITICAL THERMAL POWER PROJECT AT ASH DYKE OF NCTPS, CHENNAI.
TITLE :- INST. DRAWING FOR LEVEL TRANSMITTERS
FOR BID PURPOSE ONLY:

	NAME	SIGN.	DATE
CAD/DRAWN	VIKAS		23.04.13
DESIGNED	SKM/SN		23.04.13
CHECKED	S.K.M.		24.04.13
SCALE	N.T.S.		
JOB. No.	D-4027		
DWG.No.	114-04-0110		REV. 0

Sheet No. 13 of 19

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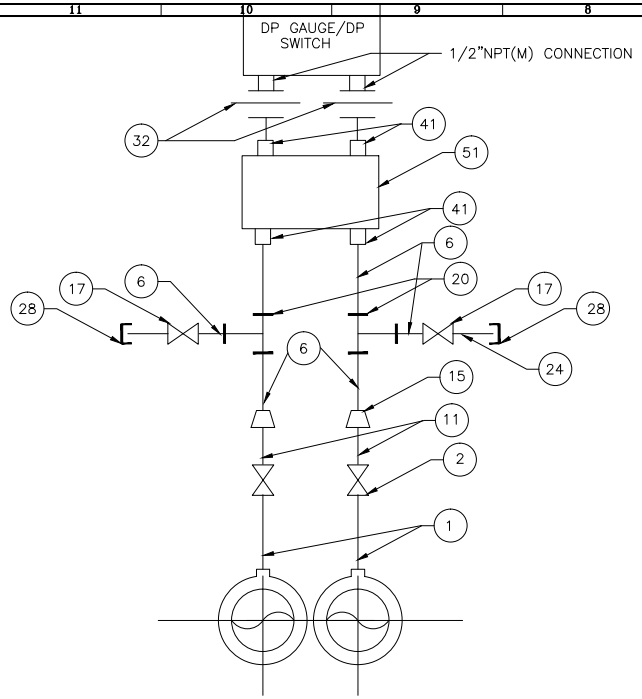
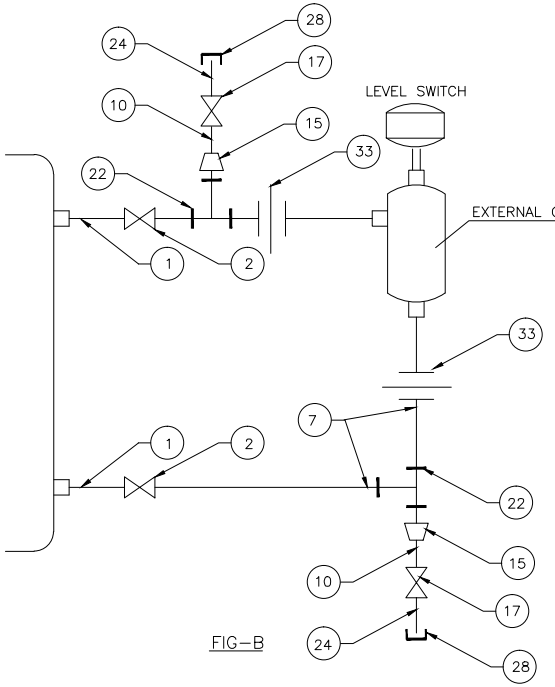
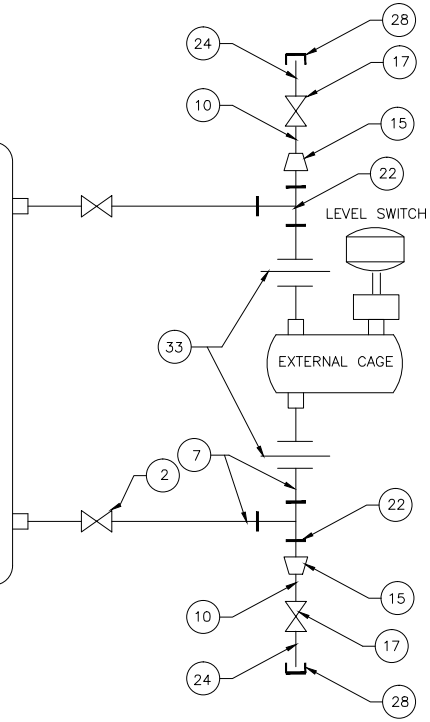


FIG–A



FIG–B



FIG–C

TAG NO.	DESCRIPTION	A	B	C
		QTY.		
78	1/2" NPT(F) X 1/2" NPT(M) SNUBBER/PULSATION DAMPNER	1	–	–
51	5 VALVE MANIFOLDS, SS–316	–	–	–
41	1/2" NPT(M) X 1/2" OD TUBE COMPRESSION FITTING,SS–316	–	–	–
38	3 WAY GAUGE VALVE 1/2"NB SW	1	–	–
33	1" SW EQUAL PIPE UNION	–	2	2
32	1/2" NPS,3 PIECE PIPE UNION 1/2" NPT(F) SCREWED AND 1/2" SW CONNECTION	1	–	–
28	1/2" NPT(F) CS. CAP	1	2	2
24	1/2" NPS,SCH 80/160 X 1/2" NPT(M) CS/AS NIPPLE	1	2	2
22	1" SW EQUAL TEE CS/AS	–	1	2
20	1/2"SW EQUAL TEE CS/AS	1	–	–
17	1/2" SW,CS/AS, GLOBE VALVE	1	2	2
15	1" TO 1/2" SOCKET WELD REDUCER	1	2	2
11	1"NPS SCH 80/160 CS/AS NIPPLE	1	–	–
10	1/2"NPS,SCH 80/160 CA/AS NIPPLE	–	2	2
6	1/2"NPS,SCH 80/160 CARBON/ALLOY STEEL PIPE	AS REQD.		
7	1" NPS,SCH 80/160 CS/AS STEEL PIPE	AS REQD.		
2	1/2"3/4"/1" ROOT VALVE – SW GLOBE VALVE	2	2	2
1	1/2"/3/4"/1" CARBON/ALLOY STEEL NIPPLE OF MTL SAME AS THAT OF MAIN PIPE (AS PER PROCESS REQD.)	AS REQD.		

NOTE:–
WITH VALVE OF SIZE 1/2"SW NIPPLE PIECE IS NOT REQUIERED

REFERENCE DRAWINGS.

NOTES

1. DO NOT SCALE, ASK WHEN IN DOUBT.
2. ALL DIMENSIONS ARE IN MILIMETRES UNLESS NOTED OTHERWISE.
3. ABOVE DRWING IS FOR BASIC GUIDE LINE TO BE MEET BY BIDDER, ANY FURTHER IMPROVEMENT DURING DETAILED ENGINEERING SHALL ALSO BE CONFIRMED/PROVIDED BY CONTRACTOR.
4. QUANTITIES OF INSTRUMENTS/ ERECTION HARDWARE SHALL BE AS PER NIT AND AS FINALISED DURING DETAIL ENGINEERING
5. FOR DM PLANT MATERIAL OF ERECTION HARDWARE SHALL BE SS 316 ONLY.

NOTICE

ZONE	MARK	PARTICULARS	DATE	CIVIL	MECH.	ELEC.	C&I	H.O.D.
	A	PRELIMINARY	25.04.13				SLN	

REVISIONS | APPROVED

DESEIN
CONSULTING ENGINEERS
NEW DELHI – INDIA

CLIENT: TAMILNADU GEN. & DIST. CORPORATION
PROJECT: 2x660MW ENNORE SEZ COAL BASED SUPERCRITICAL THERMAL POWER PROJECT AT ASH DYKE OF NCTPS, CHENNAI
TITLE :– INST. DRAWING FOR DIFF. PRESS. SWITCH/GAUGE/LEVEL SWITCHES
FOR BID PURPOSE ONLY

	NAME	SIGN.	DATE
CAD/DRAWN	VIKAS		23.04.13
DESIGNED	SKM/SN		23.04.13
CHECKED	S.K.M.		24.04.13
SCALE	N.T.S.		
JOB. No.	D–4027		
DWG.No.	114–04–0108		REV. 0

Sheet No. 11 of 19

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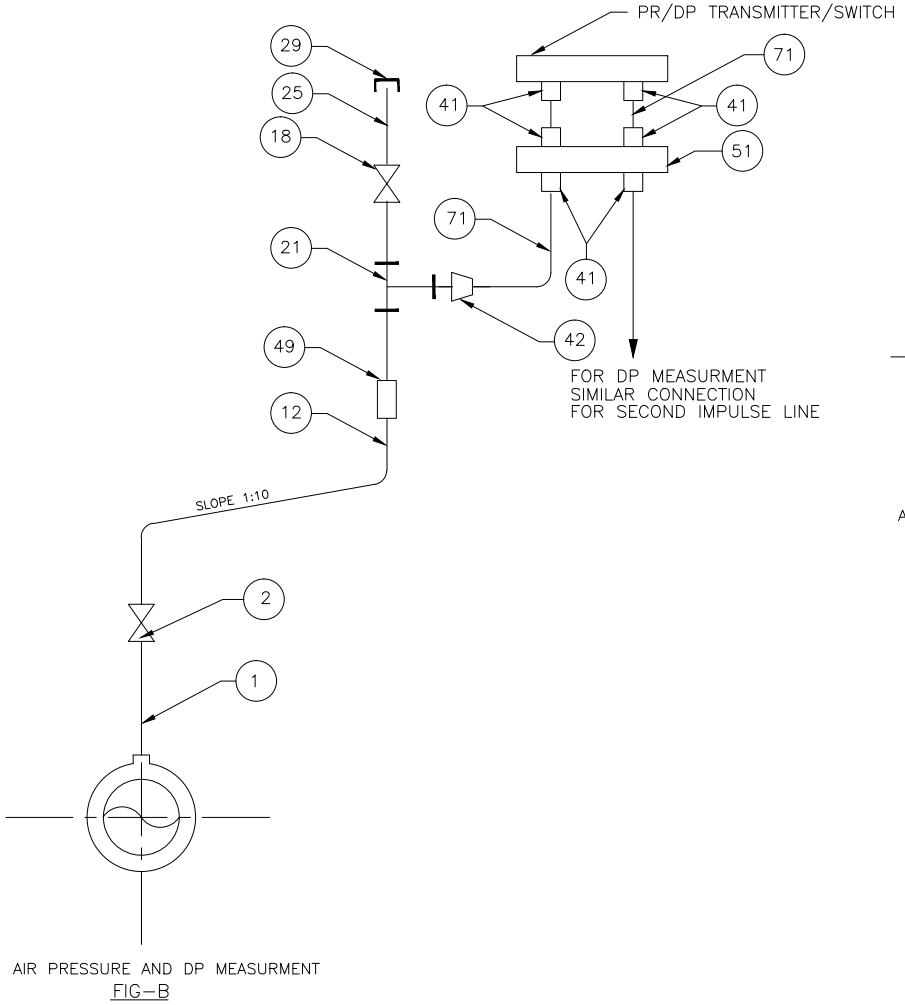
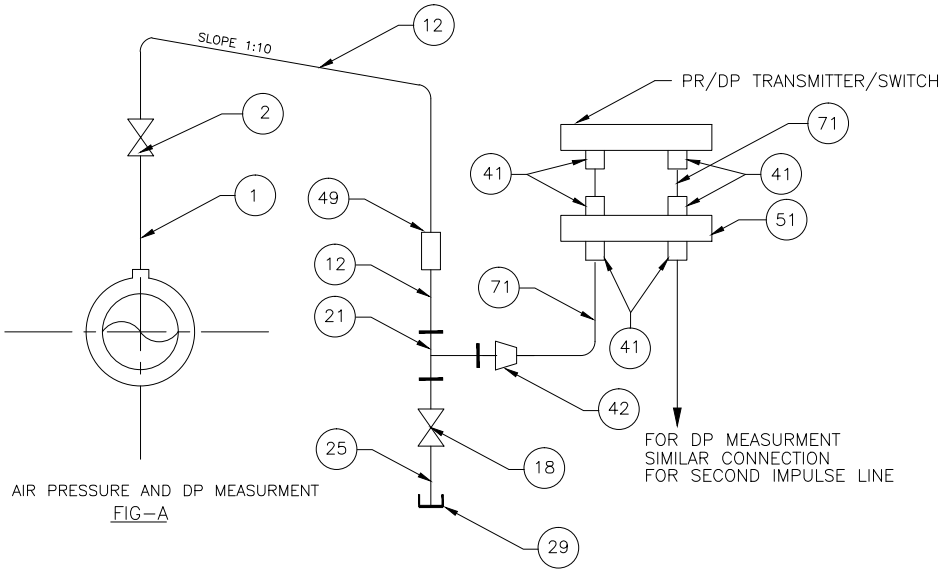


AIR PRESSURE AND DP MEASURMENT
FIG–B



AIR PRESSURE AND DP MEASURMENT
FIG–A

TAG NO.	DESCRIPTION	A	B
		QTY.	
71	1/2"OD IMPULSE TUBE,SS–316	AS REQD.	
51	5/3/2–VALVE MANIFOLDS,SS–316	1	1
49	3/4"SW,CS/AS BULK HEAD PIPE UNION	1	1
42	3/4"BW X 1/2"OD TUBE FITTING,SS–316	1	1
41	1/2"NPT(M) X 1/2"00 TUBE COMPRESSION FITTING,SS–316	6	6
29	3/4"NPT(F) CS CAP	1	1
25	3/4"NPS,SCH–80 X 3/4"NPS(M)CS NIPPLE	1	1
21	3/4" EQUAL TEE,CS	1	1
18	3/4" SW,CS GLOBE VALVE	–	1
12	3/4" NPS. SCH–80 CARBON STEEL PIPE	AS REQD.	
2	1/2"/3/4"/1" ROOT VALVE – SW GLOBE VALVE	1	1
1	1/2"/3/4"/1" CARBON/ALLOY STEEL NIPPLE OF MTL. SAME AS THAT OF MAIN PIPE(AS PER PROCESS REQD.)	AS REQD.	

BILL OF MATERIAL

NOTE:–
QUANTITY IN COLUMN A&B TO BE DOUBLED
FOR DP TAPPING EXCEPT ITEM NO. 51

REFERENCE DRAWINGS.

NOTES
1. DO NOT SCALE, ASK WHEN IN DOUBT.
2. ALL DIMENSIONS ARE IN MILIMETRES UNLESS NOTED OTHERWISE.
3. ABOVE DRWING IS FOR BASIC GUIDE LINE TO BE MEET BY BIDDER, ANY FURTHER IMPROVEMENT DURING DETAILED ENGINEERING SHALL ALSO BE CONFIRMED/PROVIDED BY CONTRACTOR.
4. QUANTITIES OF INSTRUMENTS/ ERECTION HARDWARE SHALL BE AS PER NIT AND AS FINALISED DURING DETAIL ENGINEERING
5. FOR DM PLANT MATERIAL OF ERECTION HARDWARE SHALL BE SS 316 ONLY.

NOTICE

ZONE	MARK	PARTICULARS	DATE	CIVIL	MECH.	ELEC.	C&I	H.O.D.
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DESEIN
CONSULTING ENGINEERS
NEW DELHI – INDIA

CLIENT: TAMILNADU GEN. & DIST. CORPORATION

PROJECT: 2x660MW ENNORE SEZ COAL BASED SUPERCRITICAL THERMAL POWER PROJECT AT ASH DYKE OF NCTPS, CHENNAI.

TITLE :– INST. DRAWING FOR PRESS. & DIFF. PRESS. TRANSMITTERS/SWITCH (AIR SERVICE)

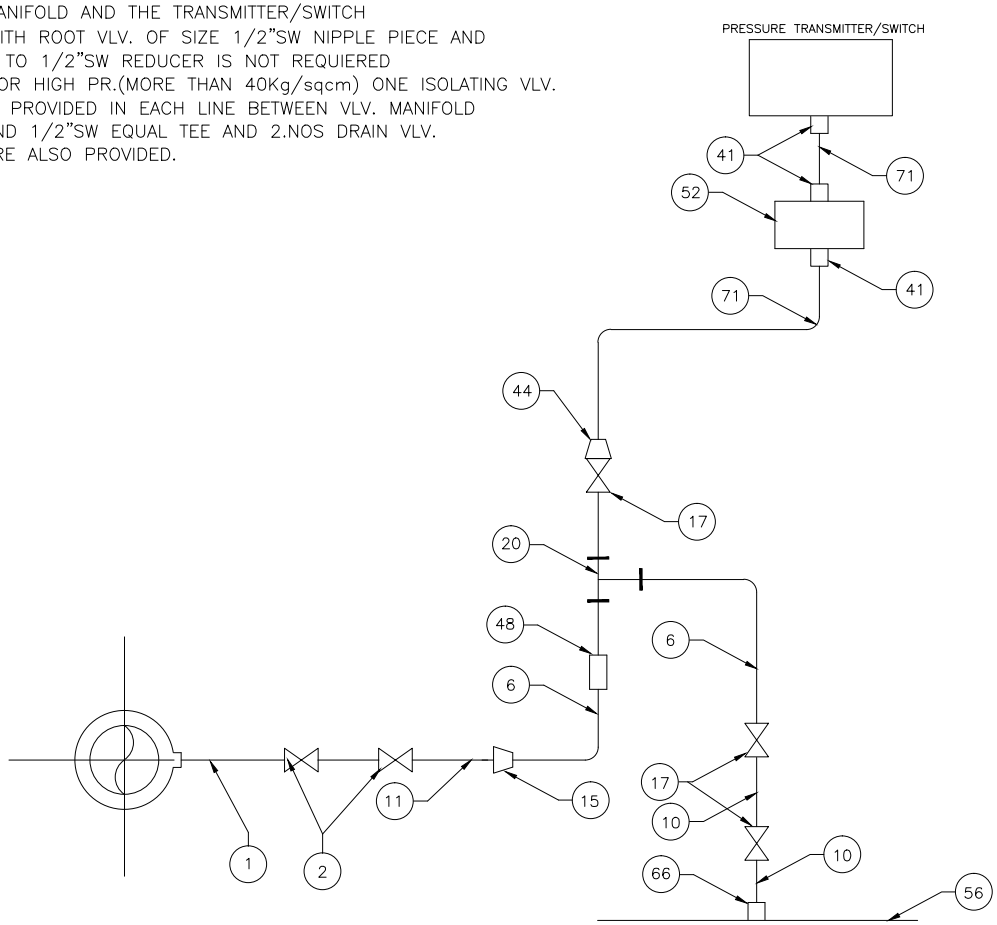
FOR BID PURPOSE ONLY:

	NAME	SIGN.	DATE
CAD/DRAWN	VIKAS		23.04.13
DESIGNED	SKM/SN		23.04.13
CHECKED	S.K.M.		24.04.13
SCALE	N.T.S.		
JOB. No.	D–4027		
DWG.No.	114–04–0103		REV. 0

Sheet No. 5 of 19

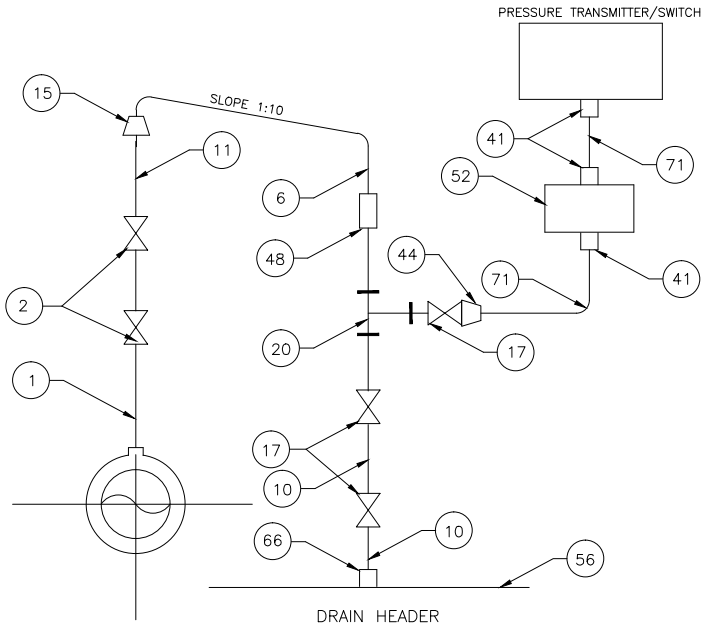
NOTE:–

1. FOR HIGH TEMP. SERVICE (MORE THAN *80C) A 'U'–TUBE / SYPHON (REF. DWG NO. IN–114–04–0100)SHALL BE PROVIDED BETWEEN THE MANIFOLD AND THE TRANSMITTER/SWITCH
2. WITH ROOT VLV. OF SIZE 1/2"SW NIPPLE PIECE AND 1 TO 1/2"SW REDUCER IS NOT REQUIERED
3. FOR HIGH PR.(MORE THAN 40Kg/sqcm) ONE ISOLATING VLV. IS PROVIDED IN EACH LINE BETWEEN VLV. MANIFOLD AND 1/2"SW EQUAL TEE AND 2.NOS DRAIN VLV. ARE ALSO PROVIDED.



TRANSMITTER MOUNTED ABOVE INSTRUMENT SOURCE POINT

FIG–D



TRANSMITTER MOUNTED ABOVE INSTRUMENT SOURCE POINT

FIG–C

TAG NO.	DESCRIPTION	QTY. C	QTY. D
71	1/2"OD IMPULSE TUBE,SS–316	AS REQD.	
66	1/2" GI SOCKET	1	1
56	2"NB GI DRAIN HEADER		
52	5/3/2–VALVE MANIFOLDS,SS–316	1	1
48	1/2"SW,CS/AS BULK HEAD PIPE UNION	1	1
44	1/2"BW X 1/2"OD COMRESSION TUBE FITTING,SS–316	1	1
41	1/2"NPT(M) X 1/2"00 TUBE COMPRESSION FITTING,SS–316	3	3
20	1/2"SW EQUAL TEE,CS	1	1
17	1/2" SW,CS GLOBE VALVE / NEEDLE VALVE	3	3
15	1" TO 1/2" SW REDUCER	1	1
11	1" NPS SCH–80 CS/AS NIPPLE	1	1
10	1/2" NPS,SCH 80/160, CS/AS NIPPLE	2	2
6	1/2" NPS. SCH–80/160 CS/ AS PIPE	AS REQD.	
2	1/2"/3/4"/1" ROOT VALVE	2	2
1	1/2"/3/4"/1" CARBON/ALLOY STEEL NIPPLE OF MTL. SAME AS THAT OF MAIN PIPE(AS PER PROCESS REQD.)	AS REQD.	

BILL OF MATERIAL

REFERENCE DRAWINGS.

NOTES

1. DO NOT SCALE, ASK WHEN IN DOUBT.
2. ALL DIMENSIONS ARE IN MILIMETRES UNLESS NOTED OTHERWISE.
3. BULK HEAD FITTING SW TYPE SHALL BE PROVIDED AT I/E/LIR
4. ABOVE DRWING IS FOR BASIC GUIDE LINE TO BE MEET BY BIDDER, ANY FURTHER IMPROVEMENT DURING DETAILED ENGINEERING SHALL ALSO BE CONFIRMED/PROVIDED BY CONTRACTOR.
5. QUANTITIES OF INSTRUMENTS,/ ERECTION HARDWARE SHALL BE AS PER NIT AND AS FINALISED DURING DETAIL ENGINEERING
6. FOR DM PLANT MATERIAL OF ERECTION HARDWARE SHALL BE SS 316 ONLY.

NOTICE

ZONE	MARK	REVISIONS	DATE	CIVIL	MECH.	ELEC.	C&I	H.O.D.
	A	PRELIMINARY	25.04.13				SLN	

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DESEIN
CONSULTING ENGINEERS
NEW DELHI – INDIA

CLIENT: TAMILNADU GEN. & DIST. CORPORATION

PROJECT: 2x660MW ENNORE SEZ COAL BASED SUPERCRITICAL THERMAL POWER PROJECT AT ASH DYKE OF NCTPS, CHENNAI.

TITLE :– INST. DRAWING FOR PRESS. & DIFF.PRESS. TRANSMITTERS/SWITCH (STEAM & LIQUID SERVICE)

FOR BID PURPOSE ONLY:

	NAME	SIGN.	DATE
CAD/DRAWN	VIKAS		23.04.13
DESIGNED	SKM/SN		23.04.13
CHECKED	S.K.M.		24.04.13
SCALE	N.T.S.		

JOB. No. D–4027

DWG.No. 114–04–0104 REV. 0

Sheet No. 7 of 19

SR. No. PARTY

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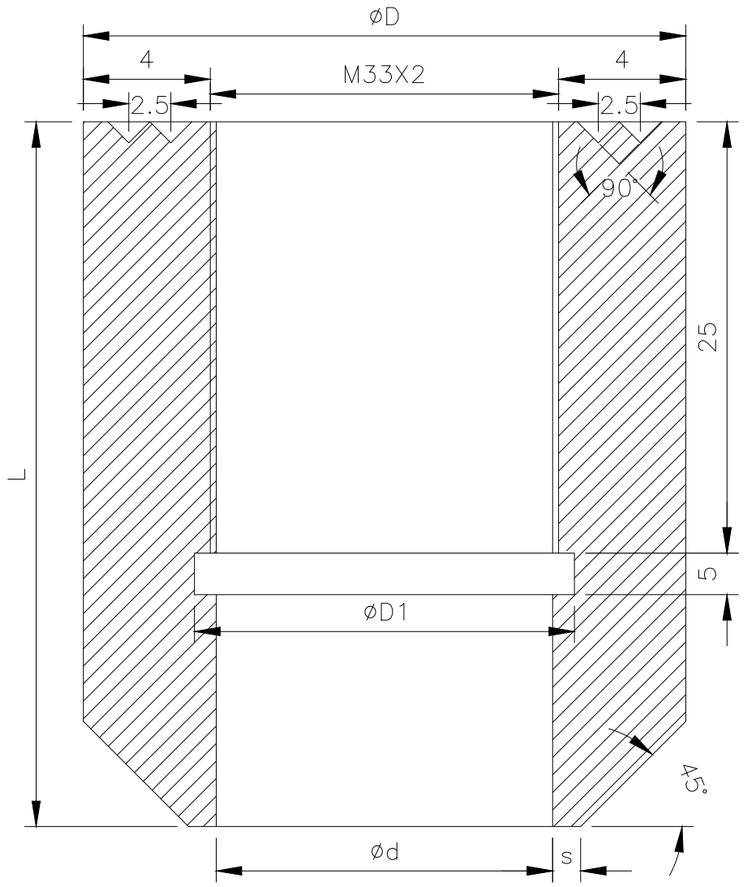
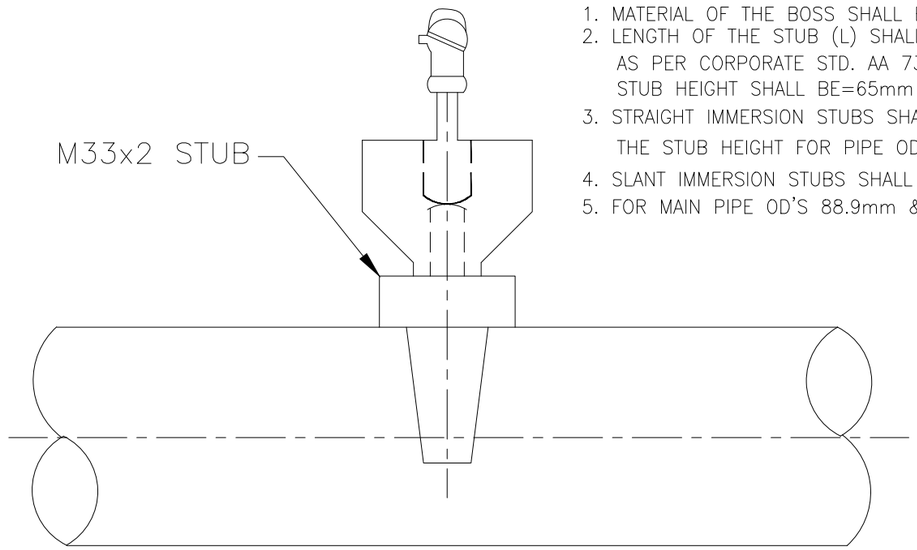


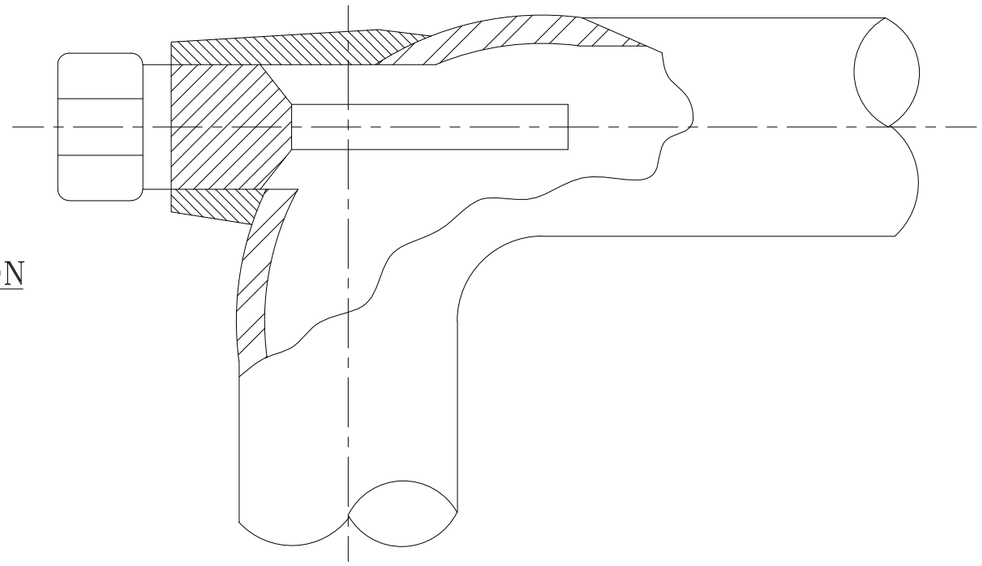
TEMPERATURE STUB FOR STRAIGHT IMMERSION

FOR PIPE OD BELOW 219.1mm	29	55	33.5	1.5	65
FOR PIPE OD 219.1mm & ABOVE	29	55	33.5	1.5	45
MAIN PIPE SIZES	d	D	D1	S	L



INSTALLATION TYPE-1

(FOR MAIN PIPE OD 168.3mm & ABOVE)



INSTALLATION TYPE-2

(FOR MAIN PIPE OD 88.9mm & BELOW)

NOTE :-

1. MATERIAL OF THE BOSS SHALL BE THE SAME AS THE PIPE INTO WHICH IT IS WELDED.
2. LENGTH OF THE STUB (L) SHALL BE 65/45 mm DEPENDING UPON PIPE SIZE, AS PER CORPORATE STD. AA 7326102.(FOR PIPE OD 88.9mm TO 159mm STUB HEIGHT SHALL BE=65mm & FOR PIPE OD >219.1mm STUB HEIGHT SHALL BE=45mm)
3. STRAIGHT IMMERSION STUBS SHALL BE USED FOR PIPE OD'S 168.3mm & ABOVE. THE STUB HEIGHT FOR PIPE OD, 168.3mm TO <219.1mm SHALL BE 65mm.
4. SLANT IMMERSION STUBS SHALL BE USED FOR PIPE OD'S 88.9mm TO 159mm.
5. FOR MAIN PIPE OD'S 88.9mm & bELOW SUITABLE EXPANDER SHALL BE USED.

REFERENCE DRAWINGS.

NOTES

1. DO NOT SCALE, ASK WHEN IN DOUBT.
2. ALL DIMENSIONS ARE IN MILIMETRES UNLESS NOTED OTHERWISE.
3. BULK HEAD FITTING SW TYPE SHALL BE PROVIDED AT LIE/LIR
4. ABOVE DRWING IS FOR BASIC GUIDE LINE TO BE MEET BY BIDDER, ANY FURTHER IMPROVEMENT DURING DETAILED ENGINEERING SHALL ALSO BE CONFIRMED/PROVIDED BY CONTRACTOR.
5. QUANTITIES OF INSTRUMENTS/ ERECTION HARDWARE SHALL BE AS PER NIT AND AS FINALISED DURING DETAIL ENGINEERING
6. FOR DM PLANT MATERIAL OF ERECTION HARDWARE SHALL BE SS 316 ONLY.

NOTICE

ZONE	MARK	PARTICULARS	DATE	CIVIL	MECH.	ELEC.	C&I	H.O.D.
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PROJECT: 2x660MW ENNORE SEZ COAL BASED SUPERCRITICAL THERMAL POWER PROJECT AT ASH DYKE OF NCTPS, CHENNAI.

TITLE :- INST. DRAWING FOR TEMPERATURE STUB

FOR BID PURPOSE ONLY:

	NAME	SIGN.	DATE
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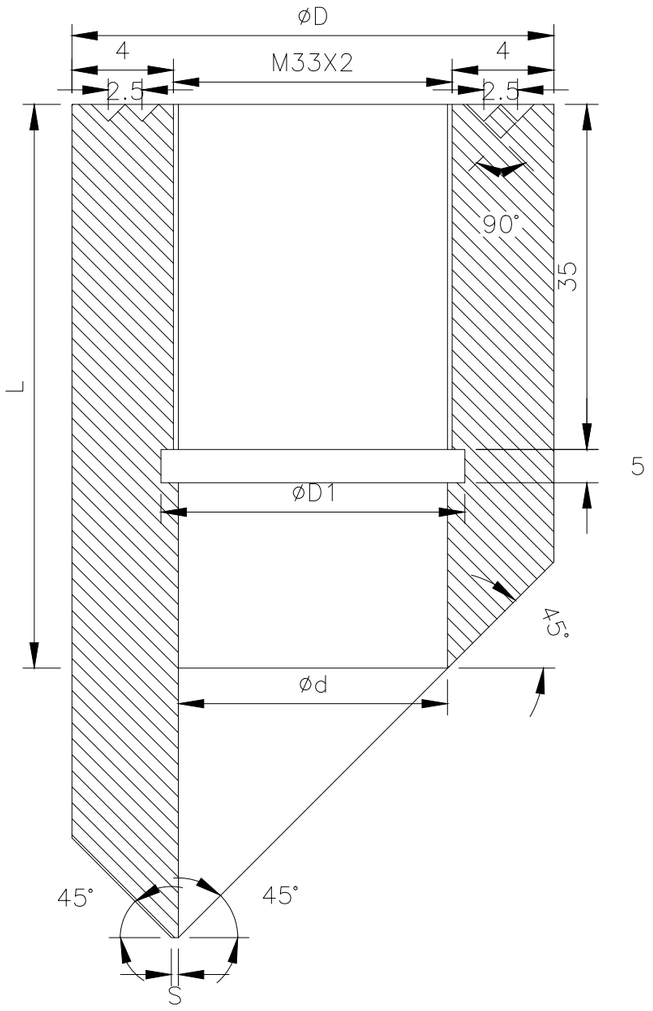
JOB. No. D-4027

DWG.No. 114-04-0111 Sheet No. 14 of 19

REV. 0

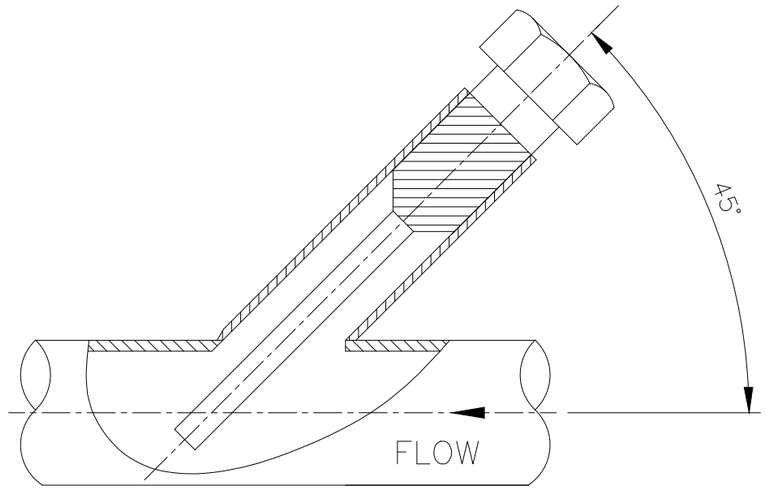
NOTE :–

1. MATERIAL OF THE BOSS SHALL BE THE SAME AS THE PIPE INTO WHICH IT IS WELDED.
2. LENGTH OF THE STUB (L) SHALL BE 65/45 mm DEPENDING UPON PIPE SIZE, AS PER CORPORATE STD. AA 7326102.(FOR PIPE OD 88.9mm TO 159mm STUB HEIGHT SHALL BE=65mm & FOR PIPE OD >219.1mm STUB HEIGHT SHALL BE=45mm)
3. STRAIGHT IMMERSION STUBS SHALL BE USED FOR PIPE OD'S 168.3mm & ABOVE. THE STUB HEIGHT FOR PIPE OD, 168.3mm TO <219.1mm SHALL BE 65mm.
4. SLANT IMMERSION STUBS SHALL BE USED FOR PIPE OD'S 88.9mm TO 159mm.
5. FOR MAIN PIPE OD'S 88.9mm & bELOW SUITABLE EXPANDER SHALL BE USED.



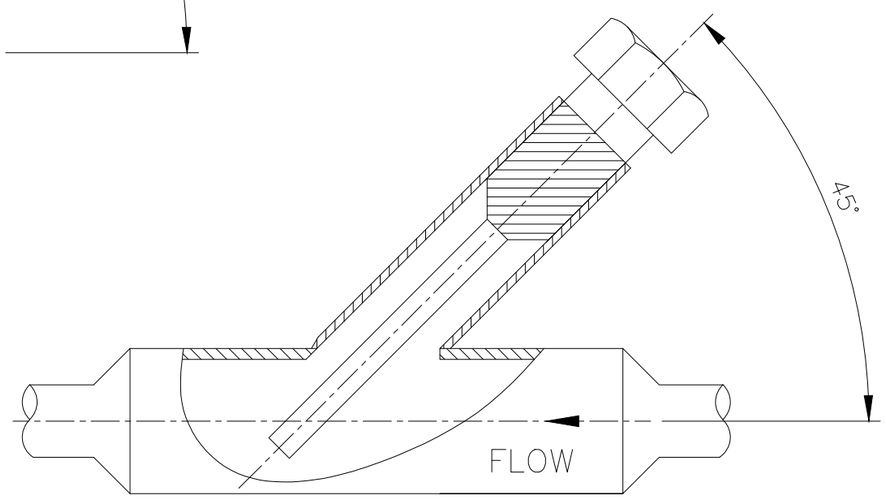
TEMPERATURE STUB FOR SLANT IMMERSION

FOR PIPE OD BELOW 219.1mm	29	55	33.5	1.5	65
FOR PIPE OD 219.1mm & ABOVE	29	55	33.5	1.5	45
MAIN PIPE SIZES	d	D	D1	S	L



INSTALLATION TYPE–3

(FOR MAIN PIPE OD 88.9mm TO 159mm)



INSTALLATION TYPE–4

(FOR MAIN PIPE OD 88.9mm & BELOW)

REFERENCE DRAWINGS.

NOTES

1. DO NOT SCALE, ASK WHEN IN DOUBT.
2. ALL DIMENSIONS ARE IN MILIMETRES UNLESS NOTED OTHERWISE.
3. BULK HEAD FITTING SW TYPE SHALL BE PROVIDED AT LIE/LIR
4. ABOVE DRWING IS FOR BASIC GUIDE LINE TO BE MEET BY BIDDER, ANY FURTHER IMPROVEMENT DURING DETAILED ENGINEERING SHALL ALSO BE CONFIRMED/PROVIDED BY CONTRACTOR.
5. QUANTITIES OF INSTRUMENTS/ ERECTION HARDWARE SHALL BE AS PER NIT AND AS FINALISED DURING DETAIL ENGINEERING
6. FOR DM PLANT MATERIAL OF ERECTION HARDWARE SHALL BE SS 316 ONLY.

NOTICE

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PROJECT: 2x660MW ENNORE SEZ COAL BASED SUPERCRITICAL THERMAL POWER PROJECT AT ASH DYKE OF NCTPS, CHENNAI.

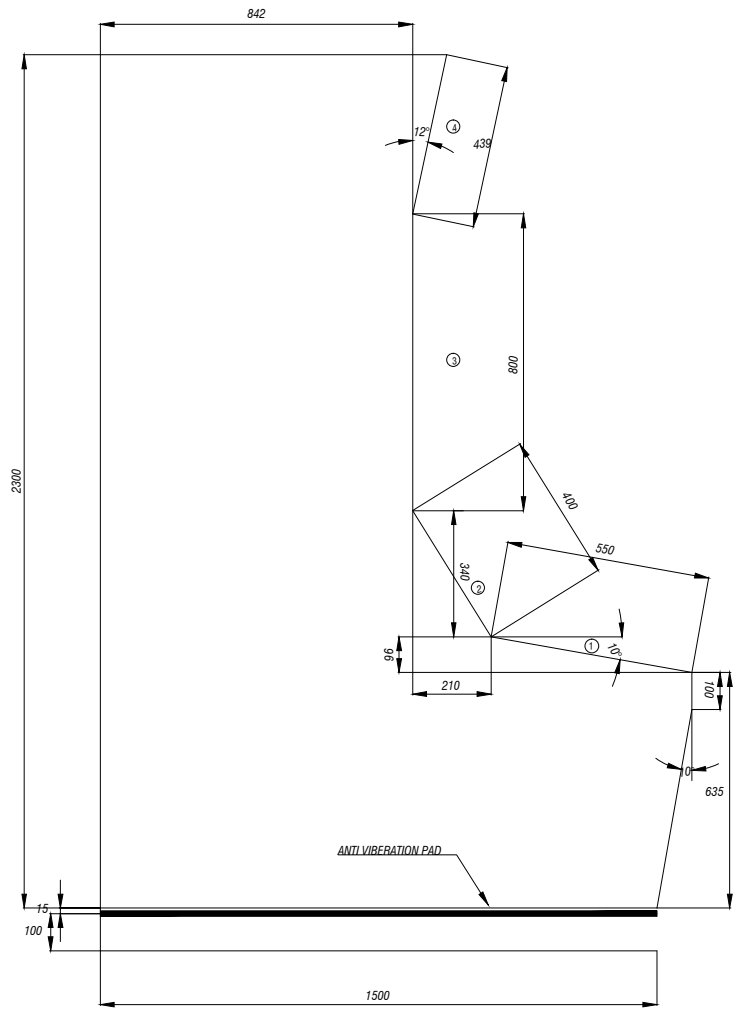
TITLE :– INST. DRAWING FOR TEMPERATURE STUB

FOR BID PURPOSE ONLY:

	NAME	SIGN.	DATE
CAD/DRAWN	VIKAS		23.04.13
DESIGNED	SKM/SN		23.04.13
CHECKED	S.K.M.		24.04.13
SCALE	N.T.S.		
JOB. No.	D–4027		
DWG.No.	114–04–0111	REV.	0

Sheet No. 15 of 19

FURNITURE DETAILS



NOTE:-

1 : Panel for Mounting annunciation P.B., Desk release PB, Emergency Trip P.B.

2 : Panel for Mounting ILPB for OLCS / Sequential Operation.

3 : Sheet metal panel for mounting MIMIC , Ammeters,Indicator, Totalizer, recorder etc.

4. Inclined Sheet metal panel for mounting Annunciation Facia windows.

NOTES

1. DO NOT SCALE, ASK WHEN IN DOUBT.
2. ALL DIMENSIONS ARE IN MILIMETRES UNLESS NOTED OTHERWISE.
3. DETAILS OF PANELS/ DESK SHALL BE AS PER SPECIFICATION.

NOTICE

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NEW DELHI – INDIA

CLIENT– TAMILNADU GEN. & DIST. CORPORATION

PROJECT: 2x660MW ENNORE SEZ COAL BASED SUPERCRITICAL THERMAL POWER PROJECT AT ASH DYKE OF NCTPS, CHENNAI.

TITLE :– GEN.ARRG.OF DESK CUM PANEL (TYP) FOR BOP PACKAGES

FOR BID PURPOSE | SHEET NO. 1 of 1

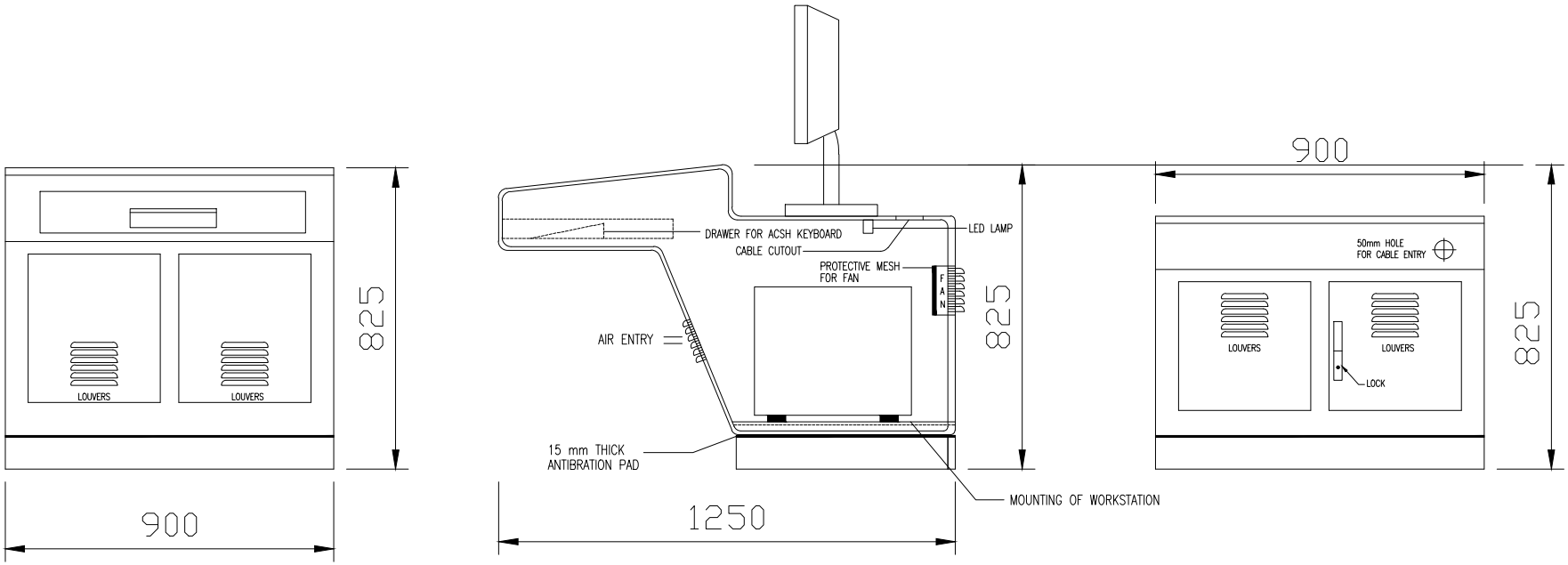
DRAWN	DESIGNED	CHECKED
VIKAS	SKM/SN	SKM
23.04.13	23.04.13	24.04.13

SCALE NTS

JOB NO. D–4027

DRG NO. 114–05–0105 | REV. 0

DRG. NO. 114-05-0108



FRONT VIEW

SIDE VIEW

REAR VIEW

NOTES

1. DO NOT SCALE, ASK WHEN IN DOUBT.
2. ALL DIMENSIONS ARE IN MILIMETRES UNLESS NOTED OTHERWISE.
3. DETAILS OF PANELS/CONSOLE/LVS SHALL BE AS PER SPECIFICATION.
4. DESK/CONSOLE FOR PA SYSTEM SHALL ALSO BE PROVIDED BY BIDDER.

ZONE	MARK	PARTICULARS	DATE	C&I	MECH.	ELEC.
	5					
	4					
	3					
	2					
	1					
	0					
	A	PRELIMINARY	25.04.13	SLN		

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NEW DELHI – INDIA

CLIENT– TAMILNADU GEN. & DIST. CORPORATION

PROJECT– 2x660MW ENNORE SEZ COAL BASED SUPERCRITICAL THERMAL POWER PROJECT AT ASH DYKE OF NCTPS, CHENNAI.

TITLE OUTLINE GERENAL ARRANGEMENT (OGA) OF HMI SYSTEM FOR DDCMIS & PLC SYSTEM. SHEET NO. 3 of 4

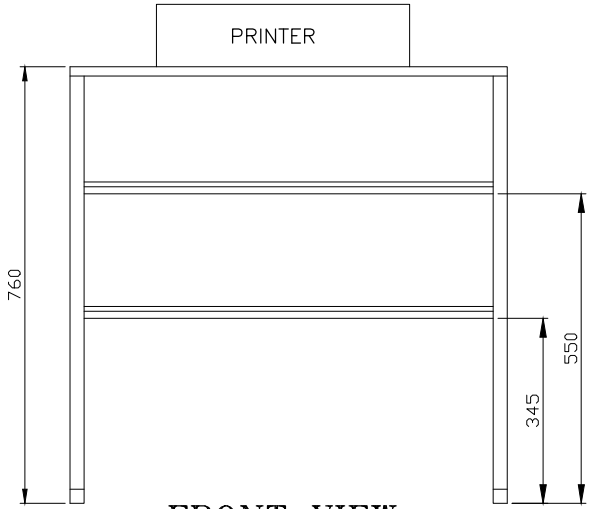
DRAWN	DESIGNED	CHECKED
VIKAS	SKM/SN	SKM
23.04.13	23.04.13	24.04.13

SCALE N.T.S

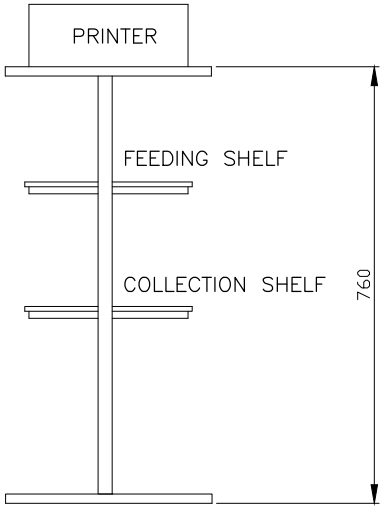
JOB NO. D–4027

DRG. NO. 114–05–0108

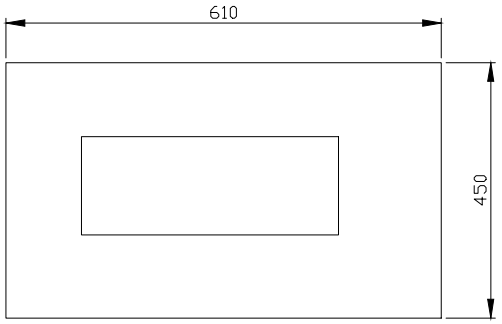
REV. 0



FRONT VIEW



SIDE VIEW



TOP VIEW

NOTES

1. DO NOT SCALE, ASK WHEN IN DOUBT.
2. ALL DIMENSIONS ARE IN MILIMETRES UNLESS NOTED OTHERWISE.
3. DESK/CONSOLE FOR PA SYSTEM SHALL ALSO BE PROVIDED BY BIDDER.

ZONE	MARK	PARTICULARS	DATE	C&I	MECH.	ELEC.
	5					
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	2					
	1					
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	A	PRELIMINARY	25.04.13	SLN		

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NEW DELHI – INDIA

DRAWN	DESIGNED	CHECKED
VIKAS	SKM/SN	SKM
23.04.13	23.04.13	24.04.13

CLIENT– TAMILNADU GEN. & DIST. CORPORATION

SCALE N.T.S

PROJECT– 2x660MW ENNORE SEZ COAL BASED SUPERCRITICAL THERMAL POWER PROJECT AT ASH DYKE OF NCTPS, CHENNAI.

JOB NO. D–4027

TITLE:– OGA–PRINTER TABLE FOR DDCMIS AND PLC SYSTEM

DRG. NO. 114–05–0108 | REV. 0

FOR BID PURPOSE | SHEET NO. 4 of 4

ERECTION HARDWARE

CHAPTER-9

ERECTION HARDWARE

9.00.00 PROCESS CONNECTION AND PIPING

9.00.01 General Requirements

This section covers the material requirement for instrument connection to process, instrument process, piping, tubing, supports, Instrumentation cables, control cables and power cables for connecting UPS, 24/48 V DC, unregulated power supply for cubicle illumination, compensating cables/Extension cables, transmitter racks and main accessories to be furnished under this specification and the requirements of installation and routing. Impulse lines, fittings and other accessories required for the erection of complete Instrumentation and Control System supplied under various packages of this specification shall be supplied on “as required’ basis. Bidder shall offer all necessary items for this section based on his experience on similar plants, plant layout diagrams, installation drawings and other applicable sections of this specification. Based on the good engineering practices Bidder shall furnish installation drawings during the engineering of the system for Owner’s review and approval .The installation of the drawings shall be suitable for his installation of his range of instrumentation.

The Bidder shall furnish and test all required erection hardware, which is necessary for proper installation and interconnection of the equipment/systems furnished by the Bidder and their integration with main equipment/systems as per the enclosed installation drawings and other applicable clause. The Bidder shall furnish all hardware and accessories to ensure that the equipment/systems furnished form a complete and operational system meeting the intent and requirement of this specification.

All materials, furnished shall conform to the latest editions of America National Standard Code for Pressure piping, Power piping, ANSI B311.1, ANSI B16.11, ASME Boiler and Pressure Vessel Codes, IBR and other applicable ASME, ANSI and Indian Standards. Schedule numbers, sizes and dimensions of all carbon steel, stainless steel and alloy seamless steel pipe shall confirm to ANSI B.36.10 and of stainless steel pipe shall confirm to ANSI B 36.19 unless otherwise specified.

All materials supplied under this section shall be suitable for intended service; process operating conditions and type of instruments used and shall fully conform to the requirements of this specification.

The Bidder is responsible for the performance of the equipment furnished on system basis any shortfall in erection material observed during erection stage shall be compensated by the Bidder at no extra cost. (Installation drawings # 114-04-0000, 0100 to 0113 shall also be referred by bidder).

9.01.00 GUIDLINE FOR INSTALLATION AND ROUTING OF INSTRUMENT PIPING

9.01.01 General Requirements

The following general erection guidelines have been enumerated here to enable the Bidder to estimate the requirement of instrument piping in plant:-

i) All instrument piping shall be in accordance with good engineering practice. It shall be finalized during engineering stage. Instrument piping shall be complete with fittings, valves and other required accessories.

ii) Instrument piping shall not be routed:-

a) Across equipment removal areas
b) Below mono-rails and cranes
c) Above or below removable gratings
d) Above or below cable trays.

iii) Primary Impulse Piping System:

a) The primary impulse piping system shall include the instrument piping and all required accessories from process tap off point (root valves onwards) up to the respective instruments. From the same source, Tee off for instruments are not allowed. Separate tapping shall be provided for each instrument. The Bidder shall provide the necessary fittings and accessories along with impulse pipes for completeness and arrangements as per the finalized Instrument Installation Diagrams. Special accessories such as reservoirs and other devices shall be installed as required for flow primary element connection as required by the design of instruments, in accordance with the instructions of the instrument manufacturer.

b) The Bidder shall prepare impulse pipe routing drawings.

c) Impulse piping shall include a blow-down line and shut-off valve adequate for the duty requirements and for withstanding continuous design pressure and temperature of process medium. For process pressure above 40 Kg/Cm²g, double valves shall be used before connecting to the blow-down header (This arrangement shall be provided for installation for the new transmitter if the existing transmitter has the same arrangement.)

d) To assure a constant static head the connections from low pressure steam and low pressure liquid filled lines should preferably slope downward continuously towards the instrument as the instrument is mounted below the source point. If downward slope is not feasible or the instrument is mounted above the source point, the line should slope upward continuously and a “pigtail” installed at the instrument to assure a water seal for temperature protection. Upward sloping liquid lines should be used only if the process pressure is sufficient to assure a head of liquid at the instrument. Horizontal runs should have a slope of not less than 40 mm per meter and must be adequately supported to maintain a constant slope. Vacuum connections to the condenser should always slope upward to the instrument.

e) Primary process piping for steam flow, liquid flow and manometric level measurement systems should preferably slope downward from the primary element connections to the instrument. Primary piping for flue gas and air flow measurement systems should preferably slope upward from

the primary element connections to the instrument. If these requirements cannot be met, special venting or drain provisions will be required. Horizontal runs must have a slope of not less than 40 millimeters per meter and must be adequately supported to maintain a constant slope.

f) Primary process piping from the field which enters the instrument enclosure from the bottom shall extend into the enclosure approximately 150 millimeters and be equipped with a socket weld to flare less tubing coupling of stainless steel. This coupling shall be used to connect the field primary process line to the enclosure process line. The field primary process line shall be anchored to the enclosure angle with U-bolts. Holes for supporting U-bolts shall be field or drilled.

g) All impulse piping shall be supported rigidly at an interval not exceeding 1.5 meters so as to prevent excessive sag in piping. Process piping shall not be used for supporting impulse piping.

h) Impulse lines subject to severe sonic pulsations such as boiler feed pump discharge, shall be of sufficient length and of suitable configuration to scatter harmful sonic wave energy before it reaches the instrument.

i) Impulse piping shall be installed to permit thermal expansion without placing excessive stress on the piping and without affecting the gradient of slope. Long continuous straight runs of piping shall always be avoided. If required, expansion loops shall be provided at least every 2.5 meters to break the continuity.

j) All welded and screwed fittings shall conform to ANSI B16.11. Threads of piping components shall be taper pipe thread in accordance with ANSI B2.1. All threads shall be clean machine cut with all burrs and chips removed. Lubricants shall be of dry filc type. Any one of the following compounds may be used as a pipe thread sealer. Bidder shall supply adequate amount of his preferred sealer for erection purpose.

a) Permatex
b) Molycote
c) Neolube

(Teflon tape shall not be used as a pipe thread sealer).

9.01.02 Impulse Piping System

Impulse piping system consists of primary impulse pipes/tubes, valves, fittings, valve manifolds and other accessories between the source connection point (source shut-off valve onwards) and all instruments/devices. Impulse pipe span for supporting clamp shall be 1.5 mtr. This will also include all piping and valves etc. required for instrument drain and vent connections. The Bidder shall furnish and test all items required for completeness of this specification.

9.01.03 AIR SUPPLY PIPING

The piping for air supply shall be as specified below (However the Bidder shall supply the materials as required basis to complete the system in all respect)

i) Individual Supply Lines and Control Signal Lines:-

Air lines shall be ¼ inch size, connected by brass/SS316 flare less tubing fittings. Copper/SS316 tubing shall be light drawn tampered tubing conforming to ATM B75 except copper tubing in tubing cables shall be annealed soft temper tubing conforming to ASTM B68 or B75. Fittings on the branch line to facilitate connections to the individual supply line shall be cast brass screwed type.

ii) Flexible Hoses:-

Flexible hoses shall be ¼ inch SS flexible hose pipe and with Buna-N liner steel wire braid reinforcement complete with ¼ inch brass/SS316 fittings and shall have swivel male pipe threads. Each hose shall be done meter in length.

iii) Pipe Material Specification:-

The piping material shall be carbon steel hot-dipped galvanized inside and outside as per IS-1239 or the equivalent of these standard heavy quality with screwed ends. The piping threads shall be as per ASA B.2.1.

iv) Isolating Valves:-

Gate valves as per ASTM B62 inside screw rising stem screwed female ends as per ASA B.2.1 valve bonnet shall be union type and trim shall be stainless steel body rating 150 pounds ASA. Valves sizes shall be ½ inch to 2 inch.

v) Fittings:-

Forged cast steel A234 Gr. WPM galvanized inside and outside; screwed as per ASA B2.1 dimensions as per ASA B16.11, rating 2000 pounds, elbows and soft seats. The size of the fittings shall be ½ inch through 2 inch.

vi) Air Filter Regulator Set:-

An instrument Air Filter Regulator Set with mounting assembles shall be provided for each pneumatic device requiring air supply.

vii) Instrument Air Piping System:-

a) Instrument Air shall be made available by the bidder at 3.5 to 7.0 Kg/cm² pressure. The instrument air may be arranged as under:-

11. For the control valves and power cylinders in owner's scope but controlled by bidder's control system, the instrument air requirement for E/P converter shall be tapped from the nearby instrument air header laid by bidder / already laid existing piping with accessories available near the control valves or damper.

Complete hardware required for interfacing with Owner system shall be in bidder scope.

b) Air supply piping shall be installed at site always with a slope of over 1/100 to prevent accumulation of condensed water within the pipe.

c) All joints in the instrument air sub-header shall be of screwed type.

d) Instrument air line shall be separate for each individual instrument, equipment & drive with own isolation valve and other required hardware. Tee off of instrument line for two or more same/similar services instrument, equipment & drive are not acceptable.

e) Instrument air flushing/purging lines shall be provided for Bowl Mill DP, secondary air flow measurement instrument and other all flue gas services instruments etc.

viii) Signal / Control Air Tubing System:-

Necessary tubes with fittings and accessories for output signal from pneumatic instruments mounted in the field and control signals to final control elements shall be covered under this tubing system.

9.02.00 SPECIFICATION FOR ERECTION HARDWARE

The erection hardware shall meet the following specifications:-

	Item	Specification
9.02.01	**Impulse Piping**	
i)	High pressure and high temperature services (Medium: Steam & Water and furnace region)	Seamless Alloy Steel piping to ASTM A335 GR.P91/22 (schedule XXS/160 for high pressure & high temperature)
ii)	Low pressure and low temperature services (Medium: Steam & Water)	Seamless carbon steel piping to STM A106, Gr.C
iii)	Low pressure and low temperature services (Air, Flue gas)	ERW carbon steel piping to IS 1239:1973 Heavy class System)
iv)	Steam and water analysis system	Seamless stainless steel piping to ASTM A312 GR. TP-321
v)	Seamless copper tubing	ASTM B-75

9.02.02 **Fittings Double compression type**

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.	Gr. F-321

9.02.03 **Valves**

i)	3 – way valves	SS body/forged CS body stellited internals and SW ends as per requirement for 2500 lb/800 lb ASA ratings.
ii)	5- valve manifolds	FAS body/FCS body 316SS stellited internals with NPT(F) SCRD ends for 3000/2500 lb/1500 lb/800 lb ASA ratings. Construction – Single block (Bar stock)
iii)	3-valve manifolds	FAS body/FCS body 316SS stellited internals with NPT(F) SCRD ends for 3000/2500 lb/1500 lb/800 lb ASA ratings. Construction – Single block (Bar stock)
iv)	2-valve manifolds	FCS body, 316SS stellited internals, NPT(F) SCRD ends. Construction – Single block (Bar stock)
v)	Isolation and drain valves	Globe valves with FAS body/FCS body, 316SS stellited internals SW ends for 3000/2500 lb/1500 lb/800 ASA ratings.

9.02.04	Condensation vessels	FAS/FCS body with NPT (F) SCRD connection and vent plugs for 3000/2500/1500/800 lb ASA ratings.
9.02.05	Racks and Associated Equipment	ANSI C83.9-1972
9.02.06	Code for pressure piping, welding and Hydrostatic testing	ANSI B-31.1

9.02.07	Flexible conduits with fittings	Lead coated, paper insulated, heat resistant flexible metallic conduits with necessary fittings.

9.02.08 3 Valve manifold shall be used, wherever Diff Pressure transmitter/switch have been used for pressure measurement.

9.02.09 5 Valve manifold shall be used for Diff. Pressure & Flow measurement Transmitters/Switches.

9.02.10 In addition to above, table # 9.1 shall also be followed for selection of specific erection hard ware as per process requirements.

9.03.00 TRANSMITTER & SWITCHES ENCLOSURES

In general, BTG process transmitters & switches installed at outdoor location and in areas where they are subjected to splashing oil, water, steam etc., shall be mounted in closed type transmitter rack. For other areas (indoor), open type racks may be used for installation of transmitters and process switches. However the actual requirement shall be finalized during detailed Engineering considering following:-

i) Transmitter/Switches enclosures shall be free standing, enclosed type offering protection against dust, moisture and vermin. Enclosures shall be suitable for outdoor installations, in thermal power plants.

ii) The enclosures shall comprise of Galvanized Sheet mounting plate internally. Also external-mounting brackets in Polyamide or Stainless Steel shall be available. Alternatively transmitter enclosures can be glass Fiber Reinforced Polyester (GRP) compression moulded and shall be weather proof.

iii) Instrument piping inside the enclosure shall conform to the specification and in line with typical installation drawings enclosed with the specification.

iv) Blow down header shall be provided inside the enclosure as called for.

v) Bulk head connection shall be provided to receive and terminate the impulse pipes from root valves.

vi) Instrument tubing, fittings and isolation, drain valves shall be to ANSI code for pressure piping. Piping/tubing shall be subject to hydrostatic tests at 1.5 times maximum system pressure.

vii) 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.

viii) 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.

x) A minimum of twenty (20) percent spare terminals shall be provided. Only one wire per terminal shall be used on the outgoing side of these blocks (for cable panel). Any common connections required shall be provided on the panel side of the block. All incoming power terminals are to be clearly identified in a manner distinctly different from all other terminals and grouped in a logical pattern.

xi) Chapter no. 6 of this volume shall also be referred for designing of Transmitter/Switches enclosures.

9.04.00 LOCAL INSTRUMENTS, LOCAL BOARDS AND TAPPING POINTS

i) All local gauges as well as sensors, Transmitters and switches any other instruments for parameters like pressure, temperature, level, flow etc for safe and efficient operation of equipment under the scope of specification, shall be provided by bidder as approved by Owner. Such equipment shall be listed by the Bidder detailing the items with the respective functions in service. All field mounted instruments shall be mounted in such a way as not to be affected by vibration & environmental conditions. Racks to mount these instruments shall be furnished by bidder complete with requisite erection hardware, tubings and junction boxes with all terminals of the instruments duly wired complete with cable glands. Groupings of instruments, actual number of racks for instruments and its construction shall be to Owners approval.

ii) Transmitters & Switches provided shall be mounted in transmitter/Switches enclosures to owner's approval. The junction box for electrical connections shall be outside the transmitter enclosures.

iii) All erection hardware required for complete installation/ implementation of entire instrumentation specified is included in bidders scope. Any change in size, type, rating or in quantity deemed necessary during engineering shall be supplied within package price with no additional financial implication to owner.

iv) Bidders scope includes providing counter flanges on pipe lines/ vessels to suit owner arranged flanged devices. Counter flanges shall be complete with gaskets, nuts, bolts and other requisite accessories for proper installation.

v) Separate and independent tapping on equipment/associated piping shall be provided to suit the philosophy of redundant primary sensors. Separate sensors for control and monitoring etc are as decided by Owner. This shall include application such as first stage pressure. Wherever the process value being measured needs to be compensated for temp, pressure variations, the tapping points for such compensating elements shall be provided in requisite number along with the tapping for the process value.

vi) Whereever transmitters & switches are provided, in addition Local gauges shall also be provided by bidder for local field monitoring.

vii) Local instruments and remote sensors & transmitters to be furnished with the equipment shall generally be as indicated herein and as per redundancy criteria indicated elsewhere but not be limited to the following: -

1. Pressure Measurement

i. **Pressure Gauge** for:

a) Shell pressures of all Deaerator, HP and LP heaters and other vessels.
b) Mercury manometers shall be provided during air outlet flows measurement.
c) Bleed steam pressure at extraction point for all turbine extractions and for pressure on drain lines.
d) Pressure gauges at inlets and outlets of condensate extraction pumps, main oil pump, each auxiliary oil pump, AC standby oil pump, DC Emergency oil pump, jacking oil pumps, DM makeup pumps, DMCW pumps, BFP, or any other pumps etc.
Pressure Gauge at outlet of each type of Fan.
e) Lube oil pressure before and after oil coolers, HPT & IPT front seal chamber leak off pressure.
f) MS pressure downstream of ESV, after HPT control valves and after HPT first stage, HRH steams pressure after IV, Gland steam header pressure, HPT exhaust etc.
g) Condensate pressure in condensate pump discharge header, and feed water pressure at inlet and outlet of each LP & HP heaters.
h) LP turbine exhaust pressure and condenser pressure
i) Relay/Lube/Control oil pressure, Drain oil lines pressure.
j) Pressure gauges for vacuum pumps and each pump discharge.
k) Pressure gauge at Instrument and service air header in compressor room and in the field at the main location of instrument/service air header, the pressure gauges shall be provided.
l) Pressure gauges at inlet and outlet of each heat exchanger and cooler.
m) Frame mounted Pressure Gauges (FMG) shall be provided for Main steam Pressure, Feed water pressure to economizer, CRH Steam Pressure, HRH Steam Pressure etc.
n) For condensate storage tank the pressure gauge in terms of 0-10000 mm wc or suitable range having **dial size of 300 mm or bigger size** shall be provided.
o) **U tube manometer with Hg filled for direct measurement of condenser vacuum** shall be provided in the fixed with isolation valve for local indications.
p) Above are the minimum requirements, actual quantities shall be as decided during detailed engineering by owner.
q) Pressure gauge for all BoP packages as decided during detailed engineering by owner.

ii. **Pressure Switches**

a) Pressure switches at condensate Extraction Pump Discharge header, Boiler feed pump, seal water line or any other pumps for alarm (high & low) and interlock purpose.

b) Pressure switches for steam supply to LP/HP heaters.
c) Pressure switches for initiation of turning gear.
d) Pressure switches for control oil, jacking oil and lube oil pressure for all required alarms and interlocks.
e) Steam pressure downstream of ESV, steam pressure after first stage of HPT, gland steam header pressure and suction line from turbine glands to Gland cooler.
f) Pressure switches for condenser vacuum low, very low alarms & interlocks.
g) Condenser water box pressure for alarm interlocks.
h) Pressure switches (low & high) for individual pumps/blowers suction/discharge and discharge header – alarms, interlocks and protection
i) At the main location of instrument air header the pressure low switches shall be provided for alarms in DDCMIS
j) Pressure switches/any other process switch etc. for OLCS / Alarms / Interlocks / Protection. Pressure switches at inlet, outlet of individual pumps and discharge header of pumps for protection and auto start / stop & alarms.
k) Above are the minimum requirements, actual quantities shall be as decided during detailed engineering as per redundancy criteria by owner.
l) Pressure switches for all BoP packages as decided during detailed engineering. by owner.

iii. **Differential Pressure Transmitters, Diff Pressure Switches & Diff. Pressure Gauges**

a) Pressure across strainers and filters.
b) Diff. Pressure Transmitters/switches/Gauges for all BoP packages as decided during detailed engineering by owner.
c) Diff. Pressure Transmitter across condenser on CW lines, Air pre heaters on air & flue gas lines, on PA lines, CEP suction strainers, Feed control station etc.
d) Above are the minimum requirements, actual quantities shall be as decided during detailed engineering as per redundancy criteria by owner.

iv. Pressure Transmitters

a) For all services as mentioned for Pressure gauges & Pressure Switches.
b) Pressure Transmitters at condensate Extraction Pump individual Discharge and discharge header, Boiler feed pump individual Discharge and discharge header, seal water line or any other pumps/fans/HT/LT unidirectional drive for alarm (high & low) and interlock purpose.
c) Pressure transmitter for wind box (Left/Right) & pulverizer seal air fans discharge pressure.
d) Pressure Transmitters as on required basis for monitoring, interlocks & controls as per redundancy criteria and approved by owner.
e) Above are the minimum requirements, actual quantities shall be as decided during detailed engineering as per redundancy criteria and approved by owner.
f) Pressure Transmitters for all BoP packages as decided during detailed engineering by owner.

2. Temperature Measurments:-

The Bidder shall furnish all temperature sensing elements to be installed in their piping. The scope of supply shall include, but not limited to the following: -

i) Duplex RTDs for all bearing, drain oil from bearings, LPT exhaust steam, 3 no's of duplex RTDs each on left and right CW outlet of condenser etc.

ii) 6 no. duplex or 12 no. simplex Embedded temperature detectors for various motor stator windings and duplex RTDs for Motor/Pump bearing temp.

iii) Chromel-alumel surface/other thermocouples for turbine casings, ESV, IV bodies, superheated steam, hot reheat steam piping, steam of first stage HPT, inlet bowl of IPT, steam exhaust of HPT, down stream of ESV and IV, steam in ESVs and IVs, steam admission pipes metal temperatures, HPC, IPC flange metal temperature etc.

iv) For all HP heaters remote monitoring with redundant independent sensors of inlet/outlet temperatures of feed water and extraction steam shall be provided in addition to local gauges.

v) For all LP heaters remote monitoring with redundant independent sensors of inlet/outlet temperatures of feed water and extraction steam shall be provided in addition to local gauges.

iv) Temperature sensors for HP-LP bypass system for measurement as well as for control.

v) Adequate number of temperature Elements shall be furnished to provide initiating contacts for temperature interlocking and trip circuits. The temperature elements shall be provided, but not limited to the following: -

Steam temperature of HPT exhaust, steam temperature after ESV (L&R), IV (L&R), LPT exhaust hood steam, drain oil temperature of all journal bearings and thrust bearing & lube oil header temperatures, thrust bearing of each condensate extraction pump and vacuum pump protection, interlocks.

vi) Metal Temp measurement and steam temp measurement at each super heater & Reheater location.

vii) Temp. Element & Temp gauges at Feed water line to economizer inlet, economizer to steam separator, spray water lines to desuperheaters, Soot blower steam, Soot blower steam drain lines, steam drain lines, Flue gas & air lines etc

viii) Temp. Measurements (Local & remote) for all BoP packages as decided during detailed engineering.

ix) Thermocouples for Temp. above 200 deg C shall be provided by bidder.

x) For plate heat exchangers, spare thermowell provision shall be made at inlet & outlet of ACW & DMCW lines in addition to local & remote temperature monitoring points.

xi) Each ESP Hopper shall be provided with RTDs to control the temperature of ash through Hopper heater.

xii) Temperature gauges.

a) For bearing temperatures AC and DC lube oil pumps, LPT exhaust hood etc.

b) For condensate and feed water at inlet and outlet of HP heaters, Vacuum pumps, LP heaters etc.

c) Steam & water inlet/outlet of LP and HP heaters, steam and air mixture inlet to vacuum pumps, and drain lines etc.
d) Journal/thrust bearing drain oil, lube oil at inlet/outlet of oil coolers, cooling water at inlet and outlet of oil coolers etc.
e) Thrust bearing of each condensate extraction pump.
f) Temp. Gauges at inlet and outlet of each heat exchanger and cooler.
g) Frame mounted Temperature Gauges (FMG) shall be provided for Main steam Temperature, Feed water Temperature to economizer, CRH Steam Temperature, HRH Steam Temperature etc

xiii) Above are the min. requirements, actual quantities shall be as decided during detailed engineering by owner.

3. Level Measurement

i) Level gauges - level gauges for boiler separator, HP heaters, LP heaters, deaerator, drain cooler, gland steam cooler, vacuum tanks, condenser hot well CBD tank, stator water tank, Stator water expansion tank and other pressure vessels, main oil tank and all oil tanks in BTG & BOP package. The level gauges shall be mica shielded steel armoured transparent glass type. Level gauges for condenser hot well shall be provided on both sides.

ii) Level switches for HP/LP heaters, drain cooler, gland steam cooler, condenser hot well, deaerator, main oil tank and other pressure vessels, tanks, sumps etc. The separate switches for high, very high and low levels shall be provided as per interlocks and protection requirements.

External cage mounted magnetic level switches/ displacer type shall be employed for low pressure & low temp. services.

However conductivity type level switches shall be provided for high pressure & high temp services like HP heaters, CRH/HRH drain Pot, Turbine Drains etc.

iii) Level Transmitters (Type as per Owner approval) for open sump/tank/bunker/vessel/heaters.

iv) Level measurement for all BoP packages as decided during detailed engineering.

v) Level switches for OLCS / Alarms / Interlocks / Protection. Level switches for sump/tank level high/normal/ low/very low interlocks.

vi) Each ESP hopper must be provided with 3 nos. level switch (switches 2 nos. for high level and One no. for low level.)

vii) Above are the min. requirements, actual quantities shall be as decided during detailed engineering by owner.

4. Flow Measurements:-

a) Primary Elements: Flow nozzles shall be used for feed water flow and other critical measurements where weld-in construction is required. Flow nozzles shall be made of stainless steel, with three sets of pressure taps installed in the pipe wall where required. One no. spare set of pressure tap shall also be provided on flow nozzle,

wherever required. Installation of flow nozzles and pressure taps shall be made in the pipe fabricator's shop and shall be witnessed by a representative from the flow nozzle manufacturer.

b) Paddle type orifice plates shall be used for other flow measurements where flanged construction and higher pressure loss are acceptable. Orifice plates shall be made of stainless steel. Orifice flanges shall be of the raised face weld neck type with dual sets of taps.

c) Construction and installation of flow nozzles and orifices shall conform to the requirements of ASME Performance Test Code PTC-19.5, and discharge coefficients shall be predicted in accordance with data published in ASME Research Report on Fluid Meters.

d) Airfoil or venturi flow sections, shall be used for measuring boiler combustion airflow.

e) A special high accuracy flow nozzle pipe shall be provided to determine feed water flow to the economizer. This nozzle shall be hydraulically calibrated and utilized for feed water flow control and for turbine testing as described in ASME PTC 6 (latest revision).

f) Orifice plates shall be supplied with carrier rings as per process requirement.

g) Doppler effect type flow meters shall be used for sludge applications.

h) For Raw water, water treatment plant and effluent treatment plant, ultrasonic type flow meters to be used.

i) Secondary Elements: Secondary elements for differential type flow sensors shall be strain gauge or capacitance type differential pressure transmitters. Square root extraction required for the DP transmitters shall be performed electronically in the transmitter itself.

j) HFO/LDO flow meters shall be based on coriolis mass flow technology. Fuel Oil meters shall be provided for fuel oil unloading system and near boiler after day oil tank (at main supply & return lie).

k) Flow nozzles shall be provided for following services in main plant:-

i) Steam flow measurement for BFP Turbines.
ii) Feed water flow measurement
iii) Auxiliary steam flow measurements
iv) HP bypass flow measurements
v) BFP suction flow.
vi) Deaerator water flow measurement
vii) HP heaters drain Flow measurements.

Orifices shall be provided for following services:-

i) Spray water flow measurement

ii) Condensate flow measurements
iii) DM/hotwell makeup to condenser.
iv.) Condensate dump flow to CST
v) Gland Steam Condensate flow measurements

l) For DM water flow & Ash Slurry flows measurements online electromagnetic flow meter shall be used.

m) At CW & ACW pump discharge headers flow transmitters shall be provided (Non Contact ultrasonic Type are preferable). In addition flow measurement shall also be provided for CW water used any where except condenser service.

n) Instrument and Service Air - Vortex/Swirl type Flow meter

o) Flow transmitters for general applications shall be of the differential pressure type

.

p) Flow switches for OLCS / Alarms / Interlocks / Protection.

q) Lubricating oil Flow transmitter/meter with switch shall be provided for Bearing systems of APH, FD, PA, etc.,

r) Sight glasses flapper indication type shall be provided on lube oil cooling water piping as required to ensure indication of fluid flow.

s) On line Fuel flow & velocity measurement facility in each Pulverized Fuel (PF) pipe for each coal pulveriser shall be provided by bidder for accurate, absolute and simultaneous measurement of coal velocity, coal density, coal mass flow rate and air-to-fuel ratio. The equipments shall compromise of sensors working on micro wave technology.

t) In addition to the **conventional triple DP measurement techniques** involving venturi/Airfoil for secondary air flow measurement, One number **Flow measurement** system each on Left side and Right side shall be provided **as redundant/checking measurement for secondary air flow** which could be used in the optimization package.

On line secondary air flow & velocity measurement facility in each on left side & right side shall be provided by bidder for accurate, absolute and simultaneous measurement of air velocity & flow rate. The equipments shall compromise of sensors working on tribo-electric (Correlation technique) technology.

u) Any other flow element/meter required for system shall be finalised as per system requirement and as per approved drawings/documents by owner.

9.05.00 **Process Connections**

The type of instrument source connection shall depend upon the process parameters and the tapping size. The source connection drawings shall be finalised during the engineering stage.

Size of tapping point stub, number and size of root valves for different types of measurements are as follows:

Sl. No.	Quantity of root valves	Size of stub and root valve	Service Condition
Pressure and Differential Pressure Measurement			
(i)	2	25NB	≥ 40 bar(g) OR 425^{0}C
(ii)	1	15NB	< 40 bar(g) AND 425^{0}C.
Level Measurement			
(a)	**Level Gauge & Switch**		
(i)	2	25NB	≥ 40 bar(g) OR 425^{0}C
(ii)	1	25NB	< 40 bar(g) AND 425^{0}C
(b)	**Level transmitter (displacement type)**		
(i)	2	40NB	≥40 bar(g) OR 425^{0}C
(ii)	1	40NB	<40 bar(g) AND 425^{0}C
(c)	**Stand pipe for level measuring instrument**		
(i)	2	80 NB	≥40 bar(g) OR 425^{0}C
(ii)	1	80 NB	< 40 bar(g) AND 425^{0}C
Flow Measurement			
(i)	2	25NB	≥ 40bar(g) OR 425^{0}C
(ii)	1	25NB	< 40 bar(g) AND 425^{0}C
Sampling system measurement (Steam and Water Service)			
(i)	2	25 NB	≥40 bar(g) OR 425^{0}C
(ii)	1	25 NB	< 40 bar(g) AND 425^{0}C

Technical Specifications for C&I Systems-Table-No. 9.1

S.No.	System/Line Description	Piping Class	Impulse Pipe material	Schedule (Size)	Materials for fitting/ valve body	Valve steam material	Rating of Piping Fitting	Pressure Class of valve
1	Main steam, Up steam & down stream of HP bypass and up stream of auxiliary steam pressure reducing valve.	A	ASTM-A335 Gr.P-91/22 (Note-2)	XXS (½ Inch)	Note-3	Note-3	9000lb	3000 SPL
2	BFP discharge/ superheater attemperator/spray to PRDS	B	ASTM-A106 Gr. C	160 (½ Inch)	Note-3	ASTM-A-182 Gr.F6a	6000lb	2500 SPL
3	Reheater attemperator	C	ASTM-A106 Gr. C	160 (½ Inch)	ASTM-A-105	ASTM-A-182 Gr.F6a	6000lb	1500 SPL
4	Hot. Reheat/Down stream of Aux.Steam pressure reducing valve upto desuperheater/flash tank drain manifold, HRH upstream & down stream of LP Bypass valve.	D	ASTM-A335 Gr.P-91/22 (Note-2)	160 (½ Inch)	ASTM-A182 Gr.F-22	Note-3	3000lb	2500 SPL
5	Cold reheat upto Tee-off for HP bypass.	E	ASTM-A335 Gr.P-22	80 (½ Inch)	ASTM-A182 Gr.F-22	ASTM-A-182 Gr.F6a	3000lb	800
6	Cold reheat down steam of Tee-off (HP Bypass)	F	ASTM-A106 Gr. C	80 (½ Inch)	ASTM-A105	ASTM-A-182 Gr.F6a	3000lb	800

7	BFP suction/condensate system/Extraction to LPH/HPH and Extractions to BFPT, Desecrator, auxiliary steam.	G	ASTM-A106 Gr. C, ASTM-A335 Gr.P-11/22	80 (½ Inch)	ASTM-A105	ASTM-A-182 Gr.F6a	3000lb	800
8	Air/Flue gas outside furnace.	M	ASTM-A106 Gr.B/C	80 (3/4 Inch)	ASTM-A105	ASTM-A-182 Gr.F6a	3000lb	800
9	Air flue gas inside furnace	N	ASTM-A335 Gr.P-22	80 (3/4 Inch)	ASTM-A182 Gr.F-22	ASTM-A-182 Gr.F6a	3000lb	800
10.	Purge Air	O	ASTM-A106 Gr.C	80 (3/4 Inch)	ASTM-A105	SS316	3000lb	800
11.	DM Cooling water	P	ASTM-A312 TP 316	80/40 (1/2 Inch)	ASTM – A 182 F 316	SS316	3000lb	800
12.	CW & ACW	Q	ASTM-A106 Gr.C	80 (1/2 Inch)	ASTM-A105	SS316	3000lb	800

Note:-

1). Above requirements are minimum to be complied by bidder. Rating of piping / fittings / valves etc. is subjected to be approved by owner as per the final design pressure & temperature finalized during the detailed engineering, as per ANSI B 31.1.
2). In case temperature is more than 540 deg C, the material shall be P-91 only.
3). Material shall be compatible with that of the impulse pipe material and design parameter.
4). For DM Plant or DM water services, complete erection Hardware material shall be SS316 only.

DRAWING DOCUMENT DISTRIBUTION SCHEDULE

(ANNEXURE-A)

No. of copies required from the contractor after award of the contract.

S.NO.	DESCIPTION	TANGEDCO	DESEIN	BHEL (PEM)	BHEL SITE AND REGION
1	Drawing for approval/ information	5+1S+2CD	5+1S+1CD	2+1S	--
2	Final drawing (APPROVED)	4+1S+3CD	4+1S+3CD	1+1S	10+1S+1CD
4	AS BUILT DRAWINGS	4+1S+3CD	4+1S+3CD	1+1S	10+1S+1CD
5	CD ROM "FINAL DRAWING"	2CD	1-CD	1CD	2CD
6	Type test reports	2+1S	2+1S	---	2+1S
7	O & M Manuals for approval	2+1CD+SS	2+1CD+SS	1+CD+SS	------
8	Final O & M Manuals	4+6CD+SS	4+4CD+SS	1+CD+SS	10+5CD+SS
9	Performance guarantee test reports	2+1S	2+1S	---	2+1S

* Applicable for vendor drawings

CD - Compact Disc (Read Only)

S-SOFT COPY (IN EMAIL/WRENCH).

NOTE: ALL DRGS. SHALL BE PREPARED ON COMPUTER ***AUTOCAD (LATEST VERSION)*** AND OTHER DOCUMENTS (LIKE DATA SHEET ETC.) ON ***MS-OFFICE (LATEST VERSION).*** SOFTWARE. BIDDER NOT COMPLYING WITH THE REQUIREMENT SHALL NOT BE CONSIDERED.

SITE STORAGE AND PRESERVATION

(ANNEXURE-B)

SITE STORAGE AND PRESERVATION GUIDELINES

FOR

MECHNANICAL BOPs

(Doc No: PE-DC-SSG-A001 REV.00)

PROJECT ENGINEERING MANAGEMENT, POWER SECTOR

BHARAT HEAVY ELECTRICALS LIMITED-NOIDA

CONTENT

1. SCOPE OF THE DOCUMENT

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

2. PURPOSE OF STORAGE & PRESERVATION

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

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

a) GENERAL STORAGE REQUIREMENTS

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

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

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

b) GENERAL PRESERVATION REQUIREMENTS

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

10. All the electrical equipment such as motors, generators, etc. shall be tested for insulation resistance at least once in three months and a record of such measured insulation values shall be maintained.

11. Following preservatives/preservation methods can be used depending upon type of equipment

    a. Rust preventive fluid (RPF)

    b. Rust protective paints

    c. Tarpaulin covers, in case of outdoor storage

    d. De-oxy aluminate for weld-ments

c) GENERAL INSPECTION REQUIREMENTS

1. Period inspection of materials with specific reference to –

    - Ingress of moisture and corrosion damages.
    - Damage to protective coating.
    - Open ends in pipes, vessels and equipment -
        - In case any open ends are noticed, same shall be capped.

2. Any damages to equipment / materials.

    - In case of any damages, these shall be promptly notified and in all cases, the repairs / rectification shall be carried out.
    - Any items found damaged or not suitable as per project requirements shall be removed from site. If required to store temporarily, they shall be clearly marked and stored separately to prevent any inadvertent use.

4. TYPE OF STORAGE FOR VARIOUS EQUIPMENT

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

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

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

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

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

iii Open storage (O)

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

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

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

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

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

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

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

Sl. No.	Description of the equipment	Type of Storage	Check for	Remarks
51.	Elevators(CONTAINERIZED)	O	Damage , packing, corrosion	
52.	Chillers/VA machines	S	Damage , packing	
53.	Air handling Unit/Package unit	S	Damage , packing	
54.	Chlorinators & Evaporators	C	Damage , packing	
55.	Ejectors	C	Damage , packing	
56.	Electrolyser	C	Damage , packing	
Miscellaneous items like chain pulley blocks, hoists etc.				
57.	Chain pulley blocks	S	Damage, Packing	
58.	Electric hoists	S	Damage, Packing	
59.	Fire extinguishers	C	Damage, expiry date	
60.	Fork Lift Truck	S	Damage, Packing	
61.	Hydraulic Mobile Crane	O	Damage, Packing	
62.	Mobile Pick Up & Carry Crane	O	Damage, Packing	
63.	Motor boats	O	Damage, Packing	
64.	Safety showers	S	Damage, Packing	
65.	Diffusers/dampers	S	Damage, Packing	
Chemicals and consumables (acid, alkali, paints, oils, reagents and special chemicals)				
66.	Hydro Chloric Acid (HCl)	Store in canes/ storage tank in dyke area	Date of production/ leakage/fumes	hazardous chemical
67.	Sulphuric acid (H_2SO_4)	Store in canes/ storage tank in dyke area	Date of production/ leakage/fumes	hazardous chemical

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

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

5. CONCLUSION

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

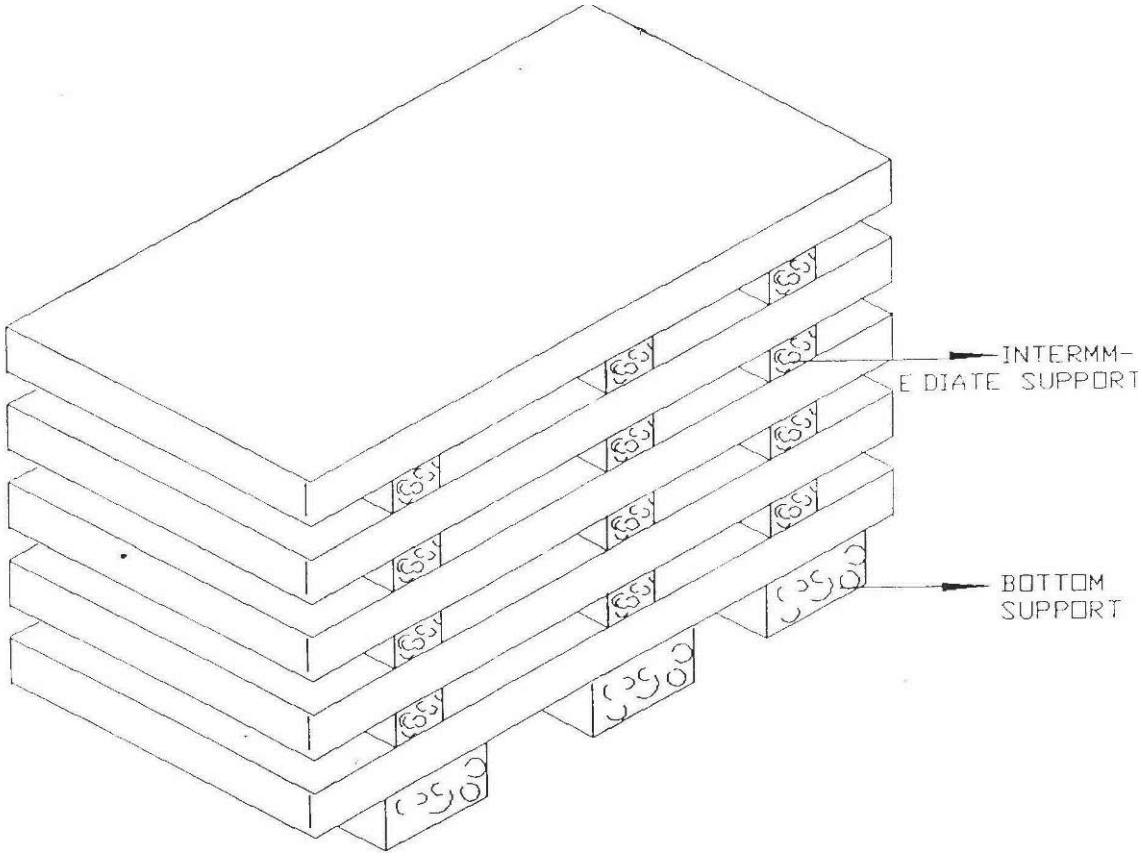


Figure – 1 – PLATE STACKING ARRANGEMENT

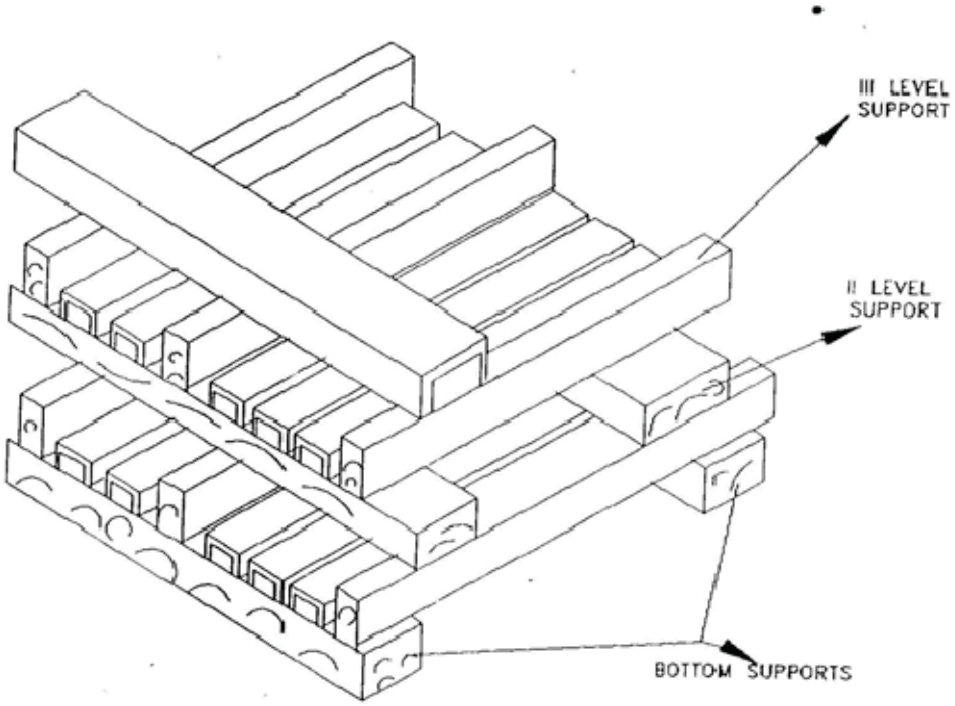


Figure – 2 – STRUCTURAL STEEL STACKING ARRANGEMENT

ALREADY APPROVED/COMMENTED DOCUMENTS (SUBMITTED BY M/S DENORA)

(ANNEXURE-C)

NOTE:

1) BIDDER CAN ALSO GO WITH OTHER MAKE/SUB-VENDOR ITEMS FOR WHICH THE MODIFICATION WORK ON EXISTING CIVIL FOUNDATION TO BE TAKEN CARE BY BIDDER AT SITE.

2) THE MAKE OF ITEMS SHALL BE AS PER ENCLOSED APPROVED SUB VENDOR LIST (**PE-V11-412-174-A104**). HOWEVER, ANY ADDITIONAL SUB-VENDOR REQUIRED THE SAME SHALL BE SUBJECT TO BHEL/CUSTOMER APPROVAL DURING DETAILED ENGINEERING WITHOUT ANY COMMERCIAL/DELIVERY IMPLICATION TO BHEL/CUSTOMER.

MDL FOR ELECTRO CHLORINATION PLANT			
SL NO	**BHEL DOC NO.**	**DOC TITLE**	**STATUS**

1	PE-V11-412-174-A101	Piping & Instrumentation Diagram	APPROVED
2	PE-V11-412-174-A102	Process Design Basis and Sizing Calculation	APPROVED
3	PE-V11-412-174-A103	Equipment Layout	APPROVED
4	PE-V11-412-174-A104	Sub vendor list & inspection criteria	APPROVED
5	PE-V11-412-174-A105	Control Philosophy with control system configuration Diagram	APPROVED
6	PE-V11-412-174-A110	TECHNICAL DATA SHEET OF VERTICAL / HORIZONTAL PUMPS	APPROVED
7	PE-V11-412-174-A111	TECHNICAL DATA SHEET OF BLOWERS	APPROVED
8	PE-V11-412-174-A113	QAP FOR VERTICAL / HORIZONTAL PUMPS WITH MOTOR	APPROVED
9	PE-V11-412-174-A114	QAP FOR BLOWERS WITH MOTOR	APPROVED
10	PE-V11-412-174-A116	Datasheet & GA of Hypochlorite generator (Electrolyzer)	APPROVED
11	PE-V11-412-174-A117	QAP of Hypochlorite generator	APPROVED
12	PE-V11-412-174-A121	GA & Data sheet of Transfer Rectifier	APPROVED
13	PE-V11-412-174-A122	QAP OF TRANSFORMER RECTIFIER	APPROVED
14	PE-V11-412-174-A132	PG Test Procedure	APPROVED
15	PE-V11-412-174-A134	Drive list	APPROVED
16	PE-V11-412-174-A106	CIVIL ASSIGNMENT DRAWING	APPROVED
17	PE-V11-412-174-A107	Electrical Load list	APPROVED
18	PE-V11-412-174-A112	GA & Data sheet of Motors	APPROVED
19	PE-V11-412-174-A118	GA of Atmospheric Tanks	APPROVED
20	PE-V11-412-174-A119	Mechanical Datasheet & GA for Strainers	APPROVED
21	PE-V11-412-174-A120	Datasheet for safety items	APPROVED
22	PE-V11-412-174-A123	INSTRUMENT SCHEDULE	APPROVED
23	PE-V11-412-174-A124	VALVE SCHEDULE	APPROVED
24	PE-DG-412-100-E049	Cable tray layout	APPROVED
25	PE-V11-412-174-A128	QAP / ICL of Elecrochlorination System(BALANCE OF ITEMS)	APPROVED
26	PE-V11-412-174-A129	ERECTION PROCEDURE	APPROVED
27	PE-V11-412-174-A138	CAUSE EFFECT CHART	APPROVED
28	PE-V11-412-174-A131	DATA SHEET FOR EOT CRANE	APPROVED
29	PE-V11-412-174-A115	Data sheet for instruments AND ANALYSER (chlorine)	CAT-II

30	PE-V11-412-174-A125	PLC DOCUMENTS FOR ECP--GA & WIRING DETAILS OF PLC PANEL.	CAT-II
31	PE-V11-412-174-A126	QAP/FAT FOR PLC	CAT-II
32	PE-V11-412-174-A133	I/O list	CAT-II
33	PE-V11-412-174-A135	Control Scheme	CAT-II
34	PE-V11-412-174-A109	Datasheet for UPS	CAT-II
35	PE-V11-412-174-A139	DATA SHEET OF VALVE	CAT-II
36	PE-V11-412-174-A130	Cable schedule, submission of cable interconnection diagram	1ST SUBMISSION PENDING
37	PE-V11-412-174-A136	Plant Schematic / MIMIC	1ST SUBMISSION PENDING
38	PE-V11-412-174-A137	O&M Manual	1ST SUBMISSION PENDING
39	PE-V11-412-174-A108	Piping Layout with diffuser installation	1ST SUBMISSION PENDING
40	PE-V11-412-174-A127	Painting Schedule	2ST SUBMISSION PENDING

APPROVED

L E G E N D

	BUTTERFLY BALVE
	BALL VALVE
	NON RETURN VALVE
	ALARM
	INTERLOCK
	CENTRIFUGAL PUMP
	METERING PUMP
LIT	LEVEL INDICATING TRANSMITTER
	FILLING CONNECTION
	STRAINER ('Y' TYPE)
TIT	TEMPERATURE INDICATING TRANSMITTER
DPT	DIFFERENTIAL PRESSURE TRANSMITTER
FT	FLOW TRANSMITTER (ELECTRO MAGNETIC TYPE)
	DIFFUSER
	PNEUMATIC OPERATED
	MOTOR OPERATED
	VENT
	DRAIN
FS	FLOW SWITCH
	DAMPER VALVE
	DIAPHRAGM VALVE
	BASKET STRAINER
SOV	SOLENOID OPERATED VALVE
M	MOTOR OPERATED
DPI	DIFFERENTIAL PRESSURE INDICATOR

APPROVED VIDE Lr.No.CE/Pr/SE/E/ THPro./EE2/AEE/F.BHEL/HPVP/ D. 550 /18 dtd.03 .10.2018

BHARAT HEAVY ELECTRICALS LTD
PROJECT ENGINEERING MANAGEMENT.

This approval status shall be interpreted as laid down in the contract and it shall not relieve the contractor from the contractual obligation.

APPROVAL CATEGORY AWARDED = I

CAT I - Approved
CAT II - Approved With Comments as Noted
CAT III - Not Approved
CAT IV - Reference Drawing

DEPARTMENT	MECHANICAL AUXILIARY
NAME: FALGUNI SAHA	

2018.10.08 10:38:05 +05'30'

JOB No. : 412

2X660 MW ENNORE SEZ COAL BASED STPP AT ASH DYKE OF NCTPS, CHENNAI.

STATUS: CONTRACT

TAMILNADU GENERATION AND DISTRIBUTION CORPORATION (TANGEDCO)

DISTRIBUTION

CONSULTANT: DESEIN PVT LTD, NEW DELHI.

TO				
No.OF				
REV	DATE	ALTD	CHD	APPD

BHARAT HEAVY ELECTRICALS LTD
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT
NEW DELHI

BHEL DWG No.
PE-V11-412-174-A101

SUB-CONTRACTOR : DE NORA INDIA LIMITED, KUNDAIM - GOA

ASSOCIATE PARTNER : DE NORA WATER TECHNOLOGIES, SINGAPORE BRANCH

DE NORA

DEPT CODE		NAME	SIGN	DATE
M	DRN	BW		13DEC17
	CHD	VY		13DEC17
	APPD	DT		13DEC17

LOA NO:PW/PE/PG/EN1/P--24/17 DATED:22 APR 2017

TITLE

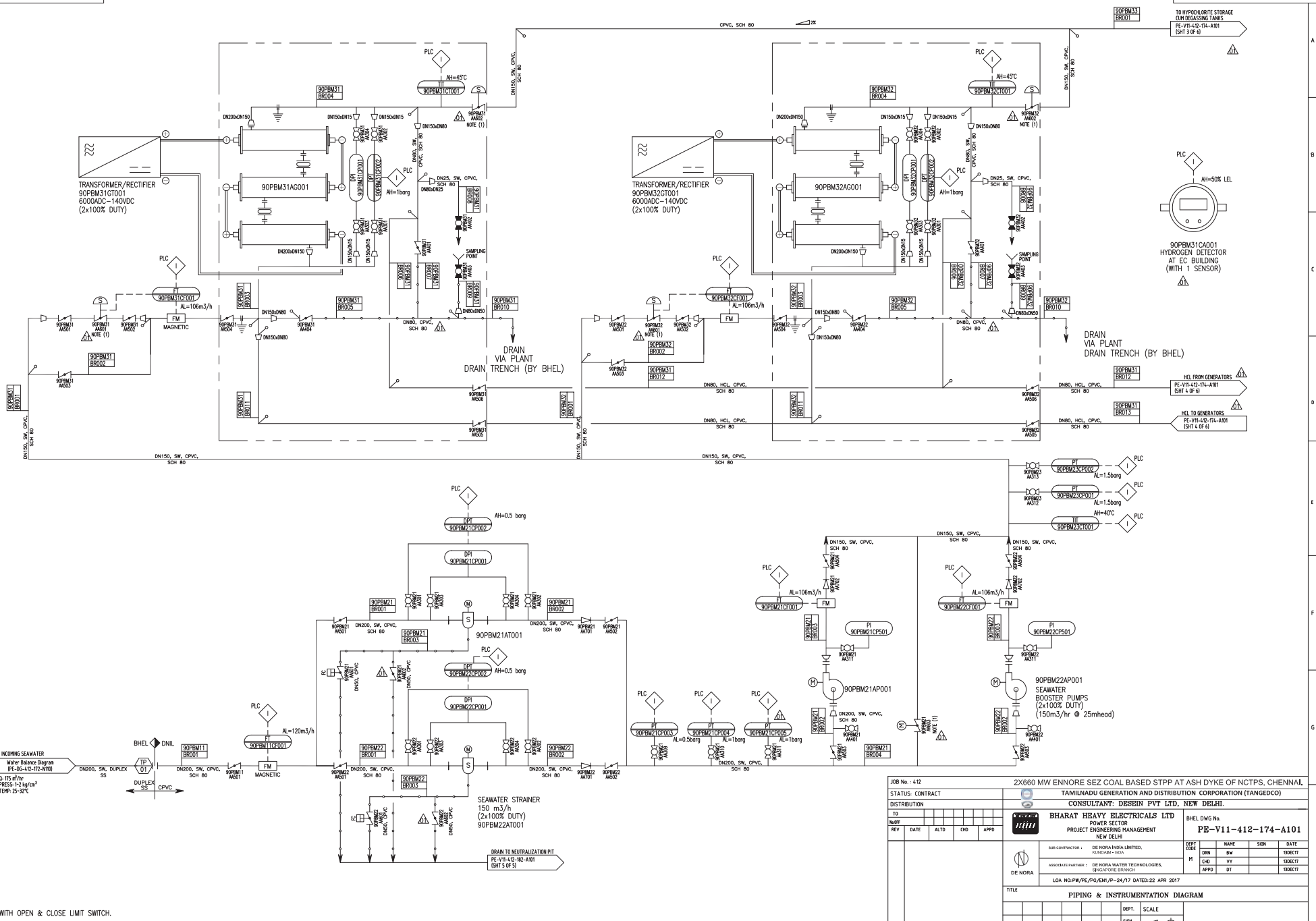
PIPING & INSTRUMENTATION DIAGRAM

DEPT. SCALE

SIGN

DATE

SHEET 1 OF 6 REV. 3



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TO	BHARAT HEAVY ELECTRICALS LTD, POWER SECTOR, PROJECT ENGINEERING MANAGEMENT, NEW DELHI
No.OFF	BHEL DWG No. PE-V11-412-174-A101
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	LOA NO:PW/PE/PG/EN1/P--24/17 DATED: 22 APR 2017
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	DEPT. / SCALE / SIGN / DATE
	SHEET 2 OF 6 REV. 3

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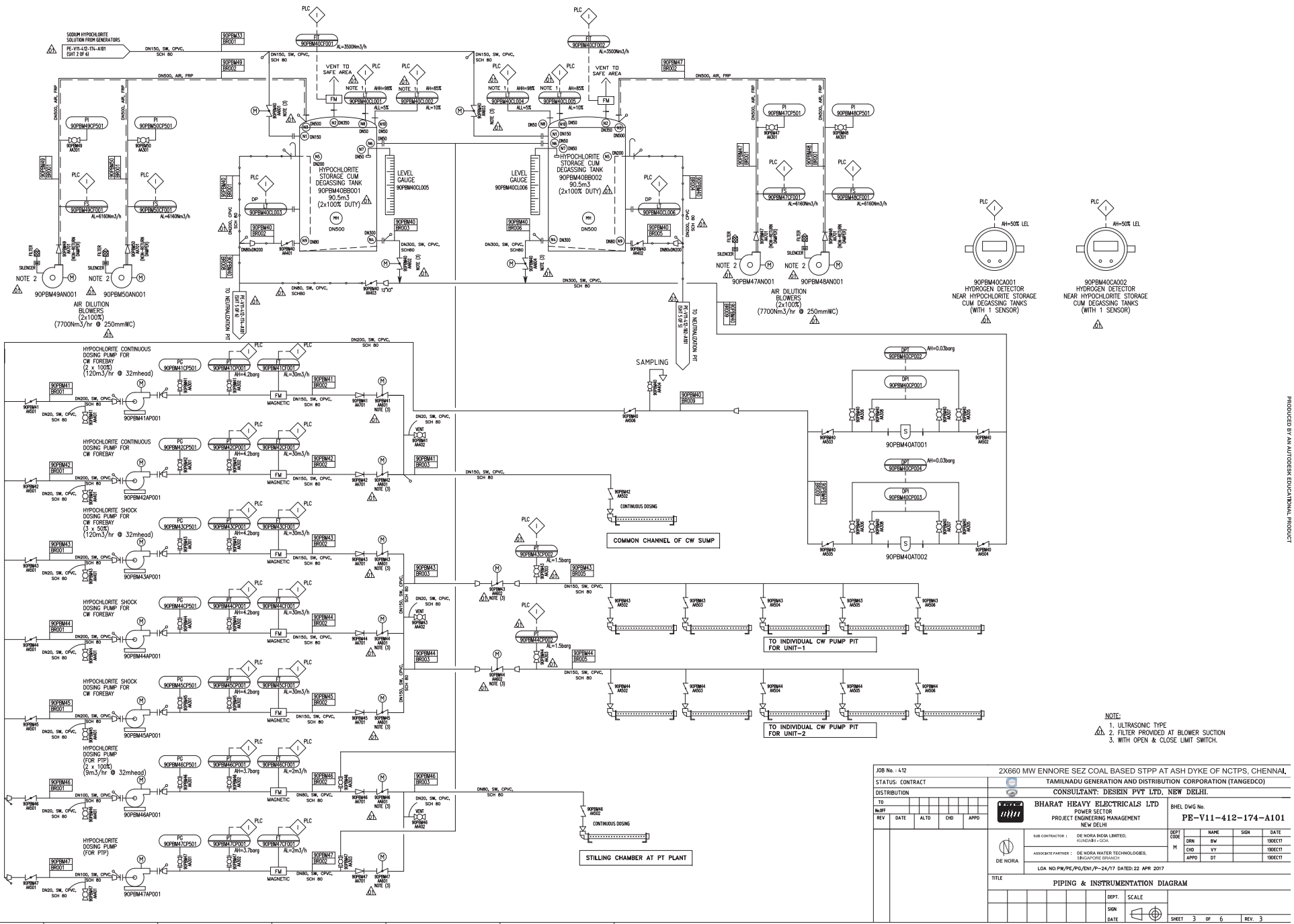

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No.OFF					
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	LOA NO: PW/PE/PG/EN1/P-24/17 DATED: 22 APR 2017				
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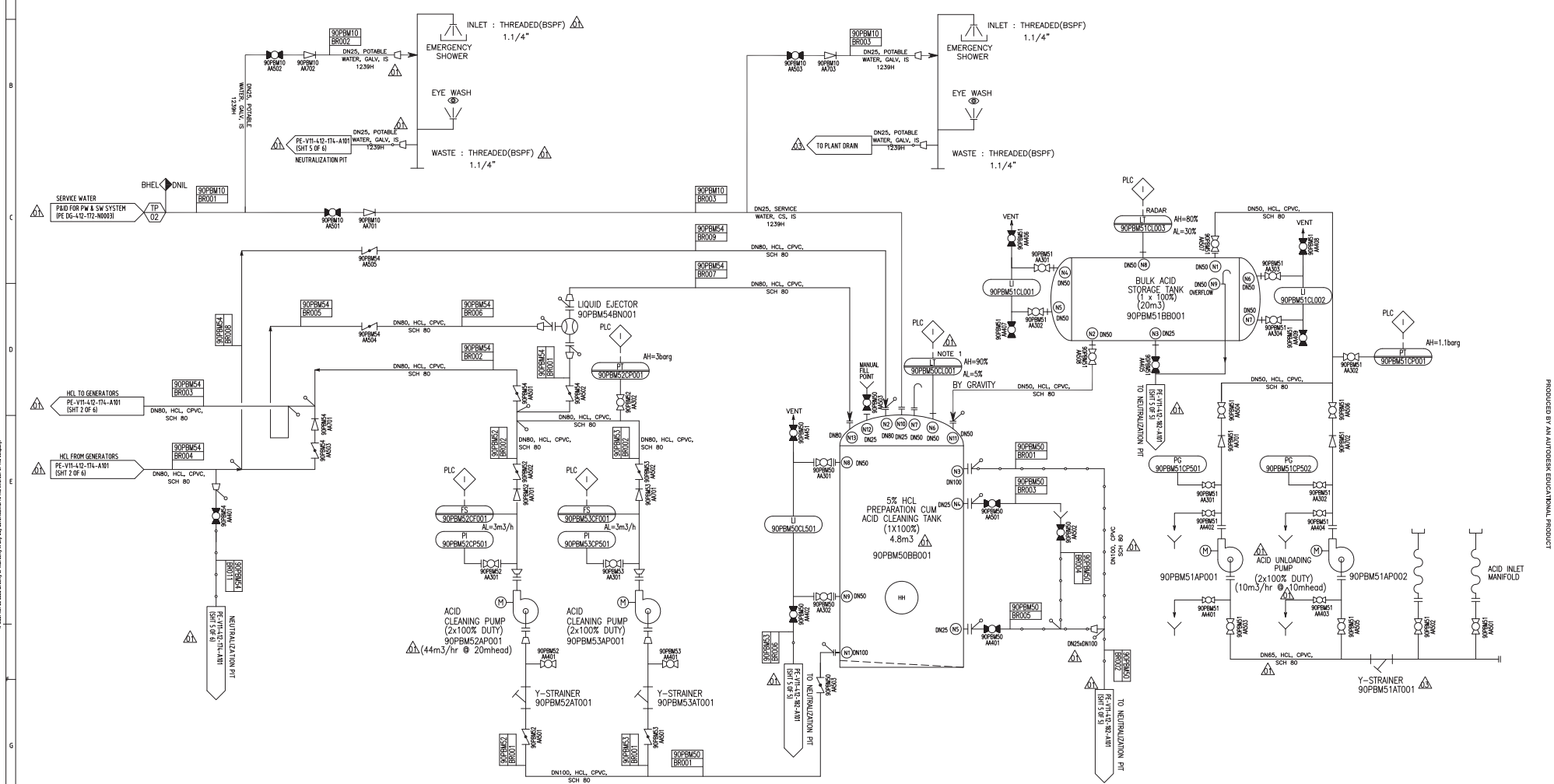
	DEPT. / SCALE / SIGN / DATE				SHEET 3 OF 6 REV. 3



NOTE:

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STATUS: CONTRACT							TAMILNADU GENERATION AND DISTRIBUTION CORPORATION (TANGEDCO)
DISTRIBUTION							CONSULTANT: DESEIN PVT LTD, NEW DELHI.
TO							BHARAT HEAVY ELECTRICALS LTD POWER SECTOR PROJECT ENGINEERING MANAGEMENT NEW DELHI
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	CHD	VY		19DEC17
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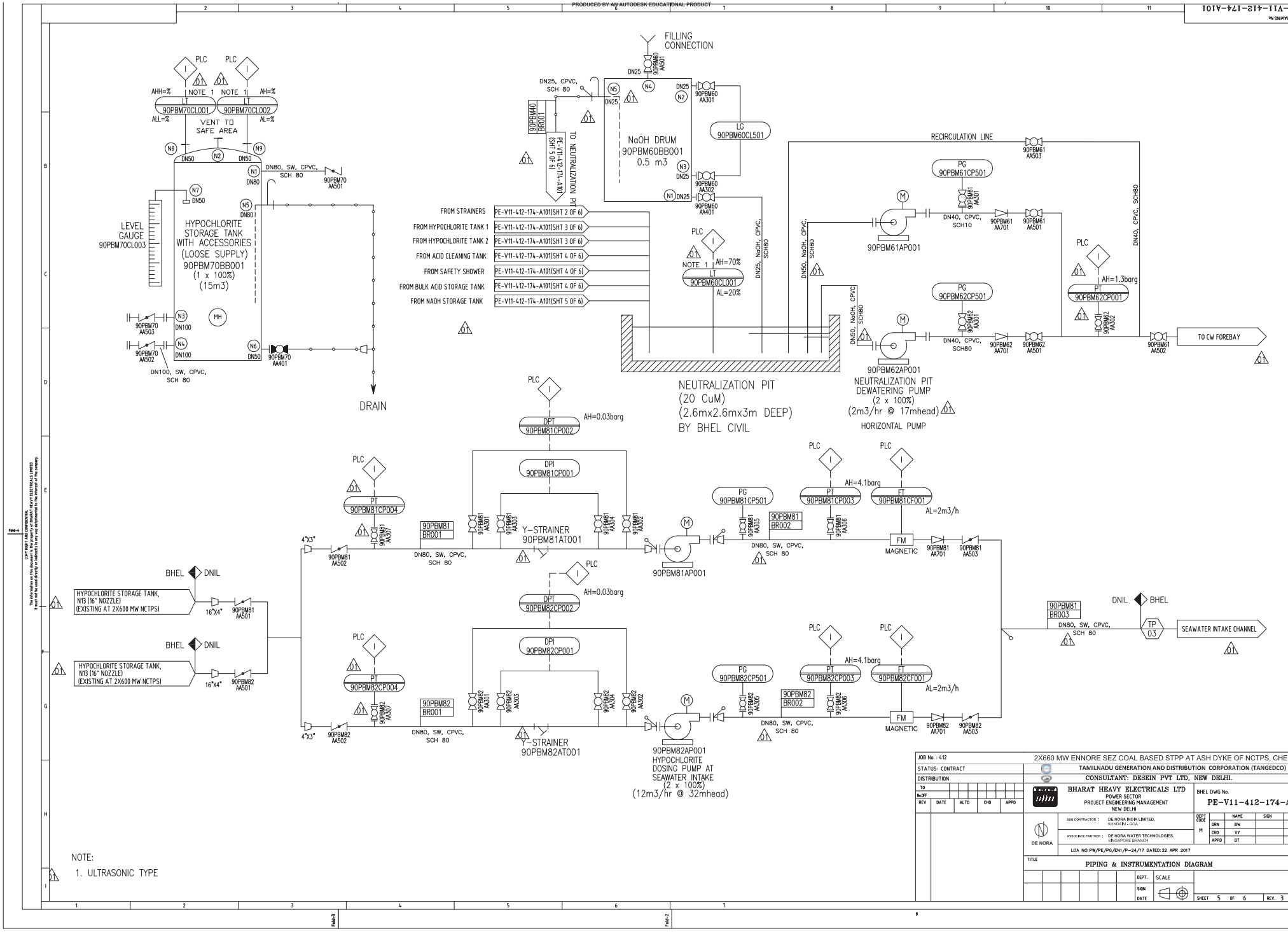
SHEET 4 OF 6 | REV. 3



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SUB CONTRACTOR : DE NORA INDIA LIMITED, KUNDAIM - GOA	DEPT CODE M; DRN BW; CHD VY; APPD DT; NAME; SIGN; DATE 19DEC17
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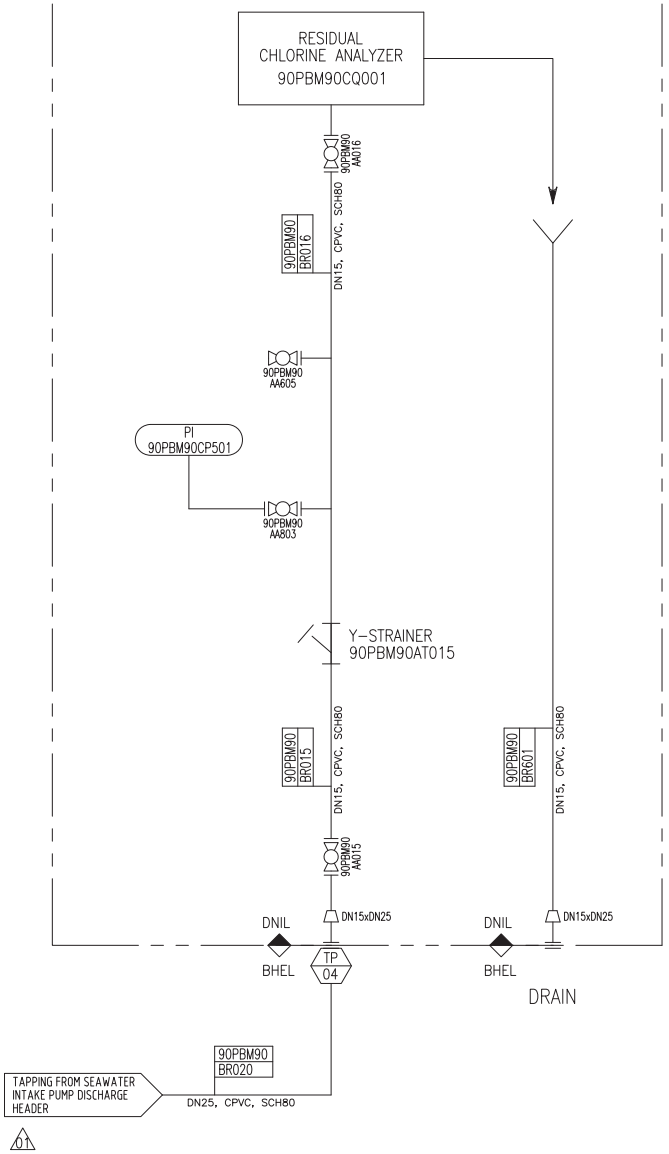
SHEET 5 OF 6	REV. 3

RESIDUAL CHLORINE ANALYZER SKID AT SEAWATER INTAKE



NOTE:
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	ASSOCIATE PARTNER : DE NORA WATER TECHNOLOGIES, SINGAPORE BRANCH					DRN BW	19DEC17
	LOA NO: PW/PE/PG/EN1/P-24/17 DATED: 22 APR 2017					CHD VY	19DEC17
	TITLE: PIPING & INSTRUMENTATION DIAGRAM					APPD DT	19DEC17
						DEPT. / SCALE	
						SIGN / DATE	
						SHEET 6 OF 6	REV. 3

FIRST ANGLE PROJECTION (ALL DIMENSIONS ARE IN MM)

REV	DATE	ALTERED:	REV	DATE	ALTERED
		CHECKED:			CHECKED

APPROVED

STATUS : CONTRACT

JOB NO.: 412

2X660 MW ENNORE SEZ COAL BASED STPP AT ASH DYKE OF NCTPS, CHENNAI.

TAMILNADU GENERATION AND DISTRIBUTION CORPORATION (TANGEDCO)

CONSULTANT: DESEIN PVT LTD, NEW DELHI.

BHARAT HEAVY ELECTRICALS LIMITED
PROJECTS ENGINEERING MANAGEMENT, NOIDA.

BHEL DWG NO. PE – V11 – 412 – 174 – A102

DE NORA

SUB CONTRACTOR: DE NORA INDIA LIMITED KUNDAIM – GOA

ASSOCIATE PARTNER: DE NORA WATER TECHNOLOGIES, SINGAPORE BRANCH

LOA NO: PW/PE/PG/EN1/P–24/17 DATED: 22 APR 2017

DEPT.	CODE		SCALE	WEIGHT(KG)	REF DRG.	ITEM
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Process design & sizing calculation of Electro chlorination plant for CW system.

	NAME	SIGN	DATE
PREP	SN		
CHKD	PG		
APPD	RF		

DEPT.		CARD CODE	BHEL DOC. NO. PE - V11 - 412 - 174 - A102	REV 2
SIGN	N.A.			
DATE	2018.03.01 15:04:13 +05'30'		NO. OF SHEETS 13 EXCLUDING COVER PAGE	

BHARAT HEAVY ELECTRICALS LTD.
PROJECT ENGINEERING MANAGEMENT.
This approval status shall be interpreted as laid down in the contract and it shall not relieve the contractor from his contractual obligation.
APPROVAL CATEGORY AWARDED (✓)
CAT I - Approved
CAT II - Approved With Comments as Noted
CAT III - Not Approved
CAT IV - Reference Drawing
DEPARTMENT: MECHANICAL AUXILIARY
NAME:
PARIKSHIT SAHA

Sea water flow-rate to be treated CW & ACW system (Unit 1 and 2) Pretreatment Plant	 80,552 + 80,552 m^3/h 2365 m^3/h
Nominal capacity chlorine production	200 kg/hr
Generator Rating:	2 x 100%
Normal continuous injection rate: Continuous injection capacity necessary: Shock injection capacity necessary:	 1ppm (unit 1,2) 5ppm (Pretreatment Plant) 2ppm (unit 1,2)

CHLORINE PRODUCTION:

CONTINUOUS DOSING Cl production necessary for continuous dosing to CW & ACW system:	: $161{,}104\frac{m^3}{hr}$ x $1\frac{mg}{L}$ x $\frac{1000L/m^3}{1000000mg/kg}$ = 161.104 kg/h Cl_2 av.
CONTINUOUS DOSING Cl production necessary for continuous dosing to Pretreatment Plant:	: $2365\frac{m^3}{hr}$ x $5\frac{mg}{L}$ x $\frac{1000L/m^3}{1000000mg/kg}$ = 11.825 kg/h Cl_2 av.
SHOCK DOSING Cl production necessary for shock dosing to CW & ACW system:	: $161{,}104\frac{m^3}{hr}$ x $2\frac{mg}{L}$ x $\frac{1000L/m^3}{1000000mg/kg}$ = 322.22 kg/h Cl_2 av.

CONCLUSION:

Design Av. Cl production for package Considering 5% margin, total required chlorine production	: (161.104x22.5) +(11.825x24) + (322.2x1.5) / 24 = 182.993 kg/h Cl_2 av. : 192.14 kg/h Cl_2 av.
Design Av. Cl production per generator (2 x 100%)	: 200 kg/h
Rectifier Rating	: 6000A / 140VDC
Design Conc. of Sodium Hypochlorite per generator at 100% DC output	: 2000 mg/l as Cl_2 av.
Strength of Sodium Hypochlorite per generator	: 1500 - 2000 mg/l as Cl_2 av.

SEAWATER BOOSTER PUMPS CAPACITY CALCULATION

a) 2 x 100% Seawater Booster Pump flowrate at design condition is as follows:
Seawater flowrate to each generator at design condition is:

$$P_1 = \frac{200\,kg/h}{1500\frac{mg}{L}\,x\,\frac{1000L/m^3}{1000000mg/kg}} = 133.33m^3/h$$

Taking into account additional spare 10% capacity, the selected pump capacity is P_1 = 150 m^3/hr.

Considering additional seawater flow rate required for strainer backwash, total seawater flowrate required at package limit at design condition

= 150 + 25 m^3/hr = 175 m^3/hr.

1

CONTINUOUS DOSING PUMPS CAPACITY CALCULATION

a) 2 x 100% Continuous Dosing Pump flowrate at design condition to CW system is as follows:

$$P_2 = \frac{161.104\,kg/h}{1500\frac{mg}{L}\,x\,\frac{1000L/m^3}{1000000mg/kg}} = 107.4m^3/h$$

1

Taking into account additional spare 10% capacity, the selected pump capacity is P_2 = 120 m^3/hr.

b) 2 x 100% Continuous Dosing Pump flowrate at design condition to Pretreatment Plant is as follows:

$$P_3 = \frac{11.825\,kg/h}{1500\frac{mg}{L}\,x\,\frac{1000L/m^3}{1000000mg/kg}} = 7.88m^3/h$$

Taking into account additional spare 10% capacity, the selected pump capacity is P_3 = 9 m^3/hr.

c) 2 x 100% Continuous Dosing Pump flowrate at design condition to Seawater Intake is as follows:

$$P_4 = \frac{15.6\,kg/h}{1500\frac{mg}{L}\,x\,\frac{1000L/m^3}{1000000mg/kg}} = 10.4m^3/h$$

Taking into account additional spare 10% capacity, the selected pump capacity is P_4 = 12 m^3/hr.

SHOCK DOSING PUMPS CAPACITY CALCULATION

a) 3 x 50% Shock Dosing Pump flowrate at design condition to CW system is as follows:

$$P_5 = \frac{322.22\ kg/h}{1500\frac{mg}{L}\ x\ \frac{1000 L/m^3}{1000000 mg/kg}} = 214.8 m^3/h$$

1

$$\text{Per pump capacity} = \frac{214.8}{2} = 107.4 m^3/h$$

Taking into account additional spare 10% capacity, the selected pump capacity is P_5 = 120 m^3/hr.

HYPOCHLORITE STORAGE CUM DEGASSING TANK CAPACITY CALCULATION (2 x 100%)

Continuous dosing: 5 minutes retention time at design condition:

(7.88+107.4) [m^3/hr] * 5 min / 60 [min/hour] = 9.61 m^3

Hypo solution volume necessary for one shock dosing every 8 hours:

1

107.4 [m^3/hr] * 30 min / 60 [min/hour] = 53.7 m^3

Total working volume required = 9.61+ 53.7 = 63.31 m^3

Plus additional capacity for overflow; HH; H – gross capacity required: 94.25m^3

Net capacity of each tank: 90.5 m^3

HYPOCHLORITE STORAGE CUM DEGASSING TANK FOR SEAWATER INTAKE (LOOSE SUPPLY)

Gross Capacity: 15m^3 as per specification

AIR BLOWER CALCULATION

The production of hydrogen is 0.35 Nm^3/h per kg Cl_2 av.

200 kg/h * 0.35 Nm^3 = 70 Nm^3/h

The dilution of hydrogen concentration to less than 1% air flow shall be:

$$P_6 = \frac{70 Nm^3/h}{(0.01)} = 7000\ Nm^3/h$$

1

Taking into account additional spare 10% capacity, the selected blower capacity is 7700 Nm^3/hr.

ACID CLEANING TANK SIZING:

Amount of water required for 5% hydrochloric acid preparation:	3.465m^3
Amount of 33% hydrochloric acid required for 5% hydrochloric acid preparation:	0.550m^3
Amount of 33% hydrochloric acid required for 1st refresh from 3% to 5%:	0.277m^3
Amount of 33% hydrochloric acid required for 2nd refresh from 3% to 5%:	0.277m^3
Total net working volume of solution in acid tank:	4.569 m^3 **(Selected 4.8 m^3)**

Plus additional capacity for overflow; gross capacity required: 7.2 m^3

Net capacity of each tank: 4.8 m^3

To calculate the amt of 45% NaOH req to neutralise spent HCl of 3% (after acid cleaning the concentration of 5% acid will reduced to 3%).

Atomic Weights: H = 1g/ mol
O = 16g/ mol
Na = 23g/ mol
Cl = 35.5g/ mol

Molecular wts (MW) of NaOH = 40g/ mol
HCl = 36.5g/ mol

Balance equation for neutralization process is:

$$HCl + NaOH = NaCl + H_2O$$

$$\frac{\text{Moles of Neut.}}{\text{Moles of Spent}} \times \frac{\text{MW (Neut.)}}{\text{MW (Spent)}} \times \frac{\text{Conc. of Spent}}{\text{Conc. of Neut.}} = y$$

where moles are the coefficients for the terms in the balanced equation &
y = no. of times the wt. of SPENT required for neutralization.

Hence,

$$\frac{1}{1} \times \frac{40}{36.5} \times \frac{3}{45} = 0.073$$

vol of spent acid in tank = 4.569 m^3
mass of spent acid = pv
= 1.013 x 4569
= 4628 kg

mass of NaOH required = 0.073 x 4628
= 338 kg @ 1.464

vol of NaOH required = m / p
= 231 litres

Vol of spent acid = 4569 litres
Total volume to N-Pit = 4800 litres
Total volume to N-Pit = 20 CuM (Selected)

1

ACID CLEANING PUMP SIZING:

Free area for electrolyzer = 0.111m^2

Required velocity across electrolyzer = 0.10m/s

Thus, flowrate = $0.111m^2 * 0.10 \frac{m}{s} x \frac{3600s}{1hr} = 40 \frac{m^3}{h}$

Taking into account additional spare 10% capacity, the selected pump capacity is P_7 = 44 m^3/hr.

BULK ACID STORAGE TANK SIZING:

Amount of 33% hydrochloric acid required for one cleaning requirement

= 0.550 + 0.277 + 0.277

= 1.104m^3

1

Total net volume of solution in bulk acid tank = 20 m^3

Total gross volume of tank = 22.3 m^3

1

ACID UNLOADING PUMP:

Assume time require to fill a 20m^3 of Bulk Acid Storage Tank: 2 hours

Acid unloading pump capacity: 10 m^3/hr

NEUTRALIZATION PIT SIZING:

Neutralization pit volume provided by BHEL = 20 CuM (2.7m L x 2.7m W x 3m Ht
Incoming trench depth= 200 mm.
Hence, effective dimension is 2.7m x2.7m x 2.8m=20.412 CuM.

2

A) SEAWATER BOOSTER PUMP HEAD CALCULATION

Operating Conditions			
Sr. No.	Pump	Flow rate	UOM
1	incoming SW	175.00	m^3/ hr
2	1 pump running	150.00	m^3/ hr

Use Hazen- Willams equation for pipe pressure loss:
(h/L)^0.54 x R^0.63 x C x 0.849 = V
h/L -> Head Loss (m/m)
R -> Hydraulic Radius D/4 (m)
C -> Hazen Williams Coefficient
V -> Velocity inside pipe (m/s)

List of Fittings	Nominal diameter, (mm)	Pipe SCH (80)	Main Size ID, (mm)	Length (m)	Quantity	Flow (m3/h)	Velocity (m/s)	Hazen-William Coefficient	K Factor	Head Loss through pipe (Hazen-Williams equation) (m)	Head Loss through fitting (= $KV^2/2g$) (m)	Head Loss through other misc. items (m)	Remarks
Std. Pipe	200	80	193.65	30		175.00	1.6505	150		**0.3282**			
Elbow, 90	200	80	193.65		10	175.00	1.6505		0.42		**0.5831**		
Tee	200	80	193.65		6	175.00	1.6505		0.84		**0.6998**		
butterfly valve	200	80	193.65		4	175.00	1.6505		0.63		**0.3499**		
check valve	200	80	193.65		1	175.00	1.6505		1.4		**0.1944**		
Std. Pipe	150	80	146.33	45		150.00	2.4776	150		**1.4486**			
Elbow, 90	150	80	146.33		16	150.00	2.4776		0.42		**2.1025**		
Tee	150	80	146.33		6	150.00	2.4776		0.84		**1.5769**		
butterfly valve	150	80	146.33		4	150.00	2.4776		0.63		**0.7884**		
check valve	150	80	146.33		1	150.00	2.4776		1.4		**0.4380**		
									Head Loss through pipe and fittings, [Hpf]:		**8.5098**	m	
Safety factor for Pipe Friction Loss, [Hfs]				10%							**0.8510**	m	

Strainer	Hst			**5**	m
Electrolyzer	He			**5**	m
Flow Control Valve	Hfcv	**1**	**Nos**	**5**	m
Static Head	Hsh			**8**	m

TOTAL HEAD LOSS FOR THIS SECTION	**[Hpf + Hfs + Hst + He + Hfcv + Hsh]**	**32.3607**	**m**
PRESSURE OF SEA WATER AT BATTERY LIMIT		**10.0000**	**m**
TOTAL DIFFERENTIAL HEAD FOR PUMP		**22.3607**	**m**
PUMP HEAD SELECTION		**25**	**m**
AVAILABLE MARGIN		11%	

OVERALL PRESSURE DROP	**=**	**32.3607**	**m**

B) CONTINOUS DOSING PUMP FOR CW FOREBAY HEAD CALCULATION

Operating Conditions			
Sr. No.	Pump	Flow rate	UOM
1	1 pump running	120.00	m^3/hr
2	flow at pump suction	129.00	m^3/hr
	(cont. + PTP)		

Use Hazen- Willams equation for pipe pressure loss:
(h/L)^0.54 x R^0.63 x C x 0.849 = V
h/L -> Head Loss (m/m)
R -> Hydraulic Radius D/4 (m)
C -> Hazen Williams Coefficient
V -> Velocity inside pipe (m/s)

List of Fittings	Nominal diameter, (mm)	Pipe SCH (80)	Main Size ID, (mm)	Length (m)	Quantity	Flow (m3/h)	Velocity (m/s)	Hazen-William Coefficient	K Factor	Head Loss through pipe (Hazen-Williams equation) (m)	Head Loss through fitting (= $KV^2/2g$) (m)	Head Loss through other misc. items (m)	Remarks
Std. Pipe	300	80	286.87	10		129.00	0.5544	150		**0.0092**			
Elbow, 90	300	80	286.87		4	129.00	0.5544		0.39		**0.0244**		
Tee	300	80	286.87		2	129.00	0.5544		0.78		**0.0244**		
buterfly valve	300	80	286.87		2	129.00	0.5544		0.35		**0.0110**		
Std. Pipe	200	80	192.15	20		129.00	1.2357	150		**0.1292**			
Elbow, 90	200	80	192.15		5	129.00	1.2357		0.45		**0.1751**		
Tee	200	80	192.15		2	129.00	1.2357		0.9		**0.1401**		
buterfly valve	200	80	192.15		3	129.00	1.2357		0.68		**0.1588**		
Std. Pipe	150	80	145.01	350		120.00	2.0183	150		**7.7893**			
Elbow, 90	150	80	145.01		10	120.00	2.0183		0.45		**0.9343**		
Tee	150	80	145.01		3	120.00	2.0183		0.9		**0.5606**		
check valve	150	80	145.01		1	120.00	2.0183		1.5		**0.3114**		
buterfly valve	150	80	145.01		2	120.00	2.0183		0.68		**0.2824**		
									Head Loss through pipe and fittings, [Hpf]:		**10.5502**	m	
Safety factor for Pipe Friction Loss, , [Hfs]				10%							**1.0550**	m	

Static	Hs	**12**	m

TOTAL HEAD LOSS FOR THIS SECTION	**[Hpf + Hfs + Hs]**	**23.6052**	**m**
PUMP HEAD SELECTION		**32**	**m**
AVAILABLE MARGIN		26%	

OVERALL PRESSURE DROP	**=**	**23.6**	**m**

C) SHOCK DOSING PUMP FOR CW FOREBAY HEAD CALCULATION

Operating Conditions			
Sr. No.	Pump	Flow rate	UOM
1	1 pump running	120.00	m^3/hr
2	flow at pump suction	249.00	m^3/hr
	(shock + PTP)		

Use Hazen- Willams equation for pipe pressure loss:
(h/L)^0.54 x R^0.63 x C x 0.849 = V
h/L -> Head Loss (m/m)
R -> Hydraulic Radius D/4 (m)
C -> Hazen Williams Coefficient
V -> Velocity inside pipe (m/s)

List of Fittings	Nominal diameter, (mm)	Pipe SCH (80)	Main Size ID, (mm)	Length (m)	Quantity	Flow (m3/h)	Velocity (m/s)	Hazen-William Coefficient	K Factor	Head Loss through pipe (Hazen-Williams equation) (m)	Head Loss through fitting (= $KV^2/2g$) (m)	Head Loss through other misc. items (m)	Remarks
Std. Pipe	300	80	286.87	10		249.00	1.0701	150		**0.0310**			
Elbow, 90	300	80	286.87		4	249.00	1.0701		0.39		**0.0911**		
Tee	300	80	286.87		2	249.00	1.0701		0.78		**0.0911**		
buterfly valve	300	80	286.87		2	249.00	1.0701		0.35		**0.0409**		
Std. Pipe	200	80	192.15	20		249.00	2.3852	150		**0.4367**			
Elbow, 90	200	80	192.15		5	249.00	2.3852		0.45		**0.6524**		
Tee	200	80	192.15		3	249.00	2.3852		0.9		**0.7829**		
buterfly valve	200	80	192.15		3	249.00	2.3852		0.68		**0.5915**		
Std. Pipe	150	80	145.01	350		120.00	2.0183	150		**7.7893**			
Elbow, 90	150	80	145.01		10	120.00	2.0183		0.45		**0.9343**		
Tee	150	80	145.01		3	120.00	2.0183		0.9		**0.5606**		
check valve	150	80	145.01		1	120.00	2.0183		1.5		**0.3114**		
buterfly valve	150	80	145.01		4	120.00	2.0183		0.68		**0.5647**		
									Head Loss through pipe and fittings, [Hpf]:		**12.8779**	m	

Safety factor for Pipe Friction Loss, [Hfs]	10%	**1.2878**	m
Static	Hs	**12**	m
TOTAL HEAD LOSS FOR THIS SECTION	**[Hpf + Hfs + Hs]**	**26.1657**	**m**
PUMP HEAD SELECTION		**32**	**m**
AVAILABLE MARGIN		18%	

OVERALL PRESSURE DROP	=	**26.2**	**m**

D) CONTINOUS DOSING PUMP FOR PTP HEAD CALCULATION

Operating Conditions			
Sr. No.	Pump	Flow rate	UOM
1	1 pump running	9.00	m^3/hr
2	max flow at pump suction	249.00	m^3/hr
	(shock + PTP)		

Use Hazen- Willams equation for pipe pressure loss:
(h/L)^0.54 x R^0.63 x C x 0.849 = V
h/L -> Head Loss (m/m)
R -> Hydraulic Radius D/4 (m)
C -> Hazen Williams Coefficient
V -> Velocity inside pipe (m/s)

List of Fittings	Nominal diameter, (mm)	Pipe SCH (80)	Main Size ID, (mm)	Length (m)	Quantity	Flow (m3/h)	Velocity (m/s)	Hazen-William Coefficient	K Factor	Head Loss through pipe (Hazen-Williams equation) (m)	Head Loss through fitting (= $KV^2/2g$) (m)	Head Loss through other misc. items (m)	Remarks
Std. Pipe	300	80	286.87	10		249.00	1.0701	150		**0.0310**			
Elbow, 90	300	80	286.87		4	249.00	1.0701		0.39		**0.0911**		
Tee	300	80	286.87		2	249.00	1.0701		0.78		**0.0911**		
buterfly valve	300	80	286.87		2	249.00	1.0701		0.35		**0.0409**		
Std. Pipe	200	80	192.15	20		249.00	2.3852	150		**0.4367**			
Elbow, 90	200	80	192.15		5	249.00	2.3852		0.45		**0.6524**		
Tee	200	80	192.15		4	249.00	2.3852		0.9		**1.0439**		
buterfly valve	200	80	192.15		3	249.00	2.3852		0.68		**0.5915**		
Std. Pipe	80	80	72.75	2000		9.00	0.6014	150		**10.5738**			
Elbow, 90	80	80	72.75		10	9.00	0.6014		0.54		**0.0996**		
Tee	80	80	72.75		3	9.00	0.6014		1.08		**0.0597**		
check valve	80	80	72.75		1	9.00	0.6014		1		**0.0184**		
buterfly valve	80	80	72.75		4	9.00	0.6014		0.81		**0.0597**		
									Head Loss through pipe and fittings, [Hpf]:		**13.7898**	m	

Safety factor for Pipe Friction Loss, [Hfs]	10%	**1.3790**	m
Static	Hs	**12**	m
TOTAL HEAD LOSS FOR THIS SECTION	**[Hpf + Hfs + Hs]**	**27.1687**	**m**
PUMP HEAD SELECTION		**32**	**m**
AVAILABLE MARGIN		15%	

OVERALL PRESSURE DROP	=	**27.2**	**m**

E) CONTINOUS DOSING PUMP FOR SEA WATER INTAKE HEAD CALCULATION

Operating Conditions			
Sr. No.	Pump	Flow rate	UOM
1	1 pump running	12.00	m^3/hr

Use Hazen- Willams equation for pipe pressure loss:
(h/L)^0.54 x R^0.63 x C x 0.849 = V
h/L -> Head Loss (m/m)
R -> Hydraulic Radius D/4 (m)
C -> Hazen Williams Coefficient
V -> Velocity inside pipe (m/s)

List of Fittings	Nominal diameter, (mm)	Pipe SCH (80)	Main Size ID, (mm)	Length (m)	Quantity	Flow (m3/h)	Velocity (m/s)	Hazen-William Coefficient	K Factor	Head Loss through pipe (Hazen-Williams equation) (m)	Head Loss through fitting (= $KV^2/2g$) (m)	Head Loss through other misc. items (m)	Remarks
Std. Pipe	100	80	96.16	10		12.00	0.4590	150		**0.0231**			
Elbow, 90	100	80	96.16		2	12.00	0.4590		0.51		**0.0110**		
Tee	100	80	96.16		1	12.00	0.4590		1.02		**0.0110**		
buterfly valve	100	80	96.16		1	12.00	0.4590		0.77		**0.0083**		
Std. Pipe	80	80	72.75	20		12.00	0.8019	150		**0.1801**			
Elbow, 90	80	80	72.75		2	12.00	0.8019		0.54		**0.0354**		
Tee	80	80	72.75		5	12.00	0.8019		1.08		**0.1770**		
buterfly valve	80	80	72.75		1	12.00	0.8019		0.81		**0.0265**		
Std. Pipe	80	80	72.75	1000		12.00	0.8019	150		**9.0068**			
Elbow, 90	80	80	72.75		4	12.00	0.8019		0.54		**0.0708**		
Tee	80	80	72.75		3	12.00	0.8019		1.08		**0.1062**		
check valve	80	80	72.75		1	12.00	0.8019		1		**0.0328**		
buterfly valve	80	80	72.75		1	12.00	0.8019		0.81		**0.0265**		
									Head Loss through pipe and fittings, [Hpf]:		**9.7155**	m	

Safety factor for Pipe Friction Loss, [Hfs]	10%	**0.9715**	m
Static	Hs	**12**	m
TOTAL HEAD LOSS FOR THIS SECTION	**[Hpf + Hfs + Hs]**	**22.6870**	**m**
PUMP HEAD SELECTION		**32**	**m**
AVAILABLE MARGIN		29%	

OVERALL PRESSURE DROP	=	**22.7**	**m**

F) ACID CLEANING PUMP HEAD CALCULATION

Operating Conditions			
Sr. No.	Pump	Flow rate	UOM
1	1 pump running	44.00	m^3/ hr

Use Hazen- Willams equation for pipe pressure loss:
(h/L)^0.54 x R^0.63 x C x 0.849 = V
h/L -> Head Loss (m/m)
R -> Hydraulic Radius D/4 (m)
C -> Hazen Williams Coefficient
V -> Velocity inside pipe (m/s)

List of Fittings	Nominal diameter, (mm)	Pipe SCH (80)	Main Size ID, (mm)	Length (m)	Quantity	Flow (m3/h)	Velocity (m/s)	Hazen-William Coefficient	K Factor	Head Loss through pipe (Hazen-Williams equation) (m)	Head Loss through fitting (= $KV^2/2g$) (m)	Head Loss through other misc. items (m)	Remarks
Std. Pipe	80	80	72.75	1		44.00	2.9403	150		**0.0999**			
Elbow, 90	80	80	72.75		1	44.00	2.9403		0.54		**0.2379**		
Tee	80	80	72.75		1	44.00	2.9403		1.08		**0.4759**		
check valve	80	80	72.75		1	44.00	2.9403		1		**0.4406**		
butterfly valve	80	80	72.75		1	44.00	2.9403		0.81		**0.3569**		
Std. Pipe	80	80	72.75	45		44.00	2.9403	150		**4.4950**			
Elbow, 90	80	80	72.75		8	44.00	2.9403		0.54		**1.9036**		
Tee	80	80	72.75		3	44.00	2.9403		1.08		**1.4277**		
butterfly valve	80	80	72.75		4	44.00	2.9403		0.81		**1.4277**		
										Head Loss through pipe and fittings, [Hpf]:	**9.4376**	m	

Safety factor for Pipe Friction Loss, [Hfs]		10%	**1.0865**	m

Electrolyzer	He	**5**	m
Static Head	Hsh	**3**	m

TOTAL HEAD LOSS FOR THIS SECTION	**[Hpf + Hfs + He + Hsh]**	**19.9518**	**m**

PUMP HEAD SELECTION	**20**	**m**

G) ACID UNLOADING PUMP HEAD CALCULATION

Operating Conditions			
Sr. No.	Pump	Flow rate	UOM
1	1 pump running	10.00	m^3/ hr

Use Hazen- Willams equation for pipe pressure loss:
(h/L)^0.54 x R^0.63 x C x 0.849 = V
h/L -> Head Loss (m/m)
R -> Hydraulic Radius D/4 (m)
C -> Hazen Williams Coefficient
V -> Velocity inside pipe (m/s)

List of Fittings	Nominal diameter, (mm)	Pipe SCH (80)	Main Size ID, (mm)	Length (m)	Quantity	Flow (m3/h)	Velocity (m/s)	Hazen-William Coefficient	K Factor	Head Loss through pipe (Hazen-Williams equation) (m)	Head Loss through fitting (= $KV^2/2g$) (m)	Head Loss through other misc. items (m)	Remarks
Std. Pipe	50	80	48.59	10		10.00	1.4980	140		**0.5214**			
Elbow, 90	50	80	48.59		1	10.00	1.4980		0.57		**0.0652**		
Tee	50	80	48.59		1	10.00	1.4980		1.14		**0.1304**		
check valve	50	80	48.59		1	10.00	1.4980		1.1		**0.1258**		
ball valve	50	80	48.59		1	10.00	1.4980		0.06		**0.0069**		
									Head Loss through pipe and fittings, [Hpf]:		**0.8496**	m	
Safety factor for Pipe Friction Loss, [Hfs]				10%							**0.0850**	m	
Static Head	Hsh										**4**	m	

TOTAL HEAD LOSS FOR THIS SECTION	**[Hpf + Hfs + Hsh]**	**4.9346**	**m**
PUMP HEAD SELECTION		**10**	**m**
AVAILABLE MARGIN		51%	

H) NEUTRALIZATION PIT PUMP HEAD CALCULATION

Operating Conditions			
Sr. No.	Pump	Flow rate	UOM
1	1 pump running	2.00	m^3/ hr

Use Hazen- Willams equation for pipe pressure loss:
(h/L)^0.54 x R^0.63 x C x 0.849 = V
h/L -> Head Loss (m/m)
R -> Hydraulic Radius D/4 (m)
C -> Hazen Williams Coefficient
V -> Velocity inside pipe (m/s)

List of Fittings	Nominal diameter, (mm)	Pipe SCH (80)	Main Size ID, (mm)	Length (m)	Quantity	Flow (m3/h)	Velocity (m/s)	Hazen-William Coefficient	K Factor	Head Loss through pipe (Hazen-Williams equation) (m)	Head Loss through fitting (= $KV^2/2g$) (m)	Head Loss through other misc. items (m)	Remarks
Std. Pipe	40	80	37.49	1		2.00	0.5033	150		**0.0082**			
Elbow, 90	40	80	37.49		1	2.00	0.5033		0.63		**0.0081**		
Tee	40	80	37.49		1	2.00	0.5033		1.26		**0.0163**		
check valve	40	80	37.49		1	2.00	0.5033		1.2		**0.0155**		
ball valve	40	80	37.49		1	2.00	0.5033		0.06		**0.0008**		
Std. Pipe	40	80	37.49	200		2.00	0.5033	150		**1.6476**			
Elbow, 90	40	80	37.49		4	2.00	0.5033		0.63		**0.0325**		
ball valve	40	80	37.49		2	2.00	0.5033		0.06		**0.0015**		
									Head Loss through pipe and fittings, [Hpf]:		**1.7306**	m	

Safety factor for Pipe Friction Loss, [Hfs]	10%	**0.1731**	m

Negative Suction Head	**3**	m
Static Head	**12**	m

TOTAL HEAD LOSS FOR THIS SECTION	**16.9036**	**m**
PUMP HEAD SELECTION	**17**	**m**

APPROVED

DOC APPROVED Lr.No.:SE/E/ Th&HyP/EE-7/M/AEE/M/F.En SEZ STPP/D.670/18 dt.08.10.2018.

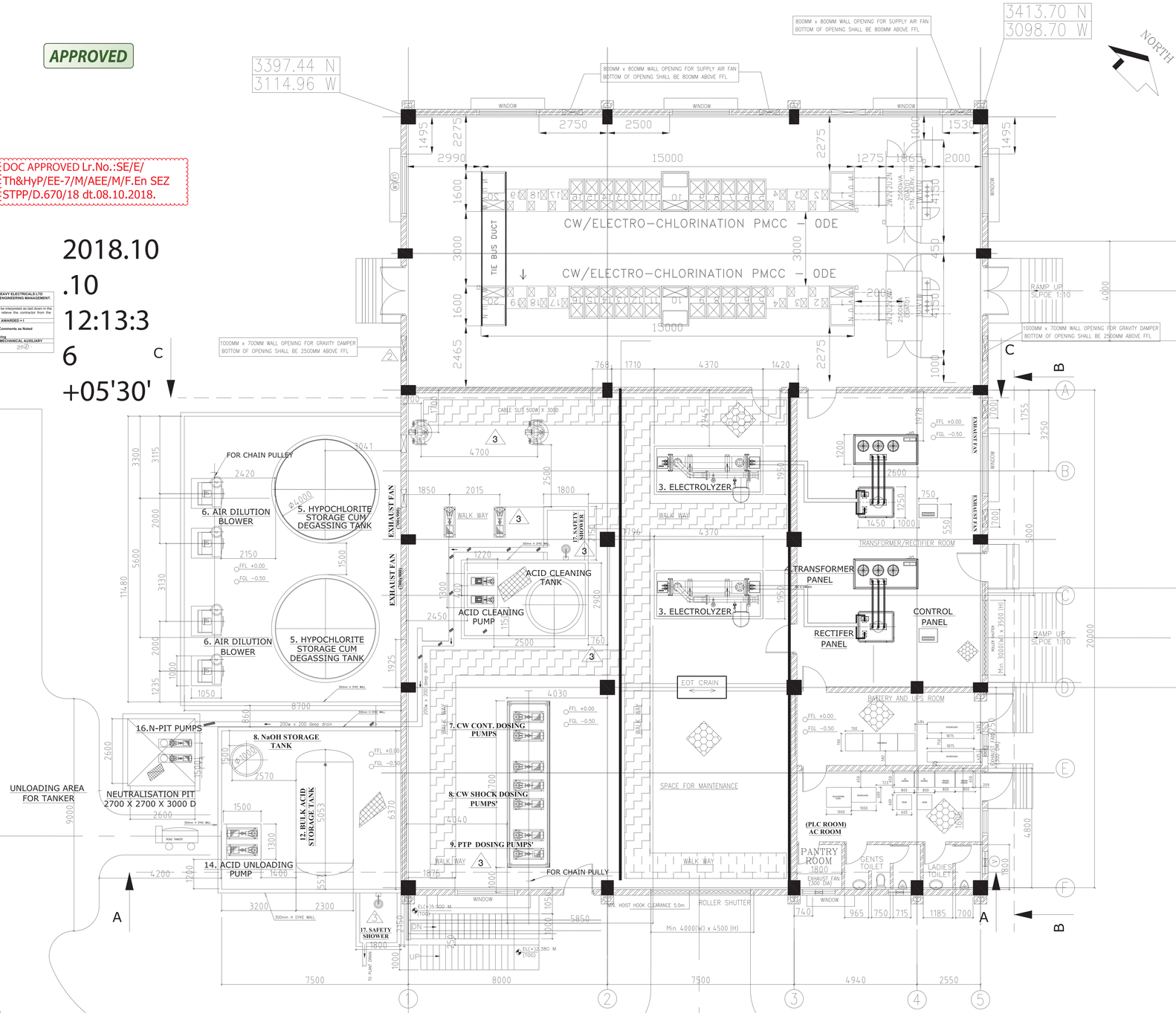
2018.10 .10 12:13:3 6 +05'30'

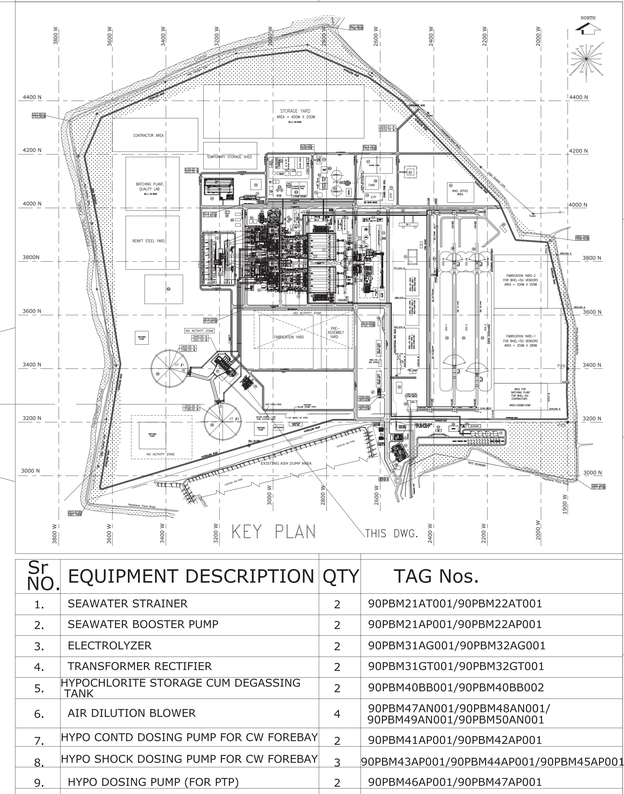
BHARAT HEAVY ELECTRICALS LTD
PROJECT ENGINEERING MANAGEMENT.

This approval status shall be interpreted as laid down in the contract and it shall not relieve the contractor from the responsibility of complying with the requirements of the contract.

APPROVAL CATEGORY AWARDED = I

CAT I - Approved	
CAT II - Approved With Comments as Noted	
CAT III - Not Approved	
CAT IV - Reference Drawing	
DEPARTMENT	MECHANICAL AUXILIARY
NAME	FALGUNI SAHA





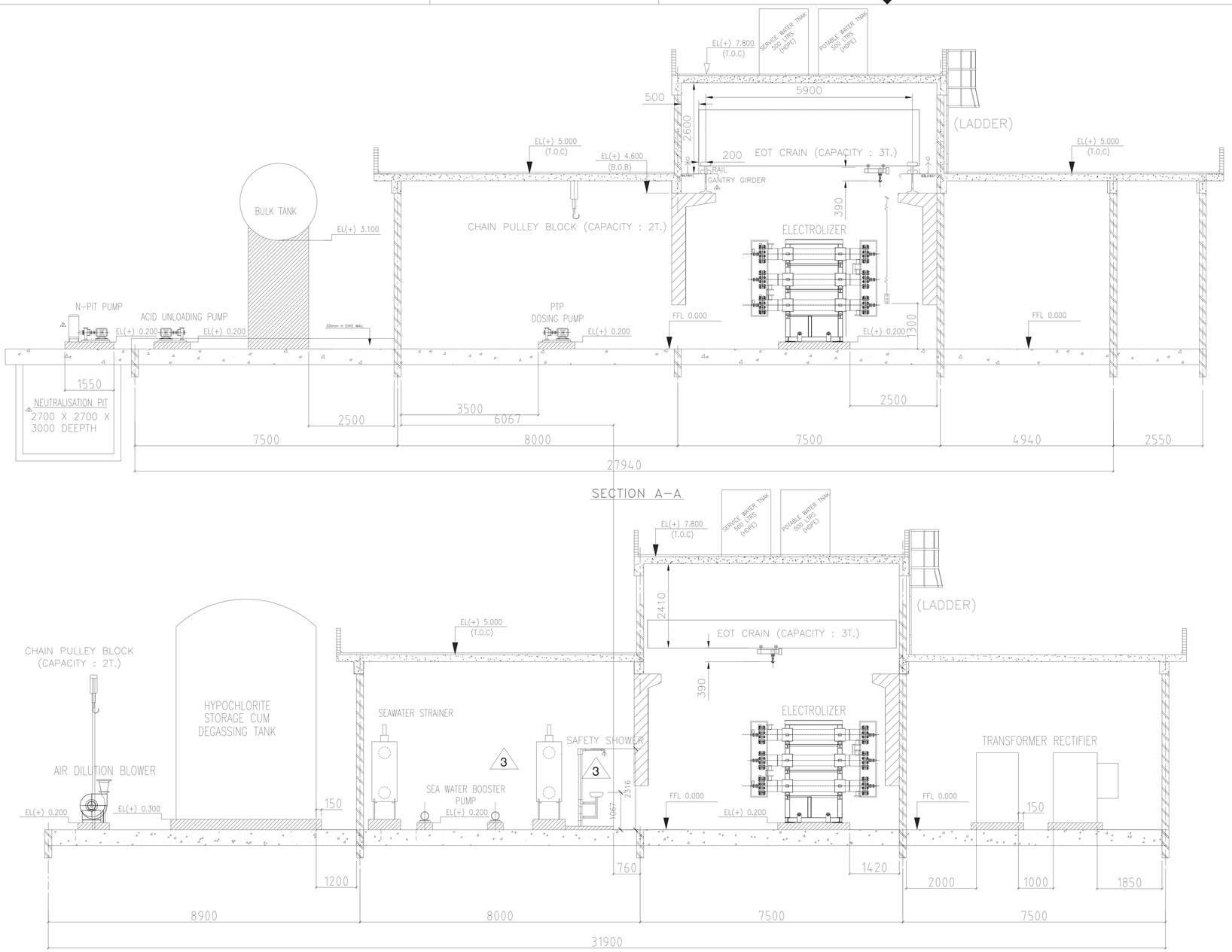
Sr NO.	EQUIPMENT DESCRIPTION	QTY	TAG Nos.
1.	SEAWATER STRAINER	2	90PBM21AT001/90PBM22AT001
2.	SEAWATER BOOSTER PUMP	2	90PBM21AP001/90PBM22AP001
3.	ELECTROLYZER	2	90PBM31AG001/90PBM32AG001
4.	TRANSFORMER RECTIFIER	2	90PBM31GT001/90PBM32GT001
5.	HYPOCHLORITE STORAGE CUM DEGASSING TANK	2	90PBM40BB001/90PBM40BB002
6.	AIR DILUTION BLOWER	4	90PBM47AN001/90PBM48AN001/ 90PBM49AN001/90PBM50AN001
7.	HYPO CONTD DOSING PUMP FOR CW FOREBAY	2	90PBM41AP001/90PBM42AP001
8.	HYPO SHOCK DOSING PUMP FOR CW FOREBAY	3	90PBM43AP001/90PBM44AP001/90PBM45AP001
9.	HYPO DOSING PUMP (FOR PTP)	2	90PBM46AP001/90PBM47AP001
10.	HYPO DOSING PUMP AT SEAWATER INTAKE	2	90PBM81AP001/90PBM82AP001
11.	HYPOCHLORITE STORAGE TANK (LOOSE)	1	90PBM70BB001
12.	BULK ACID STORAGE TANK	1	90PBM51BB001
13.	5% HCL PREP CUM ACID CLEANING TANK	1	90PBM50BB001
14.	ACID UNLOADING PUMP	2	90PBM51AP001/90PBM51AP002
15.	ACID CLEANING PUMP	2	90PBM52AP001/90PBM53AP001
16.	NEUT PIT DEWATERING PUMP	2	90PBM61AP001/90PBM62AP001
17.	SAFETY SHOWER	1	90PBM10AZ001
18.	LOCAL CONTROL PANEL	1	90PBM10GH001
19.	NaOH STORAGE TANK	1	90PBM60BB001

- ACID/ALKALI RESISTANCE TILES
- MAINTENANCE SPACE
- CABLE TRAY
- CABLE SLIT
- CABLE TRENCH
- NEUTRALIZATION PIT (2600X2600X3000 depth)
- CABLE TRENCH

Reference drg:
1) P&ID with drg no.(PE-V11-412-174-A101)
2) Plot plant (PE-DG-412-100-M001)
3) Cable Tray Layout (PE-DG-412-100-E049)

NOTES:–
1. ALL DIMENSIONS ARE IN MM AND ELEVATIONS IN METRES.
2. ALL ELEVATIONS MARKED ARE W.R.T. TG HALL FINISHED FLOOR LEVEL AS 0.0M WHICH CORRESPONDS TO EL 10.0M.

JOB No. : 412	2X660 MW ENNORE SEZ COAL BASED STPP AT ASH DYKE OF NCTPS, CHENNAI.				
STATUS: CONTRACT	TAMILNADU GENERATION AND DISTRIBUTION CORPORATION (TANGEDCO)				
DISTRIBUTION	CONSULTANT: DESEIN PVT LTD, NEW DELHI.				
TD / No:OFF	BHARAT HEAVY ELECTRICALS LTD POWER SECTOR PROJECT ENGINEERING MANAGEMENT NEW DELHI				
REV DATE ALTD CHD APPD	SUB CONTRACTOR : DE NORA INDIA LIMITED KUNDAIM-GOA	DEPT CODE		NAME	SIGN DATE
	ASSOCIATE PARTNER : DE NORA WATER TECHNOLOGIES, SINGAPORE BRANCH	M	DRN	SN	
			CHD	PG	
			APPD	RF	
	LOA NO:PW/PE/PG/EN1/P-24/17 DATED: 07 DEC 2017				
	TITLE: EQUIPMENT LAYOUT FOR ELECTRO CHLORINATION PLANT FOR CW SYSTEM				
	DEPT. SIGN DATE	SCALE	BHEL DWG No. PE-V11-412-174-A103		
			SHEET 1 OF 2	REV. 3	



SECTION A-A

SECTION C-C

SECTION B-B

DESCRIPTION	EQUIPMENT SIZE
SEAWATER STRAINER	1000x2700H
SEA WATER BOOSTER PUMP	4600X1600
ELECTROLYZER	2150X2000X2500H
HYPOCHLORITE STORAGE CUM DEGASSING TANK	Ø4000X5900H
AIR DILUTION BLOWER	800X625
HYPO CONTD DOSING PUMP FOR CW.	1190X430
HYPO SHOCK DOSING PUMP FOR CW.	1190X430
HYPO DOSING PUMP (FOR PTP)	745X300
HYPO DOSING PUMP AT SEAWATER INTAKE	780X300
HYPOCHLORITE STORAGE TANK (LOOSE)	Ø4000X6285H
BULK ACID STROGE TANK	Ø2300X5053L
5% HCL PREP CUM ACID CLEANING TANK	Ø2000X2947H
ACID UNLOADING PUMP	1000X280
ACID CLEANING PUMP	1100X330
NEUT PIT DEWATERING PUMP	1450X330
SAFTY SHOWER	1500X1000X2316H
LOCAL CONTROL PANEL	2400X800
NaOH PUMP	250X1000H
NaOH TANK	Ø1000X1280H

- CIVIL FOUNDATION

- CONCRETE

JOB No. : 412	2X660 MW ENNORE SEZ COAL BASED STPP AT ASH DYKE OF NCTPS, CHENNAI.
STATUS: CONTRACT	TAMILNADU GENERATION AND DISTRIBUTION CORPORATION (TANGEDCO)
DISTRIBUTION	CONSULTANT: DESEIN PVT LTD, NEW DELHI.
TD / No.OFF	BHARAT HEAVY ELECTRICALS LTD, POWER SECTOR, PROJECT ENGINEERING MANAGEMENT, NEW DELHI
SUB CONTRACTOR : DE NORA INDIA LIMITED, KUNDAIM-GOA	DEPT CODE: M
ASSOCIATE PARTNER : DE NORA WATER TECHNOLOGIES, SINGAPORE BRANCH	DRN, CHD, APPD — NAME / SIGN / DATE: SN, PG, RF
LOA NO: PW/PE/PG/EN1/P-24/17	DATED: 07 DEC 2017
TITLE: EQUIPMENT LAYOUT FOR ELECTRO CHLORINATION PLANT FOR CW SYSTEM	
DEPT. / SIGN / DATE	SCALE
BHEL DWG No.	PE-V11-412-174-A103
SHEET 2 OF 2	REV. 3

TAMIL NADU GENERATION AND DISTRIBUTION CORPORATION LIMITED

From
Er.R.KAMARAJ,B.E.,(Hons.),M.E.,
Chief Engineer/Projects,
V Floor, Western Wing,
144, Anna Salai,
Chennai-600 002.
Fax No : 044- 28520878
Cell No: 9445857543
Email ID: cepr@tnebnet.org

To
Er.Perminder Singh,AGM - PEM
M/s. Bharat Heavy Electrical Limited,
Project Engineering Management,
PPEI Building, HRDI & ESI Complex,
Plot No.25, Sector-16A, Noida-201301(U.P)
Fax : 0120-423522
E mail : anujkumar@bhelpem.co.in,
jd@bhel.in,deveshverma@bhel.in,
pmgss@bhel.in, rajivb@bhel.in

Lr.No.CE/P/SE/E/T&H(P)/EE-6/E/P/F.Ennore SEZ Vend. Appl/D.674 / 18 Dt. 15.03.18

Sir,

Sub: TANGEDCO - Setting up of 2x660 MW Ennore SEZ Coal based super critical thermal power project at ash dyke of North Chennai Thermal Power Station (Kattupalli) – EPC cum Debt Finance Contract awarded to M/s.BHEL on 27.09.2014- Sub-vendor approval and Inspection categorisation sought by M/s BHEL/ PEM for Supply Items for Electro Mechanical and C & I items for Electro Chlorination Plant (Doc.No.PE-V11-412-182-A104/Rev.0) - Reg.

Ref: 1)Lr.No. CE/P/SE/M/P/EE-10/E/P/F.2x660 MW Ennore SEZ STPP/D.60/14,dt.27.09.2014
2)Your letter Ref: MS-1-13-E-0005 dated 27.09.2014.
3)M/s BHEL/PEM Electro Chlorination Plant (Doc.No.PE-V11-412-182-A104/Rev.0) received from PEDM on 11.01.2018.

****

Please refer to the letter cited (3) above.

Sub-vendor approval along with Inspection categorisation approval is accorded as per Annexure based on M/s BHEL/ PEM's submission for Supply Items for Electro Mechanical and C & I items for Electro Chlorination Plant (Doc.No.PE-V11-412-182-A104/Rev.0) vide ref.(3).

Encl:-Annexure (5 Pages)

Yours faithfully,

15/03/18

CHIEF ENGINEER /PROJECTS I

Copy to the CE/Civil/Ennore Sez/Chennai -120. (by email)
Copy to the SE/Civil/Ennore Sez/Chennai -120(by email)
Copy to the SE/Electrical/Ennore Sez/Chennai -120(by email)
Copy to M/S.Desein Pvt Ltd, New Delhi. (by email)

2x660MW ENORE SEZ STPP

Annexure

SUB VENDOR ALONG WITH INSPECTION CATEGORIZATION APPROVAL FOR ELECTRO CHLORINATION PLANT

Order placed by BHEL to Subvendor M/s.DE NORA INDIA LIMITED, KUNDAIM-GOA for ELECTRO CHLORINATION PLANT

This is Annexure to Lr.No.CE/P/SE/E/THP/EE-6/E/P/F.Ennore SEZ Vend.app/D.674 Dt..15.03.2018

LIST OF SUB-VENDORS FOR ELECTRO MECHANICAL ITEMS				
Sl.	ITEMS	VENDOR	INSPECTION CATEGORY Approval for Ennore SEZ	REMARKS ON SUB VENDOR APPROVAL ELECTRO CHLORINATION PLANT (for Electro Mechanical items) for Ennore SEZ
1	HYPOCHLORITE GENERATORS	DE NORA WATER TECHNOLOGIES, SINGAPORE	CAT-1	Approved
2	SEA WATER BOOSTER PUMP	FLOWMORE LIMITED, MUMBAI	CAT-1	Approved
3	HYPOCHLORITE DOSING PUMP (TITANIUM)	PROCESS PUMPS (I) PVT. LTD. BANGALORE	CAT-1	Approved
4	ACID TRANSFER & CIRCULATION PUMP (NON METALIC)	ANTICORROSIVE PUMPS, MUMBAI	CAT-2	Approved
5	AIR DILUTION BLOWER	SWAM PNEUMATICS, DELHI	CAT-2	Approved
6	TRANSFORMER RECTIFIER	HIND RECTIFIER (HIRECT), NASIK	CAT-1	Approved
7	ELECTRICAL HOIST & CHAIN PULLEY BLOCK	REVA INDUSTRIES LTD.,FARIDABAD	CAT-3	Approved
8	MOTOR	CROMPTON GREAVES, AHMEDNAGAR	CAT-1	Approved
		BHARAT BIJLEE, MUMBAI	CAT-1	Approved
9	MS-FRP TANKS	BHAVI PLAST, MUMBAI	CAT-3	Approved
10	(Y-TYPE STRAINER)-CPVC/PVC/PP/ HDPE/PVDF	GEORG FISCHER PIPING SYSTEMS PVT LTD.DELHI	CAT-3	Approved
		ASTRAL PLYTECHINC LTD, AHMEDABAD	CAT-3	Approved

11	SIMPLEX BASKET TYPE STRAINERS	OTOKLIN GLOBAL BUSINESS LTD.MUMBAI	CAT-2	Not approved
		FILTERATION ENGINEERS (I) PVT. LTD.MUMBAI	CAT-2	Approved
12	SELF CLEANING STRAINER	OTOKLIN GLOBAL BUSINESS LTD.	CAT-2	Not approved
		FILTERATION ENGINEERS (I) PVT. LTD.	CAT-2	Approved
13	FITTINGS (METALLIC)	M.S. FITTINGS, KOLKATA	CAT-3	Approved
		METAL LLOYDS,MUMBAI	CAT-3	Approved
14	MS/GI ERW PIPES	SAIL,ROURKELA	CAT-3	Approved
		JINDAL, GHAZIABAD/HISSAR	CAT-3	Approved
15	CI Gate/Globe/Ball/ NRV (Manual valves)	H.SARKAR,HOWRAH	CAT-3	Approved
		A.V. VALVES LTD,AGRA	CAT-3	Approved
16	(CS/MS) STEEL PLATE,ANGLES, SQUARE TUBES, CHANNELS, BEAM	SAIL, GOA	CAT-3	Approved
		TISCO, GOA	CAT-3	Approved
		JINDAL,GOA	CAT-3	Approved
17	CONTROL / POWER CABLE	POLYCAB,DAMAN	CAT-3	Approved
		UNIVERSAL CABLES,SATNA	CAT-3	Approved
18	FLANGES (CS)	BHARAT FORGE,PUNE	CAT-3	Approved
		RELIANCE FORGE,MUMBAI	CAT-3	Approved
19	VALVES (GATE/GLOBE/NRV/BALL)- CPVC/PVC/PP/ HDPE/PVDF	GEORG FISCHER PIPING SYSTEMS PVT LTD, DELHI	CAT-3	Approved
		ASTRAL PLYTECHINC LTD,AHMEDABAD	CAT-3	Approved
20	PIPE/FITTINGS/ FLANGES CPVC/PVC/PP/HDPE/PFDF	GEORG FISCHER PIPING SYSTEMS PVT LTD.DELHI	CAT-3	Approved
		ASTRAL PLYTECHINC LTD,AHMEDABAD	CAT-3	Approved
		SANGIR PIPE	CAT-3	Approved
21	NON RETURN VALVE (CPVC/PVC/ PP/HDPE/PFDF)	FIP - ALIAXIS UTILITIES AND INDUSTRY PVT. LTD,GOA	CAT-3	Approved
22	PAINT	BERGER, INDIA	CAT-3	Approved
		ASIAN PAINTS, INDIA	CAT-3	Approved

LIST OF SUB-VENDORS FOR C&I ITEMS				
Sl.	ITEMS	VENDOR	INSPECTION CATEGORY Approval for Ennore SEZ	REMARKS ON SUB VENDOR APPROVAL ELECTRO CHLORINATION PLANT (for C& I items) for Ennore SEZ
1	CONTROL VALVE (CPVC)	GEORG FISCHER PIPING SYSTEMS PVT LTD. DELHI	CAT-3	Credentials Required
2	PLC	SIEMENS LIMITED, INDIA	CAT-1	Rockwell (AB) - Control Logix. Siemens- S7- 400 Controllers with S7-300 I/O Cards are approved
		ROCKWELL AUTOMATION INDIA LTD, MUMBAI	CAT-1	
3	ENCLOSURE FOR PLC	RITTAL, GOA	CAT-3	Approved
4	UPS	HITACHI HI-REL UPS INDIA	CAT-1	Approved
		SCHNEIDER ELECTRIC - APC INDIA	CAT-1	Not Approved. No credentials are available as per Specification i.e for Power Plants rating >= 500MW
		EMERSON LIEBERT, INDIA	CAT-1	Approved
5	DESK TOP PC/LAPTOP/ PRINTER	DELL, GOA	CAT-3	Approved
		HP, GOA	CAT-3	Approved
6	CHLORINE ANALYSER	FORBES MARSHAL PVT. LTD., PUNE	CAT-3	Credentials Required
		EMERSON PROCESS MANAGEMENT (INDIA) PRIVATE LIMITED, INDIA	CAT-3	Credentials Required
7	HYDROGEN DETECTOR	DETECTION INSTRUMENTS, INDIA	CAT-3	Credentials Required
		OLDHAM (PENTEX ENGINEERING PVT LTD) MUMBAI	CAT-3	Credentials Required

8	TRANSMITTER- FLOW, LEVEL, PRESSURE, PRESSURE DIFF, TEMPERATURE,	YOKOGAWA INDIA LIMITED, PUNE	CAT-3	Approved
		FORBES MARSHALL LTD.,PUNE	CAT-3	Not Accepted for Transmitters since as per Specification, no credentials for Power Plants rating greater than 500MW
		EMERSON PROCESS MANAGEMENT (INDIA) PRIVATE LIMITED, MUMBAI	CAT-3	3051 Model Approved
9	INSTRUMENT TUBE AND FITTINGS FITTINGS	PRECISION ENGG INDUSTIES, MUMBAI	CAT-3	Material of the items shall be Super Duplex SS. Credentials Required for the capability of supplying Super Duplex SS
		ASTEC VALVES & FITTINGS, MUMBAI	CAT-3	
		COMFIT AND VALVES PVT LTD, AHMEDABAD	CAT-3	
10	LEVEL GAUGE	TOSHNIWAL BROTHERS PVT LTD, AJMER	CAT-3	Not Accepted. As per Specification, no credentials for Power Plants rating greater than 500MW
		PYRO CLARK RELIANCE LEVEL SOLUTIONS (I) P LTD,GOA	CAT-3	Not Accepted. As per Specification, no credentials for Power Plants rating greater than 500MW
11	LEVEL SWITCH	LEVCON INSTRUMENTS PVT LTD,KOLKATA	CAT-3	Approved
		PUNE TECHTROL, PUNE	CAT-3	Approved
12	PRESSURE GAUGE AND DIFF PRESSURE GAUGE	GAUGE BOUDRON INDIA PVT LTD, MUMBAI	CAT-3	Approved
		PRECISION MASS PRODUCTS PVT LTD, GUJARAT	CAT-3	Not Accepted. As per Specification, no credentials for Power Plants rating greater than 500MW
		GOA THERMOSTATIC INSTRUMENT PVT LTD, GOA	CAT-3	Approved
13	PRESSRUE SWITCH AND DIFF PRESSURE SWITCH	PRECISION MASS PRODUCTS PVT LTD, GUJARAT	CAT-3	Not Approved. As per Specification, no credentials for Power Plants rating greater than 500MW
		INDOFS (INDIA) LTD,CHENNAI	CAT-3	Approved

14	TEMP ELEMENT & THERMOWELL	GAUGES BOURDON INDIA, MUMBAI	CAT-3	Approved
		PYRO ELECTRIC INSTRUMENTS, GOA	CAT-3	Approved
15	FLOW SWITCH	ORION (PENTEX ENGINEERING PVT LTD) INDIA	CAT-3	Credentials Required
		IFM ELECTRONIC INDIA PRIVATE LIMITED MAHARASHTRA	CAT-3	Credentials Required
16	NON MATALLIC JUNCTION BOX	SUCHITRA INDUSTRIES, BANGALORE	CAT-3	Approved
		M/S PHOENIX MECANO (INDIA) LTD. MUMBAI	CAT-3	Approved
17	INSTRUMENT CABLE	LAPP, INDIA	CAT-1	Approved
		POLYCAB, INDIA	CAT-1	Approved

NOTES:-

1)**Category 1** – Quality Plan approval & Physical Inspection by TANGEDCO as agreed in the Quality Plan are envisaged. Based on Inspection/Inspection Test Report approval, TANGEDCO will issue MDCC.

2)**Category 2** – Quality Plan approval & Physical Inspection by BHEL as agreed in the Quality Plan are envisaged. Test Reports to be submitted by BHEL & got it approved by TANGEDCO before the issuance of MDCC by TANGEDCO.

3)**Category 3** - Quality Plan approval & Physical Inspection by TANGEDCO are not envisaged. MDCC to be obtained from TANGEDCO based on submission of Certificate of Clearance (COC) by BHEL.

15/03/18

CHIEF ENGINEER/PROJECTS-I

TAMIL NADU GENERATION AND DISTRIBUTION CORPORATION LIMITED

From
Er.K.Subash Chandra Bose,M.E.,
Chief Engineer/Projects I,
V Floor, Western Wing,
144, Anna Salai,
Chennai-600 002.
Fax No : 044- 28520878
Cell No: 9445857543
Email ID: cepr@tnebnet.org

To
Er.Perminder Singh, GM/PEM,
M/s. Bharat Heavy Electrical Limited,
Project Engineering Management
PPEI Building, HRDI & ESI Complex,
Plot No.25, Sector-16A, Noida-201301(U.P)
Fax : 0120-423522
E mail : pmgus@bhel.in,permindersingh@bhel.in,
vkumar@bhel.in,deveshverma@bhel.in,
pmgsalil@bhel.in, karuna.kaushik@bhel.in

Lr.No.CE/P/SE/E/T&H(P)/EE-6/E/P/AEE/M/F. Ennore SEZ Vendor Appl/D. 529/18,dt 26.10.18

Sir,

Sub: TANGEDCO - Setting up of 2x660 MW Ennore SEZ Coal based super critical thermal power project at ash dyke of North Chennai Thermal Power Station (Kattupalli) – EPC cum Debt Finance Contract awarded to M/s.BHEL on 27.09.2014 - Sub Vendor Items and Categorisation approval sought by BHEL/PEM for ELECTRO CHLORINATION PLANT - Approval accorded –Reg.

Ref:
1) Lr.No. CE/P/SE/M/P/EE-10/E/P/F.2x660 MW Ennore SEZ STPP/D.60/14,dt.27.09.2014
2) Your letter Ref: MS-1-13-E-0005 dated 27.09.2014.
3) BHEL/PEM Doc.No:PE-V11-412-182-A104/Rev 0
4) Lr.No.CE/P I/SE/E/T&H(P)/EE-6/E/P/F. 2X660 Ennore SEZ Vendor appl/D. 674 /18,dt 15.03.18
5) BHEL/PEM Letter Dated 11.05.2018 (Received on 11.05.2018)

****

Please refer to the letters cited above.

In Continuation to the Vendor approval accorded vide Ref (4) against the credentials submitted vide Ref (5) by M/s BHEL /PEM for the ELECTRO

CHLORINATION PLANT (ECP) , the Vendor Items List and Categorisation approval is accorded as per the Annexure to BHEL/PEM for their main supplier M/s Denora India Limited for ECP for 2X660 MW Ennore SEZ STPP.

Encl: As above (3 Pages)

Yours faithfully,

CHIEF ENGINEER /PROJECTS I

Copy to the CE/Civil/Ennore Sez/Chennai -120. (by email)
Copy to the SE/Civil/Ennore Sez/Chennai -120(by email)
Copy to the SE/Electrical/Ennore Sez/Chennai -120(by email)
Copy to M/S.Desein Pvt Ltd, New Delhi. (by email)

2X660MW ENNORE SEZ STPP

This is Annexure to Lr.No CE/P I /SE/E/T & H (P)/EE6/E/P/AEE/M/ F. 2X660MW Ennore SEZ Vendor appl /D 529 18 dated 26.10.2018 for Subvendor approval and Categorisation approval to BHEL/PEM for Electrochlorination Plant to be supplied by M/s Denora India Limited

BHEL: PEM : Ref dated 11.05.2018 for ECP Package

SR. NO	ITEMS	VENDOR Name	PLACE/LOCATION	INSPECTION CATEGORY approved by TANGEDCO	BHEL REMARKS	TANGEDCO approval for Ennore SEZ STPP
	Annexure A – Mechanical Items:					
A	LIST OF SUB VENDORS FOR MECH ITEMS					
1	ACID UNLOADING, ACID CIRCULATION PUMP & N-Pit PUMP (NON METALIC)	PROCESS PUMPS (I) PVT, LTD.	BANGALORE	CAT-2	Fresh request.	Not approved.
2	TRANSFORMER RECTIFIER	RAYCHEM RPG	MUMBAI	CAT-1	Fresh request.	Approved
3	SIMPLEX BASKET TYPE STRAINERS	OTOKLIN GLOBAL BUSINESS LTD.	MUMBAI	CAT-2	CRIDENTIAL ENCLOSED	Approved
4	SELF CLEANING STRAINER	OTOKLIN GLOBAL BUSINESS LTD.	MUMBAI	CAT-2	CRIDENTIAL ENCLOSED	Approved
	Annexure B- C & I Items:					
	LIST OF SUB VENDORS FOR C&I ITEMS					
1	CONTROL VALVE (CPVC)	GEORG FISCHER PIPING SYSTEMS PVT LTD.	DELHI	CAT-2	CRIDENTIAL ENCLOSED	Approved
		ASHAI YUKIZAI CORPORATION	JAPAN	CAT-2	Fresh request	Approved
2	CHLORINE ANALYZER	EMERSON PROCESS MANAGEMENT (INDIA) PRIVATE LIMITE	INDIA	CAT-2	CRIDENTIAL ENCLOSED	Approved
3	HYDROGEN DETECTOR	CROWCON DETECTION INSTRUMENTs (UK)-supplied by DETECTION INSRUMENTS	INDIA	CAT-2	CRIDENTIAL ENCLOSED	Approved
		OLDHAM-(FRANCE) SUPPLIED BY PENTEX ENGINEERING PVT LTD)	MUMBAI	CAT-2	CRIDENTIAL ENCLOSED	Approved
4	INSTRUMENT TUBE AND FITTINGS (for SUPER DUPLEX and MONEL)	PARKER		CAT-3	CRIDENTIAL NOT REQUIRED	Approved
		SANDVIK		CAT-3	CRIDENTIAL NOT REQUIRED	Approved
		SWAGELOCK		CAT-3	CRIDENTIAL NOT REQUIRED	Approved
		COMFIT AND VALVES PVT LTD	AHMEDABAD	CAT-3	CRIDENTIAL ENCLOSED	Not approved
5	LEVEL GAUGE	V AUTOMAT	DELHI	CAT-2	Fresh request.	Approved
		LEVCON INSTRUMENTS PVT LTD	KOLKATA	CAT-2	Fresh request.	Approved

2X660MW ENNORE SEZ STPP

This is Annexure to Lr.No CE/P I /SE/E/T & H (P)/EE6/E/P/AEE/M/ F. 2X660MW Ennore SEZ Vendor appl /D 529/ 18 dated 26.10.2018 for Subvendor approval and Categorisation approval to BHEL/PEM for Electrochlorination Plant to be supplied by M/s Denora India Limited

BHEL: PEM : Ref dated 11.05.2018 for ECP Package

SR. NO	ITEMS	VENDOR Name	PLACE/LOCATION	INSPECTION CATEGORY approved by TANGEDCO	BHEL REMARKS	TANGEDCO approval for Ennore SEZ STPP
6	PRESSRUE SWITCH AND DIFF PRESSURE SWITCH	SWITZER PROCESS INSTRUMENTS PVT LTD/INDFOS (INDIA) LTD	CHENNAI	CAT-2	Fresh request.	Approved
		GENERAL INSTRUMENT CONSORTIUM	MUMBAI	CAT-2	Fresh request.	Approved
7	FLOW SWITCH/ FLOW ELEMENT	SWITZER PROCESS INSTRUMENTS PVT LTD	CHENNAI	CAT-2	Fresh request.	Approved
		KROHNE MARSHAL	PUNE	CAT-2	Fresh request.	Approved
		GENERAL INSTRUMENT CONSORTIUM	MUMBAI	CAT-2	Fresh request.	Approved

Note:

1) Category I – Quality Plan approval & Physical Inspection by TANGEDCO as agreed in the Quality Plan are envisaged. Based on Inspection/Inspection Test Report approval, TANGEDCO will issue MDCC.

2) Category II – Quality Plan approval & Physical Inspection by BHEL as agreed in the Quality Plan are envisaged. Test Reports to be submitted by BHEL & got it approved by TANGEDCO before the issuance of MDCC by TANGEDCO.

3) Category III - Quality Plan approval & Physical Inspection by TANGEDCO are not envisaged. MDCC to be obtained from TANGEDCO Based on submission of Certificate of Celearance (COC) by BHEL.

26/10/18

CHIEF ENGINEER/PROJECTS I

97

TAMIL NADU GENERATION AND DISTRIBUTION CORPORATION LIMITED

From
Er.K.Subash Chandra Bose,M.E.,
Chief Engineer/Projects I,
V Floor, Western Wing,
144, Anna Salai,
Chennai-600 002.
Fax No : 044- 28520878
Cell No: 9445857543
Email ID: cepr@tnebnet.org

To
Er.Perminder Singh, GM/PEM,
M/s. Bharat Heavy Electrical Limited,
Project Engineering Management
PPEI Building, HRDI & ESI Complex,
Plot No.25, Sector-16A, Noida-201301(U.P)
Fax : 0120-423522
E mail : pmgus@bhel.in,permindersingh@bhel.in, vkumar@bhel.in,deveshverma@bhel.in, pmgsalil@bhel.in, karuna.kaushik@bhel.in

Lr.No.CE/P/SE/E/T&H(P)/EE-6/E/P/AEE/M/F. Ennore SEZ Vendor Appl/D.791 /19,dt 19.1.19

Lr.No.CE/P/SE/E/T&H(P)/EE-6/E/P/AEE/M/F. Ennore SEZ Vendor Appl/ D.791/19, dt. 19.1.19

Sir,

Sub: TANGEDCO - Setting up of 2x660 MW Ennore SEZ Coal based super critical thermal power project at ash dyke of North Chennai Thermal Power Station (Kattupalli) – EPC cum Debt Finance Contract awarded to M/s.BHEL on 27.09.2014 - Sub Vendor Items and Categorisation approval sought by BHEL/PEM for ELECTRO CHLORINATION PLANT - Approval accorded –Reg.

Ref:
1) Lr.No. CE/P/SE/M/P/EE-10/E/P/F.2x660 MW Ennore SEZ STPP/D.60/14,dt.27.09.2014
2) Your letter Ref: MS-1-13-E-0005 dated 27.09.2014.
3) BHEL/PEM Doc.No:PE-V11-412-182-A104/Rev 0
4) Lr.No.CE/P I/SE/E/T&H(P)/EE-6/E/P/F. 2X660 Ennore SEZ Vendor appl/D. 674 /18,dt 15.03.18
5) BHEL/PEM Letter Dated 11.05.2018 (Received on 11.05.2018)
6) Lr.No.CE/P I/SE/E/T&H(P)/EE-6/E/P/AEE/M/F. 2X660 Ennore SEZ Vendor appl/D. 529 /18,dt 26.10.18
7) BHELRef No: Ennore /ECP/FS/sub vendor/02 ated 11.05.2018 (Handed over on 21.12.2018)

****

Please refer to the letters cited above.

In Continuation to the Vendor approval accorded vide Ref (4& 6) against the credentials submitted vide Ref (3&5) by M/s BHEL /PEM for the ELECTRO CHLORINATION PLANT (ECP) , the Vendor Items List and Categorisation approval is accorded as per the Annexure to BHEL/PEM based on their submission vide Ref (7) for their main supplier M/s Denora India Limited to the Items Transformer Rectifier and Actuator for ELECTRO CHLORINATION PLANT Package for 2X660 MW Ennore SEZ STPP.

Encl: As above (1 Page)

Yours faithfully,

CHIEF ENGINEER /PROJECTS I

Copy to the CE/Civil/Ennore Sez/Chennai -120. (by email)
Copy to the SE/Civil/Ennore Sez/Chennai -120(by email)
Copy to the SE/Electrical/Ennore Sez/Chennai -120(by email)
Copy to M/S.Desein Pvt Ltd, New Delhi. (by email)

2X660MW ENNORE SEZ STPP
This is Annexure to vendor Items and Categorisation approval to M/s Denora India Limited for Electrochlorination Plant
Lr.No CE/P I /SE/E/T & H (P)/EE6/E/P/AEE/M/ F. 2X660MW Ennore SEZ Vendor appl /D 791 / 19 dated 19.01.2019
BHEL: PEM : Ref dated 21.11.2018 (Handed over on 21.12.18) for ECP Package

Annexure A – Mechanical Items:

SR. NO	ITEMS	VENDOR Name	PLACE/ LOCATION	INSPECTION CATEGORY approved by TANGEDCO	BHEL REMARKS	TANGEDCO approval for Ennore SEZ STPP
A	LIST OF SUB VENDORS FOR MECH ITEMS					
1.0	TRANSFORMER RECTIFIER	GE TEK ELECTRONICS PRIVATE LIMITED.,	CHENNAI	CAT-I	Fresh request.	Approved

Annexure B- C & I Items:

SR. NO	ITEMS	VENDOR Name	PLACE/ LOCATION	INSPECTION CATEGORY approved by TANGEDCO	BHEL REMARKS	TANGEDCO approval for Ennore SEZ STPP
B	LIST OF SUB VENDORS FOR C&I ITEMS					
1.0	ACTUATOR	ROTORK	CHENNAI/ BANGALORE	CAT-III	Fresh request	Approved
		LIMITORQUE	FARIDABAD	CAT -III	Fresh request	Approved
		AUMA	BANGALORE	CAT-III	Fresh request	Approved

Note:

1) Category I – Quality Plan approval & Physical Inspection by TANGEDCO as agreed in the Quality Plan are envisaged. Based on Inspection/Inspection Test Report approval, TANGEDCO will issue MDCC.

2) Category II – Quality Plan approval & Physical Inspection by BHEL as agreed in the Quality Plan are envisaged. Test Reports to be submitted by BHEL & got it approved by TANGEDCO before the issuance of MDCC by TANGEDCO.

3) Category III - Quality Plan approval & Physical Inspection by TANGEDCO are not envisaged. MDCC to be obtained from TANGEDCO Based on submission of Certificate of Celearance (COC) by BHEL.

CHIEF ENGINEER/PROJECTS I

TAMIL NADU GENERATION AND DISTRIBUTION CORPORATION LIMITED

From
Er.K.Subash Chandra Bose, M.E,
Chief Engineer/Projects I,
V Floor, Western Wing,
144, Anna Salai,
Chennai-600 002.
Fax No : 044- 28520878
Cell No: 9445857543
Email ID: cepr@tnebnet.org

To
M/s. Bharat Heavy Electrical Limited,
Project Engineering Management
PPEI Building, HRDI & ESI Complex,
Plot No.25, Sector-16A, Noida-201301(U.P)
Fax : 0120-423522
E mail : anujkumar@bhelpem.co.in, jd@bhel.in,deveshverma@bhel.in, pmgss@bhel.in, rajivb@bhel.in

Lr.No.CE/P /SE/E/Project-I/AEE/M/F. Ennore SEZ Vendor Appl/D. 81 /20, dt.13 .03.2020

Sir,

Sub: TANGEDCO - Setting up of 2x660 MW Ennore SEZ Coal based super critical thermal power project at ash dyke of North Chennai Thermal Power Station (Kattupalli) – EPC cum Debt Finance Contract awarded to M/s.BHEL on 27.09.2014 - Sub Vendor approval sought by BHEL/PEM for Electro Chlorination Plant (Main Supplier – M/s.Denora India Limited, Goa) - Approval accorded – Reg.

Ref:
1) Lr.No. CE/P/SE/M/P/EE-10/E/P/F.2x660 MW Ennore SEZ STPP/ D.60/14,dt.27.09.2014
2) Your letter Ref: MS-1-13-E-0005 dated 27.09.2014.
3) Lr. CE/P/SE/E/T&H(P)/EE-06/E/P/F. Ennore SEZ Vend.Appl/ D.674/ 18, dt.15.03.2018
4) vide Lr. CE/P/ SE/E/T&H(P)/EE-06/E/P/AEE/ M/F. Ennore SEZ Vendor Appl/D.529/18,dt.26.10.2018
5) Lr. CE/P/ SE/E/T&H(P)/EE-06/E/P/F.2x660 MW Ennore SEZ STPP/ D.228/15,dt.11.08.2015.
6) BHEL/ Project Engineering Management Lr.No BHEL/EPC/ETPS/ 19-20/FEB/02 dated 10.02.2020 (Hard copy received on 07.03.2020)

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Please refer to the letters cited above.

In continuation to the categorization approval for Electro Chlorination Plant accorded vide ref (3), Sub Vendor Approval to M/s.Denora India Ltd,(Main supplier for Electro Chlorination Plant) accorded vide ref(4), 2 vendors namely M/s.George fisehes piping system, Delhi and Ashai yukizai Corporation, Japan for CPVC alone and Sub vendor approval accorded to BHEL/Ranipet vide ref (5). It is informed that the credentials submitted by M/s BHEL/ Project Engineering Management vide ref (6) has been scrutinized and sub vendor approval is hereby accorded as below for the for Electro Chlorination Plant (Main Supplier – M/s.Denora India Limited, Goa) to the subject project 2X660 MW Ennore SEZ STPP.

Sl. No	Work Description	Name of Sub Vendor	TANGEDCO Remarks on Sub Vendor approval for Ennore SEZ
01.	Valves(Gate/Globe/ NRV/ Ball/ Butterfly/ Diaphram) - CPVC/PVC/ HDPE/PFDF Y – Type Strainer – (CPVC/PVC/ PP/HDPE/ PVDF)	M/s.Spears, USA	Technically Acceptable for CPVC Valves only
02.			Technically Acceptable for CPVC Strainers only
03.	Motors	M/s.Kirloskar Electric Co Ltd. Bengaluru/ Chennai	Technically Acceptable
		M/s. Siemens Ltd, Joka.	Technically Acceptable

Yours faithfully,

11/3/2020

CHIEF ENGINEER /PROJECTS-I

3/4

Copy to the CE/Civil/Ennore Sez/Chennai -120. (by email)
Copy to the SE/Civil/Ennore Sez/Chennai -120(by email)
Copy to the SE/Electrical/Ennore Sez/Chennai -120(by email)
Copy to M/S.Desein Pvt Ltd, New Delhi. (by email)

APPROVED

FIRST ANGLE PROJECTION (ALL DIMENSIONS ARE IN MM)

REV	DATE	ALTERED: / CHECKED:	REV	DATE	ALTERED / CHECKED

STATUS : CONTRACT

JOB NO.: 412

Approval vide **Lr.No.SE/E/THPro./EE2/AEE/F.BHEL/ PEM/ D. 258 /19 dtd. 20.03.2019**.

2019.03.12 13:24:24 +05'30'

BHARAT HEAVY ELECTRICALS LTD
PROJECT ENGINEERING MANAGEMENT.

This approval status shall be interpreted as laid down in the contract and it shall not relieve the contractor from the contractual obligation.

APPROVAL CATEGORY AWARDED = IV

CAT I - Approved
CAT II - Approved With Comments as Noted
CAT III - Not Approved
CAT IV - Reference Drawing

DEPARTMENT	MECHANICAL AUXILIARY
NAME: FALGUNI SAHA	2021

2X660 MW ENNORE SEZ COAL BASED STPP AT ASH DYKE OF NCTPS, CHENNAI.

TAMILNADU GENERATION AND DISTRIBUTION CORPORATION (TANGEDCO)

CONSULTANT: DESEIN PVT LTD, NEW DELHI.

BHARAT HEAVY ELECTRICALS LIMITED
PROJECTS ENGINEERING MANAGEMENT, NOIDA.

BHEL DOC. NO. : PE-V11-412-174-A105

SUB CONTRACTOR :DE NORA INDIA LIMITED
KUNDAIM - GOA

DE NORA

ASSOCIATE PARTNER: DE NORA WATER TECHNOLOGIES, SINGAPORE BRANCH

LOA NO: PW/PE/PG/EN1/P–24/17 DATED: 22 APR 2017

DEPT.	CODE	SCALE	WEIGHT(KG)	REF DRG.	ITEM
––	A	–	–	–	–

Control Philosophy with control system configuration Diagram for Electro Chlorination Plant.

	NAME	SIGN	DATE
PREP	SN		
CHKD	PG		
APPD	RF		

DEPT.							CARD CODE
SIGN			N.A.				–
DATE							

BHEL DOC. NO.
PE-V11-412-174-A105

REV 03

NO. OF SHEETS 36 EXCLUDING COVER PAGE

Reference Doc:
1) Piping & Instrumentation Diagram (PE-V0-412-174-A101, Rev-03). 3
2) Design Memorandum (PE-DC-412-174-A101, Rev-05).

1.1 SCOPE

The Electro Chlorination Plant provides onsite generation of Sodium Hypochlorite by partial electrolysis of sodium chloride contained in seawater. Seawater flows in a cell equipped with electrodes (anodes and cathodes) energized with direct current; the following chemical and electrochemical reactions occur:

a. Free chlorine is generated at the anode:
$2\ Cl^- \rightarrow Cl_2 + 2e^-$

b. Hydrogen is evolved at the cathode with the corresponding formation of hydroxyl ion:
$2\ H_2O + 2e^- \rightarrow 2\ OH^- + H_2 \uparrow$

c. The overall electrochemical reaction is:
$2\ Cl^- + 2\ H_2O \rightarrow Cl_2 + H_2 + 2\ OH^-$

d. Then chlorine and hydroxyl ions react chemically producing hypochlorite and chloride:
$2\ OH^- + Cl_2 + Na^+ \rightarrow NaClO + Cl^- + H_2O$

e. The overall chemical reaction can be expressed as follows:
$2\ NaOH + Cl_2 \rightarrow NaClO + NaCl + H_2O$

f. Overall reaction can be expressed as follows:
$NaCl + H_2O$ ---- (Electrolysis)----> $NaClO + H_2$

Side reactions, both chemical and electrochemical, take place simultaneously with the basic reactions, such as the decomposition of hypochlorite to chloride, the anodic oxidation of hypochlorite to chlorate (traces only), the cathodic reduction of hypochlorite to chloride and the anodic evolution of oxygen. All these side reactions affect the current efficiency so that D.C. power required to produce hypochlorite is actually higher than the theoretical one.

Moreover, some cations which are present in sea water (e.g. calcium, magnesium and other metals) form hydroxides and carbonates resulting in suspended solids which are mostly carried out of the electrolyser by the chlorinated sea water stream. Anyhow, due to deposit formation on the electrodes surface, the electrolysers units must undergo a periodic cleaning with diluted hydrochloric acid (5% w/w). The frequency of acid washing can be best determined only on the basis of field experience. In the

chemical literature, hypochlorite concentrations are in terms of “available” (or “active”) chlorine, i.e. the quantity of chlorine having the same oxidizing effect as the hypochlorite when analyzed by standard methods.

The Electro Chlorination Plant produces and feeds sodium hypochlorite solution to:

- inhibit the growth of marine organisms, bacterial slime and algae.

1.2 PLANT SECTIONS LIST

The plant consists essentially of the following equipment:-

DESCRIPTION	TAG	TYPE	DETAILS
Seawater Strainer	90PBM21AT001 90PBM22AT001	Auto-backwash	Configuration: 1 working strainer, 1 standby strainer
Seawater Booster Pumps	90PBM21AP001 90PBM22AP001	Horizontal centrifugal	Operating Capacity: 150m^3/hr @ 25mhead Configuration: 1 working, 1 standby
Electrolytic Generator	90PBM31AG001 90PBM32AG001	SEACLOR® 3HX.375	Rated Capacity: 200kg/hr Configuration: 1 working, 1 standby
Transformer Rectifiers	90PBM31GT001 90PBM32GT001	Forced air cooled	Configuration: 1 working, 1 standby
Hypochlorite Storage Cum Degassing Tank	90PBM40BB001 90PBM40BB002	Vertical, Dish top and bottom	Gross Capacity: 90.5m^3 Configuration: 1 working, 1 standby
Hypochlorite Continuous Dosing Pumps (for CW Forebay)	90PBM41AP001 90PBM42AP001	Horizontal centrifugal	Operating Capacity: 120m^3/hr @ 32mhead Configuration: 1 working, 1 standby
Hypochlorite Shock Dosing Pumps (for CW Forebay)	90PBM43AP001 90PBM44AP001 90PBM45AP001	Horizontal centrifugal	Operating Capacity: 120m^3/hr @ 32mhead Configuration: 2 working, 1 standby
Hypochlorite Continuous Dosing Pumps (for PTP)	90PBM46AP001 90PBM47AP001	Horizontal centrifugal	Operating Capacity: 9m^3/hr @ 32mhead Configuration: 1 working, 1 standby
Air Dilution Blower	90PBM47AN001	Centrifugal	Operating Capacity: 7700Nm^3/hr @ 250mmWC

	90PBM48AN001 90PBM49AN001 90PBM50AN001		Configuration: 2 working, 2 standby
Neutralisation Pit Dewatering Pump	90PBM61AP001 00PBM62AP001	centrifugal	Operating Capacity: 2m^3/hr @ 17mhead Configuration: 1 working, 1 standby
5% HCl Preparation cum Acid Cleaning Tank	90PBM50BB001	Vertical, Dish top and flat bottom	Useful Capacity: 4.8m^3 Configuration: 1 x 100% (Normal Case)
Acid Cleaning Pumps	90PBM52AP001 90PBM53AP001	Magnetic Driven	Operating Capacity: 44m^3/hr @ 20mhead Configuration: 1 working, 1 standby
Bulk Acid Storage Tank	90PBM51BB001	Horizontal	Capacity: 20m^3 Configuration: 1 x 100% (Normal Case)
Acid Unloading Pumps	90PBM51AP001 90PBM51AP002	Magnetic Driven	Operating Capacity: 10m^3/hr @ 10mhead Configuration: 1 working, 1 standby
Hypochlorite Storage Tank at Seawater Intake	90PBM70BB001	Vertical, Dish top and bottom	Gross Capacity: 15m^3 Configuration: 1 x 100% (Normal Case)
Hypochlorite Dosing Pump at Seawater Intake	90PBM81AP001 90PBM82AP001	Horizontal centrifugal	Operating Capacity: 12m^3/hr @ 32mhead Configuration: 1 working, 1 standby

2.0 DESIGN PARAMETERS

a.	Rated generation capacity (as available chlorine)	2 x 200 kg/h
b.	Strength of hypochlorite at 100% capacity	1500 - 2000 mg/l as Cl_2 av.
c.	Constant seawater feed flow-rate into each electrolytic generator train	133.33 m^3/h
d.	Produced by-product hydrogen	approx.0.35Nm^3/h per kg Cl_2 av.
e.	Design pressure	5.0 Barg
f.	Design temperature	50°C
g.	Rectifier rated DC output at 100% capacity	6000A/140VDC
h.	Seawater pressure at battery limit inlet	1-2 kg/cm^2g
i.	Normal operating pressure of system	3.0 – 4.0kg/cm^2
j.	Seawater temperature (operating)	25°C – 32°C
k.	Seawater feed flow at plant inlet	175 m^3/h

3.0 SYSTEM DESCRIPTION

3.1 SEAWATER FILTRATION SYSTEM

Seawater is delivered to the plant battery limits as follows:

Normal seawater pressure at plant inlet	1-2 kg/cm^2g
Seawater temperature (operating)	25°C – 32°C
Design seawater at plant inlet	175 m^3/h

For normal operation of the plant the following seawater flows are required:

Design seawater flow to plant	175 m^3/h
Seawater feed flow to 1 Electrolytic Generator	133.33 m^3/h
Backwash flow to Seawater Strainer	25 m^3/h

At the Electro Chlorination Plant battery limit, the pressure of the incoming seawater is available at 1 - 2 kg/cm^2g. A flow transmitter 90PBM11CF001 is provided to

monitor the seawater flow to the strainer. Low flow alarm at 120m^3/hr is provided to notify the operator of the abnormal condition.

Before entering the Seawater Booster Pump, seawater is delivered to Seawater Strainer to remove solid particles greater than 500 microns. Seawater Strainer configuration – 1 unit in duty with 1 unit standby. During filtration, the water enters through the inlet pipe into the screen area and flow through the screen from inside out. The collected material is accumulated on the screen surface and causes head loss to develop. When Pressure Differential Transmitter across the Seawater Strainer reaches a pre-set value of 0.5barg, a backwash cycle automatically occurs.

Pressure on seawater supply header is monitored by pressure transmitter at Seawater Strainer common discharge header. In case of low pressure (0.8barg), detected by 90PBM21CP004 or 90PBM21CP005, an alarm is displayed on the HMI to notify operator of the abnormal condition.

In the event low low pressure (0.3barg) is detected by 90PBM21CP003, this will interlock to prevent the system from starting. Furthermore, this will stop the duty booster pump. With a low low pressure latched signal, once process is normalized, operator to press RESET and START on the HMI to resume the booster pump. This is to ensure there is sufficient pressure to overcome all the downstream equipment.

3.2 SEAWATER BOOSTER

Seawater Booster Pumps are installed to boost the incoming seawater to required pressure. Pump configuration – 1 unit of Seawater Booster Pump in duty with 1 unit standby. Flow transmitter 90PBM21CF001 / 90PBM22CF001 is provided at the discharge of seawater booster pump to prevent pump from running in dry conditions. Low flow alarm at 106m^3/hr is provided to notify the operator of the abnormal condition.

Pressure on seawater common header is monitored by pressure transmitter at Seawater Booster Pump common discharge header. In case of low pressure (1.5barg), detected by 90PBM23CP001 or 90PBM23CP002, alarm is activated.

Furthermore, temperature is monitored by temperature transmitter (90PBM23CT001) at Seawater Booster Pump common discharge header. In case of high temperature (40degC), alarm is activated.

At the start-up of Electro Chlorination Plant, the control system opens 30% flow control valve when respective Electrolytic Generator start-up. Then, at the expiry of a pre-set time delay (0 ~ 30" adjustable), the flow control loop increases gradually the output signal, and opens more the flow control valve, in order to reach the set-point of Electrolytic Generator feed flowrate.

3.3 ELECTROLYTIC GENERATION

This module provides the primary function of generating the required sodium hypochlorite.

3.3.1 General description

The system comprised of two parallel Electrolytic Generator trains 3HX.375.

Each train consists of three electrolyzers, rated at 200 kg/h available chlorine, form the key components of the Electro Chlorination Plant. Electrolytic Generator configuration – 1 units of Electrolytic Generator train in duty with 1 unit standby.The three electrolyzers on each assembly are in hydraulic series: the seawater flows from the electrolyzer "A" to electrolyzer "B" then to electrolyzer "C". The produced sodium hypochlorite solution, together with by-product hydrogen, flows through the outlet header to the Hypochlorite Storage Cum Degassing Tank. Please note that hydrogen degassing is accomplished in the Hypochlorite Storage Cum Degassing Tank, and that hydrogen can be vented to safe area from tank's vent line only. Therefore, for safety reason hydrogen is maintained in mixed phase up to the storage and degassing system.

Seawater enters Electrolytic Generator trains. The feed seawater into each Electrolytic Generator remains constant, in normal operation, at its rated flow of 133.33 m^3/h. This flow rate is monitored and the D.C current supply is inhibited if the flow rate falls below the required value.

Flow transmitters are installed before Electrolytic Generator to monitor the flow rates and provide low low flow signal to protect the electrolyzers. Low low flow conditions can cause severe damage to the electrolyzers. Interrupting electrical current in the low low flow condition and shutting down the train prevents damage to the electrolyzers. A low low alarm provides notification of the trouble. The flow transmitters have a local indication and a 4-20mA output signal to PLC Panel to scale the signal and stop the operating train if the flow falls below 80% of the nominal flow. (Set point for low low flow is at 106m^3/h).

Temperature transmitter is installed after the Electrolytic Generator to protect the electrolyzers of high high temperature at 45^oC.

Differential Pressure transmitter 90PBM31CP002 / 90PBM32CP002 is installed across the Electrolytic Generator. High differential pressure of 1 barg indicates that the electrolytic generator needs to be acid cleaned.

3.3.2 Electrolytic Generator

The Electrolytic Generator consists of three Seaclor® electrolyzers model HX.375. Each electrolyzer consists of 10 electrolytic cells of modular construction, connected in electrical and hydraulic series to form an "electrode assembly" which is placed in an electrolyzer body entirely constructed of high grade corrosion resistant and electrically insulating materials (PVC+FRP).

The modular cells are bipolar in design. This means that the cathodes of every electrolytic cell are directly connected to the anodes of the next cell. The cathodes are made of titanium, while the anodes are made with titanium covered by De Nora special coating. The aim of the above-mentioned coating is to decrease the electrolysis potential and to prevent any titanium corrosion. Therefore, the anodic electrode is dimensionally stable DSA®.

A unique feature on an "electrode assembly" is the ease of replacement of the electrodes installed in the electrolyzers. The electrolyzers are designed to allow replacement of an electrode assembly with a spare assembly in a very short time,

without need for special equipment or skilled manpower. The guaranteed life of electrodes is 5 years.

Design parameters

Seawater flowrate to be treated: 80,552 + 80,552 m^3/h (Unit 1 and 2)

2365 m^3/h (Pretreatment Plant)

Hypochlorite solution concentration (at 100 % current): approx. 2000 ppm

Continuous dosing rate:

- Unit 1 and 2 1.0 ppm
- Pretreatment Plant 5.0 ppm

Shock dosing rate:

- Unit 1 and 2 2.0 ppm

Production at 100 % of current (Per Generator): 200 kg/h Cl_2 av.

Performance

The performance of each electrolyzers unit is as follows:

a.	Generator rating	2 x 100%
b.	Number of electrolyzers per generator	3
c.	Rated generation capacity as available chlorine	200 kg/h
d.	Range of production control	10-100% (of rated capacity)
e.	Strength of hypochlorite at 100% capacity	2000 mg/l Cl_2 av.
f.	Constant seawater feed flowrate	133.33 m^3/h
g.	Produced by-product hydrogen	approx. 0.35 Nm^3/kg Cl_2 av.
h.	Design pressure	5 kg/cm^2g
i.	Operating pressure	3 - 4 kg/cm^2g
j.	Test pressure	7.5 kg/cm^2g
k.	Design temperature	50 °C
l.	Rated D.C. current of rectifier	6000 A

m. Rated D.C. voltage of rectifier 140 V

3.3.3 Transformer Rectifier

The electrical D.C. power is supplied to each Electrolytic Generator by an electrical conversion unit, consisting of one rectifier transformer and one silicon thyristor rectifier, connected to the electrolyzers by a set of electric feeders.

The Transformer Rectifiers receive its AC input power from customer's 415V, 50Hz, 3Phase. Sodium hypochlorite produced by the electrolyzer is directly proportional to the DC amperage. Operator can set the rectifier output DC current accordingly at HMI when operating locally. With constant DC current output, the DC voltage will vary in accordance with the prevailing salinity condition and seawater temperatures – Low seawater salinity results in increased in DC voltage and at low seawater temperature, the DC voltage increases due to lower seawater conductance.

The maximum production rate of 200 kg/h Cl_2 av. is obtained when the Electrolytic Generator 3HX.375 is operated at maximum load of 6000A.

In fact, by varying the D.C. load it is possible to adjust the production, varying the concentration of the produced hypochlorite too. Please note that the raw seawater rate to each generator has to be kept constant at normal value of 133.33 m^3/h, and in any case not below 106 m^3/h.

Normally the active chlorine production, not its concentration in the produced hypochlorite solution, is the leading parameter: thus, in order to avoid an excessive scaling on the electrode surface, it is advisable to operate the unit at the normal seawater flowrate.

Available chlorine production is controlled, under normal operating conditions, in a range of 10 ~ 100% of rated capacity, by adjusting current set-point from 600 to 6000A.

The D.C. current is then automatically kept stable by the rectifier control system at the pre-set value, with an accuracy of ± 1% rated full current.

3.4 HYPOCHLORITE STORAGE CUM DEGASSING TANK

The chlorinated seawater coming from Electrolytic Generator is sent to Hypochlorite Storage Cum Degassing Tank. Hydrogen gas (by-product of the electrochemical reaction) disengages from the liquid phase in the upper part of the open tank. The retention of hypochlorite solution in the tank is kept approx. 5mins, to allow for complete hydrogen gas removal from the solution.

As hydrogen gas is lighter in weight than air, there will not be any accumulation around the Hypochlorite Storage Cum Degassing Tank. Prior to every system shut-down, piping and electrolyzers are flushed with seawater to prevent hydrogen gas accumulation along the pipeline.

Three level instruments are provided on each Hypochlorite Storage Cum Degassing Tank. During normal operation, one Hypochlorite Storage Cum Degassing Tank are in operation. When this tank is full, the second Hypochlorite Storage Cum Degassing Tank will be used. Flow transmitter 90PBM40CF001 / 90PBM40CF002 are installed on Hypochlorite Storage Cum Degassing Tank to monitor the air flow out of the tank vent. Low flow alarm (6160Nm^3/hr) is provided to alert operator of the abnormal condition.

3.5 AIR DILUTION BLOWER

The hydrogen in each Hypochlorite Storage Cum Degassing Tank is diluted to less than 1% by one of the two Air Dilution Blowers (1 Duty, 1 Standby). The lower explosive limit (LEL) of a hydrogen/air mixture is 4% hydrogen. One blower is set on continuous operation. The second blower is set on automatic stand-by. The Duty blower is selected before the start-up of the package. Inlet filter screen are installed on the air blowers' suction to prevent unwanted debris from being admitted into the vent system.

Non-return dampers prevent backflow through the stand-by blower during operation. After the hydrogen is diluted to below the lower explosive limit, it is safely vented to atmosphere at safe location.

Flow switch 90PBM47CF001 / 90PBM48CF001 / 90PBM49CF001 / 90PBM50CF001 are installed at the individual Air Dilution Blower discharge. In case of low flow (6160Nm^3/hr), the standby blower will start. If low flow persists after blower changeover, the relevant electrolyzer will trip with no flushing. Inlet flow control valve and outlet on/off valve for the respective electrolytic generator closed with no time delay.

In case of failure of running blower, the standby blower will start. If the standby blower fails, the relevant electrolyzer will trip with no flushing. Inlet flow control valve and outlet on/off valve for the respective electrolytic generator closed with no time delay.

3.6 HYDROGEN DETECTOR

One Hydrogen Detector (with 1 sensor) is installed at EC Building to detect any hydrogen gas release/leak from the Electrolytic Generators.

One Hydrogen Detector (with 1 sensor) is installed near each Hypochlorite Storage Cum Degassing Tanks to detect any hydrogen gas release from the tanks' vent.

In the event that high level (25% LEL) is detected by the hydrogen detector, a high level alarm is display on the HMI to alert the operators. High High level (50% LEL) triggers the tripping alarm which will initiate system trip. In the event of system trip, DC current to duty Transformer Rectifier is cut off immediately. Duty Seawater Booster Pump, duty Hypochlorite Continuous and Shock Dosing Pumps and acid cleaning pump and acid unloading pump and duty air blowers stops. Instrument air to flow control valves and on/off valves is cut off. Operator to investigate the abnormal situation before (1) acknowledging the fault at PLC Panel with the reset button, and (2) press "START" pushbutton for system re-start.

3.7 SODIUM HYPOCHLORITE INJECTION

Design dosing rates are as follows:

- To 1 ppm (design) continuous chlorination to Unit 1 and 2
  Seawater flowrate to be treated: 80,552 + 80,552 m^3/h

Specification of Hypochlorite Continuous Dosing Pump as follows:
flowrate: 120 m^3/h

- To 5 ppm (design) continuous chlorination to Pretreatment Plant
  Seawater flowrate to be treated: 2,365 m^3/h
  Specification of Hypochlorite Continuous Dosing Pump as follows:
  flowrate: 9 m^3/h

- To 2 ppm (design) shock chlorination to Unit 1 and 2
  Seawater flowrate to be treated: 80,552 + 80,552 m^3/h
  Specification of Hypochlorite Shock Dosing Pump as follows:
  flowrate: 120 m^3/h

- To 1 ppm (design) continuous chlorination to Seawater intake
  Required sodium hypochlorite is taken from existing Electro Chlorination Plant for 2X660 MW North Chennai TPS.
  Specification of Hypochlorite dosing pumps for Sea water intake as follows:
  flowrate: 12 m^3/h

Manual strainers 90PBM40AT001 and 90PBM40AT002 (1 duty, 1 standby) are installed before the Dosing Pumps. When high differential pressure of 0.03barg is detected by 90PBM40CP002 / 90PBM40CP004, an alarm is provided for operator to dismantle the duty strainer for washing.

Hypochlorite Continuous Dosing Pumps are installed for sodium hypochlorite dosing to Unit 1 and 2. Hypochlorite Continuous Dosing Pumps configuration – 1 unit in duty with 1 unit standby. Each Hypochlorite Continuous Dosing Pump runs to give 120m^3/hr of injection flow. In case of low liquid level in any of the Hypochlorite Storage Cum Degassing Tanks, Hypochlorite Continuous Dosing Pumps at CW are stopped. Pressure Transmitter 90PBM41CP001 / 90PBM42CP001 and Flow Transmitter 90PBM41CF001 / 90PBM42CF001 are installed at Hypochlorite Continuous Dosing Pumps' discharge line. Low flow (30m^3/hr) alarm notify operator. High discharge pressure (4.2barg) will stop the duty Hypochlorite Continuous Dosing

Pump and close on/off valve (90PBM41AA601 / 90PBM42AA601). This is required to protect the duty Hypochlorite Continuous Dosing Pump.

Hypochlorite Shock Dosing Pumps are installed for intermittent sodium hypochlorite dosing to Unit 1 and 2. Hypochlorite Shock Dosing Pumps configuration – 2 unit in duty with 1 unit standby. Each Hypochlorite Shock Dosing Pump runs to give 120m^3/hr of injection flow. In case of low liquid level in any of the Hypochlorite Storage Cum Degassing Tanks, Hypochlorite Shock Dosing Pumps are stopped. Pressure Transmitter 90PBM43CP001 / 90PBM44CP001 / 90PBM45CP001 and Flow Transmitter 90PBM43CF001 / 90PBM44CF001 / 90PBM45CF001 are installed at Hypochlorite Shock Dosing Pumps' discharge line. Low flow (30m^3/hr) alarm notify operator. High discharge pressure (4.2barg) will stop the duty Hypochlorite Shock Dosing Pump and close on/off valve (90PBM43AA601 / 90PBM44AA601 / 90PBM45AA601). This is required to protect the duty Hypochlorite Shock Dosing Pump.

For CW system, continuous dosing is scheduled for 7.5 hours then shock dosing takes place for the next 0.5 hours. This cycle repeats for 3 times a day. When there is shock dosing, Hypochlorite Continuous Dosing Pumps to Unit 1 and 2 stops.

Hypochlorite Dosing Pumps are installed for sodium hypochlorite dosing to Pretreatment Plant. Hypochlorite Dosing Pumps (for PTP) configuration – 1 unit in duty with 1 unit standby. Each Hypochlorite Dosing Pump (for PTP) runs to give 9m^3/hr of injection flow. In case of low liquid level in any of the Hypochlorite Storage Cum Degassing Tanks, Hypochlorite Dosing Pumps (for PTP) are stopped. Pressure Transmitter 90PBM46CP001 / 90PBM47CP001 and Flow Transmitter 90PBM46CF001 / 90PBM47CF001 are installed at Hypochlorite Continuous Dosing Pumps' (for PTP) discharge line. Low flow (2m^3/hr) alarm notify operator. High discharge pressure (3.7barg) will stop the duty Hypochlorite Dosing Pump (for PTP) and close on/off valve (90PBM46AA601 / 90PBM47AA601). This is required to protect the duty Hypochlorite Dosing Pump (for PTP).

Hypochlorite Dosing Pumps at seawater intake are installed for sodium hypochlorite dosing to Seawater Intake. Hypochlorite Continuous Dosing Pumps at seawater intake configuration – 1 unit in duty with 1 unit standby. Each Hypochlorite Dosing Pump at seawater intake runs to give $12m^3$/hr of injection flow. Required sodium hypochlorite is taken from existing Electro Chlorination Plant for 2X660 MW North Chennai TPS. In case of low liquid level in any of the Hypochlorite Storage Tank, Hypochlorite Continuous Dosing Pumps at Seawater Intake are stopped. Pressure Transmitter 90PBM81CP004 / 90PBM82CP004 are installed at Hypochlorite Dosing Pumps' (at seawater intake) suction line. Pressure Transmitter 90PBM81CP003 / 90PBM82CP003 and Flow Transmitter 90PBM81CF001 / 90PBM82CF001 are installed at Hypochlorite Dosing Pumps' (at seawater intake) discharge line. Low flow ($2m^3$/hr) alarm notify operator. High discharge pressure (4.1barg) will stop the duty Hypochlorite Dosing Pump (at seawater intake). This is required to protect the duty Hypochlorite Dosing Pump.

3.8 HYDROCHLORIC ACID CLEANING SYSTEM

3.8.1 Generator acid cleaning

The generators of active chlorine by electrolysis of untreated seawater are fouled by precipitation on the cathodes of hydroxides and carbonates of cations, such as magnesium and calcium, present in the feed solution.

The fouling rate mainly depends on:

- Material and surface finishing of the cathodes;
- Cathodic current density;
- Seawater chemical composition, temperature and flowrate through the electrolyzers.

Generally, low current density together with low seawater flowrate favors the formation of precipitation in the electrolyzers. The optimum operating conditions to minimize the fouling vary for each specific design, so that a comparison of operating data of various electrolyzers disregarding the design characteristics should not be taken into consideration.

It should be noted that it may not be feasible to maintain the optimum operating conditions during the whole life of the electrolyzers. Fouling usually take place as soon as the electrolyzers operate, even for limited period of time.

For this reason, it is necessary to wash the electrolyzers to remove the scaling on electrodes surface by means of a 5% HCl water solution.

The electrolyzers units are equipped with acid cleaning facilities to dissolve and remove any fouling that takes place within the electrolyzers.

Acid washing will be performed on one Electrolytic Generator train at a time; during the washing of a unit, the other train is still in operation to assure the production of hypochlorite.

The cleaning of the electrolyzers does not require any dismantling and it is done automatically by circulating through the electrolyzers a diluted hydrochloric acid solution (5% HCl by weight). The unit to be acid washed has to be completely drained, discharging chlorinated seawater to plant drain trench, then closing drain valves.

Remark:
Acid washing prevents possible troubles related to progressive scaling of the electrode package, i.e., the increase of operating voltages, the plugging of the path between the electrodes and hence uneven distribution of flow and current to the electrodes.

Prolonged operation under those anomalous conditions will lead to an increase of power consumption, quick damage of anodic coating and even short circuits between anodes and cathodes.

3.8.2 Acid cleaning equipment

The system is composed of:

- One Bulk Acid Storage Tank
- Two Acid Unloading Pumps (1 Duty, 1 Standby)

- One 5% HCl Preparation cum Acid Cleaning Tank
- Two Acid Cleaning Pumps (1 Duty, 1 Standby)
- One liquid-liquid ejector to recover into tank HCl solution from washing system, at the end of each acid washing cycle.

3.8.3 Fresh hydrochloric acid properties

Concentrated hydrochloric acid is diluted to 5% (w/w) and store in the 5% HCl Preparation cum Acid Cleaning Tank.

Typical analysis of technical grade hydrochloric acid, (by synthesis), to be used for acid washing is here below reported

- Sp. Gr. (20°C) 1.16 g/ml
- Appearance clear
- Conc. 30-33% w/w
- Iron (Fe) 5-10 ppm (max)
- Lead (Pb) < 2 ppm
- Copper (Cu) < 1 ppm
- Ca + Mg < 1 ppm
- SiO_2 < 1 ppm
- Free chlorine < 1 ppm
- Fluoride nil

Remark:

De Nora Water Technologies strongly recommends using hydrochloric acid free of fluorides. If acid washing is performed with commercial acid with fluoride content, this will imply the decay of electrodes guarantee.

3.8.4 Frequency and duration of acid washing

Acid washing is carried out once a month. The duration and frequency of the acid washing depends on the seawater chemical composition, temperature and current density. The field experience will fix the best duration and frequency. The operation

will take about three hours depending on actual conditions. Operator must be present at field throughout the entire acid cleaning process. Furthermore, should the voltage across the electrolyzer increases more than 6% (~148VDC), acid washing should be carried. In addition, High differential pressure (1 barg) across Electrolytic Generator indicates that the electrolytic generator needs to be acid cleaned.

3.8.5 Acid Cleaning Operation

Acid washing will be performed on one Electrolytic Generator train at a time; during the washing of a unit, the other train is still in operation to assure the production of hypochlorite.

3.8.6 Spent <3% hydrochloric acid neutralisation

After two cycles of re-strengthening of hydrochloric acid, the spent hydrochloric acid (approximate 3% w/w) has to be drained to the neutralization pit.

4.0 CONTROL AND INTERFACE

4.1 MAIN CONTROL DESCRIPTION AND SAFEGUARD

4.1.1 Package Inlet

A flow transmitter on the seawater supply header, monitors the incoming flowrate. In case of low flow (120m^3/hr), a low flow alarm is displayed on the HMI to alert the operator to check on the abnormal condition.

4.1.2 Seawater Strainer

When Pressure Differential Transmitter across the Seawater Strainer reaches a pre-set value (0.5barg), a backwash cycle is activated. In the event one backwash cycle did not manage to reduce the differential pressure to clean strainer condition, another backwash cycle will be activated. More than 3 backwash cycles indicate a strainer fault.

Pressure on seawater supply header is monitored by pressure transmitter at Seawater Strainer common discharge header. In case of low pressure (0.8barg), detected by 90PBM21CP004 or 90PBM21CP005, an alarm is displayed on the HMI to notify operator of the abnormal condition.

In the event low low pressure (0.3barg) is detected by 90PBM21CP003, this will interlock to prevent the system from start. Furthermore, this will stop the duty booster pump. With a low low pressure latched signal, once process is normalized, operator to press RESET and START on the HMI to resume the booster pump. This is to ensure there is sufficient pressure to overcome all the downstream equipment.

4.1.3 Seawater Booster

For duty Seawater Booster Pump fault, standby Seawater Booster Pump will take over. An alarm is display on HMI to alert the operator.

Flow transmitter 90PBM21CF001 / 90PBM22CF001 is provided at the discharge of seawater booster pump to prevent pump from running in dry conditions (low flow of 106m^3/hr).

Pressure on seawater common header is monitored by pressure transmitter at Seawater Booster Pump common discharge header. In case of low pressure (1.5barg), detected by 90PBM23CP001 or 90PBM23CP002, a low pressure alarm is displayed on the HMI to alert the operator to check on the abnormal condition. Furthermore, temperature is monitored by temperature transmitter at Seawater Booster Pump common discharge header. In case of high temperature (40degC), alarm is displayed on the HMI to alert the operator to check on the abnormal condition.

4.1.4 Electrolytic Generator inlet

Seawater inlet flow transmitters are installed at the upstream of the Electrolytic Generator. The seawater flow-rate to the Electrolytic Generator is kept to a predetermined value. In case of low low seawater flow-rate (preset at 80% nominal flow – 106m^3/hr) to Electrolytic Generator is detected, this will trigger to cut off the duty Electrolytic Generator train DC Output cuts off immediately and close relevant

flow control valve and on/off valve. Duty seawater booster pump, air dilution blower and dosing pumps continue to run. Low Low flow alarm is display on the HMI and standby train will start-up with 5 minutes seawater flushing after the duty train is closed completely.

4.1.5 Electrolytic Generator outlet

Temperature transmitters are installed at the downstream of the Electrolytic Generator. An alarm is generated in case of high temperature (45^{o}C). This will trigger to cut off the duty Electrolytic Generator train DC Output cuts off immediately and close relevant flow control valve and on/off valve. Duty seawater booster pump, air dilution blower and dosing pumps continue to run. High temperature alarm is display on the HMI and standby train will start-up with 5 minutes seawater flushing after the duty train is closed completely.

Differential Pressure transmitter 90PBM31CP002 / 90PBM32CP002 is installed across the Electrolytic Generator. High differential pressure (1 barg) indicates that the electrolytic generator needs to be acid cleaned.

4.1.6 Transformer Rectifier control

DC output is generated from Transformer Rectifiers. The rated output of each Transformer Rectifier is 6000ADC, 140VDC. Transformer Rectifier input is 415V, 50Hz, 3Phase (TBC) supplied by Client. The DC output range is 10% to 100%. Sodium hypochlorite produced by the Electrolytic Generator is directly proportional to the DC amperage. Operator can set the rectifier output DC current accordingly at PLC Panel when operating locally. With constant DC current output, the DC voltage will vary in accordance with the prevailing salinity condition and seawater temperatures.

Before switching on the rectifier, the following process conditions need to be satisfied:-

- Auto mode and Chlorine mode selected.

- Air blowers has been started and must be more than a pre-set flow rate (6160Nm^3/hr).
- Seawater inlet flow to each Electrolytic Generator train must be more than 106m^3/hr.
- Temperature at each Electrolytic Generator train outlet must be less than 45^{o}C.
- Hypochlorite Storage Cum Degassing Tank level must be at start level and not high high level.
- E-stop reset to normal.
- Seawater pressure after Seawater Strainer must be more than a pre-set pressure of 0.3barg.
- Hydrogen level less than 50% LEL.

In case a shutdown occurs for the duty transformer-rectifier, the electrolytic generator which is connected to that transformer-rectifier will shut down (no production of Sodium Hypochlorite). Relevant inlet automatic flow control valve and on/off valve closed with 5 minutes time delay to flush the relevant electrolytic generator with seawater. Duty seawater booster pump, air dilution blower and dosing pumps continue to run. Standby train will start with 5 minutes seawater flushing after the duty train is closed completely.

In the event duty transformer-rectifier is not available, relevant inlet automatic flow control valve and on/off valve closed with 5 minutes time delay to flush the relevant electrolytic generator with seawater. Duty seawater booster pump, air dilution blower and dosing pumps continue to run. An alarm is display on HMI and standby train will start with 5 minutes seawater flushing after the duty train is closed completely.

4.1.7 Air Blower discharge line

One flow switch is installed on the discharge of each air dilution blower.

For duty Air Dilution Blower motor failure, an alarm is activated and standby Air Dilution Blower will take over. In the event that low dilution air flow (6160Nm^3/h) is

detected exceeding more than 30 seconds, an alarm is generated and standby Air Dilution Blower will take over from the duty Air Dilution Blower. Duty Air Dilution Blower continues to run for 30 seconds to ensure continuity of air flow from both blowers to dilute the hydrogen before the standby blower unit rams to full speed to produce sufficient air flow. If low flow persists after blower changeover, the relevant electrolyzer will trip with no flushing. Inlet flow control valve and outlet on/off valve for the respective electrolytic generator closed with no time delay. Duty seawater booster pump stops. Dosing pump continue to run.

4.1.8 Hydrogen Detector

One Hydrogen Detector (with 1 sensor) is installed at EC Building to detect any hydrogen gas release/leak from the Electrolytic Generators.

One Hydrogen Detector (with 1 sensor) is installed near each Hypochlorite Storage Cum Degassing Tank to detect any hydrogen gas release from the tanks' vent.

In the event that high level (25% LEL) is detected by the hydrogen detector, a high level alarm is display on the HMI to alert the operators. High High level (50% LEL) is detected by any of the hydrogen detector, it triggers the tripping alarm which will initiate system trip. In the event of system trip, DC current to duty Transformer Rectifier is cut off immediately. Duty Seawater Booster Pump, Hypochlorite Continuous and Shock Dosing Pumps and duty air blowers stop. Instrument air to flow control valves and on/off valves is cut off. Operator to investigate the abnormal situation before (1) acknowledging the fault at PLC Panel with the reset button, and (2) press "START" pushbutton for system re-start.

4.1.9 Hypochlorite Storage Cum Degassing Tank Level Control

Sodium Hypochlorite is dosed by Hypochlorite Continuous / Shock Dosing Pumps from the Hypochlorite Storage Cum Degassing Tank.

Three level instruments are provided on each Hypochlorite Storage Cum Degassing Tank for monitoring/alarm and tripping purpose. During normal operation, one Hypochlorite Storage Cum Degassing Tank are in operation. When this tank is full,

the second Hypochlorite Storage Cum Degassing Tank will be used. Flow transmitter 90PBM40CF001 / 90PBM40CF002 are installed on Hypochlorite Storage Cum Degassing Tank to monitor the air flow out of the tank vent. Low flow alarm (6160Nm^3/hr) is provided to alert operator of the abnormal condition.

High level alarm (85%) is provided for operator action. Standby Hypochlorite Storage Cum Degassing Tank will be used by opening the on/off valve at the tank inlet. On/off valve at the duty Hypochlorite Storage Cum Degassing Tank inlet shall be closed. In the event both Hypochlorite Storage Cum Degassing Tanks level goes high (85%), DC current to duty transformer rectifier is cut off immediately. Relevant inlet flow control valve and on/off valve and duty seawater booster pump is close and stop at the expiry of a pre-set 5 minutes delay to flush hydrogen with seawater out of the electrolyzers. A high level alarm is display on HMI to alert the operator. Duty air dilution blower and duty Hypochlorite Dosing Pumps continue to run. Generation of sodium hypochlorite resumes automatically when the duty Hypochlorite Storage Cum Degassing Tank level drops to 21%.

If liquid level for any of the Hypochlorite Storage Cum Degassing Tank goes high high (98%), relevant inlet flow control valve and on/off valve are closed and trips respective Transformer Rectifier and duty seawater booster pump with no flushing. Duty air dilution blower and duty Hypochlorite Dosing Pumps continue to run. A high high level alarm is display on HMI to alert the operator. With a high high level latched signal, once process is normalized, operator to press RESET and START on the HMI to resume generation process.

Transformer rectifiers sequential start and stop at tank level of 21% and 85% respectively.

Hypochlorite Continuous Dosing Pumps starts continuous dosing when tank level is at 21%. Shock dosing is initiated by timer. For CW system, continuous dosing is scheduled for 7.5 hours then shock dosing takes place for the next 0.5 hours. This cycle repeats for 3 times a day. When there is shock dosing, Hypochlorite Continuous Dosing Pumps to Unit 1 and 2 stops.

Low level alarm (10%) is provided. Any detection of low level from any level instrument will stop all Hypochlorite Continuous / Shock Dosing Pumps and dosing on/off valves. A low level alarm is display on HMI to alert the operator. At tank low level, duty transformer rectifier, booster pump and electrolytic generator continue to run. Hypochlorite Dosing pumps resume injection when tank level reaches 21%.

On low low level (5%), all Hypochlorite Continuous / Shock Dosing Pumps are tripped. Low low level alarm is display on HMI to alert the operator. With a low low level latched signal, once process is normalized, operator to press RESET and START on the HMI to resume injection process.

4.1.10 Injection Process

In the event duty Hypochlorite Dosing Pump fails, standby Hypochlorite Dosing Pump will cut-in automatically. An alarm is display on HMI.

Pressure Transmitter 90PBM41CP001 / 90PBM42CP001 and Flow Transmitter 90PBM41CF001 / 90PBM42CF001 are installed at Hypochlorite Continuous Dosing Pumps' discharge line. Low flow ($30m^3$/hr) alarm notify operator. High discharge pressure (4.2barg) will stop the duty Hypochlorite Continuous Dosing Pump and close on/off valve (90PBM41AA601 / 90PBM42AA601). This is required to protect the duty Hypochlorite Continuous Dosing Pump.

Pressure Transmitter 90PBM43CP001 / 90PBM44CP001 / 90PBM45CP001 and Flow Transmitter 90PBM43CF001 / 90PBM44CF001 / 90PBM45CF001 are installed at Hypochlorite Shock Dosing Pumps' discharge line. Low flow ($30m^3$/hr) alarm notify operator. High discharge pressure (4.2barg) will stop the duty Hypochlorite Shock Dosing Pump and close on/off valve (90PBM43AA601 / 90PBM44AA601 / 90PBM45AA601). This is required to protect the duty Hypochlorite Shock Dosing Pump. Furthermore, pressure transmitter 90PBM43CP002 and 90PBM44CP002 are installed at Hypochlorite Shock Dosing Pumps' common discharge line to Unit-1 and Unit-2. A low pressure alarm is to notify operator of the abnormal operation.

Pressure Transmitter 90PBM46CP001 / 90PBM47CP001 and Flow Transmitter 90PBM46CF001 / 90PBM47CF001 are installed at Hypochlorite Dosing Pumps' (for

PTP) discharge line. Low flow (2m^3/hr) alarm notify operator. High discharge pressure (3.7barg) will stop the duty Hypochlorite Dosing Pump (for PTP) and close on/off valve (90PBM46AA601 / 90PBM47AA601). This is required to protect the duty Hypochlorite Dosing Pump (for PTP).

Pressure Transmitter 90PBM81CP003 / 90PBM82CP003 and Flow Transmitter 90PBM81CF001 / 90PBM82CF001 are installed at Hypochlorite Dosing Pumps' (at seawater intake) discharge line. Low flow (2m^3/hr) alarm notify operator. High discharge pressure (4.1barg) will stop the duty Hypochlorite Dosing Pump (at seawater intake). This is required to protect the duty Hypochlorite Continuous Dosing Pump.

4.2 SEQUENCES

Sections 4.2.1 and 4.2.2 covers the AUTO programming sequence when operator press the SYSTEM START and STOP pushbutton. Process values are already pre-programmed to run the system.

In MANUAL mode, operators are able to individually start and stop the transformer-rectifier, pumps, blowers and valves from HMI face plates. Operators to monitor the process conditions at all time. However, certain level of equipment protection/interlocks still applies for transformer-rectifier, pumps and blowers in MANUAL mode.

1. low low pressure (0.3barg) at strainer outlet
2. low low seawater flow-rate (106m^3/hr) to Electrolytic Generator inlet
3. high temperature (45^{o}C) at Electrolytic Generator outlet
4. low dilution air flow (6160Nm^3/h) at blower discharge
5. high high level (50% LEL) at hydrogen detector
6. High High liquid level (98%) at Hypochlorite Storage Cum Degassing Tank
7. low low level (5%) at Hypochlorite Storage Cum Degassing Tank

4.2.1 Start-up sequence

At the beginning of Electro Chlorination Plant start-up, Hypochlorite Storage Cum Degassing Tanks being empty, duty seawater strainer, duty Seawater Booster Pump, inlet flow control valves and on/off valves run and open to let seawater fill up the Hypochlorite Storage Cum Degassing Tanks. Piping and Electrolytic Generator are flushed with seawater for 5 minutes before Transformer Rectifier turns on. This is to ensure that Electrolytic Generators is not isolated and valves at inlet and outlet of Electrolytic Generators are open. Furthermore, to turn on DC output to the Electrolytic Generators, provided the Duty Transformer Rectifier's internal monitoring conditions are healthy, the following process conditions need to be satisfied. Operator to press "START" pushbutton to initiate start-up sequence.

- Auto mode and Chlorine mode selected.
- Air blowers has been started and must be more than a pre-set flow rate (6160Nm^3/hr).
- Seawater inlet flow to each Electrolytic Generator train must be more than 106m^3/hr.
- Temperature at each Electrolytic Generator train outlet must be less than 45^oC.
- Hypochlorite Storage Cum Degassing Tank level must be at start level and not high high level.
- E-stop reset to normal.
- Seawater pressure after Seawater Strainer must be more than a pre-set pressure of 0.3barg.
- Hydrogen level less than 50% LEL.

4.2.2 Shutdown sequence

4.2.2.1 Shutdown sequence of Electro Chlorination Plant

A. Electro Chlorination Plant is shut down in the following manner:-

Upon an Auto Stop request, all acid cleaning pump and acid unloading pump are stop and DC current is cut off immediately. The seawater feed is stop by closing

Electrolytic Generator inlet flow control valves and on/off valves at the expiry of a pre-set 5 minutes delay to flush hydrogen with seawater out of the Electrolytic Generators. Tank level is monitored:-

(1) If tank level is more than 60%, duty Seawater Booster Pump and Electrolytic Generator inlet flow control valves and on/off valves is then stopped and closed. Hypochlorite Dosing Pumps continue to run while waiting for the tank level to drop to 50%.

(2) If the tank level is less than or equal to 50%, duty Seawater Booster Pump, inlet automatic flow control valve and on/off valves to start and open for 30 minutes of seawater flushing. Upon expiry of 30-minutes timer, duty Air Blower, Seawater Booster Pumps and Hypochlorite Dosing Pumps stops and relevant inlet flow control valves and dosing on/off valves closes.

Electro Chlorination Plant is shutdown when the following condition happens:-

- Manual mode selected
- “STOP” button pressed

B. Electro Chlorination Plant is tripped without flushing in the following manner:-

DC current to duty Transformer Rectifier is cut off immediately. Duty Seawater Booster Pump, duty Hypochlorite Continuous and Shock Dosing Pumps and acid cleaning pump and acid unloading pump and duty air blowers stops. Instrument air to flow control valves and on/off valves is cut off. Operator to investigate the abnormal situation before (1) acknowledging the fault at PLC Panel with the reset button, and (2) press “START” pushbutton for system re-start. Electro Chlorination Plant is tripped if any of the following conditions happen:-

- E-stop activated
- High High H_2 level (50% LEL) detected by any of the three hydrogen detectors
- Hypochlorite Storage Cum Degassing Tank level did not increase from 5% to 50% within 30 minutes.

- Loss of power
- Both air dilution blowers trip

4.2.3 Acid preparation, cleaning and neutralization sequence

Acid cleaning process is operated manually. Before acid cleaning of electrolyzer starts, the operator must ensure the following:-

- DC current will not turn on to selected Electrolytic Generator train.
- Electrolytic Generator train selected to Acid Mode.
- 5% HCl Preparation cum Acid Cleaning Tank level more than 5%.
- E-stop reset to normal.

Bulk acid unloading Procedure

Concentrated hydrochloric acid solution is transferred via Acid Unloading Pump and stored in Bulk Acid Storage Tank.

a) Pressure Transmitter 90PBM51CP001 is installed at Acid Unloading Pumps' discharge line. High discharge pressure (1.1barg) will stop the duty Acid Unloading Pump. This is required to protect the duty Acid Unloading Pump.

b) High level (80%) at Bulk Acid Storage Tank will stop the duty Acid Unloading Pump.

c) Alarm is activated when Low level (30%) is detected at Bulk Acid Storage Tank.

Dilute Acid Preparation Procedure

The dilute 5% hydrochloric acid solution is prepared in 5% HCl Preparation cum Acid Cleaning Tank.

For the first preparation follow the procedure here below.

- Being the 5% HCl Preparation cum Acid Cleaning Tank empty, fill the Acid Cleaning Tank manually with potable water: add about 3465L of service water.
- Feed concentrated (30-33% w/w) HCl to 5% HCl Preparation cum Acid Cleaning Tank from Bulk Acid Storage Tank, by means of gravity: add about 550L of concentrated acid.
- Operator can homogenize solution contained in 5% HCl Preparation cum Acid Cleaning Tank, by means of Acid Cleaning Pump put in re-circulation to 5% HCl Preparation cum Acid Cleaning Tank.
- Then, operator should check, by chemical analysis (titration), proper HCl concentration, which should range from 5 to 6% w/w after each filling of tank.
- Should the concentration be less, the operator would feed more acid in order to reach about 5% w/w.

Acid washing

The system is designed to be operated manually. Operator must be present at field during the entire acid cleaning process. Acid washing will be performed on one Electrolytic Generator train at a time; during the washing of a unit, the other train is still in operation to assure the production of hypochlorite.

When Electrolytic Generator unit is to be acid washed, the operator should proceed as follows:

Warning

Use Fluoride Free Acid Solution only.

Sample shall be taken for every batch of Concentrated Acid Delivery.

Ensure potable water used for dilution is also Fluoride Free.

a) Shut-down the selected Electrolytic Generator by switching to Acid Mode. Switching from Chlorine to Acid Mode initiates individual Electrolytic Generator sequential shutdown.

b) After individual Electrolytic Generator shutdown, drain Electrolytic Generator completely.

c) Open all necessary valves from 5% HCl Preparation cum Acid Cleaning Tank to Electrolytic Generator and back to 5% HCl Preparation cum Acid Cleaning Tank.

d) Start Acid Cleaning Pump manually.

e) Re-circulate 5% w/w hydrochloric acid solution, prepared in 5% HCl Preparation cum Acid Cleaning Tank, through Electrolytic Generator for approx. 3 hour, check carefully acid concentration by titration of liquid samples taken from circuit. 15 minutes after the first titration, operator to obtain another sample for second titration. When hydrochloric acid concentration becomes constant (For instance, both titrations give HCl concentration of 3.2%), the acid washing of Electrolytic Generator is complete.

f) Check fluoride concentration during acid cleaning: **fluorides concentration shall not exceed 1 mg/l in any case**. Otherwise cleaning solution must be completely changed! Laboratory tests shall be carried out for dilution water and every batch of concentrated acid delivery to ensure fluoride free acid solution.

g) Stop circulating HCl solution through Electrolytic Generator when the concentration of HCl acid is stable.

h) Recover acid solution from lines and Electrolytic Generator into 5% HCl Preparation cum Acid Cleaning Tank. For this purpose, put Acid Clean Pump in recirculation to tank through the ejector.

i) When acid recovery has completed, stop and isolate acid system and start to flush Electrolytic Generator with seawater for 15 minutes (by starting the seawater booster pump) to the plant drain trench.

j) At the end, fill Electrolytic Generator train with seawater and prepare it for a new operation cycle. Refer to next few pages for operating sequence of valves.

k) Pressure Transmitter 90PBM52CP001 is installed at Acid Cleaning Pumps' discharge line. High discharge pressure (3barg) will stop the duty Acid Cleaning Pump. This is required to protect the duty Acid Cleaning Pump.

l) Flow switch 90PBM52CF001 / 90PBM53CF001 are installed at the discharge of each Acid Cleaning Pump. Low flow ($3m^3$/hr) alarm notify operator.

m) Low level (5%) at 5% HCl Preparation cum Acid Cleaning Tank will stop the duty acid cleaning pump.

n) Alarm is activated when high level (90%) is detected at 5% HCl Preparation cum Acid Cleaning Tank.

Remark: Acid Cleaning Pump is automatically stopped through low level safety interlock by level instrument placed on 5% HCl Preparation cum Acid Cleaning Tank.

Remarks:

Kerbed area is provided around hydrochloric acid skid. Any accidental spillage of hydrochloric acid shall drain into curbed area, where it can be neutralized. In fact, direct contact between HCl and NaOCl should be avoided to prevent evolution of gas chlorine, which is irritating to mucous membranes.

Acid Washing Sequence (definition)

Sequence 1 - "Drain"

When Electrolytic Generator (90PBM31AG001 / 90PBM32AG001) has to be drained, vent and drain valves of Electrolytic Generator (90PBM31AG001 / 90PBM32AG001) are to be opened manually to discharge, by gravity, sodium hypochlorite solution. Drainage solution flow via plant drain trench.

Sequence 2 - "Recycle HCl to 5% HCl Preparation cum Acid Cleaning Tank"

Operator should start Acid Cleaning Pump (90PBM52AP001 / 90PBM53AP001) with relevant pump discharge valve open, in order to recycle 5% HCl to 5% HCl Preparation cum Acid Cleaning Tank (90PBM50BB001).

Remark: suction valve of Acid Cleaning Pump (90PBM52AP001 / 90PBM53AP001) should be already open, and it should remain always opened, unless in case of maintenance.

In this condition, hydrochloric acid solution is well homogenized.

Operator should check, by chemical analysis, actual concentration of F^-: if fluorides are present, the solution must be changed. Moreover, if HCl concentration is less than 3% w/w, operator should renew solution, or strengthen it again to 5% w/w.

Sequence 3 - "HCl washing"

Manual valves open in accordance to sequence No. 3, so that 5% HCl is sent, by means of Acid Cleaning Pump (90PBM52AP001 / 90PBM53AP001), from 5% HCl Preparation cum Acid Cleaning Tank (90PBM50BB001) to Electrolytic Generator (90PBM31AG001 / 90PBM32AG001) and then back to 5% HCl Preparation cum Acid Cleaning Tank (90PBM50BB001).

Please note that Acid Cleaning Pump (90PBM52AP001 / 90PBM53AP001) has been already started, by operator, during preceding Sequence 2.

Sequence 4 - "HCl recovery in tank"

At the end of Electrolytic Generator (90PBM31AG001 / 90PBM32AG001) washing by HCl, acid solution is recovered into 5% HCl Preparation cum Acid Cleaning Tank (90PBM50BB001), from Electrolytic Generator (90PBM31AG001 / 90PBM32AG001) and lines.

For this purpose, Acid Cleaning Pump (90PBM52AP001 / 90PBM53AP001) is set in recycle to 5% HCl Preparation cum Acid Cleaning Tank (90PBM50BB001) through liquid ejector to create vacuum in recycle line.

Ejector sucks acid solution from both delivery and return hydrochloric acid headers, which are put in connection by means of relevant valve, and sends HCl to 5% HCl Preparation cum Acid Cleaning Tank (90PBM50BB001). When hydrochloric acid solution is recovered in 5% HCl Preparation cum Acid Cleaning Tank (90PBM50BB001) and Acid Cleaning Pump (90PBM52AP001 / 90PBM53AP001) is stopped, operator should proceed to Sequence 5.

Sequence 5 - "Electrolytic Generator flushing with seawater"

In this phase seawater passes from inlet valve through Electrolytic Generator (90PBM31AG001 / 90PBM32AG001) and it is discharged to plant drain trench.

This is done in order to remove last traces of HCl from Electrolytic Generator (90PBM31AG001 / 90PBM32AG001).

Moreover, Electrolytic Generator (90PBM31AG001 / 90PBM32AG001) is filled with seawater, in order to be ready for the following start-up.

Sequence 6 - "End"

At the end of washing sequence, operator sets Electrolytic Generator (90PBM31AG001 / 90PBM32AG001) on stand-by, otherwise he can start it again and proceed to a new operating cycle.

4.2.3.1 Re-strengthening of hydrochloric acid sequence

The acid solution has a concentration of 5% HCl (w/w) when freshly prepared and can be used one acid cleaning cycle till the HCl concentration is down to approximate 3%. The weak solution is strengthened again to 5% HCl concentration by the addition of fresh HCl (30 - 33% concentration). Freshly prepared acid solution can be re-strengthen twice before it get exhausted. Exhausted acidic solution is neutralised and disposed.

Operation is as follows:-

a) Start the Acid Cleaning Pump (90PBM52AP001 / 90PBM53AP001) and recycle acid solution to 5% HCl Preparation cum Acid Cleaning Tank (90PBM50BB001).

b) Feed concentrated (30-33% w/w) HCl to 5% HCl Preparation cum Acid Cleaning Tank (90PBM50BB001) from Bulk Acid Storage Tank by opening 90PBM51AA508: add about 277L of concentrated acid.

c) Operator can homogenize solution contained in 5% HCl Preparation cum Acid Cleaning Tank (90PBM50BB001), by means of Acid Cleaning Pump (90PBM52AP001 / 90PBM53AP001) put in re-circulation to tank.

d) Then, operator should check, by chemical analysis (titration), proper HCl concentration, which should range from 5 to 6% w/w after each filling of tank.

e) Should the concentration be less, the operator would feed more acid in order to reach about 5% w/w.

4.2.3.2 Spent < 3% hydrochloric acid neutralization

Concentrated caustic soda

Typical analysis of concentrated caustic soda (from drums), to be used for spent acid neutralization is here below reported.

- Quality: Commercial grade
- Sp. Gr. (20°C) 1.3 g/ml
- Appearance clear
- Conc. 45% w/w

Spent acid neutralisation sequence

After two cycles of re-strengthening of hydrochloric acid, the spent hydrochloric acid (approximate 3% w/w) has to be neutralised by adding caustic soda before being disposed.

Operation is as follows:-

a) Open the drain valve 90PBM50AA401 to neutralization pit.

b) Feed slowly concentrated caustic soda from NaOH Drum 90PBM60BB001 to neutralization pit, by opening 90PBM60AA401: add about 231L of concentrated caustic soda.

c) Run Neutralization Pit Dewatering Pump (90PBM61AP001 / 90PBM62AP001) and recirculate the medium back to the Neutralization Pit by opening 90PBM61AA503. Operator to check the pH value of the neutralized solution with the use of litmus paper. When pH reads 6-8, neutralized solution can be disposed by closing 90PBM61AA503 and opening 90PBM61AA502.

d) A Level Transmitter 90PBM60CL001 is installed at the Neutralization Pit to monitor the water level in the pit. Dimension of the Neutralization Pit is 2.6m (L) x 2.6m (W) x 3m (H). When the level reaches 70%, an alarm is sound. Operator to run the Neutralisation Pit Dewatering Pump to transfer the medium to CW Forebay. The Neutralisation Pit Dewatering Pump trips when level drops to 20%. This is to prevent dry-running of the wastewater pump.

NOTES:

1) Operation of the pumps, Transformer Rectifier, Electrolyser and other equipment shall be performed from local control panel / OWS to be located at the Electro Chlorination Building (air conditioned area). The Control panel shall house PLC Hardware, Alarm Annunciator driven by PLC programmed sequence, Indicators, Indication lamps, Switches, local / remote selector switch, Start / Stop push buttons, Auxiliary Relays, Motor current meter etc.. Selector switch shall be provided in the control panel to achieve three positions for “Base duty”, “Stand by duty” and “Stop”.”

2) BHEL shall take care of the control of sea water intake hypochlorite dosing system described in this control philosophy shall be envisaged in the standalone DDCMIS based control system provided for Sea water intake system. Further standalone DDCMIS based control system shall be included with one no. OWS, one no. OEWS, one no. A4 size B/W LJP, one no. DMP and one no. backup control desk as per Technical specification, Vol. V, Annexure A – Sr. no. 21 and post bid resolution, Annexure 7, Sr. no. 47 & 41.

Note: All set points selected is inline with Piping & Instrumentation Diagram (PE-V0-412-174-A101, Rev-03) and shall be inline with site requirement. 

APPROVED

FIRST ANGLE PROJECTION (ALL DIMENSIONS ARE IN MM)

REV	DATE	ALTERED: / CHECKED:	REV	DATE	ALTERED / CHECKED

STATUS : CONTRACT

JOB NO.: 412

DOC APPROVED Lr.No.:SE/E/Th&HyP/EE-7/M/AEE/M/F.En SEZ STPP/D.670/18 dt.08.10.2018.

2X660 MW ENNORE SEZ COAL BASED STPP AT ASH DYKE OF NCTPS, CHENNAI.

TAMILNADU GENERATION AND DISTRIBUTION CORPORATION (TANGEDCO)

CONSULTANT: DESEIN PVT LTD, NEW DELHI.

BHARAT HEAVY ELECTRICALS LIMITED
PROJECTS ENGINEERING MANAGEMENT, NOIDA.

BHEL DOC NO.: PE-V11-412-174-A110

SUB CONTRACTOR : DE NORA INDIA LIMITED
KUNDAIM - GOA

DE NORA

ASSOCIATE PARTNER : DE NORA WATER TECHNOLOGIES
SINGAPORE BRANCH

LOA NO: PW/PE/PG/EN1/P-24/17 DATED: 22 APR 2017

DEPT.	CODE		SCALE	WEIGHT(KG)	REF DRG.	ITEM
--	A		-	-	-	-

TECHANICAL DATA SHEET FOR VERTICAL/ HORIZONTAL PUMPS

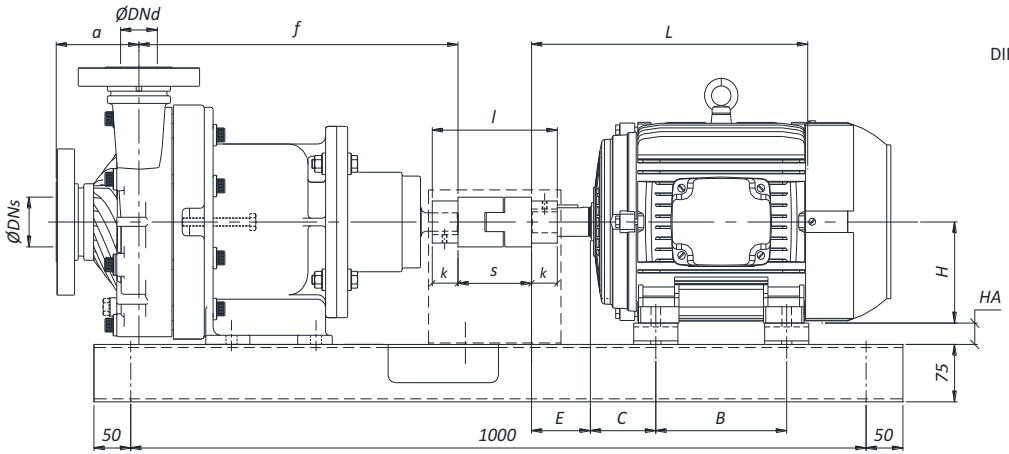
	NAME	SIGN	DATE
PREP	SN		
CHKD	PG		
APPD	RF		

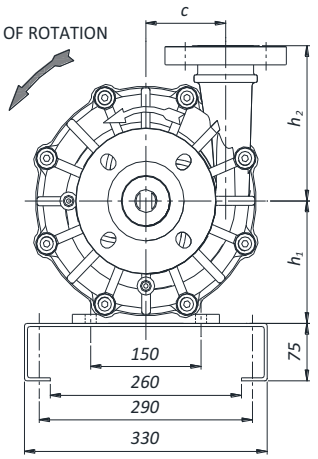
DEPT.		CARD CODE	BHEL DOC NO.:	REV
SIGN	N.A.	-	PE-V11-412-174-A110	1
DATE	2018.10.10 12:31:05 +05'30'		NO. OF SHEETS 25 EXCLUDING COVER PAGE	

BHARAT HEAVY ELECTRICALS LTD
PROJECT ENGINEERING MANAGEMENT.
This approval status shall be interpreted as laid down in the contract and it shall not relieve the contractor from the contractual obligations
APPROVAL CATEGORY AWARDED = I
CAT I - Approved
CAT II - Approved With Comments as Noted
CAT III - Not Approved
CAT IV - Reference Drawing
DEPARTMENT: MECHANICAL AUXILIARY
NAME: PALGUNI SAHA

PROJECT:	2x660MW ENNORE SEZ COAL BASED STPP			ELECTRO CHLORINATION PACKAGE	
CONTRACTOR:	BHARAT HEAVY ELECTRICALS LIMITED			TECHNICAL DATASHEET OF VERTICAL/ HORIZONTAL PUMPS	REV
BIDDER/ VENDOR:	DE NORA INDIA LIMITED				
DATASHEET FOR:	ACID CLEANING PUMP			BHEL DOC. NO. : PE-V11-412-174-A110	1
GENERAL	1	TAG NO(S)		90PBM52AP001 / 90PBM53AP001	
	2	SERVICE		ACID CLEANING	
	3	QUANTITY	No.	2	
	4	RATING		100%	
	5	MANUFACTURER		ANTICO	
	6	MODEL		MZRP 50160 R V2L	
OPERATING CONDITIONS	7	DUTY		INTERMITTENT	
	8	FLUID HANDLED		HCL (5% w/w)	
	9	SPECIFIC GRAVITY		1.023	
	10	TEMPERATURE	Deg C	25 - 32	
	11	NPSH AVAILABLE	m	FLOODED SUCTION	
	12	DISCHARGE PRESSURE (OPERATING)	m	20	
	13	CAPACITY (OPERATING)	m^3/h	40	
	14	LOCATION		OUTDOOR	
PERFORMANCE	15	CAPACITY	m^3/h	44	
	16	TOTAL DIFFERENTIAL HEAD	m	20.0	
	17	DESIGN CODE		ANTICO MANUFACTURING STANDARD	
	18	ROTATION		CLOCKWISE	
	19	NPSH REQUIRED	m	4.5	
	20	SHUT OFF PRESSURE	m	31	
	21	RPM	rpm	2900	
	22	RATED POWER	kW	4.93	
CONSTRUCTION	23	TYPE		MAGNETIC DRIVEN PUMP	
	24	COUPLING		FLEXIBLE SPACER , RRL	
	25	NUMBER OF IMPELLER	No.	1	
	26	NUMBER OF STAGE		SINGLE	
	27	SUCTION NOZZLE SIZE/TYPE		65 NB / FLANGE ANSI B 16.5 #150 RF	
	28	DISCHARGE NOZZLE SIZE/TYPE		50 NB/ FLANGE ANSI B 16.5 #150 RF 1	
	29	WEIGHT	KG	140	
MATERIAL	30	CASING		GFRPP	
	31	IMPELLER		GFRPP	
	32	SHAFT		SS316	
	33	CASING O-RING		FKM	
	34	BASE PLATE		SHEET METAL WITH EPOXY PAINT	
	35	BOLTING		SS316L	
MOTOR	36	TYPE		SQUIRREL CAGE	
	37	TEMP CLASS		B	
	38	INSULATION		F	
	39	POWER	kW	7.5	
	40	VOLTAGE		415V/ 50Hz/ 3Ph	
	41	HAZARDOUS CLASS		SAFE AREA, OUTDOOR	
	42	MANUFACTURER		Bharat bhijli / crompton greaves	
	43	DEGREE OF PROTECTION		IP55	

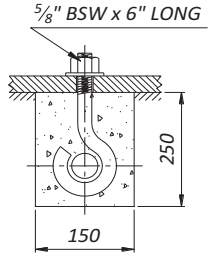
NOTES :

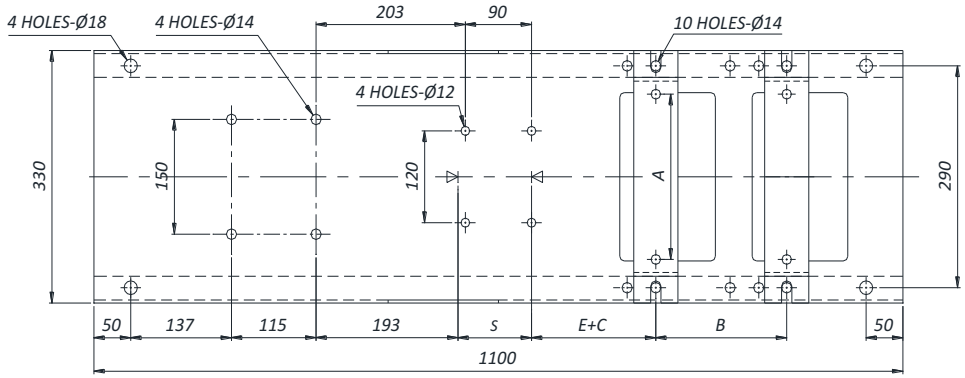




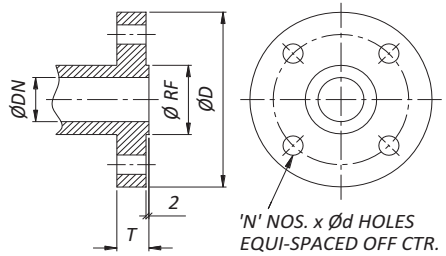
SPACE FOR APPROVAL STAMP

FOUNDATION DETAIL





DRILLED AS PER - ANSI B 16.5 # 150 RF



MOTOR DIMENSIONS in mm

RPM	kW/hp	FRAME	L	H	E + C	A	B	HA
2900	7.5 / 10	132 S	470	132	80+89	216	140	28

COUPLING DIMENSIONS in mm

TYPE	SIZE	l	k	s
RRL	100	160	30	100

PUMP DIMENSIONS in mm

PUMP TYPE	ØDNs	ØDNd	a	f	c	h_1	h_2	HB
MZ - 50160	65	50	112	435	108.5	160	208	-

MASS in kg

PUMP	BASE	COUP.	MOTOR	TOTAL
47	20	5	68	140

FLANGE DIMENSIONS in mm

LOCATION	ØDN	ØD	T	ØRF	N	Ød	PCD P
SUCTION FLANGE	65	191	25	105	4	18	140
DISCHARGE FLANGE	50	162	25	92	4	18	121

PUMP DETAILS		MOTOR DETAILS		CUSTOMER DETAILS	
SIZE (mm)	65 X 50	kW/hp	7.5 / 10	CLIENT	BHEL
CAPACITY (m^3 /hr)	40	RPM	2900	P.O. NO.	*
HEAD (m)	20	FRAME	132 S	PROJECT	2x660 MW ENNORE SEZ COAL BASED STPP
BKW	4.93	PHASE	3	ACCOUNT	DE-NORA ELECTRODE TECHNOLOGY
EFFICIENCY (%)	46	VOLTAGE (V)	415	SERVICE	5% HCL
MOC (WETTED)	GFRPP	FREQ. (Hz)	50	SP. GR.	1.029
PLAIN BEARING	SiC	COUPLING DETAILS		TAG. NO.	90PBM52AP001,90PBM53AP001
O-RING	FKM	TYPE	RRL 100	MODEL	MZRP-50160-RV2L, QTY. : 2

GENERAL TOLERANCE = ± 5, ALL DIMENSIONS ARE IN mm

REV. NO.	DATE	CHKD BY	APRVD BY	SCALE
1	28.06.17	VKS	JKS	-

TITLE: GENERAL ARRANGEMENT DRAWING

DWG. NO. AEPL /GAD /MZ - 50160 - 132 S

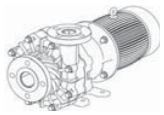
ANTICO ANTICORROSIVE EQUIPMENT PVT. LTD.

ANTICO
moulded non metallic pumps

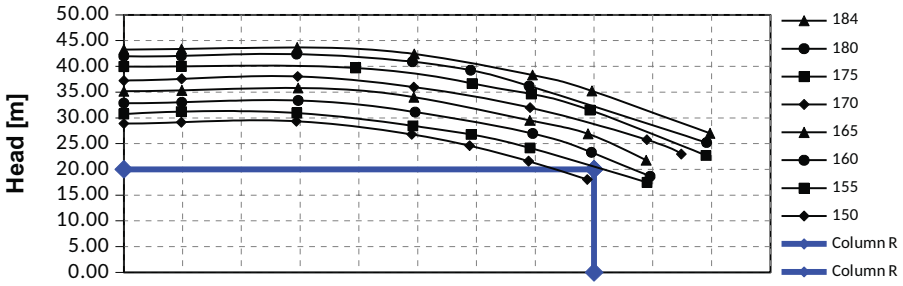
Anticorrosive Equipment Pvt. Ltd.

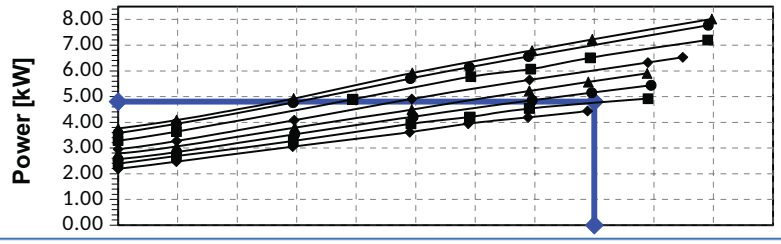
Performance Curve

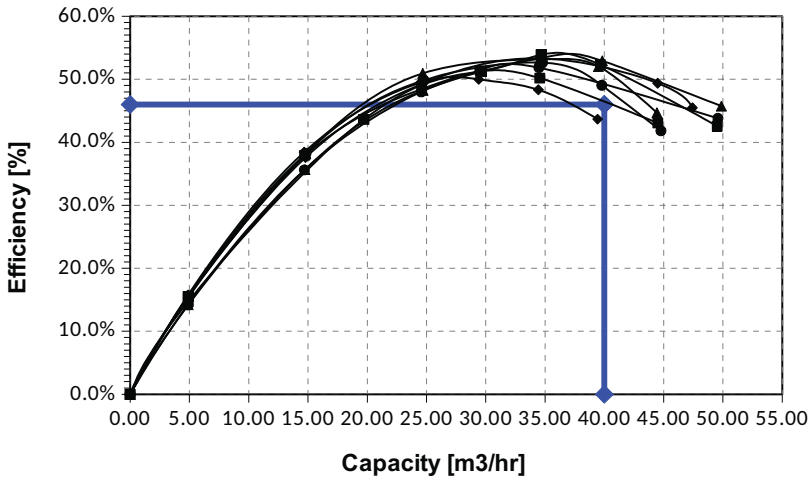
Tested with water @ ambient condition



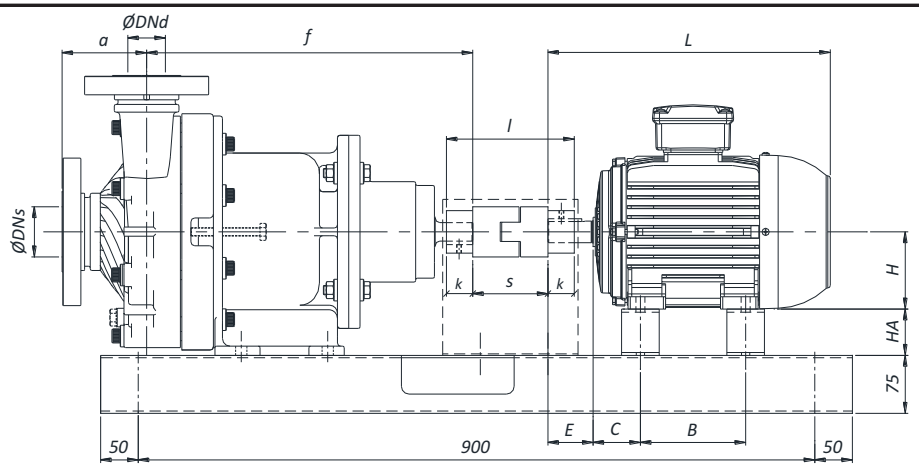
PROJECT	2x660MW ENNORE SEZ COAL BASED STPP				**REF NO.**	BH.Email.Dt.16.06.2017		
CONSULTANT	DE NORA ELECTRODE TECHNOLOGY				**GRAPH NO.**	AEPL/MZ50160/2900		
CLIENT	BHEL				**DATE**	20.06.2017	**REV**	0
TAG NO	**MODEL**	**SIZE**	**HEAD, m**	**CAPACITY, m³/hr**	**EFFICIENCY, %**	**RPM**	**kW / HP**	**BID IMP, mm**
00PBM52AP001, 00PBM53AP001	MZ	65 X 50 X 160	20	40	46%	2900	7.5/10	155

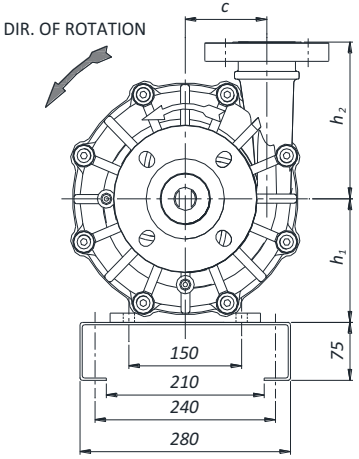


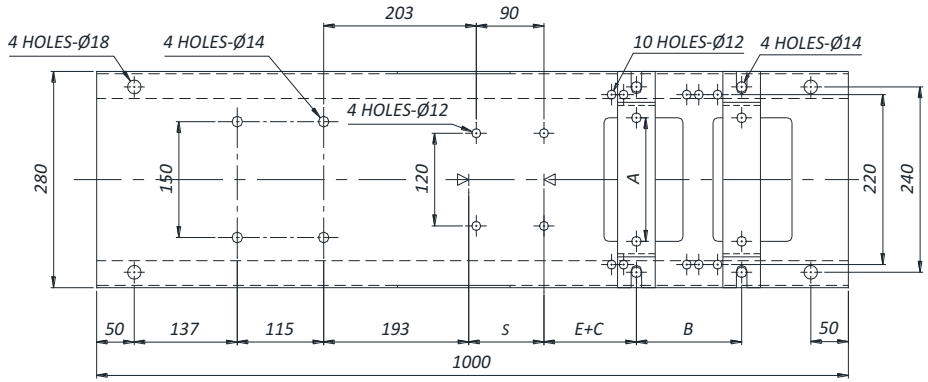




PROJECT:	2x660MW ENNORE SEZ COAL BASED STPP			ELECTRO CHLORINATION PACKAGE	
CONTRACTOR:	BHARAT HEAVY ELECTRICALS LIMITED			TECHNICAL DATASHEET OF VERTICAL/ HORIZONTAL PUMPS	REV
BIDDER/ VENDOR:	DE NORA INDIA LIMITED				
DATASHEET FOR:	ACID UNLOADING PUMP			BHEL DOC. NO. : PE-V11-412-174-A110	1
GENERAL	1	TAG NO(S)		90PBM51AP001 / 90PBM51AP002	
	2	SERVICE		ACID TRANSFER	
	3	QUANTITY	No.	2	
	4	RATING		100%	
	5	MANUFACTURER		ANTICO	
	6	MODEL		MZRP 50160 R V1L	
OPERATING CONDITIONS	7	DUTY		INTERMITTENT	
	8	FLUID HANDLED		HCL (35% w/w)	
	9	SPECIFIC GRAVITY		1.18	
	10	TEMPERATURE	Deg C	25 - 32	
	11	NPSH AVAILABLE	m	FLOODED SUCTION	
	12	DISCHARGE PRESSURE (OPERATING)	m	10	
	13	CAPACITY (OPERATING)	m^3/h	10	
	14	LOCATION		OUTDOOR	
PERFORMANCE	15	CAPACITY	m^3/h	10	
	16	TOTAL DIFFERENTIAL HEAD	m	10.0	
	17	DESIGN CODE		ANTICO MANUFACTURING STANDARD	
	18	ROTATION		CLOCKWISE	
	19	NPSH REQUIRED	m	3.5	
	20	SHUT OFF PRESSURE	m	11	
	21	RPM	rpm	1440	
	22	RATED POWER	kW	0.92	
CONSTRUCTION	23	TYPE		MAGNETIC DRIVEN PUMP	
	24	COUPLING		FLEXIBLE SPACER , RRL	
	25	NUMBER OF IMPELLER	No.	1	
	26	NUMBER OF STAGE		SINGLE	
	27	SUCTION NOZZLE SIZE/TYPE		65 NB / FLANGE ANSI B 16.5 #150 RF	
	28	DISCHARGE NOZZLE SIZE/TYPE		50 NB/ FLANGE ANSI B 16.5 #150 RF 1	
	29	WEIGHT	KG	89	
MATERIAL	30	CASING		GFRPP	
	31	IMPELLER		GFRPP	
	32	SHAFT		SS316L 1	
	33	CASING O-RING		FKM	
	34	BASE PLATE		SHEET METAL WITH EPOXY PAINT	
	35	BOLTING		SS316L	
MOTOR	36	TYPE		SQUIRREL CAGE	
	37	TEMP CLASS		B	
	38	POWER	kW	1.5	
	39	VOLTAGE		415V/ 50Hz/ 3Ph	
	40	HAZARDOUS CLASS		SAFE AREA, OUTDOOR	
	41	MANUFACTURER		Bharat bhijli / crompton greaves	
	42	DEGREE OF PROTECTION		IP55	
NOTES :					

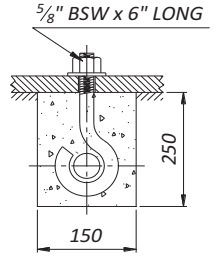




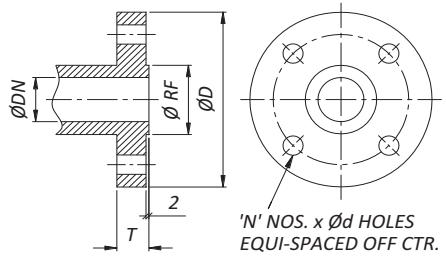


SPACE FOR APPROVAL STAMP

FOUNDATION DETAIL



DRILLED AS PER - ANSI B 16.5 # 150 RF



MOTOR DIMENSIONS in mm								
RPM	kW/hp	FRAME	L	H	E + C	A	B	HA
1450	1.5 / 2	90 L	335	90	50+56	140	125	70

COUPLING DIMENSIONS in mm				
TYPE	SIZE	l	k	s
RRL	95	150	25	100

PUMP DIMENSIONS in mm								
PUMP TYPE	ØDNs	ØDNd	a	f	c	h_1	h_2	HB
MZ - 50160	65	50	112	435	108.5	160	208	-

MASS in kg				
PUMP	BASE	COUP.	MOTOR	TOTAL
47	12	5	25	89

FLANGE DIMENSIONS in mm							
LOCATION	ØDN	ØD	T	ØRF	N	Ød	PCD P
SUCTION FLANGE	65	191	25	105	4	18	140
DISCHARGE FLANGE	50	162	25	92	4	18	121

PUMP DETAILS		MOTOR DETAILS		CUSTOMER DETAILS	
SIZE (mm)	65 X 50	kW/hp	1.5 / 2	CLIENT	BHEL
CAPACITY (m^3 /hr)	10	RPM	1450	P.O. NO.	*
HEAD (m)	10	FRAME	90 L	PROJECT	2x660 MW ENNORE SEZ COAL BASED STPP
BKW	0.92	PHASE	3	ACCOUNT	DE-NORA ELECTRODE TECHNOLOGY
EFFICIENCY (%)	37	VOLTAGE (V)	415	SERVICE	35% HCL
MOC (WETTED)	GFRPP	FREQ. (Hz)	50	SP. GR.	1.18
PLAIN BEARING	SiC	COUPLING DETAILS		TAG. NO.	90PBM51P001,90PBM51P002
O-RING	FKM	TYPE	RRL 95	MODEL	MZRP-50160-RV1L, QTY. : 2

GENERAL TOLERANCE = ± 5, ALL DIMENSIONS ARE IN mm

REV. NO.	DATE	CHKD BY	APRVD BY	SCALE
1	28.06.17	VKS	JKS	-

TITLE: GENERAL ARRANGEMENT DRAWING

DWG. NO. AEPL /GAD /MZ - 50160 - 90 L

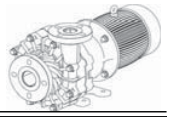
ANTICO ANTICORROSIVE EQUIPMENT PVT. LTD.

ANTICO
moulded non metallic pumps

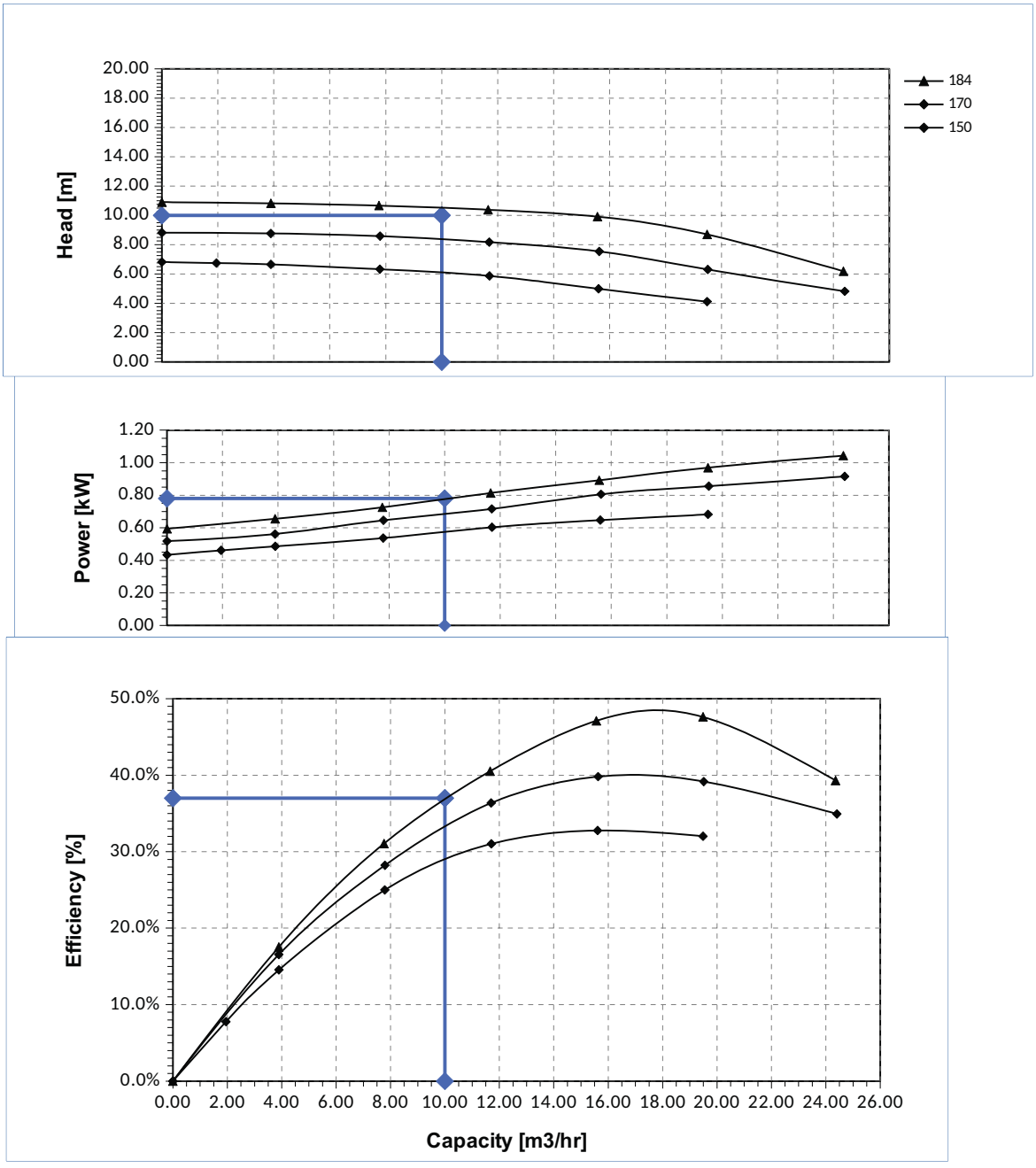
Anticorrosive Equipment Pvt. Ltd.

Performance Curve

Tested with water @ ambient condition



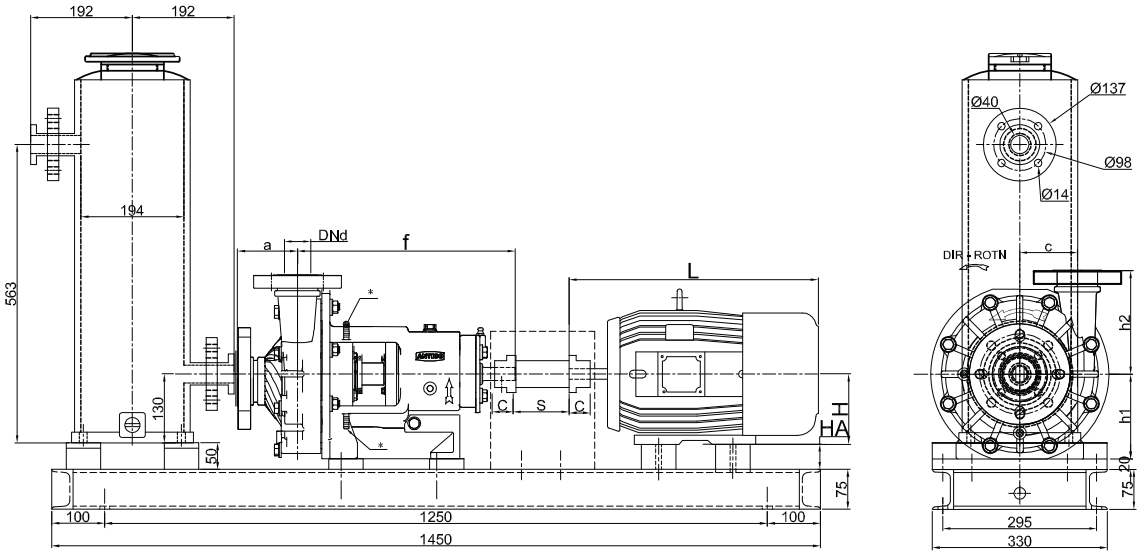
PROJECT	2x660MW ENNORE SEZ COAL BASED STPP				***REF NO.***	BH.Email,.Dt.16.06.2017		
CONSULTANT	*				***GRAPH NO.***	AEPL/MZ50160/1440		
CLIENT	DE NORA WATER TECHNOLOGIES				***DATE***	20.06.2017	***REV***	
TAG NO	***MODEL***	***SIZE***	***HEAD, m***	***CAPACITY, m³/hr***	***EFFICIENCY, %***	***RPM***	***HP /kW***	***BID IMP, mm***
00PBM51AP001, 00PBM51AP002	MZ	65 X 50 X 160	10	10	37%	1440	2 / 1.5	184

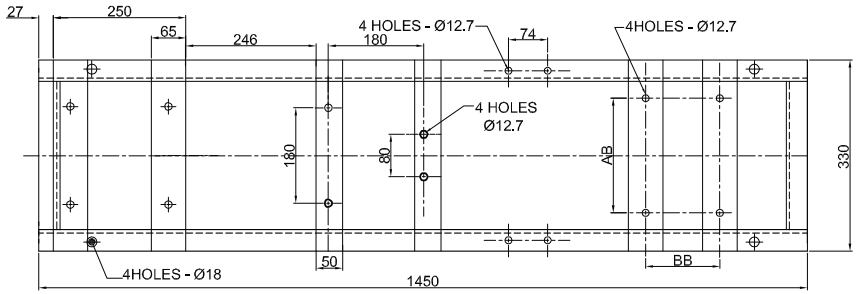


PROJECT:	2x660MW ENNORE SEZ COAL BASED STPP			ELECTRO CHLORINATION PACKAGE	
CONTRACTOR:	BHARAT HEAVY ELECTRICALS LIMITED			TECHNICAL DATASHEET OF VERTICAL/ HORIZONTAL PUMPS	REV
BIDDER/ VENDOR:	DE NORA INDIA LIMITED				
DATASHEET FOR:	NEUTRALISATION PIT PUMP			BHEL DOC. NO. : PE-V11-412-174-A110	1
GENERAL	1	TAG NO(S)		90PBM61AP001 / 90PBM62AP001	
	2	SERVICE		DEWATERING	
	3	QUANTITY	No.	2	
	4	RATING		100%	
	5	MANUFACTURER		ANTICORROSIVE EQUIPEMNT PVT LTD	
	6	MODEL		NZRP 25125 TBG V1J; Pump with 16 Liter of Priming Chamber	
	7			for 3.0m of Negative Suction 1	
OPERATING CONDITIONS	8	DUTY		INTERMITTENT	
	9	FLUID HANDLED		WASTE WATER	
	10	SPECIFIC GRAVITY		1.025	
	11	VISCOSITY	Cp	1	
	12	% SOLIDS & SIZE OF SOLID	%	3-4	
	13	TEMPERATURE	Deg C	25 - 32	
	14	PIT DEPTH	m	3	
	15	DISCHARGE PRESSURE (OPERATING)	m	17 1	
	16	CAPACITY (OPERATING)	m^3/h	2	
	17	SUCTION CONDITION		NEGATIVE	
	18	LOCATION		OUTDOOR	
PERFORMANCE	19	CAPACITY	m^3/h	2.5	
	20	TOTAL DIFFERENTIAL HEAD	m	17.0 1	
	21	DESIGN CODE		ANTICO MANUFCTURING STANDARD	
	22	ROTATION		CLOCKWISE FROM MOTOR END	
	23	NPSH REQUIRED	m	3	
	24	SHUT OFF PRESSURE	m	19	
	25	RPM	rpm	2900	
	26	SHAFT ABSORBED POWER	kW	0.92 kW (Water), 0.943 kW (Liquid)	
CONSTRUCTION	27	TYPE		HORIZONTAL CENTRIFUGAL	
	28	NUMBER OF IMPELLER	No.	1	
	29	NUMBER OF STAGE		SINGLE	
	30	IMPELLER SIZE	mm	115	
	31	SUCTION NOZZLE SIZE/TYPE		40 mm, END SUCTION, ANSI B16.5, CLASS 150#, RF	
	32	DISCHARGE NOZZLE SIZE/TYPE		25 mm, SIDE DISCHARGE, ANSI B16.5, CLASS 150# RF	
	33	WEIGHT (PUMP)	KG	47	
MATERIAL	34	CASING		GFRPP	
	35	IMPELLER		GFRPP	
	36	SHAFT		SS316	
	37	CASING O-RING		FKM (VITON)	
	38	BASE PLATE		MS WITH EPOXY PAINT	
	39	BOLTING		SS316L	
MOTOR	40	TYPE		SQUIRREL CAGE/ IE2	
	41	TEMP CLASS		B	
	42	INSULATION CLASS		F	
	43	POWER	kW	2.2 (3 hp)	
	44	VOLTAGE		415V/ 50Hz/ 3Ph	
	45	HAZARDOUS CLASS		SAFE AREA	
	46	MANUFACTURER		CG / BHARAT BIJLEE/ ABB	
	47	DEGREE OF PROTECTION		IP55	

NOTES :

NOTE : * INDICATES ¼" BSP NIPPLE FOR SEAL COOLING





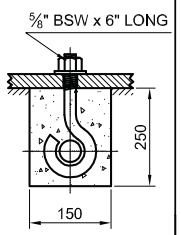
2900	2.2 / 3	90 L	340	90	90	50+56	140	125	RRL	095	150	25	100
RPM	KW/ HP	FRAME	L	H	HA	E+C	AB	BB	TYPE	SIZE	I	C	S
MOTOR DIMENSIONS										COUPLING DIMENSIONS			

NZ - 25x125	40	25	100	412	90	160	181	Weight		
MODEL	DNs	DNd	a	f	c	h1	h2	P+B+COU	M+PC	TOTAL
	PUMP DIMENSIONS							47+50+5	25+30	157

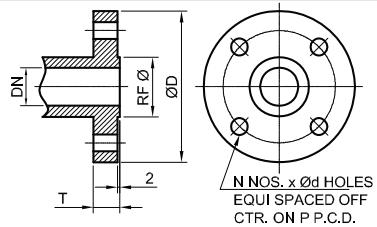
EFF (%)	12%			MODEL	NZRP 25125 TBG V1J
BKW	0.943 kW(L)	FRAME	90 L	QTY.	02 Nos.
HEAD (m)	17	PHASE	3	TAG. NO.	90PBM61AP001/90PBM62AP001
CAP (m³/hr)	2.5	RPM	2900	SERVICE	WASTE WATER SG:-1.025
SIZE	40x25 mm	KW / HP	2.2/3	ACCOUNT	DE NORA INDIA LTD
PUMP DETAILS		MOTOR DETAILS		PROJECT	2x660 MW ENNORE SEZ COAL BASED STPP
				P.O. NO.	*
				CLIENT	BHARAT HEAVY ELECTRICAL LTD

APPROVAL STAMP

FOUNDATION DETAIL



DRILLED AS PER - ANSI B 16.5 #150 RF



25	130	20	51	4	14	79.5
40	162	25	73	4	14	98.5
DN	ØD	T	RF Ø	N	Ød	P
SUCTION & DELIVERY FLANGE DIMENSIONS						

GENERAL TOLERANCE = ±5

ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE SPECIFIED.

00	09.01.18	MBP	DMD	JKS	NTS
REV. NO.	DATE	DRWN BY	CHKD BY	APRVD BY	SCALE

TITLE : GENERAL ARRANGEMENT DRAWING

DRG. NO. : AEPL / GAD /NZ 25x125 (PC -16 LTR)

ANTICO

ANTICORROSIVE EQUIPMENT PVT. LTD.

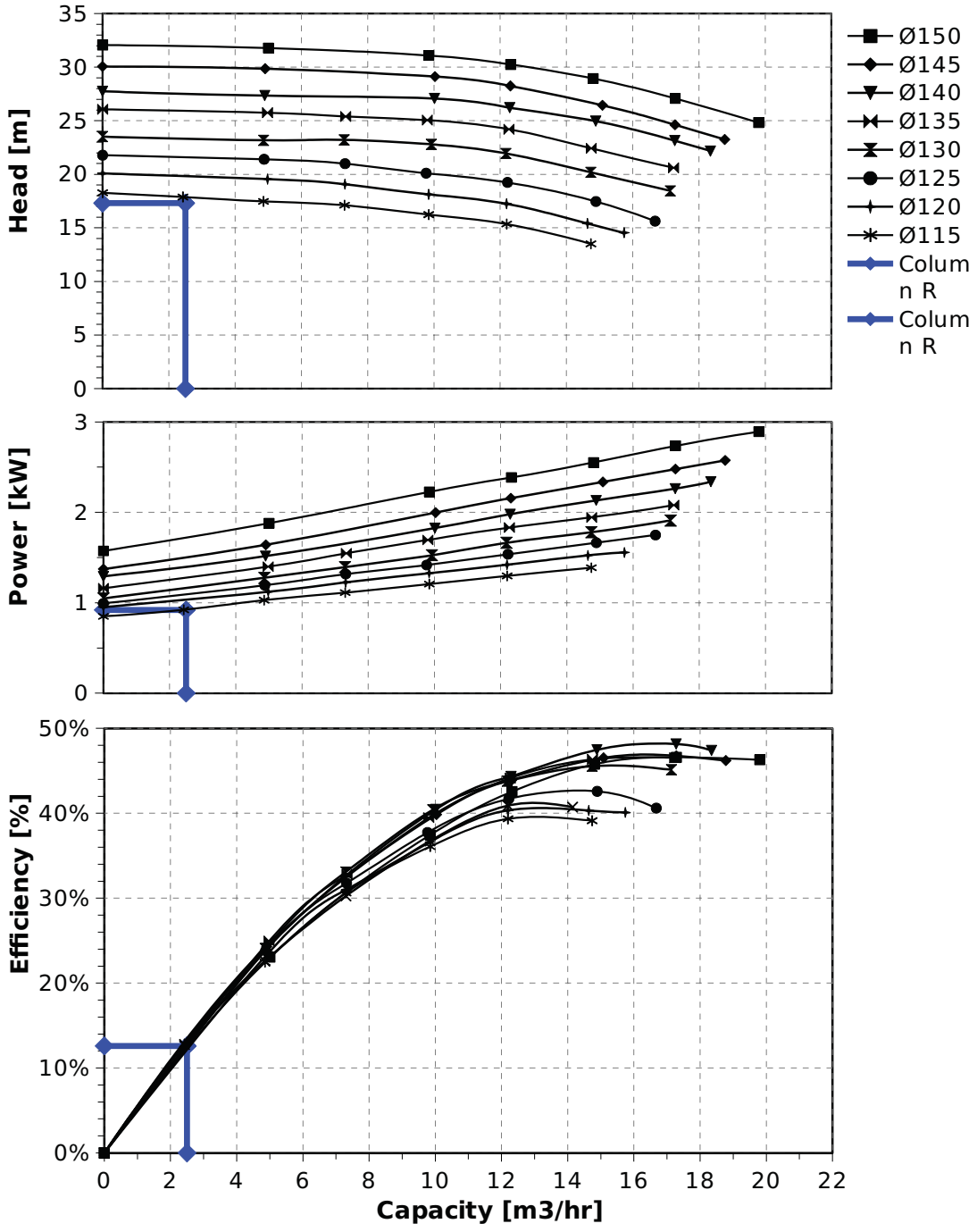
ANTICO
moulded non metallic pumps

Anticorrosive Equipment Pvt. Ltd.

Performance Curve

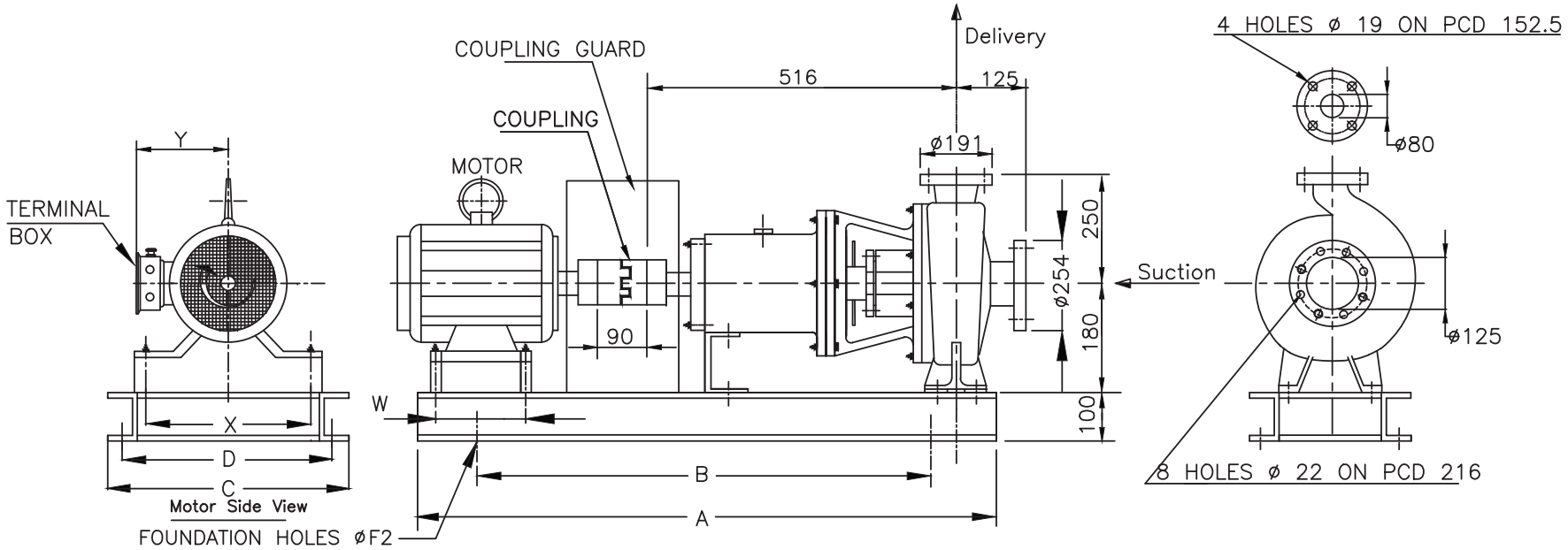
Tested with water @ ambient condition

PROJECT	2 X 660 MW ENNORE SEZ COAL BASED STPP; Neutralisation Pit Pump for Dewatering Service				***REF NO.***	Bhel Doc. No.: PE-V11-412-174-A110		
CONSULT.	DE NORA INDIA LTD				***GRAPH NO.***	AEPL/NZ/25125/2900		
CLIENT	BHARAT HEAVY ELECTRICALS LTD				***DATE***	07.01.2018	***REV***	0
TAG NO	***MODEL***	***SIZE***	***HEAD, m***	***CAPACITY, m³/hr***	***EFFICIENCY***	***RPM***	***kW / HP***	***BID IMP, mm***
90PBM61AP001, 90PBM62AP001	NZ	40 x 25	**17**	**2.5**	12%	2900	2.2/3	115 mm



PROJECT:	2x660MW ENNORE SEZ COAL BASED STPP			ELECTRO CHLORINATION PACKAGE	
CONTRACTOR:	BHARAT HEAVY ELECTRICALS LIMITED			TECHNICAL DATASHEET OF VERTICAL/ HORIZONTAL PUMPS	REV
BIDDER/ VENDOR:	DE NORA INDIA LIMITED				
DATASHEET FOR:	HYPOCHLORITE CONTINUOUS DOSING PUMP FOR CW FORBAY			BHEL DOC. NO. : PE-V11-412-174-A110	1
GENERAL	1	TAG NO(S)		90PBM41AP001 / 90PBM42AP001	
	2	SERVICE		HYPOCHLORITE CONTINOUS DOSING FOR CW FOREBAY	
	3	QUANTITY	No.	2	
	4	RATING		100%	
	5	MANUFACTURER		M/s Process Pumps (I) Pvt Ltd	
	6	MODEL		PPH-8S	
OPERATING CONDITIONS	7	DUTY		CONTINUOUS	
	8	FLUID HANDLED		SEA WATER + 0.2% NaOH	
	9	SPECIFIC GRAVITY		1.025	
	10	TEMPERATURE	Deg C	25 - 37	
	11	NPSH AVAILABLE		FLOODED SUCTION	
	12	DISCHARGE PRESSURE (OPERATING)	m	32	
	13	CAPACITY (OPERATING)	m^3/h	107.4	
	14	SUCTION CONDITION		FLOODED	
	15	LOCATION		INDOOR	
PERFORMANCE	16	CAPACITY (DESIGN)	m^3/h	120	
	17	TOTAL DIFFERENTIAL HEAD (DESIGN)	m	32.0	
	18	DESIGN CODE		ISO 2858	
	19	ROTATION		CLOCKWISE FROM DRIVE END	
	20	NPSH REQUIRED	m	3	
	21	SHUT OFF PRESSURE	m	42	
	22	RPM	rpm	2900	
	23	EFFICIENCY	%	70	
	24	SHAFT ABSORBED POWER	kW	15.32	
CONSTRUCTION	25	TYPE		END SUCTION W/ CLOSED IMPELLER	
	26	COUPLING		LOVE JOY COUPLING	
	27	NUMBER OF IMPELLER	No.	1	
	28	NUMBER OF STAGE		SINGLE	
	29	SUCTION NOZZLE SIZE/TYPE		125 NB / FLANGE ANSI #150 FF	
	30	DISCHARGE NOZZLE SIZE/TYPE		80 NB/ FLANGE ANSI #150 FF	
	31	SEAL TYPE		MECHANICAL SEAL	
	32	WEIGHT (PUMP + MOTOR +BASE FRAME)	KG	275 (APPROX.)	
MATERIAL	33	CASING		ASTM B265 Ti Gr-II	
	34	IMPELLER		ASTM B265 Ti Gr-II	
	35	BACK PLATE		ASTM B265 Ti Gr-II	
	36	SHAFT		Duplex SS 2205 UNS S31803	
	37	SHAFT SLEEVE		ASTM B265 Ti Gr-II	
	38	BASE FRAME		MS WITH EPOXY PAINT	
	39	MECHANICAL SEAL COMPONENTS		SS316	
	40	FASTENER		SS316L 1	
MOTOR	41	TYPE		SQUIRREL CAGE , TEFC, IE2 < 10 KW & IE3 >10 KW	
	42	TEMP CLASS		B	
	43	INSULATION CLASS		F	
	44	POWER	kW	18.5	
	45	VOLTAGE		415V/ 50Hz/ 3Ph	
	46	HAZARDOUS CLASS		SAFE AREA, INDOOR	
	47	MANUFACTURER		CG / BHARAT BIJLEE/ ABB	
	48	DEGREE OF PROTECTION		IP55	
NOTES :					

GENERAL ARRANGEMENT FOR HORIZONTAL BPO PUMPS

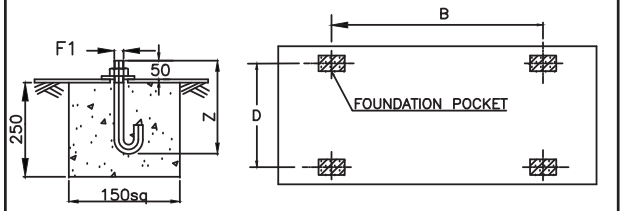


Frame Size	A	B	C	D	W	X	Y	F1	F2	Z	Motor Wt.	Frame Wt.
160L	1190	900	430	390	254	254	275	M16	18	200	148 Kg	38Kg

Offer No. : PHO/CQ/MH/619C/17 Dated :02.08.2017

Pump Qty : 02 Nos

FOUNDATION DETAILS



PUMP DETAILS				MOTOR DETAILS	
MODEL	PPH–8S	FLOW RATE	120 m3/hr	MAKE	ABB/BBL/CGL/KIRLOSKAR SIEMENS/MARATHON/HAVELLS
SIZE	125X80X200	HEAD	32 MLC	KW/HP	18.5/25
COUPLING	Love–Joy	LIQUID	SEA WATER	RPM	2900
Coupling Wt	5.0 Kg	Sp.Gr.	1.025	FRAME SIZE	160L
Pump Wt	80 Kg	TEMP (C)	25–37	SPECIAL FEATURES	IE3
CUSTOMER	M/s DeNora India Ltd			TAG No.	90PBM41AP001/90PBM42AP001

Flanges Tolerance (ASME B16.5)	
Bolt Circle PCD	±0.8
Bolt Circle diameter	±1.5

Base Frame Linear Dimension Tolerance (API–610)			
A (0–2755)	B (0–1475)	C (0–2755)	D (0–770)
±25	±3.0	±13	±3

DO NOT SCALE THE DRAWING.

ALL DIMENSIONS ARE IN MM.

APPROVED	Mahadev	16.07.2012
CHECKED	Srinivas	16.07.2012
DESIGNED	Mahadev	16.07.2012
DRAWN	Manju	16.07.2012

PROCESS PUMPS (I) PVT. LTD.
No. 86, PEENYA INDUSTRIAL AREA, PEENYA, BANGALORE–560058

SCALE NTS

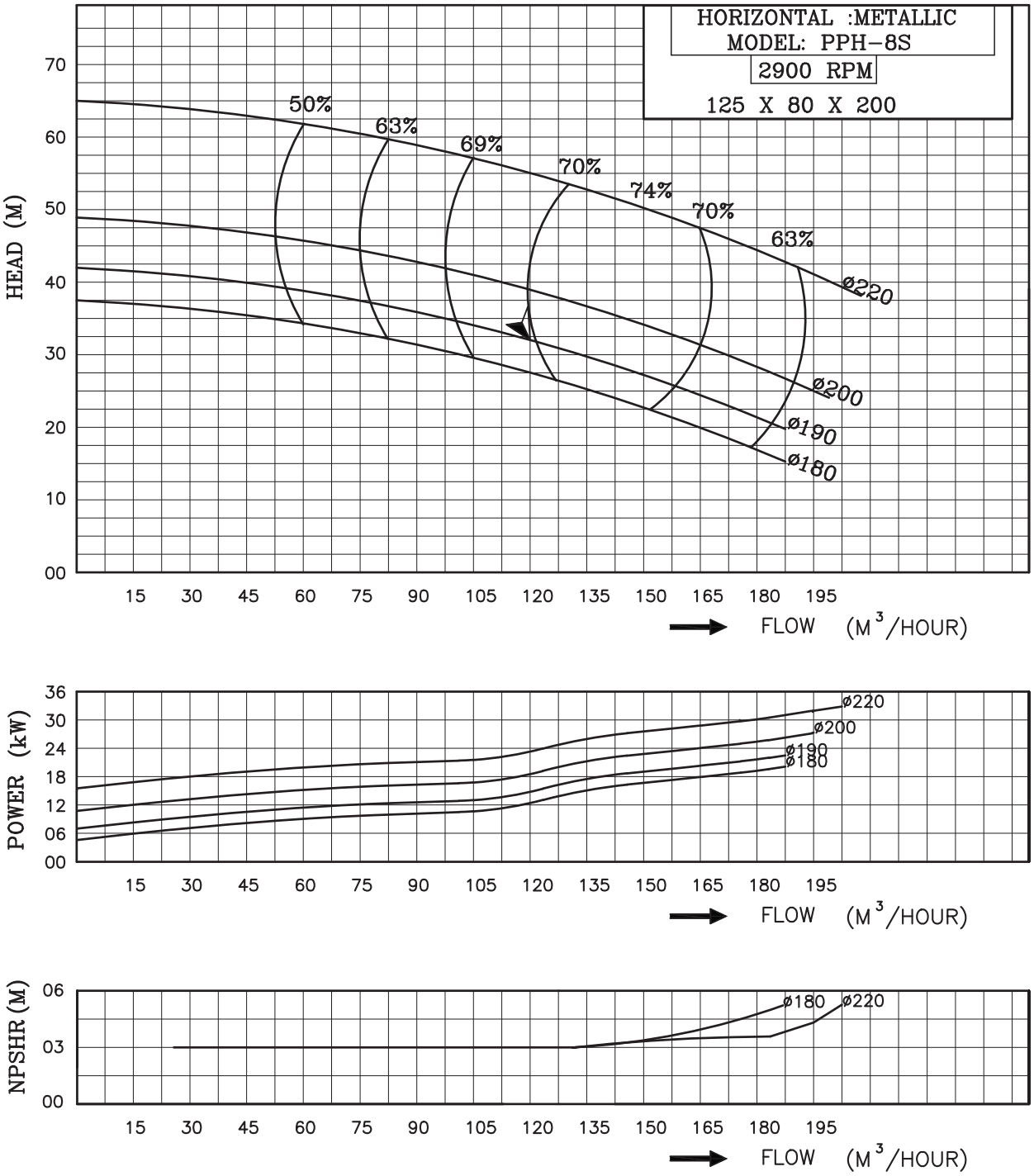
TITLE: GA DRAWING FOR PPH–8S

PROJECTION

REV No. 0 | DRG.No. GA–PPH–8S–LJ/04 | FILE NO GA–DWG–24

*Original signature are available in the master copy. As this is an issued digital copy in confirmance with the master copy,no original signature is required.

CHARACTERISTIC CURVE



DRAWN	MANJU		08.12.2012
CHECKED	SRK		08.12.2012
APPROVED	SRK		08.12.2012

DWG.NO.N05–CC–M–PPH–8S–2900
D/CC/CURVES/010405

PROCESS PUMPS (I) Pvt. Ltd.,
PLOT No. 86 , PEENYA INDUSTRIAL AREA,
BANGALORE – 560 058.

Customer Name : M/s.De Nora india ltd

Offer No. : PHO/CQ/MH/619C/17 Dated :02.08.2017

Pump Tag No. : 90PBM41AP001/90PBM42AP001

Pump Qty : 02 Nos

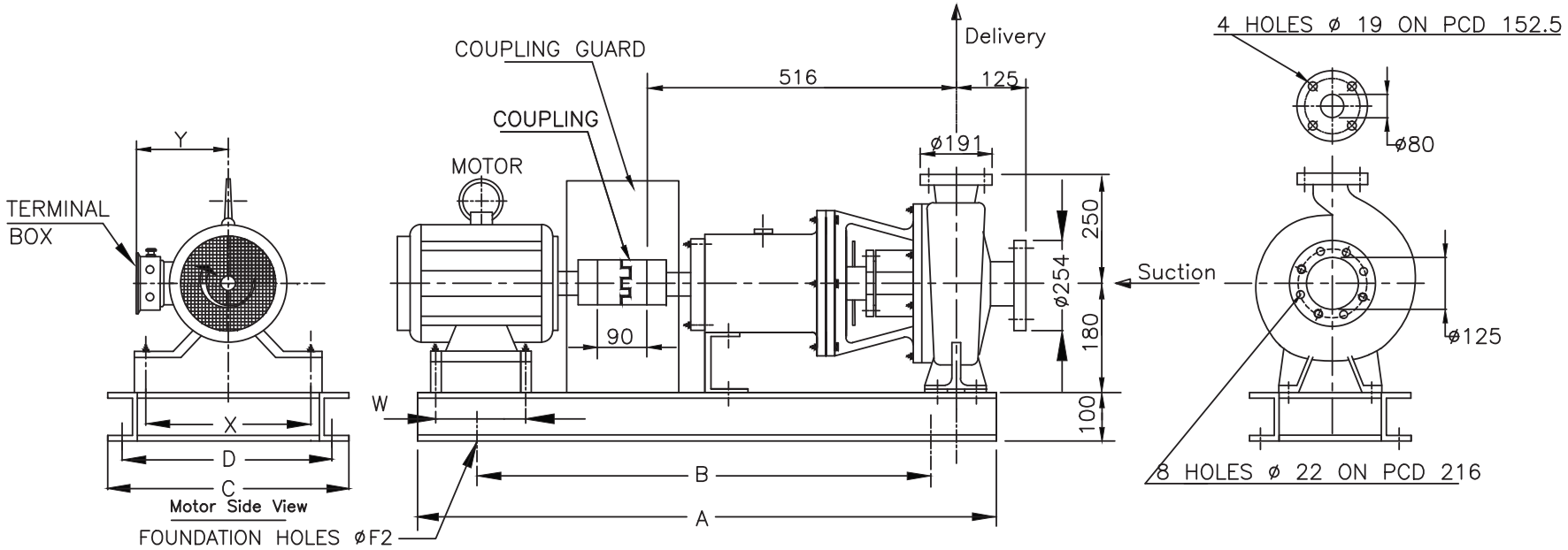
Capacity : 120 cmph BKW :15.32 kw

Head : 32 mlc

Efficiency : 70% Imp Type : Closed

PROJECT:	2x660MW ENNORE SEZ COAL BASED STPP			ELECTRO CHLORINATION PACKAGE	
CONTRACTOR:	BHARAT HEAVY ELECTRICALS LIMITED			TECHNICAL DATASHEET OF VERTICAL/ HORIZONTAL PUMPS	REV
BIDDER/ VENDOR:	DE NORA INDIA LIMITED				
DATASHEET FOR:	HYPOCHLORITE SHOCK DOSING PUMP FOR CW FORBAY			BHEL DOC. NO. : PE-V11-412-174-A110	1
GENERAL	1	TAG NO(S)		90PBM43AP001 / 90PBM44AP001 / 90PBM45AP001	
	2	SERVICE		HYPOCHLORITE SHOCK DOSING FOR CW FOREBAY	
	3	QUANTITY	No.	3	
	4	RATING		50%	
	5	MANUFACTURER		M/s Process Pumps (I) Pvt Ltd	
	6	MODEL		PPH-8S	
OPERATING CONDITIONS	7	DUTY		INTERMITTENT	
	8	FLUID HANDLED		SEA WATER + 0.2% NaOH	
	9	SPECIFIC GRAVITY		1.025	
	10	TEMPERATURE	Deg C	25 - 37	
	11	NPSH AVAILABLE		FLOODED SUCTION	
	12	DISCHARGE PRESSURE (OPERATING)	m	32	
	13	CAPACITY (OPERATING)	m^3/h	107.4	
	14	SUCTION CONDITION		FLOODED	
	15	LOCATION		INDOOR	
PERFORMANCE	16	CAPACITY (DESIGN)	m^3/h	120	
	17	TOTAL DIFFERENTIAL HEAD (DESIGN)	m	32.0	
	18	DESIGN CODE		ISO 2858	
	19	ROTATION		CLOCKWISE FROM DRIVE END	
	20	NPSH REQUIRED	m	3	
	21	SHUT OFF PRESSURE	m	42	
	22	RPM	rpm	2900	
	23	EFFICIENCY	%	70	
	24	SHAFT ABSORBED POWER	kW	15.32	
CONSTRUCTION	25	TYPE		END SUCTION W/ CLOSED IMPELLER	
	26	COUPLING		LOVE JOY COUPLING	
	27	NUMBER OF IMPELLER	No.	1	
	28	NUMBER OF STAGE		SINGLE	
	29	SUCTION NOZZLE SIZE/TYPE		125 NB / FLANGE ANSI #150 FF	
	30	DISCHARGE NOZZLE SIZE/TYPE		80 NB/ FLANGE ANSI #150 FF	
	31	SEAL TYPE		MECHANICAL SEAL	
	32	WEIGHT (PUMP + MOTOR +BASE FRAME)	KG	275 (APPROX.)	
MATERIAL	33	CASING		ASTM B265 Ti Gr-II	
	34	IMPELLER		ASTM B265 Ti Gr-II	
	35	BACK PLATE		ASTM B265 Ti Gr-II	
	36	SHAFT		Duplex SS 2205 UNS S31803	
	37	SHAFT SLEEVE		ASTM B265 Ti Gr-II	
	38	BASE FRAME		MS WITH EPOXY PAINT	
	39	MECHANICAL SEAL COMPONENTS		SS316	
	40	FASTENER		SS316L 1	
MOTOR	41	TYPE		SQUIRREL CAGE , TEFC, IE2 < 10 KW & IE3 >10 KW	
	42	TEMP CLASS		B	
	43	INSULATION CLASS		F	
	44	POWER	kW	18.5	
	45	VOLTAGE		415V/ 50Hz/ 3Ph	
	46	HAZARDOUS CLASS		SAFE AREA, INDOOR	
	47	MANUFACTURER		CG / BHARAT BIJLEE/ ABB	
	48	DEGREE OF PROTECTION		IP55	
NOTES :					

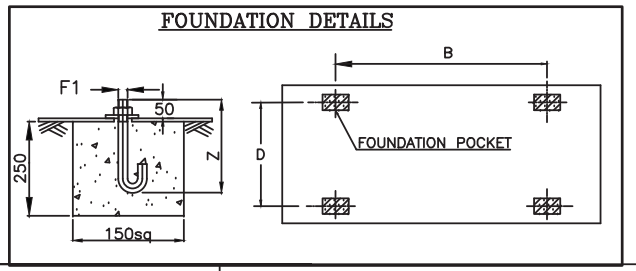
GENERAL ARRANGEMENT FOR HORIZONTAL BPO PUMPS



Frame Size	A	B	C	D	W	X	Y	F1	F2	Z	Motor Wt.	Frame Wt.
160L	1190	900	430	390	254	254	275	M16	18	200	148 Kg	38Kg

Offer No. : PHO/CQ/MH/619C/17 Dated :02.08.2017

Pump Qty : 03Nos



PUMP DETAILS				MOTOR DETAILS	
MODEL	PPH–8S	FLOW RATE	120 m3/hr	MAKE	ABB/BBL/CGL/KIRLOSKAR SIEMENS/MARATHON/HAVELLS
SIZE	125X80X200	HEAD	32 MLC	KW/HP	18.5/25
COUPLING	Love–Joy	LIQUID	SEA WATER	RPM	2900
Coupling Wt	5.0 Kg	Sp.Gr.	1.025	FRAME SIZE	160L
Pump Wt	80 Kg	TEMP (C)	25–37	SPECIAL FEATURES	IE3

CUSTOMER	M/s DeNora India Ltd	TAG No.	90PBM43AP001/90PBM44AP001 90PBM45AP001

Flanges Tolerance (ASME B16.5)	
Bolt Circle PCD	±0.8
Bolt Circle diameter	±1.5

Base Frame Linear Dimension Tolerance (API–610)			
A (0–2755)	B (0–1475)	C (0–2755)	D (0–770)
±25	±3.0	±13	±3

DO NOT SCALE THE DRAWING.

ALL DIMENSIONS ARE IN MM.

APPROVED	Mahadev	16.07.2012
CHECKED	Srinivas	16.07.2012
DESIGNED	Mahadev	16.07.2012
DRAWN	Manju	16.07.2012

PROCESS PUMPS (I) PVT. LTD.
No. 86, PEENYA INDUSTRIAL AREA, PEENYA, BANGALORE–560058

SCALE NTS

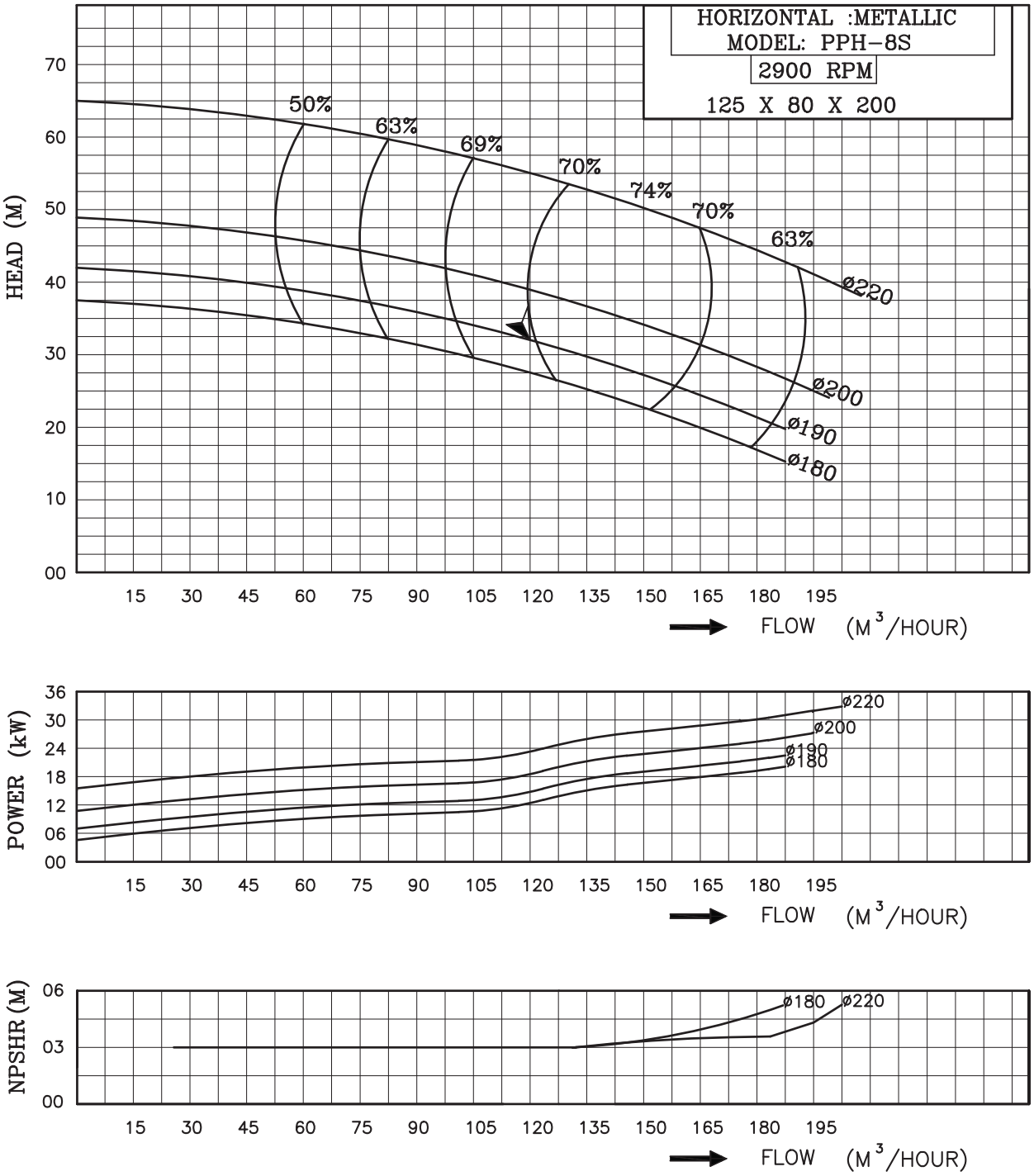
TITLE: GA DRAWING FOR PPH–8S

PROJECTION

REV No. 0 | DRG.No. GA–PPH–8S_LJ/04 | FILE NO GA–DWG–24

*Original signature are available in the master copy. As this is an issued digital copy in confirmance with the master copy,no original signature is required.

CHARACTERISTIC CURVE



DRAWN	MANJU		08.12.2012
CHECKED	SRK		08.12.2012
APPROVED	SRK		08.12.2012

DWG.NO.N05–CC–M–PPH–8S–2900
D/CC/CURVES/010405

PROCESS PUMPS (I) Pvt. Ltd.,
PLOT No. 86 , PEENYA INDUSTRIAL AREA,
BANGALORE – 560 058.

Customer Name : M/s.De Nora india ltd

Offer No. : PHO/CQ/MH/619C/17 Dated :02.08.2017

Pump Tag No. : 90PBM43AP001/90PBM44AP001/90PBM45AP001

Pump Qty : 03 Nos

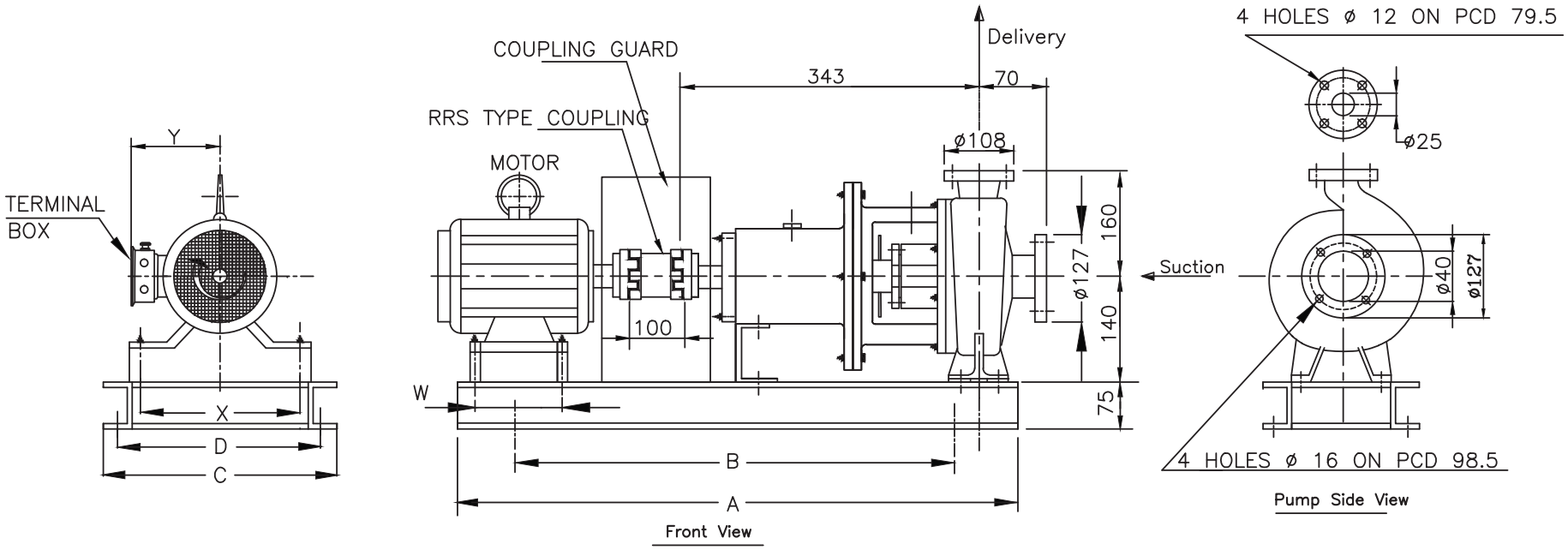
Capacity : 120 cmph BKW :15.32 kw

Head : 32 mlc

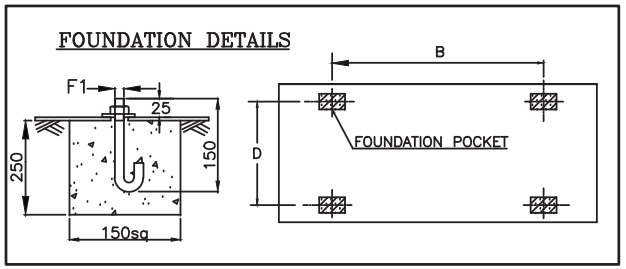
Efficiency : 70% Imp Type : Closed

PROJECT:	2x660MW ENNORE SEZ COAL BASED STPP			ELECTRO CHLORINATION PACKAGE	
CONTRACTOR:	BHARAT HEAVY ELECTRICALS LIMITED			TECHNICAL DATASHEET OF VERTICAL/ HORIZONTAL PUMPS	REV
BIDDER/ VENDOR:	DE NORA INDIA LIMITED				
DATASHEET FOR:	HYPOCHLORITE DOSING PUMP FOR PTP STILLING CHAMBER			BHEL DOC. NO. : PE-V11-412-174-A110	1
GENERAL	1	TAG NO(S)		90PBM46AP001 / 90PBM47AP001	
	2	SERVICE		HYPOCHLORITE CONTINOUS DOSING FOR PTP STILLING CHAMBER	
	3	QUANTITY	No.	2	
	4	RATING		100%	
	5	MANUFACTURER		M/s Process Pumps (I) Pvt Ltd	
	6	MODEL		PPH-C	
OPERATING CONDITIONS	7	DUTY		CONTINUOUS	
	8	FLUID HANDLED		SEA WATER + 0.2% NaOH	
	9	SPECIFIC GRAVITY		1.025	
	10	TEMPERATURE	Deg C	25 - 37	
	11	NPSH AVAILABLE		FLOODED SUCTION	
	12	DISCHARGE PRESSURE (OPERATING)	m	32	
	13	CAPACITY (OPERATING)	m^3/h	7.88	
	14	SUCTION CONDITION		FLOODED	
	15	LOCATION		INDOOR	
PERFORMANCE	16	CAPACITY (DESIGN)	m^3/h	9	
	17	TOTAL DIFFERENTIAL HEAD (DESIGN)	m	32.0	
	18	DESIGN CODE		ISO 2858	
	19	ROTATION		CLOCKWISE FROM DRIVE END	
	20	NPSH REQUIRED	m	2	
	21	SHUT OFF PRESSURE	m	37.5	
	22	RPM	rpm	2900	
	23	EFFICIENCY	%	44	
	24	SHAFT ABSORBED POWER	kW	1.82	
CONSTRUCTION	25	TYPE		END SUCTION W/ CLOSED IMPELLER	
	26	COUPLING		LOVE JOY COUPLING	
	27	NUMBER OF IMPELLER	No.	1	
	28	NUMBER OF STAGE		SINGLE	
	29	SUCTION NOZZLE SIZE/TYPE		40 NB / FLANGE ANSI #150 FF	
	30	DISCHARGE NOZZLE SIZE/TYPE		25 NB/ FLANGE ANSI #150 FF	
	31	SEAL TYPE		MECHANICAL SEAL	
	32	WEIGHT (PUMP + MOTOR +BASE FRAME)	KG	90 (APPROX.)	
MATERIAL	33	CASING		ASTM B265 Ti Gr-II	
	34	IMPELLER		ASTM B265 Ti Gr-II	
	35	BACK PLATE		ASTM B265 Ti Gr-II	
	36	SHAFT		Duplex SS 2205 UNS S31803	
	37	SHAFT SLEEVE		ASTM B265 Ti Gr-II	
	38	BASE FRAME		MS WITH EPOXY PAINT	
	39	MECHANICAL SEAL COMPONENTS		SS316	
	40	FASTENER		SS316L 1	
MOTOR	41	TYPE		SQUIRREL CAGE , TEFC, IE2 < 10 KW & IE3 >10 KW	
	42	TEMP CLASS		B	
	43	INSULATION CLASS		F	
	44	POWER	kW	2.2	
	45	VOLTAGE		415V/ 50Hz/ 3Ph	
	46	HAZARDOUS CLASS		SAFE AREA, INDOOR	
	47	MANUFACTURER		CG / BHARAT BIJLEE/ ABB	
	48	DEGREE OF PROTECTION		IP55	
NOTES :					

GENERAL ARRANGEMENT FOR HORIZONTAL BPO PUMPS



Base Frame Dimensions											
Frame Size	A	B	C	D	W	X	Y	F1	F2	Motor Wt.	B.Frame Wt.
90L	745	600	300	260	125	140	140	M12	14	25 Kg	19 Kg



Offer No. : PHO/CQ/MH/619C/17 Dated :02.08.2017

Pump Qty : 02 Nos

PUMP DETAILS				MOTOR DETAILS	
MODEL	PPH–C	FLOW RATE	09 m3/hr	MAKE	ABB/BBL/CGL/KIRLOSKAR SIEMENS/MARATHON/HAVELLS
SIZE	40X25X160	HEAD	32 MLC	KW/HP	2.2/3
COUPLING	Love–Joy	LIQUID	Sea Water	RPM	2900
COUPLING WEIGHT	3.5 Kg	Sp.Gr.	1.025	FRAME SIZE	90L
PUMP	35 Kg	TEMP (C)	25–37	SPECIAL FEATURES	IE2

CUSTOMER	M/s DeNora India Ltd	TAG No.	90PBM46AP001/90PBM47AP001

FOUNDATION POCKET

Flanges Tolerance (ASME B16.5)	
Bolt Circle PCD	±0.8
Bolt Circle diameter	±1.5

Base Frame Linear Dimension Tolerance (API–610)			
A (0–2755)	B (0–1475)	C (0–2755)	D (0–770)
±25	±3.0	±13	±3

DO NOT SCALE THE DRAWING.

ALL DIMENSIONS ARE IN MM.

APPROVED	Mahadev	16.07.2012
CHECKED	Srinivas	16.07.2012
DESIGNED	Mahadev	16.07.2012
DRAWN	Manju	16.07.2012

PROCESS PUMPS (I) PVT. LTD.
No. 86, PEENYA INDUSTRIAL AREA, PEENYA, BANGALORE–560058

SCALE NTS

TITLE: GA DRAWING FOR PPH–C

PROJECTION

REV No. 0 | DRG.No. GA–PPH–C–LJ/04 | FILE NO GA–DWG–24

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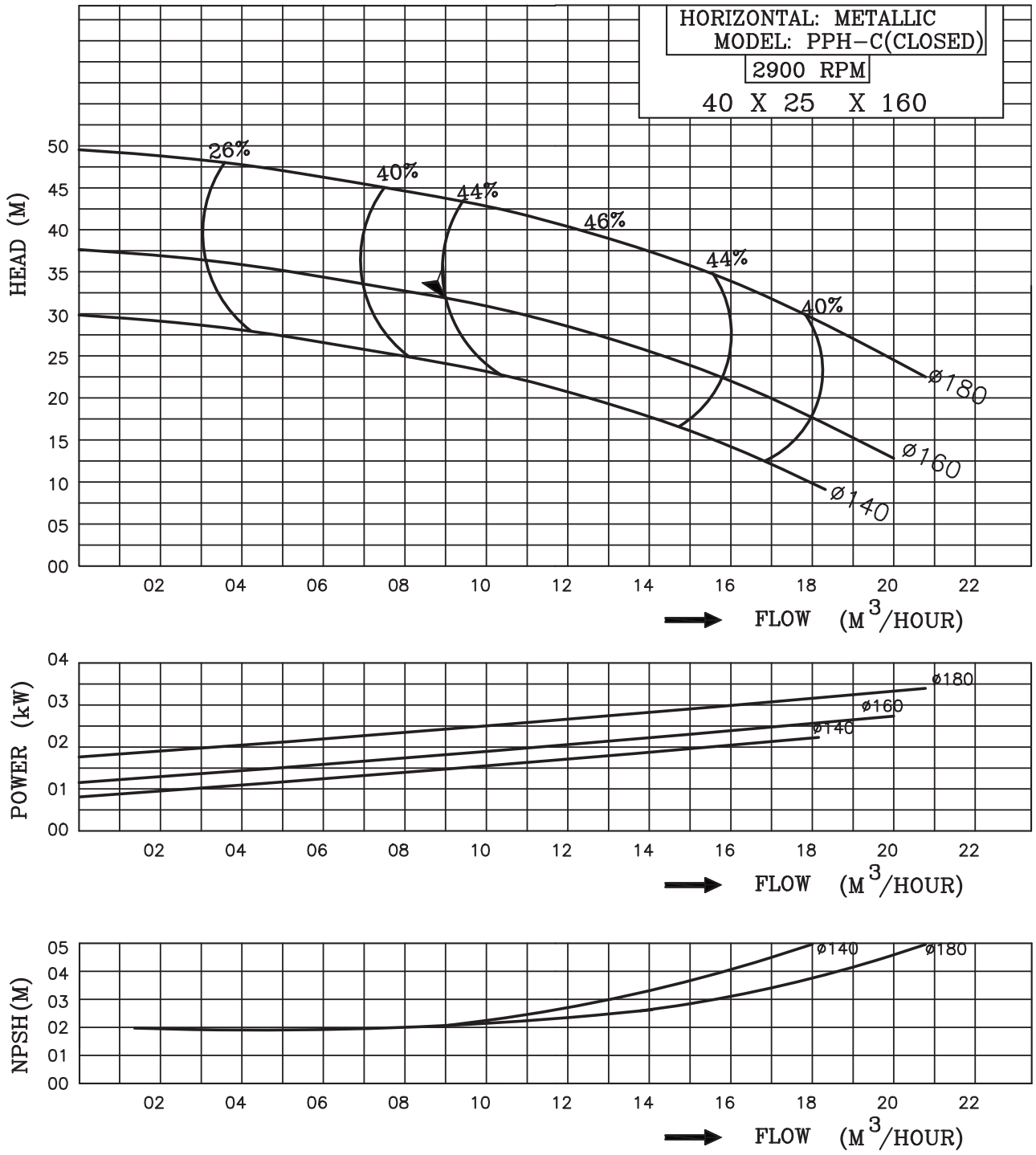
CHARACTERISTIC CURVE



DRAWN	MANJU	30.09.2015
CHECKED	SHARATH	30.09.2015
APPROVED	DHEERESH	30.09.2015
DWG.NO.:N05–CC–M–PPH–C–2900		

PROCESS PUMPS (I) Pvt. Ltd.,
PLOT No. 86 , PEENYA INDUSTRIAL AREA,
BANGALORE – 560 058.

Customer Name : M/s.De Nora india ltd

Offer No. : PHO/CQ/MH/619C/17 Dated :02.08.2017

Pump Tag No. : 0PBM46AP001/0PBM47AP001

Pump Qty : 02 Nos

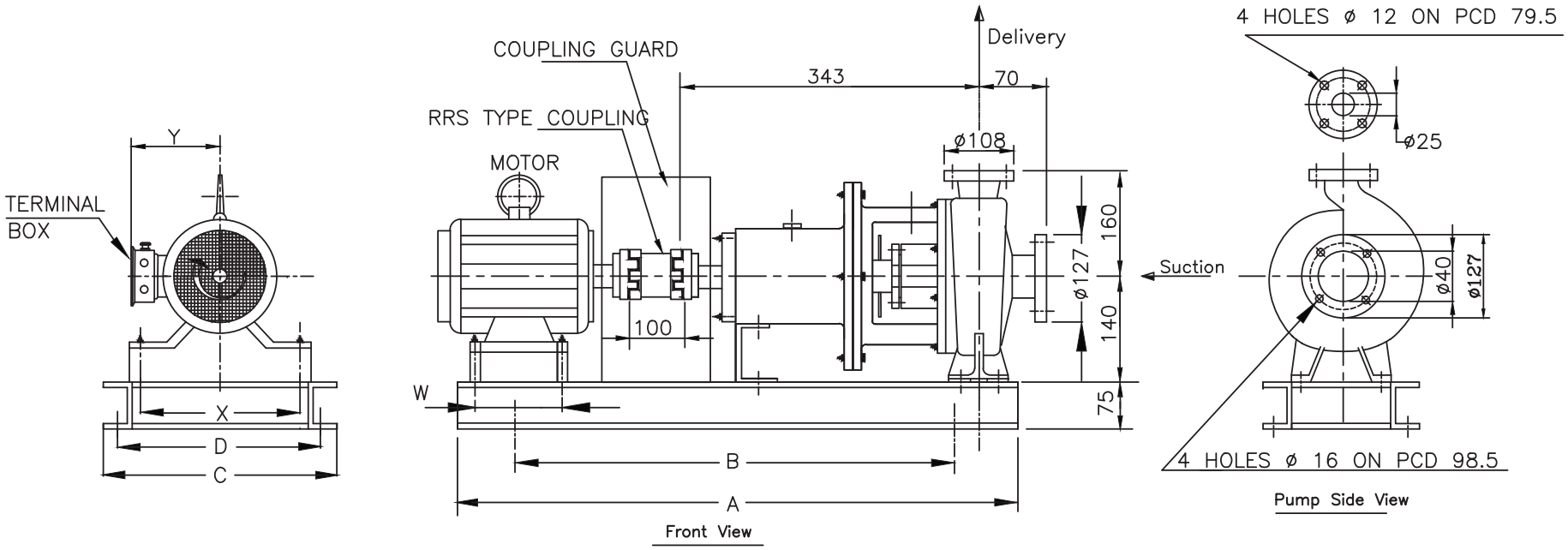
Capacity : 09 cmph BKW :1.82 kw

Head : 32 mlc

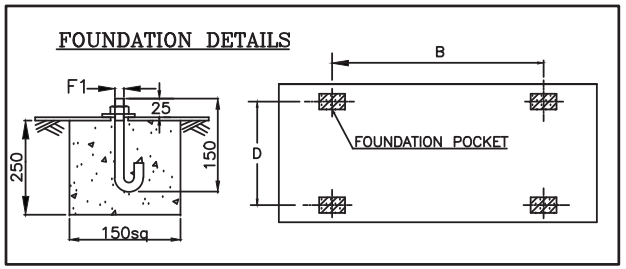
Efficiency : 44% Imp Type : Closed

PROJECT:	2x660MW ENNORE SEZ COAL BASED STPP			ELECTRO CHLORINATION PACKAGE	
CONTRACTOR:	BHARAT HEAVY ELECTRICALS LIMITED			TECHNICAL DATASHEET OF VERTICAL/ HORIZONTAL PUMPS	REV
BIDDER/ VENDOR:	DE NORA INDIA LIMITED				
DATASHEET FOR:	HYPOCHLORITE DOSING PUMP FOR SEA WATER INTAKE			BHEL DOC. NO. : PE-V11-412-174-A110	1
GENERAL	1	TAG NO(S)		90PBM81AP001 / 90PBM82AP001	
	2	SERVICE		HYPOCHLORITE CONTINOUS DOSING FOR SEA WATER INTAKE	
	3	QUANTITY	No.	2	
	4	RATING		100%	
	5	MANUFACTURER		M/s Process Pumps (I) Pvt Ltd	
	6	MODEL		PPH-C	
OPERATING CONDITIONS	7	DUTY		CONTINUOUS	
	8	FLUID HANDLED		SEA WATER + 0.2% NaOH	
	9	SPECIFIC GRAVITY		1.025	
	10	TEMPERATURE	Deg C	25 - 37	
	11	NPSH AVAILABLE		FLOODED SUCTION	
	12	DISCHARGE PRESSURE (OPERATING)	m	32	
	13	CAPACITY (OPERATING)	m^3/h	10.4	
	14	SUCTION CONDITION		FLOODED	
	15	LOCATION		INDOOR	
PERFORMANCE	16	CAPACITY (DESIGN)	m^3/h	12	
	17	TOTAL DIFFERENTIAL HEAD (DESIGN)	m	32.0	
	18	DESIGN CODE		ISO 2858	
	19	ROTATION		CLOCKWISE FROM DRIVE END	
	20	NPSH REQUIRED	m	2.5	
	21	SHUT OFF PRESSURE	m	41	
	22	RPM	rpm	2900	
	23	EFFICIENCY	%	46	
	24	SHAFT ABSORBED POWER	kW	3.7	
CONSTRUCTION	25	TYPE		END SUCTION W/ CLOSED IMPELLER	
	26	COUPLING		LOVE JOY COUPLING	
	27	NUMBER OF IMPELLER	No.	1	
	28	NUMBER OF STAGE		SINGLE	
	29	SUCTION NOZZLE SIZE/TYPE		40 NB / FLANGE ANSI #150 FF	
	30	DISCHARGE NOZZLE SIZE/TYPE		25 NB/ FLANGE ANSI #150 FF	
	31	SEAL TYPE		MECHANICAL SEAL	
	32	WEIGHT (PUMP + MOTOR +BASE FRAME)	KG	95 (APPROX.)	
MATERIAL	33	CASING		ASTM B265 Ti Gr-II	
	34	IMPELLER		ASTM B265 Ti Gr-II	
	35	BACK PLATE		ASTM B265 Ti Gr-II	
	36	SHAFT		Duplex SS 2205 UNS S31803	
	37	SHAFT SLEEVE		ASTM B265 Ti Gr-II	
	38	BASE FRAME		MS WITH EPOXY PAINT	
	39	MECHANICAL SEAL COMPONENTS		SS316	
	40	FASTENER		SS316L 1	
MOTOR	41	TYPE		SQUIRREL CAGE , TEFC, IE2 < 10 KW & IE3 >10 KW	
	42	TEMP CLASS		B	
	43	INSULATION CLASS		F	
	44	POWER	kW	3.7	
	45	VOLTAGE		415V/ 50Hz/ 3Ph	
	46	HAZARDOUS CLASS		SAFE AREA, INDOOR	
	47	MANUFACTURER		CG / BHARAT BIJLEE/ ABB	
	48	DEGREE OF PROTECTION		IP55	
NOTES :					

GENERAL ARRANGEMENT FOR HORIZONTAL BPO PUMPS



Base Frame Dimensions											
Frame Size	A	B	C	D	W	X	Y	F1	F2	Motor Wt.	B.Frame Wt.
100L	780	600	300	260	140	160	150	M12	14	36 Kg.	20 Kg



Offer No. : PHO/CQ/MH/619C/17 Dated :02.08.2017

Pump Qty : 02 Nos

PUMP DETAILS				MOTOR DETAILS	
MODEL	PPH–C	FLOW RATE	12 m3/hr	MAKE	ABB/BBL/CGL/KIRLOSKAR SIEMENS/MARATHON/HAVELLS
SIZE	40X25X160	HEAD	32 MLC	KW/HP	3.7/5
COUPLING	Love–Joy	LIQUID	Sea Water	RPM	2900
COUPLING WEIGHT PUMP	3.5 Kg 35 Kg	Sp.Gr.	1.025	FRAME SIZE	100L
		TEMP (C)	25–37	SPECIAL FEATURES	IE2

CUSTOMER	M/s DeNora India Ltd	TAG No.	0PBM81AP001/0PBM82AP001

FOUNDATION POCKET

Flanges Tolerance (ASME B16.5)	
Bolt Circle PCD	±0.8
Bolt Circle diameter	±1.5

Base Frame Linear Dimension Tolerance (API–610)			
A (0–2755)	B (0–1475)	C (0–2755)	D (0–770)
±25	±3.0	±13	±3

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APPROVED	Mahadev	16.07.2012
CHECKED	Srinivas	16.07.2012
DESIGNED	Mahadev	16.07.2012
DRAWN	Manju	16.07.2012

PROCESS PUMPS (I) PVT. LTD.
No. 86, PEENYA INDUSTRIAL AREA, PEENYA, BANGALORE–560058

SCALE NTS

TITLE: GA DRAWING FOR PPH–C

PROJECTION

REV No. 0 | DRG.No. GA–PPH–C–LJ/04 | FILE NO GA–DWG–24

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