TELANGANA STATE POWER GENERATION CORPORATION LIMITED (TSGENCO)

5X800 MW YADADRI

SUPERCRITICAL THERMAL POWER PROJECT

****

VOLUME – II B

****

TECHNICAL SPECIFICATION
FOR
HYDROGEN GENERATION PLANT

****

SPECIFICATION NO. PE-TS-417-168-A001, R0

****

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

	TITLE : 5X800 MW YADADRI TPS	SPECIFICATION NO.	
		SECTION :	
	TECHNICAL SPECIFICATION FOR HYDROGEN GENERATION PLANT	REV. NO.	

CONTENTS

PROJECT INFORMATION

YADADRI THERMAL POWER STATION

PROJECT INFORMATION

1	Name of the Project	YADADRI Thermal Power Station
2	Station Capacity	5X800 MW (Coal based)
3	Owner	Telangana State Power Generation Corporation Limited (**TSGENCO**)
4	Site Location	Site is located 7 km from the NH5.
5	Latitude	*16° 42*'20.40 N
6	Longitude	79° 34'41.56 E
7	Nearest Town	30 Km Miryalaguda
8	Nearest Railway Station	6.5 Km Damercherla
9	Nearest Airport	130 Kms (Vijayawada)
10	**Site Conditions**	
	Ambient Temperature	
	Daily minimum (average)	10°C
	Daily maximum (average)	47°C
	Design Ambient Temperature	50°C
	Ambient temperature (performance)	38°C
	Relative Humidity for design / efficiency	48-84 %
	Annual rainfall, mm	600 mm
	Plant Elevation above MSL	85 m above MSL

SPECIFIC TECHNICAL REQUIREMENTS

SUB-SECTION – IA

SPECIFIC TECHNICAL REQUIREMENTS

1.0 INTENT OF SPECIFICATION

This specification includes, but not limited to supply part , services part & mandatory spares comprising of design (i.e. Preparation and submission of drawing/ documents including " As Built " drawings and O&M Manuals) , engineering, manufacture, fabrication, assembly, inspection / testing at vendor's & sub-vendor's works, painting, maintenance tools & tackles (as applicable), fill of lubricants & consumables , mandatory spares along with spares for erection ,start up and commissioning as required, forwarding, proper packing, shipment and delivery at site, unloading, handling, transportation & storage at site, in site transportation, assembly, minor civil works, erection & commissioning, trial run at site, preparation of drawings in 3D and carrying out performance guarantee /Functional / Demonstration tests at site (As applicable), obtaining CCOE approval, training of customer/ client O&M staff & final handing over to end customer in flawless condition in line with drawings/ documents/ test procedures approved by BHEL/Customer for Hydrogen generation plant.

"Note 1: - Bidder to note that the building along with foundation of equipment has already constructed at site. Bidder to accommodate their equipment within the foundation already constructed. Any modification required in foundation to accommodate bidder's equipment shall be part of bidder's scope. Bidder is advised to visit site for clarity of actual site condition w.r.t Hydrogen generation plant civil works before bid submission. Further equipment layout with foundation details of Hydrogen Generation Plant (BHEL Dwg. No. PE-V0-417-168-A001) is enclosed here with this specification & bidder to follow the same".

"Note 2: - Bidder to note that MCC for Hydrogen Generation Plant has already manufactured and dispatched to site. Further, Bidder to note that the Final Electrical Load of all the drives are mentioned in sub-section IB and the same shall be adhered by the Bidder. In case if any modification required in MCC due to change of Load data the same shall be in bidder's scope.

"Note 3: - Bidder to note that PLC for Hydrogen Generation Plant has already manufactured and dispatched to site. Further, Bidder to note that the same shall be free issued to successful bidder. In case any modification is required in PLC due to manufacturer's design, the same shall be in bidder's scope. For PLC details of Hydrogen Generation Plant, BHEL Dwg. No. PE-V0-417-168-A006 is enclosed here with this specification & bidder to follow the same".

"Note 4: - Bidder to note that Hydrogen Generation Skids (2nos.) has already manufactured and dispatched to site. Further, Bidder to note that the same shall be free issued to successful bidder. In case any modification is required in Hydrogen Generation Skids due to manufacturer's design, the same shall be in bidder's scope. Bidder is advised to visit site for clarity of actual site condition w.r.t Hydrogen generation plant skids before bid submission for skids details, BHEL Dwg. No. PE-V0-417-168-A021 is enclosed here with this specification & bidder to follow the same". Further, refurbishment / replacement of already supplied item shall also be in bidder's scope

Note-5 Following item already dispatched at site: -

1. Item already mounted on each skid
   a. Electrolyser
   b. Lye Filter
   c. Lye Pump
   d. O2 Seperator
   e. H2 Seperator
   f. O2 Moisture Gas Seperator
   g. H2 Moisture Gas Seperator
   h. Lye Cooler
   i. Catalyst Column
   j. Dry Absorber
   k. Gas Condensor
   l. Water Gas Seperator
   m. Gas Cooler
   n. DM Water cum Lye Making Tank
   o. H2 Buffer Tank
   p. O2 Demister
   q. H2 Demister
   r. DM Water feed Pump
   s. Level indicator
   t. Differential pressure transmitter
   u. Level Transmitter
   v. Pressure Gauge
   w. Pressure Transmitter
   x. RTD with temperature Transmitter
   y. Temperature Gauge
   z. Trace 02 Sensor
   aa. Flow indicator
   bb. Dew Point Sensor.
2. 2 X 10 KVA UPS.
3. PLC Panel Including PLC Software Hardware

2.0 SCOPE OF SUPPLY:

Note 5:- Bidder to note that the technical specification is prepared considering bipolar design. So, the equipment and mandatory spares as applicable for bipolar design as per manufacturer standard practice shall be supplied.

A) Scope of Supply by Bidder: - (Strike off item already supplied to site. However, any other item required for completeness of plant and safe operation is also in scope of bidder.)

~~2.1 Two streams of electrolysers working in parallel (each of capacity minimum 15 Nm3/hr.).~~

2.2 Three (3) numbers of hydrogen gas compressors and drives (each of minimum 18.75 Nm3/hr.). Each compressor set shall be capable of compressing hydrogen gas from suction pressure corresponding to that of the low pressure at generation point to the pressure required to fill the hydrogen cylinders i.e. 150 Kg/cm2 (gauge), with pressure gauge, safety relief valve, temperature gauge etc. along with flame proof electric motor, cell purging system, hydrogen gas buffer tanks.

2.3 Two (2) nos. rectifier along with accessories like connection copper bar to electrolyser etc. is in bidders' scope.

~~2.4 Hydrogen gas buffer tanks of adequate capacity along with all accessories like PT, PG, LT etc.~~

~~2.5 Two (2) nos. Dual Type After-Filters to prevent entrainment of desiccant particles with the effluent gas from the dryer unit.~~

2.6 Two (2) nos. Portable Hydrogen Gas Purity Meters. These meters shall be battery operated.

2.7 Two (2) nos. Hydrogen filling stations with manifold isolating valve, safety valve etc. for both evacuation and simultaneous filling of minimum 8 cylinders (total 16 nos.) shall be provided with hydrogen at a maximum filling pressure of 150 Kg/cm2 (gauge). Each filling manifold shall be provided with a common vacuum pump for evacuation of air from hydrogen cylinder prior to filling.

2.8 Two (2) nos. Nitrogen manifold common for both streams shall be provided. Each nitrogen manifold shall comprise of four 4 nos. for complete purging of the hydrogen gas streams, along with complete scavenging system comprising necessary piping network, all fittings, pressure reducing station etc.

2.9 One number DM Water Storage Tank of Capacity adequate enough for 5 days' normal requirement of hydrogen gas generation on continuous basis at rated capacity of the Hydrogen Generation Plant. Tank will be fitted with drain connections, level transmitters, level indications, conductivity meter etc. The Tank shall be of SS construction. Water level shall be controlled via a solenoid valve with float type level switch assembly mounted at tank top.

2.10 Two (2) nos. Electrolyte Transfer Pumps (As Applicable) with drive motors, pressure gauge at pump discharge,

differential pressure gauge across suction filter etc. complete with all accessories.

~~2.11 De-oxy units, coolers, hydrogen gas purification system, piping fitting, valves, complete with required instrumentation and other items as per P&ID for the hydrogen generation plant enclosed with this technical specification.~~

2.12 Bidder shall include vacuum pump with motor and instruments and high-pressure cylinder testing apparatus along with all accessories for testing cylinders.

2.13 Bidder shall supply necessary leak detector system for Hydrogen Generation Plant.

2.14 Bidder shall provide one number trolley for Hydrogen Generation Plant building which shall meet all the safety expects of hydrogen generation plant.

2.15 Bidder to include the Ventilation Requirement for hazardous and non-hazardous area including toilets and MCC room in his scope for the H2 Plant building as per the requirement specified in the technical specification. The air quantity of ventilation system shall be estimated based on minimum number of air changes shall not be less than 30 air changes per hour. The exhaust air shall be discharged at a suitable height from the room. Temperature rise inside the building shall be restricted to Maximum of 3 deg.C over design ambient. Louvers for fresh air-supply as per building layout as required. Axial flow fans for exhausting air/fumes shall be provided for hydrogen generation plant area and shall be of flameproof construction with inlet and outlet dampers. However, ducts and all other parts like blades etc. shall be epoxy painted.

2.16 Bidder shall also include in his scope Air-conditioners for PLC control room.

2.17 Bidder to note that UPS has already been supplied. However, ACDB, Batteries along with other accessories is in bidders' scope. (Refer UPS scheme enclosed with the specification).

2.18 Bidder to note that PLC has already been supplied. However, back up panel, furniture, OWS, laptop etc. with other accessories is in bidders' scope. (Refer PLC scheme enclosed with the specification).

2.19 Bidder shall include in his scope necessary support/platform /ladder/hanger /anchor bolts as required for satisfactory erection / commissioning & operation of plant shall be provided by bidder.

2.20 Bidder shall include in his scope all hydrogen generation plant pipes and conduit support. All drains shall be terminated at nearest drain.

2.21 Bidder shall also provide connection, isolation device, manifold, piping etc. for N2 gas connection to cell system for purging.

2.22 Bidder to note that N2 gas required for purging the system during commissioning/Demonstration test/trial operation etc. till handing over the plant to shall be arranged by bidder.

2.23 Bidder to note that the MOC of pipes carrying Hydrogen Gas and cooling water shall be SS 304. Further insulation shall be provided for the pipes carrying cooling water.

2.24 Bidder shall also obtain the necessary clearances etc. from Govt. Agencies for the Hydrogen Generation plant. Hydrogen generation and storage system shall comply with all applicable federal state laws, and local ordinances.

2.25 Bidder shall guarantee that the equipment offered shall meet the rating and performance requirements for successful running of hydrogen Generation plant.

2.26 Start-up & Commissioning spares.

2.27 Counter flanges, blank flanges, isolation valves at all the terminal points as required as per system requirements.

2.28 All special tools necessary for proper maintenance or adjustment of the equipment packed in permanent box.

2.29 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 Hydrogen Generation Plant.

2.30 Permanent ladder (not rungs) for approaching the top of tanks, valves for All steel inserts with lugs, plates, bolts, nuts, sleeves, edge angles and all other embedding components etc. as required to grout in civil works and to support/hold the equipment being supplied under this specification for opening/maintenance purpose.

2.31 All auxiliary steel structures (U-clamps, nuts, bolts, channels etc.) for fixing the pipe on the pedestal or trestles.

2.32 Wrapping, coating and protection of all the buried pipe shall be as per IS 10221 or AWWA C 203.

2.33 Finish paint for touch-up painting of equipment after erection at site in sealed containers.

2.34 Set of special tools and tackles if required for maintenance and erection of equipment supplied.

2.35 All necessary flanges and counter flanges to interconnect the piping.

2.36 All insert plates, puddle pipes, nuts and bolts, counter flanges, grouting material wherever applicable shall be in the scope of bidder.

2.37 Embedment plates with lugs shall also be provided by bidder as per system requirement.

2.38 Monitoring gadgets, instruments and equipment required for commissioning & maintenance (till PG test and plant handover).

2.39 Instrument hook up material shall be in bidder's scope.

3.0 SCOPE OF SERVICE:

The bidder's scope also includes the following services at site:

i) Design and engineering of entire hydrogen generation Plant

ii) Erection and commissioning, unloading, storage and handling at site.

iii) Arrangement of all instruments and lab facilities to carry our trail run, commissioning and PG test.

iv) Wrapping, coating and protection of all the buried pipe shall be as per IS 10221.

v) In site transportation.

vi) Pre- Commissioning work such as flushing, hydraulic testing etc. Necessary consumables and instrumentation as required for inspection and testing at works as well as at site including pre-commissioning activities shall be arranged by the successful bidder at their own cost.

vii) Monitoring gadgets, instruments and equipment required for maintenance (till PG test and plant handed over).

viii) All personal required during commissioning and PG test.

ix) Trail run for requisite period.

x) Performance testing.

xi) Painting as per enclosed painting schedule. However, any variation in the painting schedule as finally approved by customer shall be taken care by the bidder without any commercial and delivery implication. Colour coding scheme shall be intimated to vendor during detailed engineering.

xii) Final touch up painting at site.

xiii) Obtaining CCE approval.

xiv) Any other service required for making the installation complete in all respect within battery limits and for satisfactory erection & commissioning of the system as well as to meet any statutory requirement relevant to the package, unless specifically EXCLUDED from scope of services.

4.0 TERMINAL POINTS:

TP1:- DM water

DM water shall be used as cooling water and shall be terminated at a distance of 10m from the hydrogen plant building at ambient temperature and pressure of 1 kg/cm2 (min) and the same may be used as cooling water. Bidder to include in his scope all the equipment and accessories required for closed loop cooling with chiller unit for cooling of equipment. Chiller unit consist of two nos. Air cooled chillers (1w+1sb), one number Chiller water storage tank of adequate capacity, two nos. chilled water re circulation pumps complete with drive motors along with strainers and all other necessary redundant instruments, isolation valves, piping, flanges, pipe fittings etc.

TP2: - DM water (Feed water)

Feed water (Refer annexure – VII, section-IA, for the feed water analysis): - Bidder to note that the DM quality feed water shall be terminated at one point (10 meter from hydrogen generation plant building) for hydrogen generation. Further distribution of DM feed water shall be in bidder's scope. If bidder finds the quality of DM water supplied not suitable for his/her system than the required equipment/item for achieving the desired DM quality shall be in scope of bidder.

Note: - Temperature of feed water / cooling water shall be as per ambient conditions.

TP3: - Instrument air and Service air

Bidder to note that both Instrument and service air shall be terminated at one point (10 meter from hydrogen generation plant building) for hydrogen generation. Further distribution of Instrument and service air shall be in bidder's scope.

TP4, Drains: - All drains shall be connected to the nearest plant drain by bidder.

5.0 SCOPE OF SUPPLY (CIVIL)

5.1 Total Civil construction work at site is in BHEL's Scope of work, however complete grouting for equipment, pumps, blowers etc. fixing of equipment, pumps, blowers etc. as required shall be in bidder's scope.

5.2 Pedestals for pipe supports, however, auxiliary structure, supports components for piping is in bidder's scope.

5.3 Also detailed Civil Input drawing shall be provided by bidder. Successful bidder shall furnish civil assignment drawings. The corresponding CIVIL drawing prepared by BHEL / CIVIL agency, based on civil assignment drawing of bidder will be furnished to the successful bidder for concurrence.

6.0 ELECTRICAL

Complete electrical as per specification / details indicated in Section IB (Specific Technical Requirement Electrical) and IIB (General Technical Requirement Electrical). Further, Bidder to note that the Final Electrical Load of all the drives are mentioned in sub-section IB and the same shall be adhered by the Bidder. In case if any modification required in MCC due to change of Load data the same shall be in bidder's scope.

7.0 CONTROL AND INSTRUMENTATION -

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

8.0 BIDDER TO FURNISH FOLLOWING DOCUMENT/INFORMATION ALONG WITH THE BID.

8.1 Pre-bid if any in enclosed pre-bid schedule.
8.2 Deviation schedule duly fill for deviation along with cost of withdrawal, if any.
8.3 Schedule of Declaration.
8.4 Guaranteed Performance Data.

9.0 EXCLUSIONS

a) Instrument air and service air up to the terminal point.

b) DM Water, Service water and potable water up to the terminal point.

c) All civil construction Works at site.

10.0 QP AND SUB VENDOR APPROVAL

Bidder to note the QP requirement shall be in line with the Annexure-I of technical specification. However, detailed QP, inspection checklist, certificate of conformance etc. for each sub-vendor shall be decided during detailed engineering. All inspection & testing etc. shall be carried out accordingly. Any changes/additional tests insisted upon by Owner during detailed engineering shall be accepted by bidder without any commercial implication to BHEL/Owner.

The sub vendor list (Annexure- II) enclosed is indicative only and is subject to approval / acceptance by customer. Bidder to propose his sub vendor list with back up documents (experience list, end user performance certificate as applicable) etc. The same shall subject to BHEL and Customer approval during detailed engineering stage without any commercial & delivery implication to BHEL.

11.0 DESIGN/CONSTRUCTION

- The P&IDs (Dwg.No.-PE-DG-417-168-A001) is enclosed in section IA for bidder's compliance.
- The material of construction specified in specification are minimum requirements and material of construction for other components not specified shall be similarly selected by the bidder for intended duty which shall be subjects to customer approval during detailed engineering without any delivery and price implication to BHEL.
- The technical specification requirement for items which are not included shall be subject to customer/BHEL approval during detailed engineering stage. Vendor will submit all the backup documents for provenances of the technical details selected.

12.0 DRAWING/DOCUMENTS REQUIREMENT

For the Drawings/Documents distribution procedure, please refer ANNEXURE-IV.

For the Drawings/Documents submission schedule, please refer ANNEXURE-VI.

The bidder has to submit the revised drawing/document along with the compliance sheet indicating enumerate reply to all BHEL and customer comments or observations. Without compliance sheet the submission of the drawings/documents will not be considered and the delay on this account will be solely on bidder's side only. Bidder to comply with the observations of the BHEL and CUSTOMER without price & delivery implication.

13.0 SPARES

START-UP & COMMISSIONING SPARES

Start-up and commissioning spares are those spares which are required during the start-up and commissioning of the equipment/system. All spares used till the plant is handed over to the BHEL/Customer shall come under this category. The Bidder shall provide for an adequate stock of such start up and commissioning spares to be brought by him to the site for the plant erection and commissioning. They must be available at site before the equipment are energized. The unused spares, if any, should be removed from there only after the issue of Taking Over certificate. All start up spares which remain unused at the time shall remain the property of the Bidder.

MANDATORY SPARES

a. The list of mandatory spares which is to be considered by bidder in their scope are indicated in Annexure VI.
b. All mandatory spares shall be delivered at site at least two months before scheduled date of initial operation of the first unit. However, spares shall not be dispatched before dispatch of corresponding main equipment.
c. Wherever quantity is specified both as a percentage and a value, the Bidder has to supply the higher quantity until and unless specified otherwise.
d. Inspection of mandatory spares shall be in line with the approved quality plans for the

respective items/equipment. The inspection categorization of mandatory spares shall also be in line with the approved Categorization plan for the respective items/equipment.

14.0 ADDITIONAL REQUIREMENT

- Any statutory requirement / clearance required for the package from government / local body shall be in bidder's scope.
- The vendor of their contractual obligations of completing the work as per specification requirement. Any deviation from specified requirement shall be reported by the vendor in writing and require written approval shall be taken from BHEL. Unless any change in specified requirement has been brought out by the vendor during detail engineering in writing while submitting the document to customer for approval, approved document (with implicit deviation) will not be cited as a reason for not following the specification requirement.
- KKS numbering if required, as per BHEL/Customer requirement shall be provided by the Bidder during detailed engineering stage without any commercial/delivery implication to BHEL.
- Any item/work either supply of equipment or erection material which have not been specifically mentioned but are necessary to complete the works for trouble free and efficient operation of the plant shall be deemed to be included within the scope of this specification. The bidder without any extra charge shall provide the same.
- Buried piping shall be protected as under (as per IS-10221).
  - Surface cleaning by wire brush, power tool cleaning etc.
  - Apply one coat of coaltar/primer/enamel.
  - Apply one layer of tape comprising of coaltar. Application of tape shall conform to AWWA C- 203/IS 10221 (Appendix-B) with Minimum thickness of tape as 4MM +10%
- In case vendor submits revised drawing after approval of the corresponding drawing, any delay in approval of revised drawing shall be to vendor's account and shall not be used as a reason for extension in contract completion.
- Wherever local instruments for measurement of Flow, Pressure, Level is indicated in the P&ID, Bidder to provide Diaphragm seal type instrument for Chemical (all type and concentration), corrosive, viscous fluids application.
- All the vertical pumps shall be considered as self-lubricating type unless specifically mentioned.
- All piping, valves, fittings to be selected by bidder of minimum PN 10 or 150# class rating.
- Final Electrical Load list will be submitted by the successful bidder as per agreed drawing/ doc submission schedule. Thereafter any change in the electrical load list shall be entertained only subject to its feasibility, and BHEL reserves the right to debit the vendor cost of any changes necessitated in the switch gear /MCC on account of changed loads.
- Preparation of drawings / document / P&ID's in 3D modelling software and providing soft copy of same to BHEL.

15.0 INSTRUCTIONS TO BIDDER

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

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

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

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

e) 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 **within 10 days of receipt of tender documents**. 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.

f) The bidder's offer shall not carry any sections like clarification, interpretations and /or assumptions.

g) Deviations, if any, should be very clearly brought out clause by clause along with cost of withdrawal in the enclosed schedule (Section – III); otherwise, it will be presumed that the vendor's offer is strictly in line with NIT specification. If no cost of withdrawal is given against the deviation, it will be presumed that deviation can be withdrawn without any cost to BHEL/its customer.

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

i) Unless specified otherwise, all through the specification, the word contractor shall have same meaning as successful bidder/vendor and Customer/Purchaser/Employer will mean BHEL and/or Customer.

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

k) BHEL's/Customer's representative shall be given full access to the shop in which the equipment are being manufactured or tested and all test records shall be made available to him. Pre-bid meeting shall be held before bid submission. Bidder to ask all their queries in pre-bid meeting.

ANNEXURES

ANNEXURE-I: QUALITY PLAN

CLAUSE NO.	QUALITY ASSURANCE

HYDROGEN GENERATION PLANT

HYDROGEN GENERATION PLANT-TESTS													
Tests/Check / Items / Components	Material Test	WPS/PQR/Welder	DPT/MPI	Ultrasonic test	RT	Pneumatic test	Hydraulic / Water Fill tests	Assembly / fit up	Dimension	Functional/ operational tests	Performance tests	Other tests	Remarks
H2 PLANT													
A.COMPRESSOR								Y		Y	Y		
1) Casing	Y[3]												
2) Crank shaft/connecting rod	Y[3]		Y	Y					Y				
3) Piston/Diaphragm			Y[3]							Y			
B. DRYING PLANT							Y						
1.)Raw material identification	Y[3]		Y[1]		Y[2]								
C. HYDROGEN GENERATOR							Y			Y	Y		
D. CELL MODULE							Y			Y	Y		
E. GAS HOLDER	Y[3]						Y						

1.Fillet welds/nozzles welds and knuckle portion of dished ends and all butt welds.

2. 100% butt welds and 100% for Tee joints and dished ends welds.

3. One per heat /HT batch.

Notes.

1.Quantum of checks shall be 100% unless otherwise specified.

		QUALITY PLAN	CUSTOMER :			PROJECT TITLE			SPECIFICATION : NUMBER :			
			BIDDER/ VENDOR :			QUALITY PLAN NUMBER PED-506-00-Q-006, REV-01			SPECIFICATION TITLE			
		SHEET 1 OF 2	SYSTEM			ITEM AC ELECT. MOTORS BELOW 55KW (LV)			SECTION			VOLUME III
SL. NO.	COMPONENT/OPERATION	CHARACTERISTICS CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS
									P	**W**	**V**	
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**			**11**
1.0	ASSEMBLY	1.WORKMANSHIP	MA	VISUAL	100%	MANUF'S SPEC	MANUF'S SPEC	-DO-	2	-	-	
		2.DIMENSIONS	MA	-DO-	-DO-	MFG. DRG./ MFG. SPEC.	MFG. DRG./ MFG. SPEC.	-DO-	2	-	-	
		3.CORRECTNESS COMPLETENESS TERMINATIONS/ MARKING/COLOUR CODE	MA	VISUAL	100%	MFG.SPEC./ RELEVANT IS	MFG.SPEC. RELEVANT IS	-DO-	2	-	-	
2.0	PAINTING	1.SHADE	MA	VISUAL	SAMPLE	MANUFR'S SPEC/BHEL SPEC./RELEVANT STANDARD	BHEL SPEC. SAME AS COL.7	LOG BOOK	2	-	-	
3.0	TESTS	1.ROUTINE TEST INCLUDING SPECIAL TEST AS PER BHEL SPEC.	MA	-DO-	100%	IS-325/ BHEL SPEC./ DATA SHEET	SAME AS COL.7	TEST REPORT	2	1		NOTE -1 & NOTE-3
		2.OVERALL DIMENSIONS & ORIENTATION	MA	MEASUREMENT & VISUAL	100%	APPROVED DRG/DATA SHEET	APPROVED DRG/DATA SHEET & RELEVANT IS	INSPN. REPORT	2	1	-	NOTE -1 & NOTE-3
	BHEL		**PARTICULARS**		**BIDDER/VENDOR**							
			NAME									
			SIGNATURE									

	QUALITY PLAN		CUSTOMER :			PROJECT TITLE			SPECIFICATION : NUMBER :			
			BIDDER/ VENDOR :			QUALITY PLAN NUMBER PED-506-00-Q-006, REV-01			SPECIFICATION : TITLE :			
	SHEET 2 OF 2		SYSTEM			ITEM AC ELECT. MOTORS BELOW 55KW (LV)			SECTION			VOLUME III
SL. NO.	COMPONENT/OPERATION	CHARACTERISTICS CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	W	V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
		3.NAMEPLATE DETAILS	MA	VISUAL	100%	IS-325 & DATA SHEET	IS-325 & DATA SHEET	INSPN. REPORT	2	1	-	

NOTES:

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

2 WHERE EVER CUSTOMER IS INVOLVED IN INSPECTION, (1) SHALL MEAN BHEL AND CUSTOMERS BOTH TOGETHER.

3 FOR EXHAUST/VENTILATION FAN MOTORS OF RATING UPTO 1.5KW , ONLY ROUTINE TEST CERTIFICATES SHALL BE FURNISHED FOR SCRUTINY.

Legends for Inspection agency

1. BHEL/CUSTOMER
2. VENDOR (MOTOR MANUFACTURER)
3. SUB-VENDOR (RAW MATERIAL/COMPONENTS SUPPLIER)

P. PERFORM
W. WITNESS
V. VERIFY

BHEL	**PARTICULARS**	**BIDDER/VENDOR**	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S/VENDORS COMPANY SEAL

PEM :: C&I	STANDARD QUALITY PLAN FOR PROGRAMMABLE LOGIC CONTROLLER	QUALITY PLAN NO.: **PE-QP-999-145-I036___** VOLUME IIB SECTION D REV. NO. 01 DATE: 24.08.2007 SHEET 1 OF 8

Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency $			Remarks
									P	W	V	
1.0	**Materials /Components**											
1.1	Panels & Control Desks	Physical Inspection for Dimensions, Painting, Cutouts, Lifting / Locking Arrangements, Components, Drawing Pocket, Mounting accessories, Plinth & AV Pads, Cable Gland Plates, Hardwares, Hinges, Louvers & Filters, Fans & Panel Lamps	MA	Visua l	100%	Contract specifications, Approved GA Drawings, BOQ	As per ref documents. No physical damage.	BHEL Quality Inspection Report.	3/2 2		1	
1.2	Power Supply/Packs, Battery & Battery charger, Transformer, UPS.	Physical Inspection Physical Damages Dimensions Mounting Accessories	MA	Visua l	100%	Contract specifications, BOQ.	As per reference documents, Test Report	BHEL Quality Inspection Report.	3/2 2		1	
1.3	Indicating Lamp, Annunciator, Meters, Transducers, Signal Converters, Instruments, Single Loop Controllers	Physical Verification Physical Damages Dimensions Accessories	MA	Visua l	100%	Contract specifications, BOQ.	As per ref documents No physical damage. Test/ Calibration report.	BHEL Quality Inspection Report	3/2 2		1	
1.4	PLC processors, I/O modules, Power Supply modules, Communication modules, Mounting Racks, Ethernet	Physical Inspection • Identification Labels • Physical Damages • Quantity • Spare Capacity	MA	Visua l	100%	Product Catalogue, Data sheets, Approved Configuration diagram, BOQ	As per ref documents. Test Certificates	BHEL Quality Inspection Report.	3/2 2		1	

LEGEND: * CR - Critical characteristics; MA - Major characteristics; MI - Minor characteristics
$ P - Agency Performing the Test. W - Agency Witnessing the Test. V - Agency Verifying the Test.
1 - BHEL 2 - Vendor 3 - Sub-vendor

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STANDARD QUALITY PLAN
FOR
PROGRAMMABLE LOGIC CONTROLLER

QUALITY PLAN NO.: **PE-QP-999-145-I036___**
VOLUME IIB
SECTION D
REV. NO. 01 DATE: 24.08.2007
SHEET 2 OF 8

Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency $			Remarks
									P	W	V	
1.5	CPU, Monitor, Keyboard, Mouse, CD Drives, Printers, OS, System Software, Engineering software in the form of Licensed CD.	Physical Inspection Identification Labels, Tech. Specification Physical Damages Accessories Installation arrangements for Computers & Printers	MA	Visual	100%	Contract specifications, Product Catalogue, Approved GA / Configuration drawing, BOQ.	As per reference documents.	BHEL Quality Inspection Report.	3/2 2		1	

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PEM :: C&I	STANDARD QUALITY PLAN FOR PROGRAMMABLE LOGIC CONTROLLER	QUALITY PLAN NO.: **PE-QP-999-145-I036___** VOLUME IIB SECTION D REV. NO. 01 DATE: 24.08.2007 SHEET 3 OF 8

Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency $			Remarks
									P	W	V	
2.0	**Assembly**											
2.1	Functional Test for HMI/OWS devices such as Monitors, Keyboards, Mouse, Printers etc.	Operation	MA	Functional	100%	Approved Configuration Diagram & BOQ and FAT	Correct Operation of interconnected Devices of HMI system.	BHEL Quality Inspection Report.	2 1		1	
2.2	Hardware Functional Verification.	Physical arrangement, Wiring check & labeling, Continuity Checking, IR & HV test	MA	Visual/ Electrical	100%	Approved GA Drawing, Panel Wiring Diagram, IR & HV as per relevant International standard	Test Certification	BHEL Quality Inspection Report.	2 2		1	
2.3	Powering Up	Healthiness of all the modules/equipment, associated with Powering of PLC system	MA	Visual /Electrical	100%	Approved power supply scheme	All equipment to be healthy on power ON	BHEL Quality Inspection Report.	2 1		1	
2.4	Burn in test for PLC modules	Healthiness of PLC modules on Continuous Energisation, Temperature maintenance	MA	Visual/ Electrical	100% F	AT Procedure	Test certification as per FAT	BHEL Quality Inspection Report.	2 2		1	

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									P	W	V	
3.0	**Factory Acceptance Test (FAT)**											
3.1	Input Output Functional Verification	I/O configuration, I/O operation	MA	Visual/ Eletrical	100%	FAT Procedure	AS per FAT	BHEL Quality Inspection Report.	2 1		1	
3.2	Processor Verification	Processor configuration, Powering up, standby operation (as applicable) and Loading	MA	Visual	100%	FAT Procedure	AS per FAT	BHEL Quality Inspection Report.	2 1		1	
3.3	Power Supply Module Verification	Redundancy Operation	MA	Electrical	100%	FAT Procedure	AS per FAT	BHEL Quality Inspection Report.	2 1		1	
3.4	Communication System Verification	Redundancy operation of Communication System, Measurement of Response Time, Communication with third party system	MA	Electrical	100%	FAT Procedure	AS per FAT	BHEL Quality Inspection Report.	2 1		1	
3.5	Diagnostic Verification	Self Diagnostic features of PLC system	MA	Visual	100%	FAT Procedure	AS per FAT	BHEL Quality Inspection Report.	2 1		1	
3.6	Control Panel/Desk Verification	Operation of PLC driven annunciation system, Mosaic, Push buttons & selector switches, Indicating lamps	MA	Visual	100%	FAT Procedure	AS per FAT	BHEL Quality Inspection Report.	2 1		1	
3.7	Software Verification	(i) Control Logics (ii) Engineering Features (iii) HMI Features	MA	Visual	100%	FAT Procedure	AS per FAT	BHEL Quality Inspection Report.	2 1		1	

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FACTORY ACCEPTANCE TEST (FAT) PROCEDURE

This document covers procedure to conduct/witness PLC system functional tests in order to demonstrate conformity to purchase specifications and related engineering documents. The test shall be conducted at the system suppliers works. The system supplier shall conduct all functional tests before commencing FAT and test results shall be made available during FAT. Vendor must furnish following relevant drawings, duly approved by BHEL Engineering, for reference during FAT.

a) Technical Specification of PLC.

b) PLC System Configuration

c) General Assembly Drawings.

d) Panel Wiring Diagrams.

e) Bill of Quantity for PLC System.

f) Logic Diagram.

g) HMI Schematics.

h) Input / Output List.

Further the vendor shall furnish applicable product specification, datasheets, catalogues, test-certificates, and internal inspection records to enable FAT. Vendor shall also submit, to the inspecting agency, his standard test procedure, for clauses given below; where vendor's standard practice has been referred.

APPLICABLE TEST PROCEDURE:

1. Input/Output Functional Verification.

Check for correctness of addressing of racks, slots and I/O modules as per applicable PLC configuration diagram. Appropriate signal generators shall be used to simulate Inputs and outputs to check operation and SCAN time. Check online replacement of cards, processors, power supply etc.

2. Processor Verification

PLC Configuration drawing to be referred for ascertaining

i) Redundancy

ii) Type (Hot or Cold)

Both the processors are to be checked for healthiness in case of redundant configuration as per vendor's standard practice. In case of hot redundancy, switchover of control from primary processor to standby processor shall be demonstrated for uninterrupted control and data processing as per vendor's standard practice. Switchover shall be witnessed, by manual power off or resetting the Primary CPU or simulating failure of primary processor. Checking should be by witnessing the lighting up of Processor's LEDs as per manufacturer's product standard.
Vendor shall demonstrate, as per Vendor's standard practice, adequate Loading (Spare Capacity) of Processors, as mentioned in contract specs. This shall be done, by simulating worst load operation of fully integrated PLC system.

3. Power Supply Module Verification

Check if PSM is in redundant mode as per specification. Check the healthiness of power supply from both the modules' lamp indication/measurement. Simulate failure of one PSM and verify that standby PSM has taken over without any interruption.

4. Communication System Verification

Communication system has to be in line with approved PLC Configuration Diagram. Verify that both the communication buses are intact and connected. Communication between PLC processors, I/O rack, OWS etc. is to be checked through simulation of input data. Simulate the bus failure by disconnection of working bus. Check that the communication continues without interruption or loss of data.

Following response times are to be demonstrated as per vendor's standard practice for conformance to contract specifications:

1. Screen update time
2. I/O scan time
3. SOE resolution time
4. Data transfer time with third party system using Communication Protocol as per Contract specification and as per quantum of data as per approved signal exchange list.

5. Diagnostic Verification

Product Catalogue/Literature shall be referred for checking of all diagnostic features. Hardware failure to be simulated by removing an I/O

6. Control Panel /Desk Verification

i) PLC driven annunc iation system should be checked by alar m signal simulation.

ii) Push Button and sele ctor switch operation should be checked by verification of corresponding change of status of Data Base point.

iii) Indicating lamp / MIMIC should be checked by corresponding Data Base point simulation.

7. Software Verification

i). Control Logics:– Software switches, lamps and Analog sources shall be used for simulation of field conditions .Control logics shall be checked for its correct functionality as per approved logic schemes

ii). Engineering features:-
a) Online changing of parameters, set points.
b) Online modification in Control Logic Diagrams.
c) Online configuration of Graphics, Trends, Logs, HSR.

iii). HMI features:-
Check for configuration & ope ration of Graphics, Trends, Logs, HSR and Alarms, in the for m of Displays and Printouts, by simulation of Inputs as per approved documents.

8. Burn in Elevated Temperature test

Electronic equipment s shall be subjected to Burn in elevated temperature test as per the procedure detailed below:

a) (i) PLC modules are kept at 50 Deg c under continuous energized condition for 48 hours.

ii) 48 hours test period shall be divided into 4 equal time segment of 12 hours duration each. For every 12 hours duration segment, after lapse of first 11 hours 110% of nominal voltage shall be applied to the panel under test for a period of 30 minutes followed by application of 90% of nominal voltage for the next 30 minutes.

b) Assembled Panels with complete wiring shall be kept under continuous energized condition for 120 hours at ambient temperature. Temperature rise in panels should be below 10 Deg C above ambient.

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STANDARD QUALITY PLAN FOR LOCAL CONTROL PANEL

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Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency $ P	Agency $ W	Agency $ V	Remarks
	INCOMING											
1.0	Sheet Steel (CRCA & HR)	1. Chemical Composition	MA	Chemical analysis	Sample	Relevant standard	Relevant standard	Test Certificate	3	---	2	
		2. Bend Test	CR	Mech. test	Sample	Relevant standard	Relevant standard	Log Book	2	---	---	
		3. Surface finish	MA	Visual	100%	Factory Standard / Sample	Factory Standard / Sample	Log Book	2	---	---	
		4. Waviness	MA	Visual	100%	Factory Standard	No Waviness	Log Book	2	---	---	
		5. Thickness	MA	Measurement	100%	BHEL Spec.	BHEL Spec.	Log Book	2	---	---	
		6. Mill marking	MA	Visual	100%	Factory Standard	Factory Standard	Log Book	2	---	1	
2.0	Flats / Angles / Channels	1. Dimensions	MA	Measurement	Sample	Relevant standard	Relevant standard	Log Book	2	---	---	
		2. Surface Defects	MA	Visual	100%	Factory Standard / Sample	Factory Standard / Sample	Log Book	2	---	---	
		3. Straightness	MA	Measurement	100%	Factory Std.	Factory Std.	Log Book	2	---	---	
		4. Mill marking	MA	Visual	100%	Relevant standard	Relevant standard	Log Book	2	---	1	
3.0	Cables / Wires	1. Visual / Surface defects	MA	Visual	100%	BHEL Spec. and Relevant standard	BHEL Spec. and Relevant standard	Log Book	2	---	---	
		2. IR and HV	MA	Electrical	100%	BHEL Spec. and Relevant standard	BHEL Spec. and Relevant standard	Log Book	2	---	---	

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1 - BHEL 2 - Vendor 3 - Sub-vendor

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STD QUALITY PLAN NO.:	**PE-QP-999-145-I056**
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Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency $ P	Agency $ W	Agency $ V	Remarks
		3. Conductor a) Resistance b) Size c) Sheet colour	 MA MA MA	 Electrical Measurement Visual	 100% 100% 100%	BHEL Spec. and Relevant standard	BHEL Spec. and Relevant standard	Log Book	2	---	---	
		4. Type / Routine Test Certificates	MA	Verification	100%	BHEL Spec. and Relevant standard	BHEL Spec. and Relevant standard	Log Book	3	---	2	
4.0	Electrical Components like Annunciator Transformers Lamps Switches PBs Contactors Relays Timers Space Heaters Thermostat Indicating meters etc.	1. Verification at make and Type	CR	Visual	Sample	BHEL Spec. and BOM	BHEL Spec. and BOM	Log Book	2	---	---	
		2. Verification of Test Certificates	CR	Scrutiny of Type / Routine T.Cs.	100%	Relevant standard	Relevant standard	Log Book	2	---	---	
		3. Operation / Functional check	CR	Electrical	Sample+ 100%@	Relevant standard & Catalogue	Relevant standard & Catalogue	Log Book	2	---	---	+ for relay & contactors only
		4. I.R.	MA	Electrical	100%	Relevant standard & Catalogue	Relevant standard & Catalogue	Log Book	2	---	---	@ for all components except relays & contactors.
		5. H.V.	MA	Electrical	100%	Relevant standard & Catalogue	Relevant standard & Catalogue	Log Book	2	---	---	
		6. Calibration	MA	Electrical	100%	Relevant standard & Catalogue	Relevant standard & Catalogue	Log Book	2	---	1	
		7. Pick up / Drop off Voltage	MA	Electrical	100%	Relevant standard & Catalogue	Relevant standard & Catalogue	Log Book	2	---	---	

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Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency $			Remarks
									P	W	V	
5.0	Misc. Components like Gaskets, Terminal Blocks etc.	1. Verification of Type / Make	MA	Visual	Sample	BHEL Spec. & Mfrs. Catalogue	BHEL Spec. & Mfrs. Catalogue	Log Book	2	---	---	
		2. Surface defects	MA	Visual	Sample	BHEL Spec. & Mfrs. Catalogue	BHEL Spec. & Mfrs. Catalogue	Log Book	2	---	---	
		3. IR / HV on Terminal Blocks	MA	Electrical	Sample	BHEL Spec. & Mfrs. Catalogue	BHEL Spec. & Mfrs. Catalogue	Log Book	2	---	---	
	IN PROCESS											
6.0	Blanking / Bending / Forming	1. Dimensions	MI	Measurement	100%	Approved Mfr. drgs.	Approved Mfr. drgs.	Log Book	2	---	---	
		2. Surface defects after bending	MA	Visual	100%	Factory Standard	Factory Standard	Log Book	2	---	---	
7.0	Nibbling / Punching	1. Cutout Sizes	MI	Measurement	100%	Approved Mfr. drgs.	Approved Mfr. drgs.	Log Book	2	---	---	
		2. Deburring	MA	Visual	100%	Approved Mfr. drgs.	Approved Mfr. drgs.	Log Book	2	---	---	
	ASSEMBLY											
8.0	Frame Assembly & Sheet fixing	1. Dimensions	MA	Measurement	100%	Approved drg. / Mfr. Standards	Approved drg. / Mfr. Standards	Log Book	2	---	2	
		2. Alignment	MA	Measurement	100%	Approved drg. / Mfr. Standards	Approved drg. / Mfr. Standards	Log Book	2	---	2	
		3. Welding Quality	MA	Visual	100%	Approved drg. / Mfr. Standards	Approved drg. / Mfr. Standards	Log Book	2	---	2	
		4. Surface defects	MA	Visual	100%	Approved drg. / Mfr. Standards	Approved drg. / Mfr. Standards	Log Book	2	---	2	

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Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency $			Remarks
									P	W	V	
9.0	Pre-treatment and Painting	1. Pretreatment Process	MA	Visual	100%	Factory Standard & Relevant standard	Factory Standard & Relevant standard	Log Book	2	---	1	
		2. Process parameters like bath temp. concentration etc.	MA	Measurement	Periodic	Factory Standard & Relevant standard	Factory Standard & Relevant standard	Log Book	2	---	1	
		3. Dipping / Removal Time	MA	Measurement	100%	Factory Standard & Relevant standard	Factory Standard & Relevant standard	Log Book	2	---	1	
		4. Surface quality after every dip	MA	Visual	100%	Factory Standard & Relevant standard	Factory Standard & Relevant standard	Log Book	2	---	1	
		5. Primer after phosphating	MA	Visual, Thickness	100%	Factory Standard & Relevant standard	Factory Standard & Relevant standard	Log Book	2	---	1	
		6. Putty Application & Rubbing after primer	MA	Visual	100%	Factory Standard & Relevant standard	Factory Standard & Relevant standard	Log Book	2	---	1	
		7. Paint first coat	MA	Visual, Thickness	100%	Factory Standard & Relevant standard	Factory Standard & Relevant standard	Log Book	2	---	1	
		8. Putty Application and Rubbing after first coat of paint	MA	Visual	100%	Factory Standard & Relevant standard	Factory Standard & Relevant standard	Log Book	2	---	1	
		9. Paint second coat	MA	Visual, Thickness, Scratch test Colour adhesion	100%	Factory Standard & Relevant standard	Factory Standard & Relevant standard	Log Book	2	---	1	

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PEM :: C&I

STANDARD QUALITY PLAN FOR LOCAL CONTROL PANEL

STD QUALITY PLAN NO.:	**PE-QP-999-145-I056**
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Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency $			Remarks
									P	W	V	
10.	Panel Wiring	1. Wiring Layout	MA	Visual	100%	Approved drgs. & Specs.	Approved drgs. & Specs.	Log Book	2	---	---	
		2. Wiring Termination (Crimped Lugs)	MA	Visual	100%	Approved drgs. & Specs.	Approved drgs. & Specs.	Log Book	2	---	---	
		3. Ferrule numbers	MA	Visual	100%	Approved drgs. & Specs.	Approved drgs. & Specs.	Log Book	2	---	---	
		4. Colour of wiring	MA	Visual	100%	Approved drgs. & Specs.	Approved drgs. & Specs.	Log Book	2	---	1	
		5. Size of Conductor	MA	Measurement	100%	Approved drgs. & Specs.	Approved drgs. & Specs.	Log Book	2	---	1	
11.	Component Mounting	1. Correct components	MA	Visual	100%	Approved drgs., Specs. & BOM	Approved drgs., Specs. & BOM	Log Book	2	---	---	
		2. Fixing	MA	Visual	100%	Approved drgs., Specs. & BOM	Approved drgs., Specs. & BOM	Log Book	2	---	---	
	FINAL											
12.	Final Inspection	1. Workmanship	MA	Visual	100%	Factory Standard	Factory Standard	Inspection Report	2	1	1	At Random by BHEL, based on 100 % internal test reports by Mfr.
		2. Component layout (neatness, accessibility & safety) Mounting / Proper fixing of all components	MA	Visual	100%	BHEL approved drg. / Spec.	BHEL approved drg. / Spec.	Inspection Report	2	1	1	
		3. Components identification Marking / Name plates	MA	Visual	100%	BHEL approved drg. / Spec.	BHEL approved drg. / Spec.	Inspection Report	2	1	1	

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Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency $			Remarks
									P	W	V	
		5. Dimensions	MA	Measurement	100%	BHEL approved drg. / Spec., BOM	BHEL approved drg. / Spec., BOM	Inspection Report	2	1	1	At Random by BHEL, based on 100 % internal test reports by Mfr.
		6. Door functioning	MA	Functional	100%	BHEL approved drg. / Spec.	BHEL approved drg. / Spec.	Inspection Report	2	1	1	
		7. Paint Shade	CR	Visual	100%	BHEL approved drg. / Spec.	BHEL approved drg. / Spec.	Inspection Report	2	1	1	
		8. Paint Thickness	CR	Measurement	100%	BHEL approved drg. / Spec.	BHEL approved drg. / Spec.	Inspection Report	2	1	1	
		9. Workmanship of Gaskets	MA	Visual	100%	Factory Standard	Factory Standard	Inspection Report	2	1	1	
		10. Wiring Layout	MA	Visual	100%	BHEL approved drg.	BHEL approved drg.	Inspection Report	2	1	1	
		11. Wire Termination	MA	Pulling manually	Sample	-----	Firm termination	Inspection Report	2	1	1	
		12. Continuity	MA	Electrical	100%	-----	Continuity OK	Inspection Report	2	1	1	

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Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency $			Remarks
									P	W	V	
13.	TYPE TEST	Degree of Protection	CR	Mech. Protection	Sample	BHEL approved spec., drg relevant IEC-60947, IEC-60079	BHEL approved spec., drg relevant IEC-60947, IEC-60079	Type Test Certificate	3	---	1	
14	ROUTINE TEST	IR before & after HV Test	CR	Electrical	100%	BHEL approved spec., drg., BOM & relevant standard	BHEL approved spec., drg., BOM & relevant standard	Test Report	2	1	1	
15	FUCTIONAL TEST	1. Control Logic Operation	CR	Electrical	100%	BHEL approved spec. / drg.	BHEL approved spec. / drg.	Inspection Report	2	1	1	
		2. Instrument Calibratio	CR	Electrical	10%	BHEL approved spec. / drg.	BHEL approved spec. / drg.	Inspection Report	2	1	1	
		3. Temperature rise	CR	Electrical	100%	BHEL approved spec/drg. & relevant standard	BHEL approved spec/drg & relevant standard	Inspection Report	2	1	1	

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ANNEXURE II: SUB VENDORS LIST

ANNEXURE

Yadadri TPS (5X800MW) approved sub vendor list for Hydrogen Generation Plant

Lr.No.CE/TPC/SE-3/EME-11/YTPS(5X800MW)/F.Vendors/D.No.212/22, Dt:20.01.2023

PART-I

Sl. No.	Item Description	Sl. No.	Vendor proposed for approval	TSGENCO Remarks for YTPS (5X800MW)
1	DM WATER STORAGE TANK (HDPE)	1	SINTEX, INDIA	Approved
		2	POLYPLAST CHEMI-PLANTS (I) PVT. LTD., MUMBAI	Approved
		3	DEEPA COMPOSITE INDIA PRIVATE LIMITED, MAHARASHATRA	Approved
		4	FRP COROSEAL INDUSTRIES, ANDHRA PRADESH	Approved
		5	EPP COMPOSITES PRIVATE LIMITED, GUJARAT	Approved
		6	JR FIBREGLASS INDUSTRIES PVT. LTD., MUMBAI	Approved
2	PIPE FITTINGS	1	M/S. N L HAZRA & SON, KOLKATA	Approved
		2	COMFIT & VALVES PVT LTD., MEHESANA	Approved
		3	ARYA CRAFTS & ENGINEERING PVT LTD., GUJARAT	Approved
		4	AURA INC. PHASE. 2, NEW DELHI	Approved
		5	BALDOTA VALVE, MUMBAI	Approved
		6	EXCEL HYDRO-PNEUMATICS PVT. LTD., MUMBAI	Approved
		7	FLOWTECH, KOLKATA	Approved
		8	HP VALVES & FITTINGS (INDIA) PVT. LTD., MOGAPPAIR WEST, CHENNAI	Approved
		9	METPRESS ENGINEERING WORKS, KOLKATA	Approved
		10	PANAM ENGINEERS LTD., MUMBAI	Approved
		11	PMT ENGINEERS, AHMEDABAD	Approved
		12	PRECISION ENGG INDUSTRIES, GOREGAON, MUMBAI	Approved
		13	PRIME ENGINEERS, MUMBAI	Approved
		14	V.K.INDUSTRIES, BENGALURU	Approved
		15	VIKAS INDUSTRIAL PRODUCTS, NOIDA	Approved
3	LT MOTORS	1	ABB LTD, SECUNDERABAD	Approved
		2	BHARAT BIJLEE LIMITED, MUMBAI	Approved
		3	CG POWER & INDUSTRIAL SOLUTIONS LTD., AHMEDNAGAR	Approved
		4	CROMPTON GREAVES LTD., AHMEDNAGAR	Approved
		5	KIRLOSKAR ELECTRIC CO LTD., BANGALORE	Approved
		6	LAXMI HYDRAULICS PVT LTD., SECUNDERABAD	Approved
		7	SIEMENS INDIA LTD., CHENNAI	Approved
		8	MARATHON	Approved

Chief Engineer/TPC

ANNEXURE

Yadadri TPS (5X800MW) approved sub vendor list for Hydrogen Generation Plant

Lr.No.CE/TPC/SE-3/EME-11/YTPS(5X800MW)/F.Vendors/D.No.212/22, Dt:20.01.2023

Sl. No.	Item Description	Sl. No.	Vendor proposed for approval	TSGENCO Remarks for YTPS (5X800MW)
4	MISC. PUMPS (HORIZONTAL)	1	BEACON WEIR LTD., CHENNAI	Approved
		2	BEST AND CROMPTON ENGG LTD., CHENNAI	Approved
		3	FLOWMORE LTD., HARYANA	Approved
		4	FLOWSERVE INDIA CONTROLS PVT. LTD., KOLKATA	Approved
		5	JYOTI LTD., GUJARAT	Approved
		6	KIRLOSKAR BROTHERS LTD., PUNE	Approved
		7	KISHORE PUMPS, CHENNAI	Approved
		8	KUBOTA CORPN, JAPAN	Approved
		9	MAX FLOW PUMPS INDIA PVT. LTD., GURGAON	Approved
		10	SAM PUMP, TAMILNADU	Approved
		11	WPIL LIMITED, KOLKATA	Approved
		12	WILO MATHER & PLATT PUMPS LTD., MUMBAI	Approved
5	PRESSURE GAUGE	1	A.N.INSTRUMENTS PVT. LTD., CHENNAI	Approved
		2	BAUMER INDIA PRIVATE LIMITED, PUNE	Approved
		3	GENERAL INSTRUMENTS(GIC), PANVEL	Approved
		4	WALCHANDNAGAR INDUSTRIES LTD., BAUMER	Approved
		5	WIKA INSTRUMENTS INDIA PVT. LTD., PUNE	Approved
		6	ASHCROFT INDIA PVT LTD. , GUJARAT	Approved
		7	BAUMER TECHNOLOGIES, MUMBAI	Approved
		8	BELLS CONTROLS LIMITED, KOLKATA	Approved
		9	BUDENBERG GAUGE CO LTD, UK	Approved
		10	FORBES MARSHALL (HYD) PVT. LIMITED, HYDERABAD	Approved
		11	GAUGES BOURDON INDIA, NAVI MUMBAI	Approved
		12	GOA INSTRUMENT INDUSTRIES PVT LTD., GOA	Approved
		13	GOA STATIC INSTRUMENTS, GOA	Approved
		14	H.GURU INSTRUMENTS (S.I) PVT. LTD., BANGALORE	Approved
		15	MANOMETER INDIA PVT LTD., THANE	Approved
		16	PRECISION MASS PRODUCTS PVT. LTD., GANDHINAGAR, GUJARAT	Approved
		17	WAREE INSTRUMENTS LIMITED, MUMBAI	Approved

Chief Engineer/TPC

ANNEXURE

Yadadri TPS (5X800MW) approved sub vendor list for Hydrogen Generation Plant

Lr.No.CE/TPC/SE-3/EME-11/YTPS(5X800MW)/F.Vendors/D.No.212/22, Dt:20.01.2023

Sl. No.	Item Description	Sl. No.	Vendor proposed for approval	TSGENCO Remarks for YTPS (5X800MW)
6	PRESSURE TRANSMITTER	1	ABB LIMITED,GERMANY/INDIA	Approved
		2	EMERSON PROCESS USA/NAVI MUMBAI	Approved
		3	ENDRESS + HAUSER(I) AUTOMATION, INDIA	Approved
		4	FUJI ELECTRIC SYSTEMS CO. LTD. JAPAN/FRANCE /INDIA	Approved
		5	HONEYWELL AUTOMATION INDIA LIMITED, USA/INDIA	Approved
		6	SIEMENS LTD., INDIA	Approved
		7	YOKOGAWA INDIA LIMITED, JAPAN/INDIA	Approved
7	DIFFERENTIAL PRESSURE TRANSMITTER	1	ABB LIMITED,GERMANY/INDIA	Approved
		2	BALDOTA CONTROL & (SMAR MAKE) EQUIPMENTS PVT LTD., INDIA	Approved
		3	EMERSON PROCESS MGT PVT. LTD., USA/ INDIA	Approved
		4	ENDRESS + HAUSER(I) AUTOMATION, INDIA	Approved
		5	FUJI ELECTRIC SYSTEMS CO. LTD., JAPAN/FRANCE/INDIA	Approved
		6	HONEYWELL AUTOMATION INDIA LIMITED, USA/INDIA	Approved
		7	SIEMENS LTD., INDIA	Approved
		8	YOKOGAWA INDIA LIMITED, INDIA/JAPAN	Approved
8	TEMPERATURE GAUGE	1	A.N.INSTRUMENTS PVT LTD, CHENNAI.	Approved
		2	GOA THERMOSTATIC INSTRUMENTS., GOA	Approved
		3	H GURU INSTRUMENTS (SOUTH INDIA), PVT BANGALORE	Approved
		4	GENERAL INSTRUMENTS(GIC), PANVEL	Approved
		5	WIKA INSTRUMENTS, INDIA PVT. LTD., PUNE	Approved
		6	BAUMER TECHNOLOGIES (I) PRIVATE LIMITED, MUMBAI	Approved
		7	FORBES MARSHALL(HYD) LTD., HYDERABAD	Approved
		8	GAUGES BOURDON (INDIA) PVT. LTD., MUMBAI	Approved
		9	GOA INSTRUMENTS INDUSTRIES PRIVATE LTD., GOA	Approved
		10	PRECISION MASS PRODUCTS PVT. LTD, INDIA	Approved

Chief Engineer/TPC

ANNEXURE

Yadadri TPS (5X800MW) approved sub vendor list for Hydrogen Generation Plant

Lr.No.CE/TPC/SE-3/EME-11/YTPS(5X800MW)/F.Vendors/D.No212/22, Dt:20.01.2023

Sl. No.	Item Description	Sl. No.	Vendor proposed for approval	TSGENCO Remarks for YTPS (5X800MW)
9	TEMPERATURE TRANSMITTER	1	ABB, GERMANY / BANGALORE	Approved
		2	EMERSON PROCESS, USA/NAVI MUMBAI	Approved
		3	ENDRES+HAUSER (I) AUTOMATION, INDIA	Approved
		4	HONEYWELL AUTOMATION INDIA LIMITED, USA/PUNE	Approved
		5	SIEMENS LTD., INDIA	Approved
		6	YOKOGAWA INDIA LIMITED, BANGALORE	Approved
10	TEMPERATURE ELEMENT	1	BAUMER INDIA PRIVATE LIMITED, MUMBAI	Approved
		2	DETRIV INSTRUMENTATION AND ELETRONICS LTD., MUMBAI	Approved
		3	EXOTHERM INSTRUMENTS, THANE	Approved
		4	GAUGES BOURDON INDIA PVT LTD., MUMBAI	Approved
		5	GOA INSTRUMENTS INDUSTRIES PRIVATE LTD., GOA	Approved
		6	INDUSTRIAL INSTRUMENTATION, KOLKATA	Approved
		7	OKAZAKI, JAPAN	Approved
		8	PYRO ELECTRIC INSTRUMENTS GOA PVT. LTD., MAPUSA ,GOA	Approved
		9	TECHNO INSTRUMENTS SANTEJ, GANDHINAGAR, GOA	Approved
		10	TEMPSENS INSTRUMENTS (I) PVT LTD., UDAIPUR	Approved
		11	THERMAL INSTRUMENT INDIA PVT. LTD., INDIA	Approved
		12	TOSHNIWAL INDUSTRIES PVT LTD., AJMER	Approved
11	LEVEL GAUGE	1	CHEMTROLS SAMIL (INDIA) PVT. LTD., POWAI, MUMBAI	Approved
		2	D.K.INSTRUMENTS PVT. LTD., KOLKATA	Approved
		3	LEVCON INSTRUMENTS PVT. LTD., KOLKATA	Approved
		4	PUNE TECHTROL PVT. LTD., PUNE	Approved
		5	SBEM PRIVATE LIMITED, PUNE	Approved
		6	SIGMA INSTRUMENTS COMPANY, BHAND, UP	Approved
		7	V.AUTOMAT & INSTRUMENTS PVT. LTD., NEW DELHI	Approved

Chief Engineer/TPC

ANNEXURE

Yadadri TPS (5X800MW) approved sub vendor list for Hydrogen Generation Plant

Lr.No.CE/TPC/SE-3/EME-11/YTPS(5X800MW)/F.Vendors/D.No 212/22, Dt: 20.01.2023

Sl. No.	Item Description	Sl. No.	Vendor proposed for approval	TSGENCO Remarks for YTPS (5X800MW)
12	LEVEL TRANSMITTER	1	ABB, INDIA	Approved
		2	EMERSON PROCESS, INDIA	Approved
		3	ENDRESS+HAUSER (I), GERMANY/ INDIA	Approved
		4	FORBES MARSHALL, INDIA	Approved
		5	KROHNE MARSHALL, INDIA	Approved
		6	P&F, INDIA	Approved
		7	SIEMENS MILLTRONICS, CANADA	Approved
		8	VEGA, GERMANY	Approved
13	CABLE GLANDS	1	ARUP ENGINEERING	Approved
		2	COMMET	Approved
		3	JAINSON	Approved
		4	SUNIL&CO	Approved
		5	ATLAS METAL INDUSTRIES	Approved
		6	DOWELL	Approved
		7	GLOBAL BRASS & ALLOY	Approved
		8	HEX	Approved
		9	INDUSTRIAL PRODUCTS	Approved
14	PLC/SCADA	1	GE INTELLIGENT PLATFORMS PVT. LTD.	Approved
		2	HONEYWELL AUTOMATION INDIA LTD.	Approved
		3	ROCKWELL AUTOMATION INDIA PVT., LTD.	Approved
		4	SCHNEIDER ELECTRIC INDIA PVT. LTD.	Approved
		5	SIEMENS INDIA LTD.	Approved
		6	ENERGY VENTURES (SYSTEM INTEGRATOR FOR ROCKWELL)	Approved
		7	PRIME CONTROL PUNE (SYSTEM INTEGRATOR FOR GE FANUC)	Approved
		8	DELSYS AUTOMATION CHENNAI (SYSTEM INTEGRATOR FOR GEFANUC)	Approved
		9	COTMAC ELECTRONIC PVT LTD (CHANNEL PARTNER OF M/s SIEMENS LTD)	Approved
		10	SUN INDUSTRIAL AUTOMATION & SOLUTION (SYSTEM INTEGRATOR FOR SCHNEIDER)	Approved
		11	LADDER AUTOMATION SOLUTIONS PVT LTD (CHANNEL PARTNER OF M/s HONEYWELL AUTOMATION INDIA PVT LTD.	Approved

Chief Engineer/TPC

ANNEXURE

Yadadri TPS (5X800MW) approved sub vendor list for Hydrogen Generation Plant

Lr.No.CE/TPC/SE-3/EME-11/YTPS(5X800MW)/F.Vendors/D.No 212/22, Dt: 20.01.2023

Sl. No.	Item Description	Sl. No.	Vendor proposed for approval	TSGENCO Remarks for YTPS (5X800MW)
15	PLC SYSTEM INTEGRATOR	1	CAS ELECTRICAL & AUTOMATION PVT LTD (SYSTEM INTEGRATOR FOR ROCKWELL)	Approved
		2	COTMAC ELECTRONIC PVT. LTD. (CHANNEL PARTNER OF M/S SIEMENS LTD), HARYANA	Approved
		3	DELSYS (SYSTEM INTEGRATOR FOR GE FANUC), CHENNAI	Approved
		4	DYNAMIC ENGINEERS (SYSTEM INTEGRATOR FOR ALLEN BRADLEY), NOIDA	Approved
		5	LADDER AUTOMATION SOLUTIONS PVT. LTD. (CHANNEL PARTNER OF M/S HONEYWELL AUTOMATION PVT. LTD.) HARYANA	Approved
		6	ENERGY VENTURES (SYSTEM INTEGRATOR FOR ROCK WELL AUTOMATION)	Approved
		7	PRIME CONTROLS/PUNE (SYSTEM INTEGRATOR FOR GE FANUC)	Approved
		8	SUN INDUSTRIAL AUTOMATION & SOLUTION (SYSTEM INTEGRATOR OF SCHNEIDER.)	Approved
16	OWS / PC	1	DELL	Approved
		2	HP	Approved
		3	IBM-LENOVO	Approved
17	PRINTER	1	CANON	Approved
		2	EPSON (INKJET ONLY)	Approved
		3	HP	Approved
		4	IBM	Approved
		5	LEXMARK	Approved
		6	XEROX	Approved
18	AC	1	BLUE STAR LTD., WADA	Approved
		2	CARRIER, HARYANA	Approved
		3	NATIONAL, INDIA	Approved
		4	DIAKIN, INDIA	Approved
		5	VOLTAS LTD., GUJRAT	Approved
		6	LG, INDIA	Approved
		7	SAMSUNG, INDIA	Approved
		8	HITACHI, INDIA	Approved

Chief Engineer/TPC

ANNEXURE

Yadadri TPS (5X800MW) approved sub vendor list for Hydrogen Generation Plant

Lr.No.CE/TPC/SE-3/EME-11/YTPS(5X800MW)/F.Vendors/D.No 212/22, Dt:20.01.2023

Sl. No.	Item Description	Sl. No.	Vendor proposed for approval	TSGENCO Remarks for YTPS (5X800MW)
19	UPS WITH ACDB	1	DELTA INDIA ELECTRONICS PVT. LTD., CHENNAI	Approved
		2	FUJI ELECTRIC CONSUL NEOWATT PVT. LTD., INDIA	Approved
		3	HITACHI HIREL POWER ELECTRONICS, GANDHINAGAR	Approved
		4	VERTIV ENERGY, (FORMERLY M/S EMERSON NETWORK POWER), AMBERNIATH	Approved
20	CABLE TRAY	1	AMTECH, PUNE	Approved
		2	APT ENGINEERING WORKS, NEW DELHI	Approved
		3	CHEMIN CONTROLS AND INSTRUMENTATION,PONDICHERRY	Approved
		4	GEE DEE PACKAGES PVT. LTD., MYSORE	Approved
		5	INDIA ELECTRICALS SYNDICATE, KOLKATA	Approved
		6	INDIANA GRATINGS, PUNE/MUMBAI	Approved
		7	INDUSTRIAL PERFORATION, KOLKATA	Approved
		8	INNOSPACER ENGINEERING TECHNOLOGIES, BANGALORE	Approved
		9	JAMNA METAL COMPANY, NEW DELHI	Approved
		10	KANADE ANAND UDYOG PVT. LTD., ANDHERI	Approved
		11	M.J.ENGINEERING WORKS PVT. LTD, NEW DELHI	Approved
		12	PATNY SYSTEMS PVT. LTD., SECUNDERABAD	Approved
		13	PRAMMEN INDUSTRIES, PUDDUKKOTTAI	Approved
		14	RATAN ENGINEERING AND PROJECTS, KOLKATA	Approved
		15	RUKMANI ELECTRICAL & COMPONENTS PVT. LTD., KOLKATA	Approved
		16	SILVERLINE POWER INFRASTRUCTURE PVT. LTD.	Approved
21	LEAD ACID BATTERY (PLANTE TYPE)	1	EXIDE INDUSTRIES , KOLKATA	Approved
		2	HOPPECKE, GERMANY	Approved
22	COMPUTER FURNITURE	1	COSMOS MEDIA PRODUCTS PVT. LTD., NOIDA	Approved
		2	ADARSHA CONTROLS SYSTEMS PVT. LTD., BANGALORE	Approved
		3	GODREJ AND BOYCE MANUFACTURING CO LTD., BANGALORE	Approved
		4	OTS, BANGALORE	Approved
		5	PYROTECH WORKSPACE SOLUTIONS PVT. LTD., UDAIPUR	Approved

Chief Engineer/TPC

ANNEXURE

Yadadri TPS (5X800MW) approved sub vendor list for Hydrogen Generation Plant

Lr.No.CE/TPC/SE-3/EME-11/YTPS(5X800MW)/F.Vendors/D.No242/22, Dt:20.01.2023

Sl. No.	Item Description	Sl. No.	Vendor proposed for approval	TSGENCO Remarks for YTPS (5X800MW)
23	BALL VALVE	1	WEIR BDK VALVES, HUBLI	Approved
		2	LEADER VALVES LTD., JALANDHAR	Approved
		3	A.V VALVES LIMITED, AGRA	Approved
		4	MICON VALVES (INDIA) PVT. LTD., MUMBAI	Approved
		5	MICROFINISH VALVES PVT LTD., HUBLI	Approved
		6	HAWA VALVES, MUMBAI	Approved
		7	CHEMTECH INDUSTRIAL VALVES, MAHARASHTRA	Approved
		8	DEMBLA VALVES, MAHARASHTRA	Approved
		9	INTERVALVE (INDIA) LTD., PUNE	Approved
		10	VALTECH INDUSTRIES, MUMBAI	Approved
		11	HAWA ENGINEERS LTD., GUJARAT	Approved
24	GATE / GLOBE/ NON-RETURN (CHECK) VALVES	1	LEADER VALVES LTD., JALANDHAR	Approved
		2	WEIR BDK VALVES, HUBLI	Approved
		3	FLUIDLINE VALVES COMPANY PVT. LTD., MUMBAI	Approved
		4	STEEL STRONG VALVES (I) PVT.LTD., MUMBAI	Approved
		5	SAP INDUSTRIES LTD., AHMEDABAD	Approved
		6	TECHNO VALVES, NASHIK	Approved
		7	A.V VALVES LTD, AGRA	Approved
		8	INTERVALVE(INDIA) LTD, PUNE	Approved
		9	NITON VALVES INDUSTRIES PVT. LTD., MUMBAI	Approved
		10	HAWA ENGINEERS LTD, GUJARAT	Approved
		11	MICON VALVES (INDIA) PVT. LTD., MUMBAI	Approved
		12	VALTECH INDUSTRIES, MUMBAI	Approved
		13	HAWA VALVES (INDIA)PVT. LTD., MUMBAI	Approved
25	JUNCTION BOX	1	BALIGA LIGHTING, CHENNAI	Approved
		2	HI-POWER CONTROLS, INDIA	Approved
		3	PYROTECH, UDAIPUR	Approved
		4	CHEMIN CONTROLS, PONDICHERRY	Approved
		5	ELECTRO MECHANICAL (INDIA), KOLKATA	Approved
		6	K.S. INSTRUMENTS, BANGALORE.	Approved
		7	KHODAY CONTROL SYSTEMS, BANGALORE	Approved
		8	MANISHA ENTERPRISES, PUNE	Approved
		9	SAJAS ELECTRICALS, TIRUCHIRAPALLI	Approved
		10	PRAMMEN INDUSTRIES, PUDUKKOTTAI	Approved
		11	SHERNIK & COMPANY, AHMEDABAD	Approved

Chief Engineer/TPC

ANNEXURE

Yadadri TPS (5X800MW) approved sub vendor list for Hydrogen Generation Plant

Lr.No.CE/TPC/SE-3/EME-11/YTPS(5X800MW)/F.Vendors/D.No.212/22, Dt: 20.01.2023

Sl. No.	Item Description	Sl. No.	Vendor proposed for approval	TSGENCO Remarks for YTPS (5X800MW)
26	SOLENOID VALVES	1	ROTEX AUTOMATION LTD., BARODA	Approved
		2	ASCO, CHENNAI	Approved
		3	AVCON CONTROLS PVT. LTD., MUMBAI	Approved
27	VENTILATION SYSTEM	1	AIR LINK ENGINEERS PVT. LTD., NEW DELHI	Approved
		2	ADVANCE VENTILATION PVT.LTD., NEW DELHI	Approved
		3	APC SYSTEMS & PRODUCTS PVT LTD, KOLKATA	Approved
		4	BLUE STAR LTD., MUMBAI	Approved
		5	C.DOCTOR AND CO. PVT.LTD, KOLKATA	Approved
		6	DRAFT-AIR (INDIA) PVT. LTD., NEW DELHI	Approved
		7	DUSTVEN PVT LTD, , KARNATAKA	Approved
		8	MESINA , MUMBAI	Approved
		9	ROOTS COOLING SYSTEMS PVT.LTD., NOIDA (UP)	Approved
		10	S.K.SYSTEMS PRIVATE LTD., HARYANA	Approved
		11	STERLING AND WILSON LIMITED, KOLKATA	Approved
		12	VOLTAS LTD., MUMBAI	Approved
		13	TAP ENGINEERING, CHENNAI	Approved
		14	INDUSTRIAL PROJECT & PRODUCTS CO., GURGAON	Not approved
		15	PACK PLAST INDUSTRIES, RAJASTHAN	Not approved
28	VACUUM PUMP	1	GARUDA ENGINEERING, AHMEDABAD	Approved
29	DEW POINT SENSOR	1	MICHELL INSTRUMENTS, UK	Approved
30	ENCLOSURE (LOCAL CONTROL PANEL)	1	C&S ELECTRIC, NOIDA	Approved
		2	CONTROL & SCHEMATICS, HYDERABAD	Approved

Chief Engineer/TPC

Notes:-

1. The sub vendor list above is indicative only and is subject to BHEL and customer approval during detailed engineering stage without any commercial & delivery implication to BHEL.

2. The inspection category will be intimated after award of contract by BHEL/customer. However the same will be adhered by the bidder without any commercial and delivery implication to BHEL/ customer.

ANNEXURE III: FUNCTIONAL GUARANTEES AND LIQUIDATED DAMAGES

The Bidder shall guarantee that the equipment offered shall meet the rating and performance requirements stipulated for various equipment covered in this specifications.

The guaranteed performance parameters furnished by the bidder in his offer, shall be without any tolerance values and all margins required for instrument inaccuracies and other uncertainties shall be deemed to have been included in the guaranteed figures.

The bidder shall demonstrate all the guarantees covered herein during demonstration test / PG test.

The various tests which are to be carried out during demonstration tests are listed in the specification. The guarantee tests shall be conducted by the bidder at site in presence of BHEL/ CUSTOMER. All costs associated with the tests shall be included in the bid price.

In case during demonstration test /PG test, it is found that the equipment/system has failed to meet the guarantees, the bidder shall carry out all necessary modifications and/or replacements to make the equipment/system comply with the guaranteed requirements at no extra cost to the BHEL/ CUSTOMER and re-conduct the demonstration test(s) / PG test with BHEL/ CUSTOMER's consent.

Noise

All the plant, equipment and systems covered under this specification shall perform continuously without exceeding the noise level over the entire range of output and operating frequency specified in the technical specifications.

Noise level measurement shall be carried out using applicable and internationally acceptable standards. The measurement shall be carried out with a calibrated integrating sound level meter meeting the requirement of IEC 651 or BS 5969 or IS 9779.

Sound pressure shall be measured all around the equipment at a distance of 1.0 m horizontally from the nearest surface of any equipment/ machine and at a height of 1.5 m above the floor level in elevation.

A minimum of 6 points around each equipment shall be covered for measurement. Additional measurement points shall be considered based on the applicable standards and the size of the equipment. The measurement shall be done with slow response on the A - weighting scale. The average of A-weighted sound pressure level measurements expressed in decibels to a reference of 0.0002 micro bar shall not exceed the guaranteed value. Corrections for background noise shall be considered in line with the applicable standards. All the necessary data for determining these corrections, in line with the applicable standards, shall be collected during the tests.

Hydrogen Generation Plant

i. Capacity and discharge pressure of hydrogen gas compressors at its rated duty point shall be demonstrated and proved at site.

ii. Electrolyser & rectifier capacity and power consumption shall be demonstrated at site.

iii. Parallel operation of two streams shall be demonstrated at site. Purity level and moisture content of hydrogen shall be demonstrated at site.

iv. Hydrogen generation plant capacity (stream wise) shall be demonstrated at site.

v. Vibration level and noise level of hydrogen gas compressors shall be demonstrated at site.

ANNEXURE IV: DRAWING DOCUMENTS DISTRIBUTION PROCEDURE

DISTRIBUTION SCHEDULE

S.No.	Description	TSGENCO									Consultant			Equipment Vendor	Remarks
		CMD Hyd	Director (Projects)	ED/ Civil Hyd.	ED (TPC) Hyd	CE/TPC	CE/ YTPS	SE (Civil) YTPS	SE (E&M) YTPS	EE YTPS	Head Office	HYD	YTPS Site		
A.	Vendor Drawings														
1.	Preliminary	-	1	1	2		1	1	2	-	10	1	-	S	
2.	Return preliminary with comments	-	1	1	2		1	1	1	-	S+2	-	-	1	
3.	Final and any revision thereof	1	1	1	3		1	1	3	-	2	1	1	S	
B.	Progress Report Monthly														
1.	Monthly progress report	1	1	1	2		1	1	1	1	1	1	1	S	
C.	Instruction Manuals/ Data Books/As built drawings														
1.	Equipment manufacturer	-	-	-	2		1	-	2	4	2	1	1	S	

S : Source

Hard copy distribution schedule shall be as above, Further following may please be noted

a) Vendor Drawings mentioned at Sl.no."A" above shall covered all drawings, documents, QAP, PG test and O& M Manual etc.

b) Monthly progress report mentioned at Sl.no."B" above shall be submitted to BHEL Units and PMG instead of TSGENCO/Consultant specified above.

c) 5 nos. hard copies of vendor drawings in addition to those mentioned in above table along with soft copy shall be submitted to BHEL. Further distribution to BHEL units shall be informed during detail engineering.

d) Equipment Vendor/Manufacturer means BOP contractor.

S: Indicated against agency responsible for submission of respective department

ANNEXURE V: PAINTING SPECIFICATION

SECTION-XIII

TECHNICAL SPECIFICATION

FOR

PROTECTIVE LINING AND PAINTING

1.00.00 INTENT OF SPECIFICATION

1.01.00 This specification addresses the requirements of all labour, material, and appliances necessary with reference to preparations for lining / painting, application as well as finishing of all lining / painting for all mechanical and electrical equipment, piping and valves, structures etc. included under the scope of this Package.

1.02.00 The Bidder shall furnish and apply all lining, primers including wash primers if required, under-coats, finish coats and colour bands as described hereinafter or necessary to complete the work in all respects.

2.00.00 CODES & STANDARDS

2.01.00 The Bidder shall follow relevant Indian and International Standards wherever applicable in cleaning of surface, selection of lining material / paints and their application. The entire work shall conform to the following standards / specifications (latest revision or as specified).

a) SSPC SP 10 / NACE 2 /	:	Near White Blast Cleaning
b) SSPC PA 2	:	Measurement of dry film Coating Thickness with magnetic gauges.
c) ASTM D 4541	:	Method for pull off strength using portable Adhesion Tester.
d) NACE RP 0274 – 2004	:	High-Voltage Electrical Inspection of Pipeline Coatings
e) NACE SP 0188 – 2006	:	Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates

f)	NACE RP 0169 – 2002	:	Control of External Corrosion on Underground or Submerged Metallic Piping Systems
g)	AWWA C 210 – 2007	:	Liquid-Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines
h)	IS 3589:2001 Annexure B	:	Steel Pipes for Water and Sewage Specification.
i)	AWWA C222-2000	:	Polyurethane Coating for the Interior and Exterior of Steel Water Pipe and Fittings.
j)	IS 13213 : 2000	:	Polyurethane Full Gloss Enamel (Two pack)

3.00.00 GENERAL REQUIREMENTS

3.01.00 The steel surface preparation prior to actual commencement of coating shall conform to SSPC SP 10 / NACE 2 / Sa2½ (near white metal) with sand blasting.

3.02.00 The contractor shall submit a detailed written description in the form of a manual covering coating equipment, procedures, materials inspection test, and repair etc. to Owner/Consultant for approval.

3.03.00 The contractor shall also provide copies of test reports from NABL approved laboratory (like National Test House, Kolkata) in support of the paint/primer materials to be used shall conform to the specification requirement.

3.04.00 The contractor shall also provide certificates from paint/primer manufacturer mentioning the batch numbers, date of manufacture and shelf life etc. of the materials to be used. In addition to that Manufacturing Quality Plan (MQP) and Field Quality Plan (FQP) shall also be submitted prior to commencement of supply of material and field application.

3.05.00 Paint/coating application work at site shall be done either by paint manufacturer or by their authorized applicator. The authorized applicator shall have proper training & certification from manufacturer. Applicator shall possess all the necessary specialized equipment and manpower experienced in similar job.

3.06.00 Applied coating shall be tested for dry film thickness, holiday (electrical inspection for continuity) and adhesion as per relevant standard such as SSPC PA 2, NACE RP 0274 and ASTM D 4541.

3.07.00 If necessary, the material may be heated and applied by airless spray / plural component spray system.

3.08.00 Manufacturer's specific recommendation, if any, shall be followed during application of lining / paints.

3.09.00 In areas where there is danger of spotting automobiles or other finally finished equipment or building by wind borne particles from paint spraying, a Purchaser approved method shall be adopted.

3.10.00 The colour scheme of the entire Plant, covered under this specification shall be approved by the Purchaser in advance before application.

3.11.00 All indoor and outdoor piping, insulated as well as uninsulated will have approved colour bands painted on the pipes at conspicuous places throughout the system, as approved by Purchaser.

3.12.00 Inside surfaces of vessels / tanks shall be protected by anticorrosive paints or rubber lining as required / specified elsewhere in the specification. External surfaces of all vessels / tanks shall be protected by anti corrosive painting.

3.13.00 For vessels / tanks requiring lining and epoxy painting all inside surface shall be blast cleaned using non-siliceous abrasive after usual wire brushing.

3.14.00 Natural rubber lining shall be provided on the inside of vessels / tanks as required / specified elsewhere in the specification, in three layers resulting in a total thickness not less than 4.5 mm.

3.15.00 Surface hardness of rubber lining shall be 65 +/- 5 deg. A (shore).

3.16.00 After the lining is completed, the vessels / tanks shall not be subjected to any prolonged exposure to direct sunlight in course of its transportation, erection etc. They shall not be stored in direct sunlight. No further lining or burning shall be carried out on the vessel, after application of the lining.

3.17.00 All lining projecting outside of the vessel shall be protected adequately from mechanical damages during shipment, handling storage etc.

3.18.00 Suitable warnings, indicating the special care that must be taken with respect to these lined vessels shall be stenciled on their outside surface with the letters at least 12 mm high.

3.19.00 All insulated piping shall have aluminium sheet jacketing.

4.00.00 EQUIPMENT, MATERIAL AND SERVICES TO BE FURNISHED BY THE BIDDER

4.01.00 After erection at site, the outside surfaces of all equipment having a shop coat shall be given further priming coat and finished coats of paint as detailed in following clauses. However, if the painting system is such that the shop coat and primer coat to be applied at site are not compatible, then shop coat has to be removed from the surface of equipment before application of primer coat with prior blasting.

All factory finished paints shall be touched up at site as required.

All uninsulated piping shall be finished with final paintings after use of proper wash primer and primer. Aluminium sheet jacketed piping need not be painted. Colour bands of Purchaser's approved shade shall however be applied on jacketed piping near walls or partitions, at all junctions, near valves and all other places as instructed by the Purchaser. All structures shall be painted with approved paint.

4.02.00 Surface Preparation

4.02.01 Unless mentioned otherwise, all rust and mill scale shall be removed by blasting to Sa 2-1/2 Swiss Standard before applying the primer.

4.02.02 Special care shall be taken to remove grease and oil by means of suitable solvents like Trichloroethylene or Carbon Tetrachloride.

4.02.03 The minimum degree of surface preparations for all equipment, piping, fittings, valves, structures etc. shall be "Near White" according to Steel Structure, Painting Council-SSPC-SP-10 before application of any primer/paint.

4.03.00 Painting

4.03.01 Specification for application of paints for external surfaces protection of vessels / tanks / equipment / piping / fittings / valves etc. to be installed indoor shall be as follows :

a) Surface preparation shall be done either manually or by any other approved method.

b) Primer Coat shall consist of one coat (minimum DFT of 50 microns) of chlorinated rubber based zinc phosphate.

c) Intermediate Coat (or Under Coat) shall consist of one coat (minimum DFT of 50 microns) of chlorinated rubber based paint pigmented with Titanium Dioxide.

d) Top Coat shall consist of one coat (minimum DFT of 50 microns) of chlorinated rubber paint of approved shade and colour with glossy finish.

e) Total DFT of paint system shall not be less than 150 microns.

4.03.02 Specification for application of paints for external surfaces protection of vessels / tanks / equipment / piping / fittings / valves etc to be installed **outdoor** shall be as follows :

a) Surface preparation shall be done by means of sand blasting, which shall conform to Sa 2-1/2 Swiss Standard.

b) Primer Coat shall consist of one coat (minimum DFT of 100 microns) of epoxy resin based zinc phosphate primer.

c) Intermediate Coat (or Under Coat) shall consist of one coat (minimum DFT of 100 microns) epoxy resin based paint pigmented with Titanium Dioxide.

d) Top Coat shall consist of one coat (minimum DFT of 75 microns) of epoxy paint of approved shade and colour with glossy finish. Additional one coat (minimum DFT of 25 microns) of Finish Coat of polyurethane shall be provided.

e) Total DFT of paint system shall not be less than 300 microns.

4.03.03 Specification for application of paints for external surfaces protection of steel pipes and fittings which are **buried underground / laid inside a hume pipe & or submerged Under Water and laid under Pipe Trenches** (in road/rail/pipe or trench crossings) shall be as follows :

External surface of the pipe, fittings, specialties etc. handling raw water/clarified water/filter water shall be painted with one coat of two part chemically cured polyurethane primer of min 50 micron dry film thickness followed by three or maximum four coats of two part solvent less polyurethane to build up coating of dry film thickness of 2000 micron including primer coat.

4.03.04 Specification for application of paints for **internal surface protection of large diameter pipes** (sizes above 600 mm NB and above) if any, shall be as follows :

a) All Internal surfaces of steel pipes, fittings, specialties etc. buried underground or located within pipe trenches shall be given epoxy coating to protect them from (except for drinking water service, where the compatible painting shall be so selected to meet relevant quality standards) corrosion.

b) Internal surface of the pipe should be coated with one coat of two part epoxy primer with not less than 50 micron DFT (dry film thickness) followed by two part polyamide cured solvent less epoxy.

c) The minimum dry film thickness (DFT) of internal lining shall be 600 micron.

4.03.05 Specification for application of paints for protection of **internal surfaces of DM Water Storage Tank(s)** shall be as follows :

a) Primer - One coat of epoxy primer containing high level of Zinc Phosphate anticorrosive pigment. Total Dry Film Thickness (DFT) of primer shall not be less than 125 microns.

b) Finish Paint - Three (3) coats Polyamine HB Epoxy Paint. Total Dry Film Thickness (DFT) of finish paint shall not be less than 125 microns per coat.

c) Total thickness of primer and paint should not be less than 500 microns.

4.03.06 All motors, local push button stations, cable racks, structures used for supports etc. are to be painted with acid proof paint.

4.03.07 The following surfaces shall not be painted - stainless steel, galvanized steel, aluminum, copper, brass, bronze and other nonferrous materials.

4.03.08 No painting or filler shall be applied until all repairs, hydrostatic tests and final shop inspection are completed.

4.03.09 All machined surfaces shall have two (2) coats of water repellant grease after thorough cleaning.

5.00.00 COATING PROCEDURE AND APPLICATION

5.01.00 Surface Preparation :

Pipe shall be blast cleaned by sand. The cleanliness achieved prior to application shall be in accordance with the requirement of SSPC SP 10 / NACE 2 / Sa2½ of ISO 8501 (near white metal)

a) The blast pattern or profile depth shall be 40 to 100 micron and shall be measured by dial micrometer.

b) Before sand blasting is started or during blasting or coating, temperature of the pipe surface should be more than 3°C above dew point temperature. Blast cleaned surface should be primed within 4 hours and shall be protected from rainfall or surface moisture and shall not be allowed to flash rust. If the rust occurs, the surface again to be prepared by sand blasting or wire brushing.

5.02.00 Application of Epoxy Coating

a) Coating shall be applied when

i) When the pipe surface temperature shall be atleast 3°C above dew point temperature.
ii) The temperature of mixed coating material and the pipe at the time of application shall not be lower than 10°C or greater that 50°C.

b) Material preparation shall be in accordance with manufacturer's recommendations.

c) Application of epoxy coating system :

The epoxy coating system shall be applied as per recommendation of the manufacturer and shall be applied by airless spray / plural component spray machine. For more than one coat, the second shall be applied with the time limits as recommended by the manufacturer.

5.03.00 Application of PU Coating

a) PU coating shall be applied when the pipe surface temperature atleast 3°C above dew point temperature (when R.H is more than 85%).

b) Material preparation and application shall be done as per manufacturer recommendation.

6.00.00 TEST REQUIREMENTS :

6.01.00 Measurement of dry film thickness

Measurement of dry film thickness of coating : Coating thickness shall be in the range of ±20% and as per SSPC PA 2.

6.01.01 Apparatus / Instrument:-

The instrument used for dry film thickness may be Type 1 pull of gauges or Type 2 electronic gauges.

6.01.02 Procedures:-

a) Number of measurements:
For 100 square feet (9.29 square meters), five (5) spots per test area (each spot is 3.8 cm) in diameter. Three gauge readings per spot (average becomes the spot measurement).

b) If the structure is less than 300 square feet, each 100 square feet should be measured.

c) If the structure is between 300 and 1000 sq ft, select 3 random 100 square feet test areas and measure.

d) For structure exceeding 1000 square feet, select 3 random 100 square feet testing areas for the first 1000 sq ft and select 1 random 100 square feet testing area for each additional 1000 square feet

e) Coating thickness Tolerance: Individual reading taken to get a representative measurement for the spot are unrestricted (usually low or high readings are discarded). Spot measurements (the average of 3 gauge readings) must be within 80% of the minimum thickness and 120% of the maximum thickness. Area measurement must be within specified range.

6.02.00 Electrical Inspection (Holiday) Test

6.02.01 All the coated / lined pipes shall be tested with an approved high voltage holiday detector preferably equipped with an audio visual signaling device to indicate any faults, holes, breaks or conductive particles in the protective coating.

6.02.02 The applied output voltage of holiday detector shall have a spark discharge of thickness equal to at least twice the thickness of the coating to assure adequate inspection voltage and compensate for any variation in coating thickness. The electrode shall be passed over the coated surface at approximately half the spark discharge distance from the coated surface only one time at the rate of approximately 10 to 20m/min. The edge effect shall be ignored. Excessive voltage shall be avoided as it tends to induce holiday in the coated surface thereby giving erroneous readings.

6.02.03 While selecting test voltages, consideration should be given to the tolerance on coating thickness and voltage should be selected on the basis of maximum coating thickness likely to be encountered during testing of a particular pipe.

The testing voltage shall be calculated by using following formula. (as per NACE 0274 : 2004)

Testing Voltage V = 7900 $\sqrt{T}$ ± 10 percent where T is the average coating thickness in mm.

6.02.04 Any audio visual sound or spark leads to indicate pinhole, break or conductive particle.

6.03.00 Adhesion Pull off Test :

After holiday the coated surface is subjected to adhesion pull off test as per ASTMD 4541.

6.03.01 Apparatus / Instrument: Adhesion tester consists of three basic components:

A hand wheel, a black column containing a dragging indicator pin and scale in the middle and a base containing three legs and a pulling “Jaw” at the bottom and also dollies.

6.03.02 Prepare the test surface :

Once test area is selected, test area shall be free of grease, oil, dirt, water. The area should be flat surfaces and large enough to accommodate the specified number of replicate test.

6.03.03 Prepare Dolly (Test Pull Stub) :

The dolly is a round, two sided aluminium fixture. Both sides of the dolly looks same, however, one side sloped on top surface while flat on bottom surface. As the surface of the dolly is polished aluminium, roughen the same using a coarse sand paper.

6.03.04 Select an adhesive:

Use araldite, a 100% solid epoxy adhesive. This adhesive requires at least 24 hours at room temperature to cure.

6.03.05 Attach the dolly to the surface.

a) Using a wooden stick, apply an even layer of adhesive to the entire contact surface area of the dolly.

b) Carefully remove the excessive adhesive by using a cotton swab. Allow the adhesive to fully cure before performing the adhesion test.

c) Attach the dolly to the coated surface and gently push downward to displace any excessive adhesive.

d) Push the dolly inward against the surface, then apply tape across the head of the dolly.

6.03.06 Adhesion Test Procedure

a) Attach the adhesion tester to the dolly by rotating the hand wheel counter clockwise to lower the jaw of the device.

b) Slide the jaw completely under the head of the dolly. Position the three legs of the instruments so that they are sitting flat on the coated surface.

c) Slide the dragging indicator pin on the black column to zero by pushing it downward.

d) Firmly hold the base of the instrument in one hand and rotate the handwheel clockwise to raise the jaw of the device that is attached to the head of the dolly. The dragging indicator pin will move upward on the black column as the force is increased and will hold the reading. Apply the tension using a moderate speed. Continue to increase the tension on the head of the dolly until (a) the minimum PSI/MPa/Kg/cm² required by project specification is exceeded and the test is discontinued, (b) the maximum PSI/MPa/Kg/cm² of adhesion tester has been achieved and dolly is still attached, (c) The force applied by the adhesion tester causes the dolly to dislodge.

e) Read the scale and record the adhesion value.

6.04.00 Coating Repair

Defective Coating shall be repaired in accordance with the following subsections.

6.04.01 Surface Preparation:

Accessible areas of pipe requiring coating repairs shall be cleaned to remove debris and damaged coating using surface grinders or other means. The adjacent coating shall be feathered by sanding, grinding or other method. Accumulated debris shall be removed by blowing with contaminant free air or wiping with clean rags.

6.04.02 Areas not accessible for coating repair such as interior surfaces of small diameter pipe shall be reprocessed and recoated.

6.04.03 Coating Application :

The coating system shall be applied to the prepared areas in accordance with procedure.

6.04.04 Repair Inspection :

Repaired portion shall be electrically inspected using a holiday detector.

6.05.00 Welded Field Joints

6.05.01 Preparation :

The weld joints shall be cleaned so as to be free from mud, oil, grease, welding flux, weld spatter and other foreign contaminants. The cleaned metal surfaces of the weld joint shall then be blasted or abraded using rotary abrading pads. The adjacent liquid Epoxy / PU coating shall be feathered by abrading the coating surface for a distance of 25 mm.

6.05.02 Electrical Inspection :

After curing the coating system applied to the welding joints shall be holiday tested. Any holidays indicated by the detector shall be marked with chalk to identify the area of repair.

7.00.00 INFORMATION/DATA REQUIRED

The Bidder shall submit complete list of paints and primers proposed, giving detail information, such as, chemical composition, drying time etc. and also unit rates for application of each type of paint along with supply shall be furnished.

ANNEXURE VI: DRAWING/DOCUMENTS SUBMISSION SCHEDULE

S.NO.	DRAWING NO	DRG TITLE	APPROVAL CAT	SCH WEEK AFTER LOI	SIZE
1	PE-VO-417-168-A001	GENERAL ARRANGEMENT LAYOUT, FOUNDATION DETAILS AND FLOOR DRAIN DETAILS OF HYDROGEN GENERATION PLANT	A	4	A1
2	PE-VO-417-168-A002	PIPING & INSTRUMENTATION DIAGRAM WITH I/O LIST OF HYDROGEN GENERATION PLANT	A	4	A3
3	PE-VO-417-168-A003	DESIGN & CONTROL PHILOSOPHY OF H2 PLANT	A	6	A4
4	PE-VO-417-168-A005	GA FOR COMPRESSORS WITH MOTOR OF HYDROGEN GENERATION PLANT	A	10	A4
5	PE-VO-417-168-A006	DATA SHEET, GA,& CIRCUIT DIAGRAM OF RECTIFIER TRANSFORMER OF HYDROGEN GENERATION PLANT	A	6	A4
6	PE-VO-417-168-A007	PLC DATASHEET, PLC-OWS/PRINTER FURNITURE BOM, PLC CATALOGUE, OWS & PRINTER CATALOGUES, PLC PANEL GA (INTERNAL & EXTERNAL), PANEL HEAT DISSIPATION DATA	A	12	A3
7	PE-VO-417-168-A008	GA OF FEED WATER, KOH TANK OF HYDROGEN GENERATION PLANT	A	6	A4
8	PE-VO-417-168-A009	GA OF H2 MANIFOLD OF HYDROGEN GENERATION PLANT	A	6	A4
9	PE-VO-417-168-A010	GA N2 PURGING MANIFOLD OF HYDROGEN GENERATION PLANT	A	6	A4
10	PE-VO-417-168-A011	GA HYDROGEN & NITROGEN CYLINDER OF HYDROGEN GENERATION PLANT	A	6	A4
11	PE-VO-417-168-A012	GA CYLINDER TEST STATION OF HYDROGEN GENERATION PLANT	A	6	A4
12	PE-VO-417-168-A013	GA VACUUM PUMP OF HYDROGEN GENERATION PLANT	A	6	A4
13	PE-VO-417-168-A014	PIPING INSTALLATION AND PIPING LAYOUT DRAWING	A	10	A1

14	PE-VO-417-168-A015	HYDROGEN PLANT INTER-LOCK LOGIC DIAGRAM & CONTROL SCHEMES (BLOCK LOGIC)	A	12	A4
15	PE-VO-417-168-A016	PLC INPUT / OUTPUT SIGNAL LIST, POWER SUPPLY WIRING DIAGRAM	A	12	A4
16	PE-VO-417-168-A018	H2 PLANT WIRING DIAGRAM	A	12	A3
17	PE-VO-417-168-A019	DATASHEET OF COMPRESSOR OF HYDROGEN GENERATION PLANT	A	10	A4
18	PE-VO-417-168-A020	DATASHEET OF INSTRUMENTS & ANALYSERS OF HYDROGEN GENERATION PLANT	A	10	A4
19	PE-VO-417-168-A021	DATASHEET OF MOTORS OF HYDROGEN GENERATION PLANT	A	10	A4
20	PE-VO-417-168-A023	CABLE SCHEDULE & INTERCONNECTION OF HYDROGEN GENERATION PLANT	A	16	A3
21	PE-VO-417-168-A026	INSTRUMENT SCHEDULE OF HYDROGEN GENERATION PLANT	I	10	A4
22	PE-VO-417-168-A030	ELECTRICAL LOAD DATA OF HYDROGEN GENERATION PLANT	I	10	A4
23	PE-VO-417-168-A031	DEMONSTRATION TEST PROCEDURE OF HYDROGEN GENERATION PLANT	A	20	A4
24	PE-VO-417-168-A032	O&M MANUAL OF HYDROGEN GENERATION PLANT	A	24	A4
25	PE-VO-417-168-A033	SUB VENDOR LIST & INSPECTION CRITERIA OF HYDROGEN GENERATION PLANT	A	4	A4
26	PE-VO-417-168-A034	GA OF ELECTROLYSER AND PURIFICATION SKID.	A	6	A4
27	PE-VO-417-168-A036	DRIVE LIST/SOLENOID/ACTUATOR VALVE LIST WITH LOCATION DATA	I	10	A3
28	PE-VO-417-168-A037	LIST OF SIGNAL EXCHANGE WITH DDCMIS (BOTH HARDWIRED & SERIAL INTERFACE IN BHEL FORMAT)	A	10	A3
29	PE-VO-417-168-A038	PROCESS GRAPHIC MANUSCRIPTS PLC, PROCESS GRAPHIC MANUSCRIPTS FOR DDCMIS	A	10	A1

30	PE-VO-417-168-A039	UPS BATTERY CHARGER/ BATTERY DATASHEET, UPS SIZING CALCULATIONS, BATTERY SIZING CALCULATIONS, UPS QAP, UPS TYPE TEST REPORTS ON COMPONENTS	A	10	A3
31	PE-VO-417-168-A040	CABLE TRENCH/ TRAY LAYOUT AND EARTHING DETAILS FOR HYDROGEN GENERATION PLANT WITH DETAILS OF CABLE TRAY ACCESSORIES.	A	12	A1
32	PE-VO-417-168-A041	QAP FOR COMPRESSORS WITH MOTOR OF HYDROGEN GENERATION PLANT	A	10	A4
33	PE-VO-417-168-A042	QAP FOR PLC OF HYDROGEN GENERATION PLANT	A	12	A4
34	PE-VO-417-168-A043	QAP OF RECTIFIER OF HYDROGEN GENERATION PLANT	A	6	A4
35	PE-VO-417-168-A046	QAP OF ELECTROLYSER AND PURIFICATION SKID	A	6	A4
36	PE-VO-417-168-A048	QAP FOR HYDROGEN GEN PLANT (BALANCE OF ITEM)	A	10	A4
37	PE-VO-417-168-A049	PLC QUALITY PLAN & FAT PROCEDURE	A	10	A4

Notes:

1. A= APPROVAL. I = INFORMATION.
2. Any additional drawings-documents required during detailed engineering stage shall be provided by bidder without any commercial, technical and delivery implication to BHEL and customer.
3. Non-submission of the document as per attached schedule will attract LD.

ANNEXURE VII: DM AND COOLING WATER ANALYSIS

S.No.	Characteristics	Value
1.	Silica (Max.)	0.02 ppm as SiO_2
2.	Iron as Fe	Nil
3.	Total hardness	Nil
4.	pH value	6.8 – 7.2
5.	Conductivity	Not more than 0.1 excluding the effects of free CO_2

ANNEXURE VIII: LIST OF TOOLS & TACKLES (AS APPLICABLE)

Bidder to consider necessary tools and tackles for mechanical, electrical and control & instrument as per their system requirement. In addition, bidder to adhere relevant clauses of tender specification also.

ANNEXURE IX: FORMAT FOR OPERATION AND MAINTENANCE MANUAL

Bidder to submit operation and Maintenance manual with minimum information as listed in below check list during contract stage.

15. **CHECK LIST FOR OPERATION & MAINTENANCE MANUAL**

Project name :
Project number :
Package Name :
PO reference :
Document number :
Revision number :

Sl.no. & Sections	Description	Tick (√)if included in Manual			Remarks
	1.1	Yes	No	Not Applicable	
1.	1.2 Cover page				
1.1	Project Name				
1.2	Customer/consultant Name				
1.3	Name of Package				
1.4	Supplier details with phone, FAX ,email address , Emergency Contact number				
1.5	Name and sign of prepared by , checked by & approved by				
1.6	Revision history with approval Details				
2.0	1.3 Index				
2.1	showing the sections & related page nos All the pages should be numbered section wise				
3.0	1.4 Description of Plant/System				
3.1	Description /write up of operating principle of system equipment/ associated sub-systems & accessories/controls system , operating conditions, performance parameters under normal , start up and special cases				
3.2	Equipment list and basic parameter with Tag numbers				
3.3	Data sheets approved by Customer/for information and catalogues provided by original manufacturer				
3.4	Associated other packages and Interface /terminal points				
3.5	P&ID & Process Diagrams				
3.6	GA Layout drawings, As-built drawings , Actual photograph of items/system (Drawings of A2 & bigger sizes are to be attached in the last)				
3.7	Single line/wiring diagrams				
3.8	Control philosophy /control write-ups				
4.0	1.5 Commissioning Activities (if not covered in separate document i.e. erection manual, commissioning manual)				
4.1	Pre-Commissioning Checks				

4.2	handling of items at site				
4.3	Storage at site				
4.4	Unpacking & Installation procedure				
5.0	1.6 Operation Guidelines for plant personal/user/operator				
5. 1	Interlock & Protection logic along with the limiting values of protection settings for the equipment along with brief philosophy behind the logic, drawings etc. to be provided.				
5. 2	Start up, normal operation and shut down procedure for equipments along with the associated systems in step by step mode. Valve sequence chart, step list, interlocks etc. with Equipment isolating procedures to be mentioned.				
5. 3	Do's & Don't of the equipments.				
5. 4	Safety precautions to be taken during normal operation. Safety symbols, Emergency instructions on total power failure condition/lubrication failure/any other condition				
5. 5	Parameters to be monitored with normal values and limiting values				
5. 6	Trouble shooting with causes and remedial measures				
5. 7	Routine operational checks, recommended logs & records				
5. 8	Changeover schedule if more than one auxiliary for the same purpose is given				
5. 9	Painting requirement and schedule				
5. 10	Inspection, repair , Testing and calibration procedures				
6.0	1.7 Maintenance guidelines for plant personal				
6.1	List of Special Tools and Tackles required for Overhaul/Trouble shooting including special testing equipment required for calibration etc.				
6.2	Stepwise dismantling and re-assembly procedure clearly specifying the tools to be used, checks to be made, records to be maintained, clearances etc. to be mentioned. Tolerances for fitment of various components to be given.				
6.3	Preventive Maintenance & Overhauling schedules linked with running hours/calendar period along with checks to be given				
6.4	Long term maintenance schedules especially for structural, foundations etc.				
6.5	Consumable list along with the estimated quantity required during commissioning, normal running and during maintenance like Preventive Maintenances and Overhaul. Storage/handling requirement of consumables/self-life.				
6.6	List of lubricants with their Indian equivalent, Lubrication Schedule, Quantity required for each				

	equipment for complete replacement is to be given				
6.7	List of vendors & Sub-vendors with their latest addresses, service centres ,Telephone Nos., Fax Nos., Mobile Nos., e-mail IDs etc.				
6.8	List of mandatory and recommended spare parts list				
6.9	Tentative Lead time required for ordering of spares from the equipment supplier				
6.10	Guarantee and warranty clauses				
7.0	**Statutory and other specific requirements considerations.**				
8.0	**List of reference documents**				
9.0	**Binding as per requirement**				

ANNEXURE X: SITE STORAGE AND PRESERVATION

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
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.

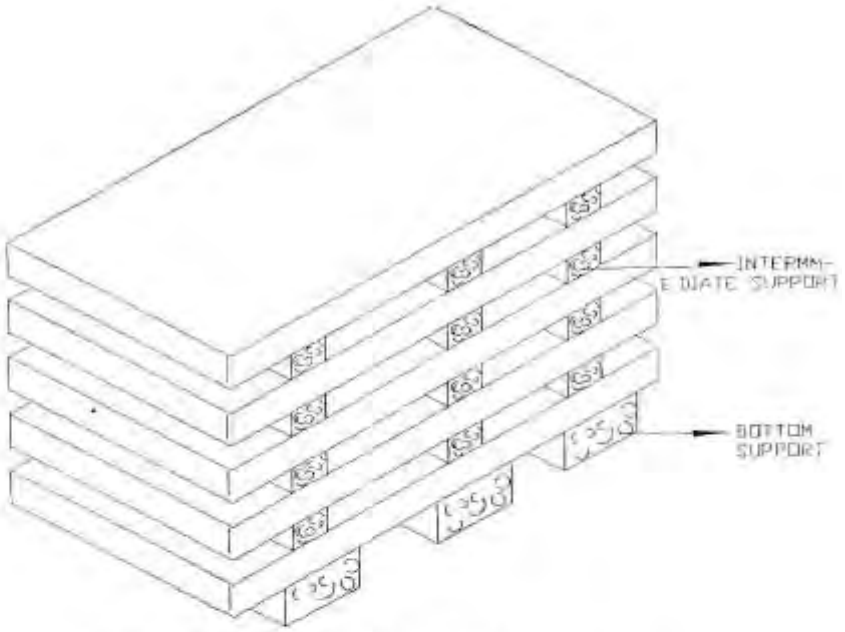


Figure – 1 – PLATE STACKING ARRANGEMENT

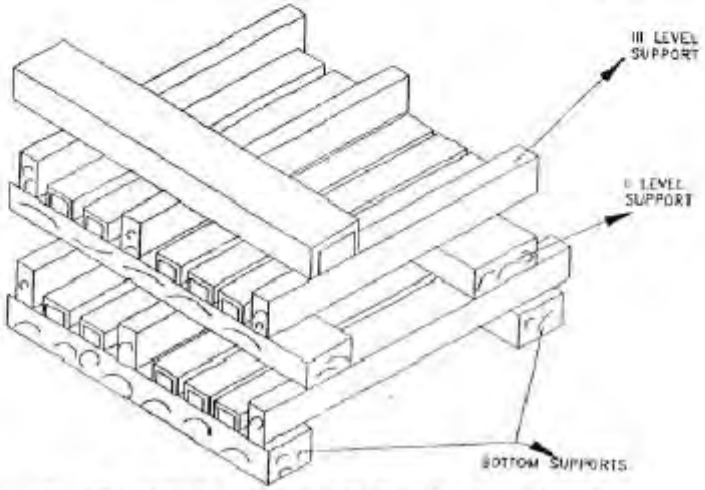


Figure – 2 – STRUCTURAL STEEL STACKING ARRANGEMENT

ANNEXURE XI -GUARANTEED PERFORMANCE DATA

S.no.	Description	Parameter
1.	Hydrogen generation plant minimum capacity (Nm3/hr.)	30
2.	Number of streams (2X50%)	2
3.	Minimum Capacity of each streams/electrolyser (Nm3/hr.)	15
4.	Hydrogen purity (%) at gas manifolds	99.9
5.	Moisture content in hydrogen- gm/m3 (max)	0.05
6.	Design delivery pressure at its rated duty point in Kg/cm2 (g)	150
7.	Dew Point	(-41) (min)
8.	Minimum capacity of each compressor (Nm3/hr.)	125% of rated Capacity of each streams (Nm3/hr.)
9.	Vibration level of compressor	As per internationally accepted standard
10.	Noise level of compressor	85 dBA (to a reference of 0.0002 micro bar).

ANNEXURE XII: MANDATORY SPARES LIST

Sl. No.	Description	Quantity for Five Units
A	**Actuator**	
1	Complete set of Actuator	2Nos. for each type and rating
2	Limit Switch	6 Nos each type and rating
3	Torque Switch	6 Nos each type and rating
4	Auxiliary Contact	2 nos each type and rating
5	Motor	2 nos each type and rating
6	Complete Seal kit	2Sets for each type and rating
7	Complete O-Ring Set	2Sets
8	Electronic Card	Two (2) for each type/make
9	Feedback Assembly (4-20mA) for Inching type	Two (2) for each type/make
B	**UPS**	
1	Fuse	6 (Six) times of total quantity of each type of fuses used in the system.
2	SCR	20% of total quantity of each type used in the system or minimum 4 (Four) nos. whichever is more.
3	Diode	20% of total quantity of each type used in the system or minimum 4 (Four) nos. whichever is more.
4	IGBT	4 (four) nos.
B.1	Electronic Module/ PCB	
1	Static Switch	2 (two) no. each type of Electronic Card/ PCB/ modules used in the system
2	Inverter	2 (two) no. each type of Electronic Card/ PCB/ modules used in the system
3	Static voltage Regulator	2 (two) no. each type of Electronic Card/ PCB/ modules used in the system
4	Charger	2 (two) no. each type of Electronic Card/ PCB/ modules used in the system
5	UPS of 2 KVA rating or below.	Two Complete set.
6	Selector Switch	2 (two) no. each type
7	Digital Voltage/ Current Indicator (LCD type)	2 (two) no. each type
8	Indication Lamp- Complete assembly (Red/ Green colour)	2 (two) no. each type
9	Cooling Fan - 240 VAC supply	2 (two) no. each type
C	**UPS Battery**	
	Battery Cell (Uncharged, Dry)	20% of total quantity of each UPS at sl.no. B.
	Inter connecting cell strips	20 nos.
	Rubber gloves	2 pairs
	Voltmeter for measuring cell voltage(Center zero type)	2 nos.
	Appron & Goggles	2 sets
	Cell lifting puller	2 nos.
	Insulated socket spanner with handle	2 nos.
	Terminal screw with Belleville washer	20% of total quantity used
	Thermometer	2 nos.

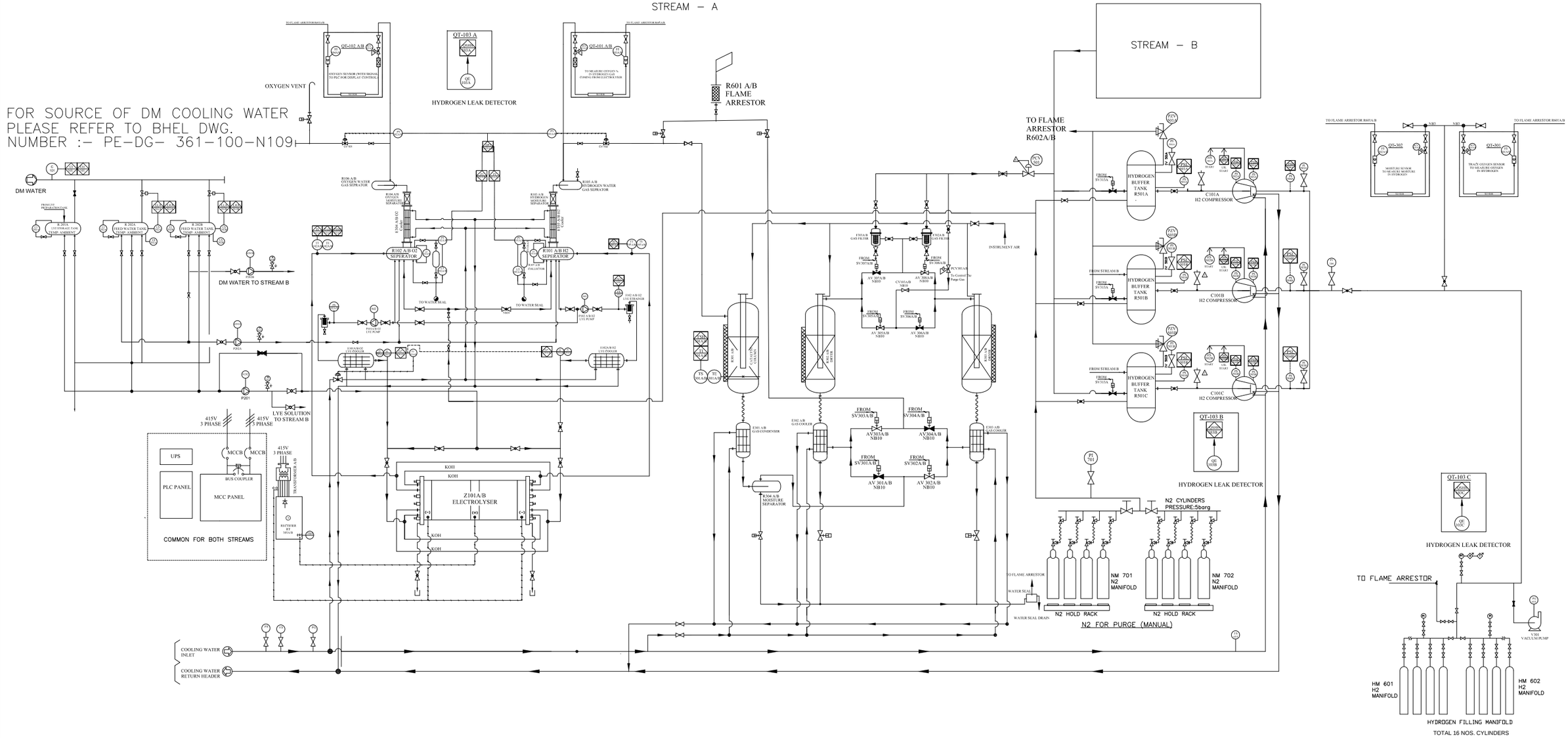
D	**Field Instruments**	
1	Transmitters/ Gauges/Switches etc. along with relevant accessories	20% of total or at least four (whichever is higher) for each type along with accessories.
2	Temperature Element (RTD/Thermo-couple) with thermowell	20% of each type, range and immersion length . Minimum 10 nos.
3	Sensor	2 nos. each for each type, model & range
4	O Rings	4 nos. of each size
	Gaskets	6 nos. of each size
E	**Analysers**	
1	Field sensor	4 nos.
2	Field transmitter/ complete electronic unit	2 nos.
3	Power supply card	2 nos.
4	Instrumentation hardware	2 nos. each item
F.	**Control Valves and Dampers**	
i)	Pneumatic Control Valves & Block Valves	
1	Plot Relay	2 sets for each valve
2	Actuator Diaphragm	2 nos.for each valve
3	Feedback Linkage	2 nos.for each valve
4	Smart Positioners	20% of total quantity of each model/type
5	I/P Converters (If any)	20% of total quantity or minimum 30 nos.
6	Complete Consumables for Valve Viz. O-ring, Gland Packing, Packing Ring, Bonnet Seal etc	4 Sets each size, rating, type
7	Valve Disc	4 Sets each size, rating, type
8	Valve Spindle	4 Sets each size, rating, type
9	Valve Seat	4 Sets each size, rating, type
10	Bush	4 Sets each size, rating, type
11	Guide	4 Sets each size, rating, type
12	Guide Bush	4 Sets each size, rating, type
13	Coupling Nut	4 Sets each size, rating, type
14	Actuator Piston with Rod & Seal	4 Sets each size, rating, type
15	Control valve stem packing and spare operator molded rubber diaphragms	2 sets for each size, rating, type
16	Valve trim (including cage, plug, stem, seat rings, guide bushings etc.) for each of the control valves as offered.	2 sets for each size, rating, type
17	Solenoid valves, position transmitters, limit switches, I/P convertors, positioners etc. of each type	20% of total quantity spare with minimum 2 no. for each size, rating, type

III)	Solenoid Valves	
1	Solenoid Valve Coil	4 nos. of each rating & insulation
2	Plunger	2 nos. of each type
3	Seat	4 nos. of each type & size
4	Gaskets	4 sets of each type & size
5	O-Ring set	10 sets of each type & size
G.	**Flow Elements**	
1	Root valves	4 nos. for each flow element
2	Gland packing for root valves	4 nos. for each flow element
3	Gaskets	6 nos. for each flow element
H.	**Process Connection Piping (Impulse piping/tubing, sampling piping / tubing & air supply piping as applicable)**	
1	Valves of all types	20% of each type, class, size & model
2	Valve Manifolds (2 way/3 way/5 way)	20% of each type, class, size & model
3	Fittings	20% of each type, class, size & model
4	Filter Regulators	40% of each model
I.	**Cables (Control & Instrumentation)**	20% of each type, pair and size of actual installed quantity
J.	**Control Panel/ Desk**	
1	Back-up panel mounted devices (Selector switches/ Push buttons/ Indicators etc.)	10% of installed capacity
2	Lamps/ LEDs	200% of the total quantity
3	Blank Tiles	20% of installed capacity
4	MCBs	20% of each type & rating
5	Fuses/ Fuse holder	200% of each type & rating
K	**Alarm/ Annunciation system**	
1	Each type of module	2 no. each
2	Lamp box with Facia & Lamps (LED type)	20% of total quantity or minimum 20 nos.
3	Hooter	2 no.
L	**Junction Box**	
1	Junction box	20% of total quantity for each size but minimum 2 nos.
2	Terminals in Terminal blocks	20 nos. of each type
M	**PLC/ Proprietary Control System**	
1	Network cards, Communication Interface cards	10% for each type or but minimum 2 no.
2	I/O Cards (Each type)	10% for each type but minimum 2 nos.

3	Controller Cards	4 nos.
4	SER Cards	10% for each type or but minimum 2 no.
5	All other Electronic Modules	10% for each type or but minimum 2 no.
6	Relays	20% of total quantity
7	Power Supply Modules & Power Packs for control system	10% for each type and range but minimum 2 nos.
8	Network Items (Network switch/ LIU unit/ Transceiver/ FO patch cord etc.)	20% of total nos. used for each type and model in the system or minimum 4(four) no. whichever is more.
9	MCB (Miniature case circuit breaker)	20% or minimum 20 nos. whichever is higher for each type and rating.
10	Fuses	400% or minimum 100 no's for each type and rating
11	Racks for housing I/O & Processor Modules	2(two) no. each type used in the system
12	Prefab interconnecting cables with connectors	20% of total nos. used in the system or minimum 8(Eight) nos. whichever is more for each type.
13	Network communication cable with end connectors	20% of total nos. used in the system or minimum 8(Eight) nos. whichever is more for each type.
14	I/O bus cables with connectors for remote I/O units	2 nos. of each type & length
15	Fiber optic cable Converter / Deconverter	2 nos.
16	Cooling Fans	4 nos. for each cabinet
17	Loose Connectors	10 nos. of each type
18	Color TFT Monitor	2 nos. complete set
19	Hard Disk Drive for the work Station	2 nos. complete set
20	Key board , mouse / trackball with connecting cables and plugs	2 nos. each type.
21	Printers Cartages	4 nos. of each type
22	SMPS for printers	2 nos. of each type/ rating
23	SVGA cards for printers	2 nos. of each type
24	Key Board & Cursor control device	2 nos. of each type
25	Complete Set of Operators Work Station	2 nos. complete set
26	Terminal Block	20% of total nos. used in the system for each type and rating.
27	Read-Write CD/DVD	4 (four) no. complete set
28	Blank CD/DVD	100 nos.
N	**415 Volt Motor (Upto 30KW Rating)**	
1	Driving End & Non-Driving End Bearing	6 Set for each type and rating of Motor
2	Cooling Fan	4 No. for each type and rating of Motor
3	Motor Terminal Block	10 No. for each type and rating of Motor
4	Complete Set of Coupling	2 Set for each Application
O	**Lugs & Glands**	
1	Glands & Lugs	40% of each type, size & rating of cables

P&ID AND EQUIPMENT LAYOUT

V301=VACUUM PUMP (1 no.)	Z101A/B=ELECTROLYZER(2 no's)	R101A/B=H2 SEPARATOR(2 no.)	R102A/B= O2 SEPARATOR(2 no.)	E103A/B=H2 GAS COOLER (2 no.)	E104A/B=O2 GAS COOLER(2 no.)	R103 A/B=H2 MOISTURE SEPARATOR(2 no.)
	R201A=LYE PREP. TANK(1 no.)	R202A/B=FEED WATER TANK(2 no.)	P201=LYE PUMP(2 no.)	P202A/B=FEED WATER PUMP(2 no.)	R301A/B=PD CATALYST COLUMN(2 no.)	R104 A/B= O2 MOISTURE SEPARATOR(2 no.)
	HM 601/ 602 = H2 MANIFOLD(1 no.)	R601A/B=FLAME ARRESTOR(2 no.)	S301/302 A/B= GAS FILTER(4 no.)	R304A/B MOISTURE SEPARATOR(2 no.)	E301/302/303A/B=GAS COOLER(6 no.)	R105A/B=H2 WATER GAS SEPARATOR(2 no.)
	NM 701 / 702 = N2 MANIFOLD(1 no.)	C101A/B/C = H2 COMPRESSORS(3 no.)	R501A/B/C = H2 BUFFER TANK(3 no.)	Z101A/B=ELECTROLYZER(2 no.)	R302/303 A/B=DRYER ABSORBER (4 no,.)	R106A/B=O2 WATER GAS SEPARATOR(2 no.)



LEGEND

CV	CONTROL VALVE
C	CONDUCTIVITY ANALYSER
	CONDENSATE TRAP
P	PUMP
M	MOTOR
	DRAIN
	FLAME ARRESTOR
	STRAINER
	SOLINOID VALVE
	BACK PRESSURE VALVE
	SAFETY VALVE
	FLOAT VALVE
	PNEUMATIC CONTROL VALVE
	NON–RETURN VALVE
	NEEDLE VALVE
	DIAPHRAGM VALVE
	BALL VALVE
	GATE VALVE
	DC CURRENT LINE
	ITP CONVERTOR
SYMBOL	DESCRIPTION

NOTES

1. ANY OTHER INSTRUMENT & DEVICES REQUIRED FOR EFFICIENT & SAFE OPERATION OF PLANT SHALL BE SUPPLIED.
2. NO. OF STAGES IN COMPRESSOR SHALL BE AS PER INLET/OUTLET PRESSURE REQUIREMENT AS PER MANUFACTURERS PRACTICE /PROCESS.
3. THERE MAY BE MINOR CHANGES IN THE P&ID AS PER MANUFACTURER STANDARD PRACTICE TO SUIT MANUFACTURERS PROCESS DESIGN.
4. A LOOSE PVC LYE PREPARATION TANK SHALL BE SUPPLIED WITH THE HYDROGEN GENERATION PLANT FOR PREPARATION OF THE KOH SOULTION. THE DM WATER REQUIRED FOR PREPARING SOLUTION SHALL BE TAKEN BY OPENING DRAIN VALVE OF FEED WATER TANK.
6. PASSIVATED DM WATER SHALL BE USED FOR COOLING OF ELECTROLYSER AND COMPRESSOR IN CLOSED LOOP WITH MAKE–UP AS DM WATER. FOR COOLING FOR COMPRESSOR, PACKAGE TYPE COOLING TOWER SHALL BE USED AND FOR ELECTROLYSER, CHILLER SHALL BE USED FOR COOLING HOT WATER

JOB No. 417									
STATUS CONTRACT									
DISTRIBUTION									
TD									
NoOFF									
REV	DATE	ALTD	CHD	APPD					

5X800 MW YADADRI TPS

BHARAT HEAVY ELECTRICALS LTD
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT
NEW DELHI

DEPT CODE		NAME	SIGN	DATE
M	DRN	SP		
	DESN	JP		
	CHD	SB		
	APPD	SB		

TITLE
P&ID FOR HYDROGEN GENERATION PLANT (BIPOLAR DESIGN)

MPL	C	MSE	I	MAX	E	DEPT.	SCALE: NTS	DRAWING No.
						SIGN		PE-DG-361-168A-A002B
						DATE		SHEET 1 OF 1 REV 04

SIZE–A0

COMPUTER FILE NAME: —

DRAWING No.

CUSTOMER'S DRAWING No.

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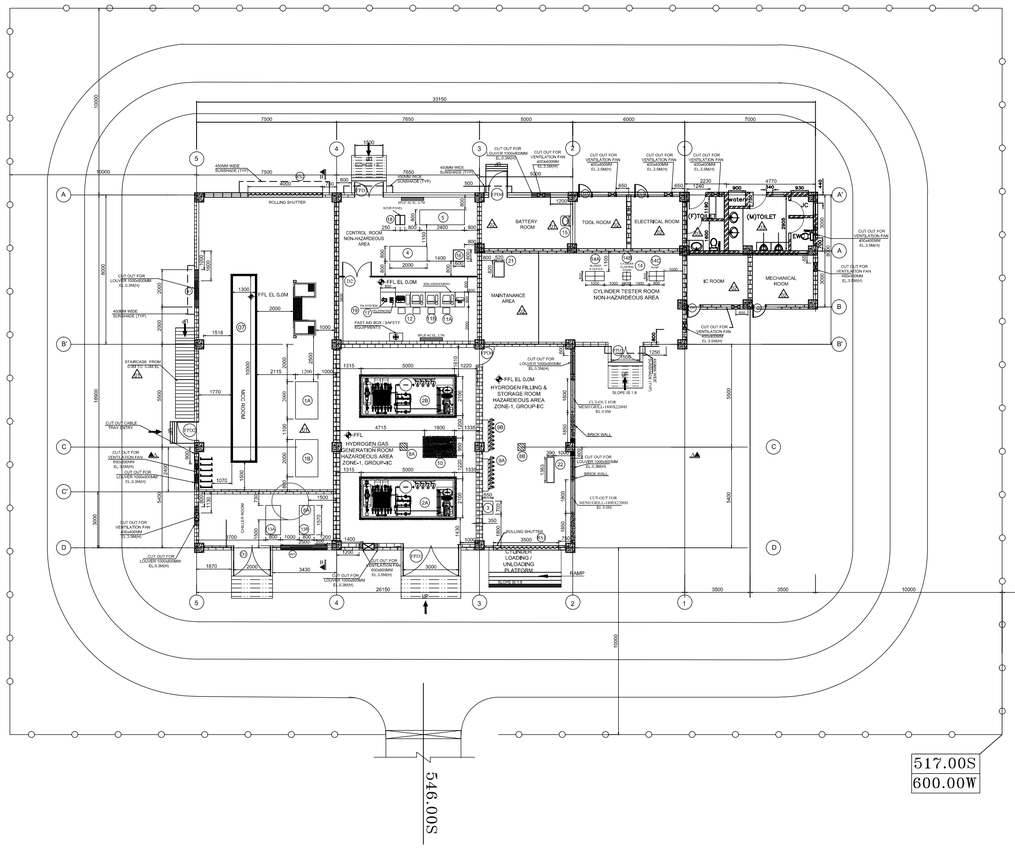
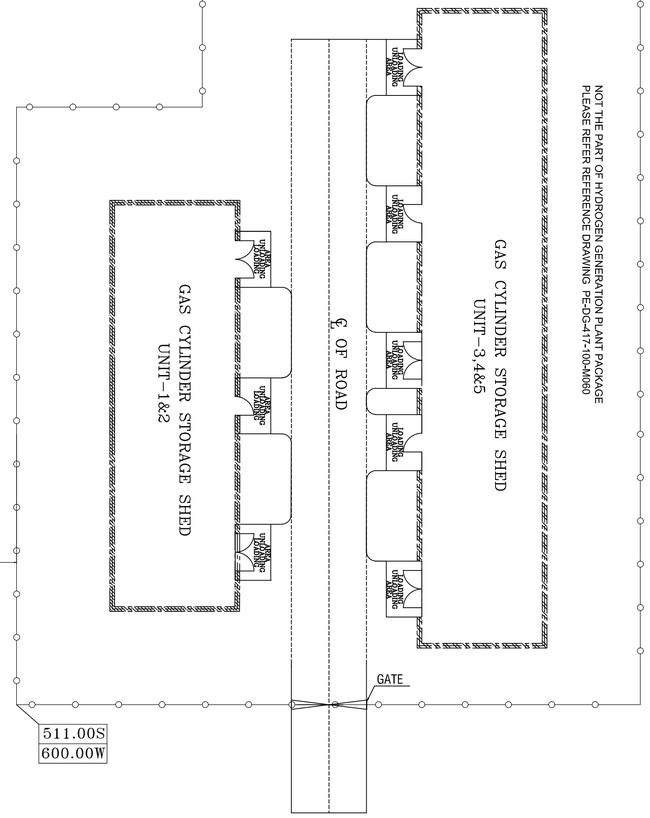
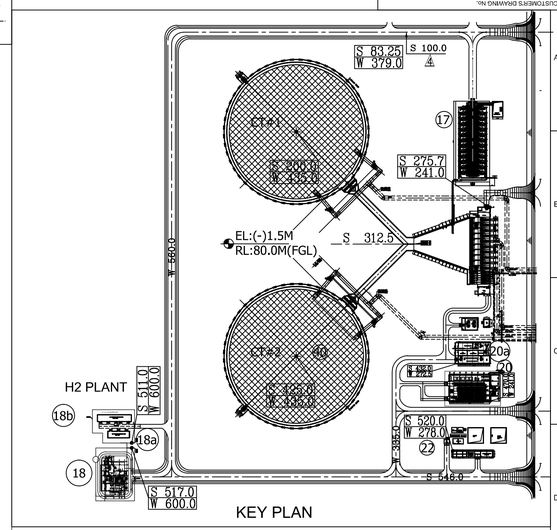




NOT THE PART OF HYDROGEN GENERATION PLANT PACKAGE
PLEASE REFER REFERENCE DRAWING PE-DG-417-100-M060



NOTES:

1. All dimension are in mm and levels are in meter. unless otherwise specified.
2. Inverted roof beams shall be considered in H2 building
3. H2 gas will be vented at height of 1 mtr from top of building.
4. In cylinder filling & storage area, there will be a parapet wall of 100 mm thk X 800 mm height & at the top of parapet wall there will be Grill/ mesh upto roof of building.
5. Quantity of AC units shown in indicative only.
6. All light fittings/fixtures, motors, starters/switchs or any other electrical/electronic equipment shall be flame proof duly approved by PESO suitable for installation in zone II of gas group II-C.
7. "EL 0.0M Corresponding to RL (+) 80.0M Which is FFL of TG building.
8. Beams shall be in same face of walls.

SAFETY NOTES:-

1. Hazardous Area
   - Hydrogen generation room is monitored for the presence of hydrogen in air.
   - Adequate ventilation via aluminium grill and/or features is provided to prevent accumulation of h2 near the roof.
   - Equipment / instrument in this area shall be explosion/flame proof.
2. Non- Hazardous Area - Hazardous material is not handled in this area
   - Separation of this area from other area is via walls.
3. Use appropriate safety measures in handling hazardous material/ equipment refer operational, manual.

REFERENCE DOCUMENT:-

1. PE-VO-417-168-A002 - P&I DIAGRAM OF HYDROGEN GENERATION PLANT
2. PE-VO-417-168-A013 - PIPING LAYOUT DRAWING OF H2 PLANT
3. PE-VO-417-168-A024 - CABLE TRENCH/ TRAY LAYOUT OF HYDROGEN GENERATION PLANT
4. PE-DG-417-100-M060 - CYLINDER STORAGE SHED.

△01

LEGENDS:	
(D)	DOOR
(W)	WINDOW
	100mm THK. RCC PARAPET WALL
	250mm THK. BRICK WALL
	GRILL/ MESH (BHEL SCOPE)

△01 DOOR DETAILS	
DOOR	DESCRIPTION
D1 TO D9	NON - FIRE PROOF DOOR
FPD1 TO FPD6	FIRE PROOF DOOR
RS1 AND RS2	ROLLING SUTTER

NOTE:- △02

1. TOTAL 5 NOS HOOKS (1 ABOVE EACH ELECTROLYZER AND 1 ABOVE EACH COMPRESSOR.
2. WE ARE PROVIDING ONE NUMBER CHAIN PULLEY FOR ABOVE HOOKS ARRANGEMENT FOR LIFTING THE COMPONENTS AS WEIGHT IS LESS THAN 500 KG FOR LOCAL MAINTENANCE. HENCE MONORAIL IS NOT REQUIRED.
3. ONE NO. PORTABLE H2 LEAK DETECTOR SHALL BE PROVIDED FOR EASY TROUBLE SHOOTING.

REV.	DATE	ALTD	CHD	APPD	REV.	DATE	ALTD	CHD	APPD	REV.	DATE	ALTD	CHD	APPD

417
CONTRACT

DEPT CODE		NAME	SIGN	DATE
M	DRN	SK		26.03.2022
	DESN	SK		26.03.2022
	CHD	AD		26.03.2022
	APPD	AKA		26.03.2022

CUSTOMER: TELANGANA STATE POWER GENERATION CORPORATION LTD
TELANGANA, INDIA
5 x 800 MW YADADRI TPS, NALGONDA

OWNER'S CONSULTANT: TATA CONSULTING ENGINEERS LIMITED,BANGALORE

BHARAT HEAVY ELECTRICALS LTD
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT
NOIDA

SUB CONTRACTOR: AIROX NIGEN EQUIPMENTS PVT. LTD.

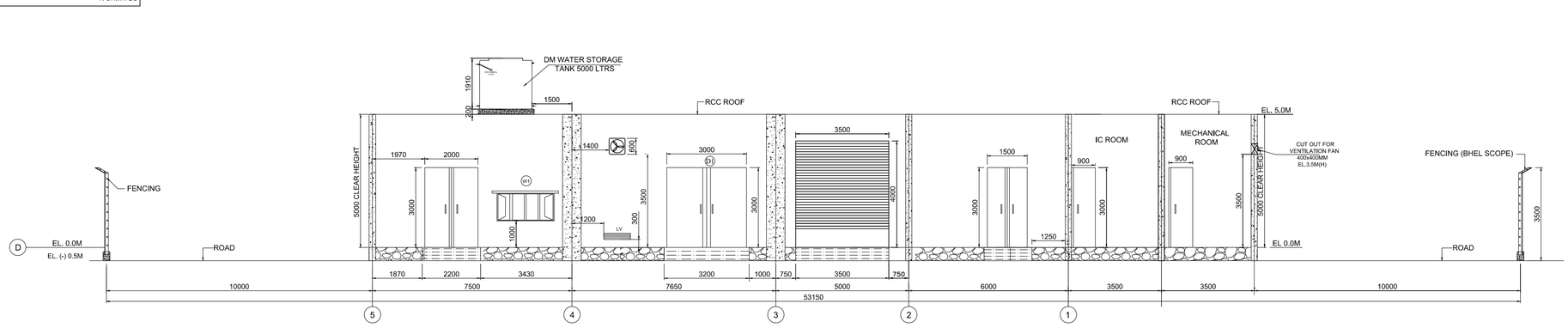
TITLE: GENERAL ARRANGEMENT LAYOUT, FOUNDATION DETAILS, VENTILATION DETAILS OF HYDROGEN GENERATION PLANT

DEPT. | SCALE | SIGN

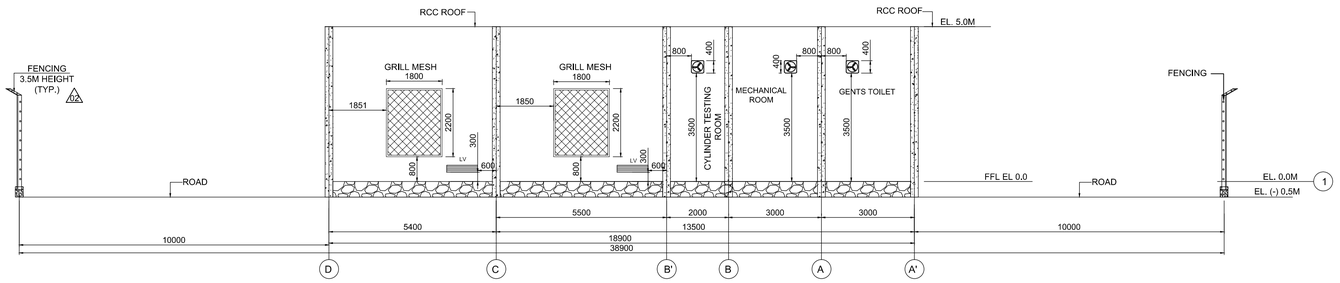
DRAWING NO. PE-VO-417-168-A001

SHEET 01 OF 03 | REV 04

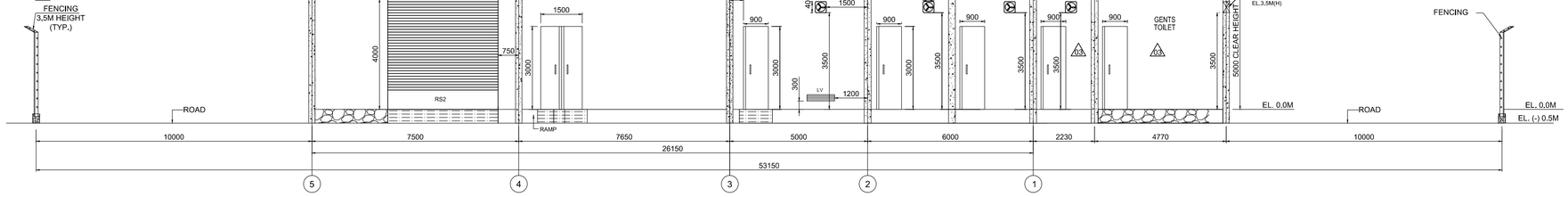
SIZE-A1



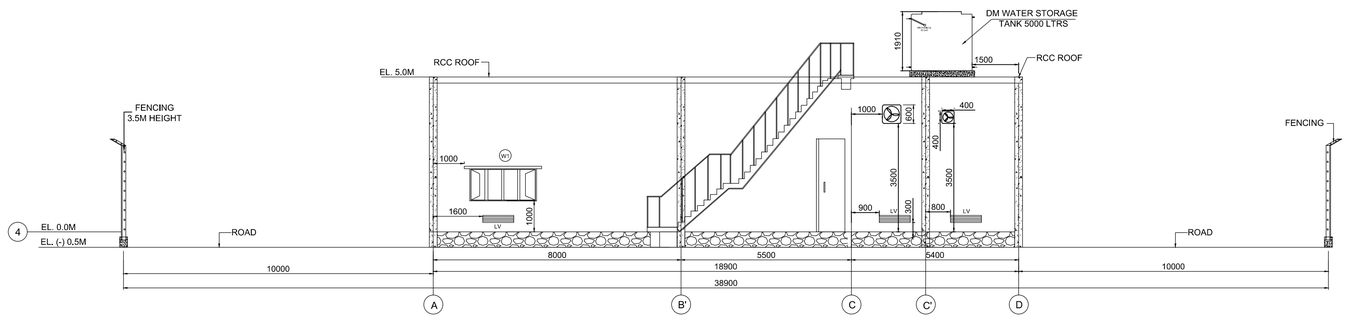
FRONT SIDE VIEW



RIGHT SIDE VIEW



BACK SIDE VIEW



LEFT SIDE VIEW

Sr. No.	EQUIPMENT NAME	Load in KG (Each)	KKS TAG NO.	QTY.
1	RECTIFIER PANEL - A/B	FOUNDATION NOT REQUIRED	90QJG00GU101/ 90QJG00GU102	2
2	ELECTROLYSER WITH GAS SEPERATION AND H2 PURIFIER ,COMPRESSOR A/B	6500	90QJG01AG101 90QJG02AG101	2
3	VACCUM PUMP	60	90QJG00AP107	1
4	PLC PANEL	FOUNDATION NOT REQUIRED	90QJG00GG101	1
5	UPS	FOUNDATION NOT REQUIRED	90QJG00BRG01	1
6	DM WATER STORAGE TANK (ON ROOF) 6A	5500	90QJG01BB103	1
7	MCC PANEL	FOUNDATION NOT REQUIRED	90QJG00BBJ01	1
8	H2 LEAK DETECTOR A/B	FOUNDATION NOT REQUIRED	90QJG00CQ001	2
9	2X8 Pt. H2 MANIFOLD A/B	FOUNDATION NOT REQUIRED	90QJF00BB102	2
10	STAND BY COMPRESSOR	1000	90QJG00AN101	1
11	COMPUTER A/B (OWS)	FOUNDATION NOT REQUIRED	-----	2
12	COMPUTER (OEWS)	FOUNDATION NOT REQUIRED	-----	1
13	CHILLER A/B	450	-----	2
14	CYLINDER TESTING APPARATUS			
A	BLOWER & HEATER	200	-----	1
B	CYLINDER CLAMPING STAND	200	-----	1
C	MOTORISED PUMP	200	-----	1
15	EYE WAHER	--	-----	1
16	BACKUP PANEL	--	-----	1
17	TELEPHONE DESK	--	-----	1
18	ACDB PANEL	--	-----	1
19	LAPTOP	--	-----	1
20	OPC SERVER	--	-----	1
21	TROLLEY (FOR LIFTING HEAVY WEIGHT)	--	-----	1
22	TROLLEY (CYLINDER HANDLING)	--	-----	1

COMPUTER FILE NAME : --

DRAWING NO.

CUSTOMER'S DRAWING NO.

FIRST ANGLE PROJECTION

ALL DIMENSIONS ARE IN MM

CUSTOMER:	TELANGANA STATE POWER GENERATION CORPORATION LTD TELANGANA, INDIA 5 x 800 MW YADADRI TPS, NALGONDA
OWNER'S CONSULTANT:	TATA CONSULTING ENGINEERS LIMITED,BANGALORE
	BHARAT HEAVY ELECTRICALS LTD POWER SECTOR PROJECT ENGINEERING MANAGEMENT NOIDA
SUB CONTRACTOR:	AIROX NIGEN EQUIPMENTS PVT. LTD.

417

CONTRACT

DEPT CODE		NAME	SIGN	DATE
M	DRN	SK		26.03.2022
	DESN	SK		26.03.2022
	CHD	AD		26.03.2022
	APPD	AKA		26.03.2022

REV.	DATE	ALTD	CHD	APPD

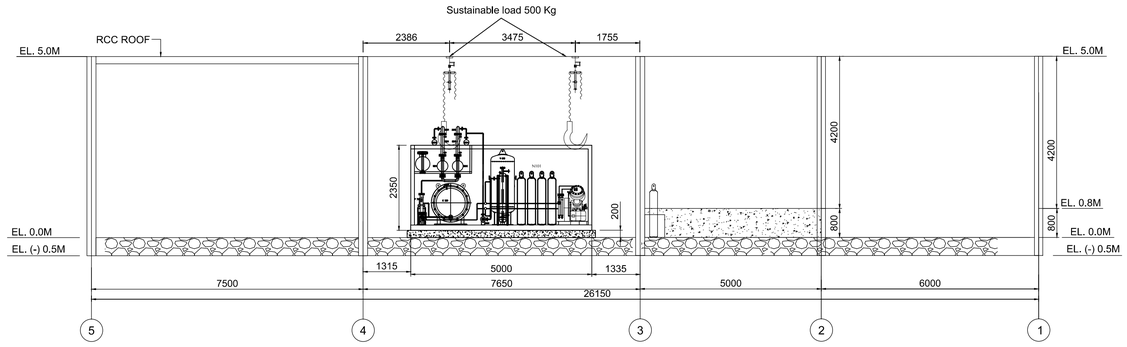
TITLE: GENERAL ARRANGEMENT LAYOUT, FOUNDATION DETAILS, VENTILATION DETAILS OF HYDROGEN GENERATION PLANT

DEPT. SIGN | SCALE

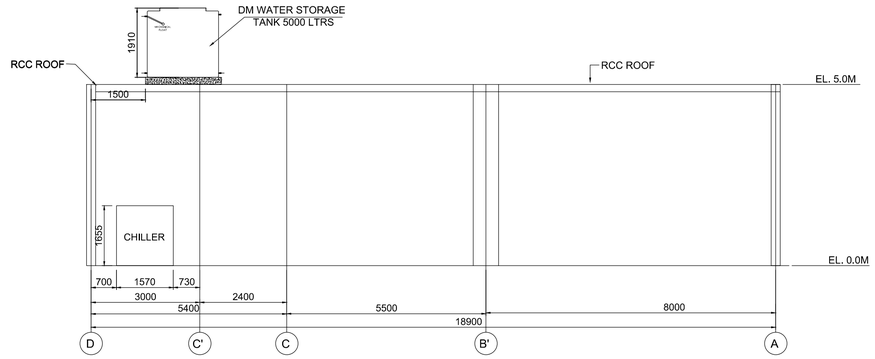
DRAWING NO: PE-VO-417-168-A001

SHEET 02 OF 03 | REV 04

SIZE-A1



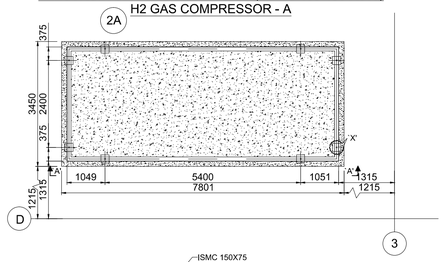
SECTION `A'-`A'

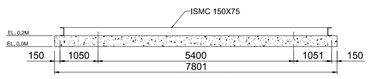


SECTION `B'-`B'

Sr No.	DESCRIPTION	CMH	QTY.	LOCATION
1	EXHAUST FAN	10500	1	H2 ROOM
2	EXHAUST FAN	15000	1	RECTIFIER & MCC ROOM
3	EXHAUST FAN	1700	2	TOILET
4	EXHAUST FAN	1700	1	BATTERY ROOM
5	EXHAUST FAN	2700	1	CHILLER ROOM
6	EXHAUST FAN	4000	1	CYLINDER TESTING ROOM
02	7 EXHAUST FAN	1700	1	ELECTRICAL ROOM
02	8 EXHAUST FAN	1700	1	TOOL ROOM
03	9 EXHAUST FAN	1700	1	MECHANICAL ROOM
03	10 EXHAUST FAN	1700	1	IC ROOM

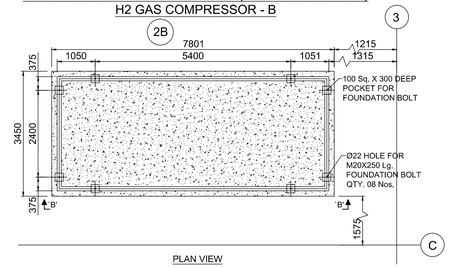
ELECTROLYSER GAS DRYER SKID (PE-V0-435-168-A015)
H2 GAS COMPRESSOR - A



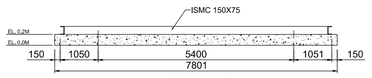


SECTION `A'-`A'

ELECTROLYSER GAS DRYER SKID (PE-V0-435-168-A015)
H2 GAS COMPRESSOR - B

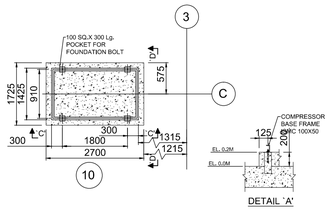


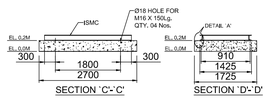
PLAN VIEW

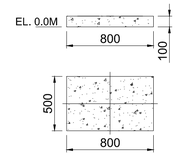


SECTION `B'-`B'

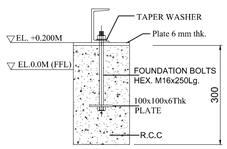
H2 GAS COMPRESSOR -C





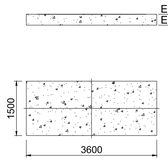


PEDESTAL FOR
MOTORISED PUMP

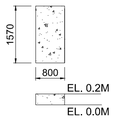


DETAIL 'X'
POCKET DETAIL
100 x 100 x 300mm DEPTH
(TYP.)

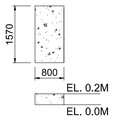
PEDESTAL FOR
DM WATER STORAGE
TANK



PEDESTAL FOR
BLOWER & HEATER



PEDESTAL
FOR CHILLER
UNIT A



PEDESTAL
FOR CHILLER
UNIT B

CUSTOMER:	TELANGANA STATE POWER GENERATION CORPORATION LTD TELANGANA, INDIA 5 x 800 MW YADADRI TPS, NALGONDA
OWNER'S CONSULTANT:	TATA CONSULTING ENGINEERS LIMITED,BANGALORE
	BHARAT HEAVY ELECTRICALS LTD POWER SECTOR PROJECT ENGINEERING MANAGEMENT NOIDA
SUB CONTRACTOR:	AIROX NIGEN EQUIPMENTS PVT. LTD.

417
CONTRACT

REV.	DATE	ALTD	CHD	APPD	REV.	DATE	ALTD	CHD	APPD	REV.	DATE	ALTD	CHD	APPD

DEPT CODE		NAME	SIGN	DATE
M	DRN	SK		26.03.2022
	DESN	SK		26.03.2022
	CHD	AD		26.03.2022
	APPD	AKA		26.03.2022

TITLE: GENERAL ARRANGEMENT LAYOUT, FOUNDATION DETAILS, VENTILATION DETAILS OF HYDROGEN GENERATION PLANT

DEPT. | SCALE | DRAWING NO. PE-V0-417-168-A001

SHEET 03 OF 03 | REV 04

SIZE-A1

COMPUTER FILE NAME: ---

COMPUTER FILE NAME :--

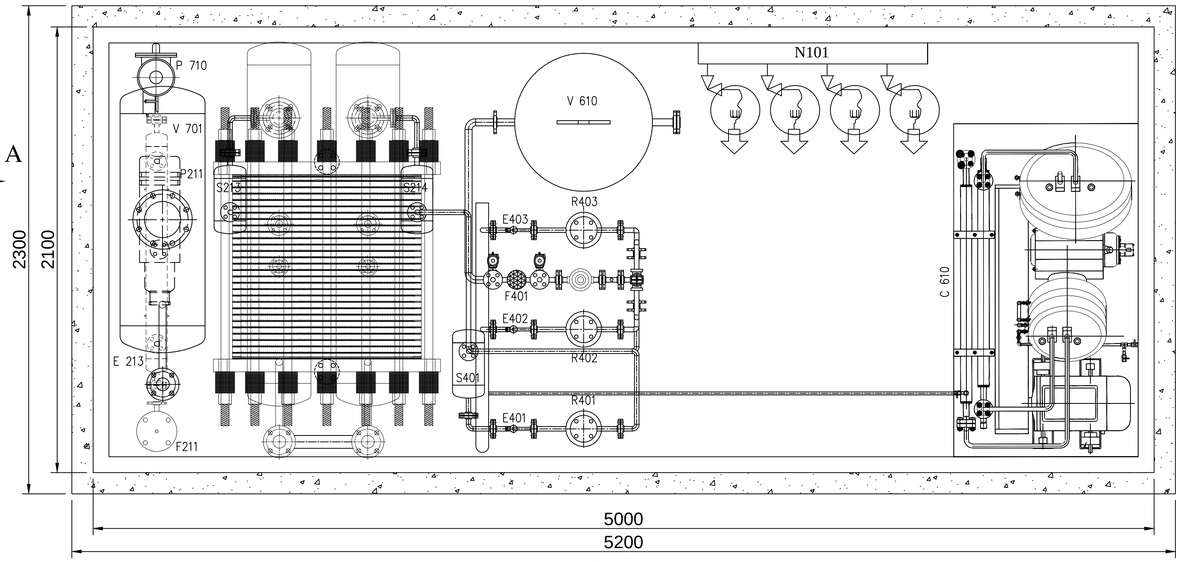
DRAWING No.

CUSTOMER'S DRAWING No.

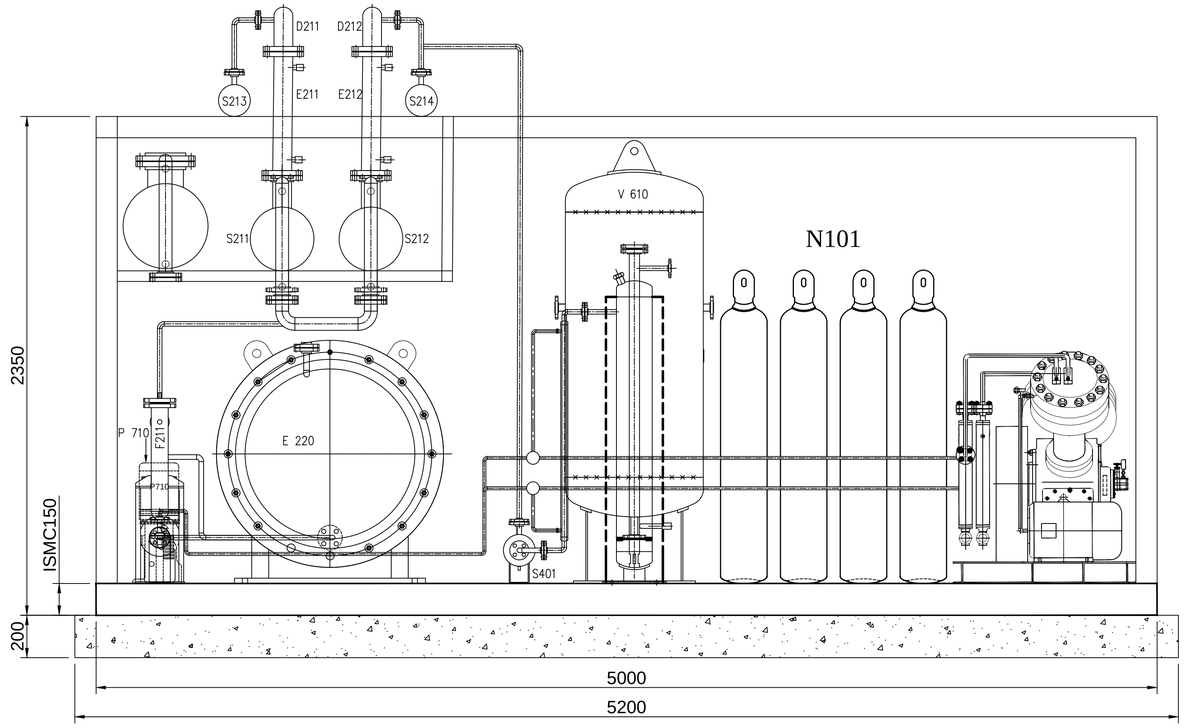
FIRST ANGLE PROJECTION

ALL DIMENSIONS ARE IN MM

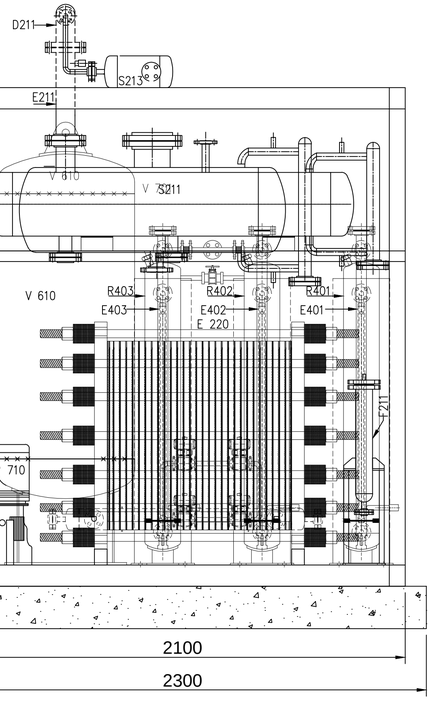
VIEW A



PLAN



ELEVATION



VIEW A

S.No.	Tag No.	Kks Tag No. Skid-1	Kks Tag No. Skid-2	Description
1.	E220/E320	90QJG01AG101	90QJG02AG101	ELECTROLYSER
2.	F211/F311	90QJG01AT107	90QJG02AT107	LYE FILTER
3.	P211/P311	90QJG01AP101	90QJG02AP101	LYE PUMP
4.	S211/S311	90QJG01AT101	90QJG02AT101	O2 SEPARATOR
5.	S212/S312	90QJG01AT102	90QJG02AT102	H2 SEPARATOR
6.	S213/S313	90QJG01AT105	90QJG02AT105	O2 MOISTURE GAS SEP.
7.	S214/S314	90QJG01AT106	90QJG01AT106	H2 MOISTURE GAS SEP.
8.	E213/E313	90QJG01AC103	90QJG02AC103	LYE COOLER
9.	R401/R501	90QJG01AT108	90QJG02AT108	CATALYST COLOUMN
10.	R402/R403\ R502/R503	90QJG01AT109/ 90QJG01AT110	90QJG02AT109/ 90QJG02AT110	DRYER ADSORBER
11.	R401/R501	90QJG01AC105	90QJG02AC105	GAS CONDENSER
12.	E402/E502	90QJG01AC106	90QJG02AC106	GAS COOLER
13.	E403/E503	90QJG01AC107	90QJG02AC107	GAS COOLER
14.	S401/S501	90QJG01AT112	90QJG02AT112	WATER GAS SEPARATOR
15.	V701/V702	90QJG01BB104	90QJG02BB104	DM WATER CUM LYE MAKING TANK
16.	V610/620	90QJG01BB101	90QJG02BB101	H2 BUFFER TANK
17.	D211/212 D311/D312	90QJG01AT103/ 90QJG01AT104	90QJG02AT103/ 90QJG02AT104	O2/H2 DEMISTER
18.	N101 / N102	90QJG01BB104	90QJG02BB104	N2 CYLINDER & MANIFOLD
19.	F401/F501	90QJG01AT111	90QJG02AT111	IN LINE GAS FILTER
20.	P710/P720	90QJG01AP104	90QJG02AP104	FEED DM WATER PUMP
20.	C610/C620	90QJG01AN101	90QJG02AN101	H2 COMPRESSOR

NOTE:-

1. ALL DIMENSION ARE IN MM AND LEVELS ARE IN METER. UNLESS OTHERWISE SPECIFIED.
2. EMPTY WEIGHT : 7 TON
   OPERATIONAL WEIGHT : 7.5 TON
3. ALL THE PIPING AND VALVE MATERIAL SHALL BE OF SS 304 GRADE.
4. TOTAL NUMBER OF N2 CYLINDER - 4 (PER SKID)

CUSTOMER: TELANGANA STATE POWER GENERATION CORPORATION LTD
TELANGANA, INDIA
5 x 800 MW YADADRI TPS, NALGONDA

OWNER'S CONSULTANT: TATA CONSULTING ENGINEERS LIMITED,BANGALORE

BHARAT HEAVY ELECTRICALS LTD
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT
NOIDA

SUB CONTRACTOR: AIROX NIGEN EQUIPMENTS PVT. LTD.

DEPT CODE		NAME	SIGN	DATE
M	DRN	SK		30.03.2022
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	CHD	AD		30.03.2022
	APPD	AKA		30.03.2022

TITLE

GA OF ELECTROLYSER AND PURIFICATION SKID OF HYDROGEN GENERATION PLANT (BI POLAR)

DEPT. | SCALE | DRAWING NO. PE-VO-417-168-A021

SIGN | REV 00 01

SIZE-A1

DATASHEET OF HYDROGEN GENERATION SKID

Description	:	**Specification**
Make	:	Airox Nigen Equipments Pvt. Ltd.
Model Number	:	ANE 12
Technology	:	Bipolar Pressurized Water Electrolyser
Capacity	:	15Nm3/hr. x 2 streams
H_2 Purity % (By Vol.)	:	≥ 99.9% (After purifier)
Dew Point	1 :	0 TO -70°C
Working Pressure	:	10 Bar (g)
Moisture Content	:	0.05 gm/m3
Max. Oxygen Impurity in hydrogen	:	2 ppm

DATASHEET OF ELECTROLYSER & GAS SEPARATION SKID

Description	:	Specification
H_2 Capacity Nm3/hr.	:	16.5 (Ex Electrolyser)
O_2 Capacity Nm3/hr.	:	8.2 (Ex Electrolyser)
DM Water Consumption	:	15 Ltr per stream
Electrolyte (KOH%)	:	30% KOH (by Volume)
Operating Temperature	:	65˚C-85˚C
Design Temperature	:	110˚C
Working Pressure	:	10 bar (g)
Design Pressure	:	11 bar (g)
No. of module	:	1 per stream
A.C. Power Consumption	:	6 KWH/m3 of raw H_2
MOC of cell end plate (Cover)	:	Nickel Plated CS
Electrode material		
a. Cathode	:	Nickel
b. Anode	:	Activated Nickel
Diaphragm Material	:	Membrane Cloth
Turn Down Ratio	:	20% to 100%
Cooling Water Requirement	:	6m3/hr Circulating for each stream
Gas Separation skid consist of	:	Electrolyser,Hydrogen Gas Seperator, Hydrogen Gas Cooler &Moisture Seperator Dm Feed Water Tank Cum Lye Making Tank, Dm Feed Pump ,Electrolyte Strainer,Cooler, Pump. Oxygen Gas Seperator,Oxygen Gas Cooler & Moisture Seperator Interconneced Piping Associated Instrument Moisture Drain Isolation Valves As Per Our PID.
MOC of H2 /O2 Separators	:	ASME SA 312 TP304
MOC of lye cooler	:	ASME SA 312 TP304
MOC of lye filter	:	ASME SA 312 TP304
H2 gas cooler & moisture gas separator	:	ASME SA 312 TP304
O2 gas cooler & moisture gas separator	:	ASME SA 312 TP304
Gas condenser	:	ASME SA 312 TP304
O2 & H2 demister	:	ASME SA 312 TP304

1

NOTE:-1. PLEASE NOTE THAT WE ARE OFFERING OUR PROVEN SYSTEM AND WE DO NOT RECOMMEND ANY CHANGES IN OUR DESIGN. HOWEVER, WE ARE PROVIDING ONE NO. OF LYE CIRCULATION PUMP AND DM WATER FEED PUMP AS STORE STANDBY COMMON FOR BOTH SKIDS.

DATASHEET OF GAS DRYER SKID

Catalyst Column

Description	:	**Specification**
Operating Pressure	:	10 Bar (G)
Design Pressure	:	11 Bar (G)
Operating Temperature	:	150˚C
Design Temperature	:	200˚C
Pressure vessel design code	:	ASME Sec VIII
Type of deoxidizer unit	:	palladium Deoxo
No. of deoxidizer unit	:	1 for each stream
Inlet H2 Capacity for deoxidizer	:	16.5 Nm3/hr
Absorber Bed MOC	:	SS304
Body MOC	:	ASME SA312 TP304
Tag & Kks Tag No.	:	401/501 (90QJG01AT108 / 90QJG02AT108)

GAS DRYER

Description	:	**Specification**
No. of Dryer (Twin Tower)	:	2 Nos.(One per stream)
Operating Pressure	:	10 Bar (G)
Design Pressure	:	11 Bar (G)
Operating Temperature	:	150˚C
Design Temperature	:	200˚C
Pressure vessel design code	:	ASME Sec VIII
Type of Hydrogen Dryer	:	Twin Bed Desiccant Type. (heated)
No. of Desiccant Bed	:	Two
Inlet H2 Capacity	:	16.5 Nm3/hr
Outlet H2 Capacity	:	15 Nm3/hr
Desiccant type	:	Molecular sieve13 X.
Absorber Bed MOC	:	SS304
Body MOC	:	ASME SA312 TP304
Outlet Dew Point	1 :	0 TO -70°C
Tag & Kks Tag No.	:	402/403 (90QJG01AT109 / 90QJG01AT110) 502/503 (90QJG02AT109 / 90QJG02AT110)

DATASHEET OF LYE CIRCULATION PUMP

Description	:	Specification
No. of pumps	:	1 Nos.(Per Stream)
CapacityCuM/Hr	:	09
Tag & Kks Tag No.	:	P211/311 (90QJG01AP101 /90QJG02AP102)
Shaft Sleeve	:	Silicon Carbide
Gasket	:	Teflon
MOC	:	SS - 316

LYE CIRCULATION MOTOR

Rated Nameplate Rating, KW	:	0.75 HP
Rated Voltage, Phase and Frequency	:	415/3/50Hz
Rated Speed	:	2900

DATA SHEET OF BUFFER TANK

QTY.	:	2 NO. ONE FOR PER STREAM
WORKING PRESSURE	:	10 Bar (g)
DESIGN PRESSURE	:	11 Bar (g)
CAPACITY	:	400 LTR.
DESIGN CODE	:	ASME SEC VIII DIV 1
TEST PRESSURE	:	14.3 Bar (g)
MOC OF TANK	:	SA 516 GR 70

DATASHEET OF DM FEED WATER CUM LYE PUMP

Description	:	Specification
Rating	:	1.1 KW
No. of Pump	1 :	1 Nos.(Per Stream)
Capacity	:	80LPH
Tag & Kks Tag No.	:	P710/720 (90QJG01AP104 / 90QJG02104)
MOC	:	SS 316

DM FEED WATER CUM LYE PUMP MOTOR

Rated name Plate Rating	:	1.1 KW
Rated Voltage, Phase and Frequency	:	415 V± 10 % ,3PH,50Hz
Synchronous Speed	:	1440 RPM

DATASHEET OF DM WATER CUM LYE MAKING TANK

Description	:	Specification
No. of Tank	:	1 Nos. (per stream)
MOC of tank	:	SS304
Size of tank	:	200Ltr.
Tag & Kks Tag No.	:	V701/702 (90QJG01BB104 / 90QJG02BB104)

CUSTOMER: TELANGANA STATE POWER GENERATION CORPORATION LTD
TELANGANA, INDIA
5 x 800 MW YADADRI TPS, NALGONDA

OWNER'S CONSULTANT: TATA CONSULTING ENGINEERS LIMITED,BANGALORE

BHARAT HEAVY ELECTRICALS LTD
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT
NOIDA

SUB CONTRACTOR: AIROX NIGEN EQUIPMENTS PVT. LTD.

DEPT CODE		NAME	SIGN	DATE
M	DRN	SK		30.03.2022
	DESN	SK		30.03.2022
	CHD	AD		30.03.2022
	APPD	AKA		30.03.2022

TITLE
GA OF ELECTROLYSER AND PURIFICATION SKID OF HYDROGEN GENERATION PLANT (BI POLAR)

DEPT. | SCALE | SIGN | DRAWING NO. PE-VO-417-168-A021 | REV 01

SIZE-A1

SPECIFIC TECHNICAL REQUIREMENTS (ELECTRICAL)

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 equipment’s.

d) Electrical load requirement for HYDROGEN GENRATION PLANT.

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

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

g) Various drawings, 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” Annexure - I.

3.0 DOCUMENTS TO BE SUBMITTED ALONG WITH BID

3.1 The electrical specification without any deviation from the technical/quality assurance requirements stipulated shall be deemed to be complied by the bidder in case bidder furnishes the overall compliance of package technical specification in the form of compliance certificate/No deviation certificate.

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

ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR

ANNEXURE-I

REV-00, DATE: 12.03.2015

STANDARD ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR (FOR EPC PROJECTS)

PACKAGE : HYDROGEN GENERATION PLANT
SCOPE OF VENDOR: SUPPLY, ERECTION & COMMISSIONING OF VENDOR'S EQUIPMENT
PROJECT:

S.NO	DETAILS	SCOPE SUPPLY	SCOPE E&C	REMARKS
1	415V MCC	BHEL	BHEL	240 V AC (supply feeder)/415 V AC (3 PHASE 4 WIRE) supply shall be provided by BHEL based on load data provided by vendor at contract stage for all equipment supplied by vendor as part of contract. Any other voltage level (AC/DC) required will be derived by the vendor. OR (DE to select the choice applicable for their project)) ~~415 V AC, 3 phase, 3 wire supply shall be provided by BHEL based on load data provided by vendor at contract stage for all equipment supplied by vendor as part of contract. Any other voltage level (AC/DC) required will be derived by the vendor.~~
2	Local Push Button Station (for motors)	BHEL	BHEL	Located near the motor.
3	Power cables, control cables and screened control cables for a) both end equipment in BHEL's scope b) both end equipment in vendor's scope c) one end equipment in vendor's scope	 BHEL BHEL BHEL	 BHEL Vendor BHEL	1. For 3.b) & c): Sizes of cables required shall be informed by vendor at contract stage (based on inputs provided by BHEL) in the form of cable listing. Finalisation of cable sizes shall be done by BHEL. Vendor shall provide lugs & glands accordingly. 2. Termination at BHEL equipment terminals by BHEL. 3. Termination at Vendor equipment terminals by Vendor.
4	Junction box for control & instrumentation cable	Vendor	Vendor	Number of Junction Boxes shall be sufficient and positioned in the field to minimize local cabling (max 10-12 mtrs) and trunk cable.
5	Any special type of cable like compensating, co-axial, prefab, MICC, optical fibre etc.	Vendor	Vendor	Refer C&I portion of specification for scope of fibre Optical cables if used between PLC/ microprocessor & DCS.
6	Cable trays, accessories & cable trays supporting system 100/ 50 mm cable trays/ Conduits/ Galvanised steel cable troughs for local cabling	BHEL Vendor	BHEL Vendor	Local cabling from nearby main route cable tray (BHEL scope) to equipment terminal (vendor's scope) shall be through 100/ 50 mm. cable trays/ conduits/ Galvanised steel cable troughs, as per approved layout drawing during contract stage.
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.

Shweta Guha 12/03/15

Pravoon Dutt 12/3/15

STANDARD ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR (FOR EPC PROJECTS)

PACKAGE : HYDROGEN GENERATION PLANT

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

PROJECT:

S.NO	DETAILS	SCOPE SUPPLY	SCOPE E&C	REMARKS
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.
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. Vendor to ensure the cable tray lay out shall confirm to NFPA (National fire prevention act)/TAC (Tariff advisory committee) applicable for hazardous

Shweta Gaba 12/03/15

Pravesh Dalal 12/3/15

STANDARD ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR (FOR EPC PROJECTS)

PACKAGE : HYDROGEN GENERATION PLANT
SCOPE OF VENDOR: SUPPLY, ERECTION & COMMISSIONING OF VENDOR'S EQUIPMENT
PROJECT:

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

Shweta Gale
12/03/15

12/3/15

ELECTRICAL LOAD DATA FORMAT

LOAD TITLE	RATING (KW / A)		UNIT (U)/STN (S)	Nos.		VOLTAGE CODE*	FEEDER CODE**	EMER. LOAD (Y)	CONT.(C)/ NTT.(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
Rectifier Stream-1	135 KVA	110 KW	S	1	0	D	S	N	C	_	INDOOR	_						
Rectifier Stream-2	135 KVA	110 KW	S	1	0	D	S	N	C	_	INDOOR	_						
H2 Compressor Stream-1	7.5 KW	_	S	1	0	D	U	N	C	_	INDOOR	_						
H2 Compressor Stream-2	7.5 KW	_	S	1	0	D	U	N	C	_	INDOOR	_						
H2 Compressor Standby	7.5 KW	_	S	0	1	D	U	N	C	_	INDOOR	_						
DM Water cum lye Pump Stream-1	1.1 KW	_	S	1	0	D	U	N	I	_	INDOOR	_						
DM Water cum lye Pump Stream-2	1.1 KW	_	S	1	0	D	U	N	I	_	INDOOR	_						
Lye Circulation Pump Stream-1	1.1 KW	_	S	1	0	D	U	N	C	_	INDOOR	_						
Lye Circulation Pump Stream-2	1.1 KW	_	S	1	0	D	U	N	C	_	INDOOR	_						
Heater (Catalyst Column) Stream-1	2 KW	_	S	1	0	E	S	N	C	_	INDOOR	_						
Heater (Catalyst Column) Stream-2	2 KW	_	S	1	0	E	S	N	C	_	INDOOR	_						
Dryer Heater-1 Stream-1	2 KW	_	S	1	0	E	S	N	C	_	INDOOR	_						
Dryer Heater-1 Stream-2	2 KW	_	S	1	0	E	S	N	C	_	INDOOR	_						
Dryer Heater-2 Stream-1	2 KW	_	S	1	0	E	S	N	C	_	INDOOR	_						
Dryer Heater-2 Stream-2	2 KW	_	S	1	0	E	S	N	C	_	INDOOR	_						
Vacuum Pump	1.1 KW	_	S	1	0	D	U	N	I	_	INDOOR	_						
UPS Charger-1	16 A	_	S	1	0	D	S	N	C	_	INDOOR	_						
UPS Charger-2	16 A	_	S	1	0	D	S	N	C	_	INDOOR	_						
Cylinder Testing Apparatus Heater	2 KW	_	S	1	0	E	S	N	I	_	INDOOR	_						
Cylinder Testing Apparatus Blower	2.2 KW	_	S	1	0	D	U	N	I	_	INDOOR	_						
Cylinder Testing Apparatus Pump	3.7 KW	_	S	1	0	D	U	N	I	_	INDOOR	_						
Exhaust Fan-1	1.5 KW	_	S	1	0	D	U	N	C	_	INDOOR	_						

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.	417	ORIGINATING AGENCY	PEM (ELECTRICAL)
		PROJECT TITLE	5 x 800 MW YADADRI TPS, NALGONDA	NAME	DATA FILLED UP ON
		SYSTEM	HYDROGEN GENERATION PLANT	SIGN.	DATA ENTERED ON
		DEPTT. / SECTION	ELECTRICAL	SHEET 1 OF 2 REV. 01	DE'S SIGN. & DATE

LOAD TITLE	RATING (KW / A)		UNIT (U)/STN (S)	Nos.		VOLTAGE CODE*	FEEDER CODE**	EMER. LOAD (Y)	CONT.(C)/ NTT.(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
Exhaust Fan-2	1.5 KW	_	S	1	0	D	U	N	C	_	INDOOR	_						
Exhaust Fan-3	1.1 KW	_	S	1	0	D	U	N	C	_	INDOOR	_						
Exhaust Fan-4	0.75 KW	_	S	1	0	D	U	N	C	_	INDOOR	_						
Exhaust Fan-5	0.37 KW	_	S	1	0	D	U	N	C	_	INDOOR	_						
Exhaust Fan-6	0.37 KW	_	S	1	0	D	U	N	C	_	INDOOR	_						
Exhaust Fan-7	0.37 KW	_	S	1	0	D	U	N	C	_	INDOOR	_						
Exhaust Fan-8	0.37 KW	_	S	1	0	D	U	N	C	_	INDOOR	_						
Exhaust Fan-9	0.37 KW	_	S	1	0	D	U	N	C	_	INDOOR	_						
Exhaust Fan-10	0.37 KW	_	S	1	0	D	U	N	C	_	INDOOR	_						
Exhaust Fan-11	0.37 KW	_	S	1	0	D	U	N	C	_	INDOOR	_						
Chiller	5.5 KW	_	S	1	0	D	U	N	C	_	INDOOR	_						
Chiller Standby	5.5 KW	_	S	0	1	D	U	N	C	_	INDOOR	_						

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)

BHEL	LOAD DATA (ELECTRICAL)	JOB NO.	417	ORIGINATING AGENCY		PEM (ELECTRICAL)
		PROJECT TITLE	5 x 800 MW YADADRI TPS, NALGONDA	NAME		DATA FILLED UP ON
		SYSTEM	HYDROGEN GENERATION PLANT	SIGN.		DATA ENTERED ON
		DEPTT. / SECTION	ELECTRICAL	SHEET 2 OF 2	REV. 01	DE'S SIGN. & DATE

CABLE SCHEDULE FORMAT

ANNEXURE III

CABLE SCHEDULE FORMAT

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

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

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

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

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

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

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

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

(C) CABLE CODES

PVC Copper

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

PVC Aluminium

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

XLPE Copper

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

XLPE Aluminium

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

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

6. Once a cable list has been given to PEM for routing, any subsequent changes required in the cable list (which may be in the form of addition of cables, deletion of cables, change of type or size of cable, etc.) must be informed as specific changes (as a separate file MS Excel of the same format as the original file) to the cable list given earlier if the cable list has been routed and cable schedule generated. The routing status of the cable list shall be got confirmed from PEM by the agency that has prepared the cable list before the changes are intimated. In case PEM confirms that the cable list in question has not been taken up for routing, and the revised cable list is acceptable, the same may be sent. Since cable routing through the program involves adding each cable list to the project cable schedule database, the original cable schedule shall not be furnished to PEM with revisions incorporated within.

SPECIFIC TECHNICAL REQUIREMENTS (CONTROL & INSTRUMENTATION)

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

2. **Hydrogen Plant shall be operated & controlled from PLC based control system** with interface with plant DCS. Operation & Control shall also be through Local Control Panel(LCP), which is also being referred as Backup Panel. These panels shall be placed in Control Room envisaged in Hydrogen Building.

3. LCP shall have the provision of command (start/stop), feedback, hardwired annunciation facia, push buttons, digital indicators, lamps, colored mimics etc.

4. For Control Philosophy for Hydrogen Plant, Bidder to refer Balance of Plant (BOP) packages Control Philosophy attached along with this specification

5. PLC shall have the facility to synchronize its time with BHEL supplied GPS.
   Necessary Hardware (IRIG-B port) for same at PLC end to be provided by bidder. The cable connecting PLC and GPS shall be in BHEL scope.

6. Redundant PLC communication shall be provided for communication between PLC and DCS through serial link with OPC Compliant for monitoring /Control. For detail, please refer PLC Architecture Diagram.

7. **Following is the HMI requirement**
   - **1 no. OWS to be placed in CCR1**
   - **1 no. OWS to be placed in CCR2**
   - **1 no. OWS to be placed in CCR3**
   - **2 no. OWS to be placed in local control room (LCR)**
   - **1 no. OEWS to be placed in local control room (LCR)**
   - **1 no. printer**
   - **In addition to above, Back up panel with coloured mimic, start/stop PBs of all drives, Indications (feedback, instruments), Annunciation, digital indicators shall be provided.**
   - *** 1 no. Laptop**

8. **Redundancy of sensors shall be provided, irrespective of instrumentation shown in the PID, by bidder as per following:**
   (i) Triple redundancy for all analog and binary inputs required for protection of system /drives.
   (ii) For all other control functions & alarms, dual redundancy of the sensors shall be provided by the bidder.

9. Supplied system shall provide group alarms to be hardwired to plant DCS.

10. Redundant Uninterrupted Power Supplies (UPS) with adequate rating of continuous duty with backup shall be provided for the system. Non-UPS supply feeder 415 V, 3 phase, AC supply shall be provided by BHEL based on the load data provided by the bidder. UPS is in bidder's scope and shall be in line with the specifications. Standard UPS of rating 10 kVA or 20 kVA shall be considered depending upon the load. If load is < 10 kVA, UPS of 10 kVA and if load is > 10 kVA, UPS of 20 kVA shall be provided.

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

12. All the instruments shall be supplied along with necessary fittings, accessories, valve manifold, root valves, Junction box, Canopy & Structural steel as required. Instrument Installation along with hardware shall be in bidder scope. Double root valves shall be provided where pressure is above 40 Kg/cm2.

13. The solenoid operated valves/ damper/gates shall have limit switches for open/ close feedback. Solenoid valve shall be rated for 24 V DC only.

14. The junction boxes/LIEs for termination of instruments /solenoid valve limit switches etc are in bidder's scope. All instruments shall be terminated on JB/LCP in field and both instrument and JB/LCP are in bidder scope.

15. All transmitters & electronics items including JBs will be explosion proof / intrinsically safe as per hazardous area classification.

16. The make/model of various instruments/items/systems shall be subject to approval of owner/purchaser during detailed engineering stage. No commercial implication in this regard shall be acceptable. In case of any conflict or repetition of clauses in the specification, the more stringent requirements among them are to be complied with.

17. All necessary instruments such as transmitters/temperature elements/sensors/switches/gauges etc. shall be provided for safe, efficient & reliable peration and maintenance of the H2 generation plant. All electric instrument devices like switches/ transmitters/ controllers/ analyzers/ solenoid valves which are located in the field/ hazardous locations shall be intrinsically safe by providing suitable type zener barriers of standard approved make meeting the requirements as approved by chief controller of explosives, India and other statutory authorities. Otherwise, such instruments shall be provided with explosion proof enclosure suitable for hazardous area described in National electric code(USA), Article 500, class -1, Division -1 zone-II as approved by Chief Controller of Explosives, India and other statutory authority.

18. All Instruments must have separate tapping lines. Sharing of the same tapping pipe for redundant instruments or various different instruments is not acceptable.

19. As a general rule, measuring points and measuring equipment for critical protection shall be separate from and not combined with measuring equipment for the automatic control equipment.

20. Electronic instruments shall not be located close to hot lines, vessels or other hot equipment. Ambient temperatures exceeding 80 °C shall not result in calibration difficulties or rapid deterioration of electronic components.

21. The design, manufacture, inspection, testing, site calibration and installation of all C&I equipment and systems covered under this specification shall conform to the latest editions of applicable codes and standards eg. ANSI, ASME, IEEE, ISO, IEC, IGCI, AWS, NFPA, AISC, IGS, SAMA, UBC, UL, NESC, NEMA, ISA, DIN, VDE, IS etc.

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

23. Provision for separate Terminal block/wiring diagram for power and control blocks of control panel to be ensured.

24. Power supply derived for Transmitters, contact interrogation, interposing relay and solenoid shall generally be ungrounded 24V D.C only. In all cases redundancy in power modules shall be considered.

25. Bidder to note that all the transmitters/instruments supplied by Bidder shall be rack mounted. The racks shall be preassembled and provided by Bidder. Also no instruments / analyzers & JBs/Racks should be protruding on the walkway.

26. Each valve/instrument shall be fitted with a stainless steel or aluminum nameplate indicating the valve/instrument service and reference number in accordance with the approved equipment coding system.

27. The equipment shall be of modern, compact design incorporating the latest developments in proven technology.

28. Transmitters shall be provided instead of switches.

29. Solenoid valves shall be kept in pneumatic junction boxes only. Air distribution for SOV's shall be through SS manifold with SS isolation valves and auto drain traps and SS tubing from SOV to valves shall not be more than 6 meters.

30. All furniture (tables, chairs etc.) required for PLC operator HMI shall be in bidder's scope. Chairs shall be capable of being adjusted for height and position of backrest. One table and chair shall be provided for each operator station and separate table for each printer.

31. Bidder's presence is required for 5 Man days at site during commissioning of PLC for assistance related to process correctness. All the expenses like boarding, lodging and travel, Air fare etc. shall be in bidder's scope.

32. Electronic instruments shall not be located close to hot lines, vessels or other hot equipment. Ambient temperatures exceeding 80 °C shall not result in calibration difficulties or rapid deterioration of electronic components.

33. All the instruments/equipment/electrical items shall be provided & designed with maximum star rating in line with energy conservation policies as per latest international standards at the time of supply.

34. Bidder to provide erection hardware including canopies, structural steel as required.

35. Bidder to perform tests of C&I items/instruments/systems as per quality plans/type test attached in the specification.

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

37. Each valve/instrument shall be fitted with a stainless steel or aluminium nameplate indicating the valve/instrument service and reference number in accordance with the approved equipment coding system.

38. Provision for separate Terminal block/wiring diagram for power and control blocks of control panel to be ensured.

39. Mandatory spares have to be supplied by bidder as mentioned in the specification.

40. The specifications for instruments mentioned in the specification are minimum requirements. Datasheets of instrument shall be subject to customer/owner approval.

41. Editable & pdf copy of Drawings/Documents and data to be furnished after award of the contract:

- Local Control room drawing
- GA & wiring diagram of local panel.
- Local control panel & instruments data sheet.
- Control & operational write-up for the system
- Control scheme/ logic diagram
- List of Drives (Solenoid valves etc)
- I/O list
- Power requirement.
- JB grouping document.
- Cable schedule and cable interconnection drawing.
- Instrument schedule
- Alarm Schedule

- SOE schedule
- Instrument hook-up diagram.
- Mandatory spare BOQ
- UPS load list
- Any other document decided during detailed engineering.

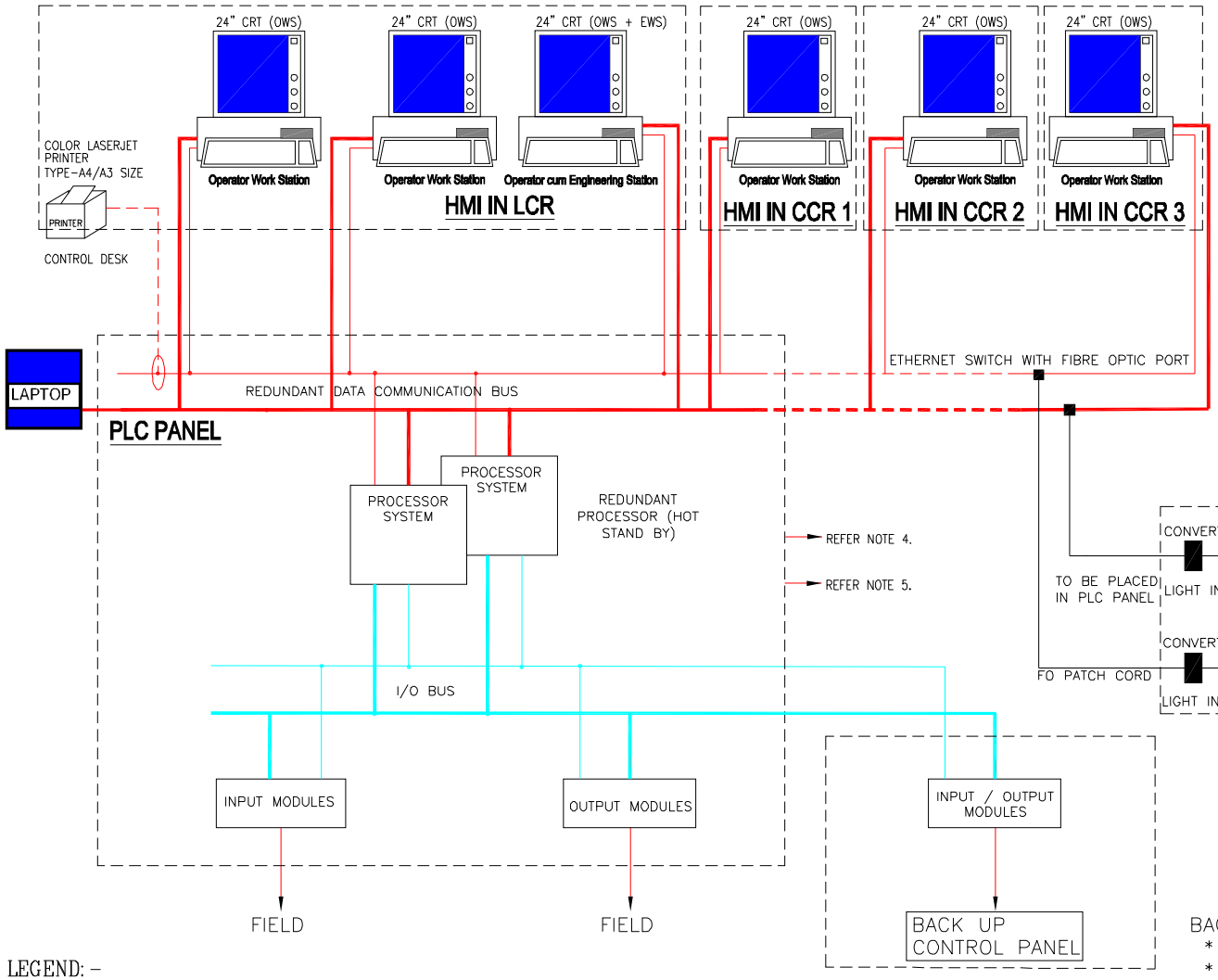
Notes:

1. All equipment items shall be of latest design with proven on track record from reputed experienced manufacturers of specified type and range of equipment. The make/model of various instruments/items/systems and instrument sub-vendor shall be subject to approval of BHEL/Customer during detailed engineering stage.

2. The above given scope is indicative & minimum. Any item/ equipment not indicated above however required for the completeness of the system is to be supplied by bidder without any technical, commercial and delivery implication to BHEL.

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

4. Uniformity of make and type of instruments and control components shall be followed throughout for rationalization of spares' inventory, except for certain proprietary items where this requirement cannot be met.



NOTES:

1) TABLE TOP OWS/EWS SHALL BE 24"
2) ALL PLCS SHALL HAVE DUAL HOT REDUNDANT PROCESSOR AND EACH RACK SHALL HAVE DUAL POWER SUPPLY MODULES, DUAL NETWORK COMMUNICATION CARDS/MODULE FOR DUAL REDUNDANT RING OR DUAL REDUNDANT STAR NETWORK.
3) REDUNDANT UPS POWER SUPPLY SHALL BE USED FOR PLC PANEL(S),RIO, BACKUP PANELS, OWS/EWS,4 WIRE INSTRUMENTS AND NETWORK COMPONENTS.FOR APPLICABLE UPS SCHEME REFER DWG: PE-DG-417-145-I004
4) PLC PANEL SHALL HAVE PROVISION TO ACCEPT TIME SYNC. SIGNAL (NTP/IRIG-B) FROM MASTER CLOCK SYSTEM.
5) PLC PANEL SHALL HAVE PROVISION FOR DATA EXCHANGE (OPC) WITH PLANT DCS. NECESSARY OPC CLIENT/SERVER SOFTWARE TO BE PROVIDED.SEPARATE OPC SERVER FOR EACH PLC SHALL BE PROVIDED.
6) NECESSARY PATCH CORD/CONVERTERS, LIU AT BOTH PLC AND DCS END SHALL BE IN BIDDER SCOPE FOR OPC LINK TO DDCMIS.
7) PLC SPECIFICATION SHALL BE AS PER KTPS TENDER SPECIFICATION VOLUME-VI, SECTION VI, SUBSECTION B ONLY
8) PLC PROCESSOR AND IO CARDS/MODULES SHALL BE FROM SAME FAMILY AND SHALL BE OF LATEST MODEL.
9) UPS SPECIFICATION SHALL BE AS PER KTPS TENDER SPECIFICATION VOLUME-V B,SECTION XIV.UPS SIGNALS TO PLC SHALL BE THROUGH HARD WIRED AND SOFT SIGNALS(MODBUS).
10) FIELD INSTRUMENT REDUNDANCY SHALL BE AS PER SPECIFICATION ONLY. PROTECTION & CLCS: TRIPLE REDUNDANCY; INTERLOCK/ PERMISSIVE: DUAL REDUNDANCY; MONITORING/ ALARM: SINGLE
11) ALL RTDS/ THERMO COUPLES IF APPLICABLE SHALL BE DUPLEX TYPE
12) NECESSARY PATCH CORD, CONVERTERS, LIU ETC AT BOTH PLC AND DCS END SHALL BE IN VENDORS SCOPE.
13) VENDOR TO PROVIDE HIRSCHMAN MAKE ETHERNET SWITCHES ONLY.

14) STANDARD UPS OF RATING 10 KVA OR 20 KVA SHALL BE CONSIDERED DEPENDING UPON THE LOAD. IF LOAD IS < 10 KVA, UPS OF 10 KVA AND IF LOAD IS > 10 KVA, UPS OF 20 KVA SHALL BE PROVIDED.
15). FOR EACH OF THE PLC / PROPRIETARY CONTROL SYSTEM, THE PROGRAMMING SOFTWARE SHALL BE SUPPLIED IN A LAPTOP FOR EACH PACKAGE AND ALL TYPES OF PROGRAMMING PACKAGES SHALL BE LICENSED WITH FACILITY OF EDITING AND CONFIGURATION.

BACK UP CONTROL PANEL WITH
* COLORED MIMIC
* HARDWIRED ANNUNCIATION
* PUSH BUTTONS, LAMPS, INDICATORS

LEGEND: –

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

Maharatna Company

PROJECT: 5 X 800 MW YADADRI TPS

TITLE: PLC CONFIGURATION HYDROGEN GENERATION PLANT

DRG.NO.	PE-DM-417-145-I900
DATE	08.01.2018
REV.NO.	00
SHT	6 OF 8

SECTION – IIA

GENERAL TECHNICAL REQUIREMENT (MECHANICAL)

1.0 SCOPE

This design memorandum is intended to cover design, engineering, manufacture, inspection, testing at manufacturer's works, supply/delivery duly packed at site including freight, unloading, storage and handling at site, erection and commissioning, trial run at site, Demonstration test, obtaining CCE approval and plant handing over to customer etc. inclusive of all prevailing taxes, duties and other levies of Hydrogen Generation Plant complete with all accessories inducing start up, mandatory and commissioning spares as required for 5X800 MW, Yadadri Thermal Power Station.

2.0 DESIGN BASIS

Hydrogen generation plant will be designed to maintain hydrogen purity at gas manifolds 99.9% and moisture content 0.05 g/m^3 (max). The complete hydrogen generation plant system, equipment, layout shall be designed as per the guidelines of explosive authority (chief controller of explosive) of India and other statutory authorities for the design and installation of the plant. The hydrogen generation plant can be of **bipolar** design.

3.0 GENERAL OPERATION CRITERIA / PHILOSOPHY:

3.01.0 Designed for Continuous duty.

3.02.0 Designed for parallel operation of both streams.

3.03.0 Flexibility to operate electrolyser in part load.

3.04.0 Complete operation from PLC based local control panel.

3.05.0 To trip the plant in case of high hydrogen level inside the building suitable numbers of hydrogen gas detectors shall be provided for each of the room.

3.06.0 Set pressure to be maintained with the help of back pressure regulating valve.

3.07.0 Automatic operation of standby compressor as and when required.

3.08.0 To provide alarm & tripping of compressor based on suction conditions ("suction pressure not low").

4.0 CONSTRUCTION DETAILS OF EQUIPMENT

4.01.00 Electrolyser cells:

4.01.01 Electrolyser cells shall be of bipolar design.

4.01.02 Cells in electrolyser shall be connected to each other. The cells in electrolyser shall be of corrosion resistant material. In case of bipolar design one explosion proof temperature switch in each generator module for electrolyser temperature high alarm on the control panel has been provided.Temperature transmitter or RTD shall be provided on electrolyser to maintain the electrolyser temperature to a preset value by controlling cooling water flow to the electrolyser through the temperature control valve. One temperature gauge for local indication for electrolyte temperature. One off-line specific gravity measuring instrument.

4.01.03 The electrolyser will be designed to operate at part load of normal capacity without any disconnection and operation interruption and shall produce the hydrogen gas of specified purity and dryness.

4.01.04 All measuring instruments, controllers, and control valves shall be provided.

4.01.05 Safety devices will be provided on each collecting pipe to release gas pressure in case it goes above the limits.

4.01.06 Eelctrolyser will be designed so that it can be cleaned and maintained easily. Cells module will be part of the gas generating station.

4.01.07 Proper sealing shall be provided, while crossing the wall to avoid any gas leakage to Rectifier Room. Provision shall be incorporated for minimizing electrical leakage between cells and from cells to ground.

4.01.08 Electrolyser cells, hydrogen gas purifications system, compressor skid including instrumentation are part of the vendor's standard manufacturing skid system. The instrumentation shall be triple redundant for protection and dual redundant for interlock / permissive for instruments installed outside the manufactures standard compact skids of electrolyser, purification and compressors.

4.02.00 Rectifier:

4.02.01 Two nos. of rectifiers (one for each Electrolyser) to cater the load of each of the electrolyser shall be provided. The rectifier equipment shall be complete in all respects with air-cooled rectifier transformer, thyristor convertor, electronic control and annunciation, filters choke etc. mounted in suitable panels.

4.04.00 Demineralized water tank

4.04.01 One number tank of Capacity adequate for 5 days' normal requirement of hydrogen gas generation on continuous basis at rated capacity of 15 Nm^3/hr. for both the streams of Hydrogen Generation Plant.

4.04.02 Tank will be fitted with removable drain connections, level transmitters, level indicators etc.

4.05.00Electrolyte Preparation Tank: - (As applicable)

The KOH tank may be part of the standard gas generating cabinet. The electrolyte is typically mixed in KOH tank and then transferred to Electrolyser through KOH pump. However, this arrangement may vary and shall be provided as per manufacturer standard practices. KOH is not consumed in the electrolysis process, but periodically checked to verify that the concentration has not been changed.

(a) Accessories (As Applicable) like Wire rope, counter weight, guide pulley required to suspend the gas holders, steel stairs four way motorized valves, flame proof low & high level switches interlock and control, float type level indicators, etc.

(b) Venting of hydrogen should be through flame arrestor.

4.07.00 De-oxy unit

Numbers	1 (To handle both the streams and capable to remove oxygen as impurity)
Accessories	Heater with temperature control device, gas cooler, filter, Necessary Instruments etc.

4.08.00 Hydrogen compressors and drives

i)	Number	3x50% (Two working & one standby)
ii)	Capacity of each compressor	125% of each stream
iii)	Design delivery Pressure	150 Kg/cm^2 (g)
iv)	Type	Preferably Oil free, Piston or Diaphragm type.
v)	Piston type	of proven design
vi)	Diaphragm type	with triple diaphragm failure detection system. The side and oil side diaphragms shall be of Stainless Steel.
vii)	Drive cage	Constant speed Sq. cage flame proof type Electric motor suitable for group-IIC location as per IS:2148 or Class-I Div. II of NEC.
viii)	Activated carbon filters	2x100% and required in case of oil lubricated compressors

ix) All metal to metal joints shall be provided with “O” rings of suitable grade material.

x) Compressors are provided with accessories as applicable:- pressure switches (low) at the suction and pressure switches (high) at the discharge. A back pressure regulating valve is provided at the compressor discharge to maintain a constant regulating pressure at the compressor outlet. Normally the compressors will run in automatic mode. The compressor will start compressing hydrogen gas when the suction pressure reaches the setting of low-pressure set point and will continue to run until the discharge pressure reaches the upper set point of the high discharge pressure and then go to standby mode.

Then as the gas is drawn from storage and the storage pressure decays down to the lower set point of the high pressure switch, the compressor will automatically restart to refill the storage vessels.

The compressor includes leak detection system to protect compressor and / or hydrogen gas system in case of diaphragm failure. In case of diaphragm rupture, a pressure signal would be sent to leak detection switch which will shut down the compressor. The automatic operation of the standby compressor is not envisaged due to safety reasons.

xi) All suitable auxiliaries (as applicable) such as built in relief valves, Pressure and temperature gauges after every compressor stages, mechanical lubricator, built in automatic unloader devices, Water cooled inter coolers after every compression stage, flow switches, pressure gauges in coolant line, sight flow indicators in coolant line, V belt drive with pulleys, a transfer switch to allow operation of stand by compressor automatically, suction filters, scrubber to remove any traces of entrapped electrolyte, separator and filters, suitable protection device to prevent suction of water from gas holders as a back-up to low level switch provided on the gas holders for compressor TRIP, Mist Eliminators (if applicable). One number on-line hydrogen purity analyzer at the suction etc. shall be provided for continuously monitoring hydrogen purity before compressor and also to provide suitable alarm and automatic tripping of plant in case, hydrogen purity falls below the preset level.

4.09.00 Drying system for Hydrogen gas

a) Twin tower moisture separating columns of regenerative design along with instruments.
b) Valves arrangement to suit operation of one column and another under regeneration. The changeover operation shall be automatic based on PLC command.

4.10.00 Back Pressure regulating valve:

One number spring loaded disc. Operated self-actuating type backpressure regulating valve to maintain 150 Kg/cm^2 (g) pressure on the compressor discharge.

4.11.00 Cylinder Manifold:

One dual filling cylinder filling manifold, arrangement for two banks of minimum eight cylinders each to permit connection and removal of cylinder (water capacity – 46.7 liters (approx.) without interruption of filling. Accessories such as isolating valves, safety valves, pressure gauges, pressure switch (to shut off compressor beyond set pressure) shall be provided, ”ON – LINE “Hydrogen purity analyzer, trace oxygen analyzer, moisture analyzer at cylinder manifold, records of hydrogen purity and moisture content and one number portable hydrogen gas purity gas testing kit etc. shall be provided.

Nitrogen manifold shall be supplied having capacity to connect 8 no’s cylinders with accessories such as isolating valves, safety valves, pressure gauges etc.

4.12.00 Flushing System

4.12.01 To be provided with necessary connection with proper isolation devices, nitrogen cylinders,
Valves, manifolds piping etc. to enable purging of the system with nitrogen during commissioning and each maintenance work.

4.13.00 Hydrogen leak detection system.

Hydrogen leak detection and interlock system shall be provided in generator / compressor
rooms and hydrogen filling area for alarm and trip of Hydrogen generation plant.

4.14.00 Piping:

4.14.01 All pipe to conform to ASTM or equivalent pressure piping code, and seamless type.

4.14.02 All high pressure joints shall of ferrule/welded construction.

4.14.03 All hydrogen vents will be fitted with flame arrestor.

4.14.04 All high pressure drains to be terminated through H2 traps and all low pressure drains to be terminated through V-bends.

4.14.05 Cooling water pipe be minimum 80 NB size.

5.0 AIR CONDITIONING AND VENTILATION SYSTEM

It shall consist of adequate number of roof exhausters / wall mounted exhaust fans (as applicable), ducting (if required), drives & other electrical accessories ducting supports

and supporting system, rain protection cowl, bird screens, vibration isolators nuts & bolts, grouting frame, transition piece etc. as required to complete the system.

The air quantity of ventilation system shall be estimated based on minimum number of air changes shall not be less than 30 air changes per hour. The exhaust air shall be discharged at a suitable height from the room. Temperature rise inside the building shall be restricted to Maximum of 3 deg.C over design ambient.

Louvers for fresh air-supply as per building layout as required.

Axial flow fans for exhausting air/fumes shall be provided for hydrogen generation plant area and shall be of flameproof construction with inlet and outlet dampers. However, ducts and all other parts like blades etc. shall be epoxy painted.
Control Room having PLC shall be fully air conditioned with split air conditioners.

6.0 HYDROGEN AND NITROGEN GAS CYLINDERS

16 Nos. of Hydrogen storage cylinders shall be supplied to store the hydrogen gas. The hydrogen storage cylinders shall be suitably designed for 150kg/cm^2 (g) working pressure. The water capacity of each cylinder shall be 46.7 liters (approx) (7 Nm3). The cylinders shall be as per IS: 3224 and IS: 7285. The total cylinder capacity is adequate for flushing the system.

8 Nos. of Nitrogen gas cylinders shall be supplied and installed in Gas flushing manifold. Cylinder
capacity water capacity –46.7 liters (approx.) (7 Nm3). The cylinders shall be as per IS: 3224 and IS: 7285.
The total cylinder capacity is adequate for flushing the system
All the cylinders shall have following standard fitting: -

i) neck collar.
ii) protection cap
iii) outlet valve to IS:3224
iv) safety valve / bursting disc

N2 gas required for purging the system during commissioning, demonstration test/trial operation etc. till handing over of the plant to the CUSTOMER shall be arranged by the hydrogen generation plant vendor. Cylinders are to be supplies along with valid test certificates.

7.0 VACUUM PUMP AND CYLINDER TESTING APPARATUS

01 No. Vacuum pump and high pressure cylinder testing apparatus along with all the accessories for testing of cylinders shall be provided.

8.0 COOLING WATER

The DM water shall be used in closed circuit with chiller unit for cooling of equipment. 2 nos. (1 working and 1 standby) packaged type chiller with inbuilt control and protection is provided to supply cooling water.

9.0 CODES AND STANDARDS.

All the codes and standards shall be in line with applicable National/International standards.

10.0 One number trolley shall be provided within H2 generation plant for handling of cylinders.

11.0 CONTROL AND INSTRUMENTATION

All necessary instruments such as transmitters/temperature elements/sensors/switches/gauges etc. shall be provided for safe, efficient & reliable operation and maintenance of the H_2 generation plant. All electric instrument devices like switches/ transmitters/ controllers/ analyzers/ solenoid valves which are located in the field/ hazardous locations shall be intrinsically safe by providing suitable type zener barriers of standard approved make meeting the requirements as approved by chief controller of explosives, India and other statutory authorities. Otherwise, such instruments shall be provided with explosion proof enclosure suitable for hazardous area described in National electric code(USA), Article 500, class -1, Division -1 zone-II as approved by Chief Controller of Explosives, India and other statutory authority.

PLC based monitoring and control system with hot standby processor shall be provided for plant. PLC shall have the facility to synchronize its time with plant GPS.

PLC system shall be provided with 2x100% UPS fed from redundant 415V, 3-ph feeders. Plant schematic for monitoring & operation shall be available on OWS.

EMPTY HYDROGEN / NITROGEN CYLINDER

1.0 SCOPE

This section covers the design, manufactures, testing and supply of empty seamless hydrogen cylinders as per the requirements specified herein.

2.0 STANDARD APPLICABLE

Latest edition of IS:3224 and IS:7285

3.0 DIMENSIONS

a.	Outside diameter	-	232 mm
b.	Cylinder wall thickness	-	5.4 mm (min)
c.	Overall length	-	1445 mm

4.0 DESIGN

The top end should be necked down to 2" dia and screw internally to dia 1" standard taper 1 in 8, 14 TPI to IS :3224. The bottom of cylinder shall be concave.

5.0 FITTINGS

The gas cylinders should be complete with the following fittings/ accessories.

a. Neck collar
b. Protection cap
c. Outlet valve to IS:3224
d. Safety valve/Bursting disc.

6.0 CAPACITY

a.	Water capacity	-	46.7 liters
b.	Volume gas	-	7m³(app.)

7.0 WORKING PRESSURE - 150kg/cm²

8.0 MATERIAL

The cylinders shall be conforming to IS:7285 and shall be made of seam less solid drawn high carbon manganese steel. The valve body shall be made of brass and internals of stainless steel.

9.0 REQUIREMENT OF CYLINDERS

As per IS:7285

10.0 PAINTING & MARKING ON CYLINDERS

To be as per IS : 7285

11.0 INFORMATION REQUIRED WITH THE OFFER

Cylinder drawing indicating the following details:

a) The standard to which cylinders and fittings confirm.
b) Capacity, size and wall thickness of cylinder.
c) Details and arrangement of fittings.
d) Minimum wall thickness of cylinder.
e) Working pressure, pneumatic test pressure, hydraulic test pressure and hydraulic stretch test pressure.

12.0 TEST CERTIFICATES

a) Test certificates for all the tests indicated in clause 9.0 of this specification.
b) Manufacturer shall furnish inspection certificate from BIS and approval certificate from deptt. of explosive Nagpur.

13.0 GENERAL

a) The offer submitted shall be strictly in line with the requirements specified in this specification.
b) All the documents as required in clause 12 and 13 shall be submitted in 5 copies.

VOLUME : IIIE

SECTION-V

LOW PRESSURE PIPING, VALVES AND SPECIALTIES

1.00.00 GENERAL INFORMATION

This section covers all the low-pressure piping up to 400mm NB size, associated valves and specialties that include but is not limited to the following systems.

1.01.00 Service Air System - shall consist of distributions service air to different buildings.

1.02.00 Instrument Air System - shall comprise of distribution of instrument quality air to pneumatically operated instruments/ valves/dampers.

1.03.00 Demineralised Water Supply system including hot well make-up water piping from condensate storage tank.

1.04.00 Demineralised Water closed cycle cooling system.

1.05.00 Service water system.

1.06.00 Potable water system.

1.07.00 Any other low pressure piping as found necessary during detail engineering shall also be included.

2.00.00 CODES AND STANDARDS

2.01.00 In addition to the requirements spelt out in Volume IIA, the design, manufacture, inspection and testing of the piping, fittings, valves and specialties covered under this specification shall conform, in general, to the standards and codes (latest edition) mentioned below:

2.01.01	IS-1239 [Part-I & II]	:	Mild steel tubes, tubular and other wrought steel fittings.
2.01.02	IS-3589	:	Electrically welded steel pipes for water, gas and sewage (150 to 2000 mm nominal diameter)
2.01.03	IS-554	:	Dimensions for pipe threads where pressure tight joints are required on the threads.
2.01.04	IS-1363 [Part-I & II]	:	Hexagonal head bolts, screws and nuts (size range M5 M36)

2.01.05	IS-1364	:	Precision and Semi-precision hexagon bolts, screws, nuts and lock nuts (diameter range 6 to 39 mm)
2.01.06	IS-3138	:	Hexagon bolts & nuts (M42 to M150)
2.01.07	IS-5312	:	Swing check type reflux (non-return) valves.
2.01.08	IS-2379	:	Colour code for the identification of pipelines.
2.01.09	IS-2016	:	Plain washers
2.01.10	IS-2712	:	Compressed asbestos fibre jointing
2.01.11	ANSI B-16.5	:	Steel pipe flanges and flanged fittings
2.01.12	ANSI B-16.9	:	Wrought steel Butt welding flanged
2.01.13	ANSI B-16.11 ANSI B-36.10	: :	Forged steel fittings, Socket-welding and Threaded. Steel pipes thickness
2.01.14	API-600	:	Steel gate valves
2.01.15	BS-2633	:	Class I Arc welding of ferrite steel pipe work for carrying fluids.
2.01.16	BS-534	:	Specification for steel pipes and specials for water and sewage.
2.01.17	BS-5351	:	Specification for Ball valves.
2.01.18	AWWA-C-504	:	Specification for Butterfly valves.
2.01.19	AWWA-C-208	:	Dimension for fabricated steel water pipe fittings.

2.02.00 Other international codes and standards may also be offered by bidder. However, same may be subject to acceptance by the Purchaser.

3.00.00 **SCOPE OF WORK**

3.01.00 The equipment and materials to be supplied shall include but not be limited to the following:

a) Supply of all low pressure piping including bends, elbows, tees, branches, laterals, crosses, reducing union, couplings, caps, saddles, shoes, flanges, blank flanges, Y-pieces etc. as required for the piping system under the scope of this section.

b) Matching pipes, matching pieces like reducers/enlargers etc., counter flanges with bolts, nuts, washers, temporary and permanent gaskets, threaded union etc.

c) Supply and machining work of flanges, pipe spools and matching pipes to connect flow measuring orifices/nozzles with the main pipe work.

d) All isolating and regulating valves, non-return valves, steam/air traps, relief/safety valves (wherever applicable), strainers, pressure reducing orifices etc. complete with the counter flanges and matching connecting pieces as required within the entire low pressure piping system.

e) Anchors, hangers and supports, etc. as required. Any platform necessary for maintenance and operation of valve and equipment located 1.5 m above any permanent floor or platform including access ladders, supporting structures etc.

f) All secondary structural steel members required for pipe supports from building steel structures and from embedded steel wherever provided including pipe supports in trenches. However, trench piping should be avoided to the extent possible.

g) Funnels, tundishes for drips and drains including all miscellaneous drain piping and drain piping from tundish outlet up to drain points. All drain and vent lines shall be conveniently terminated to floor drain points/permanent drain trenches.

h) Flanges, counter flanges, blank flanges, bolts, nuts, washers, temporary and permanent gaskets, fasteners caps etc. as required for interconnecting piping, valves & fittings.

i) Cleaning and Painting of all piping, valves & specialties at manufacturer's shop.

3.02.00 Following general requirements shall however be provided

a) Instrument Connections including instruments, root valves, sensing lines etc.

b) Pipe stubs and blanking plates etc. required for chemical cleaning and hydro testing.

For conducting acceptance test, the required pressure, temperature, flow measurement points shall be provided.

3.03.00 All miscellaneous instruments

4.00.00 GENERAL DESIGN AND CONSTRUCTION

4.01.00 General Considerations

4.01.01 The piping systems included in this section shall be designed to operate continuously without replacement during the plant service life of 30 years.

4.01.02 The piping system shall be complete in every detail and in accordance with the highest standard of workmanship.

4.01.03 All design and fabrication shall be in accordance with codes/standards specified.

4.01.04 No pipe work shall be run in trenches carrying electrical cables.

4.01.05 Pipe size above 50 NB shall be shop fabricated and of size 50 NB and below shall be field run.

4.01.06 All piping shall be identified by means of colour strips and by adequate lettering, conveniently spaced and located. Identification colours and lettering shall be as approved.

4.01.07 Air release and drain branches shall be provided wherever necessary depending upon the layout and arrangement so that the drains and air release valves are located for easy operation.

4.01.08 Unless otherwise specified, all pipe work shall be suitable for a minimum pressure of 10.0 kg/sq. cm(g) at 80 deg. C or as required by the design of the different piping system, if higher.

4.01.09 **Drain Pipe Work**

a) Low pressure drains shall have an isolating valve at the point of take-off from the pipe or vessel to be drained, or as near as possible for conventional operation.

b) Unless otherwise stated, all drain piping shall be of 25 mm NB minimum and all vent pipings shall be of 15 mm NB size minimum. For pipes up to 50mm NB, pipe wall thickness shall be as per schedule 80 of ANSI B36.10.

c) Unless otherwise stated, wherever a main or branch of any pipeline is terminated with a valve, such terminal valve shall be provided with a blank flange/blanking cap at the free end.

4.01.10 Specification of pipes used in different services included in the L.P piping section has been detailed in Annexure-I.

4.02.00 **Material Specification**

4.02.01 Materials for pipes and fittings shall be as stipulated in Annexure-I. In case bidder wants to offer alternative piping material, same may be accepted by the Purchaser depending on the merits of alternative material.

4.02.02 Pipe attachments for supports, anchors and restraints, which are coming in direct contact with pipes, shall have similar materials as the piping concerned. All other materials of supports, anchors and restraints shall be of tested quality and as per manufacturer's standards.

4.03.00 **Fabrication**

Except where otherwise specified all piping shall have butt-welded connections with a minimum of flanged joints necessary for maintenance. Where flanges are adjacent to welded fittings, weld neck flanges shall be used.

Branches shall, in general, be formed by welding. Standard fittings may be used in positions and for sizes where approval has been given in detail drawings. Pipe bends and tees shall be truly cylindrical and of uniform section. all welded branches shall be reinforced where needed as per the applicable codes/regulations.

4.03.01 Piping shall be fabricated in the shop in the largest transportable sections to minimize the number of field weld joints. The choice of field weld joints locations shall be based on the traverse of the pipe through walls, floors, sleeves or other restrictive areas. Support attachments for major piping shall be done at shop.

4.03.02 All pipes bends shall be made true to angle with no negative tolerance and shall have a smooth surface free of flat spots, crease and corrugations. A cross section through any bent portion of the pipe shall be true in diameter, within plus or minus 3% of the pipe diameter. Pipe bends shall be made from straight pipe pieces of sufficiently higher thickness so that after thinning, the minimum thickness of bends shall not be less than the minimum thickness required for the straight pipe. Thinning allowance shall be considered as per the relevant code.

4.03.03 For bends in pipes straight piece of pipes shall be bent by the contractor to required bend radius. However, forged bends (Bend radius = 1.5 x pipe diameter) wherever required shall be provided.

4.03.04 The ends of Pipe and welded fittings shall be bevelled according to details shown in the relevant piping code. All welding shall be made in such a manner that complete fusion and penetration are obtained without an excessive amount of filler metal beyond root area. The reinforcement shall be applied in such a manner that it shall have a smooth contour merging gradually with the surface of adjacent pipe and welded fittings. Backing rings shall not be used on any pipe welds, unless otherwise approved by the Engineer.

4.03.05 Cutting and Bevelling

a) Carbon steel piping - End preparation for butt welding shall be done by machining/flame cutting.

b) Socket welding - Socket weld and preparation shall be done by saw or machine cutting.

4.04.00 **Hangers, Supports, Anchors**

Normally pipe supports and anchors shall be selected at those points in the buildings where provision has been made for the loads imposed. The cutting of floor/roof beams or the reinforcement in slabs will not be permitted. Piping attached to a plant item shall be supported in such a way that the weight of the piping is not taken by the plant item.

4.04.01 Support spacing shall be as per good engineering practice. However in no case it shall be less than support spacing stipulated in ANSI B31.1.

4.04.02 Accurate weight balance calculations shall be made to determine the required supporting force at each hanger location and the pipe weight load at each equipment connection.

4.04.03 All large pipes and all long pipes shall have at least two supports each arranged so that any length of pipe or valve may be removed without any additional supports being required.

4.04.04 Support steel shall be of structural quality. Perforated strap, wire or chain shall not be used. Support components shall be connected to support steel by welding, by bolting or by beam clamps. Bolt holes shall be drilled not burned. Support components may be bolted to concrete using approved concrete anchors.

4.05.00 **Valves and Accessories**

4.05.01 General Requirements

a) All valves shall be of approved make and type and shall have cast/forged bodies with covers and glands of approved construction and materials as specified in Annexure-II & III. In general all pumps (other than sump pumps), discharge valves shall be motor operated only. Tank inlet valves shall be motor operated only.

b) Valves and specialties to be supplied under this specification will be used for various air and water services and will be located indoor/outdoor and on horizontal/vertical runs of the pipelines. However, mounting of valves in vertical pipe runs should be avoided as far as possible.

c) All valves shall, unless otherwise stated, have the internal diameter same/as the internal diameter of the pipes to be joined.

d) All valves shall receive tests at manufacturer's or contractor's works in accordance with the specific requirements of the approved Codes of Practice. Valves shall be rising stem or otherwise as approved by the Purchaser.

e) Gate valve and Ball valve have been specified with the intention of achieving isolation and tight shut-off. In full open condition, these valves should offer minimum of resistance to fluid flow.

f) Globe valves have been specified with the intention of achieving good control of fluid passing. The plug and seat will have therefore suitable profiles for obtaining such controlling action.

g) Check valves have been specified in order to prevent reverse flow through them.

h) All valves shall function smoothly without sticking, rubbing or vibration on opening or closing and shall be suitable for most stringent service conditions i.e. flow, temperature and pressure under which they may be required to operate.

i) Material, design, manufacture, testing etc. for all valves and specialties along with the accessories shall conform to the latest editions of codes.

j) By pass valves shall be provided for larger size valves as per standards followed and as felt necessary for smooth and easy operation, even though not specifically mentioned in the specification.

k) All flanged valves and specialties to be supplied under this section shall be provided with two (2) counter flanges, bolts, nuts, washers, gaskets etc.

l) All valves shall be of approved design and manufacture. Where valves are of similar size and type they shall be interchangeable with one another. Valves shall have welded or flanged connections subject to the Purchaser's approval.

m) All valves shall have outside screwed spindles and screwed thread of spindle shall not pass through or into the stuffing box. Where valves are exposed to the weather, protective covers shall be provided for the spindles, which shall be subject to approval.

n) Gate, Globe and Ball valves shall be provided with the following accessories in addition to other standard items:

   i) Hand wheel with embossed open and shut directions.
   ii) Local position indicator.
   iii) Motorised operation as specified by Engineer.

o) Gate valves, in addition shall be provided with following extra features

   i) Bypass valve for larger valves

   ii) Draining arrangement

   iii) Enclosed Gear operators for valves 300 mm size and above for ease in operation.

   iv) Motorised operation as specified by Engineer.

p) All gate and globe valves shall be rising stem type.

q) All valves shall be provided with hand-wheels, chain, operator, extended spindle and floor stand wherever required so that they can be operated manually by a single operator from the nearest operating floor either at a lower or higher elevation as the case may be. If such a valve is provided with integral bypass then similar arrangement shall be done for the bypass valve also.

r) All valves and specialties shall be provided with brass Tag Discs indicating Tag numbers and nomenclature of the valve including duty or service intended and the function of the valves specialties.

s) Stems shall preferably be arranged vertically with gland at the top, however, in no circumstances must the stem be inclined downward from horizontal or gland be at the bottom. Globe valves shall be installed with the pressure under the disc. Valves shall not be fitted in inverted position.

t) Where necessary, for accessibility, grease nipples shall be fitted at the end of extension piping and where possible these shall be grouped together and mounted on a common panel situated at a convenient position. A separate nipple shall be provided to lubricate each point. The Bidder shall supply the first fill of oil or grease for these parts. The Bidder shall supply a suitable manually operated grease gun for the standard type of nipple provided.

u) The spindles for all valves for use outside the building shall have weatherproof protection covers of approved construction.

v) All valves shall be fitted with indicators so that it may be readily seen whether the valves are open or shut. In the case of those valves fitted with extended spindles, indicators shall be fitted both to the extended spindles and to the valve spindles.

w) Plastic or bakelite valve hand wheels will not be accepted.

x) All valves shall be closed by rotating the hand wheel in a clockwise direction when looking at the faces of the hand wheel. The face of each hand wheel shall be clearly marked with the words 'Open' and 'Shut' with arrows adjacent to indicate the direction of rotation to which each refers.

y) Wherever practicable heavy valves of total weight including actuator, drive motor, integral by-pass etc., equal to or greater than 500 kg. shall be provided with suitable lugs to permit direct suspension by hanger rod or direct resting on bottom support, as applicable.

z) Special attention shall be given to the operating mechanism for large size valves in order that quick and easy operation is obtained and maintenance is kept to a minimum.

aa) Eyebolts shall be provided where necessary to facilitate handling heavy valves or parts of valves.

bb) The Bidder shall supply with his bid and in addition during the course of the Contract, comprehensive drawings showing the design of valves, test pressure and working pressure/temperatures. They should include a parts list referring to the various materials used in the valve construction.

cc) All sampling and root valves shall be of integral body bonnet type.

4.05.02 For Design Requirements for different valves refer Annexure-II & III.

4.06.00 **Safety/Relief Valves**

Safety/Relief valves shall be of direct spring loaded type and shall have a tight, positive and precision closing.

All safety valves shall be provided with manual lifting lever.

Valves used for air and any other compressive fluid shall be of pop type.

Safety/Relief valves shall be constructed and adjusted to permit the fluid to escape without increasing the pressure beyond 10% above the set blow off pressure. Valve shall reset at a pressure not less than 2.5% and more than 5% of the set pressure.

Releasing capacity of the safety/relief valves shall be as per the applicable codes and standards and shall be subject to the approval of the Engineer.

The seat and disk of safety valves shall be of suitable material to resist erosion. The seat of valve shall be fastened to the body of the valve in such a way that there is no possibility of the seat lifting.

4.07.00 **Hosepipe and Accessories**

4.07.01 Hose valves for service water system shall be Gate valves and service air system shall be Globe valves.

4.07.02 Hose pipes with fittings for Service Water System:

a) The water hose shall be as per IS-444 (Type-3).

b) Length of each hose shall be 15 metres.

c) For each hose, one end shall be fitted with M.S. female coupling with swiveling nuts and soft seating ring suitable for connection to male end of hose valve and other end shall be made threaded for joining with the swiveling nut of a second hose whereby two hose lengths may be joined.

4.07.03 Hose pipes with fittings for Compressed air System

a) The compressed air hose shall be as per IS-911 (Type 2).

b) The length and type of each end shall be similar to as specified in above clause no. (4.07.02) above.

5.00.00 **DRAWINGS, DATA, INFORMATION & MANUALS**

5.01.00 Drawings, data, Information to be furnished by the Bidder besides those already mentioned in volume : IIA with the offer.

5.01.01 A complete list of all piping and fittings of various sizes with their quantities and details e.g. nominal size, O.D., I.D. (as applicable) thickness, design pressure, design temperature, material of construction/code/standards etc.

5.01.02 A complete list of all valves with their type, quantities & ratings.

5.01.03 Manufacturer's catalogue indicating complete range of available size and rating of pipes & fittings.

5.01.04 Descriptive literature on the manufacturing process and quality control procedures highlighting the manufacturing, fabricating and testing facilities available in the shop.

5.02.00 **After Award of Contract**

Detail drawings including fabrication drawings of all shop fabricated piping system indicating design parameters and complete bill of material (Relevant Standards and grades to be indicated) and information/data pertaining to the hydrostatic and non-destructive test requirements to be submitted progressively.

5.02.01 Detail dimensioned drawing of each valve, specialties, indicating tag no., pressure rating, manufacturing standard, the bill of materials and hydrostatic test pressures. The drawing shall include the end preparation details and shall indicate the position of the hand wheel/operator. Technical particulars of motor operators wherever applicable shall also be indicated.

5.02.02 General arrangement drawing for each hanger/support/anchor etc. indicating identification number, auxiliary supporting structural details, other details & information as required in the specification.

5.02.03 Wiring diagram for all limit switches of motor operated valves.

5.02.04 The loading data required for design of structures shall be furnished well in advance to suit Purchaser's time schedule.

6.00.00 **BROAD GUIDELINES FOR ERECTION AND INSTALLATION OF LP PIPING**

6.01.00 All fittings like "T" pieces, flanges, reducers etc. shall be suitably matched with pipes for welding. The valves will have to be checked, cleaned or overhauled in full or in part before erection, after chemical cleaning and during commissioning.

6.02.00 Adjustments like removal of oval ties in pipes and opening or closing the fabricated bends of high pressure piping to suit the layout shall be considered

part of work and is required to carry out such work as per instruction of Owner, which shall include specified heat-treatment procedures, etc. also wherever required.

6.03.00 Certain adjustments in length may be necessary while erecting high pressure pipelines and the contractor should remove the extra lengths to suit the final layout after preparing edges afresh and adopting specified heat treatment procedures.

6.04.00 Suspension for piping, pressure parts, etc., will be supplied in running lengths, which shall be cut to suitable sizes and adjusted as required.

6.05.00 All the valves, lifting equipments, actuators, power cylinders, etc., shall be serviced and lubricated to the satisfaction of Engineer before erecting the same and also during pre-commissioning. Even after commissioning, the equipments, if there are problems in the operation, they have to be attended to by the Bidder during the tenure of the contract. Welding or jointing of extension spindle for valves to suit the site conditions and operational facility shall be part of erection work.

6.06.00 All tubes and pipes shall be cleaned and blown with compressed air and shown to the engineer before lifting. Bigger size pipes should be cleaned with flexible wire brush, wherever necessary. After cleaning is over the end caps shall be put back in tube openings till such time they are welded to other tubes.

6.07.00 Fine fittings, drain piping, oil systems & other small bore piping have to be routed according to site conditions and hence shall be done only in position. As such, layout of small-bore piping shall be done as per site requirement. There is a possibility of slight change in routing the above pipelines even after completion of erection, which shall be carried out by the Bidder without any extra cost to the Purchaser. Work shall also include fabrication of small bends at site from straight lengths to suit the site conditions.

6.08.00 No temporary supports shall be welded on the pressure parts. Welding of temporary supports, cleats, etc., on the building columns shall also be avoided. In case of absolute necessity, Contractor shall take prior approval from Engineer. Further, any cutting or alteration of member of the structure or platform or other equipments shall not be done without specific prior approval of Engineer.

6.9.00

a) All piping shall be grouped wherever practicable and shall be routed to present a neat appearance.

b) The piping shall be arranged to provide clearance for the removal of equipment for maintenance and for easy access to valves, instruments and other piping accessories required for operational maintenance.

c) Piping shall be routed above ground unless otherwise specifically indicated/ approved by the Engineer. In such special case, the piping may be arranged in trenches, or buried and properly protected as per AWWA Standards.

d) Overhead piping shall have a minimum overhead clearance of 4 meters above walkways and working areas and 7 meters above roadways unless otherwise approved by the Engineer.

e) Drains shall be provided at all low points and vents at high points as per actual layout regardless of whether some have been shown in respective drawings or not. The pipelines shall be sloped towards the drain points.

6.10.00 All drips and drains for piping and equipment whether shown in the drawings or not shall terminate on the ground floor up to station drain unless otherwise specified. Leading such drains up to station drainage is also the responsibility of the Contractor.

ANNEXURE-I

SPECIFICATION OF PIPES FOR DIFFERENT SERVICES

	A		B		C	D
Services	1. Clarified Water piping 2. DMCW piping		1. Drinking/ Potable Water Supply, piping (Clarified water, chlorinated)		1. Demineralised Water, Service and Instrument Air Piping less than and equal to 50 mm NB	1. Demineralised Water, Service and Instrument air piping for sizes equal to greater than 65 mm NB
1.00.00 Material of Pipe	Carbon Steel IS-1239 Heavy Grade upto 150 mm NB and IS-3589 for sizes above 150 mm with minimum pipe thickness of 6 mm.		Carbon Steel as per IS-1239 Heavy Grade for sizes upto 150 mm NB and IS-3589 for sizes above 150 mm NB with minimum pipe thickness of 6 mm. The pipes shall be galvanized as per IS-4736		Stainless Steel as per ASTM A-312 Gr. 304. Size- as per schedule 40 ANSI B36.10	Stainless steel as per ASTM A-312 Gr. 304. Size-upto 150 mm NB as per schedule 10S, ANSI B-36.10.
2.00.00 Construction	ERW / Seamless		ERW / Seamless		ERW	ERW
3.00.00 Joints	Slip-on Flange and butt weld for size 65 mm NB and above and Socket weld joint for size 50 mm NB and below.		Screwed flange for sizes 65 mm NB and above and screwed socket for size 50 mm NB and below.		Socket welded for size 50 NB and below	Slip-on flange and butt weld joint.
4.00.00 Fittings	Pipe Sizes > = 65 mm NB	Pipe Sizes < = 50 mm NB	Pipe Sizes > = 65 mm NB	Pipe Sizes < = 50 mm NB		

	A		B		C	D
Services	1. Clarified Water piping 2. DMCW piping		1. Drinking/ Potable Water Supply, piping (Clarified water, chlorinated)		1. Demineralised Water, Service and Instrument Air Piping less than and equal to 50 mm NB	1. Demineralised Water, Service and Instrument air piping for sizes equal to greater than 65 mm NB
4.01.00 Materials	ASTM-A-234 Gr. WPB	ASTM-A-105	ASTM-A-234 Gr. WPB galvanized as per IS-4736	ASTM-A-105 galvanised as per IS-4736	ASTM-A-182 F304	ASTM-A-351-CF8
4.02.00 Construction	Welded/ Seamless	Forged	Welded/ Seamless	Forged	Forged	Welded/Seamless
4.03.00 Standard	ANSI-B-16.9 for fabricated fitting AWWA-C-208	ANSI-B-16.11	ANSI-B-16.9	ANSI-B-16.11	ANSI-B-16.11	MSS-SP-43
4.04.00 End details	Pipe size >=65mm NB Butt welded as per ANSI-B-16.25	Pipe size <=50 mm NB Socket welded as per ANSI-B-16.11	Pipe size >=65 mm NB Screwed Flanged	Sizes <=50 mm Screwed socketed as per ANSI-B-16.11All fittings shall be galvanized.	Socket welded	Slip - on flanges

	A	B	C	D
Services	1. Clarified Water piping 2. DMCW piping	1. Drinking/ Potable Water Supply, piping (Clarified water, chlorinated)	1. Demineralised Water, Service and Instrument Air Piping less than and equal to 50 mm NB	1. Demineralised Water, Service and Instrument air piping for sizes equal to greater than 65 mm NB
5.00.00 Flanges	150 lb class as per ANSI-B-16.5 complete with nuts, bolts and gaskets	As per ANSI-B-16.5 pressure class 150lbs - galvanised-complete with nuts, bolts and gaskets.	As per ANSI-B-16.5 pressure class 150lb complete with nuts, bolts and gaskets. Material as per class 4.01.00.	150lb class, flat face, as per ANSI-B-16.5 complete with nuts, bolts and gaskets.
Pipes which fall under IS:1239 shall be hydrostatically tested according to the said code, for others refer Section-V, Vol.: II-A.				

ANNEXURE-II

SERVICES OF VARIOUS CATEGORIES OF VALVES

Valve Classification		Service		
A.	Cast iron body Gate/Globe/Check Valve	i) ii) iii) iv)	Service Water Clarified Water Drinking/ Potable Water Inhibited Demineralised Water	For sizes 65mm NB and above.
B.	Stainless steel body/ Gate/Globe /Check/Ball Valve	i) ii) iii)	For Demineralised water Potable/ Drinking Water Service and Instrument Air	For all sizes For sizes less than and equal to 50 mm NB For all sizes. Ball valves to be used in air line.
C.	Steel Body valves	i) ii)	Clarified Water Inhibited Demineralised Water for DMCW system	For sizes less than and equal to 50 mm NB
D.	Cast Iron body butterfly valve	i) ii) iii) iv) v)	For Demineralised Water Raw water Clarified Water Filtered Water Inhibited Demineralised Water for DMCW system	For butterfly valve specification refer Annexure II, Sec.IV of Vol. IIIE. For DM water line rubber lining/ EPDM/equivalent protection to be provided

ANNEXURE-III

SPECIFICATION OF VALVES

		A. Cast Iron Body Gate/ Globe/Check Valve	B. Stainless steel Body Gate/Globe/Check/Ball Valve	C. Steel Body Gate/ Globe/Check Valve/ Ball Valve
1.00.00	Valve Classification Code	CIGC	SSGC	STGC
2.00.00	Basic Design Code			
	a) Gate	a) i) IS 780 for 50 mm - 300 mm NB ii) IS2906 for 350 mm NB and above or as per MSS-SP-70	a, b, c) ANSI-B-16.34	i) API 600 for 50mm ii) API 602 for size
	b) Globe	b) MSS - SP - 85		b) BS-1873/ANSI-B-16.34
	c) Check	c) IS-5312/MSS - SP -71		c) BS-1868/ANSI B16.34
	d) Ball		d) BS-5351	
3.00.00	Pressure Class	To be suitably chosen considering the pressure requirement. Refer Clause No. 4.01.08 in this regard.		
4.00.00	Construction	Cast body and bonnet / cover	Forged body up to 50mm NB and Cast body above that	Same as Group-B
5.00.00	Material			
5.01.00	Body & Bonnet/ cover	IS 210 Gr. FG 260	ASTM-A-182 F304 for Ball Valves: A351 CF8M for cast body, A 182 F304 for forged body.	ASTM-A-216 Gr. WCB for cast body & ASTM-A-105 for forged body

		A. Cast Iron Body Gate/ Globe/Check Valve	B. Stainless steel Body Gate/Globe/Check/Ball Valve	C. Steel Body Gate/ Globe/Check Valve/ Ball Valve
5.02.00	Trim / Disc.	IS-210 Gr. FG 260	ASTM-A-182 F304 for Gate, Globe, Check valves and 351CF 8M for Ball valves. For DKW system : ASTM-A-182 F6A (min. 250 HB)	13% Cr Steel as per ASTM-A-182 Gr. F6 heat treated and hardened(min 250 NB) for cast body and ASTM-A-105 Hard faced with Stellite (min 350 HB) for forged body
5.03.00	Seating surface	13% Cr steel as per IS 1570	For Ball valves PTFE seats and seals.	13% Cr. Steel as per ASTM-A-182 Gr. F6
6.00.00	End Preparation	Socket welded for size equal to and below 50mm NB and flanged with counter flanges for 65mm NB and above.		
7.00.00	Testing			
	a) Gate	i) As per IS - 780 for 50 mm - 300 mm NB		API-598
		ii) IS-2906 for sizes equal to and above 350 mm NB	As per ANSI B-16.34	
	b) Globe	Hydrostatic Test as per MSS-SP-85		BS-1873
	c) Check	IS-5312/MSS-SP-71		BS--1868

GENERAL TECHNICAL REQUIREMENT (ELECTRICAL)

1.0 This document covers the basic technical features of low tension (LT) squirrel cage induction AC motors employed for driving auxiliaries of BHEL-PEM scope packages in **5 x 800 MW YADRADRI TPS.**

2.0 CODES AND STANDARDS

All motors shall conform to the latest applicable standards as listed below;

1) Three phase induction motors: IS: 12615, IEC: 60034
2) Single phase AC motors: IS: 996, IEC: 60034
3) Crane duty motors: IS: 3177, IEC: 60034
4) Energy Efficient motors: IS 12615 or IEC: 60034-30 with Efficiency class IE3

3.0 DESIGN REQUIREMENTS

3.1 **Service Conditions**

The motors will be installed in hot, humid and tropical atmosphere highly polluted at places with coal dust and/or fly ash. For motor installed outdoor and exposed to direct sunrays, the effect of solar heat shall be considered in the determination of the design ambient temperature.
The design ambient temperature shall be 50 deg C.

3.2 Supply system and rated voltage of motors

KW rating	Supply system	Rated voltage of motor
Upto 0.2 kW	240V/415 V	240V415 V
Above 0.2 kW & up to 175kW	415 V	415 V

3.2.1 Supply voltage & variations shall be as follows:-

Voltage variation (AC Supply): (+/-) 10%
Frequency variation : (+) 3% to (-) 5%
Combined V & F variation : 10% (sum of absolute values)

During starting of large motor, the voltage may dr op to 80% of the rated voltage for a period of 60 seconds. All electrical equipment while running s hall successfully ride over such period without affecting system performance.

3.2.2 Motors shall be capable of running continuously at rated output for each of the conditions specified.

3.3 **Motor Rating**

All motors shall be rated for continuous duty. They shall also be suitable for long period of inactivity. LT motor rating at 50 degree C shall have at least 15% margin over the input power requirement of the driven equipment at rated duty point unless stated otherwise in driven equipment specification. The motor characteristics shall match the requirements of the driven equipment so that adequate starting, accelerating, pull up, break down and full load torques are available for the intended service.

3.4 **Starting Requirements**

3.4.1 Motor shall start smoothly and rapidly. Motor characteristics such as speed, starting torque, break away torque and starting time shall be properly co-ordinat ed with the requirements of driven equipment. The

accelerating torque at any speed with the minimum starting voltage shall be at least 10% higher than that of the driven equipment.

3.4.2 Motors shall be capable of starting and accelera ting the load with direct on line starting without exceeding acceptable winding temperature.

The limiting value of voltage at rated frequenc y under which a motor will successfully start and accelerate to rated speed with load shall be taken to be a constant value of 85 (eighty five) percent rated voltage.

3.4.3 Continuous duty LT motors up to 175 KW Output rati ng (at 50 deg. C ambient temperature), shall be Premium efficiency (IE3) as per IEC: 60034-30/ IS: 12615 and the locked rotor current of motors shall as per IS 12615.
However, as per system requirement drives ra ted in the range of 160-210 KW may be considered in either 415V or 3.3 KV

3.4.4 Pump motor subject to reverse rotation shall be designed to withstand the stresses encountered when starting with shaft rotating at 125% rated speed in reverse direction. The motors shall be designed to withstand 120% of rated speed for 2 minutes without any mechanical damage.

3.4.5 The following frequency of starts shall apply

i) Three cold starts in succession with the motor being initially at a temperature not exceeding the ambient temperature.

ii) Two hot starts in succession with the motor being initially at a tem perature not exceeding the rated load temperature.

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

3.4.6 Locked motor withstand time of hot motors at 110% rated voltage shall be as follows:

a) For motors with starting time upto 20 sec.

- at least 3 sec. more than starting time.

b) For motor with starting time above 20 secs but not exceeding 45 secs.

- at least 5.0 sec. more than starting time.

c) For motors with starting time above 45 secs.

- at least 10%. more than starting time.

The starting time of the motor referred above is at minimum permissible voltage. Wherever the above requirements are not complied with, speed switches of approved make & type shall be provided to bypass the locked rotor protection for a pre-selected time during starting of motors. The speed switches shall have one NO & one NC contacts having maximum interrupting capacity of 5 Amps at 240V AC and 0.25 amps at 220 V DC.
Hot thermal withstand curve shall have a margin of at least 10% over the full load current of the motor to permit relay setting utilising motor rated capacity.

3.5 **Running Requirements**

3.5.1 Motor shall run continuously at rated output over the entire range of voltage and frequency variations as given above.

3.5.2 The motor shall be capable of operating satisfactorily at full load for 5 minutes without injurious heating with 75% rated voltage at motor terminals.

3.5.3 The motor shall be designed to withstand momentary overload of 60% of full load torque for 15 second without any damage.

3.6 **Stress during bus Transfer**

3.6.1 The motor may be subjected to sudden application of 150% rated voltage during bus transfer, due to the phase difference between the incoming voltage and motor residual voltage.

3.6.2 The motor shall be designed to withstand any torsional and/or high current stresses, which may result, without experiencing any deterioration in the normal life and performance characteristics.

4.0 SPECIFIC REQUIREMENTS

4.1 **Enclosure**

All motor enclosures for outdoor, semi-outdoor & indoor application shall conform to the degree of protection IP-55 unless otherwise specified. Motor for outdoor or semi-outdoor service shall be of weather-proof construction with canopy. For hazardous area approved type of increased safety enclosure shall be furnished.

4.2 **Cooling**

4.2.1 The motor shall be self-ventilated type, either totally enclosed fan cooled IC 411(TEFC), totally enclosed tube ventilated IC 511(TETV) or closed air circuit air- cooled IC 611(CACA).

4.3 **Winding and Insulation**

All insulated winding shall be of copper. All motors shall have class F insulation but limited to class B temperature rise. Windings shall be impregnated to make them non-hygroscopic and oil resistant.

Tropical Protection

All motors shall have fungus protection involving special treatment of insulation and metal against fungus, insects and corrosion.

All fittings and hardware shall be corrosion resistant.

4.4 **Bearings**

4.4.1 Motor shall be provided with antifriction bearings, unless sleeve bearings are required by the motor application. Bearings shall be rated for minimum service life of 40,000Hrs.

4.4.2 Vertical shaft motors shall be provided with thrust and guide bearings. Thrust bearing of tilting pad type is preferred.

4.4.3 Bearings shall be provided with seals to prevent leakage of lubricant or entrance of foreign matters like dirt, water etc. into the bearing area.

4.4.4 Sleeve bearings shall be split type, ring oiled, with permanently aligned, close running shaft sleeves.

4.4.5 Grease lubricated bearings shall be pre-lubricated and shall have provisions for in-service positive lubrication with drains to guard against over lubrication. LT motors 15kW and above shall be provided with external greasing arrangement.

4.4.6 Oiled bearing shall have an integral self-cooled oil reservoir with oil ring inspection ports, oil sight glass with oil level marked for standstill and running conditions and oil fill and drain plugs.

4.4.7 Forced lubricated or water cooled bearing shall be used as per requirement.

4.4.8 Lubricant shall not deteriorate under all service conditions. The lubricant shall be limited to normally available types with IOC equivalent.

4.4.9 Bearings shall be insulated as required to prevent shaft current and resultant bearing damage.

4.5 **Noise & Vibration**

4.5.1 For 415V motors, maximum double amplitude vibrations upto 1500 rpm shall be 40 microns and 15 microns upto 3000 rpm.

4.5.2 The noise level shall not exceed 85db (A) at 1.5 meters from the motor.

4.6 **Motor Terminal Box**

4.6.1 Motor terminal box shall be detachable type and located in accordance with Indian Standards clearing the motor base- plate/ foundation

4.6.2 Terminal box shall be capable of being turned 360 deg in steps of 90 Deg. for LT motors unless otherwise approved.

4.6.3 The terminal box shall be split type with removable cover with access to connections and shall have the same degree of protection as motor.

4.6.4 The terminal box shall have sufficient space inside for termination/connection of XLPE insulated armoured aluminium cables.

4.6.5 Terminals shall be stud or lead wire type, substantially constructed and thoroughly insulated from the frame.

4.6.6 The terminals shall be clearly identified by phase markings, with corresponding direction of rotation marked on the non-driving end of the motor.

4.6.7 The terminal box shall be capable of withstanding maximum system fault current for a duration of 0.25 sec.

4.6.8 Motor terminal box shall be furnished with suitable cable lugs and double compression brass glands to match with cable used.

4.6.9 The gland plate for single core cable shall be non-magnetic type. A suitable cable adopter box shall be provided if the cable size does not allow the direct termination in the main TB.

4.6.10 Minimum clearances to be provided between phase to phase and phase to earth shall be as under-

Voltage Rating of Motor Minimum Ph-Ph & Ph-Earth clearance
0.415 kV : 25 mm

Note: In case it is not possible to maintain these clearances, the live parts shall be totally insulated from earth and other Phases. Adequate clearances shall be provided for cable connections.

4.7 **Grounding**

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

4.8 **Rating Plate**

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

a) Temperature rise in Deg.C under rated condition and method of measurement.
b) Degree of protection.
c) Bearing identification no. and Type of lubrication, Quantity and frequency/ time interval
d) Location of insulated bearings.

5.0 ACCESSORIES

5.1 SPACE HEATERS

Motor of rating 30 kW and above shall be provided with space heaters, suitably located for easy removal or replacement. The space heater shall be rated 240 V, 1 Phase, 50Hz and sized to maintain the motor internal temperature above dew point when the motor is idle. The minimum cable size for space heater shall be 2.5 sq.mm copper cable.

5.2 DELETED

5.3 INDICATOR/ SWITCH

5.3.1 Dial type local indicator with alarm contacts shall be provided for the following:

Hot and cold air temperature of the closed air circuit for CACA motor.

5.3.2 Alarm switch contact rating shall be minimum 2.0 A at 220V D.C. and 10A at 240V A.C.

5.4 ACCESSORY TERMINAL BOX

5.4.1 All accessory equipment such as space heater, temperature detector, current transformers etc., shall be wired to and terminated in terminal boxes, separate from and independent of motor (power) terminal box.

5.4.2 Accessory terminal box shall be complete with double compression brass glands and pressure type terminals to suit owner's cable connections.

DRAIN PLUG

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

5.5 LIFTING PROVISIONS

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

5.6 DOWEL PINS

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

7.0 PAINTING

Colour scheme for motors shall be shade 631 of IS-5.

8.0 TESTING

8.1 Type Tests

For LT Motors, type test reports for type te sts as per IS: 12615/ IEC: 60034 conducted on equipment similar to those proposed to be supplied sha ll be submitted. The type Test should have been conducted within last 5 years from enquiry date.

8.2 Routine Tests

All motors shall be subjected to routine tests as per IS: 12615/ IEC: 60034 in the presence of customer or customer representative.

9.0 **Variable Frequency Drive motor details:**

i) The motor shall be suitable for operation with a solid-state power supply consisting of an adjustable frequency inverter for speed control.
ii) The motor shall be suitable for the current waveforms produced by the power supply including the harmonics generated by the drive.
iii) The Motor shall be designed to operate continuously at any speed over the range 20-100 % of rated speed.
iv) The permitted voltage variation should take into account the steady state voltage drop across the AC drive and all other system components upstream of the motor.
v) Motors required to be transferred to DOL, by-pass mode shall be rated for specified variations in system line voltage and frequency. Starting current of motor in DOL, bypass mode shall be limited to value in motor specifications.
vi) The motor shall be constructed to withstand torque pulsations resulting from harmonics generated by the solid-state power supply.
vii) The motor insulation shall be designed to accept the applied voltage waveform, within the Vpeak and dv/dt limits as per IEC-61800-4.
viii) The drive manufacturer shall be solely responsible for proper selection of the motor for the given load application and the output characteristics of the drive.

1.0	Design ambient temperature	:	50 ^{o}C
2.0	Maximum acceptable kW rating of LV motor	:	175 KW
3.0	Installation (Indoors/ Outdoors)	:	As required
4.0	Degree Of Protection	:	IP55
5.0	Details of supply system		
	a) Rated voltage (with variation)	:	240V, 415V $\pm$ 10%
	b) Rated frequency (with variation)	:	50 Hz (Variation: +3% TO –5%)
	c) Combined voltage & freq. variation	:	10% (sum of absolute values)
	d) System fault level at rated voltage	:	50 kA for 1 sec
	e) Short time rating for terminal box	:	50 kA for 0.25 sec
	f) LV System grounding	:	Solidly
6.0	Class of insulation	:	Class ‘F’,with temp rise limited to class B.
7.0	Minimum voltage for starting (As percentage of rated voltage)	:	80% of rated voltage
8.0	Power cables data	:	Shall be given during detailed engg.
9.0	Earth Conductor Size & Material	:	Shall be given during detailed engg.
10.0	Space heater supply (30KW & ABOVE)	:	240 V, 1Φ , 50 Hz
11.0	Rating up to which Single phase motor	:	Acceptable below 0.20 Kw
12.0	TYPE OF STARTER PROVIDED IN MCC	:	DOL
13.0	Locked rotor current		
	a) Limit as percentage of FLC	:	As per IS-12615
	b) Permissible tolerance, if any	:	As per IS-12615
14.0	Terminal box	:	Suitable to rotate at 90 degrees
15.0	Paint shade	:	Shade 631 of IS-5

	TITLE MOTOR DATA SHEET – C 5 X 800 MW YADADRI TPS	SPECIFICATION NO.
		VOLUME II B
		SECTION D
		REV NO. 00 DATE
		SHEET 1 OF 2

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

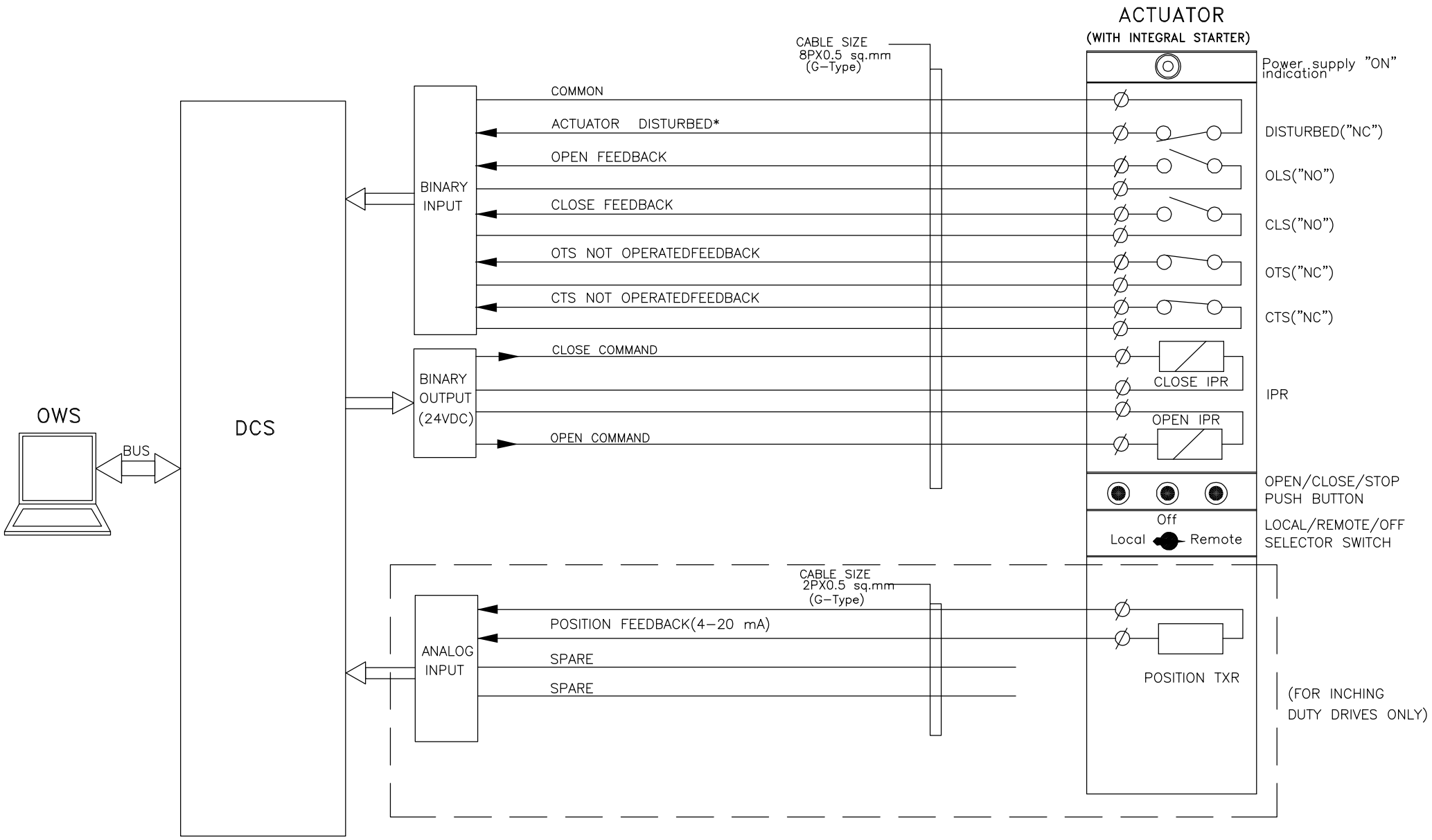
NAME OF VENDOR			SEAL	REV.	
NAME	SIGNATURE	DATE			

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

GENERAL TECHNICAL REQUIREMENT (CONTROL AND INSTRUMENTATION)

Drive Control Philosophy

DCS INTERFACE FOR BIDIRECTIONAL DRIVE (WITH INTEGRAL STARTER)

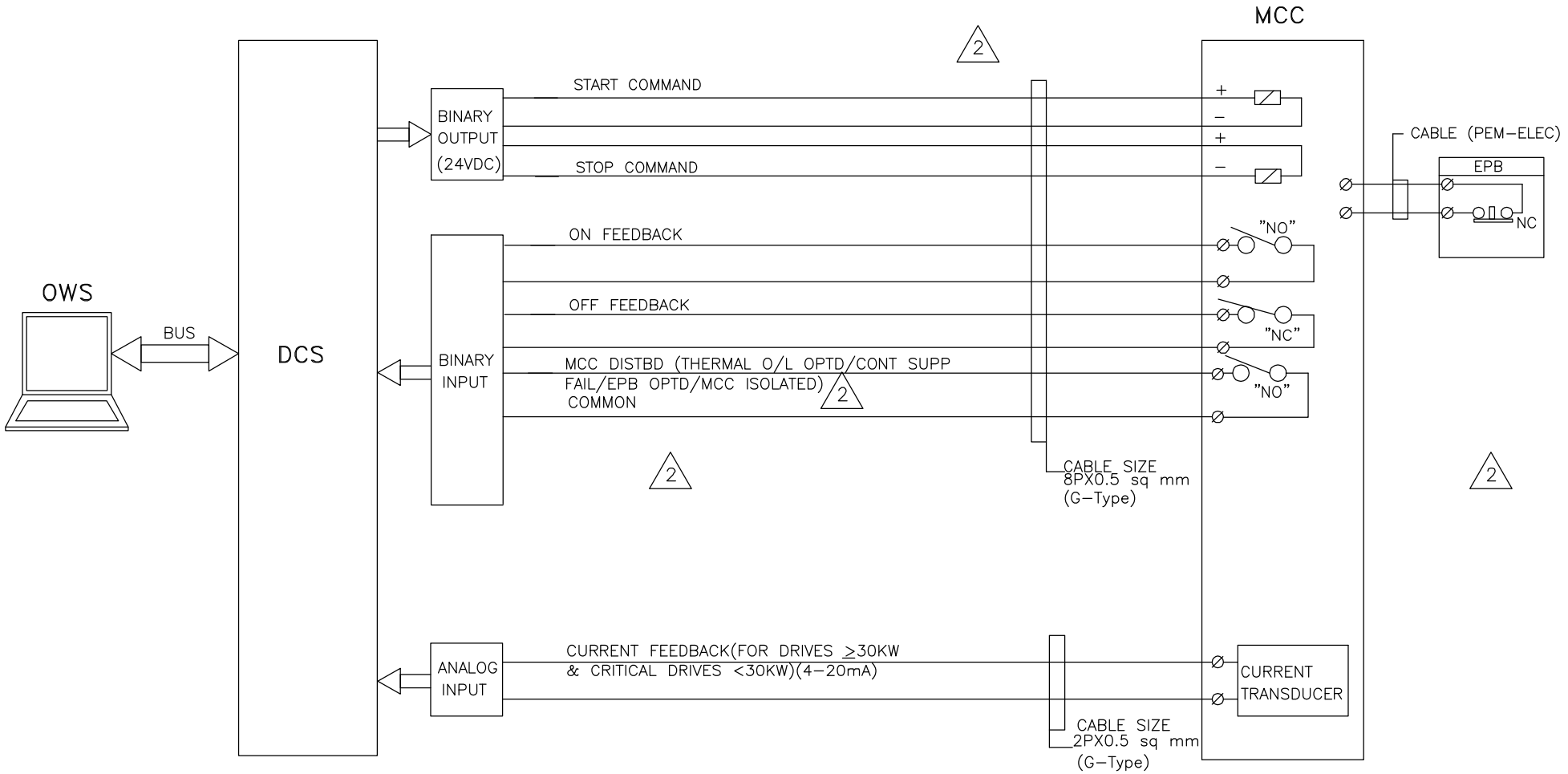


NOTE:

* 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 Stop PB optd.

PROJECT: 5X800 YADADRI THERMAL POWER STATION UNIT # 1 TO 5	DRG.NO.	PE-DM-417-145-I002
	DATE	06.12.2019
TITLE: DDCMIS INTERFACE FOR BIDIRECTIONAL DRIVE	REV.NO.	03
	SHT	7 OF 11

DCS INTERFACE FOR UNIDIRECTIONAL LT DRIVE



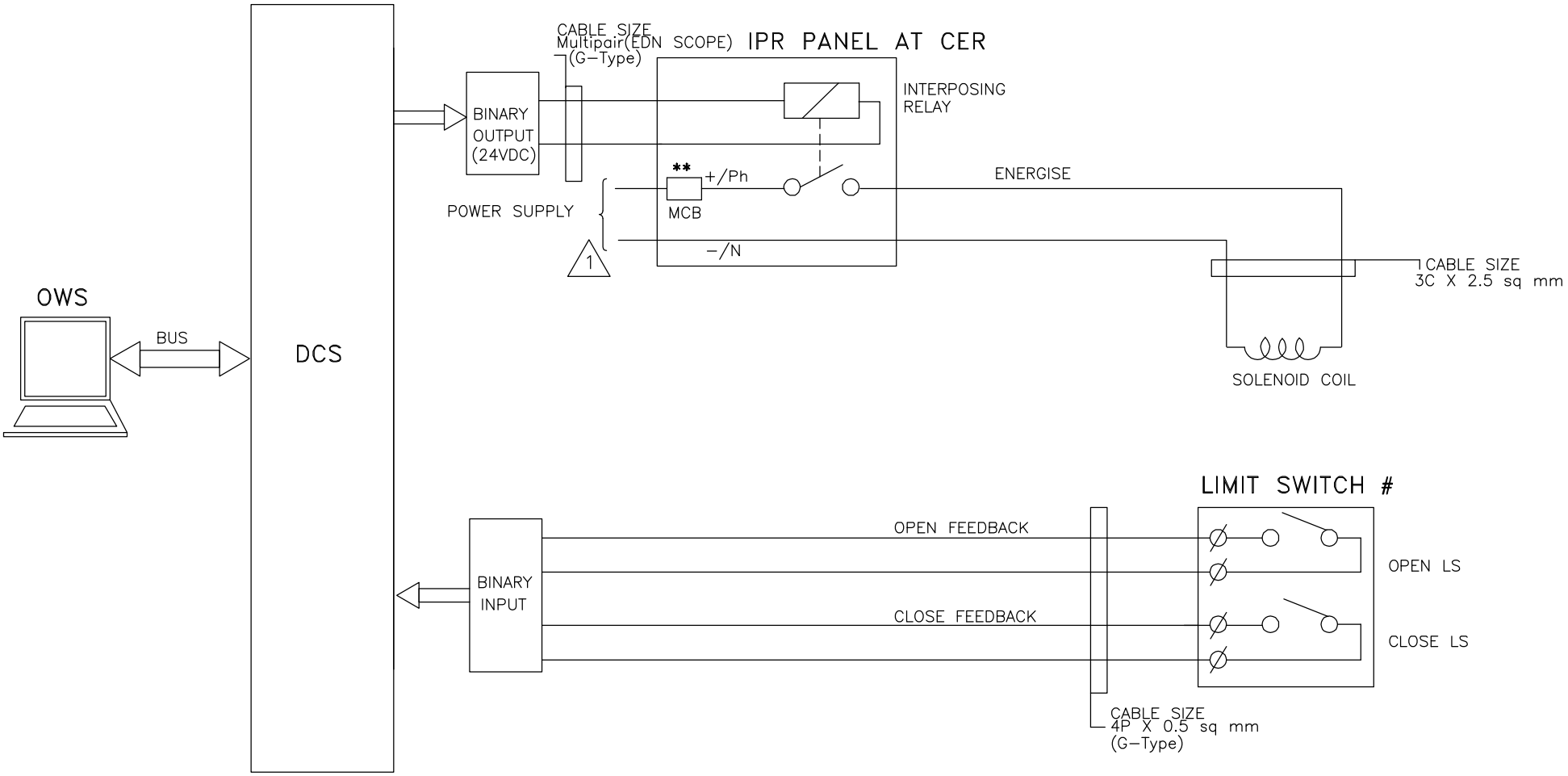
NOTE:–

1) EPB OF RESPECTIVE DRIVE WILL BE MOUNTED NEAR TO DRIVE ONLY. 1

2) 4–20mA CURRENT TRANSDUCER SHALL BE CONSIDERED. FOR LTUDs >30 KW AND IMPORTANT DRIVES, LUBE OIL PUMPS (REFER CLAUSE D, SHEET 6 OF 11) 2

BHEL	PROJECT: 5X800 YADADRI THERMAL POWER STATION UNIT # 1 TO 5	DRG.NO.	PE–DM–417–145–I002
		DATE	06.12.2019
	TITLE: DDCMIS INTERFACE FOR UNIDIRECTIONAL LT DRIVE	REV.NO.	03
		SHT	8 OF 11

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



NOTES:

** MCB SHALL BE PROVIDED FOR EACH SOLENOID

FOR ON/OFF TYPE, SOLENOID ACTUATED CONTROL VALVE.

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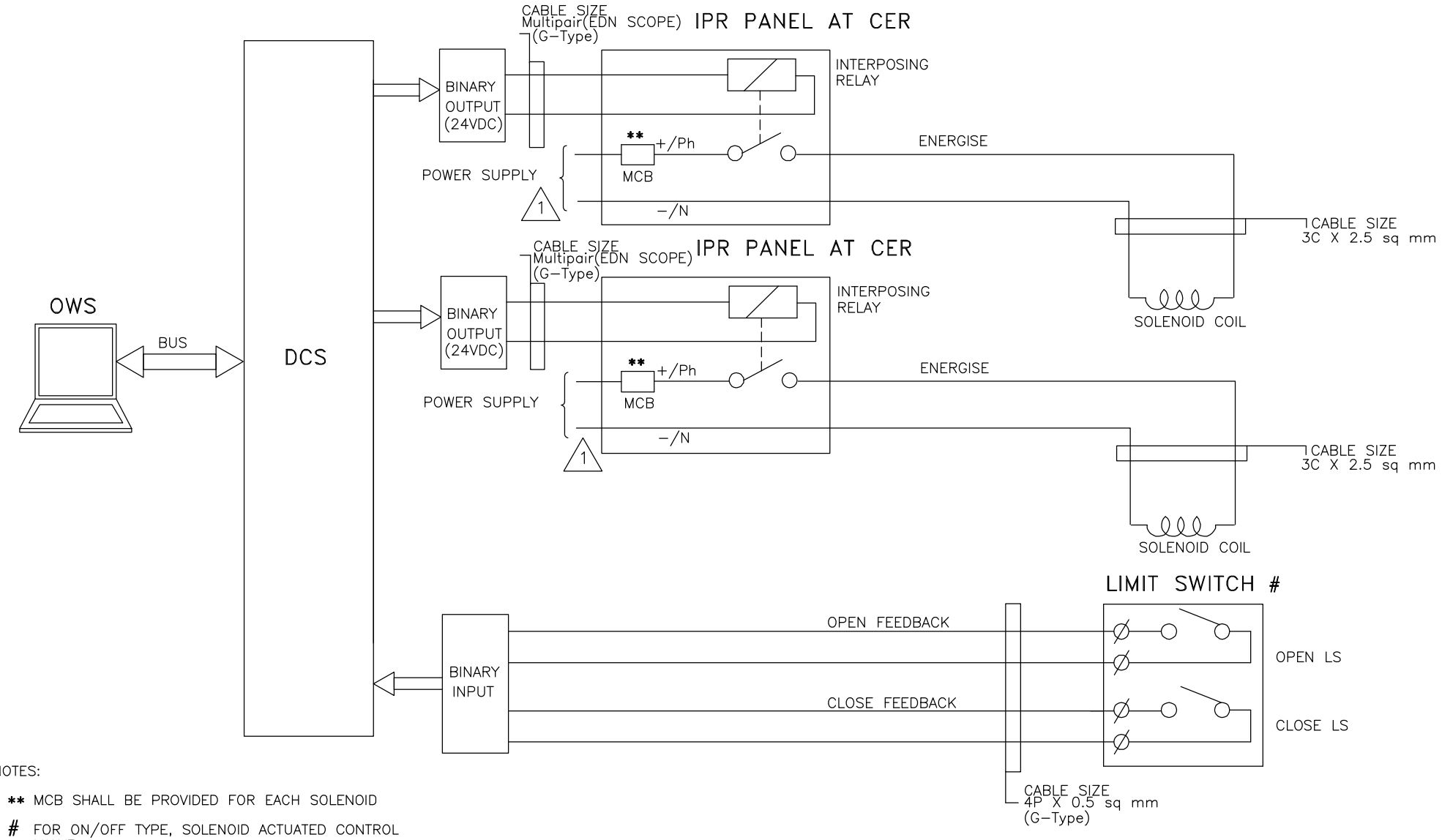
PROJECT: 5X800 YADADRI THERMAL POWER STATION UNIT # 1 TO 5	DRG.NO.	PE-DM-417-145-I002
	DATE	06.12.2019
TITLE: DDCMIS INTERFACE FOR SOLENOID DRIVE (SINGLE COIL)	REV.NO.	03
	SHT	9 OF 11

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



NOTES:

** MCB SHALL BE PROVIDED FOR EACH SOLENOID

FOR ON/OFF TYPE, SOLENOID ACTUATED CONTROL VALVE.

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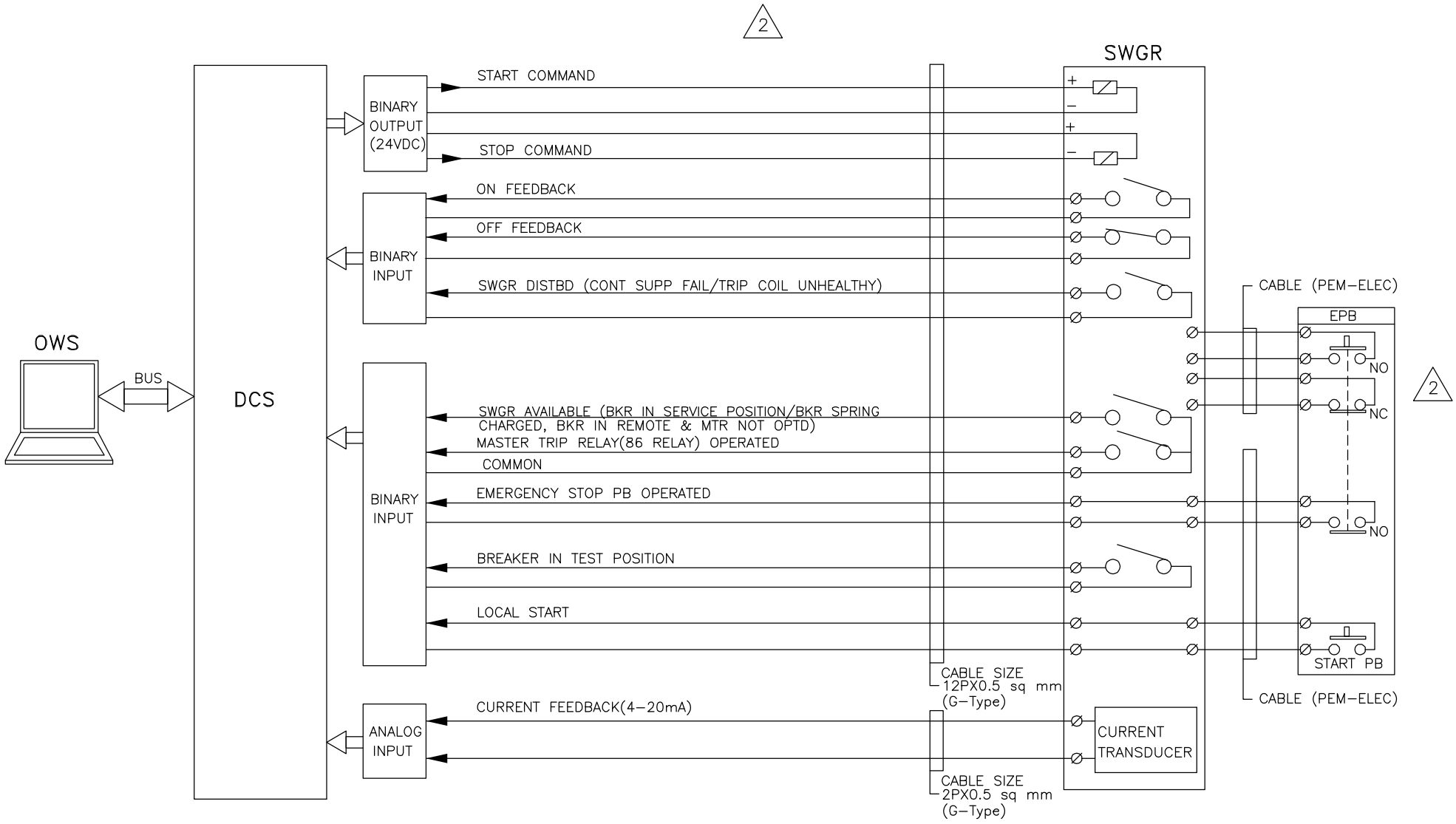
BHEL	PROJECT: 5X800 YADADRI THERMAL POWER STATION UNIT # 1 TO 5	DRG.NO. PE–DM–417–145–I002
		DATE 06.12.2019
	TITLE: DDCMIS INTERFACE FOR SOLENOID DRIVE (DOUBLE COIL)	REV.NO. 03
		SHT 9a OF 11

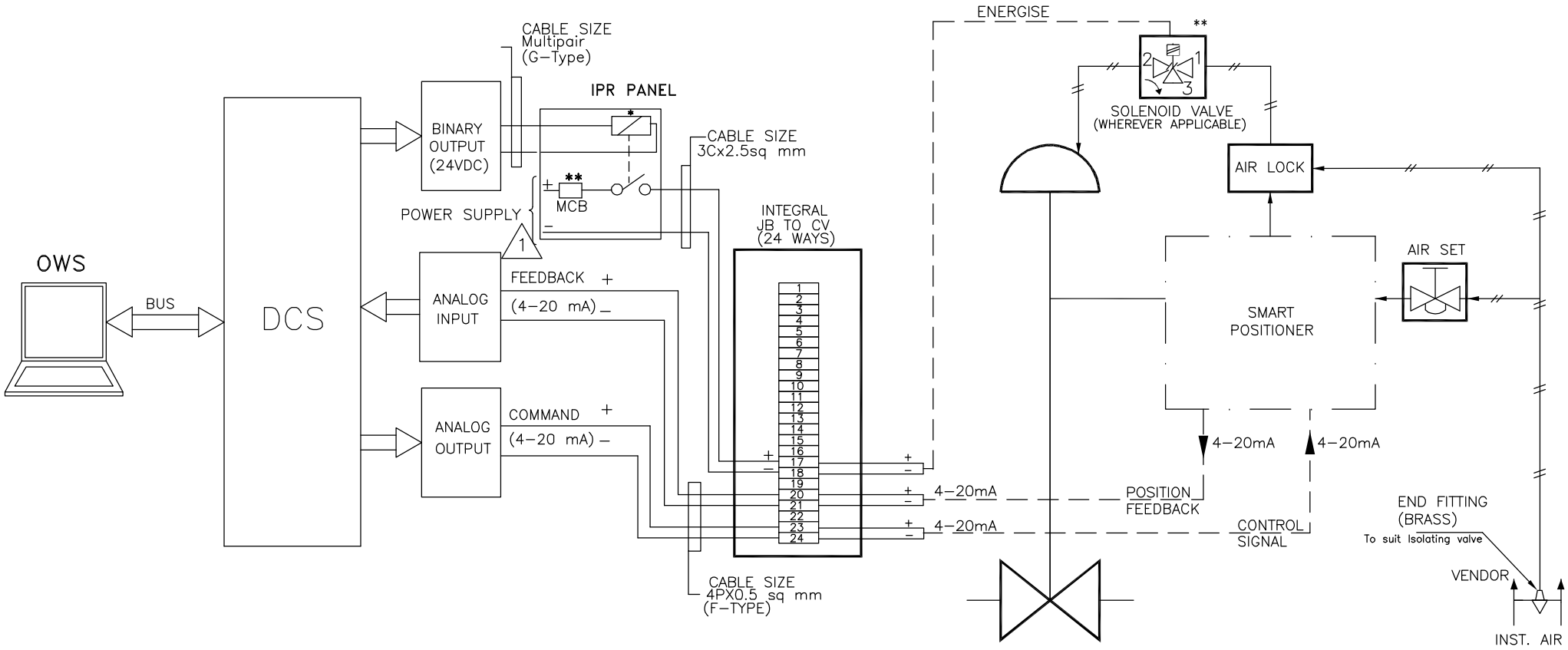
DCS INTERFACE FOR HT/LT UNIDIRECTIONAL DRIVES(BREAKER OPERATED)



NOTE:-
EPB OF RESPECTIVE DRIVE WILL BE MOUNTED NEAR TO DRIVE ONLY.
1

PROJECT: 5X800 YADADRI THERMAL POWER STATION UNIT # 1 TO 5	DRG.NO.	PE-DM-417-145-I002
	DATE	06.12.2019
TITLE: DDCMIS INTERFACE FOR UNIDIRECTIONAL HT DRIVE	REV.NO.	03
	SHT	10 OF 11

DCS INTERFACE FOR ANALOG DRIVE (WITH SMART POSITIONER)



NOTES:

** APPLICABLE TO VALVES WHERE PROTECTION OPEN/CLOSE ACTION FOR CONTROL DEMAND OVERRIDING IS REQUIRED.

PROJECT: 5X800 YADADRI THERMAL POWER STATION UNIT # 1 TO 5	DRG.NO.	PE–DM–417–145–I002
	DATE	06.12.2019
TITLE: TYPICAL HOOK–UP DIAGRAM ANALOG DRIVE (WITH SMART POSITIONER)	REV.NO.	03
	SHT	11 OF 11

ACTUATOR SPECIFICATION

VOLUME: V-A

SECTION-III

TECHNICAL SPECIFICATION FOR ELECTRIC MOTOR ACTUATORS

1.00.00 SCOPE

1.01.00 This Section covers the general requirements of Electric Motor Actuators for valves/dampers.

1.02.00 All electric motor actuators shall be furnished in accordance with this general specification and the accompanying driven equipment specification. All the electrical actuators shall be INTEGRAL type only.

2.00.00 STANDARDS

2.01.00 All electrical equipment shall conform to the latest applicable IS, ANSI and NEMA Standards, except when stated otherwise herein or in driven equipment specification.

2.02.00 Major standards, which shall be followed, are listed below. Other applicable Indian Standards for any component part even if not covered in the listed standards shall also be followed

i) IS -9334

ii) IS-325

3.00.00 SERVICE CONDITIONS

3.01.00 The actuator shall be suitable for operation in hot, humid and tropical atmosphere, highly polluted at places with coal dust and/or fly ash.

3.02.00 Unless otherwise noted, electrical equipment/system design shall be based on the service conditions and auxiliary power supply given in the general specification.

3.03.00 For actuator motor installed outdoor and exposed to direct sun rays, the effect of solar heat shall be considered in the determination of the design ambient temperature.

4.00.00 RATING

4.01.00 For isolating service, the actuator shall be rated for three successive open-close operation of the valve/damper or 15 minutes, whichever is longer.

4.02.00 For regulating service, the actuator shall be suitably time-rated for the duty cycle involved with necessary number of starts per hour, but in no case less than 150 starts per hour.

5.00.00 **PERFORMANCE**

The actuator shall meet the following performance requirements:

5.01.00 Open and close the valve completely and make leak-tight valve closu re without jamming.

5.02.00 Attain full speed operation before valve load is encountered and imparts an unseating blow to start the valve in motion (hammer blow effect).

5.03.00 Operate the valve st em at st andard stem speed and shall function against design differential pressure across the valve seat.

5.04.00 The motor reduction g earing shall be sufficient to lock the shaft when the motor is de-energised and prevent drift from torque switch spring pressure.

5.05.00 The entire mechanism shall withstand shock resulting from closing with improper setting of limit sw itches or from lodging of foreign matter und er the valve seat.

6.00.00 **SPECIFIC REQUIREMENT**

6.01.00 **Construction**

6.01.01 The actuator shall essentially comprise the drive motor, torque/ limit switches, gear train, clutch, hand wheel, position indicator/ transmitter, in-built thermostat for over load protection, space heater and internal wiring.

6.01.02 The actuator enclosure shall be totally enclosed, dust tight, weather-proof suitable for outdoor use without necessity of any canopy. Degree of protection of enclosure for motor actuator shall be IP-65.

6.01.03 All electrical equipment, accessories and wiring shall be provided with tropical finish to prevent fungus growth.

6.01.04 The actuator shall be designed for mounting in any position without any lubricant leakage or operating difficulty.

6.02.00 **Motor**

6.02.01 The drive motor shall be three phase, squirrel cage, induction machine with minimum class B insulation and IPW-55 enclosure, designed for high torque and reversing service. Canopy shall be provided for outdoor service.

6.02.02 The motor shall be designed for full voltage direct on-line start, with starting current limited to 6 times full-load current.

6.02.03 The motor shall be capable of starting at 85 percent of rated voltage and running at 80 percent of rated v oltage at rated torque and 85 percent rated voltage at 33 percent excess rated torque for a period of 5 minutes each.

6.02.04 Motor leads shall be terminated in the limit switch compartment.

6.02.05 Motor actua tors for valves/dampers shall be with inte gral starter with 3phase/3wire, 415V AC and operable from remote.

6.02.06 Earthing terminals shall be provided on either side of the motor.

6.03.00 **Limit Switches**

Each actuator shall be provided with following limit switches: -

6.03.01 2 torque limit switches, one for eac h direction of travel, self-locking, adjustable torque type.

6.03.02 4 end-of-travel limit switches, two for each direction of travel.

6.03.03 2 position limit switches, one for each direction of travel, each adjustable at any position from fully open to fully closed positions of the valve/damper.

6.03.04 Each limit swit ch shall have 2 NO + 2 NC potential free contacts. Contact rating shall be 5A at 240V A.C. or 0.5A at 220V D.C.

6.04.00 **Hand Wheel**

Each actuator shall be provided with a hand wheel for emergency manual operation. The hand wheel shall declutc h automatically when the moto r is energized.

6.05.00 **Position Indicator/Transmitter**

The actuator shall have:

6.05.01 One (1) built-in local position indicator for 0-100% travel.

6.05.02 One (1) position transmitter, 4-20 mA current signal as position feedback, for remote indicator.

6.06.00 **Space Heater**

A space heater shall be included in the limit switch compartment suitable for 240V, 1 phase, 50 Hz supply.

6.07.00 **Wiring**

All electrical devices shall be wired up to and terminated in a terminal box. All wiring shall be done with 1100 V grade fire resistance PVC insulated stranded copper conductor of not less than 2.5 Sq.mm cross section. All wiring shall be identified at both ends with ferrules. A ll the electrical actuators shall have uniform wiring.

6.08.00 **Terminal Box**

The terminal box shall be weather proof, with removable front cover and cable glands for cable connection. The terminal shall be suitable for connection of 2.5 Sq.mm copper conductor.

7.00.00 **ACCESSORIES**

As required for the driven equipment, the actuator shall be furnished with starting equipment mounted on the actuator. This shall include:

7.01.00 One (1) triple pole MCCB

7.02.00 One (1) reversing starter with mechanically interlocked contactors, 3 thermal overload relays, 2 NO + 2 NC auxiliary contacts for each contactor.

7.03.00 One (1) remote-local selector switch.

7.04.00 CLOSE-STOP-OPEN oil tight push buttons with indication lights.

7.05.00 415/240 V control transformer with primary & secondary fuses.

8.00.00 **TEST**

The actuator and all components thereof shall be subject to tests as per relevant Standards. In addition, if any special test is called for in equipment specification, the same shall be performed.

9.00.00 **DRAWINGS, DATA & MANUALS**

9.01.00 Drawings, Data & Manuals shall be submitted in triplicate with the bid and in quantities and procedures as specified in General Conditions of Contract and/or elsewhere in the specification for approval and subsequent distribution after the issue of 'Letter of Intent'.

9.02.00 **To be submitted with Bid**

Data sheet for each type of actuator shall be furnished along with internal wiring diagram, suggested control schematic and torque limit switch contact development and manufacturer's catalogues. Drawings, Data & Manuals shall be submitted in triplicate with the bid and in quantities and procedures as specified in General Conditions of Contract and/or elsewhere in the specification for approval and subsequent distribution after the issue of 'Letter of Intent'.

9.03.00 **To be submitted for Owner / Purchaser's Approval and Distribution**

All relevant drawings and data pertaining to the equipment like GTP, GA drawing, foundation plan, BOM, control & schematics, QAP, etc. shall be submitted by the Bidder for approval of Owner/Owner's consultant. Also refer clause no. 1.19.02(u) of Section-I of Volume – V-A: Technical Specifications for Electrical Equipment & Accessories.

ANNEXURE-A

DESIGN DATA

1.0 AUXILIARY POWER SUPPLY

Supply		Description	Consumer
L.V. Supply	(i)	415V, 3Ø, 3W, 50 Hz Effectively earthed Fault level 50 kA symm. for 1 sec.	Motors above 0.2kW upto less than 175kW.
	(ii)	240V AC/415V AC	Motors upto 0.2kW.
		240V, 1Ø, 2W, 50 Hz effectively earthed	Lighting, Space heating , A.C supply for Control & protective devices.
D.C. Supply		220V, 2W, unearthed Fault level 25* kA. for 1 sec.	D.C. alarm, control & protective devices

* Indicative only, the actual value will be decided by the Bidder, after substantiating the same by calculation.

2.0 RANGE OF VARIATION

A.C. Supply :

Voltage	:	± 10%
Frequency	:	+3% to -5%.
Combined Volt + frequency	:	10% (absolute sum)

During starting of large motor, the voltage may drop to 80% of the rated voltage for a period of 60 seconds. All electrical equipment while running shall successfully ride over such period without affecting system performance.

D.C. Supply :

Voltage : 187 to 242

Actuator Data Sheet

	SPECIFICATION FOR MOTORISED VALVE ACTUATOR	DOCUMENT NO. : PE-ID-417-145-I902	
		VOLUME II B	
		SECTION D	
		REV. NO. 00	DATE:15/05/2019
		SHEET 1 OF 4	

Data Sheet A & B

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

GENERAL*	* PROJECT	**5 X 800 MW YADADRI TPS, NALGONDA**	
	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 as per standard EN 12570:2000	* 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) (REFER NOTE NO. 6 & 7)	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) DRG. NO. 3-V-MISC-24227 R00	
	COLOUR SHADE	☐ BLUE (RAL 5012) ☐ …….	
	PAINT TYPE **(## Refer Notes)**	☐ ENAMEL ☐ EPOXY CONFIRMING TO CORROSION CATEGORY C5-I	
	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	
	@ ENCLOSURE CLASS OF MOTOR	☐ IP 67 ☐ IP 68 ☐ FLAME PROOF	
	@ INSULATION CLASS	CLASS-F TEMP. RISE LIMITED TO CLASS-B	

Data Sheet A & B

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

	@ WINDING TEMP PROTECTION	■ THERMOSTAT (3 Nos.,1 IN EACH PHASE) ☐ ----------	
	SINGLE PHASE / WRONG PHASE SEQUENCE PROTECTION	REQUIRED (THERMISTOR PTC)	
INTEGRAL STARTER	INTEGRAL STARTER	■REQUIRED ☐ NOT REQUIRED	
	TYPE OF SWITCHING DEVICE	☐ CONTACTORS ☐ THYRISTORS	
	TYPE	☐ CONVENTIONAL ☐ SMART (NON-INTRUSIVE)	
	IF SMART (REFER BELOW POINT a – h)		
	a) SERIAL LINK INTERFACE	☐ INTEGRAL ☐ FIELD MOUNTED	
	b) SERIAL LINK PROTOCOL	☐ FOUNDATION FIELD-BUS ☐ PROFI-BUS ☐ DEVICE NET ☐……	
	c) SERIAL LINK MEDIA	☐ TWISTED PAIR Cu-CBL ☐ CO-AXIAL Cu-CBL ☐ OFC	
	d) HAND HELD PROGRAMMER	☐ REQUIRED ☐ NOT REQUIRED	
	e) TYPE OF HAND HELD PROGRAMMER	☐ BLUETOOTH ☐ INFRARED ☐.....	
	f) MASTER STATION	☐ REQUIRED ☐ NOT REQUIRED	
	g) MASTER STN INTRFACE WITH DCS	☐ MODBUS ☐ TCP/IP	
	h) DETAILS OF SPECIAL CABLE	☐ ENCLOSED ☐ NOT REQUIRED	
	STEP DOWN CONT. TRANSFORMER	■ REQUIRED	
	OPEN / 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(Refer Note 14)	REQUIRED (O/L RELAY OPERATED, CONT./POWER SUPPLY FAILED, S/S IN LOCAL, TORQUE SWITCH OPTD. MID WAY,)	
	ACTION ON LOSS OF EXTERNAL ELECTRIC POWER	☐STAYPUT ☐ FAIL SAFE	
INTERPOSING RELAY/OPTO COUPLER (Applicable for integral Starter) **DATASHEET & WIRING DIAGRAM OF ISOLATION DEVICE TO BE PROVIDED**	TYPE OF ISOLATING DEVICE	■ INTERPOSING RELAY ☐ OPTO COUPLER TO BE DECIDED DURING DETAILED ENGINEERING	
	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	MFR & MODEL NO.	BIDDER TO SPECIFY	
	OPEN : INT : CLOSE	☐1 No ■2 Nos. / 2 Nos. (ADJ.) / ☐1 No. ■2Nos.	

Data Sheet A & B

	DATA SHEET-A (TO BE FILLED BY PURCHASER)	DATA SHEET-B (TO BE FILLED-UP BY BIDDER)
Actuator) **($$ Refer Notes)**	CONTACT TYPE	2 NO + 2 NC	
	RATING (AC / DC)	5A 240V AC AND 0.5A 220V DC	
	ACCURACY	2% OF SET VALUE	

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	☐ REQUIRED ☐ NOT REQUIRED	
	NO. OF PINS REQUIRED(TO BE CHECKED AS PER SIGNALS IN DRIVE CONTROL PHILOSOPHY)		
	NOS. OF PLUG & SOCKET	☐ 1 Nos. for ON/OFF ☐ 2 NOS.(for inching duty) ☐ OTHER (TO BE SPECIFIED INLINE WITH DRIVE CONTROL PHILOSOPHY)	
CABLE GLANDS	@ POWER CABLE GLAND	SIZE:----------	
	@ SPACE HEATER CABLE GLAND	SIZE:----------	
	CONTROL CABLE GLANDS-1	INSTRUMENT CABLE SIZE FOR ON/OFF DUTY VALVES SHALL BE 8PX0.5 SQMM. ONE CABLE GLAND OF OD SIZE 20 MM. INSTRUMENT CABLE SIZE FOR INCHING DUTY TYPE VALVES SHALL HAVE TWO NO. CABLES (ONE NO. 8PXO.5 SQMM AND 2ND 2PXO.5 SQMM) - TWO NO. GLANDS OF OD SIZES 20 MM & 15 MM.	
	CONTROL CABLE GLANDS-2		
WEIGHT	TOTAL WEIGHT (ACTUATOR + ACCESSORIES)	BIDDER TO SPECIFY	_____ Kg.

	SPECIFICATION FOR MOTORISED VALVE ACTUATOR	DOCUMENT NO. : PE-ID-417-145-I902
		VOLUME II B
		SECTION D
		REV. NO. 00 DATE:15/05/2019
		SHEET 4 OF 4

Data Sheet A & B

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

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, IS-4722, IEC 60947-5-1 AND EN 15714-3 :2010 OR LATEST VERSION.
3. TEMPERATURE RISE SHALL BE RESTRICTED TO 70 DEG. C FOR AMBIENT TEMPERATURE OF 50 DEG C.
4. CABLE GLANDS OF DOUBLE COMPRESSION TYPE, BRASS MATERIAL SHALL BE PROVIDED.
5. THE TORQUE SWITCHES SHALL BE PROVIDED WITH MECHANICAL LATCHING DEVICE TO PREVENT OPERATION WHEN UNSEATING FROM THE END POSITIONS. THE LATCHING DEVICE SHALL UNLATCH AS SOON AS THE VALVE LEAVES THE END POSITION. IF SUCH PROVISION IS NOT POSSIBLE, THE TORQUE SWITCHES SHALL BE BYPASSED BY END-POSITION LIMIT SWITCHES WHICH OPENS ON VALVE LEAVING END POSITION.THESE LIMIT SWITCHES ARE ADDITIONAL TO THE NUMBER OF LIMIT SWITCHES SPECIFIED ELSEWHERE.
6. THE MOTOR SHALL BE SUITABLE FOR DIRECT ON LINE STARTING.
7. THE MOTOR SHALL BE CAPABLE OF STARTING AT 85 PERCENT OF RATED VOLTAGE RUNNING AT 80 PERCENT OF RATED VOLTAGE AT RATED TORQUE AND 85 PERCENT RATED VOLTAGE AT 33 PERCENT EXCESS RATED TORQUE FOR A PERIOD OF 5 MINUTES EACH.
8. IN ADDITION TO ABOVE REQUIREMENTS FOR LIMIT/TORQUE SWITCH, **MECHANICAL END STOP** WITH ACCURACY OF 2% SHALL BE SUPPLIED.
9. IT SHOULD BE POSSIBLE TO OPERATE THE ACTUATOR LOCALLY. LOCKABLE LOCAL/REMOTE SELECTION SHALL BE PROVIDED ON THE ACTUATOR.
10. LOCAL POSITION INDICATOR SHALL BE PROVIDED FOR 0 TO 100 % TRAVEL.
11. CONTROL WIRING SHALL BE SUITABLE VOLTAGE GRADE COPPER WIRE 1.5 SQ. MM.
12. ENDURANCE: RATED TORQUE RANGE SHOULD BE BASED ON ISO 5211, ISO5210.
13. TAG PLATE SHALL BE CONFIRMING TO STANDARD BS-15714.
14. INTEGRAL STARTER/ACTUATOR DISTURBED SIGNAL SHALL BE CHECKED AND INCLUDE AS PER DRIVE CONTROL PHILOSOPHY.
15. **** VALVES WITH 10 DEGREE/20DEGREE FEEDBACK REQUIREMENT FOR APPLICATIONS SUCH AS CW/ACW/PLANT WATER SYSTEM ETC SHALL BE CONSIDERED AS INCHING DUTY VALVES. ACCORDINGLY, POSITION FEED BACK TRANSMITTER, PLUG & SOCKET REQUIREMENT SHALL BE CONSIDERED.**

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

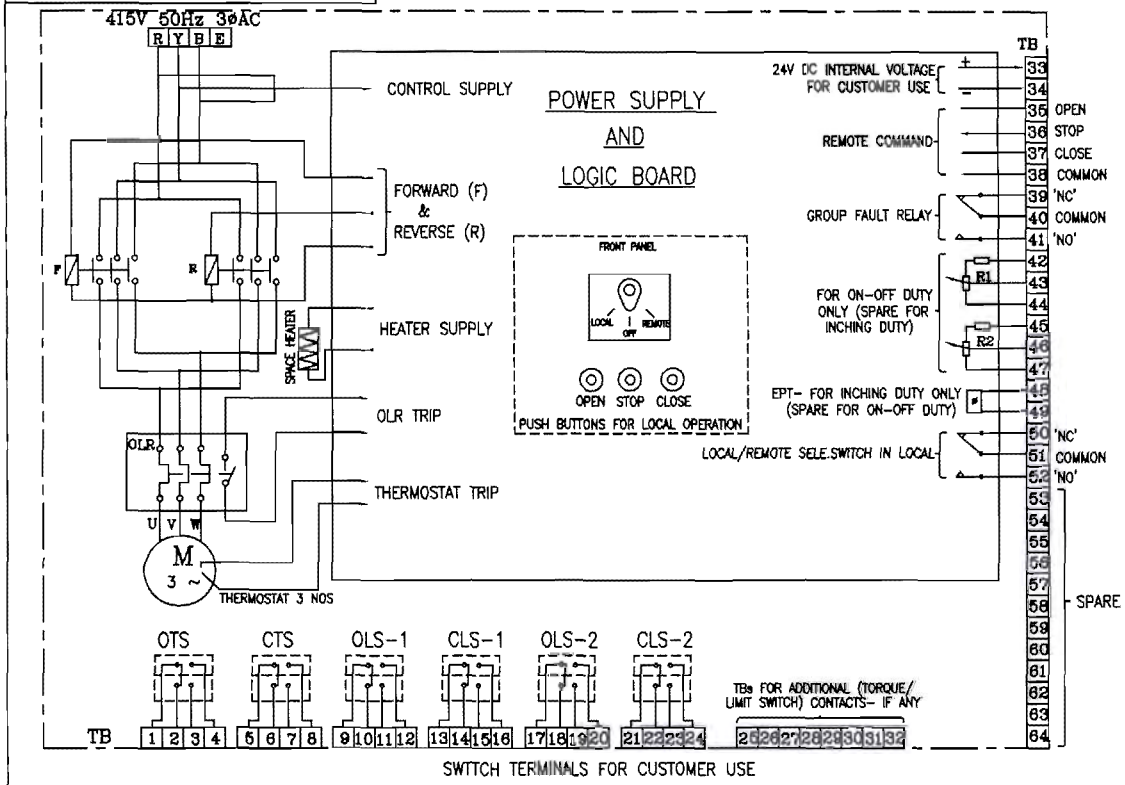
EPOXY PAINT IS RECOMMENDED FOR COASTAL AREAS.

	PREPARED BY	CHECKED BY	APPROVED BY	VENDOR COMPANY SEAL
NAME	RINKY	RAVINDER K RAINA	SHIVRAJ SINGH BANSALA	NAME
SIGNATURE				SIGNATURE
DATE	15.05.2019	15.05.2019	15.05.2019	DATE

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

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

DRAWING NO. 3-V-MISC-24227



CONTACT DEVELOPMENT DIAGRAM

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

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

INDICATES CONTACT CLOSED

INDICATES CONTACT OPEN

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

SETTING PROCEDURE OF POSITION LIMIT AND TORQUE SWITCH

VALVES	OPEN		CLOSE	
	MAIN	BACK UP	MAIN	BACK UP
GATE VALVE OF 100 mm AND ABOVE IN 1500 CL AND ABOVE RATINGS	OLS	OTS *	CLS	CTS
ALL OTHER GATE & GLOBE VALVES	OLS	OTS *	CTS	#

- CLS NOT TO BE CONNECTED IN TRIP CIRCUIT

* - BYPASS OTS FOR INITIAL 5% OF TRAVEL (FOR GATE VALVES ONLY)

NOTE:-

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

REV	DATE	ALTERED
		CHD & APPD

TYPE OF PRODUCT OR NAME OF CUSTOMER/PROJECT: ELECTRICAL VALVE ACTUATORS (AC) WITH INTEGRAL STARTERS (DRAWN FOR INTERMEDIATE POSITION OF VALVES)

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

	NAME	SIGN	DATE	NO.OF VAR.
DRN	N.P.ESWAR	N.P	07.10.04	
CHD	D.DINAKARAN	D.D	07.10.04	
APPD	K.ARUNACHALAM	K.A	07.10.04	

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

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

CARD CODE: U 01

DRAWING NO.: 3-V-MISC-24227

REV: 0

Size A3

1.00.00 **GENERAL**

1.01.00 Control valves for regulating service shall normally be globe body, preferably cage guided, metal-to-metal seated, pneumatically operated and shall be provided with characterized plugs

1.02.00 Where high stroking speed , high actuation forces and accurate positioning is critical for the operation of the plant, as in case of HP or LP bypass valves, Separator Drain Valves , hydraulic actuators with electro-hydraulic interface shall be offered.

2.00.00 **GENERAL TECHNICAL REQUIREMENTS**

2.01.00 Bidder shall exercise caution in selecting severe service control valves like BFP recirculation, HP & LP bypass, superheater & reheater attemperator, PRDS for Boiler & Turbine, Feed control station ,Soot blower steam pressure, Fuel oil heating and pressurizing ,minimum economizer flow control ,DM make up (emergency / normal), control valves whose down stream are connected to vacuum such as HP/LP heater emergency level control, condenser make up water, separator level control , CEP minimum flow control etc. For such critical applications, Bidder shall offer valves which are proven for similar application. Above valves shall have leakage class equal or better than class-VI with metal-to-metal seating.

2.02.00 Valve with ANSI leakage class-V shall be provided for all applications except for the control valves indicated above.

2.03.00 Bidder shall provide redundant control valves for some services such as Main condensate flow control, Superheat attemperation control and Reheat attemperation control as a minimum for high availability. For other application, if the availability criteria for the plant cannot be met even with the best established product, redundant control valves shall be provided.

2.04.00 Control valves shall be located near floor or platform for ease of access and with adequate clearances for maintenance and lay-down and shall be placed as station with upstream motorized isolating valve, down-stream motorized isolating valve, inching duty motorized bypass valve and manual drain valves. Each redundant control valve shall have its upstream motorized and down-stream motorised isolating valves. Where quick shut off requirement is foreseen such as in case of SH & RH attemperation valves, upstream isolation valve shall be pneumatic type.

2.05.00 Wherever, steam conditioning calls for , Pressure reducing & desuperheating, combined PRDS type valves shall be offered.

2.06.00 Control Valve shall be furnished with IBR certification wherever required .

2.07.00 Valve Body / End Connections

2.07.01 Valve end to end dimension and connection shall be according to ANSI standard, straight through pattern. However, Bidder may offer angle body valve for high pressure drop applications. For high pressure drop applications, construction of the valve shall be such that the gland is not exposed to inlet pressure.

2.07.02 Control valves of 40 mm. size and above with line pressure up to 50 Kg / Sq. cm may have flanged or welded end connections.

2.07.03 Control valves, used in high pressure services shall have butt welded end connections for size 65mm and above and socket weld end connection for size 50 mm or below.

2.07.04 Control valve body shall be selected as per the ISA GUIdeline. Generally control valve body shall be cast and machined for pressure rating up to 1500 lbs. Above 1500 lbs, valve body shall be of forged steel. For Demineralized Water application, valve body shall be Stainless Steel.

2.07.05 Bonnet joints for all control valves shall be of flanged and bolted type.

2.07.06 Flanged valve shall be rated at no less than class 300 lbs

2.07.07 The direction of flow shall be clearly engraved on the body . Valve tag no, , description or purpose, stroke time shall be painted on all control valve body with black letters on white background in Bold letters.

2.07.08 Valve Body Materialial shall match the process conditionrequirement as per ANSI. . General guideline shall be as follows

SR. NO.	SERVICE		MATERIAL
1.	Non corrosive, non-flashing and non cavitating service for fluid temperature up to 275ºC	:	Cast carbon steel ASTM A216 Gr. WCB , Trim material - 316 SS stellited faced GUIde posts and bushings.
2.	Non corrosive, non-flashing and non cavitating service for fluid temperature above 275ºC	:	Cast alloy steel ASTM A217 Gr. WC9 Trim material - 316 SS stellited faced GUIde posts and bushings.
3.	Severe flashing / cavitating services	:	Alloy steel ASTM A217 Gr. WC9 , Trim material - 440C
4.	Low flashing / cavitating services	:	Alloy steel ASTM A217 Gr. WC6 ,Trim material - 17-4 PH SS
5.	DM water application (condenser hotwell normal, emergency make up etc.)	:	316 stainless steel

2.07.09 Bidder may supply valves with body and trim materials with superior quality than specified material and in such cases Bidder shall furnish the comparison of offered material properties ,such as cavitation resistance , , hardness , tensile strength , strain energy , corrosion and erosion resistance etc. , with specified material for Owner's approval.

2.08.00 Valve Size

The control valve sizing (Cv / Kv) shall be based on following guidelines :

a) The valves shall pass normal flow (MCR condition) with 60 to 70 percent opening for linear characterised valves and between 70 to 80 percent opening for equal percentage characterised valves.

b) The valves shall have adequate rangeability to pass the minimum and maximum flows at 10% and 85% of the valve opening respectively. Valve stem travel range from minimum to maximum flow condition shall not be less than 50% of the total valve stem travel.

c) Valve Cv shall be selected in such a way that the valve shall be capable of handling at least 120% of required maximum flow.

d) The valve selection shall be based on the highest size dictated by the above considerations unless noise, flashing or other factors dictate the final selection.

e) Trim exit outlet velocity as defined in ISA handbook does not exceed 8 m / sec for liquid services , 150 m/sec for steam services anf 50/% of sonic velocity for flashing services The sizing procedure followed shall be as per latest edition of ANSI/ISA or equivalent standard.

2.09.00 Valve Top work

2.09.01 Top work shall be sized so that the valve shall operate properly when upstream pressure is 10 percent above maximum inlet pressure and downstream pressure is atmospheric.

2.09.02 Extended bonnet/ bonnet when maximum temperature fluid is greater than 280^0 C shall be provided and high temperature packing shall also be used for high temperature application.

2.09.03 The gland material shall be chosen to suit the operating temperature. PTFE may be chosen for lower temperature application (232ºC maximum) and for high temperature application graphited asbestos glands are to be provided. For vacuum services,. All valves connected to vacuum on downstream side shall be provided with packing suitable for vacuum applications eg. double vee type chevron packing.

2.10.00 Valve Trim

2.10.01 Valve trim for applications up to leakage class-V shall be stainless steel 316 SS for pressure drop up to 7 Kg/ Sq. cm. For pressure drops above 7 Kg/Sq. cm hard trim (stelliting or equivalent) shall be used. Other alloys or treatment such as nitride shall be used if severe erosion is expected.

2.10.02 Balanced trim valves shall be offered for high shut-off pressure or high pressure drop condition to reduce the size of the actuators.

2.10.03 For flashing services and two stage mixtures, the trim material shall be 17-4 PH SS or equivalent.

2.10.04 If cavitating condition is foreseen, Bidder shall offer multistage or labyrinth trims valves. Trim of severe service valves shall be of multistage and multipath design with number of discrete pressure drop stages to eliminate the chances of erosion, cavitation, noise and vibration throughout the control range of the valve.

2.10.05 Quick replacement type trim shall be considered for easy maintenance.

2.10.06 Plug shall be one-piece construction cast , forged or machined from solid bar stock .Plug shall be screwed or pinned to valve stems or shall be integral with the valve stems.

2.11.00 Noise Level

The equivalent sound level measured at 1.5M above nearest floor level in elevation and 1 M horizontally from the control valve expressed in decibels to a reference of 0.0002 microbar shall not exceed 85 dBA. The noise abatement shall be achieved by valve body & trim design and not by use of silenecers. Valve Actuators

2.12.00 Actuator

2.12.01 Spring-diaphragm type actuators shall generally be used. Piston type actuators shall be offered in case of high shut-off pressure & quick response requirement. Hydraulic actuation system shall be provided for Critical valves as described elsewhere in the specification.

2.12.02 The actuator shall be designed for 150% thrust required for the valve (at shut-off pressure) at an air line supply pressure of 5.5 Kg/Sq. cm.

2.12.03 Diaphragms shall be designed for 200% maximum operating pressure.

2.12.04 Nylon reinforced neoprene is preferred as diaphragm material.

2.12.05 Valve actuators shall be capable of operating at 80^0 C ambient, continuously.

2.12.06 Entire actuator assembly shall be painted with corrosion inhibiting paint.

2.12.07 Air connection size shall be 1/4" NPT (F) unless otherwise dictated by process response time. Integral tubing shall be stainless steel.

2.12.08 Bidder shall indicate the stroking time of the valve assemblies with ositioned and ensure that the stroke time shall meet the process and equipment dynamics and shall be better than 10 seconds.

2.12.09 All actuators shall be of fail safe design signifying that the spring direction will tend to move the valve (open or close) in a direction safe for the process. "Failure to Open" or "Failure to Close" shall be marked on the actuator.

2.12.10 Hydraulic actuation system

The system shall consist of , but not limited to , Hydraulic cylinder , proportional valve with blocking unit , SMART positioner with position transmitter , SOVs , safety bypass unit , safety control unit , Hydraulic supply unit and local controller cubicle with controller unit

2.13.00 Valve Positioners

2.13.01 All regulating service valves shall be offered with HART protocol based Smart Electro Pneumatic Positioners to ensure accuracy and repeatability of response.

2.13.02 Positioners shall have integral non contact type position transmitter, input and output gauges, local keypad & display and 4-20 mA DC output to DDCMIS in CCR.

2.13.03 Positioners shall be capable of functioning under hot, humid and vibrating conditions.

2.13.04 Positioner casings shall be dust tight, corrosion resistant and weatherproof to IP 65 .and explosion proof in hazardous areas.

2.13.05 In general, positioner shall operate at signal range 4 – 20 mA DC for the full travel of the valve. Split range operation in few cases may be required.

2.13.06 Remote calibration from control room shall be possible through HART management station.

2.14.00 Performance

2.14.01 Performance of the complete assembly of the control valves shall be better than +/- 1% of FS for linearity , +/- 0.5 % of FS for hysteresis , 1% for accuracy.

2.15.00 Valve Accessories

2.15.01 Accessories shall include side mounted hand wheels, open & close , intermediate (as applicable) limit switches for both regulating and On off valves ,, junction boxes with 20 % spare terminals , Air filter regulators , airlock relays , volume chambers etc. Solenoid valve (SOV) wherever required shall be furnished. Each limit switch shall have not less than 2 NO & 2 NC contacts with contact rating 5A , 240 V AC / 0.5 A , 220 V DC . SOV shall have SS bar stock body , SS316 Trim , SS coil enclosure , Class H insulation Air filter regulator shall have sintered bronze filter element with maximum 5 microns filter size & 2 inch dial size pressure gauges. .Protection class of all Limit switches , junction boxes , SOV etc. shall have protection class IP 65 and explosion proof for hazardous areas.

2.15.02 Air distribution line to all final control elements like control valves, pneumatic dampers (both regulating / on-off type) , SOV operated valves shall be through SS manifolds and SS isolating valves only. These valves shall be properly tagged also with KKS tag no. and description of final control element / instrument for which they are intended.

2.16.00 Test and Examination

All valves shall be tested in accordance with the Quality Assurance programme agreed between the Owner and Bidder , which shall meet the requirements of IBR and other applicable codes mentioned elsewhere in the specification . The test shall include but not be limited to Non destructive test , Hydrostatic shell test prior to seat leakage test , Seat leakage test , Valve closure test , Functional test of fully assembled valves including actuators and accessories. CV test etc. For all control valves Cv test shall be witnessed by Owner.

1.00.00 SPECIFICATION FOR ELECTRONIC TRANSMITTERS

1.01.00 PRESSURE TRANSMITTER

1.	Working Principle	:	Smart (HART Compatible)
2.	Type	:	Microprocessor based, 2 – Wire
3.	Output Signal	:	4-20 mA DC along with superimposed digital signal
4.	Measuring Element	:	Capsule / Diaphragm
5.	Element material	:	SS-316 (Stainless Steel) or better
6.	Static Pressure	:	150 % of maximum span continuously, without affecting the calibration
7.	Turn-down ratio	:	100: 1
8.	Span and Zero	:	Continuous, tamper proof, remote as well locally adjustable with zero elevation and suppression by 100% of span
9.	Enclosure Class	:	IP-65 (Explosion proof for NEC Class-1, Division 1 area)
10.	Output Indicator	:	LCD (Integral indicator of 5 digit display)
11.	Nameplate	:	Tag number, service engraved in SS tag plate
12.	Body	:	SS
13.	Operating Voltage	:	24V DC
14.	Load	:	600 Ohms (min.) at 24 Volts D.C.
15.	Ambient Temperature	:	0 - 50 ^{O}C
16.	Performance:	:	
	i. Accuracy		$\pm$ 0.075% of Span or better

	ii.	Repeatability		± 0.05% of Span or better
17.	Sealing/Isolation	:	Extended diaphragm (Silicon oil/ Flurolub filled) with 5 meters SS armoured capillary for corrosive/viscous/solid bearing or slurry type fluid applications	
18.	Accessories	:	a. Universal mounting bracket suitable for 2" pipe mounting b. High tensile carbon steel U-bolts c. Siphon for steam and hot water services d. ½" NPT 2-valve stainless steel manifold, constructed from SS316 bar stock e. Companion flange with nuts, bolts and gaskets f. ½" NPT cable gland g. Handheld calibrator	
19.	Adjustment/Calibration/ Maintenance	:	From handheld calibrator/ HART management system	

Notes: For primary air/ secondary air/ flue gas applications, DP type transmitters shall be provided for pressure measurement.

LVDT type is not acceptable.

1.02.00 DIFFERENTIAL PRESSURE TRANSMITTER / FLOW TRANSMITTER

1.	Working Principle	:	Smart (HART Compatible)
2.	Type	:	Microprocessor based, 2 – Wire
3.	Output Signal	:	4-20 mA DC along with superimposed digital signal
4.	Measuring Element	:	Capsule / Diaphragm

5.	Element material	:	SS-316 (Stainless Steel) or better
6.	Static Pressure	:	150 % of maximum span continuously, without affecting the calibration
7.	Turn-down ratio	:	100: 1
8.	Span and Zero	:	Continuous, tamper proof, remote as well locally adjustable with zero elevation and suppression by 100% of span
9.	Enclosure Class	:	IP-65 (Explosion proof for NEC Class-1, Division 1 area)
10.	Output Indicator	:	LCD (Integral indicator of 5 digit display)
11.	Nameplate	:	Tag number, service engraved in SS tag plate
12.	Body	:	SS
13.	Operating Voltage	:	24V DC
14.	Load	:	600 Ohms (min.) at 24 Volts D.C.
15.	Ambient Temperature	:	0 - 50 ^{O}C
16.	Performance:		
	i. Accuracy	:	± 0.075% of Span or better
	ii. Repeatability	:	± 0.05% of Span or better
17.	Sealing/Isolation	:	Extended diaphragm (Silicon oil/ Flurolub filled) with 5 meters SS armoured capillary for corrosive/viscous/solid bearing or slurry type fluid applications
18.	Accessories	:	a. Universal mounting bracket suitable for 2” pipe mounting b. High tensile carbon steel U-bolts

c. Siphon for steam and hot water services

d. ½" NPT 5-valve stainless steel manifold, constructed from SS316 bar stock

e. Companion flange with nuts, bolts and gaskets

f. ½" NPT cable gland

g. Handheld calibrator

19. Adjustment/Calibration/ Maintenance : From handheld calibrator/ HART management system

1.03.00 Displacer Type Level Transmitters

1.	Type	:	Smart (HART Compatible)
2.	Stages of operation	:	Continuous
3.	Material	:	
4.	i. Displacer		SS-316
5.	ii. Suspension wire		SS-316
6.	iii. Torque tube housing		SS
7.	iv. Torque tube		Inconel
8.	v. Displacer chamber		SS
9.	vi. Transmitter Housing		SS
10.	Operating Voltage	:	24 V DC
11.	Transmission	:	Microprocessor based, 2-wire
12.	Output Signal	:	4-20 mA DC along with superimposed digital signal
13.	Static / overload	:	Maximum static pressure without

	pressure		permanent deformation or loss of accuracy
14.	Turn-down ratio	:	10 : 1 or better
15.	Zero & Span	:	Continuous, tamper proof, remote as well locally adjustable with zero elevation and suppression by 100% of span
16.	Enclosure Class	:	IP-65
17.	Output Indicator	:	LCD type (Integral indicator of 5 digit display)
18.	Nameplate	:	Tag number and Service engraved in stainless steel tag plate
19.	Ambient Temperature	:	0 - 50 ^{O}C
20.	Load Impedance	:	600 Ohms at 24 Volts (minimum)
21.	Process Connection	:	2” Flanged
22.	Performance - Accuracy	:	$\pm$ 0.075 % of span or better
23.	Accessories	:	a) Counter Flange, nuts, bolts, gaskets etc b) Weights for 5 point calibration of instruments c) Vent and drain plugs d) ½” NPT Glands e) Handheld calibrator
24.	Preferred Features	:	a) Test plug connection and cutout terminals physically separated from other electronics b) Electronic Damping facility (adjustable)
25.	Adjustment/Calibration/ Maintenance	:	From handheld calibrator/ HART management system

	26.	Applications	:	During detail engineering on Owner's approval

1.04.00 MASS FLOW METER

1.04.01 SENSOR

	1.	Measuring Principle	:	Coriolis Mass flow
	2.	Primary Element	:	Flow Tube of 316SS or better
	3.	Heating Arrangement	:	Integral
	4.	Temperature Control	:	For heavy fuel oil application
	5.	Process Connection	:	Flanged of rating as per process requirement
	6.	Drain	:	Self-draining facility
	7.	Enclosure	:	Stainless steel
	8.	Accessories	:	Counter flanges, Mounting nuts, bolts, gaskets etc.

1.04.02 TRANSMITTER

	1.	Measured quantities	:	Mass Flow rate, Total Mass Flow, Density
	2.	Input Signal Processing	:	Smart (HART compatible)
	3.	Display	:	LCD
	4.	Output	:	2 nos. isolated output of 4-20mA DC selectable from four measured quantities
	5.	Load	:	< 750 ohms
	6.	Power supply	:	240V AC, 50 Hz

7.	Turn Down	:	100:1
8.	Accuracy	:	± 0.2 % of measured value
9.	Housing	:	IP 65 (Explosion proof)
10.	Nameplate	:	Tag number, service engraved in stainless steel tag plate
11.	Accessories	:	a) Handheld calibrator b) Mounting U-bolts, nuts, bolts, prefab cable etc c) ½"NPT cable gland
12.	Adjustment/Calibration/ /Maintenance	:	From handheld calibrator/ HART management system
13.	Applications	:	Fuel Oil service

1.05.00 RADAR TYPE LEVEL MEASUREMENT

1.	Type	:	Smart (HART Compatible)
2.	Antenna	:	Co axial / guided wave radar /–Overspill protection
3.	Principle	:	TDR (Time Domain Reflectometry)
4.	Communication	:	Two wire 4-20mA DC with HART
5.	Environmental temperature	:	0 – 50 ºC
6.	Enclosure	:	IP-65 (Explosion proof for NEC Class-1, Division 1 area)
7.	Calibration	:	a) Self calibration with internal reference : b) Zero & Span calibration
8.	Process Connection	:	External cage mounting Flanged /screwed
9.	Electronic Housing	:	Epoxy painted Die-Cast aluminium

			alloy
10.	Antenna / Flange assembly	:	316 SS or Hestalloy (as required)
11.	Power supply	:	24 V DC
12.	Output Indicator	:	LCD
13.	Accuracy	:	5 mm or 0.1% of probe length
14.	Accessories	:	a) Handheld calibrator
		:	b) Counter Flange, nuts, bolts, gaskets etc
		:	c) ½"NPT cable gland
		:	d) SS Nameplate
15.	Adjustment/Calibration/ /Maintenance	:	From handheld calibrator/ HART management system
16.	Applications	:	Vessels under vacuum or low pressure applications, solid levels

1.06.00 ULTRASONIC LEVEL TRANSMITTER

1.	Type	:	Microprocessor based, 2-wire, Smart (HART Compatible)
2.	Operating Principle	:	Detection of reflected ultrasonic pulse
3.	Output Signal	:	4-20 mA DC along with superimposed digital signal
4.	Operating frequency	:	10 KHz to 50 KHz (typical)
5.	Display	:	LCD
6.	Temperature Compensation	:	Built in –Programmable
7.	Power supply	:	24 V DC
8.	Enclosure	:	SS, IP-65 (Explosion proof for NEC Class-1, Division 1 area)

9.	Zero & Span	:	Continuous, tamper proof, remote as well locally adjustable. It shall be possible to calibrate the instrument without any level in the sump/ tank
10.	Accuracy & Repeatability	:	0.15 % of span or better
11.	Resolution	:	0.1 % of span
12.	Operating temp.	:	Transmitter- 500 C and Sensor - 800 C
13.	MOC Sensor	:	SS-316/Body- PVC and Face – Polyurethene
14.	Mounting	:	4” Flanged/ 2” NPT for sensor and Transmitter on panel
15.	Accessories	:	a) Handheld calibrator b) Weather canopy for protection from direct sunlight and direct rain c) ½”NPT cable gland d) All mounting hardware (SS-316), Prefab cable e) SS Nameplate
16.	Diagnosis	:	On-line
17.	Status Indication	:	Power On, HI, HI-HI, Lo, LO-LO, Fault
18.	Output Contacts	:	2 SPDT, 230V, 5A
19.	Adjustment/Calibration/ /Maintenance	:	From handheld calibrator/ HART management system
20.	Applications	:	Coal Bunker, Water Service etc.

1.07.00 ULTRASONIC FLOW TRANSMITTER

1.	Type	:	Ultrasonic – Clamp On
2.	Accuracy	:	+/- 1 % of reading
3.	Repeatability	:	+/- 0.3 % of reading
4.	Rangeability	:	400 : 1
5.	Output Signal	:	4-20 mA DC with HART
6.	Measured Parameter	:	Volumetric flow, Totalized flow and flow Velocity
7.	Display	:	LCD with internal Key Pad (Flow rate & Totalization)
8.	Power Supply	:	24 V DC (2 Wire)
9.	Enclosure	:	SS (IP- 68 – Submersible)
10.	Mounting	:	SS Chain or Strap
11.	Accessories		1. Handheld calibrator 2. ½"NPT cable gland 3. Transducer cable 4. All mounting hardware (SS-316) 5. SS Nameplate
12.	Adjustment/Calibration/ /Maintenance	:	From handheld calibrator/ HART management system
13.	Applications	:	Plant water service

Note: Multi-path insertion type (minimum 4 path) Ultrasonic Flow meter shall be provided for Raw water/ Cooling Water flow measurements.

2.00.00 **HART HAND HELD CALIBRATOR**

Hand held calibrators (5 nos. for each type) shall be provided for adjustment/ calibration/maintenance of the HART compatible

transmitters. The hand held calibrator shall be suitable for all types of transmitters supplied in the package. If one type of hand held type calibrator is not suitable for communicating with all types of transmitters then separate hand held calibrator will be provided.

3.00.00 PROCESS ACTUATED SWITCHES

3.01.00 PRESSURE SWITCH

1.	Type	:	i. Piston for high pressure application ii. Bellow / Diaphragm for low pressure application
2.	Sensing element material	:	SS-316. All other wetted part SS316
3.	Case Material	:	SS
4.	Setter Scale	:	Black graduation on white linear scale. Graduation 0-100% with red pointer for set points
5.	Over range	:	150 % of maximum pressure
6.	Adjustments	:	a) Internal Set Point
		:	b) Differential adjustment
7.	End Connection	:	1/2" NPT bottom connected
8.	Switch configuration	:	Two SPDT (240V, 5A AC/220V, 0.5A DC)
9.	Switch Type	:	Snap acting, shock & vibration proof
10.	Terminal Block	:	Suitable for full ring lugs
11.	Enclosure Class	:	IP-65 (Explosion proof for NEC Class-1, Division 1 area)
12.	Performance	:	a) Repeat accuracy ± 1.0%
		:	b) Accuracy of Setting Indication of ± 1.5%
13.	Ambient temperature	:	0 – 50 Deg.C

14.	Nameplate	:	Tag number, service engraved in SS tag plate
15.	Accessories	:	a) Silicon oil/ Flurolub filled Remote diaphragm seal with SS-316 capillary for corrosive/ viscous/ solid bearing or slurry type fluid applications b) Snubbers for pulsating fluid applications c) Siphons for steam and hot water services d) Retention ring and screws for surface mounting e) 1/2" NPT 2 Valve SS-316 barstock manifold f) ½" NPT cable gland
16.	Applications	:	During Detail Engineering on Owner's approval

3.02.00 DIFFERENTIAL PRESSURE SWITCH

1.	Type	:	i. Piston for high pressure application ii. Bellow / Diaphragm for low pressure application
2.	Sensing element material	:	SS-316. All other wetted part SS316
3.	Case Material	:	SS
4.	Setter Scale	:	Black graduation on white linear scale. Graduation 0-100% with red pointer for set points
5.	Over range	:	150 % of maximum pressure

6.	Adjustments	:	a) Internal Set Point
		:	b) Differential adjustment
7.	End Connection	:	1/2" NPT bottom/ back connected
8.	Switch configuration	:	Two SPDT (240V, 5A AC/220V, 0.5A DC)
9.	Switch Type	:	Snap acting, shock & vibration proof
10.	Terminal Block	:	Suitable for full ring lugs
11.	Enclosure Class	:	IP-65 (Explosion proof for NEC Class-1, Division 1 area)
12.	Performance	:	a) Repeat accuracy ± 1.0% b) Accuracy of Setting Indication of ± 1.5%
13.	Ambient temperature	:	0 – 50 Deg.C
14.	Nameplate	:	Tag number, service engraved in SS tag plate
15.	Accessories	:	a) Silicon oil/ Flurolub filled Remote diaphragm seal with SS-316 capillary Diaphragm seals for corrosive/ viscous/ solid bearing or slurry type fluid applications b) Snubbers for pulsating fluid applications c) Siphons for steam and hot water services d) Retention ring and screws for surface mounting e) 1/2” NPT 5 Valve SS-316 barstock manifold f) ½” NPT cable gland
16.	Applications	:	During Detail Engineering on Owner’s

approval

3.03.00 LEVEL SWITCH

3.03.01 FLOAT OPERATED

1.	Float material	:	SS-316
2.	Wetted parts	:	SS-316
3.	Float chamber	:	Stainless steel/Carbon steel, construction welded
4.	Float chamber mounting	:	Side mounted
5.	Fluid connection	:	Side – Side
6.	Fluid connection size	:	1" ANSI RF Flange (rubber line, if required)
7.	Drain	:	½ inch NPT with Plug
8.	Pressure rating of chamber	:	Minimum 1.5 times of design pressure
9.	Repeatability	:	+/- 1.5 mm or better
10.	Switch housing	:	Stainless Steel
11.	Switch housing type	:	IP- 65
12.	Type of switch	:	Snap acting magnetically operated hermetically sealed
13.	Switch configuration	:	2 SPDT (5A, 240 V AC, 0.5A, 220V DC)
14.	Accessories	:	a) Counter flange, nuts & bolts, suitable gasket etc. b) Steel globe type drain valve c) ½"NPT cable gland

			d)	Stainless steel nameplate with alpha-numeric engraved for service and tag
	15. Application	:	During Detail Engineering on Owner's approval	

3.04.00 FLOW SWITCH

1.	Type	:	Paddle /Piston/Disk	
2.	Wetted part material	:	Stainless steel or Hastelloy for acidic application	
3.	End connection	:	a)	Threaded upto 1" line size with integral Tee
		:	b)	Flanged for line size > 1 ½"
4.	Enclosure material	:	Stainless Steel	
5.	Enclosure class	:	IP 65	
6.	Switch configuration	:	2 SPDT (5A, 240 V AC, 0.5A, 220V DC)	
7.	Repeatibility	:	2%	
8.	Cable connection	:	½"NPTF	
9.	Accessories	:	a)	Tee, Counter flange, nuts & bolts, suitable gasket etc
			b)	½"NPT cable gland
			c)	Stainless steel nameplate with alpha-numeric engraved for service and tag

3.05.00 RF LEVEL SWITCH

1.	Type	:	RADIO FREQUENCY
	Sensing probe		
2.	Material	:	SS-316
3.	Mounting	:	Threaded
4.	Application Temperature	:	250°C (Max.)
	Electronic Controller		
5.	Input Supply Voltage	:	240V AC ±10%, 50 Hz.
6.	Relay Output	:	2 SPDT (240V AC, 5A)
7.	Ambient Temperature	:	50 °C
8.	Enclosure Protection	:	IP-66
9.	Enclosure Housing	:	SS
10.	Local LED Indication	:	Normal Level Power On Alarm Level Probe Healthy
11.	Switching Repeatability	:	±0.5%
12.	Accessories	:	Co-axial cable for probe connection to controller SS Tag plate ½" NPT Cable Glands
13.	Application	:	Solid level

3.06.00 CONDUCTIVITY TYPE LEVEL SWITCH

1.	Type	:	Conductivity discrimination
2.	Probe MOC	:	SS-316
3.	Mounting	:	Flanged on external cage
4.	Application Temperature	:	250°C (Max.)
5.	Test Pressure	:	Two times rated pressure

	6. Input Supply Voltage	:	240V AC ±10%, 50 Hz.
	7. Input	:	Four independent channel with selectable switching threshold for water conductivity
	8. Relay Output	:	2 SPDT (240V AC, 5A)
	9. Ambient Temperature	:	50 °C
	10. Enclosure Protection	:	IP-65 (Explosion proof for NEC Class-1, Division-1 area)
	11. Enclosure Housing	:	SS
	12. Local LED Indication	:	HI,LO, HIGH-HIGH, LOW-LOW Power Fault
	13. Accessories	:	a) Interconnecting cable from probe to electronics b) Mounting accessories c) External cage d) Washer & Gasket e) ½" NPT Cable Glands f) SS Tag Plate
	14. Application	:	During Detail Engineering on Owner's approval
3.07.00	TEMPERATURE SWITCH		
	1. Type	:	Bimetallic or gas filled
	2. Sensing Element Material	:	SS-316
	3. Bulb Material	:	SS-316
	4. Capillary	:	Stainless Steel armored

5.	Movement Material	:	Stainless Steel
6.	Case material	:	Stainless Steel with neoprene gasket and clear glass where applicable cover conforming to IP-65. (Explosion proof for NEC Class-1, Division 1 area).
7..	Scale	:	Black graduation on white linear scale. Graduation 0-100% with red pointer for set points
8.	Over range Protection	:	120 %
9.	Instrument connection	:	Bottom
10.	Switch configuration	:	Two SPDT (240V, 5A AC/220V, 0.5A DC)
11.	Switch type	:	Snap acting, shock and vibration-proof
12.	Adjustability	:	Internal Set point adjustable over span range
13.	Compensation	:	a) Capillary compensation with invar wire throughout the capillary length b) Case compensation
14.	Performance		
	a) Scale Accuracy	:	±1.0 % of full scale
	b) Repeatability	:	< 0.5 % of full range
	c) Response time	:	Less than 40 seconds with thermowell
15.	Capillary length	:	5 meters (minimum) for local mounting/15 meters for local panel mounting
16.	Nameplate	:	Tag number, service engraved in stainless steel tag plate
17.	Accessories	:	Mounting accessories, ½" NPT cable gland
18.	Applications	:	During Detail Engineering on Owner's

approval

4.00.00 LOCAL INSTRUMENTS

4.01.00 PRESSURE GAUGE AND DIFFERENTIAL PRESSURE GAUGE

1.	Type	:	Bourdon/Bellows/Diaphragm
2.	Sensing & Socket	:	SS-316
3.	Movement Material	:	SS-316
4.	Case Material	:	Stainless steel. IP-65 (Explosion proof for NEC Class-1, Division 1 area)
5.	Dial Size	:	Generally 150 mm
6.	Scale	:	Black lettering on white in 270 O arc.
7.	Window	:	Shatterproof glass
8.	Range Selection	:	Normal process pressure: 50~70 % of range
9.	Over-range Protection	:	125% of maximum range by internal stop. External stop at zero
10.	Adjustment	:	For Zero adjustment (Micrometer screw external) For Range adjustment (Micrometer screw internal).
11.	Element Connection	:	Argon welding
12.	Process Connection	:	1/2" NPT (M) Bottom for local, back for panel mounting
13.	Performance	:	Accuracy of ± 1.0 % of span or better
14.	Operating ambient	:	0 - 50 ^{O}C
15.	Safety Feature	:	Blow out disc /diaphragm at the back
16.	Accessories	:	a) Snubbers for pulsating fluid application.discharge b) Stainless steel Diaphragm seals

			for corrosive/ viscous/ solid bearing or slurry type fluid applications
		c)	3-Way SS316 Gauge cock for pressure gauges
		d)	5-valve SS316 manifold from barstock for differential pressure gauge
		e)	Siphons for steam and hot water services
	17. Nameplate	:	Tag number, service engraved in stainless steel tag plate

4.02.00 LEVEL INDICATOR (FLOAT & BOARD TYPE)

1.	Type	:	Float and Board
2.	Float Material	:	SS-316
3.	Float Cable	:	SS-316
4.	Indicator Assembly	:	Epoxy painted Aluminium
5.	Guide wire spring assembly	:	SS-316 (2 Nos.)
6.	Guide Wire Anchor	:	SS-316
7.	Scale Board	:	Anodized Aluminium with engraved marking (Minimum graduation 10mm), mounting brackets and suitable hardware required as per tank height
8.	Elbow Assembly	:	Anodized Aluminium
9.	Flanges	:	RF , ANSI 150 , SS (3 Nos.)
10.	Accuracy	:	± 10 mm or better
11.	Accessories	:	All mounting accessories including counter flange, nuts & bolts, suitable

gasket etc. as applicable, SS Tag plate

4.03.00 GAUGE GLASS

1.	Type	:	Reflex /Transparent
2.	Material		
	Glass	:	Toughened borosilicate resistant to thermal shock
	Body Material	:	~~Carbon Steel~~ Stainless Steel
	Enclosure	:	IP-65 (Explosion proof for NEC Class-1, Division 1 area)
3.	Integral cocks & valves/Fittings	:	i. SS 316
4.		:	ii. Rubber lined corrosion resistant stainless steel (for DM/RO service)
5.	Vessel Connection	:	ANSI Flanged SS316
6.	Accessories	:	i. Integral cocks ii. Drain Valves iii. Companion Flanges, Bolts, nuts, gaskets, SS Tag plate iv. Illuminating lamps, Mica shield as required v. Calibrated scale
7.	Pressure rating	:	Twice the maximum working pressure
8.	Temperature	:	300 ^{O} C
9.	Other details	:	For larger lengths (greater than 1200mm), additional gauge glasses shall be provided with minimum of 50 mm overlap.

4.04.00 SLIGHT GLASS

1.	Type	:	Flap-type.
2.	End connection	:	Screwed / Flanged
3.	Material		
	a) Body	:	SS- 304
	b) Cover plate	:	SS- 304
	c) Indicator	:	SS- 316
4.	Sight Glass	:	Toughened Borosilicate
5.	Gasket	:	Neoprene
6.	Bolts & Nuts	:	High tensile steel.
7.	Hydraulic Test Pressure	:	1.5 times maximum working pressure
8.	Accessories	:	Companion Flanges, Bolts, nuts, gaskets as required, SS Tag plate.

4.05.00 ROTAMETER

1.	Type	:	ON-LINE for line upto and including 50 mm NB. Borosilicate BY-PASS for line size above 50 NB
2.	Metering tube	:	Toughened Borosilicate
3.	Float	:	SS-316
4.	End fittings	:	SS-316
5.	Packing material	:	Teflon / PTFE
6.	Casing	:	Stainless Steel
7.	Gland Rings /Followers/ Other wetted parts	:	Stainless Steel
8.	Orifice Plate	:	Stainless Steel (for bypass type)
9.	Operating Temperature	:	0-50 Deg. c

10.	Test Pressure	:	200% of maximum operating pressure
11.	Scale	:	250 mm nominal length
12.	Graduation	:	Direct reading
13.	Process Connection	:	Flanged (RF) to line size as per ANSI standards (150#)
14.	Tapping	:	D & D/2
15.	Accuracy	:	+/- 2% of full scale reading
16.	Reproducibility	:	Within 0.5% of instantaneous reading
17.	Accessories	:	SS Tag Plate, orifice plate

5.00.00 TEMPERATURE ELEMENTS & ACCESSORIES

5.01.00 RESISTANCE TEMPERATURE DETECTOR

1.	Type	:	Platinum (Duplex), Ungrounded
2.	Platinum (Duplex), Ungrounded	:	100 ohm at 0 ^{O}C
3.	Base	:	Wound on ceramic (anti-inductive)
4.	Wiring	:	3 Wire
5.	Protecting Tube		
	a) O.D.	:	6 mm
	b) Material	:	SS-316, Seamless
	c) Filling	:	Magnesium oxide (Purity above 99.4%).
6.	Response time	:	a) 15 sec. (bare). b) 30 sec. (with thermowell)
7.	Calibration	:	DIN 43760
8.	Accuracy	:	± 0.5%
9.	Head		
	a) Type	:	IP-65 universal screwed type

	b)	Material	:	Stainless Steel
	c)	Terminal blocks	:	Nickel plated Brass-screw type / silver plated
	d)	Cable connection	:	½" NPT gland and grommet
	e)	Others	:	Terminal head cover with SS chain and suitable gasket. Head of TE to be provided with sufficient space and arrangement to mount head mounted temperature transmitter (as applicable).
10.	Accessories		:	a) Adjustable nipple-union-nipple [1/2" Sch 80 X ½" NPT] with thermowell connection b) Compression fittings/unions c) Flanges etc. (for flanged connections only) d) Thermowell (As specified below)
11.	Thermowell connection		:	½" NPT (M) or 150 RF Flanged
12.	Nameplate		:	Tag number, service engraved in stainless steel tag plate

Note: The specifications for RTDs of winding/ bearing of motor/pump, can be as per their manufacturer standards. The manufacturer shall submit the adequate supporting documents for establishing their standard practice. However, the type of RTD shall be Pt-100.

5.02.00 THERMOCOUPLES

1. Type : a) 16 SWG wire of Chromel Alumel) (Type-K)
   b) Duplex
   c) Ungrounded
2. Protecting Tube
   a) O.D. : 6 mm
   b) Material : SS-316, Seamless
   c) Filling : Magnesium oxide (Purity above 99.4%).
3. Response time : a) < 20 seconds for measurement
   b) < 10 seconds for control
4. Accuracy : $\pm$ 1.1^0 C up to 300 ^{0} C & 0.4% of measured temperature range above 300 ^{0}C
5. Head
   a) Type : IP-65 universal screwed type
   b) Material : Stainless Steel
   c) Terminal blocks : Nickel plated Brass-screw type / silver plated
   d) Cable connection : ½" NPT gland and grommet
6. e) Others : Terminal head cover with SS chain and suitable gasket.

			Head of TE to be provided with sufficient space and arrangement to mount head mounted temperature transmitter (as applicable).
7.	Accessories	:	a) Adjustable nipple-union-nipple [1/2" Sch 80 X ½" NPT] with thermowell connection b) Compression fittings/unions c) Flanges etc. (for flanged connections only) d) Thermowell (As specified below)
8.	Thermowell connection	:	½" NPT (M) or 150 RF Flanged
9.	Nameplate	:	Tag number, service engraved in stainless steel tag plate

5.03.00 TEMPERATURE GAUGE

1.	Type	:	Expansion type (Liquid filled system)
2.	Sensing Element Material	:	Bourdon – SS-316
3.	Bulb and Capillary Material	:	SS-316
4.	Capillary Tubing	:	Inner sheath - solid drawn Material copper tube Outer sheath - PVC tube
5.	Movement Materials	:	Stainless Steel / Direct Bourdon tip connection to pointer spindle
6.	Case Material	:	Stainless Steel stove enameled, black finish, threaded bezel ring, clear glass

			cover conforming to IP 65.
7.	Dial size	:	150 mm
8.	Scale	:	Black lettering on white background in 270 Deg.C arc
9.	Over range protection	:	125 percent of FSD
10.	Capillary Glanding	:	1/2" NPT(M) x compression fitting (SS) to suit capillary
11.	Instrument Connection	:	Bottom connection for local mounting, back connection for panel mounting
12.	Process Connection	:	½" NPT (M) or 150 RF Flanged
13.	Extension Neck Length	:	50 mm
14.	Compensation	:	a) Capillary compensation
15.		:	b) Case compensation
16.	Performance	:	a) Accuracy : + /- 1.0 percent of full scale Deflection
		:	b) Repeatability : Less than 0.5 percent of full range
		:	c) Response time: 15 seconds (max.).
17.	Capillary length	:	3.0 meters (local) / 15.0 metres (local panel)
18.	Other features	:	Shatter proof glass
19.	Nameplate	:	Tag number, service engraved in stainless steel tag plate
20.	Accessories	:	SS316 Thermowell

5.04.00 THERMOWELL

1.	Material	:	SS-316
2.	Manufacture	:	Drilled from bar stock, Hex Head, Tapered design (As per ASME PTC 19.3)

3.	Process connection	:	M33x2
4.	Certification	:	Not applicable
5.	Bore concentricity	:	+5% of wall thickness
6.	Identification mark	:	Tag number punched on head
7.	Surface treatment	:	Polish after machining
8.	Element connection	:	½" NPT (M) or 150 RF Flanged
9.	Head	:	Hex
10.	Length of the hex head	:	31.75 mm (min.)
11.	Accessories	:	SS Plug and chain for test thermo wells SS Nameplate, Flange with companion flange & all required accessories for flanged connections.

Note: Wake frequency calculations shall be furnished for all thermowells for approval.

Thermowells shall be designed such that the resonant frequency is above the exciting frequencies generated by vortex shedding in the process fluid.

5.05.00 METAL TEMPERATURE THERMOCOUPLE

1.	Measuring medium	:	Metal temperature
2.	Type	:	Chromel Alumel (Type-K) Duplex, Ungrounded
3.	Insulation	:	Mineral Insulation Magnesium Oxide
4.	Wire gauge	:	16 AWG
5.	Protective sheath	:	SS
6.	Protective sheath diameter	:	8 mm O.D.
7.	Characteristics	:	Special limits of error as in ANSI thermocouple MC 96.01
8.	Accessories	:	½" BSP SS sliding end connector, weld pad, clamps of heat resistant steel

1.	Type	:	Hydrometer Type
2.	Mounting	:	On line
3.	Accuracy	:	+/- 2% of range
4.	Scale	:	Black letter on white scale
5.	End connection	:	PVC flange

9.06.00 DENSITY/ CONCENTRATION METER

1.	Wetted Part		Stainless Steel
2.	Enclosure		Stainless Steel (IP-65)
3.	Power Supply		24 V DC
4.	Output signal	:	4-20 mA DC (isolated) into 600 ohms
5.	Accuracy		±0.001 g/cc
6.	Indication	:	LCD display
7.	Temp. Compensation	:	Integral
8.	Accessories		Mounting hardware, integral amplifier (if required), cable glands, tag plate etc.

10.00.00 **SOLENOID VALVES**

1.	Operating Principle	:	Electromagnetic (noiseless)
2.	Coil voltage rating	:	240 V AC /24 V DC (as required)
3.	Ways	:	2/3/4 way
4.	Port size	:	1/4" NPT all ports
5.	Body	:	SS bar stock
	Trim	:	SS-316
6.	Duty	:	Suitable for continuous energization
7.	Sealing	:	Airtight and leak proof
8.	Ambient Temperature	:	0 - 50 ^{O} C

9.	Fluid Temperature	:	0-150 ^{O} C (approx.)
10.	Coil Enclosure	:	Stainless Steel
11.	Insulation	:	Class-H
12.	Coil Casing	:	IP-65 (Explosion proof for NEC Class-1, Division-1 area)
13.	Mounting	:	On pipe or on panel
14.	Cable Connection	:	½" NPT
15.	Accessories	:	Cable glands, SS Tag plate

Note : Solenoid valves shall be kept in pneumatic junction boxes only. Air distribution for SOV's shall be through SS manifold with SS isolation valves and auto drain traps and SS tubing from SOV to valves shall not be more than 6 meters.

PLC SPECIFICATION WITH CONFIGURATION DIAGRAM AND UPS SCHEME WITH SPECIFICATION

PROGRAMMABLE LOGIC CONTROLER (PLC) / PROPRIETARY CONTROL SYSTEM

1.00.00 **GENERAL**

1.01.00 Each of the relevant BOP areas and different auxiliary systems shall be provided with dedicated PLC or proprietary control systems for overall operation and control.

1.01.01 The Common DDCMIS network shall also control and monitor the packages envisaged for PLC based local control systems. Operator workstations shall be provided in CCR for the overall control and monitoring of each system through network.

There shall be redundant bidirectional OPC link between this Common DDCMIS network and each Packge PLC including PADO for monitoring / performance activities.

These areas have been indicated with other details in Section-V of this volume of the specification.

1.02.00 These control systems shall conform to high standard of engineering meeting all applicable codes and standard, design and workmanship and shall meet the functional requirements in all respects and shall be capable of performing satisfactorily in continuous commercial operation under the specified environmental condition.

1.03.00 Further this part of the specification details the common technical and functional requirements applicable for all the systems unless specified elsewhere in the specification. Only specific requirements are indicated in this section .However ,Bidder shall also adhere to the Section-VI , Subsection A (DDCMIS) of this volume of the specification for other basic and detailed scope & services , philosophy & technical requirements of different hardwares and softwares including response time , loading , interface , redundancy criteria , display , logs ,spares criteria , drawings and document submission etc.

1.04.00 All local PLCs shall be supplied from one manufacturer for all plants and shall provide single unified hardware and software platform for realizing all the control and monitoring functions.

1.05.00 In general local PLC, ,Proprietary control system by third party system integrators shall not be allowed and only main PLC/ Proprietary control system manufacturer shall be allowed to do the design engineering , system integration etc. Owner will be the final authority in allowing third party system integrators , if required , for only small applications

1.06.00 Common DDCMIS shall basically control and monitor the BOP package systems , as detailed in section V of the volume of specification , through the workstations from the Central Control Room (CCR) during normal operation of the plant.. However, local control and monitoring facility of the equipments from the respective package control room and local panels shall also be available. However, if required, based on operator choice, normal and emergency operation from the local PLC system shall also be done. The control room operator shall have also access to common database for all the packages.

1.06.01 The redundant upper level network of each Package PLC system will be connected to redundant server to be located in Plant Engineer's room. Suitable Fibre optic cable shall be used for redundant interconnections.

1.06.02 The hot redundant Server shall continuously update all the inputs. The switchover to the hot standby Server shall be smooth and bump less with proper indication to the operator.

1.06.03 In addition to local PLC Workstations , programming activities for control systems of all the packages including set point change , logic build up & modifications , graphics build up & modifications etc . shall also be achieved through Common DDCMIS network workstation.

1.06.04 Common DDCMIS Network workstations stations, local workstations shall have access to the processor of the individual package control system for programming. Programming shall not require special computer skills. On the programming console, it shall be possible to do the programming, self-diagnostics, testing of sequence, simulation and any sequence modification.

1.06.05 All the screens as available in the local package monitors will be also available one to one basis in the Common DDCMIS network screens. Alarm monitoring / reporting, generation of logs, trends, calculations, printing of logs & reports etc. shall be available in local workstations as well as in remote Common DDCMIS network workstations .In case of failure of Common DDCMIS network, control and monitoring of the individual packages shall still be possible from the Operator Work Stations in the respective package control room

1.06.06 There shall be flexibility in operation from CCR Common DDCMIS network operator workstations. Any of the BOP packages can be controlled and monitored from any of the workstations. .

1.06.07 The system shall permit carrying out of the on-line dynamic test and self-diagnostic checks while maintaining safe condition and without endangering the safety of equipment without having any influence on the process being controlled.

2.00.00 GENERAL TECHNICAL REQUIREMENTS

2.01.00 Bidders scope of supply shall include , but not limited to , Hot standby local PLC / Proprietary control & monitoring system for each of BOP areas and shall consist of IO cards, remote and Local IO rack, control rack, redundant Power supply modules, redundant communication /networking and interconnection Cables, redundant processor and communication cards, redundant Servers, operator work stations / GUI , LVS , printer, redundant networking hardware, redundant interface hardwares / softwares with DDCMIS , MCS , PADO etc. , system cabinets ,startup, commissioning, mandatory and recommended spares, drawing, documents and training to owner's personnels at site and at vendors works etc.

2.02.00 All types of programming packages shall be licensed with facility of editing and configuration. For each of the PLC / proprietary control system, the programming software shall be supplied in a laptop for each package

preloaded with package in addition to other types of devices such as CD, DAT etc.

2.03.00 In addition to the Operator and/ cum Engineering workstations , Bidder shall also supply LCD screen based display unit, control switches and other operational keys (GUI). Bidder shall also provide minimum of one no. laptop computer for each PLC based package and with latest hardware configuration and loaded with suitable operating , application program including licensed softwares as a backup engineering cum programming and configuration station. This loaded laptop shall be handed over by Bidder well in advance of FAT to Owner's head office at Hyderabad .

2.04.00 The System shall allow dependable and effective control of the process equipment and shall be designed for maximum integrity and reliability. Integrity shall be maintained by providing a dual hot redundant system .The System shall have a capability to monitor and take actions for distributed functions from a central location.

2.05.00 The control & Instrumentation shall be through dedicated microprocessor based PLC ,Common DDCMIS network ,proprietary system for the each of the respective plants covering the total functional requirement of sequence control, regulatory control, interlock & protection, monitoring, alarm, data logging.

2.06.00 The loop cycle time shall be less than 1 sec for close loops and open loops. The switchover from main controller to redundant controller shall be bumpless; and shall be within one cycle time i.e. within 50 msec.

2.07.00 Each controller shall have 40% functional capacity to implement additional functional blocks over and above implemented logic / loops under worst loading conditions.

2.08.00 Field Input/Outputs

The System shall meet the following I/O card requirements.
The maximum number of inputs / outputs to be connected to each type of module shall be as follows:

a)	Analog input module	8
b).	Analog output module	8
c)	Binary input module	16
d)	Binary output module	16

2.09.00 Communications System

2.09.01 The Bidder shall include a dual hot redundant communication system

2.09.02 The data highway speed shall be 1000 Mbps.

2.10.00 Operator Interface

Operator Work Station (OWS) / GUI / LVS shall perform control monitoring and operation of all auxiliaries/ drives . However , Push button stations are

also to be provided with RIOs as detailed out in Section V of this volume of the specification .

2.11.00 Interface with Common DDCMIS system

Each PLC , proprietary control systems shall be interfaced to Common DDCMIS network with bidirectional OPC link .The link shall be redundant.

2.12.00 PLC shall be of latest version and all the modules like Control modules, communication modules, IO modules, network interface modules etc., modules shall be from the same family of hardwares and softwares and shall be sourced from Bidder's Original Principlal's works.

2.13.00 PLC shall have also , but not limited to, the following requirements ,

2.13.01 I/O LAN Speed shall be minimum 5 Mbps - 100 MBPS on Deterministic LAN.

2.13.02 I/Os shall be Rack based and not Din Rail Mountable .

2.13.03 Processors and I/Os shall be of same family.

2.13.04 Channel Level Diagnostics for DI/DO, AI & AO shall be provided . Each individual Channel healthiness shall be monitored at workstation / GUI level.

2.13.05 All PLC I/O Rack Power Supplies shall be redundant. Only Bulk power supply redundancy will not be acceptable.

2.13.06 Processor shall have minimum 256 PID loops execution capability. Minimum memory shall be 10 MB. It should be 32 Bit.

2.13.07 SOE module (if applicable) must stamp and store 250+ events at card level.

2.13.08 PLC shall store tag details and bit word addresses on upload of logic as well as tag descriptions.

2.13.09 I/O Bit forcing in Primary to reflect in secondary immediately. (single scan update)

2.13.09 Remote I/O Rack outside control room shall be on Fiber Optic communication only.

2.13.10 Processor shall be self learning in case of failure. No need to configure and program replaced processor.

2.14.00 Operating work stations must be Runtime license/servers. Client server architecture no acceptable.

2.15.00 Each operator work station must have minimum 8000 tags handling capability.

2.16.00 Auto Tuning feature of PIDs at PLC controller level shall be available.

2.17.00 Floating IP selection of Controller under PLC processor switchover condition

2.18.00 Automatic Program update on secondary on loading to Primary Processor.

2.19.00 Programming facility shall be available from Remote IO stations.

2.20.00 Processor shall support minimum 22000 IO handling capacity in Redundant configuration.

2.21.00 Online editing of Program shall be possible.

2.22.00 Processors shall be Hot back up.

2.23.00 Automatic synchronization of primary processor/controller of PLC with secondary processor/controller.

2.24.00 Bumpless switchover to secondary processor/controller of PLC when the primary fails.

2.25.00 Power supply module redundancy shall be true power supply redundancy

2.26.00 Automatic program and data equalization of primary processor/controller of PLC.

2.27.00 Automatic 'Forcing Bit' update in the secondary processor/controller of PLC when any Forcing is applied in the primary processor/controller of PLC. (Forcing Bit Table of both the PLCs must be automatically synchronised.)

2.28.00 Communication speed of 5 Mbps between PLC and I/O module network

2.22.00 Softwares

The latest version of all necessary applications and networking software shall be supplied for the system. The software tool shall have facility to interface with third party software packages. Window base operating system shall be provided. The system shall be OPC compliant. Easy upgradation and future expansion facility shall be available.

All softwares used shall be licensed versions only. All software user licenses shall be valid for entire life of power plant. User shall not have to pay any recurring license fee during the usage period of the system.

It shall be possible to upgrade the installed system with the latest available version of the software model during the plant life.

2.23.00 Redundant Uninterrupted Power Supplies (UPS) shall be provided for each Local PLC.. UPS specification shall be as per requirements indicated in Section V of this specification.

	TITLE:	SPECIFICATION NO. PES-145-36	
BHEL	**SPECIFICATION FOR PROGRAMMABLE LOGIC CONTROLLER SYSTEM**	VOLUME **II-B**	
		SECTION **D**	
		REV. NO. 02	DATE: July 19, 2008
		SHEET 1	OF 9

1. SCOPE

This specification covers the Design, Manufacture, Assembly, Inspection and Testing at manufacturer's works, proper packing and delivery to site, erection and commissioning of the PLC Control & Monitoring System comprising PLC Control panel/Remote I/O panel (housing Processors, I/O cards, power supply packs etc.), Operator workstations(OWS), Printers, Annunciation system, UPS, cables and all other equipments and accessories required for completeness of the system as mentioned in different sections of this specification.

2. GENERAL

2.1. The PLC shall perform protection logic, interlock and sequential control functions such as binary logic operation, set/reset operation, timers, counters, logic blocks, math functions, input quality checking engineering unit conversion, Boolean functions & PID control (Analog logic function).

2.2. The system shall be redundant in processor, power supply and communication interfaces unless otherwise specified. The system shall have self-diagnostic features. The control of all drives and equipment shall be effected through the keyboard/mouse / panel mounted push button / control switches as per Data sheets-A&B.

2.3. The system shall have facility for connecting to Main Plant's Distributed control system (DCS) using hardware / software interface for two-way transfer of signals.

2.4. The mimic shall be displayed on the OWS screen and may also be provided on the control desk/panel (as per Data sheets).

2.5. In case OWS is provided, HMI functions like Trends, Curves, Bar charts, Historical storage of Data, Logs and reports etc. shall be provided in addition to Plant-schematics. The necessary catalogue / literature elaborating the features of HMI shall be supplied along with the bid.

2.6. It shall be possible to use the same OWS as programming station.

2.7. The PLC system shall be sized to meet process/system requirements as per the approved P&IDs and Control write-up.

2.8. The PLC system shall be designed to ensure that no single device failure should result in failure of any other device.

2.9. Signal multiplication where required shall be done in PLC. Use of relays for multiplication of contacts (for control, monitoring and alarm) is not acceptable. The control/ monitoring components on the control panel/ desk shall be driven through I/O modules.

3. TECHNICAL REQUIREMENTS

Details of various PLC system components shall be inclusive of but not limited to the following:

3.1. CODES AND STANDARDS

3.1.1. The equipment covered under this specification shall meet the requirements of latest edition of all applicable codes and standards like ANSI, NEMA, IEEE, IEC, NEC

3.1.2. PLC shall conform to IEC: 1131

3.1.3. The offered PLC shall comply with safety standards as per Data sheet-A&B.

3.2. CONTROL PANEL

3.2.1. PLC control panel shall be freestanding type with provision for mimic display, push-button stations, control switches, indicating lamps, metering instruments like Indicators, ammeters etc. and facia windows for critical alarms.

3.2.2. The salient features of construction shall be:

Sheet material: Cold rolled sheet steel
Frame thickness: Not less than 3.0mm
Enclosure thickness: Not less than 2.0 mm for load bearing sections (mounted with instruments) and Not less than 1.6 mm for others
Gland plate thickness: 3.0mm
Base channel: ISMC 100 with anti-vibration mounting & foundation bolts.

3.2.3. Each panel shall be identified by a name plate, which shall be of non-rusting metal or three ply lamicold, with engraved lettering.

3.2.4. 25 x 6 mm Copper ground bus to be provided for each panel.

3.2.5. 240V AC single phase, thermostatically controlled space heaters shall be provided. Each free standing panel shall have a door switch operated fluorescent lamp and a 240V AC plug point.

3.2.6. Painting treatment shall be as per IS: 6005. Two coats of lead oxide primer shall be followed by powder coating. Paint shade shall be as specified in the “Data sheet for PLC system”-Data Sheet-A&B.

3.2.7. The annunciation system shall be facia window type, driven by the PLC. Audible alarm, Acknowledge, Reset and lamp test facility shall be provided as per ISA sequence – S18.1, M.

3.3. PROCESSORS

3.3.1. The microprocessors shall be 32 bit, and Hot redundant.

3.3.2. Hot redundancy: PLC shall be provided with two processors (Main processing unit and memories) one for normal operation and one as hot standby. In case of failure of working processor, there shall be an appropriate alarm and simultaneously the hot standby processor shall take over the complete operation automatically. This transfer from main processor to standby processor shall be bump less and shall not cause any disturbance whatsoever. In the event of both processors failing, the system shall revert to fail safe mode. It shall be possible to keep any of the processor as master and other as standby.

3.3.3. An authorized forcing facility shall be provided for changing the status of inputs and outputs, timers and flags to facilitate fault finding and other testing requirements.

3.3.4. The standby processor shall be updated automatically in line with the changes made in the working processor.

3.3.5. In the event of any replacement of the processor, synchronization of the replaced processor shall be automatic upon live insertion.

3.3.6. The cycle time for input scanning, execution of logics, overheads and output scan shall not exceed 120 m sec.

3.3.7. The processor & memory shall be loaded up to 50% at normal conditions and maximum up to 60% under worst loading conditions.

3.3.8. The memories shall be field expandable.

3.4. INPUT / OUTPUT Modules

3.4.1. Input/output card assignments shall be modular i.e. no single card shall be assigned with more than one drive of a particular sub-system. The maximum number of channels per I/O module shall be as follows.

- Analog Input Module: 16
- Analog Output Module: 16
- Binary Input Module: 32
- Binary Output Module: 32
- Analog Input/output combined: 16
- Binary Input/output combined: 32

3.4.2. On line I/O replacement: All I/O cards shall have quick disconnect terminations allowing for card replacement without disconnection of external wiring and without switching off the power supply.

3.4.3. 10% spare capacity shall be ensured in each card channel assignment. Overall minimum 20% spare channels shall be provided.

3.4.4. Output command to MCC/Switchgear shall be through coupling relays, whose mounting location shall be as per "Data sheet A & B for PLC System". In case coupling relays are located in PLC Panel, the same shall be in PLC vendor's scope of supply.

3.4.5. Status feedback from MCC shall be in the form of potential free contact.

3.5. DATA BUS/ I/O BUS

3.5.1. The Data bus connecting PLC and HMI work stations shall be TCP/IP on Ethernet.

3.5.2. The Data bus and I/O bus communication medium shall be twisted pair shield copper conductor for indoor locations and those areas not subjected to induced signals. Repeaters/signal amplifiers shall not be used. Copper conductor cable used shall be Category-5 or better. The communication medium shall be Fibre optic cable in the event any portion of communication cable run is in outdoor or where distances are beyond 500 meters.

3.6. OPERATOR WORK STATION (OWS)

3.6.1. The OWS and Keyboard shall be desktop mounted and shall be used for controlling, monitoring and programming function.

3.6.2. Colour CRT(s) with keyboard and mouse shall be as per Data Sheet-A&B. CRT shall have graphic display facility.

3.6.3. The OWS shall be with Windows based operating system having necessary Engineering/Configuring software.

3.7. PRINTER

Printers shall be provided as per Data Sheet-A&B.

3.8. COMMUNICATION WITH PLANT DCS

3.8.1. The PLC system shall be provided with hardwired/serial interface for communication with plant DCS.

3.8.2. Serial communication to / from DCS where provided shall be engineered to ensure that signal communication time from / to DCS shall not exceed 1 seconds for control / feedback.

3.8.3. Serial communication to DCS shall be OPC (Data access 2.0), Ethernet based TCP/IP Protocol. Alternatively the serial communication shall be MODBUS protocol on RS 485 network.

3.8.4. Data transmitted from PLC to DCS shall include all information necessary for the DCS graphic displays to monitor and control the process equipment and PLC. Such data may include pertinent analog and digital status information, interlock, alarms and maintenance conditions. Data transmitted from DCS to the PLC shall include necessary signals to provide operator control interface from DCS for the process/ equipment being controlled by PLC.

3.8.5. Bidder to include 'Light interface units, converters, Ethernet switch, accessories at PLC end for connectivity to other system. The bidder's terminal point shall be Ethernet port in case of copper medium connection to DCS or LIU in case of Fiber optic medium for connectivity with plant DCS. In case distance between PLC & DCS is greater than 1.8 Km, single mode of optical fiber cable with compatible accessories shall be used. For distance less than 1.8 Km multimode optical fiber ports shall be used.

3.9. POWER SUPPLY Scheme

3.9.1. PLC Panel and I/O Cabinets: PLC system shall be provided with 2x100% UPS fed from Two Nos. redundant 415V, 3-ph feeders, ~~as per the scheme PE-SD-999-145-001, sh-08 of 08. Each UPS shall have 30 minutes back up.~~ Input feeder failure shall be monitored in the PLC system. Necessary redundant power pack and transformers shall be provided (in the PLC panel) to derive the power supply for control desk, PLC panel and input / output cabinets etc

3.9.2. Remote I/O panels: Similar power supply arrangement as for PLC panels shall be provided if it is not possible to extend the power cable form UPS of PLC panels.

3.9.3. Each OWS and associated HMI peripherals shall be provided with a feeder from either one of the UPS

4. DRAWING/DOCUMENT AND DATA TO BE FURNISHED AFTER AWARD OF THE CONTRACT:

4.1. For Approval:

- PLC system configuration drawing along with functional write-up.
- Input/Output signal list.
- BOM of PLC
- List of PLC controlled devices
- Control panel/control desk GA drawings.
- Control desk/panel component layout drawing.
- Control panel/control desk Foundation detail and cutout drawings
- Power distribution scheme.

- Block logic diagrams.
- Annunciation list.
- PLC control room layout drawing.
- List of soft signal exchange with Plant DCS.
- List of mandatory spares
- Quality plan
- Data Sheet-C
- CRT display
- Power supply scheme for PLC system, HMI & peripherals, Remote I/O etc.

4.2. For Information:

- Cable schedule and cable interconnection drawing(in BHEL approved format)
  - Between Field and PLC
  - Between Field and MCC
  - Between MCC and PLC
- Electronic earthing requirements.
- Panel Heat dissipation data
- Product/component catalogues.
- Operation & Maintenance Manual on CDs.
- Softcopy of Final/As-built drawings on CDs.
- Calculation for Processor, Memory & Data bus loading

The above list is the minimum requirements. Additional documents/calculations required shall be finalized during contract stage.

5. DRAWINGS AND DOCUMENTS TO BE SUBMITTED ALONG WITH THE BID

- Proposed PLC system configuration drawing with write-up
- Product catalogues and specifications for PLC as well as HMI application.
- Proposed power supply schemes for PLC system, peripherals, and Remote I/O panels.

6. TESTING AND INSPECTION

6.1. The bidder shall adopt suitable quality assurance program to ensure that the equipments offered will meet the specification requirements in full.

6.2. BHEL's standard Quality Plan for PLC is enclosed with the specification. The bidder shall furnish his acceptance to BHEL's QP and submit the signed and stamped copy of QP along with the offer.

6.3. The complete PLC system, including all instrument and devices shall be subjected to standard factory tests (i.e. Type Tests and Routine Tests) as per relevant NEMA, IEEE, IEC.

6.4. Factory Acceptance Test-FAT (Functional Tests) shall be performed prior to shipment and Owner/Purchaser shall be notified 15 days before the schedules dates of the test.

6.5. The certificates for following type tests, as per IEC Standard, shall be submitted: -

- Surge protection test as per IEC-225-4
- Dry heat test as per IEC-68-2-2
- Damp Heat test as per IEC-68-2-3

- Vibration Heat test as per IEC-68-2-6
- Electrostatic discharge test as per IEC-801-2 or equivalent
- Radio frequency Immunity test as per IEC-801-6 or equivalent
- Electromagnetic Immunity test as per IEC-801-3 or equivalent

7. SPARES AND CONSUMABLES

7.1. Commissioning Spares and consumables

The bidder shall supply all commissioning spares and consumables 'as required' during Start-up, as part of the main equipment supply.

7.2. Mandatory Spares

The bidder shall offer alongwith main offer, the Mandatory Spares as specified elsewhere in the specification. The Mandatory Spares offered shall be of the same make and type as the main equipment.

7.3. Recommended Spares

The bidder shall furnish a list of Recommended Spares indicating the normal service expectancy period and frequency of replacement; quantities recommended for 3 years operation alongwith unit rate against each item to enable BHEL/BHEL's Customer to place a separate order later, if required.

7.4. Special Tools & Tackles

The bidder shall supply all Special Tools & Tackles 'as required' during Start-up and further maintenance of the system, as part of the main equipment supply.

7.5. Spares, Service support

Bidder shall provide availability of spares and service support for minimum 10 years after guarantee period.

8. MARKING AND PACKING

8.1. Marking:

A stainless steel name-plate shall be permanently fixed on each equipment giving its Tag/serial Number and salient technical specification.

8.2. Packing:

All equipment/materials shall be suitably packed and protected for the entire period of dispatch, storage and erection against impact, abrasion, corrosion, incidental damage due to vermin, sunlight, high temperature, rain, moisture, humidity, dust, sea-water spray (where applicable) as well as rough handling and delays in transit and storage in open.

9. PERFORMANCE AND GUARANTEE

The PLC system shall be guaranteed to meet the performance requirement as specified and also for trouble-free continuous operation for 12 months from the date of commissioning or 18 months from the date of delivery at site whichever is later unless specified otherwise in Vol-IIB Section - B or Section - C.

10. APPLICABLE DATA SHEET FORMS

This document shall be read with the following data sheet forms :

- Data Sheet A & B for PLC system - PE-DC-999-145-I036-1
- Data Sheet C for PLC system - PE-DC-999-145-I036-2

FORM NO. PEM-6666-0

BHEL	**DATA SHEET FOR PLC SYSTEM**	SPECIFICATION NO.:	
		VOLUME	II B
		SECTION	D
		REV. NO. 02	DATE: 19.07.2008
		SHEET 1 OF 1	

Data Sheet No.: **PES-145-36-DS1-0**

Data Sheet A & B

		DATA SHEET-A FOR PLC SYSTEM (TO BE FILLED BY PURCHASER)	DATA SHEET – B (TO BE FILLED BY BIDDER)
GENERAL	PROJECT	5X800 MW YADADRI TPS	
	SERVICE		
	QUANTITY	☐ UNITISED ■ COMMON	
	LOCATION	■ INDOOR ☐ OUTDOOR	
PLC EQUIPMENT	MAKE / MODEL NO.	BIDDER TO INDICATE	
	PROCESSOR	REDUNDANT WITH HOT STANDBY	
	DATA BUS (HMI)	☐ COPPER WIRE ☐ FIBRE OPTIC	
	DATA BUS (I/O - CPU)	☐ COPPER WIRE ☐ FIBRE OPTIC	
	DATA BUS (REMOTE I/O - CPU)	☐ COPPER WIRE ☐ FIBRE OPTIC	
	FIELD CONTACTS INTERROGATION VOLTAGE	■ 24 V ☐ 48 V	
	LOCATION OF COUPLING RELAYS	■ MCC ☐ PLC PANEL	
	DESKTOP OWS QUANTITY	☐ ONE ■ TWO ☐ _____	
	DESKTOP MONITOR TYPE	☐ 19" ■ 24" TFT/CRT MONITOR	
	PRINTER (A4) - QUANTITY	INKJET _____ LASER B/W _____ COLOR INKJET _____ COLOR LASER _____	
	PRINTER (A4) - MODEL	■ DOT MATRIX (1 No.) _____ LASER B/W _____ ■ COLOR INKJET (1 No.) _____ COLOR LASER _____	
	PROGRAMMING / CONFIGURATION FACILITY	A) ☐ HAND HELD B) ENGINEERING SOFTWARE ■ ONE OWS ☐ ALL OWS ☐ _____	
	SAFETY STANDARD	_____	
	COMPUTER FURNITURE	■ YES ☐ NO	
PANEL	QUANTITY	BIDDER TO INDICATE	
	CLASS OF PROTECTION	☐ _____	
	REMOTE I/O PANEL	☐ YES ■ NO	
	COLOUR	AS PER IS-5 SHADE _____	
	BACK-UP DESK	☐ YES ☐ NO	
	MIMIC	■ YES ☐ NO	
	CONTROL HARDWARE	■ PB ■ INDICATORS ■ FACIAS _____ Nos. ☐ OTHERS	
COMMUNICATION TO OTHER SYSTEM	HARDWIRED	☐ YES ☐ NO	
	PURPOSE	■ CONTROL ☐ MONITORING	
	MEDIUM	☐ UTP ■ FIBRE OPTIC ☐ OTHERS	
	TIME SYNCRONIZATION SIGNAL FORMAT	☐ PULSE ☐ RS-485 ■ IRIG-B	
	SOFTLINK	☐ MODBUS ■ OPC	
	SERIAL LINK	COMMUNICATION PORT TYPE _____	
POWER SUPPLY INPUT FEEDER	PLC PANEL	a. 24V DC Charger for electronics b. 240V AC UPS for HMI/PRINTERS	
	REMOTE I/O PANEL		

FORM NO. PEM-6666-0

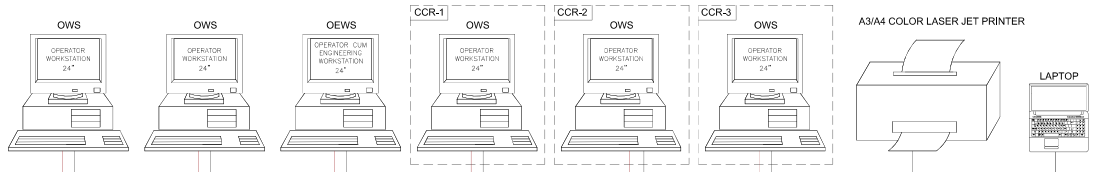
	DATA SHEET FOR PLC SYSTEM	SPECIFICATION NO.:	
		VOLUME II B	
		SECTION D	
		REV. NO. 02	DATE: 19.07.2008
		SHEET 1 OF 1	

Data Sheet No.: **PES-145-36-DS2-0**

Data Sheet C

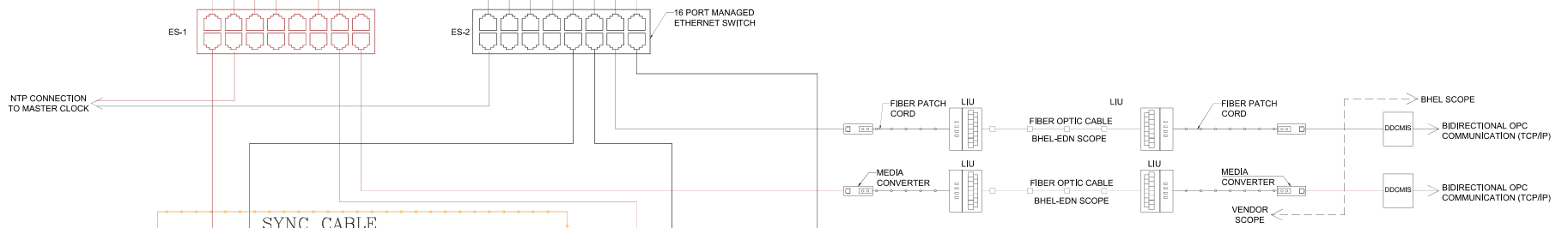
DATA SHEET – C
(TO BE FILLED BY BIDDER AFTER AWARD OF CONTRACT)

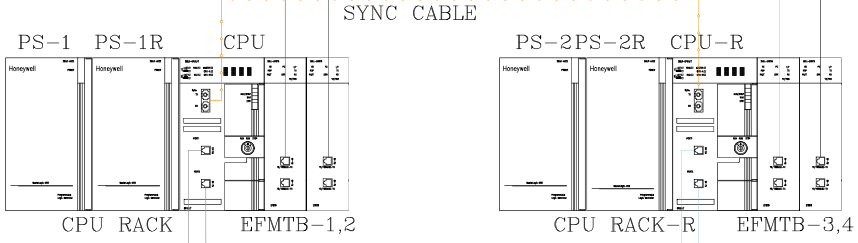
GENERAL*	PROJECT	
	SERVICE	
	QUANTITY	
	LOCATION	
PLC EQUIPMENT	MAKE / MODEL NO.	
	PROCESSOR	
	DATA BUS (HMI)	
	DATA BUS (I/O - CPU)	
	DATA BUS (REMOTE I/O - CPU)	
	FIELD CONTACTS INTERROGATION VOLTAGE	
	LOCATION OF COUPLING RELAYS	
	DESKTOP OWS QUANTITY	
	DESKTOP MONITOR TYPE	
	PRINTER (A4) - QUANTITY	
	PRINTER (A4) - MODEL	
	PROGRAMMING / CONFIGURATION FACILITY	
	SAFETY STANDARD	
	COMPUTER FURNITURE	
PANEL	QUANTITY	
	CLASS OF PROTECTION	
	REMOTE I/O PANEL	
	COLOUR	
	BACK-UP DESK	
	MIMIC	
	CONTROL HARDWARE	
COMMUNICATION TO OTHER SYSTEM	HARDWIRED	
	PURPOSE	
	MEDIUM	
	TIME SYNCRONIZATION SIGNAL FORMAT	
	SOFTLINK	
	SERIAL LINK	
POWER SUPPLY INPUT FEEDER	PLC PANEL	
	REMOTE I/O PANEL	



IO COUNTS			
IO	Used	Total With 20% Spares	Total wired IOs
DI	40	48	48
DO	76	91	96
AI	78	94	96
MODBUS	1	--	1

CAT 6 CABLE ETHERNET
CAT 6 CABLE ETHERNET
CAT6 CABLE I/O LINK - A
CAT6 CABLE I/O LINK - B
FIBER PATCH SYNC CABLE
FIBER PATCH CORD
FIBER OPTIC CABLE

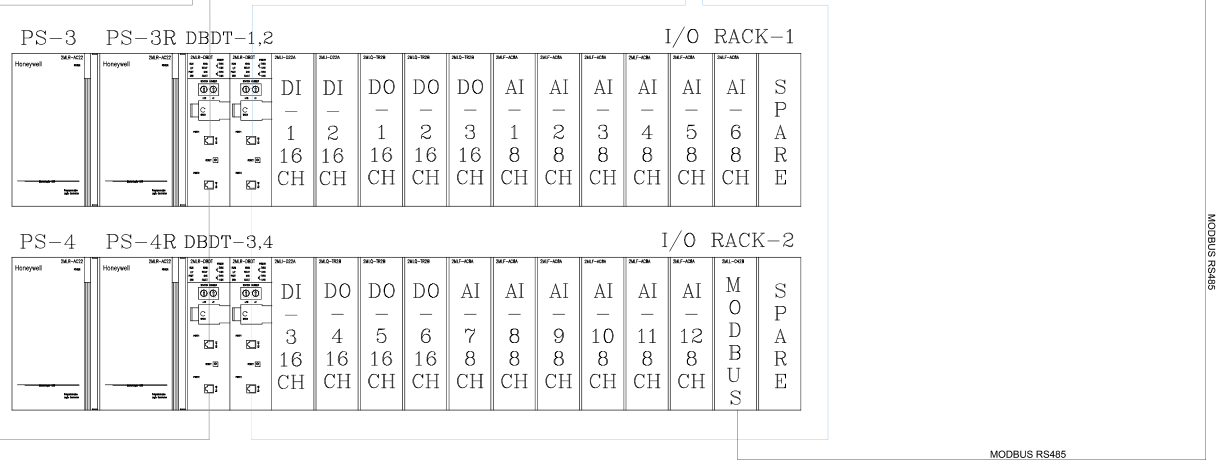




(*NOTE-1)

PANEL DOOR MOUNT 10" HMI MANUAL BACKUP PANEL

24 WINDOW ANNUNCIATOR



ANNUNCIATOR WINDOW DETAIL

Sr. No.	Description
1	Skid-1 DM Tank Level LT LL
2	Skid-1 Rectifier current high HH
3	Skid-1 Rectifier voltage High HH
4	Skid-1 O2 separator Inlet Temperature TE HH
5	Skid-1 H2 separator Inlet Temperature TE HH
6	Skid-1 O2 separator Pressure HH
7	Skid-1 O2 separator Level LL
8	Skid-1 O2 separator Level HH
9	Skid-1 Lye Flow DPT LL
10	Skid-1 Lye Flow DPT HH
11	Skid-1 H2 LeakDetector HH 4%
12	Skid-2 DM Tank Level LT LL
13	Skid-2 Rectifier current high HH
14	Skid-2 Rectifier voltage High HH
15	Skid-2 O2 separator Inlet Temperature TE HH
16	Skid-2 H2 separator Inlet Temperature TE HH
17	Skid-2 O2 separator Pressure HH
18	Skid-2 O2 separator Level LL
19	Skid-2 O2 separator Level HH
20	Skid-2 Lye Flow DPT LL
21	Skid-2 Lye Flow DPT HH
22	Skid-2 H2 LeakDetector HH 4%

(* NOTE-1)

10" Touch Screen HMI shall act as Backup Control System. The screen on HMI shall be developed in such a way that it provide manual backup control and indications related to process. HMI shall be directly connected to PLC system and shall act as Backup control panel in event of Failure of OWS & EWS system.

REV.	DESCRIPTION	DATE	DWN.	CHKD.	APPD.
R4	ISSUED FOR APPROVAL	18.11.2023	KK	KA	RD
R3	ISSUED FOR APPROVAL	25.08.2023	KK	KA	RD
R2	ISSUED FOR APPROVAL	11.07.2023	KK	KA	RD
R1	ISSUED FOR APPROVAL	10.04.2023	KK	KA	RD

NOTE: All Dimensions are in mm.

PROJECTION

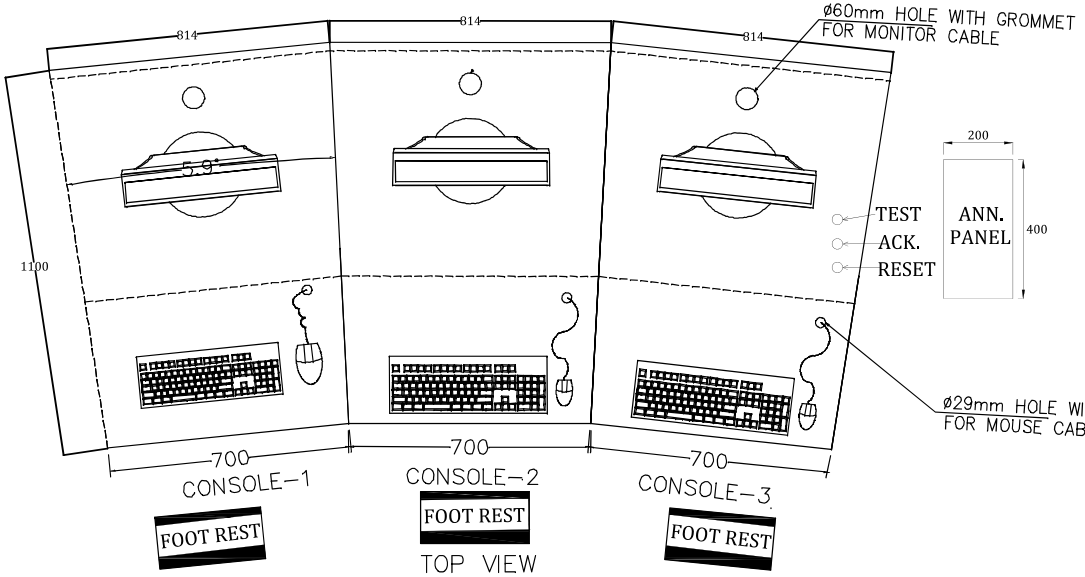
TITLE: PLC SYSTEM ARCHITECTURE DRAWING

PROJECT: PLC SYSTEM FOR HYDROGEN GENERATION PLANT

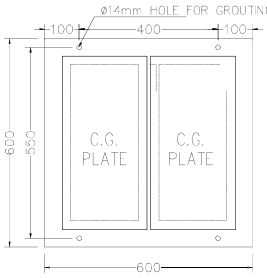
DWG NO.: LASPL/BHEL/DE001

PO. NO.: ANE/GGN/20230310/YAD/0622 DATE: 10.03.2023 Sht.: 001 Cont.on: 001 SCALE: NTS

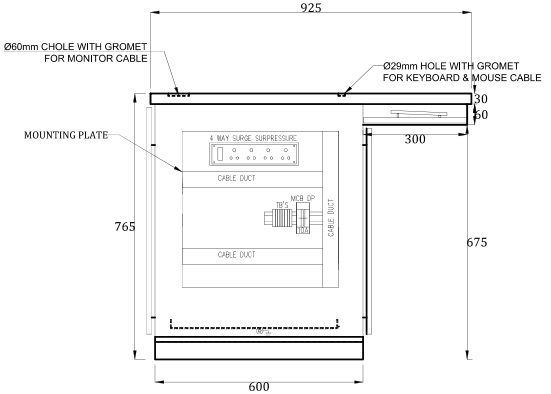
A3



TOP VIEW

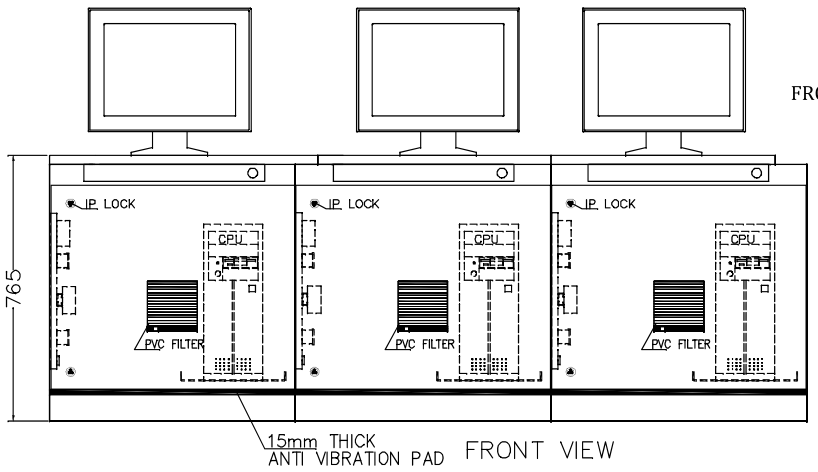


BASE FRAME

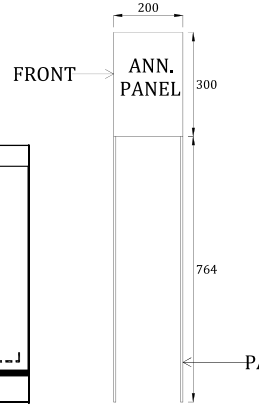


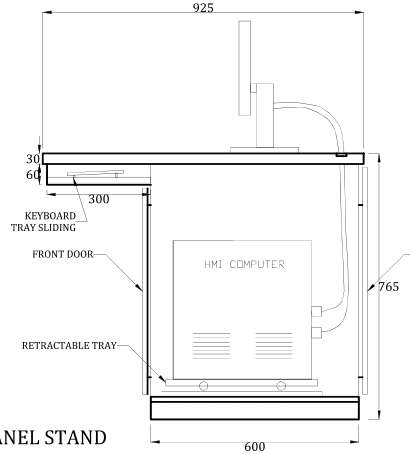
INTERNAL L.H.S. VIEW

NOTE: IA & GA IS TENTATIVE IT MAY BE CHANGE AT THE TIME OF FINAL ASSEMBLEY.

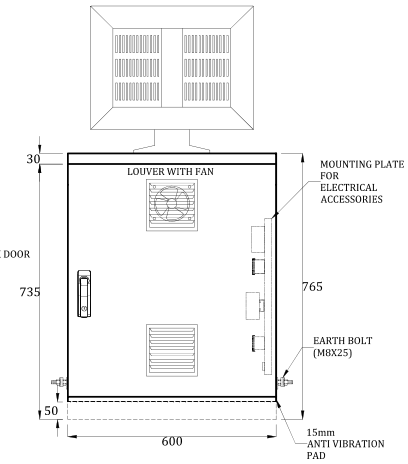


FRONT VIEW





SIDE VIEW



REAR VIEW

REV.	DESCRIPTION	DATE	DWN.	CHKD.	APPD.
R3	ISSUED FOR APPROVAL	17.11.2023	KK	KA	RD
R2	ISSUED FOR APPROVAL	11.07.2023	KK	KA	RD
R1	ISSUED FOR APPROVAL	10.04.2023	KK	KA	RD
R0	ISSUED FOR APPROVAL	20.03.2023	KK	KA	RD

NOTE:
All Dimensions are in mm.

PROJECTION

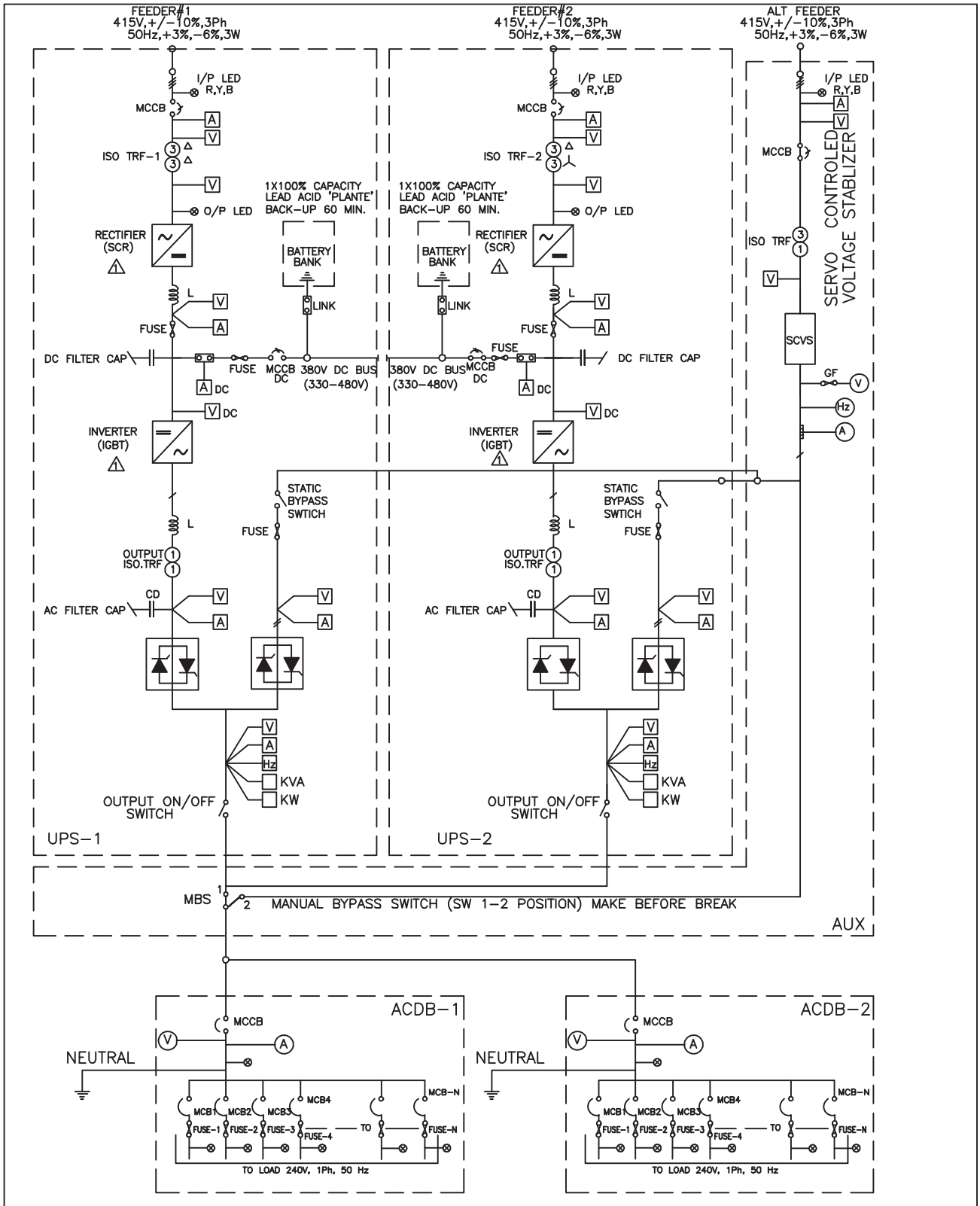
TITLE: PC CONSOLE IA & GA DRAWING

PROJECT: PLC SYSTEM FOR HYDROGEN GENERATION PLANT

DWG NO.: LASPL/BHEL/DE001

PO. NO.: ANE/GGN/20230310/YAD/0622 DATE: 10.03.2023 Sht.: 002 Cont.on: 004 SCALE: NTS

A3



BHEL	5X800 MW YADADRI TPS, NALGONDA	DRG. No.	PE−DG−417−145−I004	
	TITLE:− UPS SINGLE LINE DIAGRAM	REV. No.	01	DATE 03.11.18
		SHEET	2 OF 3	

L1

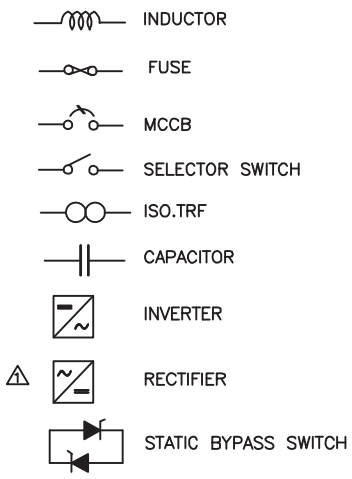
NOTES:

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 LOCATED IN DIFFERENT ACDBs.
4. SINCE, THIS DIAGRAM IS AN SLD FOR UPS, DETAILS REGARDING SIZING HAVE NOT BEEN SHOWN. BHEL–EDN SHALL DO THE SIZING AND PREPARE TECHNICAL SPECIFICATION FOR PROCURING THE UPS.
5. THE FOLLOWING LIST OF ESSENTIAL SIGNAL EXCHANGE BETWEEN PLC AND DCS SHALL BE BOTH HARD WIRED (4–20MA) AND THROUGH THE SOFT SIGNALS.
   - A. UPS MAIN INPUT VOLTAGE AND CURRENT
   - B. CHARGER OUTPUT VOLTAGE ⚠1
   - C. BATTERY CHARGING AND DISCHARGING CURRENT
   - D. INVERTER OUTPUT VOLTAGE AND CURRENT
   - E. ACDB OUTPUT VOLTAGE AND CURRENT
   - F. INVERTER OUTPUT POWER FACTOR
   - G. SCVS O/P VOLTAGE, CURRENT.
   - H. AFTER LINE TRANSFORMER–1&2 VOLTAGES.
   - I. DC VOLTAGE, & CURRENT
   - J. STATIC SWITCH MAIN I/P , ALTERNATE I/P VOLTAGE
   - K. UPS–1&2 –KVA,KW O/PS.
   - L. UPS–1&2 POWER FACTOR, SYSTEM& GRID FREQUENCY.
   - M. EMERGENCY AC SUPPLY VOLTAGE & CURRENT.

ALL THE UPS INPUTS/OUTPUTS SIGNALS SHALL BE INDICATED IN I/O LISTR

6. IGBT'S WILL BE PROVIDED IN INVERTER CIRCUIT AND SCR'S WILL BE PROVIDED IN RECTIFIER CIRCUIT. ⚠1

LEGEND:



BHEL	5X800 MW YADADRI TPS, NALGONDA	DRG. No.	PE–DG–417–145–I004		
	TITLE:– UPS SINGLE LINE DIAGRAM	REV. No.	01	DATE	03.11.18
		SHEET	3 OF 3		

TECHNICAL SPECIFICATION
FOR
UNINTERRUPTIBLE POWER SUPPLY

CONTENT

ATTACHMENTS

SECTION-XIV

TECHNICAL SPECIFICATION FOR UNINTERRUPTIBLE POWER SUPPLY

1.00.00 SCOPE OF WORK

1.01.00 Scope of Supply

The scope of supply shall include Uninterruptible Power Supply (UPS) Systems with parallel redundant arrangement as specified below for Main Plant, 400kV Switchyard control room, CHP control room with PLC system & associated RIOs and other PLC based control systems of off-site packages specified elsewhere in the specification.

Two (2) sets of UPS in Main Plant, out of which one (1) set for main TG, SG,Station, C&I etc of MAIN PLANT systems, 2nd set for common DDCMIS/PLC systems for the PLC/DCS systems of air compressor, online tube cleaning system, HVAC system, fire detection panel in CCR, which are in TG building & OWS systems of Plant Water System, AHP,CHP etc systems (which are placed in CCR common control desk)

i) Each set of UPS system will consist of :

a. 2x100% capacity static inverter & input isolation transformer

b. 100 % capacity static switches (2 nos.)

c. One manual bypass switch

d. 2x100% capacity float-cum-boost chargers

e. 2x100% capacity UPS system battery (Lead Acid Plante Type) with back up time of 1 hour.

f. One step down transformer; (415 V three phase to 240 V single phase) for bypass

g. One static voltage regulator

h. Two AC distribution boards (ACDB-1A and ACDB-1B)

i. Interconnecting cable between UPS Equipment, battery and ACDB.

j. Two (2) nos. input output isolation transformer

Any other equipment necessary for complete of the system

ii) One (1) set of special tools and tackle.

iii) Mandatory Spare parts.

iv) All relevant drawings, data and instruction manuals.

2.00.00 **CODES AND STANDARDS**

a) All equipment and materials shall be designed, manufactured and tested in accordance with the latest applicable Indian Standards (IS) except where modified and/or supplemented by this specification.

b) Equipment and materials conforming to any other standard which ensures equal or better quality may be accepted. In such case, copies of the English version of the standard adopted shall be submitted along with the bid.

c) The electrical installation shall meet the requirements of Indian Electricity Rules as amended up to date and relevant IS Codes of Practice. In addition, other rules or regulations applicable to the work shall be followed.

3.00.00 **DESIGN CRITERIA**

3.01.00 **Design Basis**

a) UPS System provides a regulated and uninterrupted single phase A.C. power, within specified tolerances, to critical station loads during normal and emergency operation. Capacity of inverter output shall be computed by the contractor considering the above requirement. 25% spare margin shall be kept on the total of above requirement.

b) The UPS system excluding its battery shall be installed indoors in A.C. environment.

c) UPS shall be worked at its full capacity even battery is not connected with the system.

d) UPS system shall be compatible for satisfactory and well-coordinated operation with other related equipment as well as with input and output systems.

e) Energizing or de-energizing any portion of the system serviced by the UPS shall not cause output changes which will affect the operation or integrity of the remaining portions of the system in any way.

f) The equipment shall be self-protecting against all A.C. and D.C. transients, voltage surges and steady state abnormal voltages and currents.

g) The circuit protection shall be coordinated with UPS short circuit capacity and protective device characteristics so that a fault on any circuit shall result in minimum loss of function.

h) All non-interrupting components of UPS system shall be capable of withstanding the prevailing short circuit current without damage.

i) All circuit interrupting components shall be capable of withstanding and interrupting the prevailing short circuit currents without damage.

j) The procedure for battery sizing calculation shall be generally as per relevant IEEE, considering design margin as 15% and aging factor as 1.25

k) For continuous operation at specified ratings, temperature rise of the various components of UPS system shall be limited to the permissible values stipulated in the relevant standards and/or this specification.

l) The chargers, inverters, static switches, regulating transformers and voltage stabilizers should be arranged in such a way that any equipment can be fully isolated for maintenance without affecting in any way the operation of other panels/components.

m) The chargers, inverters, static switches, regulating transformers and voltage stabilizers should be arranged in such a way that any equipment will be fully isolated for maintenance without affecting in any way the operation of other panels/ components.

n) In the A.C. Distribution Board, the Bidder shall provide 10% or minimum one (1) no. spare feeder of each size and type of the outgoing feeders.

o) All the cooling fans inside the panels shall be of industrial grade only.

3.02.00 **System Concept**

System Concept

a) A.C. power source are available to the UPS system. The system is so designed that its load shall be served without interruption as long as one of the above power sources is available within specified limit of voltage and/or frequency.

The UPS will consist of two physically separate sets of equipment streams each consisting of the following:

i) One set of converter to convert incoming 240V, 1 Ph, 50 Hz A.C. power to suitable D.C.

ii) One set of suitable Battery Bank to get charged by the above referred converter and to feed the inverter described below.

iii) The Float-cum-Boost charger will be normally ON, supplying the DC load current and at the same time trickle charging the battery. The characteristics shall be such that if load is high and exceeds the charger capacity, the excess load shall be supplied by the battery.

iv) The Float-cum-Boost charger shall be provided with Solid State electronic regulators to prevent rising of charging current to avoid thermal runaway of the batteries.

v) The float-cum-boost charger shall also have provision for float, equalizing and boost charging the battery through manual selection.

vi) Output of the chargers shall be controlled automatically as well as manually. AUTO/MANUAL selector switch along with voltage/current setter shall be provided for this purpose.

vii) For ungrounded DC system, suitable ground fault detection system shall be provided in the battery charger panel to detect ground fault on either polarity for annunciation in charger panel.

viii) The batteries shall be so sized as to meet emergency load duty cycle requirements for one (1) hour as referred in Annexure-A. All momentary loads shall be treated as one-minute loads.

ix) One set of inverter to take D.C. input from above referred converter - Battery assembly output and to produce high quality 240V, 1Ph 50 Hz A.C. output power.

x) One set of standby bypass stream consisting of suitable transformer, voltage stabilizer etc. to produce regulated 240V, 1 Ph. 50 Hz A.C. power from new input 240V, 1 Ph. 50 Hz A.C. power.

xi) One set of static switch, synchronizing circuit to parallel the above-mentioned Inverter output and bypass stabilized raw power stream.

xii) One UPS A.C. power distribution board with suitable no. of output feeders.

Two sets of equipment streams as mentioned above will constitute the UPS system.

One set of synchronizing equipment and high performance static switch will parallel the above two streams and common output will be taken to loads which can accept only single non-redundant power input source.

For equipment requiring dual redundant input power source, separate cables will be taken from the individual UPS Power Distribution Boards of the above-mentioned two UPS streams.

The system will ensure highest system availability around 99%.

b) Each of the two UPS streams will be of 100% capacity and will normally work, each sharing 50% load. On failure of any stream, its load gets automatically transferred to the other inverter through static transfer switch.

c) If one UPS stream is out of service for any reason then the second UPS stream will be working with 100% UPS load.

d) Inside each stream on failure of its converter/battery/inverter assembly the standby A.C. source will back up to supply the 100% UPS load automatically through static transfer switch.

3.03.00 **Layout Criteria**

The UPS system will be located indoor.

The Contractor shall indicate the space requirement for the equipment offered by them separately for UPS cabinet, UPS battery and UPS distribution board.

Battery room ventilation shall be under the scope of the Contractor.

4.00.00 **SPECIFIC REQUIREMENTS**

4.01.00 **Static Inverter**

a) The static inverters shall be static type consisting of IGBT PWM type inverter, static filters, integrated control modules including necessary oscillators, voltage regulators, current limiting and surge suppression.

b) The inverter equipment shall include all necessary circuitry and devices to conform requirements like voltage regulation, soft start, transient recovery, protection, automatic synchronisation, wave shaping, etc. as specified herein.

c) Upon transfer of full load, the inverter output voltage shall not drop below 80% of nominal voltage during the first half cycle after transfer and 90% of nominal voltage in the next half cycle. The recovery to within $\pm$ 2% of voltage shall be in less than 50 milli-seconds.

d) On occurrence of a fault in branch circuit, the inverter shall be capable of clearing the highest rated branch circuit fuse in 4 milli-seconds or less.

e) The inverter shall be protected against overload, short circuit, 100% loss of load, as well as excursions, loss or restoration of D.C. input voltage and synchronising voltage. The overload capacity shall be 125% for 10 mins., 150% for 60 secs. and 300% for 4 msecs.

f) The D.C. input current shall never exceed twice the full load current except for a short circuit within the inverter.

g) For any value of the load and load power factor drawn by the equipment served, the inverter shall not impose on D.C. source any voltage oscillations in excess of 5 volts (RMS total all frequencies) or any current oscillations in excess of 3 percent (RMS total all frequencies) of the D.C. current at full load.

h) The inverter will be self protecting against A.C. and D.C. Transients, voltage surges and steady state abnormal voltage and currents likely to be encountered in the plant.

4.02.00 **Automatic Synchronisation**

a) Inverter equipment shall include stable solid state oscillator devices designed to automatically maintain the inverter output in phase and in synchronism with the stand-by A.C. source.

b) Facility shall be provided for automatic transfer to internal oscillator operation when the stand-by source frequency is beyond specified limits and the frequency shall be automatically controlled within 50 Hz plus or minus 0.5 Hz when the inverter operates in this mode.

c) Retransfer to stand-by A.C. source for synchronisation shall be automatic after the stand-by source frequency is restored to permissible limits and remains within this limit for an adjustable time delay period (up to 5 seconds).

d) Provision shall be made for stepless adjustment of synch- disconnect frequency range from 50 Hz $\pm$ 0.5 Hz to 50 Hz $\pm$ 2 Hz.

e) Automatic adjustment of phase relationship between inverter output and stand-by A.C. source shall be gradual at a controlled slow rate, which shall not exceed one hertz per second.

4.03.00 **Static Transfer Switch**

a) The static transfer switch shall be solid-state type using SCR for automatic/manual transfer of load from "inverter" to "stand-by" source and vice-versa.

b) Stand-by source can be either of the inverter or A.C. source depending on whether both the inverters are supplying 50% load each or one of the inverter is carrying 100% load.

c) The transfer time including sensing shall not be more than one-fourth cycle. Further the transition shall be make-before-break in both directions.

d) The capacity of static transfer switch shall be equal to the continuous full-load capacity of the inverter. The switch shall be provided with protective devices in both normal and alternate power source.

e) Static transfer switch shall be furnished with contact to alarm failure of the alternate source or opening of any fuse protecting the static switch.

f) Static transfer switch shall include all necessary circuitry and devices to meet the functional requirements of transfer initiation, transfer inhibit and re-transfer back to normal as detailed below

g) Transfer Initiation

i) The transfer of static switch from normal 'Inverter' position to 'stand-by' position shall be initiated by one of the following causes.

- Inverter failure and UPS system trouble
- Inverter output voltage failure.
- Manual push button operation

ii) 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 transfer switch.

iii) The static switch shall automatic transfer the load from inverter to stand-by source when the maximum I^2t capability of the inverter is reached and when the inverter output drops below 90%.

h) Transfer Inhibit

Automatic or manual transfer from inverter to stand-by A.C. source vice versa shall be inhibited when the inverter frequency is not synchronised to the alternate source.

i) Retransfer to Normal

1) The return to inverter mode shall be manual in all cases.

2) Manual transfer shall be initiated by push button actuation.

4.04.00 **Manual By-pass Switch**

a) Manual by-pass switch is used to isolate any static transfer switch for maintenance or repair without interruption to the UPS load.

b) The switch has also the facility of by-passing both the static transfer switches during start-up at the option of the operator.

c) Switch contact shall be make-before-break type.

d) The switch shall have current rating equal to the full load inverter current and necessary short time load carrying and interrupting capacity to meet the requirement of UPS system.

4.05.00 **Battery**

a) General

i. Each set of battery shall consist of number of cells assembled together on mounting racks.

ii. The battery shall be flooded cell Lead acid PLANTE type and shall be suitable for operating satisfactorily in humid and corrosive atmosphere. The batteries will be suitable for float /boost charging and will be suitable for continuous operation.

iii. The equipment shall comply with the requirement of latest revision of Indian standards issued by BIS (Bureau of Indian Standards): IS: 1652:1991 and IEEE Std. 485 for Lead Acid (Plante) Battery.

In case Indian Standards are not available for any equipment, Standards issued by IEC/BS/VDE/IEEE/NEMA or equivalent shall be applicable.

iv. Autofill system

Bidder to provide complete system for automatic water filling (topping-up) of lead acid plante' type batteries to avoid spillage of water and acid which spoils environment. The autofill system shall be intelligent and efficient where replenishment of water is done automatically without manual intervention. The water enters the cell through the 'autofil plug' and raises the electrolyte to a preset level controlled by the float. The float raises and closes the valve in the plug by a 2.5:1 level action. When the electrolyte level drops the float operated valve will open automatically Bidder to provide the total system including necessary storage tank, pipelines, autofill plugs and all peripherals etc. The material of all parts shall be acid proof plastic material.

b) Technical Requirement

i) The battery shall be heavy duty type suitable for power plant duty with float duty operation at constant voltage permanently applied to its terminals which is sufficient to maintain the limits of +10% and -15% of the nominal system voltage at any time during the duty cycle in state close to full charge and shall be designed to supply the load in the event of normal power supply failure.

ii) The rated ampere hour capacity of the cell/battery shall be at reference temperature of 27ºC, constant current discharge at 10 hours rate (C10) for Plante type Battery to meet end cell voltage of the Cell. A design margin of 20% shall be considered.

iii) The battery shall be suitable for being boost charged to fully charged condition from fully discharged condition within eight (8) hours.

iv) The batteries shall be so sized as to meet emergency load duty cycle requirements for one (1) hour. All momentary loads shall be treated as one-minute loads.

v) For PLANTE type Battery it shall be supplied uncharged for flooded cell with the electrolyte furnished in a separate non-returnable container. 10% extra electrolyte shall be furnished to cover spillage in transit or during erection.

vi) Each battery set shall consist of a group of cell electrically connected in series to attend the nominal voltage level specified on the data sheet. The terminal cells shall be supplied with connectors for termination to the charger. The supplier shall provide inter-cell connectors and related hardware and accessories required for normal operation and maintenance. All cell posts shall be shrouded and connectors insulated. Nickel plated copper shall be furnished to connect up cells of Battery set. For lead acid battery to prevent corrosion all copper/ brass material shall be effectively coated with lead.

vii) Cell container shall be made of heat resistant, tough translucent polypropylene (SAN) material to make the cell mechanically sturdy and facilitate visual electrolyte level checks for ease in of maintenance.

viii) The cell terminals posts shall be provided with connector bolts and nuts, made of Nickel plated steel or lead coated copper/brass material to prevent corrosion. The terminals shall be suitable for short circuit current and specified discharge current without damage to cell as a result of terminal heating.

ix) Flame arresting flip-open/ or ceramic vent cap shall be provided on the cell to avoid explosion and contamination.

x) The following information shall be permanently marked on the cell :

- Nominal voltage.
- Name or manufacturer/model reference.
- Rated capacity in ampere hour (Ah) with End Cell Voltage.
- Voltage for float operation of 27° with tolerance of ±1%.
- Month and year of manufacture.

xi) Battery racks shall be constructed of best quality teakwood with at least three (3) coats of electrolyte -resistant paint of approved shade forming a rigid structure. Cell shall be supported on PVC/porcelain/Hard Rubber insulator fixed on the rack with adequate clearance between adjacent cells.

xii) Each set of battery shall be equipped with a automatic battery condition (Health check) and performance monitoring system. The battery monitoring system shall compare measured figure during a partial discharge against stored characteristics for the type and capacity of the battery. The system shall be able to test, analyse and predict the battery performance, computing remaining capacity and battery efficiency. The automatic battery monitoring system shall compensate for cell temperature and discharge load current throughout the discharge cycle, premature failure of the batteries etc. The system shall have a programmable event log shall be secured in

the event of total power failure for a period upto six month. In addition to local indication and control the battery monitoring system shall include an RS. 232 output port to enable battery parameters and alarms to be monitored from plant DCS

4.06.00 **Float-cum-Boost Charger**

4.06.01 The charger shall be solid-state type with full wave fully controlled, bridge configurations. It shall be suitable for the inverter of IGBT type.

4.06.02 The charger shall be provided with automatic voltage regulation, current limiting, smoothing filter circuit and soft-start feature.

4.06.03 The charger shall have the provision of float, equalizing and boost charging. Further the charger shall be suitable for single and parallel operation.

4.06.04 Suitable circuitry shall be provided to ensure that the charging current is voltage regulated and current limited.

4.06.05 Each charger shall be rated to meet 100% UPS load plus recharge the fully discharged UPS battery within 8 hours.

4.06.06 Voltage control shall be stepless smooth and continuous. Float & equalizing control shall have an adjustable range of ± 5%.

For Other details as given in sub-section of Battery & Battery charger specification

4.07.00 **Step-down transformer and voltage stabilizer**

a) A three phase to single phase transformer along with associated voltage stabilizer shall be furnished with the UPS system.

b) The transformer and stabilizer shall be sized for 100% UPS load and shall coordinate with the largest branch circuit protection device for feeder short circuit current without sacrificing voltage regulation.

c) The voltage stabilizer shall employ silicon solid state circuitry and shall maintain the specified output voltage for 0 to 100% load with maximum input voltage variation as indicated in the annexure.

d) Provision shall be kept for dead closing of static transfer switch from stabilizer circuit to inverter when the output of the stabilizer is zero, but at that time the inverters are running.

4.08.00 **A.C. Distribution Boards**

a) The distribution boards shall be fixed type, of modular design in freestanding gasketted sheet steel enclosure conforming to IP-54. Sheet steel thickness shall be 2 mm minimum.

b) Each module shall be housed in a separate compartment complete with individual front access door. Working height shall be limited to 1800 mm from floor level.

c) A full height vertical cable alley shall be provided in each panel to facilitate module wiring. The alley shall be liberally sized and shall have removable cover at the front. Removable back covers shall be provided at the back of the panels.

d) Switches shall be double pole, air break, heavy duty type, capable of safely making and breaking the full load current of associate circuit.

e) Switch handle shall have position indicator and provision of padlocking in ON & OFF positions. Further it shall be interlocked with access door for safety.

f) Fuses shall be HRC, preferably link type, design to permit easy & safe replacement.

Visible indication shall be provided for indication of fuse.

4.09.00 **UPS Cabinets/Enclosures**

a) The UPS system components shall be housed in a sheet steel freestanding IP-42 enclosure with all access from the front. Sheet steel thickness shall be 2 mm minimum.

b) The enclosure shall consist of vertical cabinets housing modules in rack type sub-assemblies, connected mechanically and electrically to form a rigid, self-supporting, metal enclosed structure.

c) The modular units shall be mounted in pull out and/or swing trays. Each module shall be capable of being easily removed to provide for the ready inspection of major solid-state devices.

d) Vertical wiring trough shall be provided for the entire height of the UPS cabinet. Cable entry shall be from bottom only.

e) Adequate ventilating louvers and screens shall be provided. The top of the panel shall be protected by a suitable drip cover to prevent entrance of falling liquid and foreign material.

f) If the equipment supplied requires forced air cooling, the cooling system furnished shall meet the following requirement :

i) Two (2) nos. 100% cooling fans, industrial grade, shall be provided for each vertical panel.

ii) Completely independent duplicate protection, control and wiring systems shall be provided for the cooling fans for redundancy.

iii) The cooling fans shall be powered from the output of the associated inverter. Normally one fan will be running while the other is on stand-by.

iv) Each cooling fan shall be equipped with an airflow switch having an alarm contact that closes upon failure of airflow.

4.10.00 **Alarms**

a) Solid state audio-visual annunciation system shall be provided for inverters, static transfer switch, battery charger.

b) Alarm facia shall be provided on each charger and inverter panel, complete with proper actuating devices, circuitry and legends.

c) The arrangement shall be such that on occurrence of a fault the corresponding window will light up and stays lighted until the fault is cleared and reset button pressed.

d) Each time a window lights up a master relay will get energized to provide group alarm signals for remote DDCMIS alarm system.

e) The requirements of indication/metering/alarms are given in the annexure.

f) Alarm contacts shall be rated 0.5 A at 220 V DC and 5A at 240 V A.C.

g) All indicating meter shall be digital type with in-built transducers (4-20mA) for hooking up with DDCMIS.

4.11.00 **Lamp / Space Heaters / Receptacles**

a) The panels shall be provided with :

i) Internal illumination lamp with door switch.

ii) Space heater with thermostat control.

iii) 3-pin 6A receptacle with plug.

b) Lamp, heater and receptacle circuits shall have individual switch fuse units.

4.12.00 **Wiring / Cabling**

a) The panels shall be completely wired up. All wiring shall be done with flexible, 1100V grade, fire resistance PVC insulated wires with stranded 2.5 Sq.mm. copper conductors and routed through wiring troughs. Each wire shall be ferruled by plastic tube with indelible ink print at both end having terminal block No., terminal number as per approved wiring diagram.

b) Panels shall have removable gland plate for cable entry. All incoming/ outgoing cables shall be terminated in suitable terminal block.

c) Control terminal blocks shall be box-clamp type, minimum 10 Sq.mm. 20% spare terminals shall be furnished.

4.13.00 **Nameplate**

a) Engraved nameplates shall be provided for each panel and for each equipment/device mounted on it.

b) The material shall be anodised aluminium / lamicoid, 3 mm thick, with white letters on black background.

c) Nameplates shall be held by self-tapping screws. The size of nameplates shall be approximately 20 mm x 75 mm for equipment and 40 mm x 150 mm for panels.

d) Nameplates for panels shall be provided both on the front and rear.

e) Control and meter selection switches shall have integral nameplates. Nameplates for all other devices shall be located below the respective devices.

f) Instruments and devices mounted on the face of the panels shall also be identified on the rear with the instrument/device number. The number may be painted on or adjacent to the instrument or device case.

g) Caution notice on suitable metal plate shall be affixed at the back of each panel.

4.14.00 **Grounding**

a) Normal 3-phase A.C power supply will be grounded at the source. For grounding other than this, isolation transformer shall be furnished with the U.P.S.

b) The inverter D.C. input and A.C. output shall be electrically isolated from each other and from cabinet ground.

c) Panels shall have fully rated ground bus with two ground terminals, one at each end.

d) Each terminal shall comprise two-bolt drilling M10 G.I. bolts and nuts to receive ground connection of 50 x 6 mm G.S. flat.

e) Separate electronic grounding shall be provided for each UPS system.

4.15.00 **Tropical protection**

a) All equipment accessories and wiring shall have fungus protection, involving special treatment of insulation and metal against fungus insects and corrosion.

b) Screens of corrosion resistant material shall be furnished on all ventilating louvers to prevent the entrance of insects.

4.16.00 **Painting**

Finish paint shall be as per TSGENCO practice. Refer to clause no.1.16.00 of Section-I, Volume V-A.

5.00.00 **TESTS**

5.01.00 **Shop Tests**

5.01.01 Tests on Battery

a) Test for capacity - test for voltage during discharge

b) Ampere hour & watt hour efficiency test

c) Endurance test.

5.01.02 Tests on battery charger

a) Dielectric tests.

b) Voltage regulation check from 0 to 100% load with ± 10% input voltage variation.

c) Ripple content measurement.

d) Heat run test on current limiting value.

5.01.03 Tests on UPS System

a) Type & routine test for various components.

b) Burning test on PCBS - Assembled PCBS shall be tested at 70°C for 72 hours in loaded condition.

c) Rapid temperature cycling test at 70°C and 0°C for 30 minutes at each temperature - 5 such cycles.

d) 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 inverter for synchronization with range of adjustments transfer and retransfer of static switches under influence of under voltage and over current, tests on chargers, batteries and other system component to confirm compliance with specification.

6.00.00 **DRAWINGS, DATA & MANUALS**

6.01.00 **To be submitted with the Bid**

6.01.01 UPS panels, Battery Charger and Battery layout drawing with dimensions

6.01.02 General Arrangement drawing of UPS panels

6.01.03 Bill of Material

6.01.04 Schematic drawing of UPS circuits

6.01.05 Battery cell voltage characteristics and data for different discharge rates

6.01.06 Technical leaflets on :

a) UPS System

b) Battery

c) Battery charger

d) Inverter

e) Static Switch

f) Manual bypass Switch

6.01.07 Duty cycle diagram and battery sizing calculation in the format of relevant IS Standard

6.01.08 Sizing calculation of UPS system, charger main equipment, viz. SCRs, rectifier transformers etc

6.01.09 Type test certificates for similar equipment.

6.02.00 To be submitted for Owner's Approval and Distribution
All relevant drawings and data pertaining to the equipment like GTP, GA drawing, BOM, foundation plan, schematic drawing, QAP, sizing calculations, etc shall be submitted by the Bidder for the approval of Owner/Owner's consultant. Also refer clause no. 1.19.02(u) of Section-I of Volume – V-A: Technical Specifications for Electrical Equipment & Accessories.

ANNEXURE-A

RATINGS & REQUIREMENTS

1.00.00	STATIC INVERTER		
1.01.00	Application	:	UPS System for Control system, DCS and other loads as required by Bidder.
1.02.00	Type	:	Static IGBT PWM type
1.03.00	Duty	:	Continuous
1.04.00	Enclosure	:	Sheet steel, IP42
1.05.00	Cooling	:	Natural convection or forced cooling using redundant fans.
1.06.00	Design Ambient temperature	:	50 Deg.C
1.07.00	Inverter capacity	:	To be decided by the Bidder
1.08.00	Overload capacity	:	300% for 4 m secs. 150% for 60 secs 125% for 10 mins 110% for continuous
1.09.00	Voltage		
	a) Inverter input, Battery output	:	To be decided by the Bidder
	b) Nominal output	:	240 V, 50 Hz, 1-phase
1.10.00	Voltage Regulation :		
	a) Steady state (0-100% load at all input voltages and all power factors)	:	$\pm$ 1.5%
	b) Transient voltage (On application or removal of 100% load)	:	$\pm$ 10%
	c) Time to recover from transient to normal voltage	:	50 milliseconds.

1.11.00 Wave form :

a)	Nominal frequency	:	50 Hz
b)	Frequency range for all conditions of input supplies, loads & temperature occurring simultaneous or in any combination (automatically controlled)	:	$\pm$ 0.05 Hz.
c)	Synchronisation limits (for maintenance of synchronism between inverter and standby A.C source)	:	49 Hz to 51 Hz (factory set)
d)	Field adjustment range for (c) above	:	50$\pm$ 0.05 Hz to 50$\pm$ 2 Hz
e)	Total Harmonic Content	:	5% maximum at rated load
f)	Harmonic content for any single harmonic	:	3% maximum

1.12.00 Rated output current at rated output voltage with current limit not operating

a)	Current	:	200%
b)	Duration	:	100 milliseconds.

1.13.00 Efficiency at full load (Watt output/watt input) : 90% or better.

1.14.00 SCR derating from peak voltage and peak rating : 50%

2.00.00 STATIC SWITCH

2.01.00 Type : Solid-state, SCR

2.02.00 Duty : Continuous

2.03.00 Enclosure : Sheet Steel, IP42

2.04.00 Cooling : Natural convection or forced cooling using redundant fans.

2.05.00 Ambient Temperature : 50 Deg.C

2.06.00 Capacity

a) Continuous : Equal to full load capacity of the inverter.

	b) Overload	:	300% for 4 m secs. 150% for 60 secs 125% for 10 mins 110% for continuous
	c) Peak	:	1000% of continuous rating for 5 cycle.
2.07.00	Normal Voltage	:	240V, 50 Hz, 1-phase.
2.08.00	Transient Voltage Tolerance	:	340V peak above the nominal line voltage.
2.09.00	Transfer Time	:	less than 4 m secs.
3.00.00	MANUAL BY-PASS SWITCH/BREAKER		
3.01.00	Type	:	Maintained, make before break.
3.02.00	Voltage	:	600V
3.03.00	Rated Current	:	To meet the system requirement
4.00.00	BATTERY		
4.01.00	Application	:	UPS Battery
4.02.00	Design Ambient Temperature	:	50 Deg.C
4.03.00	Type	:	Lead Acid Plante type
4.04.00	Nos. of Cells per Battery	:	To be decided by the Bidder
4.05.00	Battery nominal voltage	:	To be decided by the Bidder
4.06.00	Battery AH rating	:	Bidder to compute considering 100% UPS load for 30 minutes followed by 60% UPS load for 30 minutes.
4.07.00	Method of working		
	a) Float charge (Normal)	:	2.23 Volts / Cell
	b) Boost charge (After complete discharge)	:	2.30 Volts / Cell
	c) End cell voltage	:	1.80 Volts
4.08.00	Mounting	:	Steel Rack
4.09.00	Connection	:	Cables

5.00.00	BATTERY CHARGER		
5.01.00	Charger	:	Float + Boost
5.02.00	Type	:	Solid-state, full wave, fully controlled.
5.03.00	Duty	:	Continuous
5.04.00	Enclosure	:	Sheet Steel, IP42
5.05.00	Cooling	:	Natural convection or forced cooling using redundant fans.
5.06.00	Design Ambient Temperature	:	50 Deg.C
5.07.00	A.C. input :		
	a) Supply	:	415V, 3-phase, 50 Hz
	b) Voltage variation	:	±10%
	c) Frequency variation	:	+3% to -5%
	d) Combined volt frequency variation	:	10% (absolute sum)
	e) Short-circuit level	:	50 KA
	f) System earthing	:	Solidly grounded
5.08.00	D.C. output	:	100% UPS load plus restoring fully discharged battery to full charge condition in 8 hours.
5.09.00	Blocking Diode, Peak inverse voltage	:	800 V (minimum)

5.10.00 Performance Requirement

a) The output voltage of the charger shall be regulated within ± 1% of the set value for any load variation from 0 to 100% and A.C input voltage and frequency variation as indicated above in 4.06.00

b) The ripple content in charger D.C. output shall be limited to less than ± 1% with battery and less than ± 2% without battery.

6.00.00	DISTRIBUTION BOARDS		
6.01.00	Type	:	Fixed, Modular.
6.02.00	Enclosure	:	Sheet Steel, IP54
6.03.00	Mounting	:	Free standing (can be attended from both front & back)

ANNEXURE-B

SET OF ACCESSORIES TO BE PROVIDED FOR EACH BATTERY BANK

a) One battery log book.

b) Two copies of printed instruction sheet.

c) One no. cell testing voltmeter (3-0-3 volts) complete with leads.

d) One no. rubber syringe type hydrometer suitable for specific gravity reading.

e) Three nos. pocket thermometer.

f) One no. thermometer (0 to 100°) with specific gravity correction scale.

g) One set cell bridging connector.

h) Battery racks suitable for accommodating the cells coated with paint.

i) Delrin insulator (with 5% extra), rubber pad etc. for rack.

j) Two nos. plastic filling bottle for filling up.

k) One pair of spanners.

l) Two pairs of rubber hand gloves.

m) Two nos. cell lifting straps.

n) One set of inter cell, inter tie and inter bank connectors as required for complete installation.

o) One cell charger for each set of battery bank (of AH capacity)

o) Apron.

p) Goggles.

q) 'No Smoking' Notice Board

NOTE: Any other accessories if required for satisfactory operation of the complete battery system shall also be included under the Scope of Contractor without any price implication.

ANNEXURE-C

TENTATIVE LIST OF LOADS/LOAD CENTERS:

Bidder shall provide UPS supply to the following panels/ instruments. The list is just indicative and not exhaustive. Exact sizing of UPS is of Bidder's responsibility and shall be finalized during detail engineering. The bidder has to design/calculate the same during detailed engineering stage subjected to owner's approval.

i) Vibration Monitoring Panel

ii) Acoustic Tube Leak detection Panel

iii) Gravimetric Feeder Control Panel

iv) SWAS Panel

v) Conductivity type level transmitter for Boiler drum & HP heaters

vi) Flame Monitoring Panel

vii) CCTV System

viii) Flue gas analysers

ix) O_2 Measurement systems

x) Stack Opacity Monitoring System

xi) H_2 Purity meter & Moisture measurement system

xii) Stator water conductivity monitoring system

xiii) Mass Flow transmitters

xiv) All PLCs and control systems (non DCS) within Power House building.

xv) Electrical/Unit Control Panels including DAVR panel

xvi) One source to all DCS Panel

xvii) DCS network peripherals.

xviii) Dual (one source from each separate units) Control Supply for local Electrical Compressor panels.

xix) ASLD Panel, EWLI

xx) Bunker level monitoring system,

xxi) Switchyard Control Room

xxii) CMMIS System

UPS source in the central control room shall be extended to all network peripherals like TFTs, Engineering stations, switches, Printers, ,etc., Master Clock Panel, LVS, PADO & Simulator System .

Each UPS system shall be connected to DDCMIS/PLC through soft as well as hard wired. All parameters which are transmitted from UPS shall be shown on HMI mimics.

ERECTION HARDWARES

1.00.00 GENERAL TECHNICAL REQUIREMENTS

This section provides the general technical guidelines for the erection materials for instruments. All erection materials shall be of good quality and conform to the operating environment of the corresponding instrument.

However, any item required for erection of Bidder supplied system but not categorically indicated in this section, shall be supplied by the Bidder and all these items shall conform to International / National standards / codes.

1.01.00 Electrical Accessories

Electrical conduit and associated materials shall conform to the requirements of the articles which follow :

a) Rigid Steel Conduit

i) Conduits up to and including 25 mm shall be of 16 SWG and conduits above 25 mm shall be of 14 SWG. Minimum size of conduits shall be 19 mm.

ii) Each piece of conduit shall be straight, free from blister and other defects and covered with capped bushing at both ends.

iii) All rigid conduit couplings and elbows shall be hot dip galvanized rigid mild steel in accordance with IS:9537 Part-I (1980) and Part-II(1981).. The conduit interior and exterior surfaces shall have a continuous zinc coating with an over coat of transparent enamel lacker or zinc chromate. Conduits shall be furnished in standard length of 3 meters, threaded at both ends.

iv) All rigid conduit fittings shall conform to requirements of IS:2667,1976. Galvanised steel fittins shall be used wth steel conduit. All flexible conduit fittings shall be liquid tight, galvanized steel. The end fitting shall be compatiable with the flexible conduit supplied.

b) Flexible Conduit

i) Flexible conduit shall be of three layer construction of very high quality of lead coated steel. Outside and inside layer shall be reinforced with heat resistant material.

ii) Lead coating outside and inside of the conduit steel surface shall provide a non-corrosive characteristic particularly in acidic atmosphere. Besides flexibility, this shall be strong enough to stay at the desired profile without support and shall be durable and strong so as to offer sufficient mechanical protection. It shall also be fully liquid dust and air tight and shall withstand a continuous hydraulic pressure up to 2 Kg/Sq. cm and temperature up to 200 °C.

c) Special Fittings

i) Conduit sealing and fittings shall be provided as required and shall be consistent with the area and equipment with which they are installed.

ii) Double locknuts shall be provided on all conduit terminations not provided with threaded lugs and couplings. Locknuts shall be designed to securely bond the conduit to the enclosure when tightened. Locknuts shall not loosen due to vibration.

1.02.00 Electrical Junction Box:

Please refer to Section VII , Subsection – D of this volume of the Specification.

1.03.00 Cable Gland

1.	Type	: Double compression
2.	Entry Thread	: NPT / ET
3.	Material	: Brass
4.	Finish	: Cadmium Plated.
5.	Protection	: IP 54 or better
6.	Accessories	: Neoprene gasket, locknuts, reducers etc

1.04.00 Cable Tray

1.	Material	: Mild steel, slotted
2.	Thickness	: not less than 2.0 mm
3.	Finish	: Hot dip galvanized
4.	Perforation	: As per MFR standard
5.	Cover	: Suitable for tray

1.05.00 Process Hook Up Accessories & specification

Material and rating of the hook up items shall suit the piping and fluid condition. Hook up materials shall be IBR certified for applicable cases. Bidder shall furnish hook up drawings and the drawings for open racks & closed racks for owner's approval.

1.05.01 Seamless Stainless Steel Pipe

1.	Reference	: ASTM A-312 TP 316
2.	Material Grade	: TP 316
3.	Type	: Seamless /Plain end
4.	Size	: As applicable (e.g.½" NB etc)
5.	Schedule	: 40
6.	Standard Length	: 5 meter

1.05.02 Stainless Steel Pipe Fittings

	1.	Reference	: ASTM A-182 F 316 / ANSI B16.11
	2.	Type	: Forged
	3.	Rating	: 3000 lbs / 6000 lbs / 9000 lbs
	4.	Size	: To suit related SS pipe.
	5.	End connection	: Generally socket weld
	6.	Type of Fittings	: Reducing coupling, male-female reducer, straight coupling, equal tee, three piece union, elbow, cap etc.

1.05.03 Seamless Stainless Steel Tube

	1.	Reference	: ASTM A-213 , ASTM A-249 or ASTM A-269
	2.	Material Grade	: TP 316
	3.	Size	: As applicable (e.g.½" OD X 0.083" wall thickness / ¼" OD X 0.049" wall thickness etc.)
	4.	Type	: Cold drawn annealed, pickled, passivated, de-scaled, hydraulically cleaned seamless tube.
	5.	Properties	: The tube shall be free from scratches and suitable for bending and capable of being flared by hardened and tapered steel pin. The expanded tube shall show no crack or rupture. Hardness shall be RB 80.
	6.	Test Pressure	: 400 Kg/Sq. cm (minimum)
	7.	Tolerance	: ± 0.13 mm for outside diameter
			: ± 15 % for wall thickness
	8.	Standard Length	: 5 meter
	9.	Test	: Flare, Hardness, Ball and Bubble Test

1.05.04 Stainless Steel Tube Fittings

	1.	Reference	: ASTM-A-182
	2.	Type	: Double ferrule double compression
	3.	Material	: 316 Stainless steel forged
	4.	Ferrule	: 316 Stainless Steel

	5.	Type of Fittings	: Male / female connector, elbow, cross /equal tee, straight connector, bulkhead union, ferrule etc. as required to suit installation.
	6.	Size	: To suit SS tubing and NPT end connection

1.05.05 C.S. Pipe

	1.	Reference	: ASTM-A 106 Gr. C
	2.	Material	: Cold drawn seamless black C.S.
	3.	Type	: Seamless / Plain ends
	4.	Size	: As applicable (e.g. ½" NB etc)
	5.	Schedule	: 80, 160, XXS as required
	6.	Standard Length	: 5 meter

1.05.06 C.S. Pipe Fittings

	1.	Reference	: ASTM-A 105 / ANSI B16.11
	2.	Type	: Forged
	3.	Rating	: 3000 lbs / 6000 lbs / 9000 lbs
	4.	Size	: Suitable to related C.S.Pipe
	5.	End connection	: Generally socket weld
	6.	Type of Fittings	: Reducing coupling, male-female reducer, straight coupling, equal tee, three piece union, elbow, cap etc.

1.05.07 A.S. Pipe

	1.	Reference	: ASTM-A 335 P22 AS PER ANSI B 36.10
	2.	Material	: Cold drawn seamless A.S.
	3.	Type	: Seamless / Plain ends
	4.	Size	: As applicable (e.g. ½" NB etc)
	5.	Schedule	: XXS
	6.	Standard Length	: 5 meter

1.05.08 A.S. Pipe Fittings

1.	Reference	: ASTM-A 182 F22 AS PER ANSI B 16.11	
2.	Type	: Forged	
3.	Rating	: 9000 lbs	
4.	Size	: Suitable to related A.S.Pipe	
5.	End connection	: Generally socket weld	
6.	Type of Fittings	: Reducing coupling, male-female reducer, straight coupling, equal tee, three piece union, elbow, cap etc.	

1.05.09 G.I.Pipe

1.	Reference	:	IS-1239, Part-I
2.	Type	:	Medium grade, threaded at both ends protected with end caps
3.	Material	:	Continuous ERW galvanized MS pipe
4.	General	:	Pipe shall be galvanized both inside and outside
5.	Size	:	As applicable (e.g 1/2”/3/4”/1” etc.)

1.05.10 G.I.Pipe Fittings

1.	Reference	:	IS-1239, Part-II for material, dimension, thread etc.
2.	Style	:	Threaded
3.	Type of Fittings	:	Equal tee, three piece union, unequal tee, straight socket, 90 Deg. elbow, reducing socket cap. etc. to suit installation.
4.	Size	:	Suitable to related G.I.Pipe

1.05.11 Carbon Steel Globe Valve

1.	Reference	: ASTM A-105
2.	Type	: Globe
3.	Construction	: Forged Body Cadmium Plated
4.	End Connection	: As applicable (eg. ½” Socket Weld etc.)
5.	Rating	: Cl. 800 / CL. 2500

	6.	Material	: Body - Carbon steel
			: Stem - Hardened Steel
			: Plug - AISI 316 SS
			: Seat- Stainless steel stellited
	7.	Packing	: Teflon / Grafoil as required
	8.	Yoke	: ASTM A105
	9.	Hand wheel	: Carbon steel
	10.	Design standard	: As per ANSI B 16.34

1.05.12 Stainless Steel Globe Valve

	1.	Reference	: ASTM A-182 F316
	2.	Type	: Globe
	3.	Construction	: Forged Body
	4.	End Connection	: As applicable (eg. ½" Socket Weld etc.)
	5.	Proof Pressure	: 400 Kg/Cm2
	6.	Material	: Body - Stainless steel
			: Stem - Hardened Steel
			: Plug - AISI 316 SS
			: Seat- Stainless steel stellited
	7.	Packing	: Teflon as required
	8.	Yoke	: ASTM A182 F316
	9.	Handwheel	: Carbon steel
	10.	Design standard	: As per ANSI B 16.34

1.05.13 Alloy Steel Globe Valve

	1.	Reference	: ASTM A-182 F22
	2.	Type	: Globe
	3.	Construction	: Forged Body

4.	End Connection	: As applicable (eg. ½" Socket Weld etc.)
5.	Rating	: CL. 2500
6.	Material	: Body - Alloy steel
		: Stem - Hardened Steel
		: Plug - AISI 316 SS
		: Seat- Stainless steel stellited
7.	Packing	: Grafoil as required
8.	Yoke	: ASTM A182 F22
9.	Handwheel	: Carbon steel
10.	Design standard	: As per ANSI B 16.34

1.05.14 Structural Steel

Steel supports for JB's, trays; tubes and related equipments shall not be limited to the following:

a) MS Angle
b) MS Channel
c) I-Beam
d) Hexagonal head Bolt & Nut with washer
e) Foundation Bolt & Nut
f) Expansion Bolt
g) Steel Plates / Flats
h) CRCA sheet
i) 50 NB Pipe
j) Pipe clamps, U Bolts & Nuts
k) Checker plate

1.05.15 Condensate Pot

1.	Reference	: ASTM A182 F22 /ASTM A105
2.	Material	: Alloy steel / carbon steel as per application
3.	Construction	: Drilled from barstock
4.	End connection	: As applicable (e.g 3 nos. ½" socket weld end etc.)

	5.	Accessories	: Vent valves

1.05.16 Instrument Valve Manifold

1.	Type	: Two valve manifold
		: Five valve manifold
2.	Mounting	: Remote 2” Pipe Mounting / Transmitter Rack mounting
3.	Construction	: Single block (bar stock)
4.	Material	: Forged body and bonnet AISI 316 stainless steel
5.	Ports	: Mfg std. (e.g 1/2 " NPT (F) etc.)
6.	Rating	: 420 Kg/Sq. cm at ambient
7.	Operating Temperature	: (-)30 to (+)170 Deg C
8.	Packing	: PTFE Wafer
9.	Seat & Stem	: AISI 316 SS
10.	Plug	: AISI 316 SS free to turn on stem / 17-4 PH
11.	Handle Bar	: AISI 316 SS
12.	Connection	: Straight
13.	Accessories	: Plugs for all ports, Mounting Bracket , bolts , nuts

1.06.00 Pneumatic Hook Up Accessories

1.07.00 Air Header

Technical Particulars	**For Panel**	**For Field**
Material of Construction	: Stainless steel	: Stainless steel
Inlet Connection	: 2" NPT (M)	: 1" NPT (M)
Header Take-off Material	: Stainless steel	: Stainless steel
Take off connection	: 1 / 2” NPT (M)	: 1/ 2” NPT (M)
Take-off Valves Material	: stainless steel	: stainless steel

Tube Take-off	: Tube adapter on valve	: Tube adapter on valve
Drain	: SS drain valve at lowest point	: SS drain valves at lowest point

KKS PHILOSOPHY

KKS NUMBERING PHILOSOPHY

For identifying (tagging) an instrument / equipment in Power plant KKS numbering scheme is used. The purpose is to assign a unique number to every equipment in the power plant. For C&I equipment unique number are to be provided up to the signal level so that a unique number Input / Output exist in DCS for every signal.

Normally KKS number is a 10 digit alpha-numeric code and is typically split into the following:

X	X	X	A	A	Y		Y	B	B	B		

First three digits indicate the Sub-System. The Code for the major system are given as per **Annexure-**1.

Fourth and Fifth digits are the **Numerical Keys at System Code Level** and used to distinguish between main systems having same Alpha Codes.

Sixth and Seventh digits are the **Equipment / Apparatus / Measuring Circuit Code**. The code of various Equipment / Apparatus / Measuring Circuit is shown in **Annexure-2**

Eight, Nine and tenth digits are the **Numerical Keys at Equipment / Apparatus / Measuring Circuit Code** and used to distinguish between various instruments in the same sub-group. Numerical keys at System / Equipment / Apparatus / Measuring Circuit is shown in **Annexure-3**.

ANNEXURE-1

List of System / Sub-System Codes used in Power Plant:

1) Compressed air system : QEA, QEC
2) Ventilation System : SAA TO SAZ
3) Fire Detection & Protection System + Fire Water pumps : SGM, SGN, SGO, SGP
4) Sewage Treatment : SJA TO SJZ
5) Pre-treatment Plant : GBI, GBM, GBV
6) RO DM Plant : GCI, GCM, GBV

ANNEXURE-2

Standard Equipment Codes:

AA	Valves including drives, also hand operated
AB	Seclusions, Lock, Gates, Doors
AC	Heat Exchanger
AE	Turning, Driving, Lifting equipment
AF	Continuous conveyors, Feeders
AG	Generator Units
AH	Heating and Cooling Units
AK	Pressing and Packaging equipment
AM	Mixer, Stirrer
AN	Blower, Air Pumps / Fans, Compressor Units
AP	Pump Units
AT	Purification, Drying, Filter
AV	Combustion Equipment e.g. grates

Standard Apparatus Codes:

BB	Vessels and Tank
BF	Foundation
BG	Boiler Heating Surfaces
BN	Injector, Ejector
BP	Flow and throughput limitation equipment (Orifice)
BQ	Holders, Carrying Equipment, Support
BR	Piping, Ducts, Chutes, Compensator
BS	Sound Absorber
BU	Insulations, Sheatings

Standard Measuring Circuits Codes:

CD	Density
CE	Electrical Quantities
CF	Flow, throughput
CG	Distance, Length, Position
CK	Time
CL	Level
CM	Humidity
CQ	Analysis (SWAS)
CS	Speed, Velocity, Frequency
CT	Temperature
CY	Vibration, Expansion

ANNEXURE-3

Numerical Keys

A) Numerical Keys at System Code Level

i) Use 10, 20, 30, ……. To distinguish between main systems having same Alpha Codes. Examples:

a) Main Steam (Left) and Main Steam (Right)

b) BFP – A/B/C

c) ID Fan – A/B, FD Fan A/B, AH – A/B

ii) For branch off from main system path having code say 10, keep the same alpha code and use 11, 12, 13 etc. Similarly for other branch off from main system path having code say 20, keep the same alpha code and use 21, 22, 23 etc and shall carry on further in the same way.

iii) If the branch off from main system / sub system path is used for some other system, where different alpha codes can be applied, then in that case the said branch line will be designated by the alpha codes of the system to which it is providing the input.

B) Numerical keys at Equipment Code level:

There are three numerical keys available for each type of equipment code. Following has been agreed upon considering present practice, better flexibility and ease in sorting.

i) Valves and Dampers --- *Equipment Code – AA*

	N1	N2 N3

Motorised *(on/off duty)*	-	*0*	*01 to 50*
Motorised (inching duty)	-	*0*	*51 to 99*
Pneumatic (Control)	-	*1*	*01 to 50*
Motorised (thyrestor Control)	-	*1*	*51 to 99*
Sol. Operated	-	2	01 to 99
(Open / Close duty (Valves, NRVs, Gate)			
Hydraulic	-	3	01 to 99
NRV (Without actuation)	-	4	01 to 99
Manual	-	5	01 to 99
Manual	-	6	01 to 99
Relief & Safety Valves	-	7	01 to 99
Reserve	-	8	01 to 99
Reserve	-	9	01 to 99

ii) Field Instruments

Field Transmitters & Analog Signals	-	0	01 to 99
Field Switches & Binary Signals	-	1	00 to 99
PG Test Point	-	4	00 to 99
Gauges	-	5	00 to 99
Automatic Turbine Tester (ATT)-HWR	-	2	00 to 99
(Reserved for protection Signals used by Hardwar)			

Example of Numerical Key Usage:

In line with the philosophy adopted for Valves / Dampers /instruments etc. pumps and fans in the main systems (having different system code) can be numbered as AP/N100 and as AP/N101, 102, ……. Where system code is same.

LCP and JUNCTION BOXES SPECIFICATION

1.00.00 **GENERAL REQUIREMENT**

1.01.00 ENCLOSURES FOR INSTRUMENTS AND OTHER EQUIPMENT

1.01.01 All panels, cabinets, distribution boxes, junction boxes, terminal boxes and all other field mounted equipment / enclosures shall have suitable environmental protection as detailed in Section-I of this volume of the specification.

1.02.00 SURFACE PREPARATION & PAINTING

1.02.01 All sheet metal panel/ desk exterior steel surfaces shall be sand blasted, ground smooth and painted as specified below.

1.02.02 Suitable filler shall be applied to all pits, blemishes and voids in the surface. The filler shall be sanded so that surfaces are level and flat; corners are smooth and even. Exposed raw metal edges shall be ground burr-free. The entire surface shall be blast clean to remove rust and scale and all other residue due to the fabrication operation. Oil, grease and salts etc. shall be removed from the panels by one or more solvent cleaning methods prior to blasting.

1.02.03 Two spray coats of inhibitive epoxy primer surfacer shall be applied to all exterior and interior surfaces, each coat of primer surfacer shall be of dry film thickness of 1.5 mil. A minimum of two spray coats of final finish color (Catalyzed epoxy or polyurethane) shall be applied to all surface of dry film thickness 2.0 Mil. The finish colors for exterior and interior surfaces shall conform to the following shades:

- Exterior – Opaline green shade 275 of IS: 5 or equivalent international code..
- Interior - Brilliant White.

1.02.04 Paint films, which show sags, cheeks, blisters, teardrops, fat edges or other painting imperfections, shall not be acceptable.

1.03.00 WIRING

1.03.01 All spare contacts of relays, switches and push buttons shall be wired up to the terminal blocks. All intercommunications between sections of panels/desks shall be furnished.

1.03.02 Each wire shall be identified at both ends with wire designation as per approved wiring diagram. Heat shrinkable type ferrules with indelible computerized ink print shall be used with cross- identification.

1.03.03 All wire termination shall be made with insulated sleeve and crimping type lugs. Wire shall not be spliced or tapped between terminals. Open-ended terminal lugs will not be accepted. Wires shall not be looped around the terminal screws or studs.

1.03.04 Internal wiring should be terminated uniformly on one side of the terminal block leaving the other side available for termination of outgoing cables. Internal wiring shall be grouped so that all outgoing wiring to each particular remote location is terminated on adjacent terminal blocks. Interior wiring and jumperings shall be arranged so that external connections can be made from internal side of terminal blocks. Common connections shall be limited to two (2) wires per terminal.

1.03.05 Wiring shall be arranged to ensure free access to all instrument or devices for maintenance. No wire shall be routed across the face or rear of any device in a manner, which will impede the opening of covers or obstruct access to leads, terminals or devices

1.03.06 Wires shall be dressed and run in trays or troughs with clamp-on type covers. Wirings may be neatly bunched in groups by non-metallic cleats or bands. Each group shall be adequately supported along its run to prevent sagging or strain on termination.

1.03.07 Shield wires shall be terminated on separate terminal blocks. Common connections shall be limited to two wires per terminal. Signal circuit shields shall be grounded at the power supply end only or as recommended by manufacturer.

1.03.08 All low level signal cables shall be separately bundled to from control cable and maintained at 300 mm minimum spacing from control bundles.

1.03.09 Panel internal wiring shall follow distinct color-coding to segregate different voltage levels viz. 24V DC, 48V, 110V AC, 240V AC, 220V DC etc.

1.03.10 Thermocouple lead wires, analyzer measuring lead wires, or any other lead wires carrying measuring signal of the order of low milli volt or micro volt shall be electrically and physically isolated from other AC and DC wiring. Shielded wires used in such cases for panel internal wiring shall be continuous and ungrounded with the shield terminated individually and separately in panel terminal block.

1.03.11 Wiring to door mounted devices shall be provided with multi-strand wires of (49 strands minimum) adequate loop lengths of hinge-wire so that multiple door openings will not cause fatigue failure of the conductor.

1.03.12 Internal wiring in factory pre-wired electronic systems cabinets may be installed according to the Contractor's standard wire size, insulation, and method of termination on internal equipment. Insulation for all wiring, including circuit board wiring, back panel wiring, power supply wiring and interconnecting cables between devices shall pass the vertical flame test per IPCEAS-1981. Identification of conductors may be done by insulation color-coding identified on drawings or by printed wiring lists.

1.04.00 TERMINAL BLOCKS

1.04.01 All terminal blocks shall be rail mounted/ post mounted type, cage clamp type with high quality non-flammable insulating material of melamine suitable for working temperature of 105 Deg C. The terminal blocks in field mounted junction boxes, instrument enclosures racks etc. shall be suitable for cage clamp connections. The terminal blocks in Control Equipment Room termination/ marshalling cubicles shall be suitable for post mounted cage clamp connection at the field input end. The exact type of terminal blocks to be provided by Bidder shall be subject to Owner.

1.04.02 All terminal blocks shall be provided complete with all required accessories including assembly rail, locking pin and section, end brackets, small partitions, transparent covers, support brackets, distance sleeves, warning level, marking etc. For RTDs ring - tong type lugs shall be used at Junction Boxes.

1.04.03 The characteristics of the terminal blocks shall be as follows.

i) High contact force, independent of conductor cross-section and large contact surface area.

ii) Integrated self-loosening protection to avoid shifting of contact surface that may allow contamination of connection point.

iii) Inspection and maintenance free (resistant to thermal aging and vibration)

iv) Low and constant voltage drop

1.04.04 The insulation of the terminal blocks shall be of suitable thermoplastic material.

1.04.05 The spacing between Terminal blocks channels in panels and cubicles shall be adequate for routing the cable troughs and to allow adequate free workspace for termination and removal of wires. The terminal blocks shall be arranged with atleast 100 mm clearance between two sets of terminal blocks and junction box walls.

1.04.06 Signals of different voltage levels shall be clearly segregated by providing separate rows to each type of signal and by using terminal blocks of different color for each type of signal and by providing barrier strips between them.

1.04.07 Terminal blocks shall be provided with white marking strips / self-adhesive marker cards and where permitted by the safety codes and standards, shall be without covers. Power terminals and high voltage (above 48 volts) terminals shall have protection covers. All terminals shall be provided with permanent terminal identification numbers on both sides.

1.04.08 At least 20% spare unused terminals shall be provided on each terminal block for circuit modifications and for termination of all conductors in a multi-conductor control cable.

1.04.09 The bottom of the terminal block shall be at least 200 mm above the cable gland for bottom entry type panels.

1.04.10 For extending 24 V DC supply to panels, the size of the terminals shall be decided based on voltage drop and not based on current.

1.04.11 Other requirements of the terminal blocks are as follows:

i) The last terminal in a rail-mounted assembly shall be closed with an end plate and end bracket.

ii) For visual and electrical separation of terminal groups, partition plates shall be provided, which can be push fitted after forming an assembly.

iii) Design shall permit testing of incoming and outgoing signals by using suitable test plug and socket without disconnecting the cable connections.

iv) It shall be possible to use jumper plugs through the above test plug socket to connect adjacent terminals. Adequate number of short circuit jumper plugs shall be provided for the purpose.

v) Where more than one connection to a terminal block is required, two tier terminals shall be used.

1.05.00 GROUNDING

1.05.01 Separate Protective and Electronic system ground as required shall be provided.

1.05.02 All panels, desks, cabinets shall be provided with a continuous bare copper ground bus (Frame ground), bolted to the panel structure at bottom on both sides and effectively ground the entire structure. The bolts shall face inside of panels.

1.05.03 For electronic system cabinets the electronic system ground bus (Electronic ground) shall be similar but insulated from the cabinet and shall be separately connected to the system ground .The same ground may be used to earth the shield of shielded signal cables, otherwise a separate ground bus shall be provided for connecting the signal cable shields. Cable shields shall be grounded at the panel end only and shall never be left open .The electronic ground between panels of a shipping section shall be firmly looped.

2.00.00 **CONTROL DESKS & PANELS**

2.01.00 GENERAL

2.01.01 All control desk, panels etc. shall be furnished fully wired with necessary provision for convenience outlets, internal lighting, utility receptacles, grounding, ventilation, space heating, anti-vibration pads, internal piping &

accessories as required for completeness of the system.

2.01.02 The design shall conform to the EN ISO 11064 (Ergonomical design of Control Room), Part 1, 2 and 3.

2.01.03 The exact dimensions, material, construction details, grounding, general arrangement etc. shall be as per actual requirement and shall be finalized during detail engineering and subjected to Owner's approval.

2.01.04 Incoming power supply feeders shall be duplicated. Alarm shall be provided for failure of a power supply feed.

2.01.05 For Control desk/ panel mounted instruments/ devices etc. which are to be powered from UPS, all required conversion of interface equipments/ accessories to make such devices compatible with UPS supply shall be provided. All necessary hardware like input switches/ fuse unit for each feeder as well as switch fuse unit for each instrument/ device on the power supply line shall be provided. From UPS redundant feeders shall be provided wih suitably rated MCB and provision of fast auto changeover of UPS feeders.

2.01.06 Crating of the panels and desks shall be suitable for protection against shock, vibration, inappropriate handling and inclement weather conditions during transportation and warehousing. Mounted equipment shall have adequate protection against damage during handling, transit and storage. Suitable desiccant shall be used inside the packing case.

2.01.07 Nameplate

a) Nameplate shall be provided for instrument or device mounted on the panel.

b) Nameplates for panels shall be provided both in front and rear.

2.02.00 CONTROL DESK

2.02.01 Control desk shall be free standing, floor mounting, table top type with doors at back and shall be constructed of 3 mm thick (minimum) CRCA steel or Aluminium extrusion. Aluminium structure shall be anodized or powder coated paint finish. The top surface of control desk shall be 30 mm (minimum) thick with the top 12 mm (minimum) of acrylic solid surface and the remaining 18 mm of laminated medium density fibre (MDF) board.

2.02.02 Monitors with retractable keyboard shall be provided on the desk. Desk shall be arranged in arc-like shape without any sharp edges. Edges shall be extruded PVC or rounded post-formed laminate.

2.02.03 Desks shall be of modular, scalable and industrially ruggedized design and shall have connections for PA system handsets & telephone sets.

2.02.04 Desks shall have concealed cable trays for wire dressing. Both Horizontal & Side Managers (2 separate horizontal cable routing wire baskets for power & data cables) shall be provided.

Each User station will be provided with 2 separate power distribution units (1 for Main line & 1 for UPS line). Each power distribution unit will have 6 points of 5/13 Amp sockets, Mains MCB On/Off Switch & Indicator.

Adequate heat management provision for Exhaust of heat from within the Console Desk Assembly shall be provided. There will be multiple fans provided in the Main Control Desk. Each Fan will be of 230 VAC 250 CFM Ball Bearing based. Ventilation louvers will be provided on both Front & Rear Modesty with special Air Filters. Adequate space for CPU & Other equipments placed with in the desk.

2.02.05 Design shall include Earthing bolts.

2.02.06 Back installed items shall be suitably concealed from front view.

2.02.07 All operator workstations for SG, TG, Auxiliaries & Off-site Plants shall be mounted on this Control Desk. The cabling / wiring between OWS & CPUs, power supply cables etc. shall be aesthetically routed and concealed from view.

2.02.08 HARDWIRED DEVICES ON CONTROL DESK (DRAW OUT SECTION)

Release and Lamp Test push buttons shall be provided for a set of push buttons (decided during detail engineering stage). Depending on the type of control/ function, required number of push buttons/ indicating LEDs & their color, push button stations shall be selected. The size of push button stations shall be 24 x 48 mm or 25 x 50 mm and shall have service inscription details at the front. Emergency push buttons (with cover) shall be mounted on top of Control Desk.

2.03.00 BACK UP PANEL

2.03.01 Construction shall be from CRCA steel of thickness not less than 3mm.

2.03.02 Upright back-up panel shall be provided where hardwired devices shall be mounted on a mosaic grid type console. The mosaic grid tiles shall be of 24 mm x 48 mm (or 25 mm x 50 mm) size, made of heat & flame retardant, self extinguishing and non-hygroscopic material with flat matt finish without glare and non reflecting type.

2.03.03 DDCMIS Back-up Panel (referred as Unit Control Panel-UCP) shall also mount annunciation fascia (minimum 500 nos.) and the flame monitoring cameras along with other hardwired devices as decided during detail engineering stage by Owner. Color coding shall also subject to Owner's approval.

2.03.04 Colored Mimic for different Off-site plant control systems (as enumerated elsewhere in this specification) and hardwired annunciation system shall also

be mounted on the back up panels.

2.04.00 PANELS/CABINETS

2.04.01 All DDCMIS system modules, power supply components and other Local Control panels (PLC/Relay based) shall be housed in cabinets as specified below.

2.04.02 The cabinet mounted equipments shall be fully assembled, installed in mounting racks, wired and fully tested as per specification requirements and Owner approved drawings prior to shipment to the project site.

2.04.03 The Bidder shall ensure that the cabinets are complete & ready for installation before dispatch from manufacturing works. The installation work at project site for these cabinets shall only involve connections through multi-pair cables from marshalling cabinets (wherever provided) to system cabinets and inter-cabinet/cabinet to Control Desk/ Back up Panel.

2.04.04 All electronic cards, network components, power supply modules etc. located shall be suitably housed in cabinets and shall be neatly arranged in sub-racks. Network components shall be visible in door closed condition (e.g. Glass doors etc.) as approved by Owner.

2.04.05 Bidder shall design the cabinet internal arrangement, floor cutout and cable gland plate such that all the cables entering or leaving the cabinet can be properly glanded in the gland plate.

2.04.06 The packaging density of panels shall be such that the temperature rise within the panels shall never exceed 10°C above ambient even under worst operating conditions. Cooling Fans shall be provided wherever required and this shall be of industrial grade.

2.04.07 TECHNICAL PARTICULARS

1.	Material of Construction	:		Cold Rolled Coal Annealed (CRCA) steel sheet
2.	Thickness of Sheet	:	a)	2.0 mm for faces supporting instruments / terminals
		:	b)	1.6 mm for other sides and top
3.	Construction	:		Welded throughout as per approved National Standards
4.	Post welding operation	:	a)	Grounding of all welds to smoothness
		:	b)	Rounding of corners

		:	c)	Cleaning of weld spatters
5.	Panel height	:	2300 mm (approx)	
6.	Corners	:	7 mm inner radius	
7.	Dimensional Tolerances	:	a)	In height & length - 3 mm
			b)	In height between adjacent sections - 2 mm
			c)	Total for a group - 6 mm
8.	Doors	:	Double, recessed, turned back edges, full height front & rear	
	i) Thickness of Sheet	:	2 mm	
	ii) Hinges	:	Stainless steel	
	iii) Door latches	:	Three point type	
	iv) Door gaskets	:	Neoprene rubber on fixed frame to result dust proof/weatherproof enclosure	
	v) Opening of the doors	:	Outward	
	vi) Louvers	:	With removable wire mesh to ensure dust and vermin proof	
9.	Gland plates	:	Removable in sections 4 mm thick (bottom)	
10.	Cable entry	:	Bottom	
11.	Hardware	:	a)	Anti vibration pad- 15 mm
			b)	Predrilled base channel ISMC – 100 or equivalent for all sides
			c)	Stainless steel buff- finished 2 mm thick kick plate for all sides
			d)	Stainless steel scratch strips along desk edges fixed with pan-head recessed screws
			e)	Rubber strips to ensure air

			tightness between kick plate and finished floor
		f)	Lifting hook / Eye bolt
		g)	Drawing pocket
		h)	Door switch, lamps, thermostat, heaters and industrial grade cooling fans,, illumination fixures
12.	Name Plate	:	Both at front and back surface of the panel
13.	Fixing of name plate	:	Stainless steel pan head screws
14.	Name plate material	:	Laminated phenolic (3 layers)
15.	Lettering	:	Black with white engraved
16.	Mounting of terminal blocks	:	Vertical angle support bracket tack welded on sheet steel plate, screwed on internal wall of enclosure

2.05.00 FURNITURE

All the furnitures in the Central / Local control Room (s), Engineers' rooms, Instrument laboratory , SWAS Room & any other rooms with C&I equipments located in different plant buildings under Bidder's scope shall be included in Bidder's scope of supply. Bidder shall provide following industrial grade furniture items as a minimum from reputed manufacturers/suppliers meeting International Standards. The furniture shall be modular and latest with ease of operational features. The furniture shall be modern, aesthetically designed, modular, flexible, space saving and future safe.

2.05.01 WORK STATION FURNITURE

Modular work station furniture, suitable for mounting servers & historians, programmer stations, PC based systems, printers (A4/A3 color laserjet) etc. shall be provided.

2.05.02 PC RACK

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

2.05.03 CHAIRS

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

2.05.04 TABLES

Industry standard computer tables shall be provided & shall be as approved by Owner during detailed Engineering. Glass top teak wood horse shoe shaped table with vertical file mounting arrangement (two layers to house approx. 40 Nos of files and lockable drawers at both ends) for Engineering Room shall be provided.

2.05.05 ALMIRAHS

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

2.05.06 KEYPAD

One keypad per unit shall be provided for the storing of keys of relevant areas of the unit in the control room.

2.05.07 LOCKERS

Suitable lockers shall be provided in the room adjacent to the control room for storing of personal articles of control room personnel. Also, lockers of bigger size shall be provided in documentation Room for storing of personal documents. Details shall be finalized and approved by Employer during detailed engineering.

3.00.00 LVS PANEL

3.01.00 An arc shaped Large Video Screen (LVS) panel shall be supplied for mounting large video screens in number of tiers in various Control rooms as specified elsewhere in this specification.

Biddr shall provide and fix ACP cladding around the LVS screen including covering the LVS back side and LVS stand. The cladding will be from floor finish to 600 mm above LVS screen like a self-standing partition with necessary openings for system requirement. ACP paneling shall be with 304 grade & approx. 0.5 mm mirror finish SS strip.

3.02.00 The profile, dimensions and the general arrangement shall be finalized & approved by Owner during detailed engineering. Recommendations, if any, for the control room lighting in order to ensure continuous proper viewing of the LVS screen by the operator & shift incharge (without any fatigue) shall be

clearly brought out by the Contractor in his offer, alongwith all relevant details/basis.

3.03.00 Any other requirement for proper LVS mounting & functioning & viewing shall also be specifically brought out by the Contractor in his offer, along with all relevant details.

4.00.00 **LOCAL INSTRUMENT RACK (LIR) & LOCAL INSTRUMENT ENCLOSURE (LIE)**

4.01.00 GENERAL

4.01.01 Devices (Transmitters/ Switches) located in the field shall be suitably grouped together to the extent possible and installed in the LIE (Closed Rack) and LIR (Open Rack) in Boiler/TG Building and Off-site plant areas.

4.01.02 Racks and enclosure shall be factory prefabricated & painted and shall complete with internal piping, tubing, manifold, isolation valves, blowdown valves, integral junction box, illumination etc.

4.01.03 No more than six instruments shall be grouped in a single rack / enclosure.

4.01.04 Racks shall be installed above the tapping points for air, flue gas and coal air mixture application whereas for applications such as for water and steam, racks to be installed below the source point.

4.01.05 Attention shall be paid in the layout to avoid air traps in liquid piping and water accumulation in air /gas piping.

4.01.06 Racks used for furnace, flue gas and air application shall be provided with intermittent & continuous air purging

4.01.07 Welding of impulse lines shall comply with the provisions of the latest applicable ANSI Code for Pressure Piping.

4.01.08 Earth stud shall be furnished at rack for safety grounding.

4.02.00 LOCAL INSTRUMENT ENCLOSURE (LIE)

4.02.01 Enclosure shall be free standing type. Racks shall be adequately reinforced to ensure true surfaces and to provide support. Major load - bearing posts shall be suitably supported by gusset plates or moment members.

4.02.02 Enclosure outer shall be constructed from at least 3 mm thick steel plate and epoxy painted to shade gray. Base frame shall be made of ISMC 100 and black colour finish.

4.02.03 2” NB galvanized pipes shall be laid horizontally and supported at two end channels to mount transmitters at accessible height. Center posts or any

member, which would reduce access, shall be avoided.

4.02.04 Double leaf interlocking front opening doors with three point locking shall be provided and shall be arranged for maximum possible access to the interior. Key shall be of identical for all enclosures.

4.02.05 Doors shall have concealed quick removal type pinned stainless steel hinges and locking handles. Gaskets shall be used between all mating sections to achieve dust and weather proof enclosure rated for IP-65 including the internal junction box. All enclosures shall have access doors on front side.

4.02.06 Removable type bulkhead plates of thickness not less than 6 mm shall be mounted at the racks with suitable high temperature gasket. Impulse lines within the enclosures shall be properly clamped.

4.02.07 All internal wirings between the instruments and junction box shall run through flexible conduits. No exposed wirings within transmitter racks both open and closed type, is admissible.

4.02.08 Racks shall have a common blowdown drain header, which will connect individual instrument blowdown line after suitable pressure breaking through regulating globe type blowdown valves. Covered funnels shall be used for saturated liquid and steam service, whereas, open funnels may be used for cold liquid services. Header (2" NB ASTM A 106, Sch-80 Gr. C) shall be suitably sloped and shall have one end flanged and extending beyond the rack for connection to plant drain header..

4.02.09 Each rack shall be provided with one receptacle, light fixtures with wire guard and one lighting switch each at instrument & Junction box compartments with wire guard. Lighting switches may be door actuated & mounted inside the panel. Outlet box, switch box and device covers shall be of galvanized stamped steel. Light switches and receptacles shall be installed inside the enclosure on the wall near the latch side of the enclosure door. Light fixtures shall be installed on the ceilings of the enclosures.

4.02.10 Power supplies for miscellaneous devices shall be provided with MCB located within the enclosures. MCB shall be mounted in fuse blocks. Nameplates shall be furnished above the MCB blocks, identifying the devices being served.

4.02.11 Vibration dampeners shall be installed for supporting each enclosure. The loading at each corner of the enclosure shall be determined by actual test weighting when construction is complete to determine the correct length of each dampener for proper loading of the dampener in accordance with manufacturer's recommendations

4.03.00 LOCAL INSTRUMENT RACK (LIR)

4.03.01 Rack shall be free standing type constructed from 6 mm thick steel channel frame provided with a canopy to protect the instrument from dripping water or

falling objects and shall be epoxy painted. Canopy shall be of CRCA steel sheet of at least 3 mm thickness.

4.03.02 Rack Major load-bearing posts shall be suitably supported by gusset plates or moment members. Suitable fenders grill shall be welded to the end-posts of the rack to outline a boundary beyond which no mounted equipment shall project to protect instrument from accidental contact during personnel movement. Center posts or any member, which would reduce access, shall be avoided.

4.03.03 2" NB galvanized pipes laid horizontally and supported at two end channels shall be employed at working accessible height for mounting of instruments.

4.03.04 All internal wirings between the instruments and junction box shall run through flexible conduits. No exposed wirings are admissible.

4.03.05 Racks shall have a common blowdown drain header, which will connect individual instrument blowdown line after suitable pressure breaking through regulating globe type blowdown valves. Covered funnels shall be used for saturated liquid and steam service, whereas, open funnels may be used for cold liquid services. Header (2" NB ASTM A 106, Sch-80 Gr. C) shall be suitably sloped and shall have one end flanged and extending beyond the rack for connection to plant drain header..

Each rack shall be provided with one receptacle, one light fixture with wire guard and one lighting switch. Outlet box, switch box and device covers shall be galvanized stamped steel. Light fixtures shall be installed on the canopy of the rack

4.03.06 Power supplies for miscellaneous devices shall be provided with MCB located within the enclosures. MCB shall be mounted in fuse blocks. Nameplates shall be furnished above the MCB blocks, identifying the devices being served.

4.04.00 JUNCTION BOX

1.	Type of Enclosure	:	Dust tight & weatherproof conforming to IP 65
2.	Material	:	3 mm sheet steel / fiberglass reinforced polyester(UV stabilized)
3.	Type of Cover	:	Solid unhinged with retention chain / Screwed at all four corners
4.	Paint	:	i) Exterior : Opaline green shade 275 of IS: 5 ii) Interior - Brilliant Glossy White.

			Surface / Two (2) inch Pipe stanchion
5.	Mounting	:	(At a dry compartment at one side of the enclosure / rack with front opening type door)
6.	Cable Entry	:	3 mm (min) Bottom / side Gland plate
7.	Gasket	:	Neoprene
8.	Grounding	:	Brass earth lug with green screw head External-2 nos , Internal-1no. (M6)
9.	Number of Drain Holes	:	Two at bottom capped
10.	Identification	:	Label for JB and Tags for cable
11.	Accessories	:	a) Rail mounted cage clamp type screwless terminals (suitable for conductor size up to 2.5sq.mm of suitable voltage grade) with markers and 20% spare terminals b) Cable gland (Brass) & raceways c) Ferrules & lugs (Brass) d) Aluminum back panel e) Canopy at top f) Mounting brackets g) bolts and nuts made of brass etc.

FORM NO. PEM-6666-0

	DATA SHEET FOR LOCAL PANELS	SPECIFICATION NO.: PE-SS-999-145-054A
		VOLUME
		SECTION
		REV. NO. 02 DATE: 16.09.2013
		SHEET 1 OF 3

TAG No. ……. Qty..... Data Sheet No.: **PES-145A-DS1-0**

Data Sheet A & B

			DATA SHEET-A FOR LOCAL PANEL (TO BE FILLED BY PURCHASER)	DATA SHEET-B (TO BE FILLED-UP BY BIDDER)
GENERAL	MANUFACTURER			
	CONSTRUCTION		■ FOLDED ☐ WELDED	
	ENCLOSURE SHEET THICKNESS **(As per Section 8.13,Volume V of contract specification)**	FRONT	☐2.0 mm	
		OTHER	☐ 2.0 mm	
		DOOR	☐ 1.6 mm	
		HEIGHT	☐ 2365 mm for stand alone panels. ☐ Other ……	
		OTHER	☐ Load bearing sheet front shall have 3mm thickness	
TECHNICAL	INPUT POWER SUPPLY * **(As per Electrical specification)** (ANY OTHER POWER REQUIREMENT TO BE DERIVED FROM THIS SUPPLY ONLY)		☐ 240V 50 Hz AC ☐ 220V DC ■ 415V 3 PHASE 3W ☐ 400V 3 PHASE 4W	
	NO. OF FEEDERS **(As per Electrical specification)**		☐ ONE ☐ TWO	
	STARTER WITH MCC		☐ REQUIRED ■ NOT REQUIRED	
	IPR POSITION		■ MCC ☐ RELAY PANEL	
	CONTACT RATING OF RELAY		■ 5 Amp, 230 V AC ■ 0.25 Amp, 220V DC	
	CONTROL SUPPLY		☐ 110V AC ☐ 220V AC ☐ 220V DC ☐ Other. (As per requirement)	
	ALARM ANNUNCIATOR WINDOW (EXCLUDING SPARES)		_____NOS. (AS REQUIRED)	
	TEMP SCANNER (IF REQUIRED –NO. OF CHANNELS TO BE SPECIFIED UNDER SEC-C)		☐ REQUIRED ■ NOT REQUIRED	
	PAINT TYPE **(As per Annex-1,Section 7.6,Voulme IV of contract specification)**		☐ EPOXY ENAMEL ☐ EPOXY POWDER COATED	
	MIMIC (TYPE OF MIMIC- MATERAIL, THICKNESS TO BE SPECIFIED DURING DETAILED ENGG.)		■ REQUIRED ☐ NOT REQUIRED	
	PANEL COLOUR (EXTERNAL) **(As per Annex-1,Section 7.6,Voulme IV of contract specification)**		☐ LIGHT GREY ☐ OPALINE GREEN	
	FINISH (EXTERNAL) **(As per Annex-1, Section 7.6,Voulme IV of contract specification)**		☐ MATT ☐ GLOSSY ☐ SEMI GLOSSY	
	PANEL COLOUR (INTERNAL) **(As per Annex-1,Section 7.6,Voulme IV of contract specification)**		☐ WHITE ☐ CREAM ☐ OFF WHITE	
	FINISH (INTERNAL) **(As per Annex-1,Section 7.6,Voulme IV of contract specification)**		☐ MATT ☐ GLOSSY ☐ SEMI GLOSSY	
	CLASS OF PROTECTION		■ IP-55 (FOR INDOOR SERVICE) ■ IP-67 (FOR OUTDOOR SERVICE) ☐ ANY OTHER	
	CONTROL HARDWARE		■ RELAY BASED	
	FOUNDATION ARRANGEMENT		☐ FOUNDATION BOLTS ☐ ANCHOR FASTENERS	
	WEIGHT OF PANEL (Kg.)		……..(Vendor to specify)	

FORM NO. PEM-6666-0

	DATA SHEET FOR LOCAL PANELS	SPECIFICATION NO.: PE-SS-999-145-054A	
		VOLUME	
		SECTION	
		REV. NO. 02	DATE: 16.09.2013
		SHEET 2 OF 3	

TAG No. ……. Qty..... Data Sheet No.: **PES-145A-DS1-0**

Data Sheet A & B

	DATA SHEET-A FOR LOCAL PANEL (TO BE FILLED BY PURCHASER)		DATA SHEET-B (TO BE FILLED-UP BY BIDDER)
	PANEL TYPE	☐ PRESSURISED ☐ UNPRESSURISED As per Requirement	
	CABLE GLAND	■ DOUBLE COMPRESSION	
	AMMETER (TYPE OF INPUT) *	☐ 1 Amp CT ☐ 4-20 mA	
	SCOPE OF SUPERVISION FOR ERECTION & COMMISSIONING	☐ APPLICABLE ■ NA	
	* TO BE CO-ORDINATED WITH PEM ELECTRICAL		

	PREPARED BY	CHECKED BY	APPROVED BY	COMPANY SEAL
NAME	AANCHAL CHOUDHARY	SACHIN SRIVASTAVA	MA MANSOORI	NAME:
DESIGNATION	SR.ENGR	DY.MNGR	D. GM	
SIGNATURE				SIGNATURE:
DATE	16.09.2013	16.09.2013	16.09.2013	DATE:

FORM NO. PEM-6666-0

	DATA SHEET FOR LOCAL PANELS	SPECIFICATION NO.: PE-SS-999-145-054A	
		VOLUME	
		SECTION	
		REV. NO. 02	DATE: 16.09.2013
		SHEET 3 OF 3	

TAG No. ……. Qty..... Data Sheet No.: **PES-145A-DS1-0**

Data Sheet C

DATA SHEET-C FOR LOCAL PANEL
(TO BE FILLED BY CONTRACTOR AFTER AWARD OF CONTRACT)

GENERAL	MANUFACTURER			
	CONSTRUCTION		☐ FOLDED ☐ WELDED (As per requirement EDN)	
	ENCLOSURE SHEET THICKNESS	FRONT		
		OTHER		
		DOOR		
		HEIGHT		
		OTHER		
TECHNICAL	INPUT POWER SUPPLY			
	NO. OF FEEDERS			
	CONTACT RATING OF RELAY			
	TEMP SCANNER			
	CONTROL SUPPLY			
	ALARM ANNUNCIATOR WINDOW (EXCLUDING SPARES)			
	PAINT TYPE			
	PANEL COLOUR (EXTERNAL)			
	FINISH (EXTERNAL)			
	TYPE OF MIMIC MATERIAL OF MIMC THICKNESS OF MIMIC			
	PANEL COLOUR (INTERNAL)			
	FINISH (INTERNAL)			
	CLASS OF PROTECTION			
	CONTROL HARDWARE			
	FOUNDATION ARRANGEMENT			
	WEIGHT OF PANEL (Kg.)			

FORM NO. PEM-6666-0

	DATA SHEET FOR LOCAL PANELS	SPECIFICATION NO.: PE-SS-999-145-054A	
		VOLUME	
		SECTION	
		REV. NO. 02	DATE: 16.09.2013
		SHEET 3 OF 3	

TAG No. ……. Qty..... Data Sheet No.: **PES-145A-DS1-0**

Data Sheet C

DATA SHEET-C FOR LOCAL PANEL
(TO BE FILLED BY CONTRACTOR AFTER AWARD OF CONTRACT)

	PANEL TYPE		
	CABLE GLAND		
	AMMETER (TYPE OF INPUT)		
	SCOPE OF SUPERVISION		

	PREPARED BY	CHECKED BY	APPROVED BY	COMPANY SEAL
NAME	AANCHAL CHOUDHARY	SACHIN SRIVASTYAVA	MA MANSOORI	NAME:
SIGNATURE				SIGNATURE:
DATE	16.09.2013	16.09.2013	16.09.2013	DATE:

Instrumentation Quality Plan

CHECK LIST FOR PRESSURE SWITCH

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECK FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS	P	V	V	
	1.1 MODEL NO/TAG NO						
	1.2 RANGE						
	1.3 END CONN						
	1.4 NO. OF CONTACT						
2	CALIBRATION			P	V	V	
	2.1 REPEATABILITY						
	2.2 SET POINT ADJUSTMENT						
	2.3 DIFFERENTIAL						
3	OVER PR & LEAK TEST			P	V	V	
4	ELECT. INSULATION/HV TEST	ONE		P	V	V	
5	REVIEW OF TC FOR MATERIALS OF	FOR LOT		V	V	V	
	5.1 SENSOR						
	5.2 MOVEMENT						
	5.3 PROCESS CONNECTION						
	5.4 HOUSING						
6	REVIEW OF TC FOR DEGREE OF PROTECTION	TYPE TEST		V	V	V	
7	REVIEW OF TC OF MICROSWITCH	FOR LOT		V	V	V	

** M = Manufacturer / Sub-contractor, C = Contractor / Nominated Inspecting Agency, B = BHEL, P = Perform, W = Witness, V = Verification

Note :

1. Quantum of check shall be as below :
   100 % - By Manufacturer
2. Manufacturer to carry out ROUTINE TEST on 100 %.
3. Contractor to provide compliance certificate for tests/checks verifid by contractor and the same alongwith test certificates to be verified by BHEL

STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR TRANSMITTER

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECKS FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS	P	W	V	
	VISUAL.						
	MODEL/TAG No						
2	PROCESS CONNECTION			P	W	V	
3	ACCURACY			P	W	V	
4	REPEATABILITY			P	W	V	
5	HYSTERESIS			P	W	V	
6	EFFECT OF TEMP VARIATION ON ACCURACY			P	W	V	
7	SPAN / ZERO ADJUSTMENT	ONE / TYPE		P	W	V	
8	EFFECT OF SUPPLY VOLTAGE VARIATION			P	W	V	
9	EFFECT OF LOADING (500 OHM METERS)			P	W	V	
10	HIGH PRESSURE TEST	SEE NOTE-1 BELOW		P	W	V	
11	BURN-IN TEST	ONE / TYPE		P	W	V	
12	DEGREE OF PROTECTION			P	W	V	
13	ACCESSORIES AS APPLICABLE	SEE NOTE-1 BELOW		V	V	V	

Legend :

** M = Manufacturer / Sub-contractor, C = Contractor / Nominated Inspecting Agency, B = BHEL, P = Perform, W = Witness, V = Verification

Note :

1. Quantum of check shall be as below :
   100 % - By Manufacturer
2. Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
3. When material corelation are not available manufacturer's compliance to be provided.
4. Contractor to provide compliance certificate for tests/checks verifid by contractor and submit the same alongwith test certificates to be verified by BHEL.

STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR PRESSURE & DP GAUGE

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECK FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS	P	W	V	
	SENSOR TYPE						
	DIAL SIZE						
	MODEL NO/TAG NO						
	RANGE/SCALE						
	SWITCH CONTACT RATING & NOS.						
	END CONNECTION						
2	CALIBRATION			P	W	V	
	ACCURACY						
	REPEATABILITY						
	SET POINT ADJUSTMENT						
3	OVER PRESSURE & LEAK TEST			P	W	V	
4	OPERATION OF PRESSURE. RELIEF DEVICE	ONE		P	W	V	
5	REVIEW OF TC FOR	FOR LOT		V	V	V	
	MATERIALS OF SENSOR						
	MOVEMENT						
	PROCESS CONNECTION						
	HOUSING						
6	REVIEW OF TC FOR DEGREE OF PROTECTION	TYPE TEST		V	V	V	
7	ACCESSORIES AS APPLICABLE	SEE NOTE-1 BELOW		V	V	V	

Legend :

** M = Manufacturer / Sub-contractor, C = Contractor / Nominated Inspecting Agency, B = BHEL, P = Perform, W = Witness, V = Verification

Note :

1. Quantum of check shall be as below :
   100 % - By Manufacturer
2. Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
3. Manufacturer to carry out ROUTINE TEST on 100 %.
4. When material corelation is not available, MFR's compliance to be provided
5. Contractor to provide compliance certificate for tests/checks verifid by contractor and submit the same alongwith test certificates to be verified by BHEL.

STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR LEVEL GAUGE

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECK FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS / DRWGS	P	W	V	
	TYPE						
	MODEL/ TAG NO.						
	DAIL SIZE						
	RANGE/SCALE						
	END CONNECTION						
2	DIMENSIONS, PROCESS CONNECTION			P	W	V	
3	ACCURACY			P	W	V	
4	MATERIAL TC FOR	ONE / LOT		P	V	V	
	BODY ISO.						
	VALVE						
	GAUGE GLASS						
5	HYD. TEST	SEE NOTE-1 BELOW		P	W	V	
6	ACCESSORIES AS APPLICABLE			P	W	V	

Legend :

** M = Manufacturer / Sub-contractor, C = Contractor / Nominated Inspecting Agency, B = BHEL, P = Perform, W = Witness, V = Verification

Note :

1. Quantum of check shall be as below :
   100 % - By Manufacturer
2. Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
3. Manufacturer to carry out ROUTINE TEST on 100 %.
4. Contractor to provide compliance certificate for tests/checks verifid by contractor and submit the same alongwith test certificates to be verified by BHEL.

STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR ANNUNCIATORS

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECK FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS	P	W	V	
	TYPE/ MODEL						
	DIMENSIONS OF HARDWARE						
	MODULARITY						
	SEQUENCE						
	FACIA DETAILS						
2	FUNCTIONAL TEST	100%		P	W	V	
3	IMMUNE TO STEP VARIATIONS IN THE POWER SUPPLY	SEE NOTE-1 BELOW		P	W	V	
4	DEGREE OF PROTECTION FOR ENCLOSURE	TYPE TEST		P	W	V	
5	I/R CHECK	SEE NOTE-1 BELOW		P	W	V	
6	RESPONSE			P	W	V	

Legend :

** M = Manufacturer / Sub-contractor, C = Contractor / Nominated Inspecting Agency, B = BHEL, P = Perform, W = Witness, V = Verification

Note :

1. Quantum of check shall be as below :
   100 % - By Manufacturer
2. Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
3. Manufacturer to carry out ROUTINE TEST on 100 %.
4. Contractor to provide compliance certificate for tests/checks verifid by contractor and submit the same alongwith test certificates to be verified by BHEL.

CABLE BOQ

CABLE SIZES FOR 5X800 MW YADADRI TPS	
Sl no.	Cable Type
	G-TYPE
1	2P X 0.5 sqmm
2	4P X 0.5 sq mm
3	8P X 0.5 sqmm
4	12P X 0.5 sqmm
5	2P X 1.5 sqmm
	F-TYPE
1	4P X 0.5 sqmm
2	8P X 0.5 sqmm
3	12P X 0.5 sqmm
4	20P X 0.5 sqmm
	CONTROL CABLE
1	3C X 2.5 sqmm
2	5C x 2.5 sq mm
3	12C x 2.5 sqmm

INSTRUMENT STUB DETAILS

CUSTOMER:	TELANGANA STATE POWER GENERATION CORPORATION LTD TELANGANA, INDIA 5 x 800 MW YADADRI TPS, UNIT # 1 TO 5
CONSULTANT: TATA	TATA CONSULTING ENGINEERS LIMITED BANGALORE, INDIA
	BHARAT HEAVY ELECTRICALS LTD POWER SECTOR PROJECT ENGINEERING MANAGEMENT NOIDA

JOB NO. 417
STATUS CONTRACT
DISTRIBUTION

REV.	DATE	ALTD	CHD	APPD

REV.	DATE	ALTD	CHD	APPD

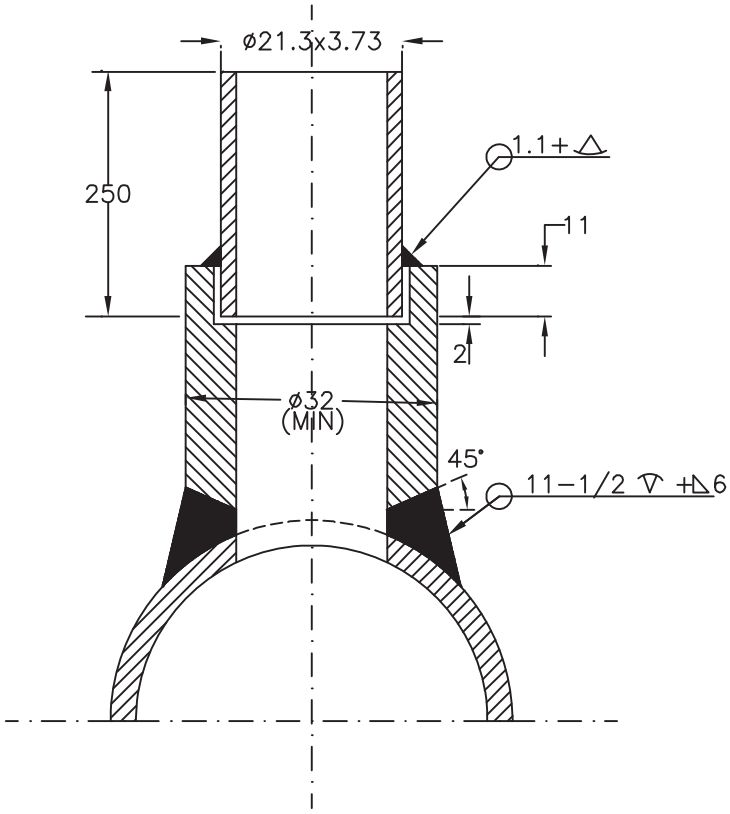
DEPT CODE		NAME	SIGN	DATE
I	DRN	AKS		20.01.18
	DESN	AKS		20.01.18
	CHD	RKR		20.01.18
	APPD	SSB		20.01.18

TITLE: INSTRUMENT STUB DETAILS

DEPT. | SCALE
SIGN

DRAWING NO. PE-DG-417-145-I101

SHEET 1 OF 6 | REV. 00



NOTE :

1. MATERIAL OF THE BOSS AND NIPPLE SHALL BE THE SAME AS THE PIPE INTO WHICH IT IS WELDED AND CONFORM TO ANSI B16.11.
2. THE LENGTH OF NIPPLE SHALL BE 250 MM.
3. THE OTHER END OF THE NIPPLE SHALL BE SOCKET WELDED WITH 1/2" GLOBE VALVE OF MATERIAL AS PER ANSI B 31.1.
4. TWO ISOLATION VALVES ARE TO BE USED FOR PRESSURE EXCEEDING 40 Kg/Cm2.
5. ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE STATED.
6. EDGE HOLE MUST BE CLEAN AND SQUARE OR ROUNDED SLIGHTLY(1/64" RADIUS) FREE FROM BURRS, WIRE EDGES OR OTHER IRREGULARITIES.

TITLE : 5 x 800 MW YADADRI TPS

STD INSTRUMENT STUB DETAILS

PRESSURE STUB

SYSTEM PRESS < 60Kg/Cm2 & SYSTEM TEMP<425 Deg C, Nb15 , CL3000

DRG. NO.
PE-DG-417-145-I101
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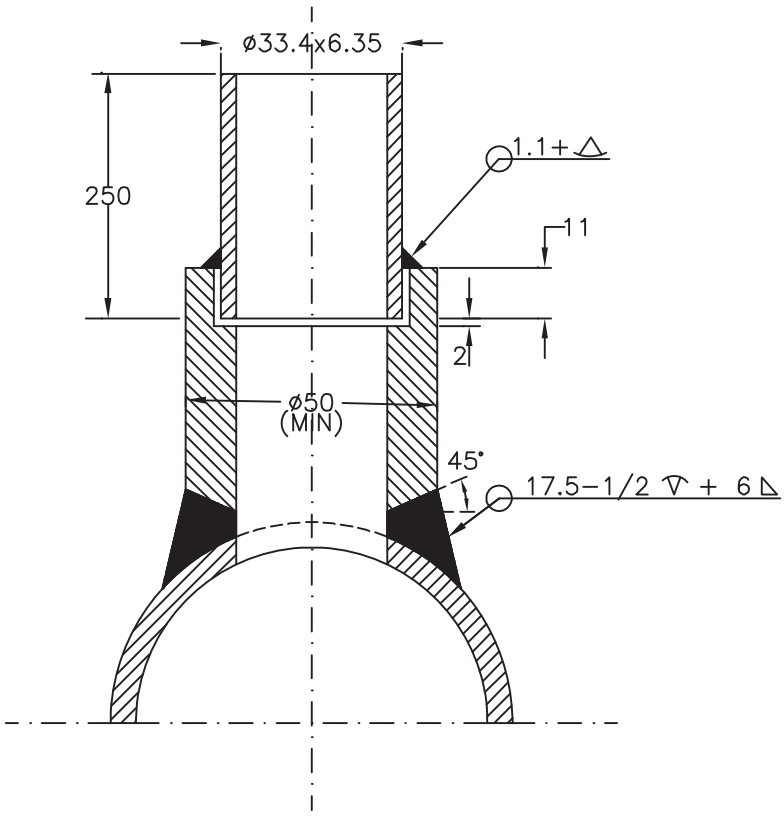


NOTE :

1. MATERIAL OF THE BOSS AND NIPPLE SHALL BE THE SAME AS THE PIPE INTO WHICH IT IS WELDED AND CONFORM TO ANSI B16.11.
2. THE LENGTH OF NIPPLE SHALL BE 250 MM.
3. THE OTHER END OF THE NIPPLE SHALL BE SOCKET WELDED WITH 1" GLOBE VALVE OF MATERIAL AS PER ANSI B 31.1.
4. TWO ISOLATED VALVES ARE TO BE USED.
5. ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE STATED.
6. EDGE HOLE MUST BE CLEAN AND SQUARE OR ROUNDED SLIGHTLY(1/64" RADIUS) FREE FROM BURRS, WIRE EDGES OR OTHER IRREGULARITIES.

TITLE : 5 x 800 MW YADADRI TPS

STD INSTRUMENT STUB DETAILS

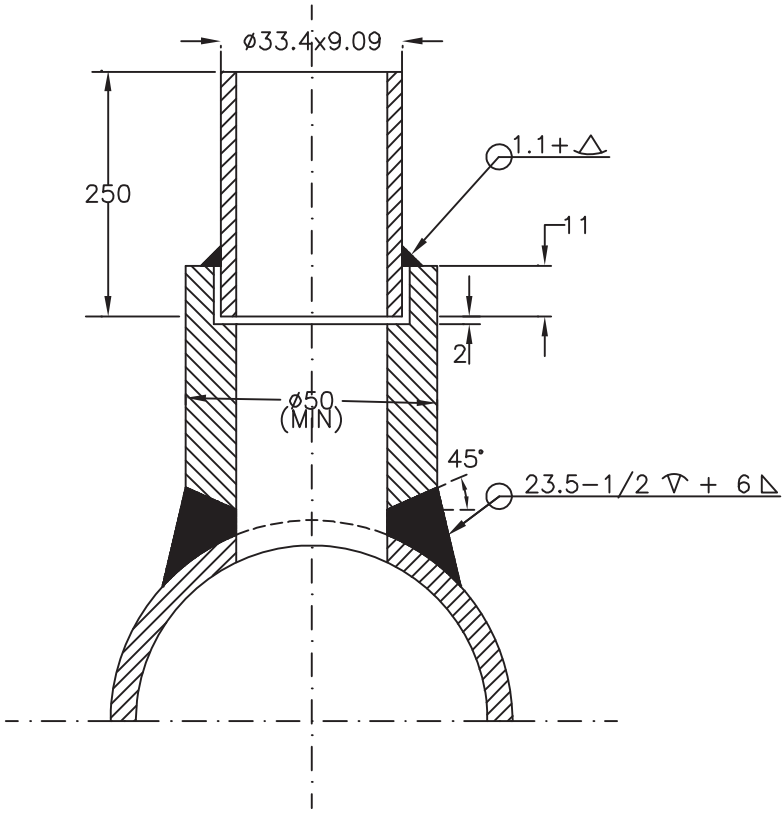
PRESSURE STUB

DRG. NO. PE-DG-417-145-I101

REV. 00

SH. 03 OF 06

SYSTEM PRESS > 60Kg/Cm2 & 425 Deg C < SYSTEM TEMP <= 500 Deg C , Nb25 , CL3000/6000



NOTE :

1. MATERIAL OF THE BOSS AND NIPPLE SHALL BE THE SAME AS THE PIPE INTO WHICH IT IS WELDED AND CONFORM TO ANSI B16.11.
2. THE LENGTH OF NIPPLE SHALL BE 250 MM.
3. THE OTHER END OF THE NIPPLE SHALL BE SOCKET WELDED WITH 1" GLOBE VALVE OF MATERIAL AS PER ANSI B 31.1.
4. TWO ISOLATED VALVES ARE TO BE USED.
5. ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE STATED.
6. EDGE HOLE MUST BE CLEAN AND SQUARE OR ROUNDED SLIGHTLY(1/64" RADIUS) FREE FROM BURRS, WIRE EDGES OR OTHER IRREGULARITIES.

TITLE : 5 x 800 MW YADADRI TPS

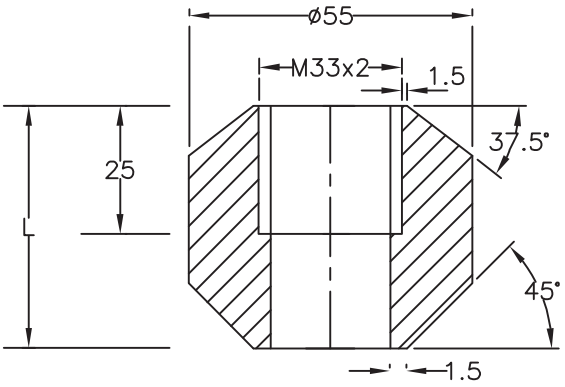
STD INSTRUMENT STUB DETAILS

PRESSURE STUB

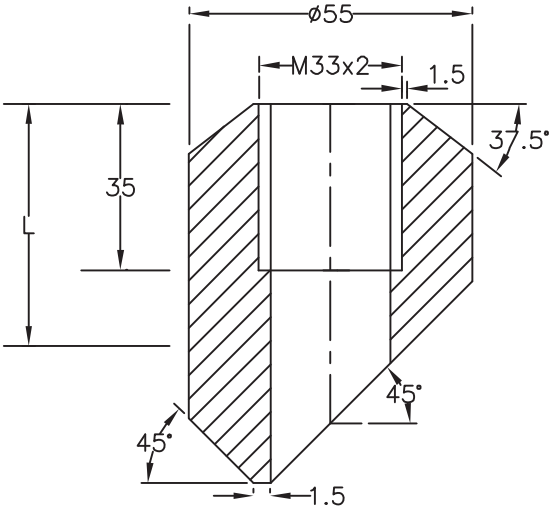
SYSTEM TEMP > 500 Deg C , Nb25 , CL9000

DRG. NO.
PE-DG-417-145-I101

REV. 00
SH. 04 OF 06



TEMPERATURE STUB FOR STRAIGHT IMMERSION



TEMPERATURE STUB FOR SLANT IMMERSION

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 64/45 mm DEPENDING UPON PIPE SIZE, AS PER CORPORATE STD. AA 7326102.(FOR PIPE OD 88.9 mm TO 159 mm STUB HEIGHT SHALL BE=64mm & FOR PIPE OD ⩾219.1mm STUB HEIGHT SHALL BE=45mm)
3. STRAIGHT IMMERSION STUBS SHALL BE USED FOR PIPE OD'S 168.3 mm & ABOVE. THE STUB HEIGHT FOR PIPE OD 168.3 mm TO <219.1 mm SHALL BE 64 mm.
4. SLANT IMMERSION STUBS SHALL BE USED FOR PIPE OD'S 88.9 mm TO 159 mm.
5. FOR MAIN PIPE OD'S 88.9 mm & BELOW SUITABLE EXPANDER SHALL BE USED.
6. PLEASE REFER SHEET–6 FOR THERMOWELL INSTALLATION.

TITLE : 5 x 800 MW YADADRI TPS

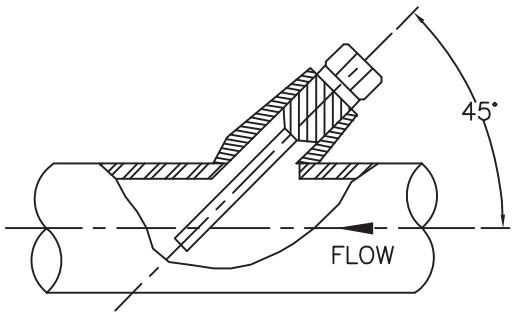
STD INSTRUMENT STUB DETAILS

TEMPERATURE STUB

DRG. NO. PE-DG-417-145-I101

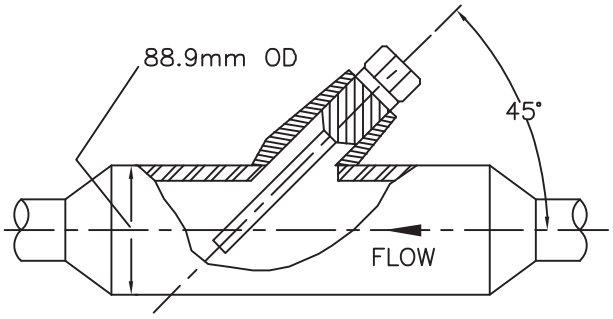
REV. 00

SH. 05 OF 06



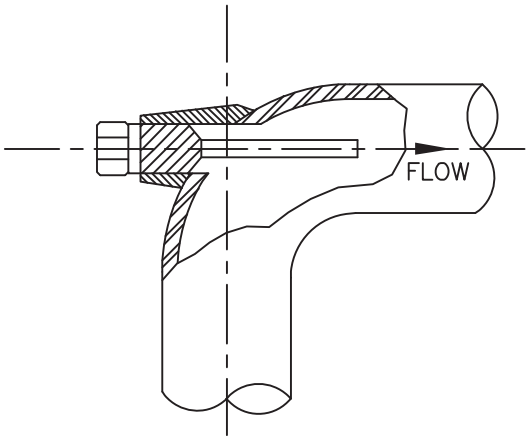
INSTALLATION TYPE–1

FOR MAIN PIPE OD 88.9mm to 159mm



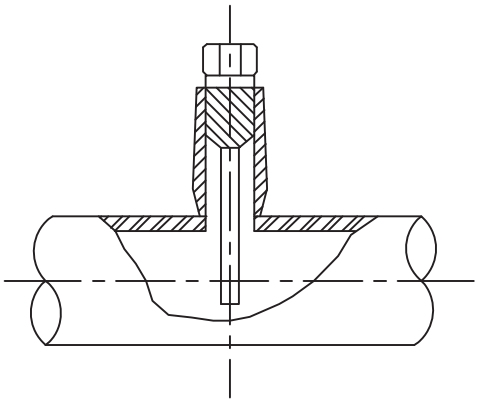
INSTALLATION TYPE–2

FOR MAIN PIPE OD BELOW 88.9mm



INSTALLATION TYPE–3

FOR MAIN PIPE OD 88.9mm & BELOW



INSTALLATION TYPE–4

FOR MAIN PIPE OD 168.3mm & ABOVE

TITLE : 5 x 800 MW YADADRI TPS

STD INSTRUMENT STUB DETAILS

THERMOWELL INSTALLATION

DRG. NO.
PE-DG-417-145-I101
REV. 00
SH. 06 OF 06

SECTION – III

SCHEDULE OF PRE-BID CLARIFICATION

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

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

COMPLIANCE CUM CONFIRMATION SCHEDULE

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

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

2. QP/ test procedures shall be submitted in the event of order based on the guidelines given in the specification & QP enclosed therein.

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

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

5. There are no other deviations with respect to specification other than those furnished in the 'Schedule of Deviations'.

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

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

8. All sub vendors shall be subject to BHEL/CUSTOMER approval.

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

10. Performance guarantee test parameters shall stand valid till the satisfactory completion of Performance guarantee test and its acceptance by BHEL/Customer.

11. Prices for recommended spares (if any) for three year operation shall be furnished separately and not to be included in the base price.

DECLARATIONS

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

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

Bidders Company Name ……

Authorized representative's Signature ……

Name ……

Bidder's Name

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

SCHEDULE OF DEVIATIONS WITH COST OF WITHDRAWAL

PROJECT:- 5X800 MW YADADRI TPS

HYDROGEN GENERATION PLANT

TENDER ENQUIRY REFERENCE:-

NAME OF VENDOR:-

SL NO	VOULME/ SECTION	PAGE NO.	CLAUSE NO.	TECHNICAL SPECIFICATION/ TENDER DOCUMENT	COMPLETE DESCRIPTION OF DEVIATION	COST OF withdrawal OF DEVIATION	REFERENCE OF PRICE SCHEDULE ON WHICH COST OF withdrawal OF DEVIATION IS APPLICABLE	NATURE OF COST OF withdrawal OF DEVIATION (POSITIVE/ NEGATIVE)	REASON FOR QUOTING DEVIATION
TECHNICAL DEVIATIONS									
COMMERCIAL DEVIATIONS									

PARTICULARS OF BIDDERS/ AUTHORISED REPRESENTATIVE

NAME	**DESIGNATIONS**	**SIGN & DATE**	

NOTES:

1. For self manufactured items of bidder, cost of withdrawal of deviation will be applicable on the basic price (i.e. excluding taxes, duties & freight) only.
2. For directly dispatchable items, cost of withdrawal of deviation will be applicable on the basic price including taxes, duties & freight.
3. All the bidders have to list out all their Technical & Commercial Deviations (if any) in detail in the above format.
4. Any deviation not mentioned above and shown separately or found hidden in offer, will not be taken cognizance of.
5. Bidder shall submit duly filled unpriced copy of above format indicating "quoted" in "cost of withdrawal of deviation" column of the schedule above along with their Techno-commercial offer, wherever applicable.
6. Bidder shall furnish price copy of above format along with price bid.
7. The final decision of acceptance/ rejection of the deviations quoted by the bidder shall be at discretion of the Purchaser.
8. Bidders to note that any deviation (technical/commercial) not listed in above and asked after Part-I opening shall not be considered.
9. For deviations w.r.t. Payment terms, Liquidated damages, Firm prices and submission of E1/ E2 forms before claiming 10% payment, if a bidder chooses not to give any cost of withdrawal of deviation loading as per Annexure-VIII of GCC, Rev-06 will apply. For any other deviation mentioned in un-priced copy of this format submitted with Part-I bid but not mentioned in priced copy of this format submitted with Priced bid, the cost of withdrawal of deviation shall be taken as NIL.
10. Any deviation mentioned in priced copy of this format, but not mentioned in the un-priced copy, shall not be accepted.
11. All techno-commercial terms and conditions of NIT shall be deemed to have been accepted by the bidder, other than those listed in unpriced copy of this format.
12. Cost of withdrawal is to be given seperately for each deviation. In no event bidder should club cost of withdrawal of more than one deviation else cost of withdrawal of such deviations which have been clubbed together shall be considered as NIL.
13. In case nature of cost of withdrawal (positive/negative) is not specified it shall be assumed as positive.
14. In case of descrepancy in the nature of impact (positive/ negative), positive will be considered for evaluation and negative for ordering.