

**TAMILNADU GENERATION AND DISTRIBUTION
CORPORATION LIMITED**

**2X660 MW UDANGUDI STPP
SUPERCRITICAL THERMAL POWER PROJECT**

VOLUME – II B

**TECHNICAL SPECIFICATION
FOR
HYDROGEN GENERATION PLANT**

SPECIFICATION NO. PE-TS-435-168-A001, R0



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



TITLE :
2X660 MW UDANGUDI STPP

SPECIFICATION NO. PE-TS-435-168-A001

SECTION :

**TECHNICAL SPECIFICATION FOR
HYDROGEN GENERATION PLANT**

REV. NO. 00

CONTENTS

SECTION	DESCRIPTION	PAGE NO.
	PROJECT INFORMATION	2-5
SECTION – I	SPECIFIC TECHNICAL REQUIREMENTS	6
SECTION – IA	SPECIFIC TECHNICAL REQUIREMENTS (MECHANICAL)	7-16
	➤ ANNEXURE I: QUALITY PLAN	17-49
	➤ ANNEXURE II: SUB VENDORS LIST	50-74
	➤ ANNEXURE III: FUNCTIONAL GUARANTEES AND LIQUIDATED DAMAGES	75-76
	➤ ANNEXURE IV: DRAWING DOCUMENTS DISTRIBUTION PROCEDURE	77-78
	➤ ANNEXURE V: PAINTING SPECIFICATION	79-95
	➤ ANNEXURE VI: MANDATORY SPARES LIST	96-98
	➤ ANNEXURE VII: DRAWING/DOCUMENTS SUBMISSION SCHEDULE	99-102
	➤ ANNEXURE VIII: DM AND COOLING WATER ANALYSIS	103-104
	➤ ANNEXURE IX: LIST OF TOOLS & TACKLES (AS APPLICABLE)	105
	➤ ANNEXURE X: FORMAT FOR OPERATION AND MAINTENANCE MANUAL	106-109
	➤ ANNEXURE XI: SITE STORAGE AND PRESERVATION	110-123
	➤ ANNEXURE XII -GUARANTEED PERFORMANCE DATA	124-125
	➤ P&ID & EQUIPMENT LAYOUT	126-130
SECTION – IB	SPECIFIC TECHNICAL REQUIREMENTS (ELECTRICAL)	131
	➤ ELECTRICAL EQUIPMENT SPECIFICATION	132-133
	➤ ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR	134-136
	➤ ELECTRICAL LOAD DATA FORMAT	137-138
	➤ CABLE SCHEDULE FORMAT	139
SECTION – IC	SPECIFIC TECHNICAL REQUIREMENTS (CONTROL & INSTRUMENTATION)	140-197
SECTION – II	GENERAL TECHNICAL REQUIREMENT	198
SECTION – IIA	GENERAL TECHNICAL REQUIREMENT (MECHANICAL)	199-259
SECTION – IIB	GENERAL TECHNICAL REQUIREMENT (ELECTRICAL)	260-285
SECTION – IIC	GENERAL TECHNICAL REQUIREMENT (CONTROL AND INSTRUMENTATION)	286-390
SECTION - III	➤ SCHEDULE OF PRE BID CLARIFICATIONS	391-392
	➤ COMPLIANCE CUM CONFIRMATION SCHEDULE	393
	➤ SCHEDULE OF DECLARATION	394
	➤ SCHEDULE OF DEVIATIONS	395



TITLE :
2X660 MW UDANGUDI STPP

**TECHNICAL SPECIFICATION FOR HYDROGEN
GENERATION PLANT**

SPECIFICATION NO. PE-TS-435-168-A001

SECTION :

SUB-SECTION:

REV. NO. 00

PROJECT INFORMATION

**5.0.0 SITE CONDITION****5.1.0 Location and existing Infrastructure**

The plant location details are as follows:

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

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

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

5.1.1 Soil Profile

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

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

5.1.2 Seismic intensity

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

5.1.3 Tide Levels

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

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

**5.2.0 Meteorological conditions****Ambient Air Temperature**

Maximum dry bulb temperature : 41 °C

Minimum dry bulb temperature : 17 °C

Relative humidity

Mean Maximum humidity (Summer) : 84%

Mean Minimum humidity (Summer) : 62%

Maximum humidity (Monsoon) : 97%

Minimum humidity (Monsoon) : 45%

Rainfall

Annual rainfall (Maximum) : 718.2 mm

Annual Rain fall (Minimum) : 384.1 mm

Twenty four (24) Hour max : 138.2 mm

High Flood Level

High Flood Level for site : RL 2.450 m

Wind

Mean Wind Speed (max) : 20.6 km/h

Wind direction : North, North East, North West, East

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

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

5.3.0 Design Requirements related to site conditions**5.3.1 Design Ambient Data****Rainfall data:**

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

Wind data

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



5.3.2 Seismic Data

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



TITLE :
2X660 MW UDANGUDI STPP

**TECHNICAL SPECIFICATION FOR HYDROGEN
GENERATION PLANT**

SPECIFICATION NO. PE-TS-435-168-A001

SECTION : I

SUB-SECTION:

REV. NO. 00

SECTION – I
SPECIFIC TECHNICAL REQUIREMENTS
SUB-SECTION IA - Specific Technical Requirements (Mech.)
SUB-SECTION IB - Specific Technical Requirements (Electrical)
SUB-SECTION IC - Specific Technical Requirements (C & I)



TITLE :

2X660 MW UDANGUDI STPP

SPECIFICATION NO. PE-TS-435-168-A001

SECTION : I

**TECHNICAL SPECIFICATION FOR HYDROGEN
GENERATION PLANT**

SUB-SECTION: IA

REV. NO. 00

SUB-SECTION – IA

SPECIFIC TECHNICAL REQUIREMENTS (MECHANICAL)



TITLE : 2X660 MW UDANGUDI STPP	SPECIFICATION NO. PE-TS-435-168-A001	
	SECTION : I	
	SUB-SECTION: IA	
	REV. NO. 00	
TECHNICAL SPECIFICATION FOR HYDROGEN GENERATION PLANT		

1.0 INTENT OF SPECIFICATION

- 1.1 The intent of specification is to cover 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 ,startup 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 and carrying out performance guarantee /Functional / Demonstration tests at site , obtaining CCOE approval & final handing over to end customer in flawless condition for project and package specified above complete with all accessories for the total scope defined as per BHEL NIT & tender technical specification, amendment & agreements till placement of order.
- 1.2 The contractor shall be responsible for providing all material, equipment & services, which are required to fulfil the intent of ensuring operability, maintainability, reliability and complete safety of the complete work covered under this specification, irrespective of whether it has been specifically listed herein or not. Omission of specific reference to any component / accessory necessary for proper performance of the equipment shall not relieve the contractor of the responsibility of providing such facilities to complete the supply, erection and commissioning, performance and guarantee of **HYDROGEN GENERATION PLANT**.
- 1.3 It is not the intent to specify herein all the details of design and manufacture. However, the equipment shall conform in all respects to highest 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 judgement is not in full accordance herewith.
- 1.4 The extent of supply under the contract includes all items shown in the drawings, notwithstanding the fact that such items may have been omitted from the specification or schedules. Similarly, the extent of supply also includes all items mentioned in the specification and /or schedules, notwithstanding the fact that such items may have been omitted in the drawing. Similarly, the extent of supply also includes all terms required for completion of the system and not withstanding that they may have been omitted in drawings / specifications or schedules.
- 1.5 The general term and conditions, instructions to tenderers and other attachment referred to elsewhere are made part of the tender specification. The equipment materials and works covered by this specification is subject to compliance to all attachments referred to in the specification. The bidder shall be responsible for and governed by all requirements stipulated herein.
- 1.6 While all efforts have been made to make the specification requirement complete & unambiguous, it shall be bidders' responsibility to ask for missing information, ensure completeness of specification, to bring out any contradictory / conflicting requirement in different sections of the specification and within a section itself to the notice of BHEL and to seek any clarification on specification requirement in the format enclosed under section-III of the specification. In absence of any such clarifications, in case of any contradictory requirement, the more stringent requirement as per interpretation of Purchaser / 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 Purchaser/ Customer as and when brought to their notice either by the bidder or by purchaser/ customer themselves. However, such requirements shall be binding on the successful bidder without any commercial & delivery implication.



TITLE : 2X660 MW UDANGUDI STPP	SPECIFICATION NO. PE-TS-435-168-A001	
	SECTION : I	
	SUB-SECTION: IA	
	REV. NO. 00	
TECHNICAL SPECIFICATION FOR HYDROGEN GENERATION PLANT		

- 1.7 The bidder's offer shall not carry any sections like clarification, interpretations and /or assumptions.
- 1.8 Deviations, if any, should be very clearly brought out clause by clause along with cost of withdrawal in the enclosed schedule (in 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.
- 1.9 In the event of any conflict between the requirements of two clauses of this specification documents or requirements of different codes and standards specified, Section – IA shall prevail over section – IIA and Section-IB & IC shall prevail over Section-IIB & IIC, however more stringent requirement as per the interpretation of the owner shall apply.
- 1.10 In case all above requirements are not complied with, the offer may be considered as incomplete and would become liable for rejection.
- 1.11 For definition of word like Contractor, bidder, supplier, vendor, Customer/ Purchaser / Employer, consultant, please referred relevant clause(s) of GCC.

- 1.12 "Note 1:- Bidder to note that the building along with foundation of equipment has already been 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-V0-435-168-A001) is enclosed with this specification & bidder to follow the same".
- 1.13 "Note 2: - Bidder to note that MCC for Hydrogen Generation Plant is already available at the 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 to by the Bidder. In case any modification is required in MCC due to change of Load data, the same shall be in bidder's scope.

- 2.0 "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-V0-435-168-A020 is enclosed here with this specification & bidder to follow the same". However, furniture, OWS, laptop etc. with other accessories is in bidders' scope. Further, refurbishment / replacement of already supplied item shall also be in bidder's Scope.

2.0 SCOPE OF SUPPLY:

Note1:- 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: -

- 2.1 Two streams of electrolyzers working in parallel (each of capacity minimum 12 Nm³/hr.).
- 2.2 Three (3) numbers of hydrogen gas compressors and drives (each of minimum 15 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. Dual Type After-Filters to prevent entrainment of desiccant particles with the effluent gas from the dryer unit.
- 2.4 One (1) no. Gas Washing Tank per stream or any other alternative device to remove traces of caustic potash entrained with hydrogen gas. Each gas washer has level transmitters.



TITLE : 2X660 MW UDANGUDI STPP	SPECIFICATION NO. PE-TS-435-168-A001	
	SECTION : I	
	TECHNICAL SPECIFICATION FOR HYDROGEN GENERATION PLANT	
	SUB-SECTION: IA	
	REV. NO. 00	

- 2.5 Two (2) nos. Portable Hydrogen Gas Purity Meters. These meters shall be battery operated.
- 2.6 Two (2) nos. Hydrogen filling stations with manifold isolating valve, safety valve etc. for both evacuation and simultaneous filling of minimum 6 cylinders (total 12 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.
- 2.7 Two (2) nos. Nitrogen manifold common for both streams shall be provided. Each nitrogen manifold shall comprise of three 3 nos. for complete purging of the hydrogen gas streams, along with complete scavenging system comprising necessary piping network, all fittings, pressure reducing station etc.
- 2.8 One (1) no. Electrolyte (caustic solution) Mixing & Storage tank of HDPE/SS construction.
- 2.9 One (1) no. Electrolyte Transfer Pumps with drive motors, pressure gauge at pump discharge, differential pressure gauge across suction filter etc. complete with all accessories.
- 2.10 Two numbers 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. The Tank shall be of HDPE construction. Water level shall be controlled via a solenoid valve with float type level switch assembly mounted at tank top.
- 2.11 De-oxy units, coolers, hydrogen gas purification system, filling manifold, 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 and high-pressure cylinder testing apparatus along with all accessories for testing cylinders.
- 2.13 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.
- 2.14 Bidder shall also include in his scope window Air-conditioners for his control panels etc. Bidder to specify the same in his offer.
- 2.15 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.
- 2.16 Bidder shall include in his scope all hydrogen generation plant pipes and conduit support. All drains shall be terminated at point in hydrogen generation plant building.
- 2.17 Bidder shall also provide connection, isolation device, manifold, piping etc. for N₂ gas connection to cell system for purging.
- 2.1 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.
- 2.18 Bidder shall include in his scope one lot of mandatory spares as per list enclosed as ANNEXURE VI of technical specification.
- 2.19 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.
- 2.20 Bidder shall guarantee that the equipment offered shall meet the rating and performance requirements for successful running of hydrogen Generation plant.
- 2.21 Start-up & Commissioning spares.
- 2.22 Mandatory spares.
- 2.23 Counter flanges, blank flanges, isolation valves at all the terminal points as required as per system requirements.
- 2.24 All special tools necessary for proper maintenance or adjustment of the equipment packed in permanent box.
- 2.25 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.
- 2.26 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.
- 2.27 All auxiliary steel structures (U-clamps, nuts, bolts, channels etc.) for fixing the pipe on the pedestal or trestles.



TITLE : 2X660 MW UDANGUDI STPP	SPECIFICATION NO. PE-TS-435-168-A001	
	SECTION : I	
	TECHNICAL SPECIFICATION FOR HYDROGEN GENERATION PLANT	
	SUB-SECTION: IA	REV. NO. 00

- 2.28 Wrapping, coating and protection of all the buried pipe shall be as per IS 10221 or AWWA C 203.
- 2.29 Finish paint for touch-up painting of equipment after erection at site in sealed containers.
- 2.30 Set of special tools and tackles if required for maintenance and erection of equipment supplied.
- 2.31 All necessary flanges and counter flanges to interconnect the piping.
- 2.32 All insert plates, puddle pipes, nuts and bolts, counter flanges, grouting material wherever applicable shall be in the scope of bidder.
- 2.33 Embedment plates with lugs shall also be provided by bidder as per system requirement.
- 2.34 Monitoring gadgets, instruments and equipment required for commissioning & maintenance (till PG test and plant handover).
- 2.35 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 out trial run, commissioning and PG test.
- iv) Minor Civil work including chipping of foundation, grouting below base plate for all structures, equipment, grouting of anchor bolts wherever these are not placed in the foundation during casting of foundation itself etc. To the extent possible, vendor shall ensure to supply all foundation bolts timely so as to facilitate placement of these bolts while casting the foundation. 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) Complete grouting for equipment including grouting material, fixing and any concreting inside the plant.
- x) Trial run for requisite period.
- xi) Performance testing.
- xii) 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.
- xiii) Final touch up painting at site.
- xiv) Obtaining CCE approval.
- xv) Preparation of civil assignment drawings i.e. pedestals details; insert plates / embedment's plates required for supporting pipes and equipment etc. and review of civil drawing prepared by BHEL based on civil assignment drawing of bidder. In case any modification is required in the civil work already done based on civil inputs given by vendor, rework shall be done at the cost and risk of the vendor.
- xvi) 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 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 (IW+1Sb), one number Chiller water storage tank of adequate capacity, two nos. chilled water re circulation pumps (IW+1Sb) complete with drive motors along with strainers and all other necessary instruments, isolation valves, piping, flanges, pipe fittings etc.



TITLE : 2X660 MW UDANGUDI STPP	SPECIFICATION NO. PE-TS-435-168-A001	
	SECTION : I	
	TECHNICAL SPECIFICATION FOR HYDROGEN GENERATION PLANT	
	SUB-SECTION: IA	
	REV. NO. 00	

TP2, Feed water (Refer annexure – VIII, 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.

Note: - Temperature of feed water / cooling water at TP1 shall be as per ambient conditions.

TP3:- 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 terminated at one point by bidder.

5.0 SCOPE OF SUPPLY (ELECTRICAL)

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

6.0 SCOPE OF SUPPLY (C&I)

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

7.0 SCOPE OF SUPPLY (CIVIL)

- 7.1 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.
- 7.2 Pedestals for pipe supports, however, auxiliary structure, supports components for piping is in bidder's scope.
- 7.3 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

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 Guarantee Power Consumption.
- 8.5 Guaranteed Performance Data.

9.0 EXCLUSIONS

- a) Instrument air up to the terminal point.
- b) 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.

11.0 SUB VENDOR

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



TITLE : 2X660 MW UDANGUDI STPP	SPECIFICATION NO. PE-TS-435-168-A001	
	SECTION : I	
	TECHNICAL SPECIFICATION FOR HYDROGEN GENERATION PLANT	
	SUB-SECTION: IA	
	REV. NO. 00	

approval during detailed engineering stage without any commercial & delivery implication to BHEL.

12.0 DESIGN/CONSTRUCTION

- The P&IDs (Dwg.No.-PE-DG-435-168-A001) is enclosed herein in this section 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.

13.0 DRAWING/DOCUMENTS REQUIREMENT

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

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

14.0 SPARES

- a. All the spares for the equipment under the contract provided by the vendor will strictly conform to the specifications and documents and will be identical to the corresponding main equipment/components supplied under the contract.

XVII) 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.

XVIII) START-UP & COMMISSIONING SPARES

- a. 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.
- b. The Bidder shall indicate the service expectancy period for the spares under normal operating conditions before replacement is necessary.



TITLE : 2X660 MW UDANGUDI STPP	SPECIFICATION NO. PE-TS-435-168-A001	
	SECTION : I	
	TECHNICAL SPECIFICATION FOR HYDROGEN GENERATION PLANT	
	SUB-SECTION: IA	
	REV. NO. 00	

- c. All spares supplied under this contract shall be strictly inter changeable with the parts for which they are intended for replacements. The spares shall be treated and packed for long storage under the climatic conditions prevailing at the site e.g. small items shall be packed in sealed transparent plastic with desecrator packs as necessary.
- d. All the spares (mandatory) shall be manufactured along with the main equipment components as a continuous operation as per same specification and quality plan.
- e. Each spares part shall be clearly marked or labelled on the outside of the packing with its description. When more than one spares part is packed in a single case, a general description of the content shall be shown on the outside of such case and a detailed list enclosed. All cases, containers and other packages must be suitably marked and numbered for the purposes of identification.
- f. All cases, containers or other packages are to be opened for such examination as may be considered necessary by BHEL / Customer.
- g. The Bidder will provide the BHEL/Customer with all the addresses and particulars of his sub suppliers while placing the order on vendors for items/components/equipment covered under the contract and will further ensure with his vendors that the BHEL/Customer, if so desires, will have the right to place order for spares directly on them on mutually agreed terms based on offers of such vendors.
- h. The Bidder shall warrant that all spares supplied will be new and in accordance with the contract Documents and will be free from defects in design, material and workmanship.
- i. The bidder to provide datasheets/assembly drawings of the manufacturer/ any other relevant document showing Bill of Material(s), Make, Model Number, Part Number etc. through which the mandatory spares to be supplied can be uniquely identified.

XIX) 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%
- 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.
- 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.



TITLE : 2X660 MW UDANGUDI STPP	SPECIFICATION NO. PE-TS-435-168-A001	
	SECTION : I	
	SUB-SECTION: IA	
	REV. NO. 00	
TECHNICAL SPECIFICATION FOR HYDROGEN GENERATION PLANT		

- Bidders shall make Site visit in order to familiarize themselves with existing condition of site before submitting the bid in order to make their offer complete. During detail engineering also, the successful bidder shall be responsible for the correctness of details w.r.t. existing facility at site. Customer approval on any drawing having details of existing facility shall not be cited by the successful bidder a valid reason for any shortcoming in the work by them. BHEL shall also not entertain any cost implication for any lack of input data with regard to site during detail engineering.
- Preparation of drawings / document / P&ID's in 3D modelling software and providing soft copy of same to BHEL.
- 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.

xx) 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 Pretreatment 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.



TITLE :

2X660 MW UDANGUDI STPP

SPECIFICATION NO. PE-TS-435-168-A001

SECTION : I

**TECHNICAL SPECIFICATION FOR HYDROGEN
GENERATION PLANT**

SUB-SECTION: IA

REV. NO. 00

- g) Deviations, if any, should be very clearly brought out clause by clause along with cost of withdrawal in the enclosed schedule (in Vol – 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.
- l) Pre-bid meeting shall be held before bid submission. Bidder to ask all their queries in pre-bid meeting.



TITLE :

2X660 MW UDANGUDI STPP

SPECIFICATION NO. PE-TS-435-168-A001

SECTION : I

**TECHNICAL SPECIFICATION FOR HYDROGEN
GENERATION PLANT**

SUB-SECTION: IA

REV. NO. 00

ANNEXURES



TITLE :

2X660 MW UDANGUDI STPP

SPECIFICATION NO. PE-TS-435-168-A001

SECTION : I

**TECHNICAL SPECIFICATION FOR HYDROGEN
GENERATION PLANT**

SUB-SECTION: IA

REV. NO. 00

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 SHEET 1 OF 2		CUSTOMER :		PROJECT			SPECIFICATION :			
				BIDDER/ :		TITLE			NUMBER :			
				VENDOR		QUALITY PLAN			SPECIFICATION			
SYSTEM		NUMBER PED-506-00-Q-006, REV-01			TITLE			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			REMARKS
1	2	3	4	5	6	7	8	9	P	W	V	11
		3.NAMEPLATE DETAILS 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. <u>Legends for Inspection agency</u> 1. BHEL/CUSTOMER 2. VENDOR (MOTOR MANUFACTURER) 3. SUB-VENDOR (RAW MATERIAL/COMPONENTS SUPPLIER) P. PERFORM W. WITNESS V. VERIFY	MA	VISUAL	100%	IS-325 & DATA SHEET	IS-325 & DATA SHEET	INSPN. REPORT	2	1	-	
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 Visual	I	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 Visual	I	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 Visual	I	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 Visual	I	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

 PEM :: C&I		STANDARD QUALITY PLAN FOR PROGRAMMABLE LOGIC CONTROLLER						QUALITY PLAN NO.: PE-QP-999-145-1036				
								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/OVS 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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 V - Agency Verifying the Test.

1 - BHEL
 2 - Vendor
 3 - Sub-vendor

		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 4		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	
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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**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 5	OF	8

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

STANDARD QUALITY PLAN FOR PROGRAMMABLE LOGIC CONTROLLER

QUALITY PLAN NO.: PE-QP-999-145-I036		
VOLUME IIB		
SECTION D		
REV. NO. 00	DATE: 23.03.2005	
SHEET 6	OF	8

Page 44 of 504

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

STANDARD QUALITY PLAN FOR PROGRAMMABLE LOGIC CONTROLLER

QUALITY PLAN NO.:	PE-QP-999-145-I036	___
VOLUME	IIB	
SECTION	D	
REV. NO.	00	DATE: 23.03.2005
SHEET	7	OF 8

6. Control Panel /Desk Verification

- i) PLC driven annunciation system should be checked by alarm signal simulation.
- ii) Push Button and selector 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 & operation of Graphics, Trends, Logs, HSR and Alarms, in the form of Displays and Printouts, by simulation of Inputs as per approved documents.

8. Burn in Elevated Temperature test

Electronic equipments 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.

**STANDARD QUALITY PLAN
FOR
PROGRAMMABLE LOGIC CONTROLLER**

QUALITY PLAN NO.: PE-QP-999-145-I036		
VOLUME IIB		
SECTION D		
REV. NO. 00 23.03.2005	DATE:	
SHEET 8	OF	8

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.

	CHECK LIST FOR PRESSURE / DIFFERENTIAL PRESSURE TRANSMITTER (Mechanical Auxiliary Packages)		SPECIFICATION NO.:	
			VOLUME	
			SECTION	
			REV. NO.	DATE:
			SHEET 1 OF 1	
Data Sheet No.: PE-CL-999-145-1026-0				

SL NO	TESTS/CHECKS	QUANTM OF CHECK	REFERENCE DOC. ACCEPTANCE NORMS	AGENCY			REMARKS
				M	C	B	
1.0	CHECKS FOR VISULA, MODEL TAG NO.	SEE NOTE-1 BELOW	APPROVED TECHINCAL REQUIREMENT/ DATA SHEET	P	W	V	MFR TO CARRY OUT ROUTINE TEST ON 100%. WHEN MATERIAL CORELATION ARE NOT AVAILABLE MFR'S COMPLIANCE TO BE PROVIDED
2.0	PROCESS CONNECTION	-do-		P	W	V	
3.0	ACCURACY	-do-		P	W	V	
4.0	REPEATEABILITY	-do-		P	W	V	
5.0	HYSTERISIS	-do-		P	W	V	
6.0	EFFECT OF TEMP VARIATION ON ACCURACY	-do-		P	W	V	
7.0	SPAN /ZERO ADJUSTMENT	ONE/TYPE		P	W	V	
8.0	EFFECT OF SUPPLY VOLTAGE VARIATION	ONE/TYPE		P	W	V	
9.0	HIGH PRESSURE TEST	SEE NOTE-1 BELOW		P	W	V	
10.0	BURN IN TEST	ONE/TYPE		P	W	V	
11.0	DEGREE OF PROTECTION	ONE/TYPE		P	W	V	

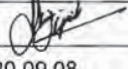
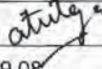
LEGEND:

M: MANUFACTURER/ SUB CONTRACTOR, C: CONTRACTOR/ NOMINATED INSP AGENCY, B: BHEL. P: PERFORM, W: WITNESS, V: VERIFICATION.

NOTE:

1. QUANTUM OF CHECK SHALL BE AS BELOW
100 % - BY MANUFACTURER
RANDOM FOR EACH TYPE - BY BHEL & CUSTOMER
2. MANUFACTURER TO MAINTAIN CALIBRATED INSTRUMENT HAVING BETTER ACCURACY THAN THE ITEM UNDER TEST. INSPECTING ENGINEER SHALL CHECK THE SAME.
3. IN CASE OF IMPORTED ITEMS CONTRACTORS SHALL REVIEW TC's AND NOT INSPECT.

CONTRACTOR TO PROVIDE COMPLIANCE CERTIFICATE FOR TESTS/CHECKS VERIFIED BY CONTRACTOR AND SUBMIT THE SAME ALONGWITH TEST CERTIFICATES TO BE VERIFIED BY BHEL.

	PREPARED BY	CHECKED BY	APPROVED BY
NAME	SACHIN SRIVASTAVA	DILIP JEJURIKAR	ALKA TUTEJA
SIGNATURE			
DATE	30.09.08	30.09.08	30.09.08



**CHECK LIST FOR
PRESSURE / DIFFERENTIAL PRESSURE SWITCH
(Mechanical Auxiliary Packages)**

SPECIFICATION NO.:

VOLUME

SECTION

REV. NO.

DATE:

SHEET 2 OF

2

Data Sheet No.: **PE-CL-999-145-I031-0**

Page 450 of 504

SL NO	TESTS/CHECKS	QUANTUM OF CHECK	REFERENCE DOC. ACCEPTANCE NORMS	AGENCY			REMARKS		
				P	W	V			
1.0	CHECK FOR		APPROVED TECHINICAL REQUIREMENT/ DATA SHEET/ RELEVANT STANDARD / MANUFACTURER CATALOGUE				MFR TO CARRY OUT ROUTINE TEST ON 100%.		
	1.1	MODEL NO/TAG NO		100%	M	C		C	
	1.2	RANGE/SCALE		100%	M	C		C	
	1.3	END CONNECTION		100%	M	C		C	
	1.4	SWITCH CONTACT RATING & NOS		100% M		C		C	
2.0	CALIBRATION							WHEN TC FOR MATERIAL FOR THE PROJECT NOT AVAILABLE , COMPLIANCE CERTIFICATE TO BE PROVIDED BY THE MANUFACTUR ER.	
	2.1	REPEATABILITY		100%	M	C			B
	2.2	DIFFERENTIAL		100%	M	C			B
	2.3	SET POINT ADJUSTMENT		100% M		C			B
3.0	OVER PRESSURE & LEAK TEST	100% M			C	C			
4.0	REVIEW OF T.C. FOR MATERIAL OF--								
	5.1	SENSOR		FOR LOT	--		B		
	5.2	MOVEMENT			-	-	B		
	5.3	HOUSING			-	-	B		
5.0	REVIEW OF T.C. FOR DEGREE OF PROTECTION	TYPE TEST	-	-	B				
6.0	REVIEW OF T.C. FOR MICRO SWITCH	FOR LOT	-	-	B				
7.0	ACCESSORIE S AS APPLICABLE	100% M		C	C				

LEGEND:

M: MANUFACTURER/ SUB CONTRACTOR, C: CONTRACTOR/ NOMINATED INSP AGENCY, B: BHEL. P: PERFORM, W: WITNESS, V: VERIFICATION.

NOTE:

CONTRACTOR TO PROVIDE COMPLIANCE CERTIFICATE FOR TESTS/CHECKS VERIFIED BY CONTRACTOR AND SUBMIT THE SAME ALONGWITH TEST CERTIFICATES TO BE VERIFIED BY BHEL.



**CHECK LIST FOR
PRESSURE / DIFFERENTIAL PRESSURE GAUGE
(Mechanical Auxiliary Packages)**

SPECIFICATION NO.:

VOLUME

SECTION

REV. NO.

DATE:

SHEET

2

OF

2

Data Sheet No.: **PE-CL-999-145-1026-0**

Page 451 of 504

SL NO	TESTS/CHECKS	QUANTM OF CHECK	REFERENCE DOC. ACCEPTANCE NORMS	AGEN CY			REMARKS	
				P	W	V		
1.0	CHECK FOR		APPROVED TECHINCAL REQUIREMENT/ DATA SHEET				MFR TO CARRY OUT ROUTINE TEST ON 100%. WHEN MATL CORELATION ARE NOT AVAILABLE MFR'S COMPLIANCE TO BE PROVIDED	
	1.1 DIAL SIZE	100%		M	C	C		
	1.2 MODEL NO/TAG NO	100%		M	C	C		
	1.3 RANGE/SCALE	100%		M	C	C		
	1.4 END CONNECTION	100%		M	C	C		
	1.5 SWITCH CONTACT RATING & NOS	100% M			C	C		
2.0	CALIBRATION							
	2.1 ACCURACY	100%		M	C	B		
	2.2 REPEATABILITY (FOR SWITCH)	100% M			C	B		
	2.3 SET POINT ADJUSTMENT FOR SWITCH	100% M			C	C		
3.0	OVER PRESSURE & LEAK TEST	100% M			C	C		
4.0	OPERATION OF PR. RELEIF DEVICE	ONE PER TYPE		M	C	C		
5.0	REVIEW OF T.C. FOR MATERIAL OF--							
	5.1 SENSOR	FOR LOT		--		B		
	5.2 MOVEMENT			-	-	B		
	5.3 PROCESS CONNECTION			-	-	B		
	5.4 HOUSING			-	-	B		
6.0	REVIEW OF T.C. FOR DEGREE OF PROTECTION	TYPE TEST		-	-	B		
7.0	REVIEW OF T.C. FOR CONTACT RATING OF SWITCH	ONE PER TYPE		--		B		
8.0	ACCESSORIE S AS APPLICABLE	100% M			C	C		

LEGEND:

M: MANUFACTURER/ SUB CONTRACTOR, C: CONTRACTOR/ NOMINATED INSP AGENCY, B: BHEL. P: PERFORM, W: WITNESS, V: VERIFICATION.

NOTE:

CONTRACTOR TO PROVIDE COMPLIANCE CERTIFICATE FOR TESTS/CHECKS VERIFIED BY CONTRACTOR AND SUBMIT THE SAME ALONGWITH TEST CERTIFICATES TO BE VERIFIED BY BHEL.

 PEM :: C&I		STANDARD QUALITY PLAN FOR SIGHT FLOW INDICATOR						QUALITY PLAN NO.: PE-QP-999-145-I029				
								VOLUME I IB				
								SECTION D				
								REV. NO. 00 DATE: 08.11.2000				
								SHEET 1 OF 2				
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	Material / Components											
1.1	Body, Cover, Interns, Flanges, Gaskets	1. Physical, Chemical Properties	MA Ph	ysical, Chemical Test	One Sample from each lot	Approved drg. / data sheet / BHEL Spec.	Approved drg. / data sheet / BHEL Spec.	Test Certificate	3/2 ---		2,1#	# Compliance certificate to be verified.
		2. Workmanship, finish and dimensions	MA Vis	ual, Measurement	100% Ma	nufacturing standards / drgs.	Manufacturing standards / drgs.	Inspection Report / Log Book	3/2 ---		2,1#	
1.2 W	indow Glass	Strength, Transparency, dimensions	MA T	oughness & Thermal shock, Visual, Measurement	one sample from each lot	Approved drg. / data sheet / BHEL Spec.	Approved drg. / data sheet / BHEL Spec.	Test Certificate/ Inspection Report	3 ---		2,1#	
2.0	Assembly											
		1. Marking – Tag No., Model, Range	MA	Visual	100%	- do -	- do -	Inspection Report	2	1	---	
		2. Workmanship	MA	Visual	100%	- do -	- do -	- do -	2	1	---	
		3. Direction of flow stamping	MA	Visual	100%	- do -	- do -	- do -	2	1	---	
		4. Dimensions and end connections	MA Measur	ement	100%	- do -	- do -	- do -	2	1	---	
3.0	Routine Test											
		1. Operation, Calibration⊕	CR	Measurement	100%	- do -	- do -	- do -	2	1**	1	⊕ For flapper type
		2. Hydro Test	CR	Measurement	100%	- do -	No Leakage	- do -	2	1**	1	**10% quantity with minimum of 1 piece / type & size

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

 PEM :: C&I		STANDARD QUALITY PLAN FOR SIGHT FLOW INDICATOR						QUALITY PLAN NO.: PE-QP-999-145-I029				
								VOLUME I IB				
								SECTION D				
								REV. NO. 00 DATE: 08.11.2000				
								SHEET 2 OF 2				
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	
4.0	Painting	Shade & Finish	MA	Visual	100%	Approved drg. / data sheet / BHEL Spec.	Approved drg. / data sheet / BHEL Spec.	Inspection Report	2	1**	1	
5.0	Packing	Soundness MA		Visual	100%	- do -	- do -	- do -	2	---	---	

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

 PEM :: C&I		STANDARD QUALITY PLAN FOR LEVEL GAUGES						QUALITY PLAN NO.: PE-QP-999-145-I028				
								VOLUME I IB				
								SECTION D				
								REV. NO. 00 DATE: 01.11.2000				
								SHEET 1 OF 2				
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	Material / Components											
1.1	Body, Cover, Interns, Flanges, Gaskets	1. Physical, Chemical Properties	MA Physical	Physical, Chemical Test	One Sample from each lot	Approved drg. / data sheet / BHEL Spec.	Approved drg. / data sheet / BHEL Spec.	Test Certificate	3/2 ---		2,1#	# Compliance certificate to be verified.
		2. Workmanship, finish and dimensions	MA Visual	Visual, Measurement	100% Manufacturing standards / drgs.	Manufacturing standards / drgs.	Manufacturing standards / drgs.	Inspection Report / Log Book	3/2 ---		2,1#	
1.2	Glass Tube	Strength, Transparency, dimensions	MA Thermal	Toughness & Thermal shock, Visual, Measurement	one sample from each lot	Approved drg. / data sheet / BHEL Spec.	Approved drg. / data sheet / BHEL Spec.	Test Certificate/ Inspection Report	3 ---		2,1#	
2.0	Assembly	1. Marking – Tag No., Model, Range	MA Visual	Visual	100%	- do -	- do -	Inspection Report	2	1	---	For Reflex type
		2. Workmanship	MA Visual	Visual	100%	- do -	- do -	- do -	2	1	---	
		3. Scale graduation	MA Visual	Visual	100%	- do -	- do -	- do -	2	1	---	
		4. Glass Opaque painting	MA Visual	Visual	100%	- do -	- do -	- do -	2	1	---	
		5. Dimensions and end connections	MA Measurement	Measurement	100%	- do -	- do -	- do -	2	1	---	
3.0	Routine Test	1. Calibration	CR Measurement	Measurement	100%	- do -	- do -	- do -	2	1**	1	**10% quantity with minimum of 1 piece / type & size
		2. Hydro Test	CR Measurement	Measurement	100%	- do -	No Leakage	- do -	2	1**	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

बी एच ई एल BHEL PEM :: C&I		STANDARD QUALITY PLAN FOR LEVEL GAUGES						QUALITY PLAN NO.: PE-QP-999-145-I028				
								VOLUME I IB				
								SECTION D				
								REV. NO. 00 DATE: 01.11.2000				
								SHEET 2 OF 2				
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	
4.0	Painting	Shade & Finish	MA Visual	Visual	100%	Approved drg. / data sheet / BHEL Spec.	Approved drg. / data sheet / BHEL Spec.	Inspection Report	2	1**	1	
5.0	Packing	Soundness MA		Visual	100%	- do -	- do -	- do -	2	---	---	

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

 PEM :: C&I		STANDARD QUALITY PLAN FOR RESISTANCE TEMPERATURE DETECTOR WITH THERMOWELL						QUALITY PLAN NO.: PE-QP-999-145-I025					
								VOLUME		IIB			
								SECTION		D			
								REV. NO.		01		DATE: 21.03.2012	
								SHEET		1		OF 2	
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	Raw Material / Component												
1.1	Resistance sheath	Material composition	CR	Chemical testing	One Sample from each lot	Approved drg. / data sheet	Relevant material std.	Test Certificate	3,2	---	2,1 ▲	▲ Relevant compliance certificate to be verified.	
1.2	Protective Sheath	Material composition	MA	Chemical testing		Approved drg. / data sheet	Relevant material std.	Test Certificate	3,2	---	2,1 ▲		
1.3	Terminal Head	Material composition	MA	Chemical testing		Approved drg. / data sheet	Relevant material std.	Test Certificate	3,2	---	2,1 ▲		
1.4	Thermowell⊕	1. Chemical properties	CR	Chemical composition	One Sample from each lot	Approved drg. / data sheet	Relevant material std.	Test Certificate	3,2	---	2,1	◆ BHEL to witness 25% Samples ⊕ IBR certificate wherever specified to be verified. **10% of total quantity with minimum of 2 random piece/type & size	
		2. Dimensions (wall thickness concentricity of bore, OD & length)	MA	Measurement	100%	Approved drg., BHEL Spec.	Approved drg., BHEL Spec.	Inspection report	2	1◆	1		
		3. Threading	MA	Thread matching	100%	Approved drg., BHEL Spec.	Approved drg., BHEL Spec.	Inspection Report	2	2,1◆	1		
		4. Leak Test (Hyd. test at 1.5 times design press)	CR	Visual	100%	Approved drg., BHEL Spec.	Approved drg., BHEL Spec.	Inspection Report	3,2	1**	2/1		

LEGEND: * CR - Critical characteristics
 MA - Major characteristics
 MI - Minor characteristics; Mfd std - Manufacturers' standard

^{\$} P - Agency Performing the Test.
 W - Agency Witnessing the Test.
 V - Agency Verifying the Test.

1 - BHEL
 2 - Vendor
 3 - Sub-vendor

 PEM :: C&I		STANDARD QUALITY PLAN FOR RESISTANCE TEMPERATURE DETECTOR WITH THERMOWELL						QUALITY PLAN NO.: PE-QP-999-145-I025					
								VOLUME		IIB			
								SECTION		D			
								REV. NO.		01		DATE: 21.03.2012	
								SHEET		2		OF 2	
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	Final Inspection												
2.1	RTD Assembly	1. Workmanship	MA	Visual	100%	Approved drg. / data sheet	Approved drg. / data sheet	Inspection Report	2	----	1▲		
		2. Marking	MA	Visual	100%				2	----	1▲		
		3. Dimensions	MA	Measurement	100%				2	----	1▲		
2.2	Routine Tests	1. Calibration (Resis Vs. Temp.)	CR	Measurement	100%	IS:2848	IS:2848	Test Report	2	2	1		
		2. Insulation Resistance	MA	Electrical	100%	IS:2848	IS:2848	Test Report	2	1	---		
		3. Thermal Response time	CR	Measurement	One Sample from each type	IS:2848	IS:2848	Test Certificate	2	1	---		
2.3	Type Test	Enclosure protection test	CR	Verification	Each type	Approved drg. / data sheet	Approved drg. / data sheet	Test Certificate	3/2	----	1*	*Type Test Certificate (not more than 5 year old) to be verified Visual	
3.0	Packing	Soundness of packing	MA	Visual	100%	Mfd std.	Mfd std.	Inspection Report	3/2	2	---		

LEGEND: * CR - Critical characteristics
 MA - Major characteristics
 MI - Minor characteristics; Mfd std - Manufacturers' standard

^{\$} P - Agency Performing the Test.
 W - Agency Witnessing the Test.
 V - Agency Verifying the Test.

1 - BHEL
 2 - Vendor
 3 - Sub-vendor

 PEM :: C&I		STANDARD QUALITY PLAN FOR TEMPERATURE GAUGE AND THERMOWELL						QUALITY PLAN NO.: PE-QP-999-145-1027					
								VOLUME		IIB			
								SECTION		D			
								REV. NO.		01		DATE: 16-05-2007	
								SHEET		1		OF 4	
Sl. No.	Component / operation	Characteristics Checked	* Cate gory	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks	
									P	W	V		
1.0	Raw Material / Component												
1.1	Capillary Bulb and Thermowell	1. Chemical composition	CR	Chemical analysis	one sample/lot	BHEL spec. / approved data sheet	Relevant raw material std.	Test report	3/2	---	2,1	Relevant compliance certificate to be verified by BHEL	
		2. Marking,	MA	Visual	100%	BHEL spec. / Mfr. Standard	BHEL spec. / Mfr. Standard	Log Book	2	---	---		
		3. Dimensions	MA	Measurement	100%	BHEL spec. / approved doc	BHEL spec. / approved doc	Log Book	2	---	---		
1.2	Casing and Bezel	1. Material	MA	Chemical analysis	Sample	BHEL spec.	BHEL spec.	Test report	3/2	---	2,1	Relevant compliance certificate to be verified by BHEL	
		2. Defects	MA	Visual	100%	Mfr. Standard	Mfr. Standard	Log Book	2	---	---		
		3. Dimension	MA	Measurement	Sample	BHEL spec. / approved doc.	BHEL spec. / approved doc.	Log Book	2	---	---		
		4. Threading	MA	Thread matching	100%	-----do-----	-----do-----	Log Book	2	---	---		
1.3	Dial	1. Size, range, scale length, least-count, spacing and graduation.	MA	Measurement and Visual	Sample	BHEL spec.	BHEL spec.	Log Book	2	---	---		
		2. Colour	MA	Visual	100%	BHEL spec.	BHEL spec.	Log Book	2	---	---		
		3. Resistance to dry heat and hot water	MA	Oven & Bath	Sample	Mfr. Standard	Mfr. Standard	Test report	3/2	---	---		

LEGEND: * CR - Critical characteristics
MA - Major characteristics
MI - Minor characteristics

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P - Agency Performing the Test.
W - Agency Witnessing the Test.
V - Agency Verifying the Test.

1 - BHEL
2 - Vendor
3 - Sub-vendor

 PEM :: C&I		STANDARD QUALITY PLAN FOR TEMPERATURE GAUGE AND THERMOWELL						QUALITY PLAN NO.: PE-QP-999-145-I027				
								VOLUME		IIB		
								SECTION		D		
								REV. NO.		01		DATE: 16-05-2007
		SHEET		2		OF		4				
Sl. No.	Component / operation	Characteristics Checked	* Cate gory	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks
									P W		V	
1.4	Complete sensing element	1. Correct assembly and workmanship.	MA	Visual	100%	Mfr. Standard drawing	Mfr. Standard drawing	Log Book	2	---	---	
		2. Dimensions	MA	Measurement	100%	Mfr. Standard drawing	Mfr. Standard drawing	Log Book	2	---	---	
		3. Welding & other defects	MA	Visual	100%	Mfr. Standard	Mfr. Standard	Log Book	2	---	---	
1.5	Thermowell ⊕	1. Dimensions of wall thickness, concentricity of bore OD & Length.	MA	Measurement	100%	BHEL spec. / approved data sheet / Drg.	BHEL spec. / approved data sheet / Drg.	Log Book	2	1	1	BHEL to witness 10 % random samples.
		2. Leak Test	CR	Hyd. test at 1.5 times of design pressure.	100%	BHEL spec. / approved data sheet / Drg.	BHEL spec. / approved data sheet / Drg.	Inspection report	3/2	2,1	1	⊕ IBR cert. wherever specified to be verified.
		3. Threading	MA	Thread matching	100%	BHEL spec. / approved data sheet / Drg	BHEL spec. / approved data sheet / Drg	Inspection report	2	2,1	1	BHEL to witness 10% samples.
2.0	Final Inspection											
2.1	Assembly	1. Correct assembly, workmanship and finish	MA	Visual	100%	BHEL spec. / approved data sheet	BHEL spec. / approved data sheet	Inspection report	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

 PEM :: C&I		STANDARD QUALITY PLAN FOR TEMPERATURE GAUGE AND THERMOWELL						QUALITY PLAN NO.: PE-QP-999-145-I027				
								VOLUME		IIB		
								SECTION		D		
								REV. NO.		01		DATE: 16-05-2007
								SHEET	3	OF	4	
Sl. No.	Component / operation	Characteristics Checked	* Cate gory	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks
									P W		V	
		2. Mounting and connection	MA	Visual ad measurement	100%	-----do-----	-----do-----	Inspection report	2	1	---	
		3. Dial Scale	MA	Visual	100%	-----do-----	-----do-----	Log Book	2	1	---	
		1. Cleanliness	MA	Visual	100%	-----do-----	Free from scratches, dirt etc.	Log Book	2	---	2	
		5. Marking (S.No., Tag No.)	MA	Visual	100%	BHEL spec. / approved data sheet	BHEL spec. / approved data sheet	Log Book	2	1	---	
2.2	Routine Test	1. Accuracy	MA	Measurement	100%	BHEL spec. / Approved data Sheet.	BHEL spec. / Approved data Sheet.	Test Report	2	1	1	BHEL to witness 10% random Samples.
		2. Overload	CR	Measurement	10%	125% of FSD for range upto 400 Deg. C. 110% of FSD for range between 400 to 500 Deg. C. 100% of FSD for range above 500 Deg. C.	No Damage	Test Report	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



STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR TEMPERATURE SWITCH

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **				Remarks
				M	C	B	D *	
1	TYPE, MODEL, SL. No., TAG No., RANGE	100%	APPROVED SPEC./ DATA SHEETS	P	W	V	R	
2	DIMENSIONS CHECK	100%	-do-	P	W	V	R	
3	ACCURACY	100%	-do-	P	W	V	R	
4	SWITCHING DIFFERENTIAL	100%	-do-	P	W	V	R	
5	CONTACT RATING / No. OF CONTACTS	RANDOM	-do-	P	W	V	R	
6	MATERIAL TC FOR BULB, CAPILLARY, ARMOUR	ONE / LOT	-do-	P	V	V	R	
7	HV / IR	RANDOM	-do-	P	W	V	R	
8	DEGREE OF PROTECTION	TYPE TEST	-do-	P	V	V	R	
9	THERMOWELLS							
9.1	DIMENSIONS, PROCESS CONN	100%	-do-	P	W	V	R	
9.2	MATERIAL TC	ONE / LOT	-do-	P	V	V	R	
9.3	HYD TEST	100%	-do-	P	W	V	R	
9.4	IBR CERTIFICATE, IF APPLICABLE		-do-	P	V	V	R	
10	REPEATABILITY	100%	-do-	P	V	V	R	
11	HYSTERESIS	100%	-do-	P	V	V	R	

Legend :

* Records identified with "R" shall be essentially included by Contractor in QA documentation.

** M = Manufacturer / Sub-contractor, C = Contractor / Nominated Inspecting Agency, B = BHEL, D = Drawings / Documents, P = Perform, W = Witness, V = Verification

Note :

- Quantum of check shall be as below :
100 % - By Manufacturer
25 % - By BHEL & Customer
- Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
- In case of imported items, contractor shall review TC's and not inspect.
- MFR to carry out routine test for 100%



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	D *	
1	CHECKS FOR VISUAL, MODEL, TAG No.	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS	P	W	V	R	
2	PROCESS CONNECTION	-do-	-do-	P	W	V	R	
3	ACCURACY	-do-	-do-	P	W	V	R	
4	REPEATABILITY	-do-	-do-	P	W	V	R	
5	HYSTERESIS	-do-	-do-	P	W	V	R	
6	EFFECT OF TEMP VARIATION ON ACCURACY	-do-	-do-	P	W	V	R	
7	SPAN / ZERO ADJUSTMENT	ONE / TYPE	-do-	P	W	V	R	
8	EFFECT OF SUPPLY VOLTAGE VARIATION	ONE / TYPE	-do-	P	W	V	R	
9	EFFECT OF LOADING (500 OHM METERS)	ONE / TYPE	-do-	P	W	V	R	
10	HIGH PRESSURE TEST	SEE NOTE-1 BELOW	-do-	P	W	V	R	
11	BURN-IN TEST	ONE / TYPE	-do-	P	W	V	R	
12	DEGREE OF PROTECTION	ONE / TYPE	-do-	P	W	V	R	

Legend :

* Records identified with "R" shall be essentially included by Contractor in QA documentation.

** M = Manufacturer / Sub-contractor, C = Contractor / Nominated Inspecting Agency, B = BHEL, D = Drawings / Documents, P = Perform, W = Witness, V = Verification

Note :

- Quantum of check shall be as below :
100 % - By Manufacturer
Random for each type - By BHEL& Customer
- Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
- In case of imported items, contractor shall review TC's and not inspect.
- Manufacturer to carry out ROUTINE TEST on 100 %.



STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR TEMPERATURE ELEMENT

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **				Remarks
				M	C	B	D *	
1	CHECKS FOR TYPE, MODEL No., TAG No., PROCESS CONN.	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS	P	W	V	R	
2	STABILITY	-do-	-do-	P	W	V	R	
3	INSULATION RESISTANCE	-do-	-do-	P	W	V	R	
4	ENCLOSURE CLASS	-do-	-do-	P	W	V	R	
5	RESPONSE TIME	-do-	-do-	P	W	V	R	
7	ACCURACY	-do-	-do-	P	W	V	R	
8	HYDROSTATIC TEST	-do-	-do-	P	W	V	R	
9	ELECTRICAL CHARACTERISTIC OF SENSOR (CONTINUITY OF T/C WIRES & INSULATION RESISTANCE OF RTD LEADS w.r.t. BODY	-do-		P	W	V	R	
10	TEMP CURVES / CHARTS			P	V	V	R	
11	AMBIENT TEMP. EFFECT CHECK	-do-	-do-	P	W	V	R	
12	HV TEST	-do-	-do-	P	W	V	R	

Legend :

* Records identified with "R" shall be essentially included by Contractor in QA documentation.

** M = Manufacturer / Sub-contractor, C = Contractor / Nominated Inspecting Agency, B = BHEL, D = Drawings / Documents, P = Perform, W = Witness, V = Verification

Note :

- Quantum of check shall be as below :
100 % - By Manufacturer
Random - By BHEL & Customer
- Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.



STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR ANALYTICAL INSTRUMENTS

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **				Remarks
				M	C	B	D *	
1	CHECK FOR VISUAL, MAKE, MODEL No., POWER SUPPLY	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS	P	V	V	R	
2	DIMENSIONS CHECK	-do-	-do-	P	V	V	R	
3	FUNCTIONAL CHECK	-do-	-do-	P	V	V	R	
4	LEAKAGE TEST	-do-	-do-	P	V	V	R	
5	HV / IR TEST	-do-	-do-	P	V	V	R	
6	LINEARITY	-do-	-do-	P	V	V	R	
7	RESPONSE TIME	-do-	-do-	P	V	V	R	
8	ENCLOSURE CLASS	-do-	-do-	P	V	V	R	TYPE TEST CERTIFICATE TO BE FURNISHED BY VENDOR
9	ACCESSORIES, AS APPLICABLE	-do-	-do-	P	V	V	R	
10	ACCURACY / CALIBRATION	-do-	-do-	P	V	V	R	
11	ALARM CONTACT TEST	-do-	-do-	P	V	V	R	
12	ANALOG OUTPUT CHECK	-do-	-do-	P	V	V	R	
13	BURN-IN TEST OF ELECTRONIC PARTS	1/LOT	-do-	P	V	V	R	
14	IN-BUILT INDICATOR, ZERO, SPAN, RANGE SCALE SELECTION ETC	SEE NOTE-1 BELOW	-do-	P	V	V	R	

Legend :

* Records identified with "R" shall be essentially included by Contractor in QA documentation.

** M = Manufacturer / Sub-contractor, C = Contractor / Nominated Inspecting Agency, B = BHEL, D = Drawings / Documents, P = Perform, W = Witness, V = Verification

Note :

- Quantum of check shall be as below :
100 % - By Manufacturer
100 % - By BHEL & Customer
- Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
- In case of imported items, contractor shall review TC's and not inspect.



TITLE :

2X660 MW UDANGUDI STPP

SPECIFICATION NO. PE-TS-435-168-A001

SECTION : I

**TECHNICAL SPECIFICATION FOR HYDROGEN
GENERATION PLANT**

SUB-SECTION: IA

REV. NO. 00

ANNEXURE II: SUB VENDORS



TITLE :
2X660 MW UDANGUDI STPP

SPECIFICATION NO. PE-TS-435-168-A001

SECTION : I

**TECHNICAL SPECIFICATION FOR HYDROGEN
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SUB-SECTION: IA

REV. NO. 00

SR No.	Items	Approved Vendor	Place
1	Hydrogen gas generator with purification system	Approved Main supplier own make	
2	Hydrogen Compressor with Motor	PPI	USA
		PDC Machines INC.	USA
		Burton Corblin	U.K
		Gardner Denver	USA
		Beijing Yitong Huizhi Co., Ltd.	China
		Seybert & Rahier	Germany
3	Combustible Gas Detector	MSA INDIA	Kolkatta
		Sierra Monitor	USA
		Unifoss	Gujrat
4	O2 Percent, O2 PPM and DEW Point Analyser	Teledyne	USA
		GE Sensing	Ireland
5	Conductivity Meter	Hach (GLI International)	



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SUB-SECTION: IA

REV. NO. 00

		Emmerson	
		Honeywell	
		AIC Controls	
6	Hygro meter	GE Sensing	
		Miechel Instruments	
7	Portable H2 purity Analyser	Teledyne USA	
		GE Sensing	Ireland
8	Vacuum pump	Acmevac Sales Pvt. Ltd	Mumbai
		DICON Products	Chennai
		Joyam Engg.	Ahmedabad
9	Hydrogen Dryer	Mellcon ENGS	Delhi
		Jindal Elect	Rourkee.
10	Cylinder test station	Indian compressors Limited	Delhi



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REV. NO. 00

		Eastern Electrolyser	Noida
		Airox Nigen	Ahemdabad
11	N2 / H2 Cylinders	BPCL Allahaba	d
		Maruti kotasu	Aurangabad
		Everst Kanto	Halol
12	Zenne r Barrier	MTL Barrier	
		P & F	
13	Air Compressor	Ingersoll Rand	Ahmedabad
		K.G.Khosla /KPC	Faridabad / Pune
14	Strainers (Y-Type & Basket Type)	MULTITEX FILTRATION ENGINEERS LIMITED,	Noida
		Sarojini Enterprises	Kolkata
		Otoklin Filters	Mumbai
		BHATIA ENGINEERING CO.	Delhi
		JAYPEE INDUSTRIES PVT. LTD.	Delhi



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REV. NO. 00

		FILTRATION ENGINEERS (I) PVT. LTD.	MUMBAI
		OTOKLIN GLOBAL BUSINESS LIMITED	Mumbai
		SUNGOV ENGINEERING PVT. LTD.	Delhi
		Grand Prix	Faridabad
15 Fittings		M.S. Fittings	Kolkata
		Metal Iloyds	Mumbai
		True Forge	Faridabad
		Tube Products	Baroda
		NL Hazra	Kolkata
		Gujrat Infra Pipes	Baroda
		Edwards USA	
		Pipefit Engineers	Baroda
		Siddarth & Gautam	Faridabad
		EBY Mumbai	
16	MS/GI ERW Pipes	SAIL Rourkela	
		Jindal Gha	zibad/Hissar
		Surya Roshni	Bahadur Garh
		TATA Tube	Jamshedpur
		PSL	Chennai/Vizag/Kutch /Daman
		Lalit Profile	Thane
		Samshi Pipes Industries	Vadodara



TITLE :
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REV. NO. 00

		Mukut Pipes	Rajpura
		Indus Tubes	G B Nagar
		Mann Ind	Indore
		Surendra Engg	Rajpura
		Pratibha Pipes & Structure Pvt Ltd	Thane
		JCO Gas Pipe	Chindwara
		Nukat Tanks and Vessels	Tarapur
		DADU Pipes	Sikrandrabad
		Good Luck Tubes	Sikandrabad
		Advance Steel Tubes	Sahibabad
		Bihar Tubes	Sikandrabad
		Hi Tech Pipes	Sikandrabad
		Ratnamani	Kutch/Ahmedabad/C hhatral
		Maharashtra Seamless	Raigad
		Welspun An	jar/Bharuch
17	Seamless Pipes	ISMT	Ahmednagar/Barama ti
		Maharashtra Seamless	Raigad
18	S.S. Pipes	REMI Mumbai	
		Ratmani Ahmeda	bad
		Apex Tubes	Behror
		Choksi Ahmeda	bad



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REV. NO. 00

19 S.S.	Tubes	Swagelok	USA
		Parker	USA
20	CI Gate/ Globe/NRV/SRV	H.Sarkar Ho	wrah
		A.V. VALVES LTD	Agra
		Leader Jala	ndhar
		SURYA VALVES AND INSTRUMENTS MFG CO.	Chennai
		ATAM VALVES PVT. LTD.	JALANDHAR
		FLUIDLINE VALVES COMPANY PVT.LTD.	Mumbai
		G.M. DALUI AND SONS PVT.LTD.	Howrah
		KBL Kondha	puri
		Bankim Kolkata	
		VENUS PUMPS AND ENGG. WORKS	Kolkata
21 SS	Valves	Compair Systems	Canada
		Hamlet Can	ada
		BDK Kolk	ata



TITLE :
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REV. NO. 00

22	Solenoid Valve	Rotex Ba	roda
		Avcon	Mumbai
		Asco Che	nnai
		SMC N	oida
		Nucon Hyderabad	d
25 Siren		Kheraj	-
		FPS Vendor approved suppliers	
26	Motor (Non Flame Proof)	Marathon, kol	kata
		Crompton Greaves	Ahmednagar
		NGEF Bangalo	re
		ABB Bangalore/Faridabad	
		Siemens Mumbai	
		Jyoti Ba	roda
		LHP Solapu	r
		BHEL Bhopal	
		Bharat Electric (BHEL)	
		Bharat Bijlee	Mumbai
27	Motor (Non Flame Proof)	KEC Bangalo	re/Hubli
		Kirloskar Hubli	
		Crompton Greaves	Ahmednagar
		Marathon USA	
		Bharat Bijli	Mumbai
28	Lighting Panel (Wall mounted)	ABB	
		Positronics Ba	roda



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REV. NO. 00

		Pyrotech Udai	pur
29	Luminaries & Lamps	CGL Mumbai	
		Bajaj Mumbai	
		Philips Kolkata	
30	Flame proof lighting fixtures, JB, PB	Baliga Che	nnai
		Ajmera Mumbai	
		Flexpro Navsari	
31 ROTAMETE R		SWITZER	
		EUREKA	
		INSTRUMENT ENGINEERS	
		Indfoss	Ghaziabad
32 Safety Barrier		MTL Barrier	
		P & F	
33	DM Water & KOH	Sintex Kalol	
		Newgen Speciality Plastics Ltd	Greater Noida
		Rolta In	dia
34	Air Conditioner	Carrier	



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**SPECIFICATION NO. PE-TS-435-168-
 A001**

SECTION : I

SUB-SECTION: IA

REV. NO. 00

		LG	
		HITACHI	
		BLUE STAR	
35 Ventilation Fans		Marathon Electric	
		Khatan	
		ABB	
		Bajaj	
		Alstom	
36	Paint (common items)	Shalimar	
		ICI	
		Asian	
		Berger	

SUB-VENDOR LIST FOR ELECTRICAL ITEMS

ITEM DESCRIPTION	SL NO.	VENDOR NAME
CABLE GLANDS	1	ALLIED TRADERS & EXPORTERS
	2	ARUP ENGG & FOUNDRY WORKS
	3	BALIGA LIGHTING EQPT.PVT.LTD.
	4	COMMET BRASS PRODUCTS
	5	DOWELLS
	6	ELECTROMAC INDUSTRIES
	7	INCAB
CABLE LUGS	1	DOWELLS
	2	UNIVERSAL MACHINES LTD.
LV MOTORS (NON FLAME PROOF)	1	ABB
	2	BHARAT BIJLEE LTD.
	3	CROMPTON GREAVES
	4	GE-POWER
	5	KIRLOSKAR ELECTRIC CO LTD.
	6	LAXMI HYDRAULICS PVT. LTD
	7	MARATHON
	8	NGEF
	9	RAJINDRA ELECT INDUSTRIES
	10	SIEMENS

PACKAGE WISE REGISTERED SUPPLIER LIST (PERMANENT

SI No	Package Name	Supplier Name	Supplier Communication Address
1	PROGRAMMABLE LOGIC CONTROLLER	GE Intelligent Platforms Private Limited	90/B, ELECTRONICS CITY, HOSUR ROAD, BANGLORE Phone- 28528328 Pincode : 561229 Email : shivesh.k.jha@ge.com
2	PROGRAMMABLE LOGIC CONTROLLER	ROCKWELL AUTOMATION INDIA LTD	(ALLENBRADLEY),C-11, SITE-4, INDUSTRIAL AREA SHHIBABAD, GHAZIABAD Phone- 2895247-52 Pincode : 201010 Email : omehrotra@rockwell.com
3	PROGRAMMABLE LOGIC CONTROLLER	SCHNEIDER ELECTRIC INDIA PVT.LTD.	A-4 , MOHAN CO-OP INDL AREA MATHURA ROAD NEW DELHI Phone- Pincode : 110044 Email : aditya.bawa@schneider-electric.com
4	PROGRAMMABLE LOGIC CONTROLLER	mitsubishi electric india pvt. ltd.	Mr. Mehul Dholakia Emerald House, EL-3, J Block, M.I.D.C., Bhosari, Pune Phone- 020-27102000 Pincode : 411026 Email : mehul.dholakia@asia.meap.com
5	PROGRAMMABLE LOGIC CONTROLLER	Honeywell Automation India Limited ,	56 & 57, Hadapsar Industrial Estate, Pune, Phone- 9689940949, Pincode : Email : amit.aglave@honeywell.com,
6	PROGRAMMABLE LOGIC CONTROLLER	SIEMENS LIMITED	Dr. Armin Bruck/Sandeep Mathur 130, Pandurang Budhkar Marg Worli Mumbai Phone- 0124 383 7377 Pincode : 400018 Email : ankit.varshney@siemens.com
7	PRESSURE SWITCH/DIFF. PRESSURE SWITCH	DRESSER INDUSTRIES INC.	Mr. Nishit Patel/Mr. Anuj Verma Plot No.2306, Phase II, GIDC Chhatral Kalol Phone- 02764-233682 Pincode : 382729 Email : Nishit.patel@ashcroftindia.com
8	PRESSURE SWITCH/DIFF. PRESSURE SWITCH	Barksdale GmbH, Germany	Michael Weileder Dorn Assenheimer, Strasse 27 Reichelsheim Phone- +91-9999107840 Pincode : D-61203 Email : msingh@barksdale.de
9	PRESSURE SWITCH/DIFF. PRESSURE SWITCH	GENERAL INSTRUMENTS CONSORTIUM	Mr. Amarendra Kulkarni 194/195, Gopi Tank Road, Off. Pandurang Naik Marg, Mahim Mumbai Phone- 9323195251 Pincode : 400016 Email : amarendra@general-gauges.com
10	PRESSURE SWITCH/DIFF. PRESSURE SWITCH	SWITZER PROCESS INSTRUMENTS PVT. LTD.	Mr. V S Jayaprakash, No.127 & 128, SIDCO North Phase, Ambattur Estates CHENNAI Phone- 044-26252017/2018 Pincode : 600050 Email : marketing@switzerinstrument.com
11	PRESSURE SWITCH/DIFF. PRESSURE SWITCH	PRECISION MASS PRODUCTS PVT. LTD.	Mr. Nishit Patel/Mr. Anuj Verma Plot No.2306, Phase II, GIDC Chhatral Kalol Phone- 9999464663 Pincode : 382729 Email : sales@precisionmass.com

12	PRESSURE SWITCH/DIFF. PRESSURE SWITCH	SOR INC.	LARRY DEGARMO/Avdhesh Chandra, 14685 W. 105TH STREET LENEXA Phone- 09810905139, Pincode : 66215 Email : Ldegarmo@sorinc.com, avdhesh@sherman-india.com,
13	PRESSURE SWITCH/DIFF. PRESSURE SWITCH	INDFOS INDUSTRIES LIMITED	B-20-21, INDUSTRIAL AREA, MEERUT ROAD, GHAZIABAD Phone- 0120-2712016 Pincode : Email : mkta@indfos.com
14	PRESSURE SWITCH/DIFF. PRESSURE SWITCH	INDFOS (INDIA) LIMITED	MR.L.C.VENKATRANGAN/MR.B.KANNAN New No.17, II Floor, Adwave Towers, Dr.Sevalia Shivaji Salai, T.Nagar Chennai Phone- +91 44 24353407 Pincode : 600017 Email : delhi@indfos.com
15	PRESSURE SWITCH/DIFF. PRESSURE SWITCH	Kaustubha Udyog,	S.No. 36/1/1, Sinhgad Road, Vadgaon Khurd, Near Lokmat Press, Pune, Phone 020-24393577, Pincode : Email : pressure@vsnl.com,
16	PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	H.GURU INDUSTRIES	Mr. G. D. Hazra/Mr. P. K. Mitra 10 B, HO-CHI-MINH SARANI, KOLKATA Phone- 033 2282 2463 / 1637 Pincode : 700071 Email : mguru@vsnl.net
17	PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	A.N. INSTRUMENTS PVT. LTD.	MARKETING DIVISION, 5th FLOOR, 59-B, CHOWRINGHEE ROAD, KOLKATA Phone- 24757784,22472509 Pincode : 700020 Email : anidel@bol.net.in
18	PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	BOSE PANDA INSTRUMENTS PVT.LTD.	Mr. Partha Bose 44, Saheed Hemanta Kumar Bose, Sarani, Kolkata Phone- +91 33 2548 7220 Pincode : 700074 Email : parthabosebpi@gmail.com; bosepanda@vsnl.net
19	PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	PRECISION MASS PRODUCTS PVT. LTD.	Mr. Nishit Patel/Mr. Anuj Verma Plot No.2306, Phase II, GIDC Chhatral Kalol Phone- 9999464663 Pincode : 382729 Email : sales@precisionmass.com
20	PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	Baumer Technologies India Pvt. Ltd.	Mr. Shyam Warilani/Mr. V Suresh Babu 36, DAMJI SHAMJI INDUSTRIAL COMPLEX, OFF.-MAHAKALI CAVES ROAD, ANDHERI(E) MUMBAI Phone- +91 99589 25151 Pincode : 400093 Email : sales.in@baumer.com
21	PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	H.GURU INSTRUMENTS (SOUTH INDIA) P. LTD	32,INDUSTRIAL SUBURB YESWANTHAPUR BANGALORE Phone- 080-23370300, Pincode : 560022 Email : info@hgurusouth.com
22	PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	FORBES MARSHALL (HYD) LTD.	MR SAILESH PATALAY/MR. M K SRINIVASAN PLOT NO.A-19/2, & T-4/2, IDA, NACHARAM, HYDERABAD Phone- 9849913704 Pincode : 500 076 Email : mksrinivasan@forbesmarshall.com

23	PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	GAUGE BOURDON INDIA PVT. LTD.	194/195, Gopi Tank Road, Off Pandurang Naik Marg, Mahim Mumbai, Phone- 011-41607463, Pincode : 400016, Email : gicdelhi@general-gauges.com,
24	PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	SCIENTIFIC DEVICES (BOMBAY) PVT LTD,	Office no. 53, Shree Manoshi Complex, Plot No. 5 & 6, Sec-3, Ghansoli (East), Navi Mumbai, Phone- 9892230623, Pincode : 400 701, Email : sdhnl@vsnl.com
25	PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	Nesstech Instruments Private Limited	26/2, G Type, Global Industrial Park Near Nahuli Railway Crossing, Valvada Vapi Phone- 9920576002 Pincode : 396105 Email : sales@nesstech.co.in
26	TEMPERATURE GAUGE	FORBES MARSHALL (HYD) LTD.	MR SAILESH PATALAY/MR. M K SRINIVASAN PLOT NO.A-19/2, & T-4/2, IDA, NACHARAM, HYDERABAD Phone- 9849913704 Pincode : 500 076 Email : mksrinivasan@forbesmarshall.com
27	TEMPERATURE GAUGE	GOA INSTRUMENTS INDUSTRIES PVT.LTD.,	D2/5, Mapusa Industrial Estate, Mapusa, Goa, Phone- 09326054551, Pincode : 403507, Email : sumukh@goainstruments.com,
28	TEMPERATURE GAUGE	H.GURU INSTRUMENTS (SOUTH INDIA) P. LTD	32,INDUSTRIAL SUBURB YESWANTHAPUR BANGALORE Phone- 080-23370300, Pincode : 560022 Email : info@hgurusouth.com
29	TEMPERATURE GAUGE	GAUGE BOURDON INDIA PVT. LTD.	194/195, Gopi Tank Road, Off Pandurang Naik Marg, Mahim Mumbai, Phone- 011-41607463, Pincode : 400016, Email : gicdelhi@general-gauges.com,
30	TEMPERATURE GAUGE	H.GURU INDUSTRIES	Mr. G. D. Hazra/Mr. P. K. Mitra 10 B, HO-CHI-MINH SARANI, KOLKATA Phone- 033 2282 2463 / 1637 Pincode : 700071 Email : mguru@vsnl.net
31	TEMPERATURE GAUGE	GOA THERMOSTATIC INSTRUMENTS PVT.LTD.	FLAT -B , GF, HILL CROWN APTS., COLLEGE ROAD, MAPUSA Phone- Pincode : 403525 Email : ottilworks@pvro-electric.in
32	TEMPERATURE GAUGE	A.N. INSTRUMENTS PVT. LTD.	MARKETING DIVISION, 5th FLOOR, 59-B, CHOWRINGHEE ROAD, KOLKATA Phone- 24757784,22472509 Pincode : 700020 Email : anidel@bol.net.in
33	TEMPERATURE GAUGE	PRECISION MASS PRODUCTS PVT. LTD.	Mr. Nishit Patel/Mr. Anuj Verma Plot No.2306, Phase II, GIDC Chhatral Kalol Phone- 9999464663 Pincode : 382729 Email : sales@precisionmass.com
34	TEMPERATURE GAUGE	Baumer Technologies India Pvt. Ltd.	Mr. Shyam Warilani/Mr. V Suresh Babu 36, DAMJI SHAMJI INDUSTRIAL COMPLEX, OFF.-MAHAKALI CAVES ROAD, ANDHERI(E) MUMBAI Phone- +91 99589 25151 Pincode : 400093 Email : sales.in@baumer.com

35	LEVEL GAUGE	TOSHNIWAL BROTHERS PVT.LTD.	WORKS:TOSHNIWAL IND.PVT.LTD, INDUSTRIAL ESTATE MAKHUPURA, AJMER Phone- 441171 Pincode : 305002 Email : toshniwalprocess@gmail.com
36	LEVEL GAUGE	BLISS ANAND PVT. LTD.	Mr. Vikas Anand/ Mr.RGRajan 92B & 93 B , IMT MANESAR Gurgaon Phone- 0124- 4366000 TO 9 Pincode : 122001 Email : sales@blissanand.com
37	LEVEL GAUGE	SIGMA INSTRUMENTS CO.	Gopal Kannan/R Gopinath 201, ANANDRAJ INDUSTRIAL ESTATE, OFF.LBS MARG, SONAPUR LANE, BHANDUP (W) MUMBAI Phone- +919821038162 Pincode : 400078 Email : sales@sigmainstruments.co.in
38	TEMP. ELEMENT	PYRO ELECTRIC INSTRUMENTS GOA PVT.LTD.	M. D. BICHU/R. M. BICHU G.B, HILL CROWN APARTMENTS, COLLEGE ROAD, MAPUSA Phone- 9326114601 Pincode : 403507 Email : priyanka.marketing@pyro electric.in
39	TEMP. ELEMENT	Baumer Technologies India Pvt. Ltd.	Mr. Shyam Warilani/Mr. V Suresh Babu 36, DAMJI SHAMJI INDUSTRIAL COMPLEX, OFF.-MAHAKALI CAVES ROAD, ANDHERI(E) MUMBAI Phone- +91 99589 25151 Pincode : 400093 Email : sales_in@baumer.com
40	TEMP. ELEMENT	DETRIVE INSTRUMENTATION & ELECTRONICS LTD.	320, TV INDUSTRIAL ESTATE, OFF.DR.A.BESANT ROAD, BEHIND GLAXO, WORLI, MUMBAI Phone- 24934125,24938403 Pincode : 400025 Email : trivtech@vsnl.com
41	TEMP. ELEMENT	Nesstech Instruments Private Limited	26/2, G Type, Global Industrial Park Near Nahuli Railway Crossing, Valvada Vapi Phone- 9920576002 Pincode : 396105 Email : sales@nesstech.co.in
42	TEMP. ELEMENT	Thermal Instrument India Pvt. Ltd.	Mr. Raghavendra M. Kulkarni 194/195, Gopi Tank Road Behind Citylight Cinema,Mahim Mumbai Phone- 09322664709 Pincode : 400016 Email : ramk@giconindia.com
43	TEMP. ELEMENT	GAUGE BOURDON INDIA PVT. LTD.	194/195, Gopi Tank Road, Off Pandurang Naik Marg, Mahim Mumbai, Phone- 011- 41607463, Pincode : 400016, Email : gicdelhi@general-gauges.com,
44	TEMP. ELEMENT	GOA INSTRUMENTS INDUSTRIES PVT.LTD.,	D2/5, Mapusa Industrial Estate, Mapusa, Goa, Phone- 09326054551, Pincode : 403507, Email : sumukh@goainstruments.com,
45	TEMP. ELEMENT	TOSHNIWAL INDUSTRIES PVT. LTD.,	Industrial Estate, Makhupura, Ajmer, Phone- 9352009000, Pincode : 305002, Email : info@tipl.com.
46	TEMP. ELEMENT	Tempsens Instrument (I) Pvt Ltd	MR. V.P.RATHI/MR. HEMANT RATHI B- 188A ROAD NO.5 , M.I.A UDAIPUR Phone- 09352420069 Pincode : 313003 Email : info@tempsens.com

47	TEMP. ELEMENT	SCIENTIFIC DEVICES (BOMBAY) PVT LTD,	Office no. 53, Shree Manoshi Complex, Plot No. 5 & 6, Sec-3, Ghansoli (East), Navi Mumbai, Phone- 9892230623, Pincode : 400 701, Email : sdhnl@vsnl.com
48	TRANSMITTERS	V. AUTOMAT & INSTRUMENTS (P) LTD.	Mr. R. K. BASSI/Mr. PRAVEEN KUMAR F-61, OKHLA INDL.AREA, PH-1 NEW DELHI Phone- 9810005826 Pincode : 110 020 Email : sales@vautomat.com
49	TRANSMITTERS	ABB LIMITED	MR. RAJIV GOVIL 14, MATHURA ROAD, FARIDABAD Phone- 09971085678 Pincode : 121003 Email : vinin.swami@in.abb.com
50	TRANSMITTERS	Pune Techtrol Pvt. Ltd.	N.P.Khatan/Sudhakar Badiger S-18, MIDC Bhosari, Pune Phone- 9850560042 Pincode : 411 026 Email : ho@punetechtrol.com
51	TRANSMITTERS	TOSHNIWAL INDUSTRIES PVT. LTD.,	Industrial Estate, Makhupura, Ajmer, Phone- 9352009000, Pincode : 305002, Email : info@tipl.com .
52	TRANSMITTERS	Endress + Hauser (India) Pvt. Ltd.,	Mr. Prakash Vaghela 215-216, DLF Tower 'A', Jasola District Centre, New Delhi, Phone- 9717593001, Pincode : 110025, Email : prakash.vaghela@in.endress.com ,
53	TRANSMITTERS	SBEM PVT. LTD.	MR.N.K. BEDARKAR/MR. VISHWANATH KARANDIK 39, ELECTRONIC CO.OP. ESTATE, PUNE SATARA ROAD PUNE, Phone- 912041030100 Pincode : 411009 Email : newdelhi@sbem.co.in
54	TRANSMITTERS	YOKOGAWA INDIA LIMITED,	PLOT NO.96, ELECTRONICS CITY COMPLEX, HOSUR ROAD, BANGALORE, Phone- 080-41586000, Pincode : Email : uday.shankar@in.yokogawa.com ,
55	TRANSMITTERS	Moore Industries International Inc.	Leonard.W. Moore/ Matt Moren 16650 Schoenborn St. North Hills Phone- +1 818 830 5548 Pincode : 91343 Email : mmoren@miinet.com
56	TRANSMITTERS	PANAM ENGINEERS	Mr. Santosh Shukla 203, Jaisingh Business,Parsiwada, Sahar road,Andheri(East), Mumbai, Phone- 9892179529, Pincode : 400099, Email : santosh@panamengineers.com ,
57	TRANSMITTERS	Honeywell Automation India Limited	Mr. Ritwij Kulkarni 917, INTERNATIONAL TRADE TOWER, NEHRU PLACE, NEW DELHI Phone- 9890200584 Pincode : 110019 Email : rajesh.chaudhary@honeywell.com
58	TRANSMITTERS	EMERSON PROCESS MANAGEMENT (INDIA) PVT.LTD.	Mr. Amit Paithankar/Vikram Raj Singh 206-210,BALARAMA BUILDING 2ND FLR. BANDRA EAST MUMBAI Phone- 9619121500 Pincode : 400051 Email : vikramraj.singh@emerson.com

59	TRANSMITTERS	SMART INSTRUMENTS LTD, BRAZIL	Agents: Digital Electronic Ltd. 74/11 'C' Cross Road MIDC Andheri (East) MUMBAI Phone- 28208477 Pincode : 400093 Email : corn@delhby.rooms.ems.vsnl.net.in
60	TRANSMITTERS	SIEMENS LIMITED	Dr. Armin Bruck/Sandeep Mathur 130, Pandurang Budhkar Marg Worli Mumbai Phone- 0124 383 7377 Pincode : 400018 Email : ankit.varshney@siemens.com
61	TRANSMITTERS	NIVO CONTROLS PVT. LTD.	Mr. Praveen Toshniwal 104-115, Electronic Complex, Indore Phone- 0731-4081305 Pincode : 452010 Email : sales@nivocontrols.com
62	TEMPERATURE SWITCH	SOR INC.	LARRY DEGARMO/Avdhesh Chandra, 14685 W. 105TH STREET LENEXA Phone- 09810905139, Pincode : 66215 Email : Ldegarmo@sorinc.com , avdhesh@sherman-india.com ,
63	TEMPERATURE SWITCH	DRESSER INDUSTRIES INC.	Mr. Nishit Patel/Mr. Anuj Verma Plot No.2306, Phase II, GIDC Chhatral Kalol Phone- 02764-233682 Pincode : 382729 Email : Nishit.patel@ashcroftindia.com
64	TEMPERATURE SWITCH	TOSHNIWAL BROTHERS PVT.LTD.	WORKS:TOSHNIWAL IND.PVT.LTD, INDUSTRIAL ESTATE MAKHUPURA, AJMER Phone- 441171 Pincode : 305002 Email : toshniwalprocess@gmail.com
65	TEMPERATURE SWITCH	INDFOS (INDIA) LIMITED	MR.L.C.VENKATRANGAN/MR.B.KANNAN New No.17, II Floor, Adwave Towers, Dr.Sevalia Shivaji Salai, T.Nagar Chennai Phone- +91 44 24353407 Pincode : 600017 Email : delhi@indfos.com
66	TEMPERATURE SWITCH	SWITZER PROCESS INSTRUMENTS PVT. LTD.	Mr. V S Jayaprakash, No.127 & 128, SIDCO North Phase, Ambattur Estates CHENNAI Phone- 044-26252017/2018 Pincode : 600050 Email : marketing@switzerinstrument.com
67	SIGHT FLOW INDICATORS	V. AUTOMAT & INSTRUMENTS (P) LTD.	Mr. R. K. BASSI/Mr. PRAVEEN KUMAR F- 61, OKHLA INDL.AREA, PH-1 NEW DELHI Phone- 9810005826 Pincode : 110 020 Email : sales@vautomat.com
68	SIGHT FLOW INDICATORS	BLISS ANAND PVT. LTD.	Mr. Vikas Anand/ Mr.RGRajan 92B & 93 B , IMT MANESAR Gurgaon Phone- 0124- 4366000 TO 9 Pincode : 122001 Email : sales@blissanand.com
69	SIGHT FLOW INDICATORS	SCIENTIFIC DEVICES (BOMBAY) PVT LTD,	Office no. 53, Shree Manoshi Complex, Plot No. 5 & 6, Sec-3, Ghansoli (East), Navi Mumbai, Phone- 9892230623, Pincode : 400 701, Email : sdbnl@vsnl.com
70	SIGHT FLOW INDICATORS	B.K.EQUIPMENTS PVT.LTD.	T. BALAKRISHNAN/S.VENKATESH 217 , ARCOT ROAD PORUR , CHENNAI Phone- 9444057761 Pincode : 600116 Email : bkequip@gmail.com

71	SIGHT FLOW INDICATORS	INSTRUMENTATION ENGINEERS PVT LTD	SH.N.V.RAM GOPAL/MS. N.NIHARIKA PLOTS 1,2,3, PHASE-III, IDA, JEEDIMETLA HYDERABAD Phone- 9848407365 Pincode : 500055 Email : iedelhi@ieflowmeters.com
72	SIGHT FLOW INDICATORS	SIGMA INSTRUMENTS CO.	Gopal Kannan/R Gopinath 201, ANANDRAJ INDUSTRIAL ESTATE, OFF.LBS MARG, SONAPUR LANE, BHANDUP (W) MUMBAI Phone- +919821038162 Pincode : 400078 Email : sales@sigmainstruments.co.in
73	DIFFERENTIAL PRESSURE SWITCH	SOR INC.	LARRY DEGARMO/Avdhesh Chandra, 14685 W. 105TH STREET LENEXA Phone- 09810905139, Pincode : 66215 Email : Ldegarmo@sorinc.com , avdhesh@sherman-india.com ,
74	JUNCTION BOX	SUCHITRA INDUSTRIES	NO-2,OPP-27 AECS LAYOUT 2ND STG REJAMAHALVILAS EXTN 2ND STG BANGALORE Phone- Pincode : Email : suchitra.industriesblr@gmail.com
75	JUNCTION BOX	K.S.INSTRUMENTS PVT.LTD.	S Raghavan No. 72, 3rd Main, 1st Stage Industrial Suburb, Yeshwanthpur Bangalore Phone- 9880385770 Pincode : 560022 Email : sales1@ksinstruments.net
76	JUNCTION BOX	Shrenik & Company,	Mr. Mitesh Shah/Mr. Pulin Shah 39 A/3 ,Panchratna Industrial Estate, Sarkhej- Bavla Road Ahmedabad Phone- 9825024921 Pincode : 382213 Email : sales@pustron.com , pullin@sumip.com
77	JUNCTION BOX	FLEXPRO ELECTRICALS PVT. LTD.	Mr. Dineshbhai Zaveri C-1/ 27&37, GIDC, Kabilpore, Navsari Phone- 02637- 265140,265003 Pincode : 396424 Email : flexpro@flexproltd.com
78	JUNCTION BOX	AJMERA INDUSTRIAL & ENGINEERING WORKS	JIGNESH MAHENDRA AJMERA DENA BANK BLDG.,SHREE NAGESH INDL. ESTATE,STATION ROAD, MUMBAI Phone- 022 67973578 Pincode : 400 088 Email : ajmera@ajmera.net , jmajmera@yahoo.com
79	INSTRUMENTS TUBE FITTINGS	VIKAS INDUSTRIAL PRODUCTS	S.R.SINGH/NAVEEN SINGH B - 2, SECTOR - 6, NOIDA Phone- +91-9810122070 Pincode : 201301 Email : naveensingh@vsnl.com
80	INSTRUMENTS TUBE FITTINGS	Fluid Controls Pvt. Ltd.	Sophie Y. Moochhala/Mayur Rajput J.V.PATEL, I.T.I CMPD, B.MADHUKAR MARG, ELPHINSTONE ROADSTN.(WR), MUMBAI Phone- (022) 43338000 Pincode : 400013 Email : sales@fluidcontrols.com
81	INSTRUMENTS TUBE FITTINGS	PRECISION ENGINEERING INDUSTRIES	K. SITARAM/ K. SRINIVAS 7,SIDHAPURA INDUSTRIAL ESTATE S.V. ROAD,GOREGAON(W) MUMBAI Phone- 022 42631700 Pincode : 400 062 Email : neiks@vsnl.com

82	INSTRUMENTS TUBE FITTINGS	AURA INCORPORATED	NIRAJ SHARAN/SUJIT KUMAR W-167A, GREATER KAILASH-II NEW DELHI Phone- 9810182430 Pincode : 110048 Email : niraj@aurainc.com
83	ROTAMETER	INSTRUMENTATION ENGINEERS PVT LTD	SH.N.V.RAM GOPAL/MS. N.NIHARIKA PLOTS 1,2,3, PHASE-III, IDA, JEEDIMETLA HYDERABAD Phone- 9848407365 Pincode : 500055 Email : iedelhi@ieflowmeters.com
84	ROTAMETER	Flow Star Engineering Pvt. Ltd.,	MR. KHALID AKHTAR/MR. TAPAN KUMAR JANA Plot No-7 F/2, Northern India Industrial 20/3, Mathura Road FARIDABAD Phone- 9818176380 Pincode : 121005 Email : khalid@flowstar.co.in
85	ROTAMETER	TANSA EQUIPMENTS PVT. LTD.	Mr. Vardhan Tamhankar, Unit No35/36/41,Om Anand Industrial Est. Mohanjee Sundarjee Road,Raghunath Nagar, Thane Phone- 022-25832323 Pincode : 400604 Email : tansaindia@gmail.com
86	ROTAMETER	EUREKA INDUSTRIAL EQUIPMENTS PVT.LTD.	Mr V. K. Pandit/Mr Ashish Shaha 17-20, Royal chambers, Paud Road Pune Phone- 9370469466 Pincode : 411038 Email : sales@eurekaflow.com
87	ROTAMETER	SCIENTIFIC DEVICES (BOMBAY) PVT LTD,	Office no. 53, Shree Manoshi Complex, Plot No. 5 & 6, Sec-3, Ghansoli (East), Navi Mumbai, Phone- 9892230623, Pincode : 400 701, Email : sdhnl@vsnl.com
88	LEVEL SWITCH-CAPACITANCE TYPE	SIGMA INSTRUMENTS CO.	Gopal Kannan/R Gopinath 201, ANANDRAJ INDUSTRIAL ESTATE, OFF.LBS MARG, SONAPUR LANE, BHANDUP (W) MUMBAI Phone- +919821038162 Pincode : 400078 Email : sales@sigmainstruments.co.in
89	LEVEL SWITCH-CAPACITANCE TYPE	V. AUTOMAT & INSTRUMENTS (P) LTD.	Mr. R. K. BASSI/Mr. PRAVEEN KUMAR F- 61, OKHLA INDLAREA, PH-1 NEW DELHI Phone- 9810005826 Pincode : 110 020 Email : sales@vautomat.com
90	LEVEL SWITCH-CAPACITANCE TYPE	SCIENTIFIC DEVICES (BOMBAY) PVT LTD,	Office no. 53, Shree Manoshi Complex, Plot No. 5 & 6, Sec-3, Ghansoli (East), Navi Mumbai, Phone- 9892230623, Pincode : 400 701, Email : sdhnl@vsnl.com
91	LEVEL SWITCH-CAPACITANCE TYPE	LEVCON INSTRUMENTS PVT. LTD.	Mr Shayak Gupta/Badal Jana Rajkamal', 7th floor, 13, Camac Street KOLKATA Phone- 0 33 2283 2766 Pincode : 700017 Email : h_jana@levcongroup.com
92	LEVEL SWITCH-CAPACITANCE TYPE	Flow Star Engineering Pvt. Ltd.,	MR. KHALID AKHTAR/MR. TAPAN KUMAR JANA Plot No-7 F/2, Northern India Industrial 20/3, Mathura Road FARIDABAD Phone- 9818176380 Pincode : 121005 Email : khalid@flowstar.co.in

93	LEVEL SWITCH-CAPACITANCE TYPE	Pune Techtrol Pvt. Ltd.	N.P.Khatan/Sudhakar Badiger S-18, MIDC Bhosari, Pune Phone- 9850560042 Pincode : 411 026 Email : ho@punetechtrol.com
94	LEVEL SWITCH-CAPACITANCE TYPE	Baumer Technologies India Pvt. Ltd.	Mr. Shyam Warilani/Mr. V Suresh Babu 36, DAMJI SHAMJI INDUSTRIAL COMPLEX, OFF.-MAHAKALI CAVES ROAD, ANDHERI(E) MUMBAI Phone- +91 99589 25151 Pincode : 400093 Email : sales.in@baumer.com
95	LEVEL SWITCH-CONDUTIVITY TYPE	Sapcon Instrument Pvt Ltd.	131, PALSHIKAR COLONY Contact Person- Mr. Ashwin (9826080207) INDORE Phone- +91-731-4085751, Pincode : 452004 Email : sales@sanconinstruments.com
96	LEVEL SWITCH-CONDUTIVITY TYPE	LEVCON INSTRUMENTS PVT. LTD.	Mr Shayak Gupta/Badal Jana Rajkamal', 7th floor, 13, Camac Street KOLKATA Phone- 0 33 2283 2766 Pincode : 700017 Email : b_jana@levcongroup.com
97	LEVEL SWITCH-CONDUTIVITY TYPE	BLISS ANAND PVT. LTD.	Mr. Vikas Anand/ Mr.RGRajan 92B & 93 B , IMT MANESAR Gurgaon Phone- 0124-4366000 TO 9 Pincode : 122001 Email : sales@blissanand.com
98	LEVEL SWITCH-CONDUTIVITY TYPE	V. AUTOMAT & INSTRUMENTS (P) LTD.	Mr. R. K. BASSI/Mr. PRAVEEN KUMAR F-61, OKHLA INDL.AREA, PH-1 NEW DELHI Phone- 9810005826 Pincode : 110 020 Email : sales@vautomat.com
99	LEVEL SWITCH-CONDUTIVITY TYPE	HI-TECH SYSTEMS & SERVICES LTD.	Mr. Vikash Agrawal/Mr. Tarun Debnath 119, PARK STREET , KOLKATA Phone- 033-22290045 Pincode : 700016 Email : sandeep@hitech.in
100	LEVEL SWITCH-CONDUTIVITY TYPE	RAMAN INSTRUMENTS PVT.LTD.	Mr. N R Shenoy/Mr G B Vijh 8, First Floor.Plot : 160A Bait-Ush-Sharaf, 29th Road,Bandra(W) MUMBAI Phone- 09892331381 Pincode : 400050 Email : ramanbpl@vsnl.com
101	LEVEL SWITCH-CONDUTIVITY TYPE	SIGMA INSTRUMENTS CO.	Gopal Kannan/R Gopinath 201, ANANDRAJ INDUSTRIAL ESTATE, OFF.LBS MARG, SONAPUR LANE, BHANDUP (W) MUMBAI Phone- +919821038162 Pincode : 400078 Email : sales@sigmainstruments.co.in
102	LEVEL SWITCH-CONDUTIVITY TYPE	SOR INC.	LARRY DEGARMO/Avdhesh Chandra, 14685 W. 105TH STREET LENEXA Phone- 09810905139, Pincode : 66215 Email : Ldegarmo@sorinc.com , avdhesh@sherman-india.com ,
103	LEVEL SWITCH-FLOAT TYPE	Pune Techtrol Pvt. Ltd.	N.P.Khatan/Sudhakar Badiger S-18, MIDC Bhosari, Pune Phone- 9850560042 Pincode : 411 026 Email : ho@punetechtrol.com
104	LEVEL SWITCH-FLOAT TYPE	D.K. INSTRUMENTS PVT.LTD.	N.SIKDAR/ SUMIT SIKDAR 76/2,SELIMPUR RD DHAKURIA Kolkata Phone- 033-2415-1310. Pincode : 700031 Email : dkinst@vsnl.net

105	LEVEL SWITCH-FLOAT TYPE	V. AUTOMAT & INSTRUMENTS (P) LTD.	Mr. R. K. BASSI/Mr. PRAVEEN KUMAR F-61, OKHLA INDL.AREA, PH-1 NEW DELHI Phone- 9810005826 Pincode : 110 020 Email : sales@vautomat.com
106	LEVEL SWITCH-FLOAT TYPE	SCIENTIFIC DEVICES (BOMBAY) PVT LTD,	Office no. 53, Shree Manoshi Complex, Plot No. 5 & 6, Sec-3, Ghansoli (East), Navi Mumbai, Phone- 9892230623, Pincode : 400 701, Email : sdhnl@vsnl.com
107	LEVEL SWITCH-FLOAT TYPE	LEVCON INSTRUMENTS PVT. LTD.	Mr Shayak Gupta/Badal Jana Rajkamal', 7th floor, 13, Camac Street KOLKATA Phone- 0 33 2283 2766 Pincode : 700017 Email : b_jana@levcongroup.com
108	LEVEL SWITCH-FLOAT TYPE	GENERAL INSTRUMENTS CONSORTIUM	Mr. Amarendra Kulkarni 194/195, Gopi Tank Road, Off. Pandurang Naik Marg, Mahim Mumbai Phone- 9323195251 Pincode : 400016 Email : amarendra@general-gauges.com
109	LEVEL SWITCH-FLOAT TYPE	Baumer Technologies India Pvt. Ltd.	Mr. Shyam Warilani/Mr. V Suresh Babu 36, DAMJI SHAMJI INDUSTRIAL COMPLEX, OFF.-MAHAKALI CAVES ROAD, ANDHERI(E) MUMBAI Phone- +91 99589 25151 Pincode : 400093 Email : sales.in@baumer.com
110	LEVEL SWITCH-FLOAT TYPE	SBEM PVT. LTD.	MR.N.K. BEDARKAR/MR. VISHWANATH KARANDIK 39, ELECTRONIC CO.OP. ESTATE, PUNE SATARA ROAD PUNE, Phone- 912041030100 Pincode : 411009 Email : newdelhi@sbem.co.in
111	LEVEL SWITCH-FLOAT TYPE	SIGMA INSTRUMENTS CO.	Gopal Kannan/R Gopinath 201, ANANDRAJ INDUSTRIAL ESTATE, OFF.LBS MARG, SONAPUR LANE, BHANDUP (W) MUMBAI Phone- +919821038162 Pincode : 400078 Email : sales@sigmainstruments.co.in
112	LEVEL SWITCH-FLOAT TYPE	SOR INC.	LARRY DEGARMO/Avdhesh Chandra, 14685 W. 105TH STREET LENEXA Phone- 09810905139, Pincode : 66215 Email : Ldegarmo@sorinc.com, avdhesh@sherman-india.com,
113	INSTRUMENTS PIPE FITTINGS	VIKAS INDUSTRIAL PRODUCTS	S.R.SINGH/NAVEEN SINGH B - 2, SECTOR - 6, NOIDA Phone- +91-9810122070 Pincode : 201301 Email : naveensingh@vsnl.com
114	INSTRUMENTS PIPE FITTINGS	Fluid Controls Pvt. Ltd.	Sophie Y. Moochhala/Mayur Rajput J.V.PATEL, I.T.I CMPD, B.MADHUKAR MARG, ELPHINSTONE ROADSTN.(WR), MUMBAI Phone- (022) 43338000 Pincode : 400013 Email : sales@fluidcontrols.com
115	INSTRUMENTS PIPE FITTINGS	AURA INCORPORATED	NIRAJ SHARAN/SUJIT KUMAR W-167A, GREATER KAILASH-II NEW DELHI Phone- 9810182430 Pincode : 110048 Email : niraj@aurainc.com

116	INSTRUMENTS PIPE FITTINGS	PRECISION ENGINEERING INDUSTRIES	K. SITARAM/ K. SRINIVAS 7,SIDHAPURA INDUSTRIAL ESTATE S.V. ROAD,GOREGAON(W) MUMBAI Phone- 022 42631700 Pincode : 400 062 Email : neiks@vsnl.com
117	ULTRASONIC FLOW METERS	Adept Fluidyne Pvt. Ltd.	Vinayak Gadre Plot No 4,S.No.17/1-B Kothrud Industrial Estate Pune Phone- 020 25464551 Pincode : 411038 Email : info@adeptfluidyne.com
118	ULTRASONIC FLOW METERS	FLEXIM Flexible Industriemesstechnik GmbH	Boxberger Str., 4, Berlin Berlin Phone- 0049 30 93 66 76 60 Pincode : 12681 Email : info@flexim.de
119	ULTRASONIC FLOW METERS	Rockwin Flowmeter India Pvt. Ltd.	B-24, Site-IV, Sahibabad Industrial Area Ghaziabad, Phone- 9810129687 Pincode : 201010, Email : amiya@rockwin.com
120	ULTRASONIC FLOW METERS	FLASH FORGE PVT LTD	Mr. Gautam Makker, 503, 'A'-wing, Delphi, Orchard Avenue Road, Powai Mumbai Phone- 022-42784300 Pincode : 400076 Email : hemendrapatil@f-f.co.in
121	ULTRASONIC FLOW METERS	Electronet Equipments Pvt Ltd.	Plot No. 84, 85 & 86, Tiny Industrial Estate Kondhwa Budruk, Pune Phone- 020-2026932039 Pincode : 411048 Email : ho@eeplindia.com
122	ULTRASONIC FLOW METERS	NIVUS GMBH	Mr. Marcus Fischer Im Taele 2, D - 75031 Eppingen Phone- 00491712233770 Pincode : Email : carolin.schuster@nivus.com
123	FLOW ELEMENT - ORIFICE	TANSA EQUIPMENTS PVT. LTD.	Mr. Vardhan Tamhankar, Unit No35/36/41,Om Anand Industrial Est. Mohanjee Sundarjee Road,Raghunath Nagar, Thane Phone- 022-25832323 Pincode : 400604 Email : tansaindia@gmail.com
124	FLOW ELEMENT - ORIFICE	SCIENTIFIC DEVICES (BOMBAY) PVT LTD,	Office no. 53, Shree Manoshi Complex, Plot No. 5 & 6, Sec-3, Ghansoli (East), Navi Mumbai, Phone- 9892230623, Pincode : 400 701, Email : sdbnl@vsnl.com
125	FLOW ELEMENT - ORIFICE	MINCO (INDIA) PRIVATE LIMITED	D/35,TIVIM INDUSTRIAL ESTATE, KARASWADA, MAPUSA, Goa, Phone- 9320197825, Pincode : 403526, Email : santoshkumar@general-gauges.com ,
126	FLOW ELEMENT - ORIFICE	CHEMTROLS INDUSTRIES PVT. LTD.	Mr. K. NANDAKUMAR AMAR HILL, SAKI VIHAR ROAD, POWAI, MUMBAI Phone- 022-67151261 Pincode : 400072 Email : manikandan@chemtrols.com
127	FLOW ELEMENT - ORIFICE	STAR-MECH CONTROLS (I) PVT.LTD.	SUSHILLOTAM, SUSHILLOTAM, 29/3A/3, SASANE NAGAR, HADAPSAR, PUNE Phone- 02026970450 Pincode : 411028 Email : marketing@starmech.net

128	FLOW ELEMENT - ORIFICE	INSTRUMENTATION LTD.	KANJIKODE WEST, PALALKKAD, PALAKKAD Phone- 2566127-130,2567128 Pincode : 678623 Email : icvldil@gmail.com;fa2@ilpgt.com
129	FLOW ELEMENT - ORIFICE	HYDROPNEUMATICS PVT. LTD.	Mr. DM Bichu G/B, Hill Crown Apts., College Road Mapusa Phone- 0832- 2360364 Pincode : 403507 Email : aiavrc@hvdronneumatics.co.in
130	FLOW ELEMENT - ORIFICE	Flow Star Engineering Pvt. Ltd.,	MR. KHALID AKHTAR/MR. TAPAN KUMAR JANA Plot No-7 F/2, Northern India Industrial 20/3, Mathura Road FARIDABAD Phone- 9818176380 Pincode : 121005 Email : khalid@flowstar.co.in
131	FLOW ELEMENT - ORIFICE	MICRO PRECISION PRODUCTS PVT. LTD.	Mr. SANJEEV CHAUHAN H.B. No.-40, Revenue Estate, Village-Dudhola, Tehsil & Distt. Palwal FARIDABAD Phone- 9871620282 Pincode : 121002 Email : Sanjeev.Chauhan@micro-precision.co.in
132	FLOW ELEMENT - ORIFICE	INSTRUMENTATION ENGINEERS PVT LTD	SH.N.V.RAM GOPAL/MS. N.NIHARIKA PLOTS 1,2,3, PHASE-III, IDA, JEEDIMETLA HYDERABAD Phone- 9848407365 Pincode : 500055 Email : iedelhi@ieflowmeters.com
133	FLOW ELEMENT - ORIFICE	MINCO (INDIA) FLOW ELEMENTS PVT. LTD.	Mr. Raghavendra M. Kulkarni D2-49/50, Tivim Industrial Estate, Karaswada Mapusa Phone- 0832-2257059 Pincode : 403526 Email : micflowelement@miconindia.com
134	FLOW ELEMENT - ORIFICE	DYNAFLUID VALVES AND FLOW CONTROLS (P) LTD.	Mr. Yogish M. Kulkarni Plot # 23, Udyambag, Belgaum Phone- 0831- 4210386 Pincode : 590008 Email : yogish@dyna-fluid.com
135	INSTRUMENT FITTINGS	AURA INCORPORATED	NIRAJ SHARAN/SUJIT KUMAR W-167A, GREATER KAILASH-II NEW DELHI Phone- 9810182430 Pincode : 110048 Email : niraj@aurainc.com
136	INSTRUMENT FITTINGS	Comfit & Valve Pvt. Ltd.	Mr. Jeetu Jain/Mr. Vinay Sosa Survey No. 23/1, Part 2, Ahmedabad-Mehsana Highway Laxmipura, Nandasan Phone- 02764-267036/37 Pincode : 382705 Email : marketing@com-fit.com
137	INSTRUMENT FITTINGS	HP VALVES & FITTINGS INDIA PVT. LTD.	S. Harichandran/P.S. Pandi B-11, Mugappair Industrial Estate, CHENNAI Phone- 044 26252537 Pincode : 600037 Email : sales@hpvalvesindia.com
138	INSTRUMENT FITTINGS	PRECISION ENGINEERING INDUSTRIES	K. SITARAM/ K. SRINIVAS 7,SIDHAPURA INDUSTRIAL ESTATE S.V. ROAD,GOREGAON(W) MUMBAI Phone- 022 42631700 Pincode : 400 062 Email : neiks@vsnl.com
139	INSTRUMENT FITTINGS	Arya Crafts & Engineering Pvt. Ltd.	Mr.Sanjay Brahman/Mr.Shyam Vazirani 102, Vora Industrial Estate No.4 Navghar, Vasai Road (E) Dist.Thane, Mumbai Phone- +91-250-2392246 Pincode : 401210 Email : arya@aryaengg.com

140	INSTRUMENT FITTINGS	Perfect Instrumentation Control (India) Pvt. Ltd.	MD Hussain Shaikh/Shahanawaz Khan Gala No. 168, Loheki Chwal, 216/ 218, Maulana Azad Rd. Nagpada Junction Mumbai Phone- 91-9324383121 Pincode : 400008 Email : shahanawaz.khan@perfectinstrumentation.com
141	INSTRUMENT FITTINGS	FLUIDFIT ENGINEERS PVT. LTD.	Mr. Abbas Bhola Potia Building No. 2, Office No. 3, 292, Bellasis Road, Mumbai Central (East) Mumbai Phone- 9920044113 Pincode : 400008 Email : ab@fluidfitengg.com
142	INSTRUMENT FITTINGS	VIKAS INDUSTRIAL PRODUCTS	S.R.SINGH/NAVEEN SINGH B - 2, SECTOR - 6, NOIDA Phone- +91-9810122070 Pincode : 201301 Email : naveensingh@vsnl.com
143	INSTRUMENT FITTINGS	Fluid Controls Pvt. Ltd.	Sophie Y. Moochhala/Mayur Rajput J.V.PATEL, I.T.I CMPD, B.MADHUKAR MARG, ELPHINSTONE ROADSTN.(WR), MUMBAI Phone- (022) 43338000 Pincode : 400013 Email : sales@fluidcontrols.com
144	INSTRUMENT FITTINGS	PANAM ENGINEERS	Mr. Santosh Shukla 203, Jaisingh Business, Parsiwada, Sahar road, Andheri (East), Mumbai, Phone- 9892179529, Pincode : 400099, Email : santosh@panamengineers.com,
145	ELECTROMAGNETIC FLOW METER	Adept Fluidyne Pvt. Ltd.	Vinayak Gadre Plot No 4, S.No.17/1-B Kothrud Industrial Estate Pune Phone- 020 25464551 Pincode : 411038 Email : info@adeptfluidyne.com
146	ELECTROMAGNETIC FLOW METER	Electronet Equipments Pvt Ltd.	Plot No. 84, 85 & 86, Tiny Industrial Estate Kondhwa Budruk, Pune Phone- 020-2026932039 Pincode : 411048 Email : ho@eeplindia.com
147	ELECTROMAGNETIC FLOW METER	SCIENTIFIC DEVICES (BOMBAY) PVT LTD,	Office no. 53, Shree Manoshi Complex, Plot No. 5 & 6, Sec-3, Ghansoli (East), Navi Mumbai, Phone- 9892230623, Pincode : 400 701, Email : sdhnl@vsnl.com



TITLE :

2X660 MW UDANGUDI STPP

SPECIFICATION NO. PE-TS-435-168-A001

SECTION : I

**TECHNICAL SPECIFICATION FOR HYDROGEN
GENERATION PLANT**

SUB-SECTION: IA

REV. NO. 00

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 intimate d after award of contract by BHEL/customer. However the same will be adhere d by the bidder without any commercial and delivery implication to BHEL/customer.



TITLE :
2X660 MW UDANGUDI STPP

SPECIFICATION NO. PE-TS-435-168-A001

SECTION : I

**TECHNICAL SPECIFICATION FOR HYDROGEN
GENERATION PLANT**

SUB-SECTION: IA

REV. NO. 00

ANNEXURE III: FUNCTIONAL GUARANTEES AND LIQUIDATED DAMAGES



TITLE : 2X660 MW UDANGUDI STPP	SPECIFICATION NO. PE-TS-435-168-A001	
	SECTION : I	
	TECHNICAL SPECIFICATION FOR HYDROGEN GENERATION PLANT	
	REV. NO. 00	

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

- Capacity and discharge pressure of hydrogen gas compressors at its rated duty point shall be demonstrated and proved at site.
- Electrolyser & rectifier capacity and power consumption shall be demonstrated at site.
- Parallel operation of two streams shall be demonstrated at site. Purity level and moisture content of hydrogen shall be demonstrated at site.
- Hydrogen generation plant capacity (stream wise) shall be demonstrated at site.
- Vibration level and noise level of hydrogen gas compressors shall be demonstrated at site.



TITLE :

2X660 MW UDANGUDI STPP

SPECIFICATION NO. PE-TS-435-168-A001

SECTION : I

**TECHNICAL SPECIFICATION FOR HYDROGEN
GENERATION PLANT**

SUB-SECTION: IA

REV. NO. 00

ANNEXURE IV : DRAWING DOCUMENTS DISTRIBUTION PROCEDURE



Apart from those documents named in the various sections of the Specification, the Contractor has to submit as minimum requirement the drawings summarized in the above clause to the Owner or his representatives within the periods specified in months, starting from the "Commencement Date" according to the Definitions of the Contract. The delivery time as far as not specified, shall be proposed by the Contractor in his Tender in accordance with his overall implementation schedule and will be defined finally during Contract negotiations.

19.4.0 Liasion Meetings

The liasion meetings shall be organised by the contractor (once in 15 days during design period and once in 15 days during construction period) in accordance with stipulations specified elsewhere in the specification.

Contractor shall supply all documents required in the appropriated number as requested by the Owner.

19.5.0 Distribution of documents

The source, distribution, no. of copies etc shall be as per the following document distribution schedule.

Document Distribution Schedule - After Placement of Order

Sl.No.	Document	Total Copies	Distribution		
			Owner		Consultant
			HQ	SITE	
1.	PERT Network, work schedules, Bar charts, Layout drawings in 2D & 3 D of all building, plant, pump house, control room etc	12	4	6	2
2.	Data, drawings, documents, write-ups, calculation				
	- Preliminary	12	5	5	2
	- Revised	12	4	6	2
3.	Approved drawings, documents etc.	12	4	6	2
4.	Instruction manuals for erection and O&M	12	5	6	1
5.	As built drawings including O &M manual				
	- Hard Copy	12	5	6	1
	- Soft Copy	5	2	2	1

19.6.0 Manuals

19.6.1 General

The Contractor shall provide the manuals in a timely manner to enable the Owner / Engineer to review and comments and request changes as necessary.



TITLE :

2X660 MW UDANGUDI STPP

SPECIFICATION NO. PE-TS-435-168-A001

SECTION : I

**TECHNICAL SPECIFICATION FOR HYDROGEN
GENERATION PLANT**

SUB-SECTION: IA

REV. NO. 00

ANNEXURE V: PAINTING SPECIFICATION

**VOLUME II****SUB-SECTION 2.25****CLEANING, PROTECTIVE COATING AND PAINTING****1.0.0 GENERAL**

This specification covers the general requirements related to the cleaning protective coating and painting of equipment, components and systems that are covered under main equipment / system specifications for 2x660 MW Supercritical Thermal Power Plant. The components and/or equipment shall be mechanically and /or chemically cleaned during the following stages of the Contract.

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

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

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

Machined surfaces shall be protected during the cleaning operations.

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

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

2.0.0 CODES AND STANDARDS

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

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

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



IS: 2339	Aluminum paint for general purposes, in dual container.
IS: 2395	Code of practice for painting of concrete, masonry and plaster surfaces: Part 2 schedules.
IS: 2524	Code of practice for painting of non-ferrous metals in buildings (Parts I & II).
IS: 2932	Specification for enamel, synthetic, exterior (a) undercoating, (b) Finishing
IS: 3140	Code of practice for painting asbestos cement building products.
IS: 6158	Recommended practice for design safeguarding against Embrittlement of hot dip Galvanized Iron & steel products.
IS: 6159	Recommended practice for design & fabrication of Iron & steel products prior to Galvanizing & metal spraying.
IS: 6278	Code of practice for white washing and Color - Washing.
IS: 10221	Code of practice for coating & wrapping of underground mild steel pipelines.
IS: 33	Inorganic pigments and extenders for paints –Methods of sampling & test.
IS: 13183	Aluminum paint, Heat resistant - specifications.
IS: 144	Specification for ready mixed paint brushing, petrol resisting, Air drying for Interior paints of tanks and containers, Red oxide.
IS: 9954	Pictorial surface preparation standards for painting of steel surfaces.
IS: 11883	Specification for Ready Mixed Paint, Air Drying, Red Oxide Priming for metals.
IS: 9404	Color code for identification of pipelines used in the Thermal Power Plants.
IS: 12744	Specification for Ready Mixed Paint, Air Drying, Red Oxide-Zinc Phosphate Priming.
BS: 2015	Glossary of paint selected terms.
BS: 5252	Final coat color.
BS: 7079A1/S1	Specification for rust grades and preparation grades of uncoated substrates after overall removal of previous coating.
BS: 7079A2	Preparations grades of previously coated steel substrates.
BS: 7079GrC	Surface roughness characteristics of blast cleaned steel substrates.
BS: 7079GrD	Methods for surface preparation.
BS-4232	Surface Finish of Blast cleaned steel for painting.
ASTM	American Standard for Testing Material.
ASTM A 780	Standard practice for repair of damaged galvanized coatings.
AWWA	American Water Works Association.
ASA-A-13.1-1981	Scheme for identification of piping system (American National Standard Institution).
DIN	Deutsehes Institute for Normung
SIS-055900-1967	Surface preparation standards for painting steel surfaces. (Swedish standard Institution)
SSPC-SP	Preparation Specifications (Steel structures painting council, U.S.A.).
	National Association of Corrosion Engineers, U.S.A. (NACE).



3.0.0 SCOPE OF WORK AND GENERAL REQUIREMENTS

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

Coating materials according to SSPC, EN ISO, ASTM, BIS or DIN standards, shall be used. The paint shall comply with applicable laws, regulations, ordinances etc., of the local authority, state or the nation pertains to the work. The materials shall be matched with each other so that they are compatible. Coatings deviating this specification shall be subject to approval.

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

The paint to be applied shall be approved by Owner.

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

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

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

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

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

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

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

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

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

Painting records shall contain:

- Equipment/components/location painted
- Date of painting
- Paint details such as specification No, colour, date of manufacture, shelf life, expiry date
- Application equipments



- Ambient conditions at the time of painting
- Surface temperature
- Drying time between coating, DFT and number of coatings
- Appropriate work plan for painting.

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

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

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

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

4.0.0 CLEANING AT MANUFACTURER'S WORKS

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

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

Surface condition:

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

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

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

Abrasives:

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

For austenitic materials only, abrasives containing 98% or more of alumina, Al_2O_3 , shall be used.

Removal of abrasive and debris:

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

5.0.0 PROTECTION AT MANUFACTURER'S WORKS

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



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

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

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

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

6.0.0 WEATHER CONDITIONS

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

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

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

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

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

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

7.0.0 SURFACE PREPARATION

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

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

All surfaces should be blast cleaned whenever possible.

**Surface preparation methods:**

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

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

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

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

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

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

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

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

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

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

d. Very thorough mechanical scraping and wire brushing St 3

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

e. Thorough scraping and wire brushing St 2

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

f. Air Blasting with Non-Metallic Abrasives Powder

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

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



Surface preparation methods	SIS 055900	DIN 55928 Part-4	BS 4232 only for blasting	SSPC-Vis
Blasting acc to item (a),(b),(c),	Sa 3		First quality	White metal SP 5
Blasting acc to item (b)	Sa 2 1/2		Second quality	near White SP 10
Blasting acc to item (c)	Sa 2		Third quality	Commercial blast SP 6
Hand/or power tool derusting acc to item (e)	St 2		--	Hand tool cleaning SP 2
acc to items (d) and (e)	St 3		--	Power tool cleaning SP 3
Flame jet cleaning		F1	--	Flame cleaning SP 4
Pickling		Be	--	Pickling

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

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

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

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

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

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

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

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

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

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

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

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



8.0.0 PREPARATION OF COATING MATERIALS

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

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

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

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

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

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

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

Two-component primers shall be mixed in accordance with the manufacturer's instructions. Thinners shall not be added to primers or paints unless necessary for proper application according to the manufacturer's instructions. When use of thinners is permitted, it must be added to the primer or paint during mixing.

8.1.0 Primer Paint

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

Primer shall be applied by brushing to ensure a continuous film without 'holidays'. The dry film thickness of each coat shall be as specified in the Annex- ANNEX 25.1.2 -Paint System of this specification.

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

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

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

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

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

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

8.2.0 Rub down and Touch Up of Primer

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



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

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

8.3.0 Non Compatible Shop Coat Primer

- a) The compatibility of finishing coat shall be confirmed from the paint manufacturer. In the event of use of primer such as zinc rich epoxy, inorganic zinc silicate etc., the paint system shall depend on condition of shop coat. If the shop coat is in satisfactory condition showing no major defect, the shop coat shall not be removed. The touch up primer and finishing coat(s) shall be identified for application by Engineer. Shop coated (coated with primer & finishing coat) equipment shall not be repainted unless paint is damaged.
- b) Shop primed equipment and surfaces shall only be 'spot cleaned' in damaged areas by means of power tool brush cleaning or hand tool cleaning and then spot primed before applying one coat of field primer unless otherwise specified. If shop primer is not compatible with field primer then shop coated primer shall be completely removed before application of selected paint system for particular environment. For package units/equipment, shop primer shall be as per the paint system given for particular environment.
- c) In case of existing paint, compatibility between finishing coat and new selected finish coat shall be ascertained before application of finish coat. In case, the coat is selected for upgrading existing alkyd coating to high performance coating then, surface preparation shall be by manual/mechanical means to remove loose rust, peeled off/damaged paint, but sound old coating need not be removed. It shall be touched with suitable primer wherever it has peeled off before application of tie coat. The tie coat shall be applied after 7 days of curing of the primer. If, new paint system is not suitable to upgrade existing coating then complete paint shall be removed by mechanical or blast cleaning before application of new coating system.

8.4.0 Finish Paint

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

9.0.0 STEEL STRUCTURES PAINTING

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

Steel surface which is to painted shall be cleaned off dust and grease and the heavier layers of rust shall be removed by chipping to grade ST-2 as per SIS05-5900 or as per IS: 1477 (part -I) prior to actual surface preparation. Suitable primer of required DFT shall be applied as specified in the Paint system of this document- Annex-25.1.1.

Suitable finish paint of required DFT shall be applied as specified in the Paint system of this document- Annex-25.1.1. The undercoat and finish coat shall be of different tint to distinguish



the same from finish paint. All paints shall be of approved brand and shade as per the Owner's requirement.

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

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

10.0.0 PAINT MATERIALS

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

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

11.0.0 STORAGE

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

12.0.0 APPLICATION

Health and safety of work

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

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

Methods

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

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



ANNEX-25.1.1

STANDARD FINAL COLOUR OF EQUIPMENT AND PIPING

1.0.0 STANDARD COLOUR CODE FOR MECHANICAL EQUIPMENT

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



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

Notes:

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

**2.0.0 STANDARD COLOUR CODE FOR ELECTRICAL EQUIPMENT**

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

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



3.0.0 COLOUR CODING FOR IDENTIFICATION OF PIPELINES USED IN THERMAL POWER PLANTS

Sl.No	Medium	Ground Shade		Band Shade		Remarks
		Color	Color No. as per IS:5	Color	Color No. as per IS:5	
1	Water system					
a)	Untreated or raw / service	Sea green	217	White	-	White is not included in IS - 5-2007
b)	Treated/dematerialized	Sea green	217	Light orange	557	
c)	Condensate	Sea green	217	Light brown	410	
d)	Potable water	Sea green	217	French blue	166	
e)	RO water	Sea green	217	Light orange	557	
f)	Service & clarified water	Sea green	217	French blue	166	
2	Steam system					
a)	Auxiliary steam	Aluminum	-	Signal red	537	with aluminum
3	Air system					
a)	Instrument	Sky Blue	101	White	-	White not included in IS- 5 - 2007
b)	Service/Plant	Sky Blue	101	White	-	
c)	Vacuum pipes	Sky Blue	101	Black	-	
4	Gas system					
a)	Hydrogen	Canary yellow	309	Signal red	537	White is not included in
b)	Chlorine	Canary yellow	309	Dark violet	796	
c)	Carbon dioxide	Canary yellow	309	Light grey	631	
d)	Oxygen	Canary yellow	309	White	218	
5	Oils					



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

4.0.0 COLOUR CODE FOR STRUCTURAL STEEL

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



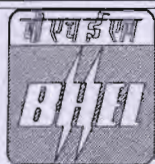
Notes

1. Covering capacity and DFT depends on method of application. Covering capacity specified above is theoretical. Allowing the losses during application, min specified DFT shall be maintained.
2. All primers and finish coats shall be cold cured and air dried unless otherwise specified.
3. All paints shall conform to relevant Indian Standard and shall be applied in accordance with manufacturer's instructions for surface preparation, intervals, curing and application. The surface preparation, quality and workmanship shall be ensured.
4. Technical data sheets for all paints shall be supplied at the time of submission of quotations.
5. In case of use of epoxy tie coat, manufacturer shall demonstrate satisfactory test for inter coat adhesion. In case of limited availability of epoxy tie coat, alternate system may be used taking into consideration the service requirement of the system.
6. Contractor will submit the final colour shade for all equipments & piping under his scope for final approval by client / consultant.



TITLE : 2X660 MW UDANGUDI STPP	SPECIFICATION NO. PE-TS-435-168-A001	
	SECTION : I	
	SUB-SECTION: IA	
	REV. NO. 01	
TECHNICAL SPECIFICATION FOR HYDROGEN GENERATION PLANT		

ANNEXURE VI: MANDATORY SPARES LIST



TITLE :
2X660 MW UDANGUDI STPP

**TECHNICAL SPECIFICATION FOR HYDROGEN
GENERATION PLANT**

**SPECIFICATION NO. PE-TS-435-168-
A001**

SECTION : I

SUB-SECTION: IA

REV. NO. 01

ANNEXURE VI: MANDATORY SPARES LIST

S.no	Equipment	Unit	Quantity
A	Compressor		
1.	Complete internals for assembling of 1 compressor except casing	Set	1
2	Filter elements	Set	1 set each for pre & after filters
3	Tube nest for inter cooler	No	1
4	Tube nest for after cooler	No	1
5	Valves in compressor house	Set	1 set of each type
6	Auto moisture trap	Set	2
B.	Horizontal centrifugal pump for each type		
1.	Bearings	Set	2
2.	Thrust pads	Set	1
3.	Shaft sleeves	Set	1
4.	Fasteners	Set	1 set reqd for assembling one pump
	LT Motors of each type and rating		
1.	Driving end bearing	Set	1
2.	Non driving end bearing	Set	1
3.	Terminal block	Nos.	10
4.	Motors of each type & rating	Nos.	10% of installed quantity or 1 –no is higher whichever is higher
C.	PLC based control system		
1.	Complete set including integral microprocessor based control system along with system & application software and special cables		10% or 1 set whichever is more
2.	UPS Electronic cards IGBT Modules of each type MCBs of each type		10% or 2 nos. min. whichever is more
3.	Digital Indicators of each model, type & range (including relevant digital indicators of electrical system)		10% or 2 nos. min. whichever is more
4.	Card Reader		10% or 2 nos. min. whichever is more
5.	Cooling fans in control panels		10% or 2 nos. min. whichever is more
	LVS Lamps		24
D.	Cables		
1.	Pre-fabricated cable of each type.		10% of installed quantity
2.	Pre-fabricated cable connector of each type		10% or 1 no. of each type and model, whichever is more.
3.	Other cables		5% of each type, pair and size of actual installed quantity
E.	Temperature elements		
1.	RTD's of each type and length(with head assembly, terminal block & nipple)		10% or 2 nos. of each type and length, whichever is more
2.	Thermocouples of each type like K-type, R-type, metal etc. (with head assembly, terminal block & nipple)		10% or 2 nos. of each type and length whichever is more
3.	Temperature transmitters		10% of each type and model
4.	Thermowell for application like mill outlet temperature and SH/RH/Eco/ flue gas temp. in furnace		10% or 2 nos. of each type and length whichever is more.
5.	Local Indicators like temperature gauges, pressure gauges, differential pressure gauges, flow gauges,		10% or 2 no. of each make, model and type whichever is more and for



TITLE : 2X660 MW UDANGUDI STPP	SPECIFICATION NO. PE-TS-435-168-A001	
	SECTION : I	
	SUB-SECTION: IA	
	REV. NO. 01	

ANNEXURE VI: MANDATORY SPARES LIST

	flow meters etc.,	each plant (to be divided to various ranges in proportion to main of all make, model, type population)
6.	Process Actuated Switch Devices Includes all types of Pressure, differential pressure, flow, temperature, differential temperature, level switch Devices	5% or 1 no. of each type and model whichever is more
7.	PD Type Flow Transmitters	1 no. of each type and model
8.	Transmitter Electronic Unit	1 no. Of each type
9.	Electronic modules for Silica, Phosphate, Dissolved Oxygen, Hydrazine analysers	1 no. Of each type
F.	Power Supply System – 24 VDC	
1.	Silicon controlled thyristors, diodes, power transistors	100%(1 Lot)
2.	Capacitors	1 set
3.	Filter regulators	20% of each model or 2 nos. whichever is more.
G.	CONTROL VALVES, ACTUATORS & ACCESSORIES	
1.	Pneumatic and electro-hydraulic actuator assembly	10% or 1 no. of each type, model and rating, whichever is more
2.	Valve trim (including cage, plug, stem, seat rings, guide bushings etc.)	1 set for each type of control valve.
3.	Diaphragms, O' rings, seals etc. of all types, make etc.	200%
4.	Pressure Gauges of all types, make, rating etc.	10% or 2 nos. of each type whichever is more.
5.	Solenoid valves (if applicable)	10% or 2 nos. of each type whichever is more.
6.	Positioner units (complete unit)	10% or 1 no. of each type whichever is more.
7.	Pneumatic air-filter/Regulator of each type, make, rating etc.	10% or 2 nos., whichever is more
8.	Position feedback transmitters	10% or 2 nos. of each type
9.	Torque and limit switch assembly	10% or 2 nos. of each type,
10.	Air lock relays	10% or 2 nos. of each type, whichever is more

Note:-

- In case spares indicated in the list are not applicable to the particular design offered by the bidder, the bidder should offer spares applicable to offered design with quantities generally in line with the approach followed as per the above list.
- One set corresponds to actual quantity of components and devices as installed for the equipment at Site



TITLE :

2X660 MW UDANGUDI STPP

SPECIFICATION NO. PE-TS-435-168-A001

SECTION : I

**TECHNICAL SPECIFICATION FOR HYDROGEN
GENERATION PLANT**

SUB-SECTION: IA

REV. NO. 00

ANNEXURE VII: DRAWING/DOCUMENTS SUBMISSION SCHEDULE

S.NO.	DRAWING NO	DRG TITLE	APPROVAL CAT	SCH WEEK AFTER LOI	SIZE
1	PE-VO-405-168-A001	GENERAL ARRANGEMENT LAYOUT, FOUNDATION DETAILS AND FLOOR DRAIN DETAILS OF HYDROGEN GENERATION PLANT	A	4	A1
2	PE-VO-405-168-A002	PIPING & INSTRUMENTATION DIAGRAM WITH I/O LIST OF HYDROGEN GENERATION PLANT	A	4	A3
3	PE-VO-405-168-A003	DESIGN & CONTROL PHILOSOPHY OF H2 PLANT ALONG WITH INTERLOCK AND LOGIC DIAGRAM	A	6	A4
4	PE-VO-405-168-A005	GA FOR COMPRESSORS WITH MOTOR OF HYDROGEN GENERATION PLANT	A	10	A4
5	PE-VO-405-168-A006	DATA SHEET, GA,& CIRCUIT DIAGRAM OF RECTIFIER TRANSFORMER OF HYDROGEN GENERATION PLANT	A	6	A4
6	PE-VO-405-168-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-405-168-A008	GA OF FEED WATER, KOH TANK OF HYDROGEN GENERATION PLANT	A	6	A4
8	PE-VO-405-168-A009	GA OF H2 MANIFOLD OF HYDROGEN GENERATION PLANT	A	6	A4
9	PE-VO-405-168-A010	GA N2 PURGING MANIFOLD OF HYDROGEN GENERATION PLANT	A	6	A4
10	PE-VO-405-168-A011	GA HYDROGEN & NITROGEN CYLINDER OF HYDROGEN GENERATION PLANT	A	6	A4
11	PE-VO-405-168-A012	GA CYLINDER TEST STATION OF HYDROGEN GENERATION PLANT	A	6	A4
12	PE-VO-405-168-A013	GA VACUUM PUMP OF HYDROGEN GENERATION PLANT	A	6	A4

13	PE-VO-405-168-A014	PIPING INSTALLATION AND PIPING LAYOUT DRAWING	A	10	A1
14	PE-VO-405-168-A015	HYDROGEN PLANT INTER-LOCK LOGIC DIAGRAM & CONTROL SCHEMES (BLOCK LOGIC)	A	12	A4
15	PE-VO-405-168-A016	PLC INPUT / OUTPUT SIGNAL LIST, POWER SUPPLY WIRING DIAGRAM	A	12	A4
16	PE-VO-405-168-A018	H2 PLANT WIRING DIAGRAM	A	12	A3
17	PE-VO-405-168-A019	DATASHEET OF COMPRESSOR OF HYDROGEN GENERATION PLANT	A	10	A4
18	PE-VO-405-168-A020	DATASHEET OF INSTRUMENTS & ANALYSERS OF HYDROGEN GENERATION PLANT	A	10	A4
19	PE-VO-405-168-A021	DATASHEET OF MOTORS OF HYDROGEN GENERATION PLANT	A	10	A4
20	PE-VO-405-168-A023	CABLE SCHEDULE & INTERCONNECTION OF HYDROGEN GENERATION PLANT	A	16	A3
21	PE-VO-405-168-A026	INSTRUMENT SCHEDULE OF HYDROGEN GENERATION PLANT	I	10	A4
22	PE-VO-405-168-A030	ELECTRICAL LOAD DATA OF HYDROGEN GENERATION PLANT	I	10	A4
23	PE-VO-405-168-A031	PG TEST PROCEDURE OF HYDROGEN GENERATION PLANT	A	20	A4
24	PE-VO-405-168-A032	O&M MANUAL OF HYDROGEN GENERATION PLANT	A	24	A4
25	PE-VO-405-168-A033	SUB VENDOR LIST & INSPECTION CRITERIA OF HYDROGEN GENERATION PLANT	A	4	A4
26	PE-VO-405-168-A034	GA OF ELECTROLYSER AND PURIFICATION SKID.	A	6	A4
27	PE-VO-405-168-A036	DRIVE LIST/SOLENOID/ACTUATOR VALVE LIST WITH LOCATION DATA	I	10	A3
28	PE-VO-405-168-A037	LIST OF SIGNAL EXCHANGE WITH DDCMIS (BOTH HARDWIRED & SERIAL INTERFACE IN BHEL FORMAT)	A	10	A3

29	PE-VO-405-168-A038	PROCESS GRAPHIC MANUSCRIPTS PLC, PROCESS GRAPHIC MANUSCRIPTS FOR DDCMIS	A	10	A1
30	PE-VO-405-168-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-405-168-A040	CABLE TRENCH/ TRAY LAYOUT AND EARTHING DETAILS FOR HYDROGEN GENERATION PLANT WITH DETAILS OF CABLE TRAY ACCESSORIES.	A	12	A1
32	PE-VO-405-168-A041	QAP FOR COMPRESSORS WITH MOTOR OF HYDROGEN GENERATION PLANT	A	10	A4
33	PE-VO-405-168-A042	QAP FOR PLC OF HYDROGEN GENERATION PLANT	A	12	A4
34	PE-VO-405-168-A043	QAP OF RECTIFIER OF HYDROGEN GENERATION PLANT	A	6	A4
35	PE-VO-405-168-A046	QAP OF ELECTROLYSER AND PURIFICATION SKID	A	6	A4
36	PE-VO-405-168-A048	QAP FOR HYDROGEN GEN PLANT (BALANCE OF ITEM)	A	10	A4
37	PE-VO-405-168-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.
4. Bidder to note that the successful bidder, during detail engineering, will submit the drg/doc through web based Document Management System in addition to hard copies to be submitted as per the Annexure IV of this specification. Bidder would be provided access to the DMS for drg/doc approval and adequate training for the same. Detailed methodology would be finalized during the kick-off meeting. Bidder to ensure following at their end
 - Internet explorer version – Minimum Internet Explorer 7
 - Internet speed – 2 mbps (Minimum preferred)
 - Pop ups from our external DMS IP (124.124.36.198) should not be blocked
 - Vendor's Internal proxy setting should not block DMS application's link (<http://124.124.36.198/wrenchwebaccess/login.aspx>)
 - DMS user manuals to be used by BHEL PEM vendors for uploading, viewing, revising, commenting and tracking documents on PEM's DMS have been uploaded on PEM internet website (www.bhelpem.com) under the Vendor session.
 - For quick access bidder may refer the link <http://bhelpem.com/DMSManuals/DMSManuals.html>

ANNEXURE VIII: 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



TITLE : 2X660 MW UDANGUDI STPP	SPECIFICATION NO. PE-TS-435-168-A001	
	SECTION : I	
	SUB-SECTION: IA	
	REV. NO. 00	
TECHNICAL SPECIFICATION FOR HYDROGEN GENERATION PLANT		

ANNEXURE IX: 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.



TITLE :

2X660 MW UDANGUDI STPP

SPECIFICATION NO. PE-TS-435-168-A001

SECTION : I

**TECHNICAL SPECIFICATION FOR HYDROGEN
GENERATION PLANT**

SUB-SECTION: IA

REV. NO. 00

ANNEXURE X: FORMAT FOR OPERATION AND MAINTENANCE MANUAL



TITLE : 2X660 MW UDANGUDI STPP	SPECIFICATION NO. PE-TS-435-168-A001	
	SECTION : I	
	SUB-SECTION: IA	
	REV. NO. 00	

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

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
		Yes	No	Not Applicable	
	1.1				
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)				



TITLE :

2X660 MW UDANGUDI STPP

SPECIFICATION NO. PE-TS-435-168-A001

SECTION : I

TECHNICAL SPECIFICATION FOR HYDROGEN GENERATION PLANT

SUB-SECTION: IA

REV. NO. 00

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 Maintenance and Overhaul. Storage/ handling requirement of consumables/self-life.				
6.6	List of lubricants with their Indian equivalent,				



TITLE : 2X660 MW UDANGUDI STPP	SPECIFICATION NO. PE-TS-435-168-A001	
	SECTION : I	
	SUB-SECTION: IA	
	REV. NO. 00	

	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				



TITLE :

2X660 MW UDANGUDI STPP

SPECIFICATION NO. PE-TS-435-168-A001

SECTION : I

**TECHNICAL SPECIFICATION FOR HYDROGEN
GENERATION PLANT**

SUB-SECTION: IA

REV. NO. 00

ANNEXURE XI: SITE STORAGE AND PRESERVATION



TITLE : 2X660 MW UDANGUDI STPP	SPECIFICATION NO. PE-TS-435-168-A001	
	SECTION : I	
	SUB-SECTION: IA	
	REV. NO. 00	
TECHNICAL SPECIFICATION FOR HYDROGEN GENERATION PLANT		

CONTENT

- 1 SCOPE OF THE DOCUMENT
- 2 PURPOSE OF STORAGE & PRESERVATION
- 3 MEASURES TO BE TAKEN FOR STORAGE AND PRESERVATION
 - a) GENERAL STORAGE REQUIREMENTS
 - b) GENERAL PRESERVATION REQUIREMENTS
 - c) GENERAL INSPECTION REQUIREMENTS
- 4 TYPE OF STORAGE FOR VARIOUS EQUIPMENT
5. CONCLUSION
6. STACKING ARRANGEMENT FOR PLATES AND STRUCTURAL STEEL



TITLE : 2X660 MW UDANGUDI STPP	SPECIFICATION NO. PE-TS-435-168-A001	
	SECTION : I	
	SUB-SECTION: IA	
	REV. NO. 00	
TECHNICAL SPECIFICATION FOR HYDROGEN GENERATION PLANT		

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,



TITLE : 2X660 MW UDANGUDI STPP	SPECIFICATION NO. PE-TS-435-168-A001	
	SECTION : I	
	TECHNICAL SPECIFICATION FOR HYDROGEN GENERATION PLANT	
	SUB-SECTION: IA	
	REV. NO. 00	

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.



TITLE : 2X660 MW UDANGUDI STPP	SPECIFICATION NO. PE-TS-435-168-A001	
	SECTION : I	
	SUB-SECTION: IA	
	REV. NO. 00	
TECHNICAL SPECIFICATION FOR HYDROGEN GENERATION PLANT		

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.



TITLE : 2X660 MW UDANGUDI STPP	SPECIFICATION NO. PE-TS-435-168-A001	
	SECTION : I	
	SUB-SECTION: IA	
	REV. NO. 00	
TECHNICAL SPECIFICATION FOR HYDROGEN GENERATION PLANT		

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.





TITLE : 2X660 MW UDANGUDI STPP	SPECIFICATION NO. PE-TS-435-168-A001	
	SECTION : I	
	SUB-SECTION: IA	
	REV. NO. 00	
TECHNICAL SPECIFICATION FOR HYDROGEN GENERATION PLANT		



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.





TITLE : 2X660 MW UDANGUDI STPP	SPECIFICATION NO. PE-TS-435-168-A001	
	SECTION : I	
	SUB-SECTION: IA	
	REV. NO. 00	
TECHNICAL SPECIFICATION FOR HYDROGEN GENERATION PLANT		

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



TITLE :
2X660 MW UDANGUDI STPP

SPECIFICATION NO. PE-TS-435-168-A001

SECTION : I

**TECHNICAL SPECIFICATION FOR HYDROGEN
GENERATION PLANT**

SUB-SECTION: IA

REV. NO. 00

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	



TITLE : 2X660 MW UDANGUDI STPP	SPECIFICATION NO. PE-TS-435-168-A001	
	SECTION : I	
	SUB-SECTION: IA	
	REV. NO. 00	

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 ₂ SO ₄)	Store in canes/ storage tank in dyke area	Date of production/ leakage/fumes	hazardous chemical



TITLE :
2X660 MW UDANGUDI STPP

SPECIFICATION NO. PE-TS-435-168-A001

SECTION : I

**TECHNICAL SPECIFICATION FOR HYDROGEN
GENERATION PLANT**

SUB-SECTION: IA

REV. NO. 00

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	



TITLE : 2X660 MW UDANGUDI STPP	SPECIFICATION NO. PE-TS-435-168-A001	
	SECTION : I	
	SUB-SECTION: IA	
	REV. NO. 00	

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.		



TITLE : 2X660 MW UDANGUDI STPP	SPECIFICATION NO. PE-TS-435-168-A001	
	SECTION : I	
	SUB-SECTION: IA	
	REV. NO. 00	
TECHNICAL SPECIFICATION FOR HYDROGEN GENERATION PLANT		

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.



TITLE : 2X660 MW UDANGUDI STPP	SPECIFICATION NO. PE-TS-435-168-A001	
	SECTION : I	
	SUB-SECTION: IA	
	REV. NO. 00	

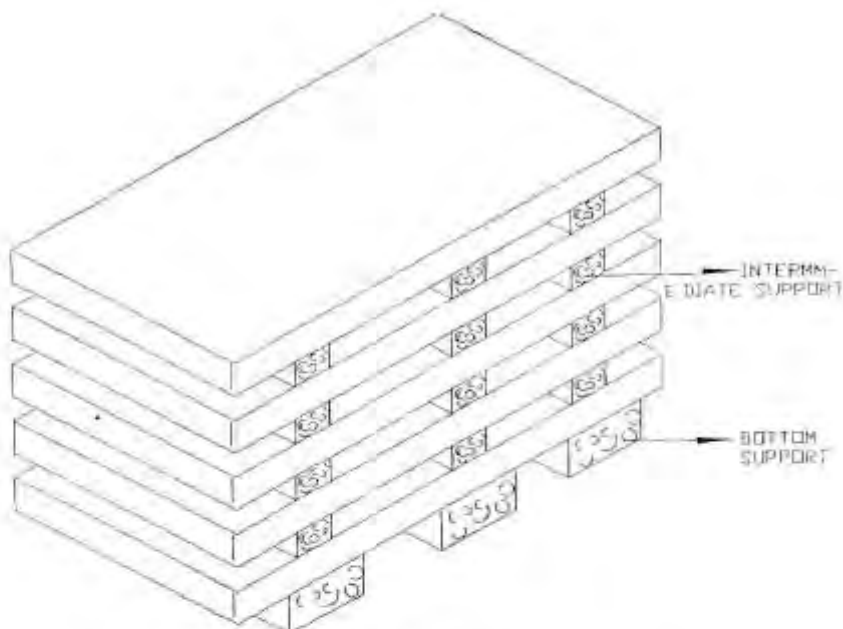


Figure – 1 – PLATE STACKING ARRANGEMENT

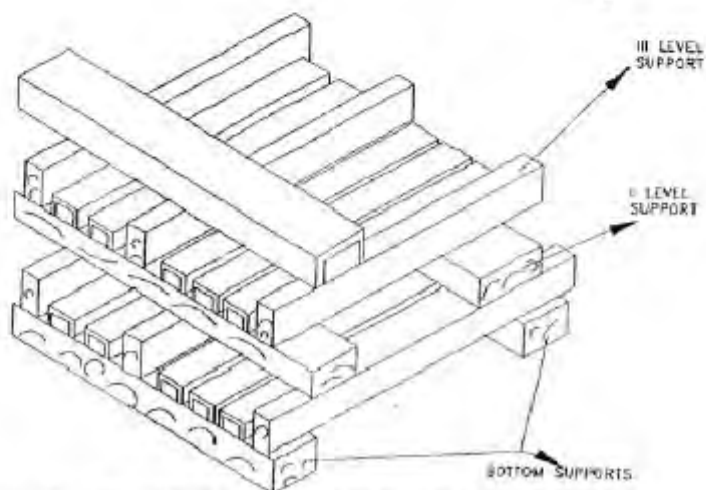


Figure – 2 – STRUCTURAL STEEL STACKING ARRANGEMENT



TITLE :
2X660 MW UDANGUDI STPP

SPECIFICATION NO. PE-TS-435-168-A001

SECTION : I

**TECHNICAL SPECIFICATION FOR HYDROGEN
GENERATION PLANT**

SUB-SECTION: IA

REV. NO. 00

ANNEXURE XII -GUARANTEED PERFORMANCE DATA

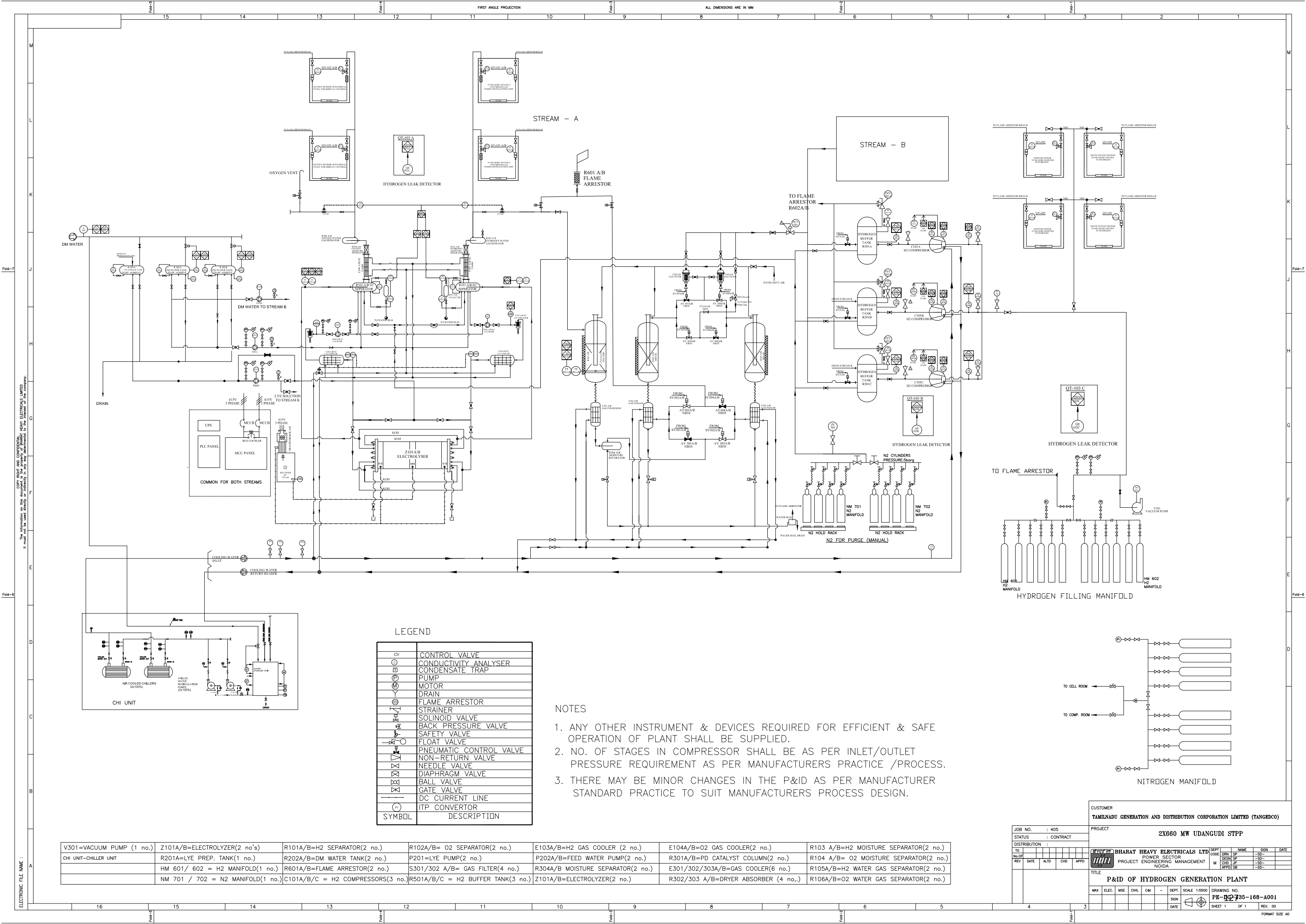
S.no.	Description	Parameter
1.	Hydrogen generation plant minimum capacity (Nm ³ /hr.)	24
2.	Number of streams (2X50%)	2
3.	Minimum Capacity of each streams/electrolyser (Nm ³ /hr.)	12
4.	Hydrogen purity (%) at gas manifolds	99.998
5.	Moisture content in hydrogen- gm/m ³ (max)	0.05
6.	Design delivery pressure at its rated duty point in Kg/cm ² (g)	150
7.	Dew Point	(-70)
8.	Minimum capacity of each compressor (Nm ³ /hr.)	125% of rated Capacity of each streams (Nm ³ /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).



TITLE : 2X660 MW UDANGUDI STPP	SPECIFICATION NO. PE-TS-435-168-A001	
	SECTION : I	
	SUB-SECTION: IA	
	REV. NO. 00	

TECHNICAL SPECIFICATION FOR HYDROGEN
GENERATION PLANT

P&ID & EQUIPMENT LAYOUT



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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.)
CHI UNIT-CHILLER UNIT	R201A=LYE PREP. TANK(1 no.)	R202A/B=DM 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.)

JOB NO.	: 405
STATUS	: CONTRACT
DISTRIBUTION	:
TO	
NO OF	
REV	DATE
ALD	
CHD	
APPD	

CUSTOMER
TAMILNADU GENERATION AND DISTRIBUTION CORPORATION LIMITED (TANGEDCO)

PROJECT
2X660 MW UDANGUDI STPP

DEPT

NAME

SIGN

DATE

DESIGN

SP

NO

DATE

CHD

SP

NO

DATE

APPD

SP

NO

DATE

BHARAT HEAVY ELECTRICALS LTD

POWER SECTOR

PROJECT ENGINEERING MANAGEMENT

Noida

TITLE
P&ID OF HYDROGEN GENERATION PLANT

MAX

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MSE

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DEPT.

SCALE

1:5500

DRAWING NO.

PE-102-735-168-A001

SHEET 1

OF 1

REV. 00

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.



1. All dimension are in mm and levels are in meter. unless otherwise specified.
2. This drawing shall be read in line with terms & conditions of the contract.
3. Inverted roof beams shall be considered in H2 building
4. H2 gas will be vented at height of 1 mtr from top of building.
5. 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.
6. Quantity of AC units shown in indicative only.
7. All ventilation wall opening are as per hydrogen generation plant GA drawing.
8. All light fittings/fixtures, motors, starters/switches or any other electrical/electronic equipment shall be flame proof duly approved by PESO suitable for installation in zone 1 of gas group II-C.
9. "EL 0.0M corresponding to RL (+)3.80M Which is FFL of TG building.
10. Beams shall be in same face of walls.
- 11.Reference document of Cable vault is PE-DG-435-100-E053
- 13.The first fill of the lye shall be provided by vendor.

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 H_2 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.

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

TITLE	EQUIPMENT LAYOUT OF H2 GENERATION PLANT

						DEPT.	SCALE: NTS	DRAWING NO.	
						SIGN		PE-V0-435-168-A002	
						DATE		SHEET 02 OF 04	
								REV. 05	

THIS PART NOT IN HYDROGEN GENERATION PLANT PACKAGE

349.20E
304.69N

393.08E
304.69N

GAS CYLINDER STORAGE SHED

349.20E
256.50N

393.08E
256.50N

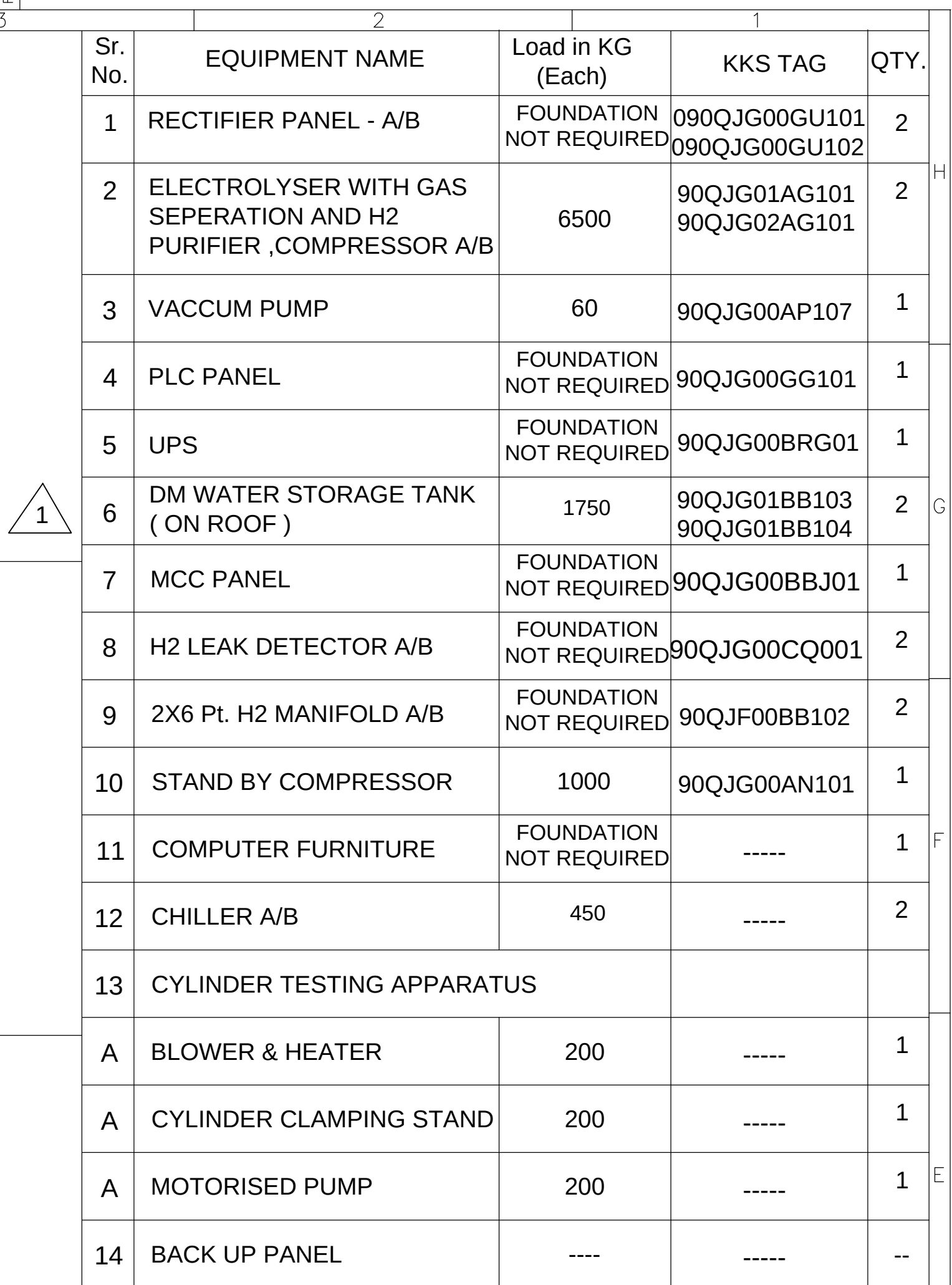
368.50E
255.50N

CONTINUATION DWG.
15-GP-114-330-4059

1. PE-DG-435-100-M008-R1 :- PLOT PLAN.
2. PE-V0-435-168-A015 :- GA and datasheet of Electrolyser and purification skid.
3. PE-V0-435-168-A011 :- Data sheet and GA for Compressors with motor OF HYDROGEN GENERATION PLANT.
4. PE-V0-435-168-A020 :- Data Sheet, GA, and wiring details for PLC panel, BOM, PLC configuration diagram OF HYDROGEN GENERATION PLANT.
5. PE-V0-435-168-A032 :- Data sheet, GA and Wiring Diagram of UPS OF HYDROGEN GENERATION PLANT.
6. PE-V0-435-168-A016 :- GA of H2 and N2 manifold, cylinders and cylinder testing apparatus.
7. PE-V0-435-168-A017 :- Piping Layout for Hydrogen Generation Plant.
8. PE-V0-435-168-A030 :- Cable Trench/ Tray layout for Hydrogen Generation Plant with details of cable tray accessories.

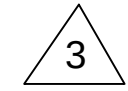
JOB NO.	435							
STATUS	CONTRACT							
DISTRIBUTION								
TO								
No. OF								

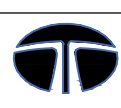
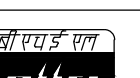
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	10					9					8					7					6					5					4					3										



1. TOTAL 5 NOS HOOKS (1 ABOVE EACH ELECTROLYZER AND 1 ABOVE EACH COMPRESSOR).

2. WE ARE PROVIDING THE CHAIN PULLEY WITH HOOK ARRANGEMENT FOR LIFTING THE COMPONENTS WEIGHT IS LESS THAN 250 KG FOR LOCAL MAINTAINANCE. HENCE MONORAIL IS NOT REQUIRED.



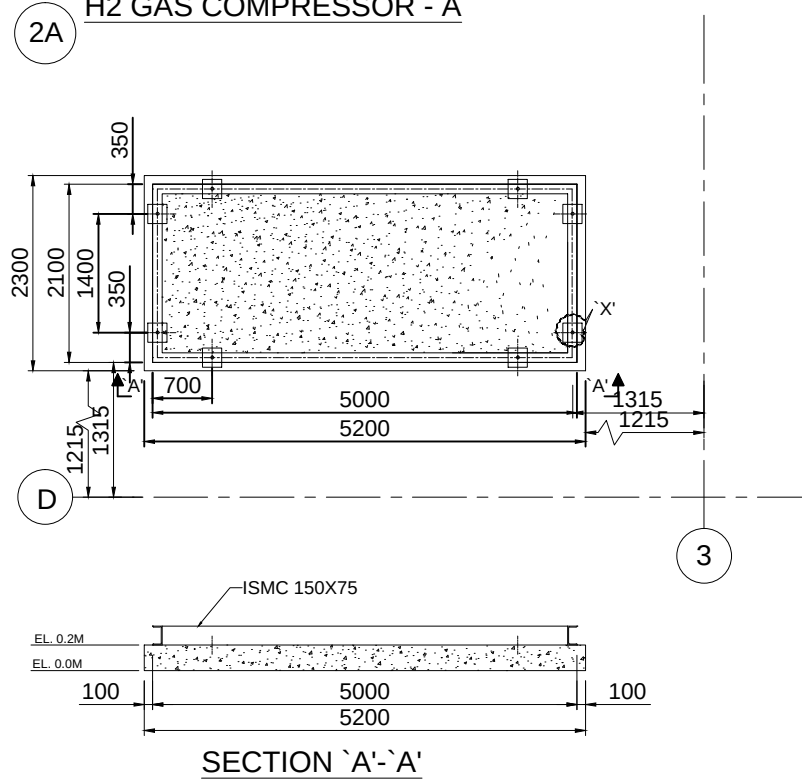
 CUSTOMER	TAMILNADU GENERATION & DISTRIBUTION CORPORATION LIMITED TANGEDCO HEAD QUARTERS, 1ST FLOOR, NEW EB QTRS., 144,Anna Salai,Chennai-600002.																			
 CONSULTANT NAME	TATA CONSULTING ENGINEERS LIMITED BENGALURU																			
PROJECT NAME	2x660 MW UDANGUDI TPP-STAGE I																			
 Maharatna Company	BHARAT HEAVY ELECTRICALS LTD POWER SECTOR PROJECT ENGINEERING MANAGEMENT NOIDA		<table><tr><th>NAME</th><th>SIGN</th><th>DATE</th></tr><tr><td>DRN SK</td><td></td><td>29.03.2022</td></tr><tr><td>DESN CSP</td><td></td><td>29.03.2022</td></tr><tr><td>CHD PG</td><td></td><td>29.03.2022</td></tr><tr><td>APPD AKA</td><td></td><td>29.03.2022</td></tr></table>	NAME	SIGN	DATE	DRN SK		29.03.2022	DESN CSP		29.03.2022	CHD PG		29.03.2022	APPD AKA		29.03.2022		
NAME	SIGN	DATE																		
DRN SK		29.03.2022																		
DESN CSP		29.03.2022																		
CHD PG		29.03.2022																		
APPD AKA		29.03.2022																		

TITLE EQUIPMENT LAYOUT OF H2 GENERATION PLANT

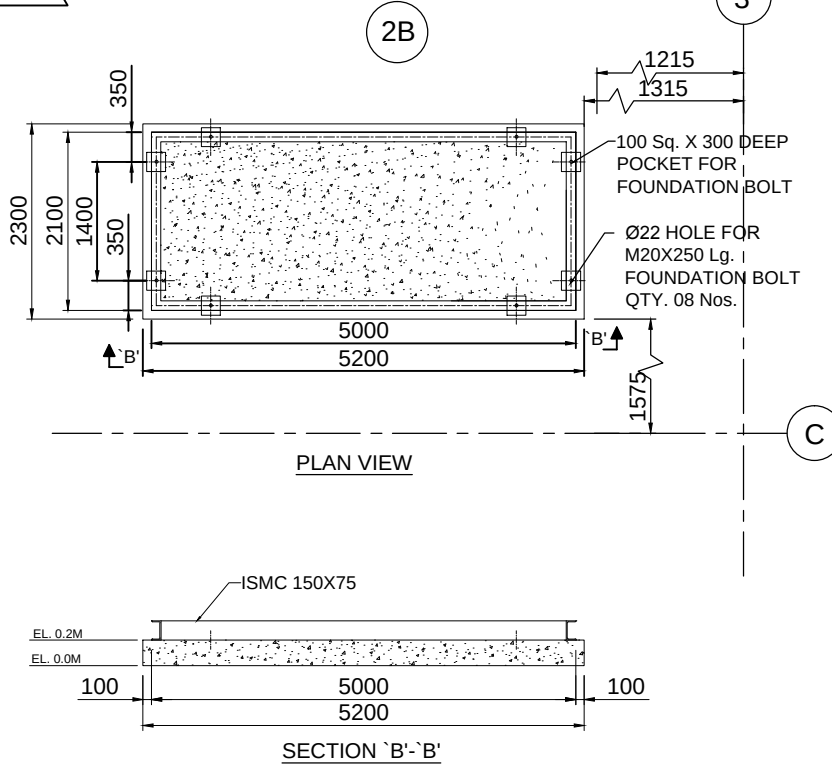
						DEPT.	SCALE: NTS	DRAWING NO. PE-V0-435-168-A002	
						SIGN DATE		SHEET 03 OF 04	REV. 05

GAS CYLINDER STORAGE SHED

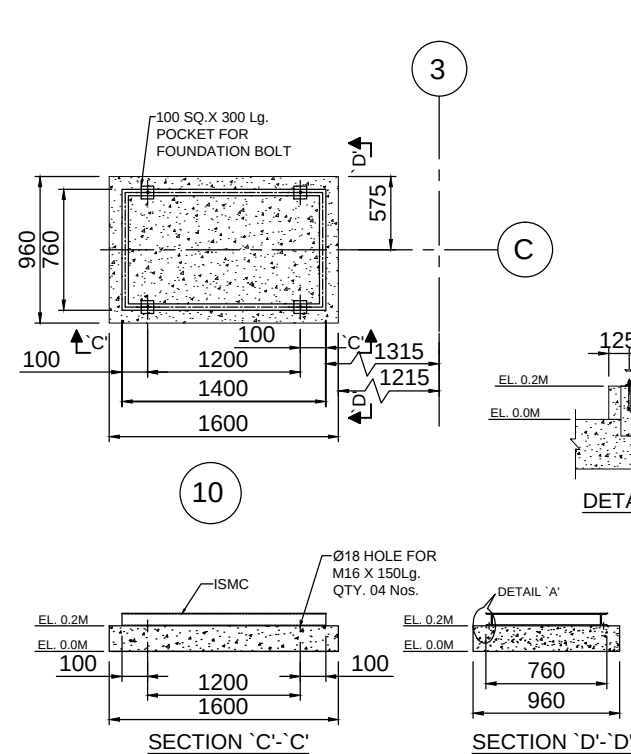
ELECTROLYSER GAS DRYER SKID (PE-V0-435-168-A015)
H2 GAS COMPRESSOR - A



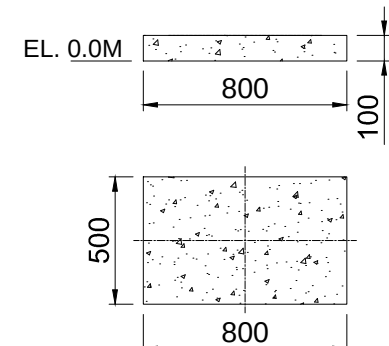
ELECTROLYSER GAS DRYER SKID (PE-V0-435-168-A015)
H2 GAS COMPRESSOR - B (3)



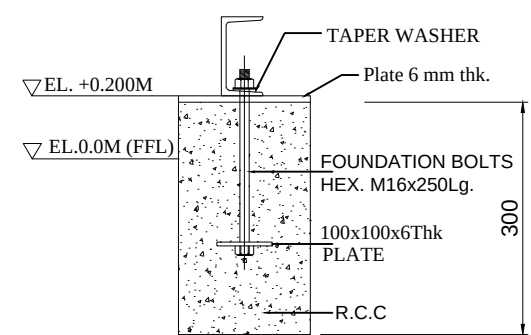
H2 GAS COMPRESSOR -C



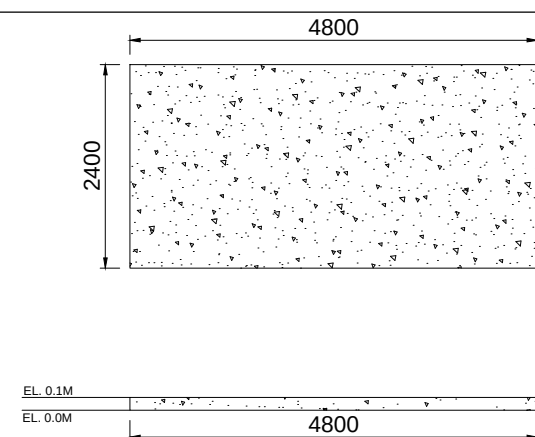
PEDESTAL FOR MOTORISED PUMP



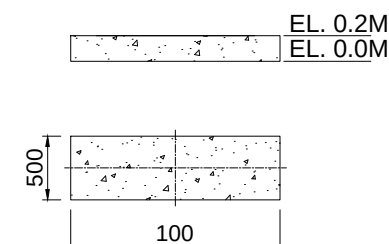
DETAIL 'X'
POCKET DETAIL
100 x 100 x 300mm DEPTH
(TYP.)



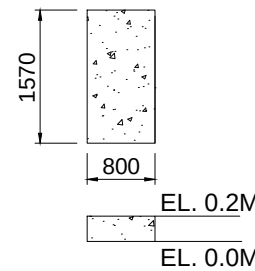
PEDESTAL FOR
DM WATER STORAGE
TANK



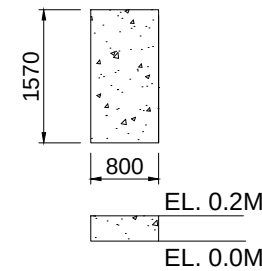
PEDESTAL FOR
BLOWER & HEATER



PEDESTAL
FOR CHILLER
UNIT A



PEDESTAL
FOR CHILLER
UNIT B



CUSTOMER 	TAMILNADU GENERATION & DISTRIBUTION CORPORATION LIMITED TANGEDCO HEAD QUARTERS, 1ST FLOOR, NEW BB QTRS., 144,Anna Salai,Chennai-600002.						
CONSULTANT NAME			TATA CONSULTING ENGINEERS LIMITED BENGALURU				
PROJECT NAME	2x660 MW UDANGUDI TPP-STAGE I						
 Maharatna Company	BHARAT HEAVY ELECTRICALS LTD POWER SECTOR PROJECT ENGINEERING MANAGEMENT NOIDA		DRN DESN CHD APPD	NAME SK CSP PG AKA	SIGN	DATE 29.03.2022 29.03.2022 29.03.2022 29.03.2022	

TITLE										EQUIPMENT LAYOUT OF H2 GENERATION PLANT									
						DEPT.	SCALE: NTS			DRAWING NO.									
										PE-V0-435-168-A002									
						SIGN DATE				SHEET 04 OF 04					REV. 05				

	TITLE : 2X660 MW UDANGUDI STPP		SPECIFICATION NO. PE-TS-435-168-A001	
	TECHNICAL SPECIFICATION FOR HYDROGEN GENERATION PLANT		SECTION : I	
			SUB-SECTION:IB	
			REV. NO. 00	

SUB-SECTION IB - SPECIFIC TECHNICAL REQUIREMENTS (ELECTRICAL)

	TITLE: ELECTRICAL EQUIPMENT SPECIFICATION FOR HYDROGEN GENERATION PLANT 2 X 660 MW UDANGUDI STPP STAGE-I	SPECIFICATION NO.
		VOLUME NO. : II-B
		SECTION: C
		REV NO.: 00 DATE: 16/01/2019
		SHEET: OF

SPECIFIC TECHNICAL REQUIREMENTS:

1.0 EQUIPMENT & SERVICES TO BE PROVIDED BY BIDDER:

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

- a) Services and Equipment as per "Electrical Scope between BHEL and Vendor".
- b) Any item/work either supply of equipment or erection material which have not been specifically mentioned but are necessary to complete the work for trouble free and efficient operation of the plant shall be deemed to be included within the scope of this specification. The bidder without any extra charge shall provide the same.
- c) Supply of mandatory spares as specified in the specifications of mechanical equipments.
- d) Electrical load requirement for HYDROGEN GENERATION PLANT.
- e) All equipment shall be suitable for the power supply fault levels and other climatic conditions mentioned in the enclosed project information.
- f) Bidder to furnish list of makes for each equipment at contract stage, which shall be subject to customer / BHEL approval without any commercial and delivery implications to BHEL.
- g) Various drawings including GA drg, data sheet as per required format, quality plans, calculations, test reports, test certificates, operation and maintenance manuals, characteristic curves, wiring diagrams/schemes etc. shall be furnished as specified at contract stage. All documents shall be subject to customer / BHEL approval without any commercial implications to BHEL.
- h) The sub-vendor list for various electrical items is subject to BHEL/Customer approval without any commercial implications.
- i) Motors shall meet minimum requirement of Electric motor specification.
- j) Purchaser will furnish data sheets to the vendor after award of contract. Vendor shall furnish filled in data sheets meeting the specification requirements.
- k) Vendor to clearly indicate equipment locations and local routing lengths in their cable listing furnished to BHEL.
- l) Cable BOQ worked out based on routing of cable listing provided by the vendor for "both end equipment in vendor's scope" shall be binding to the vendor with +10 % margin to take care of slight variation in routing length & wastages.

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

Refer "Electrical Scope between BHEL and Vendor".

	TITLE:	SPECIFICATION NO.
	ELECTRICAL EQUIPMENT SPECIFICATION FOR HYDROGEN GENERATION PLANT	
	2 X 660 MW UDANGUDI STPP STAGE-I	VOLUME NO. : II-B
		SECTION: C
		REV NO.: 00 DATE: 16/01/2019
		SHEET: OF
3.0 DOCUMENTS TO BE SUBMITTED ALONG WITH BID		
3.1	Bidder shall confirm total compliance to the electrical specification without any deviation from the technical / quality assurance requirements stipulated. In line with this, the bidder as technical offer shall furnish two signed and stamped copies of the following: a) A copy of this sheet “Electrical Equipment Specification for HYDROGEN GENERATION PLANT” and sheet “Electrical Scope between BHEL and Vendor” with bidder’s signature and company stamp. b) Electrical load requirement.	
3.2	No technical submittal such as copies of data sheets, drawings, write-up, quality plans, type test certificates, technical literature, etc., is required during tender stage. Any such submission even if made, shall not be considered as part of offer.	
4.0 LIST OF ENCLOSURES		
4.1	Electrical scope between BHEL & vendor	
4.2	Technical specification – Specification for Electric Motors/Actuators	
4.3	Standard Technical specification – LV Motors	
4.4	Datasheets & quality plan for motors.	
4.5	Load Data Format. (Annexure –II)	
4.6	BHEL Cable listing format (Annexure –III)	

	TITLE : 2X660 MW UDANGUDI STPP	SPECIFICATION NO. PE-TS-435-168-A001	
		SECTION : I	
	TECHNICAL SPECIFICATION FOR HYDROGEN GENERATION PLANT	SUB-SECTION:IB	
		REV. NO. 00	

ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR

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: 2 X 660 MW UDANGUDI STPP STAGE-I

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

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: 2 X 660 MW UDANGUDI STPP STAGE-I

S.NO	DETAILS	SCOPE SUPPLY	SCOPE E&C	REMARKS
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 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 without cost implication.
4. Vendor shall indicate location of Electronic Earth pit in their Civil assignment drawing.



TITLE :
2X660 MW UDANGUDI STPP

SPECIFICATION NO. PE-TS-435-168-
A001

SECTION : I

TECHNICAL SPECIFICATION FOR HYDROGEN
GENERATION PLANT

SUB-SECTION:IB

REV. NO. 00

ELECTRICAL LOAD DATA FORMAT

LOAD TITLE	RATING (KW/A)		UNIT (U)/STN(S)	Nos.		VOLTAGE CODE	FEEDER CODE	EMER. LOAD(Y)	CONT. (C)/INTT.(I)	STARTING TIME <5 SEC(Y)	LOCATION	BOARD NO.	CABLE		BLOCK CABLE DRG. NO.	CONTROL CODE	REMARKS	LOAD No.
	NAME PLATE	MAX.CON T.DEMAN D(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
STREAM 1																		
Rectifier	120 KVA	66 V	S	1	0	D	S	N	C	-	INDOOR	-						
H2 Compressor	5.5 KW	-	S	1	0	D	U	N	C	-	INDOOR	-						
DM Water cum lye pump	1.1 KW	-	S	1	0	D	U	N	I	-	INDOOR	-						
Lye Circulation pump	1.1 KW	-	S	1	0	D	U	N	C	-	INDOOR	-						
Heater (Catalyst column)	2 KW	-	S	1	0	E	S	N	C	-	INDOOR	-						
Dryer Heater	2 KW	-	S	1	0	E	S	N	C	-	INDOOR	-						
Dryer Heater	2 KW	-	S	1	0	E	S	N	C	-	INDOOR	-						
STREAM 2																		
Rectifier	120 KVA	66 V	S	1	0	D	S	N	C	-	INDOOR	-						
H2 Compressor	5.5 KW	-	S	1	0	D	U	N	C	-	INDOOR	-						
DM Water cum lye pump	1.1 KW	-	S	1	0	D	U	N	I	-	INDOOR	-						
Lye Circulation pump	1.1 KW	-	S	1	0	D	U	N	C	-	INDOOR	-						
Heater (Catalyst column)	2 KW	-	S	1	0	E	S	N	C	-	INDOOR	-						
Dryer Heater	2 KW	-	S	1	0	E	S	N	C	-	INDOOR	-						
Dryer Heater	2 KW	-	S	1	0	E	S	N	C	-	INDOOR	-						
COMMON																		
Cylinder testing Apparatus																		
a) Heater	2 KW	-	S	1	0	E	S	N	I	-	INDOOR	-						
b) Pump	3.7 KW	-	S	1	0	D	U	N	I	-	INDOOR	-						
c) Blower	2 KW	-	S	1	0	D	U	N	I	-	INDOOR	-						
Exhaust Fan 1	1.5 KW	-	S	1	0	D	U	N	C	-	INDOOR	-						
Exhaust Fan 2	1.5 KW	-	S	1	0	D	U	N	C	-	INDOOR	-						
Exhaust Fan 3	1 KW	-	S	1	0	D	U	N	C	-	INDOOR	-						
Exhaust Fan 4	1 KW	-	S	1	0	D	U	N	C	-	INDOOR	-						
Exhaust Fan 5	1 KW	-	S	1	0	D	U	N	C	-	INDOOR	-						
Exhaust Fan 6	1 KW	-	S	1	0	D	U	N	C	-	INDOOR	-						
Exhaust Fan 7	1 KW	-	S	1	0	D	U	N	C	-	INDOOR	-						
Vacuum pump	1.11 KW	-	S	1	0	D	U	N	I	-	INDOOR	-						
UPS - Charger 1	5 KW	-	S	1	0	D	S	N	C	-	INDOOR	-						
UPS - Charger 2	5 KW	-	S	1	0	D	S	N	C	-	INDOOR	-						
AC 1	32 AMP	-	S	1	0	D	U	N	C	-	INDOOR	-						
AC 2	32 AMP	-	S	1	0	D	U	N	C	-	INDOOR	-						
Chiller (W)	5 KW	-	S	1	0	D	U	N	C	-	INDOOR	-						
Chiller (S)	5 KW	-	S	1	0	D	U	N	C	-	INDOOR	-						
H2 Compressor (S)	5.5 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 (cc): 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 (CONTACTOR CONTROLLED)																		
	LOAD DATA (ELECTRICAL)		JOB NO.				PROJECT TITLE					ORIGINATING AGENCY			PEM (ELECTRICAL)			
							2 X 660 MW UDANGUDI STPP SUPERCRITICAL THERMAL POWER PROJECT					NAME			DATA FILLED UP ON			
							SYSTEM / S					SIGN.			DATA ENTERED ON			
			DEPTT. / SECTION				ELECTRICAL					SHEET 1 OF 1			REV 00	DE'S SIGN. & DATE		



TITLE :
2X660 MW UDANGUDI STPP

SPECIFICATION NO. PE-TS-435-168-A001

SECTION : I

**TECHNICAL SPECIFICATION FOR HYDROGEN
GENERATION PLANT**

SUB-SECTION:IC

REV. NO. 00

SPECIFIC TECHNICAL REQUIREMENTS (CONTROL & INSTRUMENTATION)

	TITLE : 2X660 MW UDANGUDI STPP	SPECIFICATION NO. PE-TS-435-168-A001	
		SECTION : I	
	TECHNICAL SPECIFICATION FOR HYDROGEN GENERATION PLANT	SUB-SECTION:IC	
		REV. NO. 00	

Specific Technical Requirements (C&I):

1. The controls for Hydrogen Generation Plant shall be realized in PLC based control. The PLC shall be in bidder's scope of supply.
2. The Contractor shall provide complete Instrumentation for control, monitoring and operation of entire Hydrogen Generation Plant. The requirements given are to be read in conjunction with detailed Technical specification enclosed in the specification. Further in case of any discrepancy in the requirement within the same section noted by the bidder in the specification, the same will be brought to the notice of BHEL in the form of pre- bid clarification. In absence of any pre-bid clarification, the more stringent requirement as per interpretation of customer shall prevail without any commercial implication.
3. PLC based control system shall be provided with hot redundant processors, redundant power supply, redundant communication module, redundant communication links etc. All hardware, software, other interfaces, cables and field sensors/instruments/erection hardware shall be in bidder's scope of supply.
4. Plant schematic for monitoring & operation shall be available on OWS, bidder to further submit list of important signal along with applicable schematic for monitoring in DCS.
5. The Hydrogen generation plant shall include all Primary and Secondary Instruments, Local control panels. All instruments required for the package shall be supplied, mounted on the gauge board racks, along with accessories like impulse pipe, fittings & valve manifolds etc.
6. The make/model of various instruments/items/systems shall be as per Customer's approved vendor list. No commercial and delivery implication in this regard shall be acceptable. In case of any conflict and repetition of clauses in the specification, the more stringent requirements among them are to be complied with.
7. Time synchronization of PLC with DCS is to be carried out. Necessary hardware/software (IRIG-B to SNTP convertor etc.) for same at PLC end to be provided by vendor.
8. The UPS system and 24VDC Supply for PLC is in bidder's scope, refer specification for details. PLC and UPS panels shall be placed under air conditioned room.
9. PLC shall be connected to DCS (in BHEL scope of supply) through bidirectional optical fibre cable with MODBUS Protocol for monitoring.
10. Bidder shall provide at least 20% additional spares for each type of modules or 20% over and above the specified number of modules connected to the system bus without any additional hardware or software requirements.
11. Bidder to provide 20% spare relays of each type and rating, mounted and wired in relays cabinets. All contacts of relays shall be terminated in terminal blocks of relay cabinets, additionally in each of the relay cabinets, 20% spare terminal blocks shall be 'provided so that additional relays can be mounted and wired. In case bidder's system employs marshalling cabinet for all inputs, the spare terminals, fully wired up to marshalling cabinets are also to be provided.
12. Wired-in "usable" space for 20% modules in each of the system cabinets for mounting electronic modules shall be provided by the bidder. Empty slots between individual modules/group of modules, kept for ease in maintenance or for heat dissipation requirement as per standard practice of Bidder shall not be considered as wired-in "usable" space for I/O modules. Field Terminal assemblies, PCB/ Connectors (if any in the offered system), corresponding to the I/O modules shall be provided for above-mentioned 20% blank space.
13. 20% spare fully wired I/O channels shall be provided in each I/O module. In addition to this 10% or minimum one no. extra assigned complete spare cards (whichever is more) fully wired mounted in the cabinets for each type of I/O modules shall also to be provided.
14. Each PLC has to be accompanied by LIU (Light interface unit/Fibre patch chord), multi/single mode SC couplers / adapters for connectivity with main plant DCS system (in bidder scope of supply).
15. Soft link communication between PLC & DDCMIS shall be redundant Bi-directional OPC link. Bidder shall include required hardware at PLC end. The protocol between PLC & DDCMIS shall be TCP/IP Ethernet & the maximum communication time for receipt of signal at DDCMIS end should not exceed 2 seconds.
16. Local annunciation panel with minimum amount of conventional hardwired pushbutton stations and indicators shall be provided for the safe shutdown of the system.
17. Hydrogen plant mimic panel with hard wired push buttons for back panel operation to be provided. Hardwired annunciation panel shall be provided for controlling the process.



TITLE :
2X660 MW UDANGUDI STPP

SPECIFICATION NO. PE-TS-435-168-A001

SECTION : I

TECHNICAL SPECIFICATION FOR HYDROGEN GENERATION PLANT

SUB-SECTION:IC

REV. NO. 00

18. For PLC system with 24" LED OWS (2 Nos.) shall also include colour laser printer (A3) & control desk as per PLC configuration diagram. Operator station in local control room shall be provided with the access to monitor the main plant operations. Furniture (chair, table, almira etc) to be provided in local control room by vendor
19. Connected data cable for PLC to remote I/O panels shall be through redundant cable/optic fiber with redundant I/O.
20. VMS (VIBRATION MONITORING SYSTEM) for HT drive shall be in bidder scope, details of the same is included in specification.
21. Training of plant O&M personnel on instrumentation and control systems (including PLC) for effectively operation shall be in bidder's scope.
22. The bidder shall furnish operation & maintenance instruction manual for all the instruments / equipment supplied by them. These shall be sent along with the instruments/equipment. Instruction regarding installation, testing, calibration, repair, maintenance and commissioning of the instruments / equipment six months in advance before the commissioning date of the unit. In addition, the bidder shall furnish instruction manual on operation & maintenance of their overall system. This shall be furnished to the Owner Six (6) months before the commissioning date of the unit.
23. All instruments and control elements shall be terminated on JB/LCP in field and both instrument and JB/LCP are in bidder scope. Number of Junction Boxes shall be sufficient and positioned in the field to minimize local cabling (max 12-15 mtrs) and trunk cable.
24. Bidder to provide earthing pits for local control rooms system. Earthing shall be <0.5 ohms and cabinet earthing shall be <1 ohms. I&C system earth shall be isolated from the plant earth.
25. For cable scope refer to electrical scope between BHEL and vendor defined in electrical specification.
26. Electrical Actuators with integral starter shall be provided for all on/off and inching type valves along with necessary interface units for linking to corresponding Control System as applicable, typical Hook-up diagram of drives is included for reference.
27. The specifications for instruments mentioned in the specification are minimum requirements. The detail specifications shall be finalized during detail engineering.
28. The bidders shall specifically mention any deviation they would like to take on the C&I specification. In absence of only deviation, a No deviation certificate is to be furnished.
29. 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.
30. Bidder to terminate all instrumentation and control elements in junction boxes. Bidder to provide input/output list, drives list, junction box schedule and termination details, recommended control logics / write-up etc. the list of documents to be submitted after award of contract is to be referred by bidder.
31. All the transmitters supplied by Bidder shall be rack mounted. The transmitter racks shall be in Bidder's scope of supply. All transmitters shall be HART compatible.
32. Bidder to perform tests of C&I items/instruments/systems as per Quality plans/type test attached in the specification. However, if any test not specified in the quality plan but specified in specification Tests for I&C equipment included elsewhere in specification will have to perform by Bidder without any cost implication. The make/model of various instruments/items/systems shall be as per customer/BHEL approved vendor list. No commercial and delivery implication in this regard shall be acceptable. In case of any conflict and repetition of clauses in the specification, the more stringent requirements among them are to be complied with.
33. Instrument installation and accessories required for the same shall be in Bidder's scope and shall be submitted after award of contract. However, any instrument/ analyzer installation not covered in the same shall be subject to customer and BHEL approval during detailed engineering.
34. All Temperature sensors shall be Duplex type and temperature transmitter shall be provided for all temperature measurement applications. Bidder to provide temperature transmitter along with compensating cable, JB/Rack & other erection hardware.
35. UPS Power supply shall be provided by bidder.



TITLE :
2X660 MW UDANGUDI STPP

SPECIFICATION NO. PE-TS-435-168-A001

SECTION : I

TECHNICAL SPECIFICATION FOR HYDROGEN GENERATION PLANT

SUB-SECTION: IC

REV. NO. 00

36. Contractor shall furnish Instrument Schedule, I/O list, Drive list, Cable Schedule, Cable interconnection (DCS end terminal details shall be provided to vendor during detail engineering to incorporate in cable interconnection), JB grouping, Annunciation list, SOE list, List of Instruments/devices for HART in BHEL approved format. Also reusable database format like MS Excel, MS Access etc. of these documents shall also be provided by Contractor in BHEL approved format. Soft copy of the formats shall be provided to the successful bidder. All the documentation shall be in English Language.
37. Bidder to perform tests of C&I items/instruments/systems as per Quality plans/type test attached in the specification. However, if any test not specified in the quality plan but specified in specification Tests for I&C equipment included elsewhere in specification will have to perform by Bidder without any cost implication.
38. Instrument installation and accessories required for the same shall be in Bidder's scope and shall be submitted after award of contract. However, any instrument/ analyzer installation not covered in the same shall be subject to customer and BHEL approval during detailed engineering.
39. Interface of MCC, HT SWGR, Solenoid valves, field instruments, Actuators etc. with DDCMIS based control system shall be as per Drive Control Philosophy enclosed in specification.
40. Local control panel, if any required for operation shall be in bidder scope. Vendor to provide Modular furniture's (Chairs, tables, racks etc.) and cabins for operators. OWS/EWS/desk shall be of modular control desk of curved nature. OWS/EWS consoles shall be provided with the facility for locating the CPU, document etc. with all required utilities.
41. The solenoid operated valves/Dampers/Gate shall have a limit switch for open/close feedback. Solenoid Valve shall be rated for 24V DC only.
42. All field instruments enclosure shall be IP65 local panel/cabinet enclosure shall be IP 55, unless otherwise specified.
43. Diaphragm seal shall be provided with Instruments having contact with corrosive media.
44. Redundancy of sensors shall be provided by bidder
 - (i) Triple redundancy for all analog and binary inputs required for protection of system/drives.
 - (ii) For all other control functions dual redundancy of the sensors shall be provided by the bidder.
45. Double root valve shall be provided for all pressure tapings where the pressure exceeds 40kg/cm².
46. Number of pairs to be selected for Screen /Control cable.
 - a) F-Type: 2P/4P/8P/12P (Size: 0.5sqmm²).
 - b) G-Type: 2P/4P/8P/12P (Size: 0.5sqmm²)
 - c) Core Cable: 3CX2.5sqmm²/ 5CX2.5sqmm²/ 12CX1.5sqmm².
47. Contractor shall provide control scheme of hydrogen generation plant.
48. Instrument installation shall be as per the attached "Standard Hook-up diagram of instrument."
49. In addition to requirements specified here, all C&I systems/ sub-systems/ equipment/devices shall also meet other requirements stipulated under other Sub-sections/ parts/sections of specification.
50. In case of any conflict and repetition of clauses in the specification, BHEL discretion will prevail.
51. For hazardous area, explosion proof enclosure for all the instruments, analyzers, equipment as described in NEC article 500 to be provided. Hazardous area fittings and conduits sealing shall conform with NEC requirements for the area classification.
52. Two out of three measurements philosophy shall be adopted for the control of all critical closed and open loop variables for reliability of operation. The control system shall select the median value for the normal control purpose.
53. In case of deviation of one transmitter output from the other two, the same shall be automatically isolated and average output of the remaining transmitters shall be fed to the control and measurement system and the control loop in this case shall be maintained on auto, with an alarm on the operator's monitor as well as maintenance engineer's monitor. In case of failure of the two remaining transmitters in circuit, deviation of one transmitter output is more than the pre-set limit compared to the other transmitter, there shall be automatic bump less transfer and changeovers shall have suitable alarms.
54. For all other control parameters, the number of sensors / transmitters shall be two. One out of two selection logic and selection of average value of the two signals shall be followed.
55. Control and UPS room is to be designed by Vendor and details/layouts of the same shall be provided during detail engineering.



TITLE :
2X660 MW UDANGUDI STPP

SPECIFICATION NO. PE-TS-435-168-A001

SECTION : I

**TECHNICAL SPECIFICATION FOR HYDROGEN
GENERATION PLANT**

SUB-SECTION:IC

REV. NO. 00

56. In addition to the OWS (operator work station), minimum amount of conventional hardwired pushbutton stations and indicators shall be provided in the back-up panel with mosaic and vertical type (not L type) for the safe shutdown of the unit.

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CUSTOMER : BHEL
PROJECT : 2 X 660 MW UDANGUDI SUPERCRITICAL TPP
DOCUMENT NUMBER : FEI/BHEL-U/1000052921-GA
DOCUMENT TITLE : GENERAL ARRANGEMENT

NUMBER OF PAGES : 08

AS BUILT					PAGE DESCRIPTION	COVER PAGE			DOC TITLE	GENERAL ARRANGEMENT			 FUJI ELECTRIC INDIA PRIVATE LIMITED DOC. NO.: FEI/BHEL-U/1000052921-GA SHEET: 01 OF 08 145
03.06.2024									PROJECT	2 X 660 MW UDANGUDI SUPERCRITICAL TPP			
REV	R8	FOR APPROVAL	16.05.2023	NP					CUSTOMER	BHEL			
REV	R7	FOR APPROVAL	31.03.2023	NP									
REV	R6	FOR APPROVAL	11.01.2023	NP			DRN	NP					
REV	R5	FOR APPROVAL	30.12.2022	NP			CHD	GP					
REVISION		DESCRIPTION	DATE	SIGN.	DESCRIPTION		APPD	ND	PAGE SIZE	A3	SCALE	1:1	

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INDEX	
SHEET NO.	PAGE DESCRIPTION
1	COVER PAGE
2	INDEX
3	ENCLOSURE SPECIFICATIONS
4	EXTERNAL VIEW
5	INTERNAL FRONT VIEW
6	TOP & BOTTOM VIEW
7	EXTERNAL SIDE VIEW
8	INTERNAL SIDE VIEW

AS BUILT 03.06.2024					PAGE DESCRIPTION	INDEX			DOC TITLE	GENERAL ARRANGEMENT				
									PROJECT	2 X 660 MW UDANGUDI SUPERCRITICAL TPP				
REV	R8	FOR APPROVAL	16.05.2023	NP					CUSTOMER	BHEL				FUJI ELECTRIC INDIA PRIVATE LIMITED
REV	R7	FOR APPROVAL	31.03.2023	NP										DOC. NO.: FEI/BHEL-U/1000052921-GA
REV	R6	FOR APPROVAL	11.01.2023	NP			DRN	NP					SHEET: 02 OF 08 146	
REV	R5	FOR APPROVAL	30.12.2022	NP			CHD	GP						
REVISION		DESCRIPTION	DATE	SIGN.	DESCRIPTION			APPD	ND	PAGE SIZE	A3	SCALE	1:1	

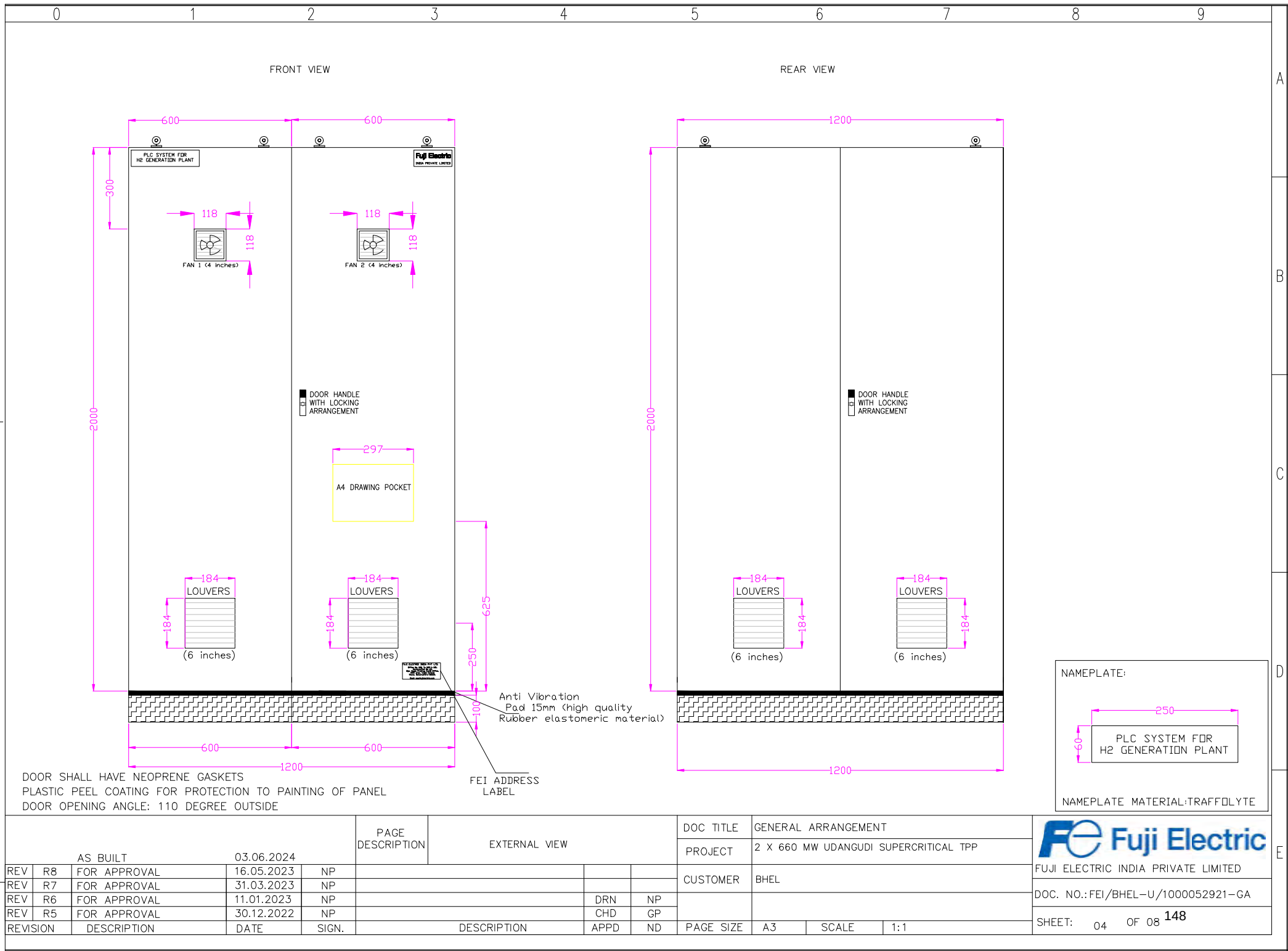


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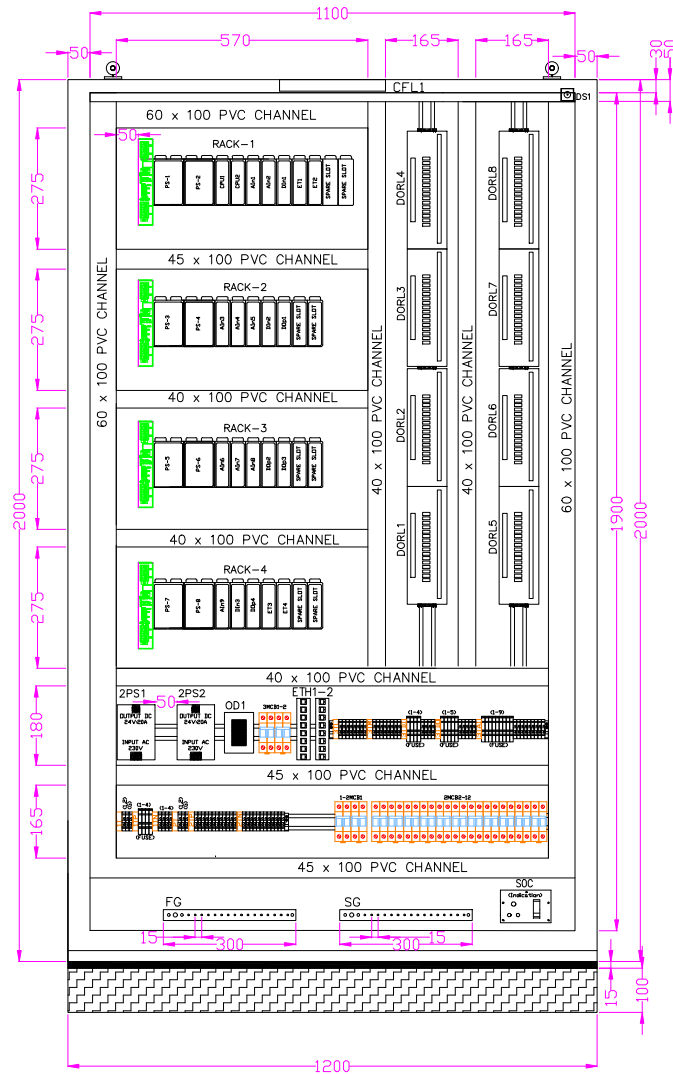
DOC. NO.: FEI/BHEL-U/1000052921-GA

0	1	2	3	4	5	6	7	8	9
1	PANEL MAKE	:	RITTAL		8	NAME PLATE	:	BLACK LETTERS ENGRAVED ON WHITE TRAFFOLYTE ABS DOUBLE COLORED PLATE	
2	NAME OF PRODUCT	:	PLC PANEL		9	COMPONENT MOUNTING	:	COMPONENT MOUNTING TO BE DONE USING WASHER	
3	TYPE OF PRODUCT	:	FLOOR MOUNTING, FIXED TYPE.		10	LIFTING HOOKS	:	REMOVABLE TYPE	
4	CABLE ENTRY	:	BOTTOM		11	ENCLOSURE SIZE:		1200 X 2000 X 800 mm	
5	PANEL ACCESS	:	FRONT ACCESS & REAR CLOSE		12	ACCESSORIES	:	EYE BOLTS, DOOR LOCKS & 15mm ANTIVIBRATION PAD	
6	SUPPLY VOLTAGE				13	INSTALLATION	:	INDOOR(AC Environment)	
	(a) SUPPLY FOR OWS/	:	230V AC FROM UPS OEWS/PRINTER		14	PAINTING	:	POWDER COATED	
	(b) PLC SUPPLY	:	24V DC			PAINT SHADE	:	RAL 7035	
7	ENCLOSURE (PROTECTION TYPE:IP42)					THICKNESS	:	50-60 MICRONS	
	DOOR	:	(2 MM) THICK SHEET STEEL.			(INTERIOR & EXTERIOR)			
	MAIN FRAME	:	(3.00 MM.) THICK SHEET STEEL.						
	REAR PANEL	:	(1.6 MM.) THICK SHEET STEEL.						
	MOUNTING PLATE	:	(3.00 MM.) GALVANIZED SHEET.						
	GLAND PLATE	:	(3 MM.) THICK PRE GALVANIZED SHEET.						
	BASE PLINTH	:	100 MM(H), BLACK COLOUR						
NOTE :- 1. ALL DIMENSIONS ARE IN mm. 2. PANEL TYPE : GENERAL PURPOSE FLOOR MOUNTING.									
AS BUILT 03.06.2024				PAGE DESCRIPTION	ENCLOSURE SPECIFICATION			DOC TITLE	GENERAL ARRANGEMENT
REV	R8	FOR APPROVAL	16.05.2023	NP				PROJECT	2 X 660 MW UDANGUDI SUPERCRITICAL TPP
REV	R7	FOR APPROVAL	31.03.2023	NP				CUSTOMER	BHEL
REV	R6	FOR APPROVAL	11.01.2023	NP		DRN	NP		
REV	R5	FOR APPROVAL	30.12.2022	NP		CHD	GP		
REVISION	DESCRIPTION		DATE	SIGN.	DESCRIPTION	APPD	ND	PAGE SIZE	A3 SCALE 1:1
									 FUJI ELECTRIC INDIA PRIVATE LIMITED DOC. NO.:FEI/BHEL-U/1000052921-GA SHEET: 03 OF 08 147

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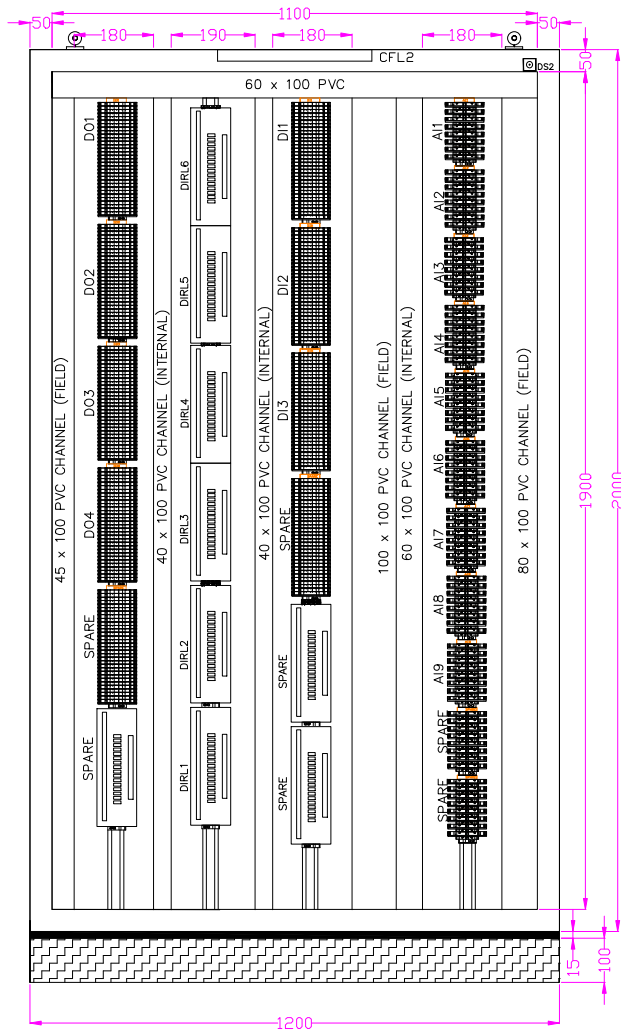
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DESCRIPTION	
CFL1-2	Panel Lamp
DS1-2	Door Limit Switch
PS 1-8	1/p 230V AC, 0/p 35W Power Supply 2 slot type (NP1S-22)
CPU 1-2	PLC Controller (NP1PS-32R)
RACK1	13 Slot Base Board (NP1BP-13D)
RACK2-4	11 Slot Base Board (NP1BS-11D)
DIIn1-3	24V DC, 32 points Digital Input Module, Connector type (NP1X3206-W)
DDp1-4	24V DC, 32 points Digital Output Module, Connector type (NP1Y32U09P1)
AIIn1-9	24V DC, 8 channel Analog Input Module (NP1AXH8I-MR)
ET1-4	1 Channel Ethernet interface module (NP1L-ET1)
SDC	15A Socket with indication lamp
FG,SG	Tinned Copper busbars for FIELD EARTH & SIGNAL EARTH
2PS1-2	20A SMPS
1T	Terminals for NON UPS-230V AC Distribution
2T	Terminals for UPS-240V AC Distribution
T1	Terminals for 24V DC Supply to Racks
1MCB1	Supply to Utility (CFL1-2, FAN1-2, SDC)
2MCB1	UPS Supply for control
2MCB2-3	6A, FDR 2PS1-2 Supply
2MCB4-11	2A, FDR PS1-8 SUPPLY
3MCB1	Supply to Field ID
3MCB2	Supply to ETH
2MCB12	6A, Spare
3T	24V DC Control Power Distribution Terminals
ETH1-2	Unmanaged Ethernet Switch
DDRL1-8	1 C/D 16 channel Relay Boards for Digital Output module (24V DC Coil)
	SX BUS duplex connection unit (NP2L-BH1)

AS BUILT 03.06.2024				PAGE DESCRIPTION	INTERNAL FRONT VIEW			DOC TITLE	GENERAL ARRANGEMENT				
								PROJECT	2 X 660 MW UDANGUDI SUPERCRITICAL TPP				
REV	R8	FOR APPROVAL	16.05.2023	NP				CUSTOMER	BHEL				FUJI ELECTRIC INDIA PRIVATE LIMITED
REV	R7	FOR APPROVAL	31.03.2023	NP									DOC. NO.: FEI/BHEL-U/1000052921-GA
REV	R6	FOR APPROVAL	11.01.2023	NP		DRN	NP						
REV	R5	FOR APPROVAL	30.12.2022	NP		CHD	GP						
REVISION	DESCRIPTION		DATE	SIGN.	DESCRIPTION		APPD	ND	PAGE SIZE	A3	SCALE	1:1	SHEET: 05 OF 08 149

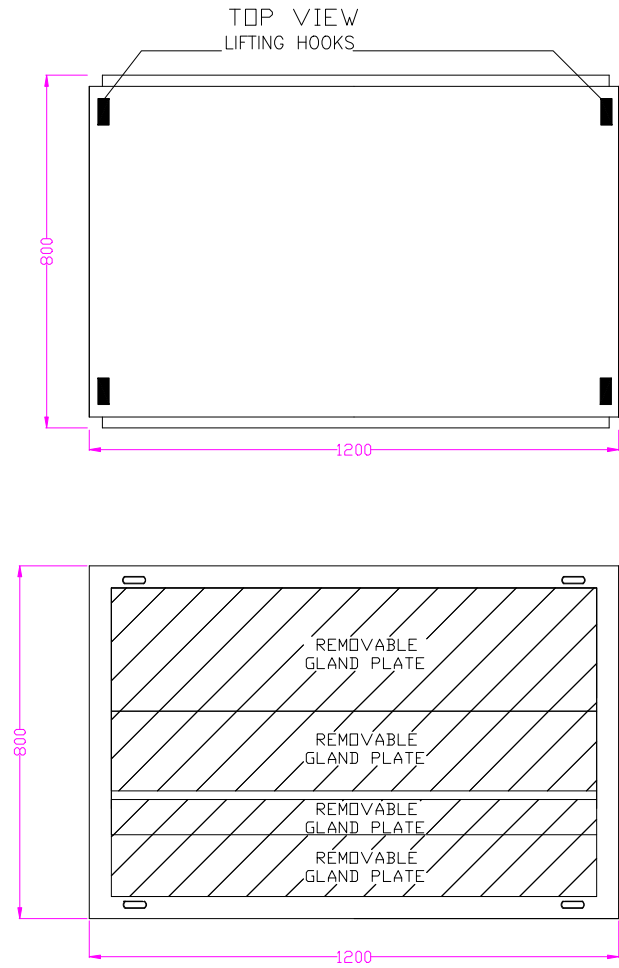
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DESCRIPTION	
D11-3	Terminals for D11-3 (Three sets of 33 Double level terminals)
D01-4	Terminals for D01-4 (Four sets of 33 Double level terminals)
A11-9	Terminals for A11-9 (Nine sets of 8 double level terminals, one level with Fuse and 8 standard terminals)
D1RL1-6	1 C/D 16 channel Relay Boards for Digital Input module (24V DC Coil)
SPARE	20% Spares

				PAGE DESCRIPTION	INTERNAL FRONT VIEW			DOC TITLE	GENERAL ARRANGEMENT				
								PROJECT	2 X 660 MW UDANGUDI SUPERCRITICAL TPP				
REV	R8	AS BUILT	03.06.2024					CUSTOMER	BHEL				FUJI ELECTRIC INDIA PRIVATE LIMITED
REV	R7	FOR APPROVAL	16.05.2023	NP									DOC. NO.: FEI/BHEL-U/1000052921-GA
REV	R7	FOR APPROVAL	31.03.2023	NP									
REV	R6	FOR APPROVAL	11.01.2023	NP		DRN	NP						
REV	R5	FOR APPROVAL	30.12.2022	NP		CHD	GP						
REVISION	DESCRIPTION	DATE	SIGN.	DESCRIPTION			APPD	ND	PAGE SIZE	A3	SCALE	1:1	SHEET: 06 OF 08 150

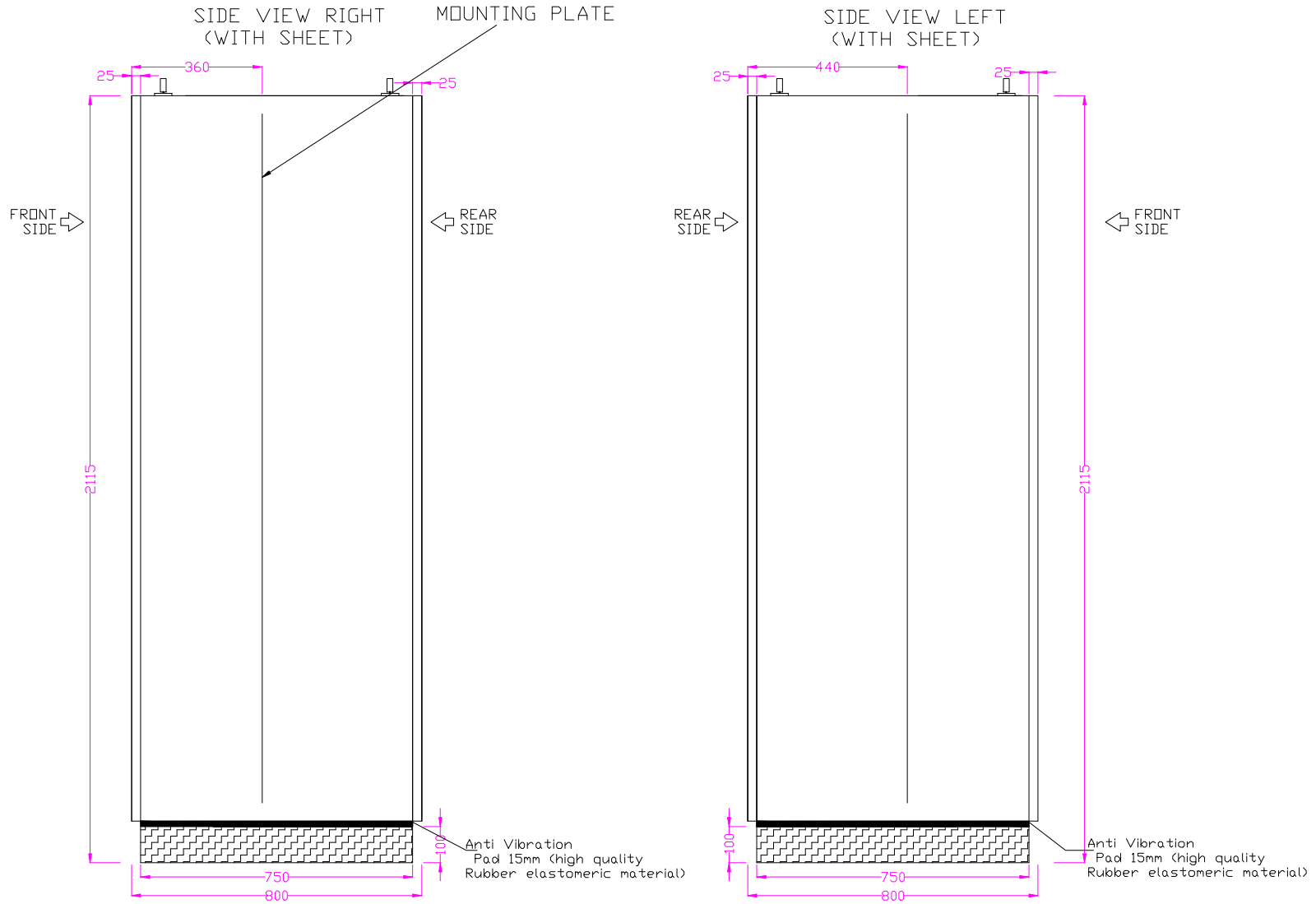
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AS BUILT					PAGE DESCRIPTION	TOP & BOTTOM VIEW			DOC TITLE		GENERAL ARRANGEMENT		
REV	R	DESCRIPTION	DATE	BY					PROJECT				
REV	R8	FOR APPROVAL	16.05.2023	NP					CUSTOMER	BHEL	FUJI ELECTRIC INDIA PRIVATE LIMITED		
REV	R7	FOR APPROVAL	31.03.2023	NP							DOC. NO.: FEI/BHEL-U/1000052921-GA		
REV	R6	FOR APPROVAL	11.01.2023	NP			DRN	NP			SHEET: 07 OF 08 151		
REV	R5	FOR APPROVAL	30.12.2022	NP			CHD	GP					
REVISION		DESCRIPTION	DATE	SIGN.		DESCRIPTION	APPD	ND	PAGE SIZE	A3	SCALE	1:1	



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AS BUILT					PAGE DESCRIPTION			EXTERNAL SIDE VIEW		DOC TITLE		GENERAL ARRANGEMENT		
03.06.2024										PROJECT		2 X 660 MW UDANGUDI SUPERCRITICAL TPP		
REV	R8	FOR APPROVAL	16.05.2023	NP						CUSTOMER		BHEL		
REV	R7	FOR APPROVAL	31.03.2023	NP										
REV	R6	FOR APPROVAL	11.01.2023	NP				DRN						
REV	R5	FOR APPROVAL	30.12.2022	NP				CHD						
REVISION	DESCRIPTION		DATE	SIGN.	DESCRIPTION			APPD	ND	PAGE SIZE	A3	SCALE	1:1	



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DOC. NO.: FEI/BHEL-U/1000052921-GA

SHEET: 08 OF 08 152

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CUSTOMER : BHEL
PROJECT : 2 X 660 MW UDANGUDI SUPERCRITICAL TPP
DOCUMENT NUMBER : FEI/BHEL-U/-WD
DOCUMENT TITLE : WIRING DRAWING

NUMBER OF PAGES : 35

AS BUILT 05.06.2024					PAGE DESCRIPTION	COVER PAGE			DOC TITLE	WIRING DRAWING			 FUJI ELECTRIC INDIA PRIVATE LIMITED DOC. NO.: FEI/BHEL-U/-WD SHEET: 01 OF 35 153
									PROJECT	2 X 660 MW UDANGUDI SUPERCRITICAL TPP			
REV	R8	FOR APPROVAL	16.05.2023	NP				CUSTOMER	BHEL				
REV	R7	FOR APPROVAL	31.03.2023	NP									
REV	R6	FOR APPROVAL	03.01.2023	NP			DRN NP						
REV	R5	FOR APPROVAL	30.12.2022	NP			CHD GP						
REVISION		DESCRIPTION	DATE	SIGN.	DESCRIPTION			APPD	ND	PAGE SIZE	A3	SCALE	1:1

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0		1		2		3		4		5		6		7		8		9	
INDEX																			
SHEET NO.					PAGE DESCRIPTION														
1					COVER PAGE														
2					INDEX														
3					COMMON NOTES														
4					UPS POWER DISTRIBUTION FOR UTILITY														
5					UPS INCOMER														
6					UPS POWER DISTRIBUTION FOR CONTROL														
7					POWER DISTRIBUTION FOR SYSTEM														
8					DC POWER DISTRIBUTION FOR FIELD														
9					SUPPLY TO FIELD DI														
10					SUPPLY TO DO RELAY BOARDS														
11					SUPPLY TO FIELD AI														
12 - 15					RACK-1 IO MODULES WIRING														
16-22					RACK-2 IO MODULES WIRING														
23 - 30					RACK-3 IO MODULES WIRING														
31 - 35					RACK-4 IO MODULES WIRING														

AS BUILT					05.06.2024		PAGE DESCRIPTION			DOC TITLE			WIRING DRAWING				Fuji Electric FUJI ELECTRIC INDIA PRIVATE LIMITED DOC. NO.:FEI/BHEL-U/-WD SHEET: 02 OF 35 154						
REV	R8	FOR APPROVAL			16.05.2023	NP				PROJECT			2 X 660 MW UDANGUDI SUPERCRITICAL TPP										
REV	R7	FOR APPROVAL			31.03.2023	NP				CUSTOMER			BHEL										
REV	R6	FOR APPROVAL			03.01.2023	NP																	
REV	R5	FOR APPROVAL			30.12.2022	NP				DRN			NP										
REVISION		DESCRIPTION			DATE	SIGN.	DESCRIPTION			APPD			ND			PAGE SIZE		A3		SCALE		1:1	

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WIRES COLOUR & SIZE

230 VAC PHASE	RED	1.5/2.5/4 Sq. mm
230 VAC NEUTRAL	BLACK	1.5/2.5/4 Sq. mm
24 V DC	BLUE	0.5/1.5/4 Sq. mm
0 V DC	WHITE	0.5/1.5/4 Sq. mm
EARTH WIRE	GREEN	1.5 Sq. mm
PANEL EARTH	GREEN+YELLOW	1.5 Sq. mm
DIGITAL INPUT		PREFAB CABLE
DIGITAL OUTPUT		PREFAB CABLE
ANALOG INPUT(4–20mA type)	BROWN	0.5 Sq. mm
ANALOG OUTPUT	ORANGE	0.5 Sq. mm
RELAY TO DO FIELD TERMINAL	GREY	1.5 Sq. mm
RELAY(24VDC COIL) TO DI FIELD TERMINAL	YELLOW	1 Sq. mm
RELAY(230V AC COIL) TO DI FIELD TERMINAL	GREY	1 Sq. mm
RTD CABLE	3 core Teflon coated Tinned wire with shield(OD 3 sqmm)	
TC CABLE	K Type Compensating Cable(Shielded)	

TERMINAL COLOUR & SIZE

NON UPS INCOMER TERMINALS(PHASE)*	RED	4 Sq. mm
UPS A–B INCOMER TERMINALS(PHASE)	RED	4 Sq. mm
NON UPS INCOMER TERMINALS(NEUTRAL)	BLACK	4 Sq. mm
UPS A–B INCOMER TERMINALS(NEUTRAL)	BLACK	4 Sq. mm
24V DC DISTRIBUTION TERMINALS*	BLUE	4 Sq. mm
0V DC DISTRIBUTION TERMINALS	GREY	4 Sq. mm
IO TERMINALS	GREY	4 Sq. mm
TC TERMINALS	K TYPE COMPENSATING TERMINALS	

TERMINAL SYMBOLS

	:STANDARD TERMINAL
	:FUSED TERMINAL
	:FUSED TERMINAL WITH LED INDICATION
	:DOUBLE LEVEL TERMINAL (ONE LEVEL WITH FUSE AND LED)
	:DOUBLE LEVEL STANDARD TERMINAL

FUSE RATING

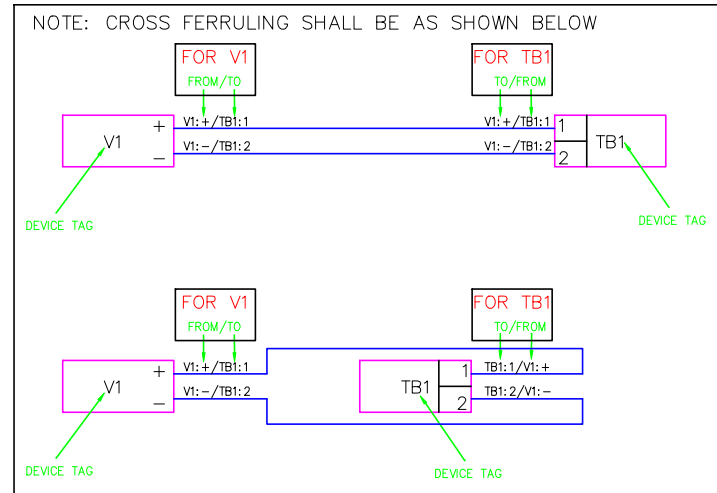
Al	0.1 Amp

*: ALL FUSE TERMINALS WILL BE GREY / BLACK COLOUR

NOTE: 1. PREFAB CABLE WILL BE MARKED AS R01S03DI i.e USED FOR DI MODULE WHICH IS BASED ON SLOT 3 OF RACK 1

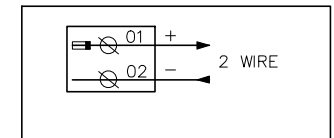
2. All MODULES CAN BE REPLACED ONLINE

3. CPU IS 60% LOADED (SUBJECTED TO PROGRAM LOGIC)

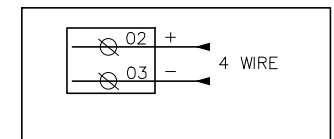


ANALOG WIRING

2 WIRE SYSTEM

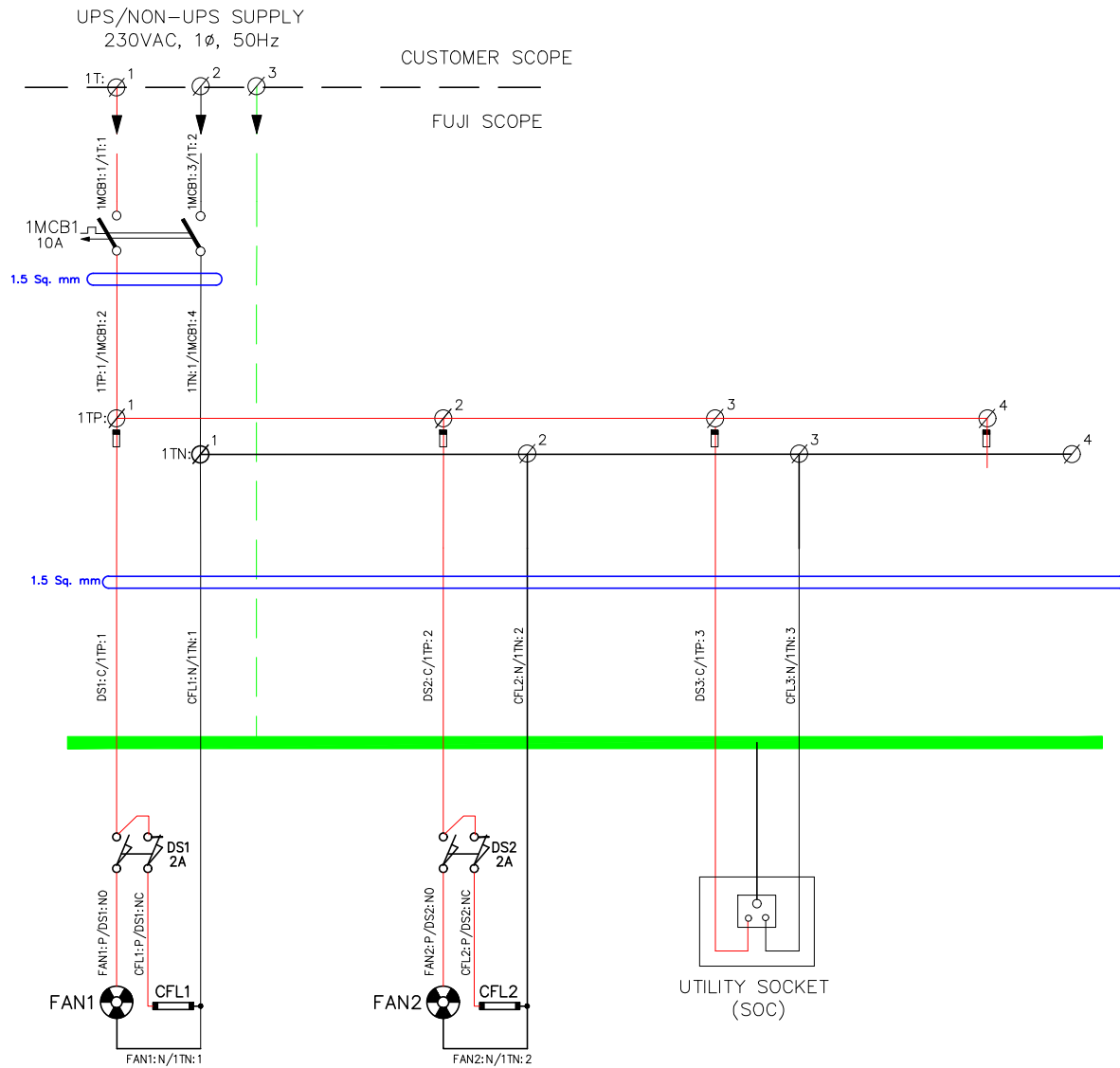


4 WIRE SYSTEM



AS BUILT				05.06.2024	PAGE DESCRIPTION	COMMON NOTES			DOC TITLE	WIRING DRAWING			 Fuji Electric
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REV	R7	FOR APPROVAL	31.03.2023	NP								DOC. NO.: FEI/BHEL–U/–WD	
REV	R6	FOR APPROVAL	03.01.2023	NP			DRN	NP					
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REVISION	DESCRIPTION	DATE	SIGN.		DESCRIPTION	APPD	ND	PAGE SIZE	A3	SCALE	1:1	SHEET: 03 OF 35	155

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 : FUSED TERMINAL 6 Amp

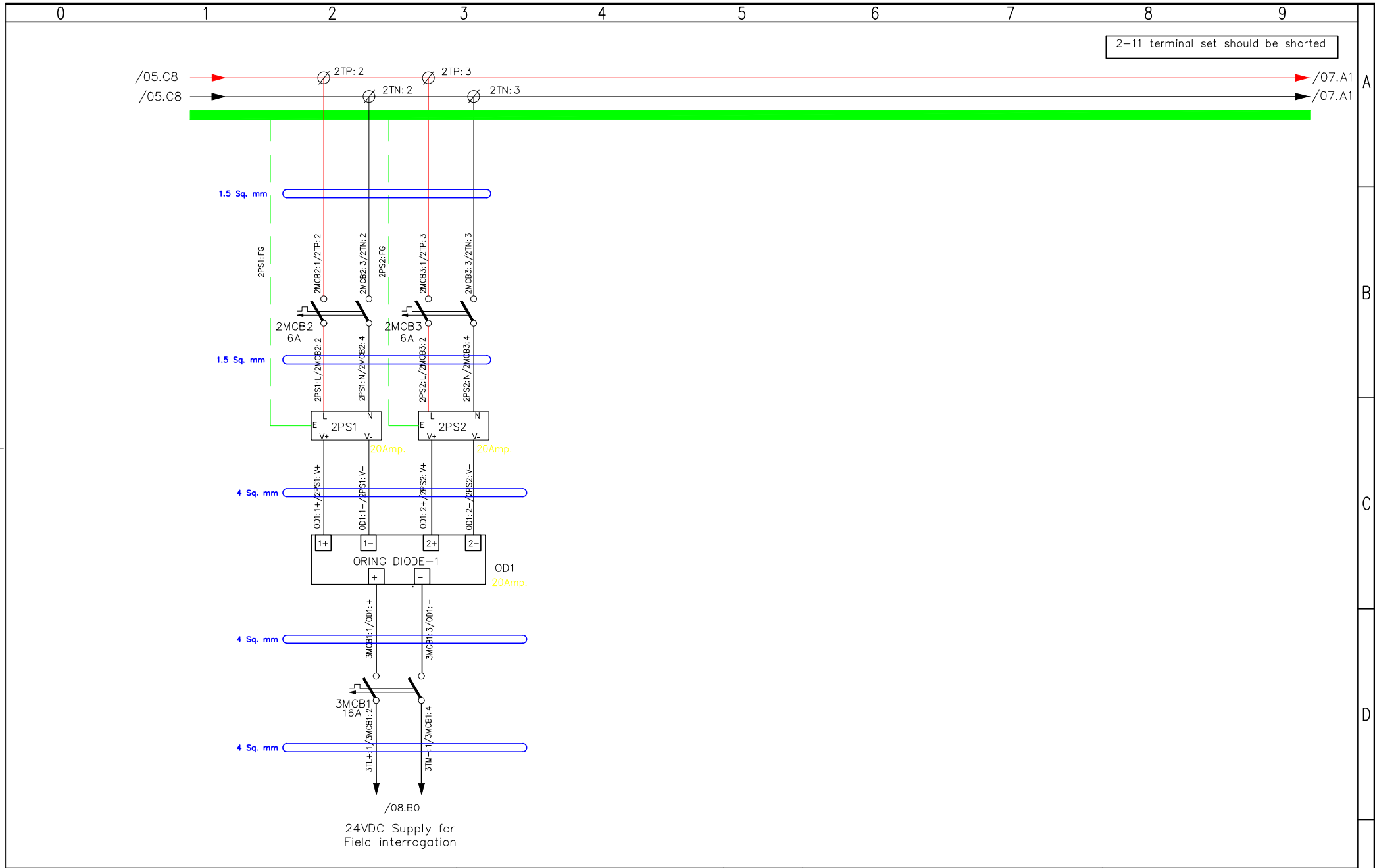
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REVISION		DESCRIPTION		DATE	SIGN.	DESCRIPTION		APPD	ND	PAGE SIZE	A3	SCALE	1:1	SHEET: 04 OF 35 156		

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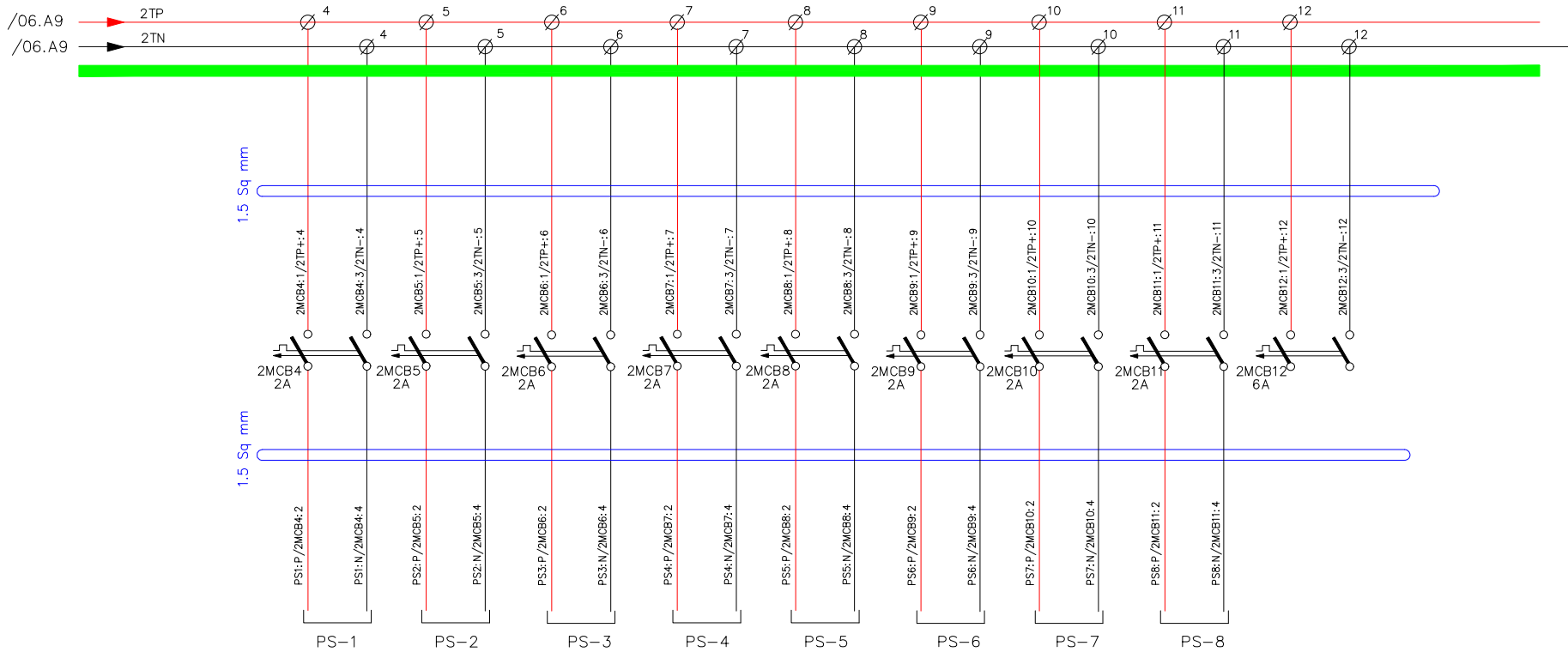
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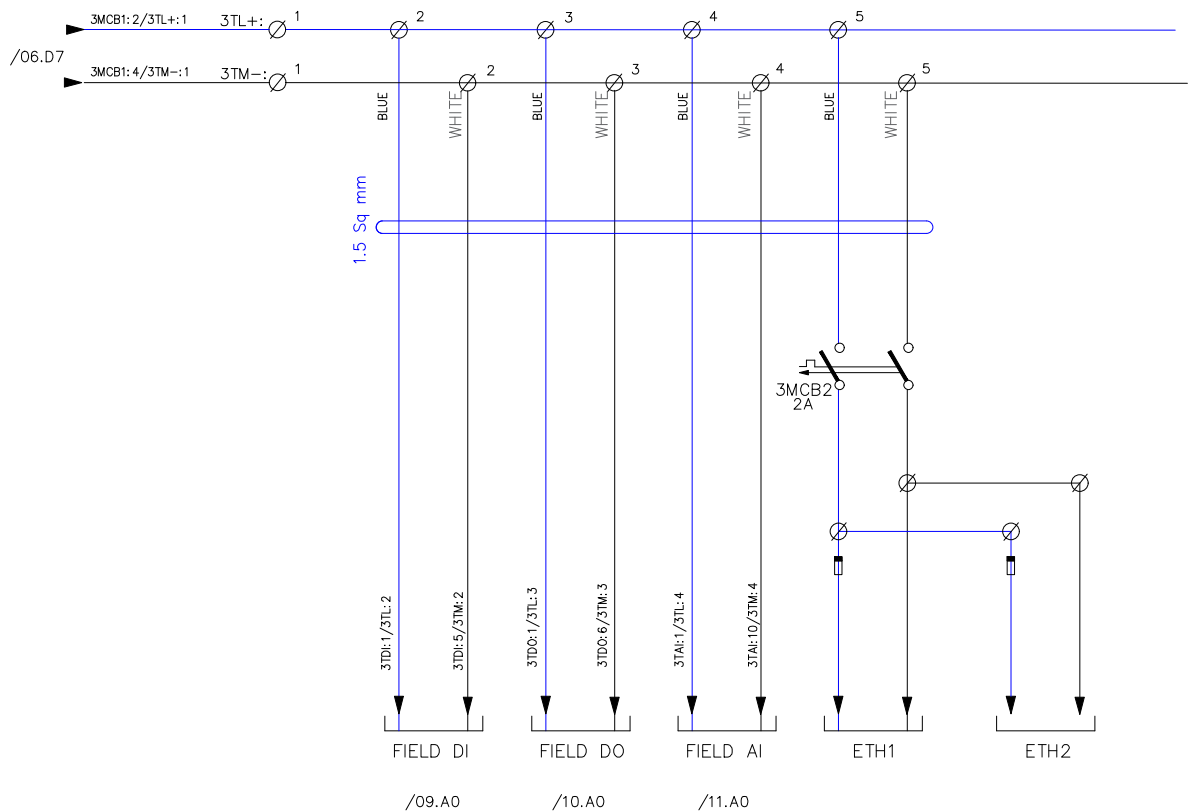
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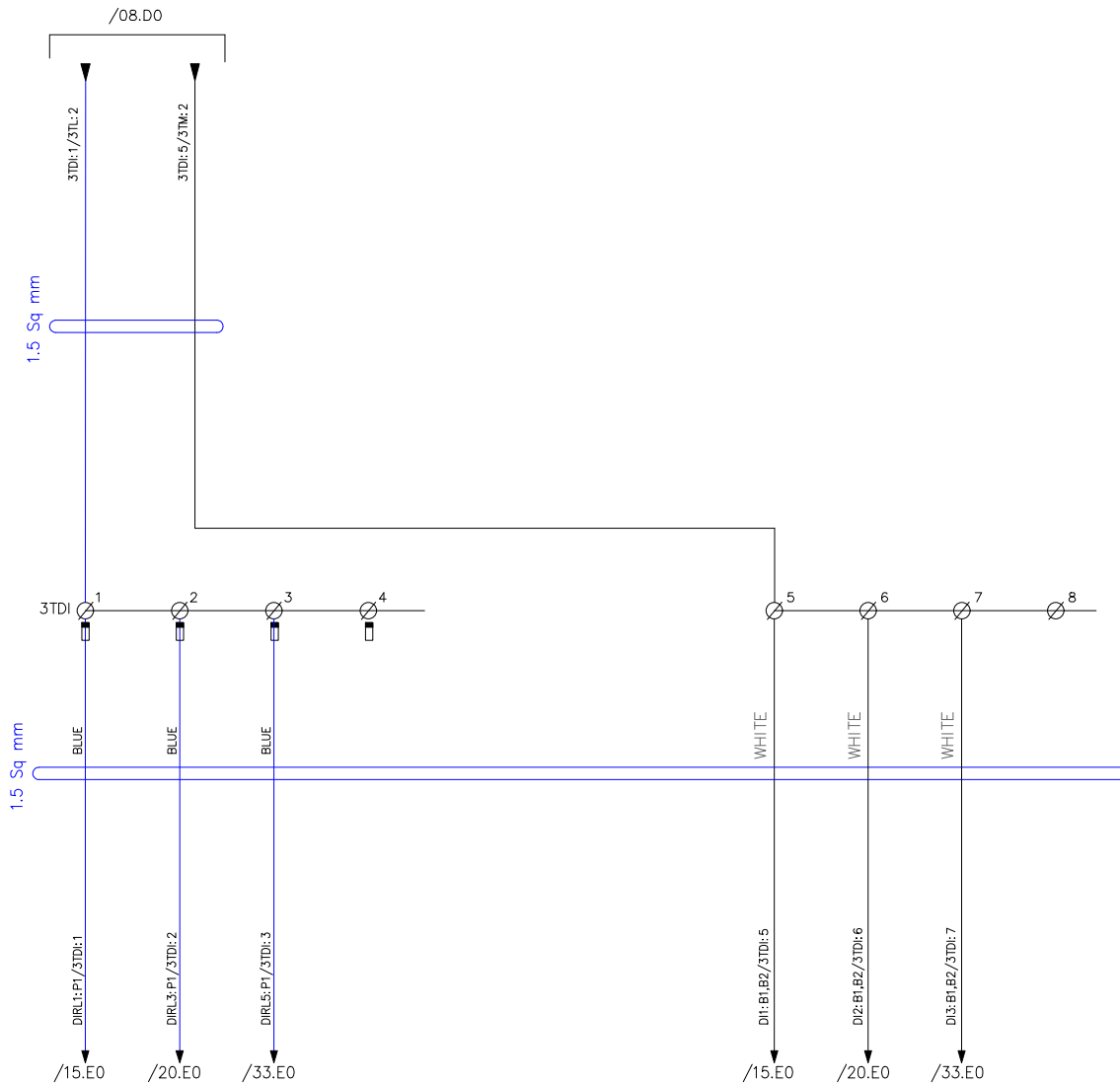
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REV	R5	FOR APPROVAL	30.12.2022	NP						SHEET: 08 OF 35		
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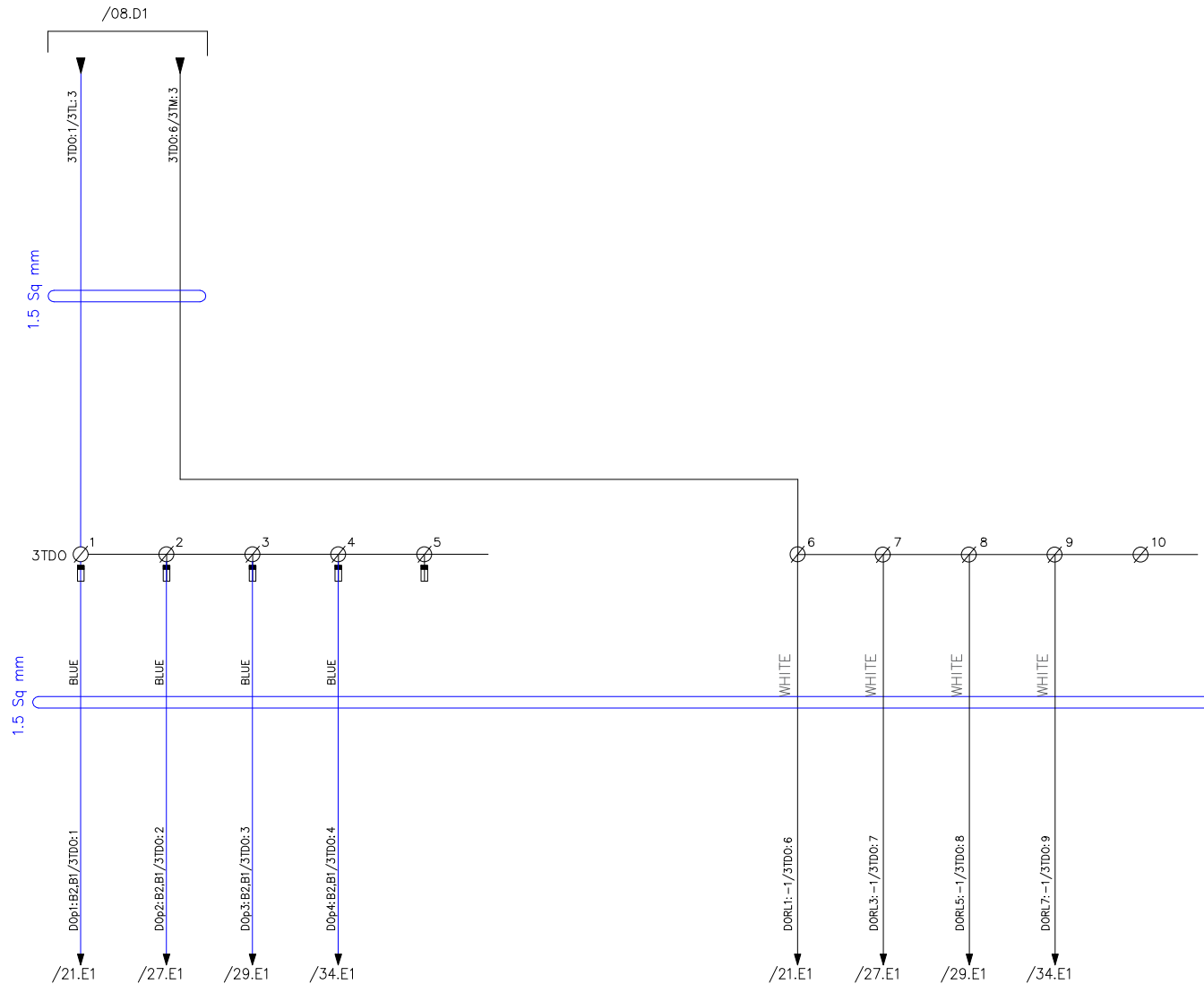


1-4 terminal set should be shorted
5-8 terminal set should be shorted

 : FUSED TERMINAL 6 Amp

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REVISION	DESCRIPTION		DATE	SIGN.	DESCRIPTION		APPD	ND	PAGE SIZE	A3	SCALE	1:1	SHEET: 09 OF 35161

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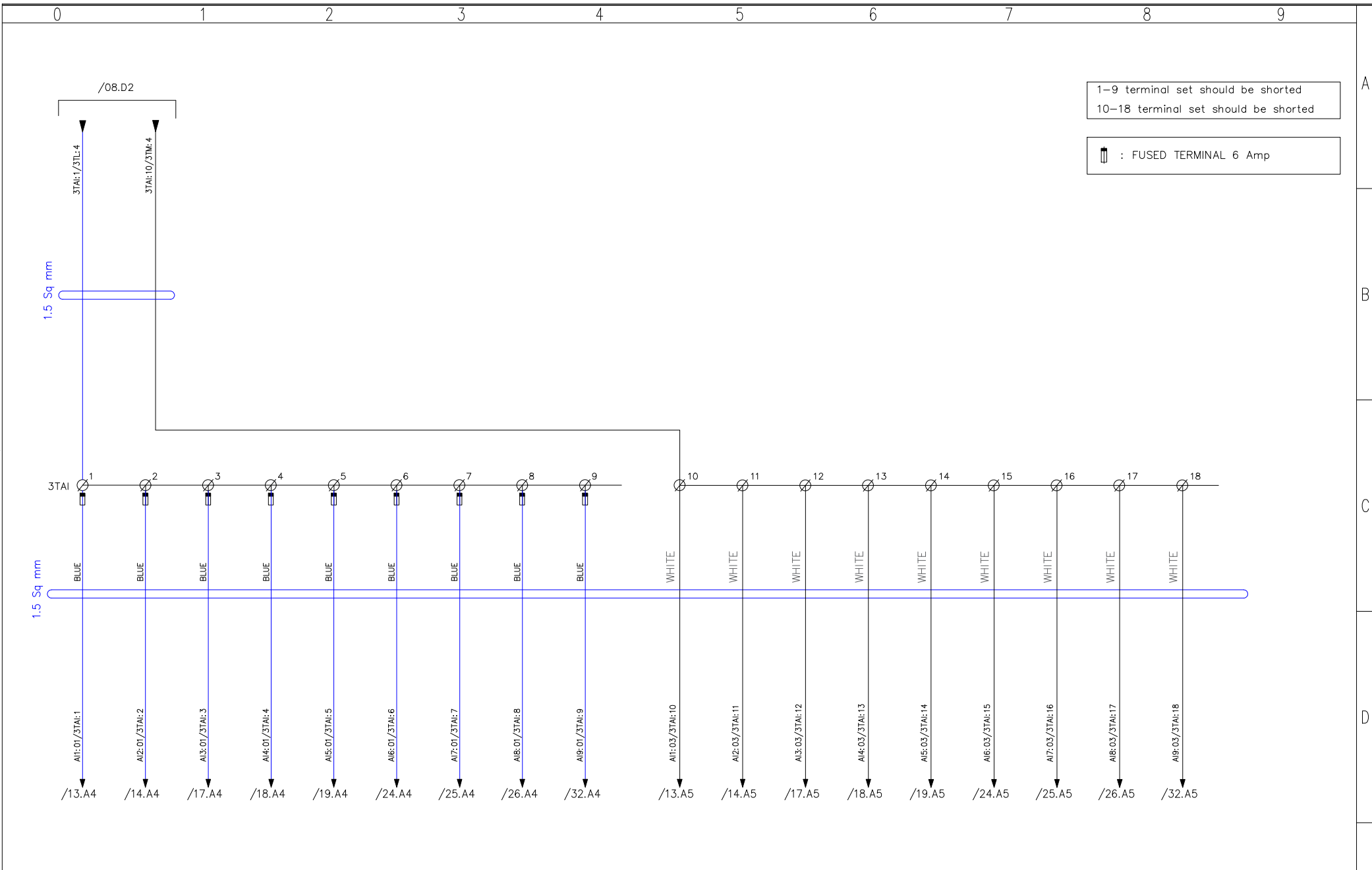


1-5 terminal set should be shorted
6-10 terminal set should be shorted

 : FUSED TERMINAL 6 Amp

AS BUILT				05.06.2024		PAGE DESCRIPTION	SUPPLY TO DO RELAY BOARDS			DOC TITLE	WIRING DRAWING			
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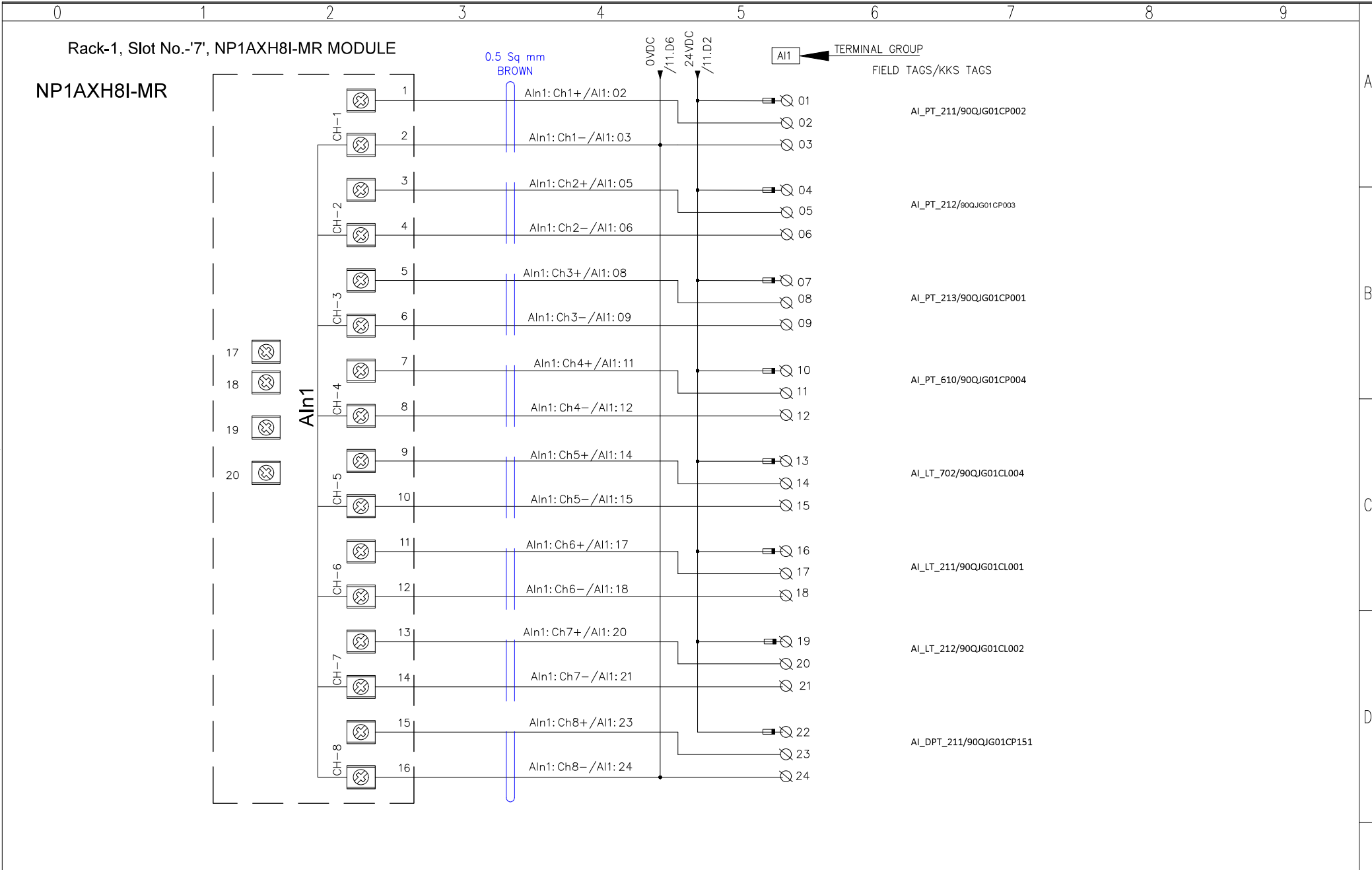
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RACK-1 IO MODULES WIRING INDEX		
SHEET NO.	SLOT NO.	PAGE DESCRIPTION
13	7	8 CHANNEL ANALOG INPUT MODULE
14	8	8 CHANNEL ANALOG INPUT MODULE
15	9	32 CHANNEL DIGITAL INPUT MODULE
	10	1 Channel Ethernet interface module (NP1L-ET1)
	11	1 Channel Ethernet interface module (NP1L-ET1)

AS BUILT05.06.2024					PAGE DESCRIPTION	RACK-1 WIRING INDEX			DOC TITLE	WIRING DRAWING			 FUJI ELECTRIC INDIA PRIVATE LIMITED DOC. NO.: FEI/BHEL-U/-WD SHEET: 12 OF 35 164
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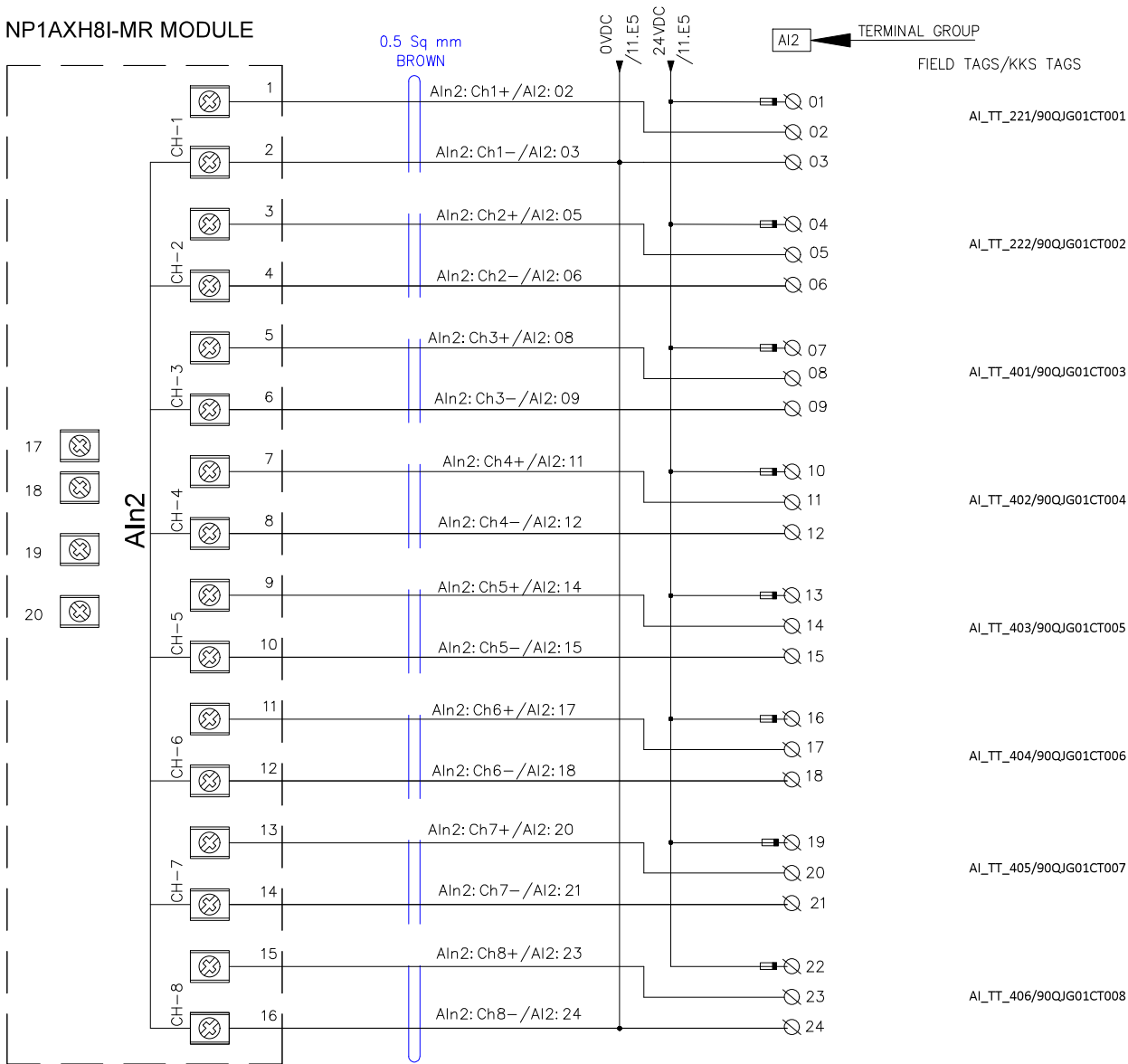


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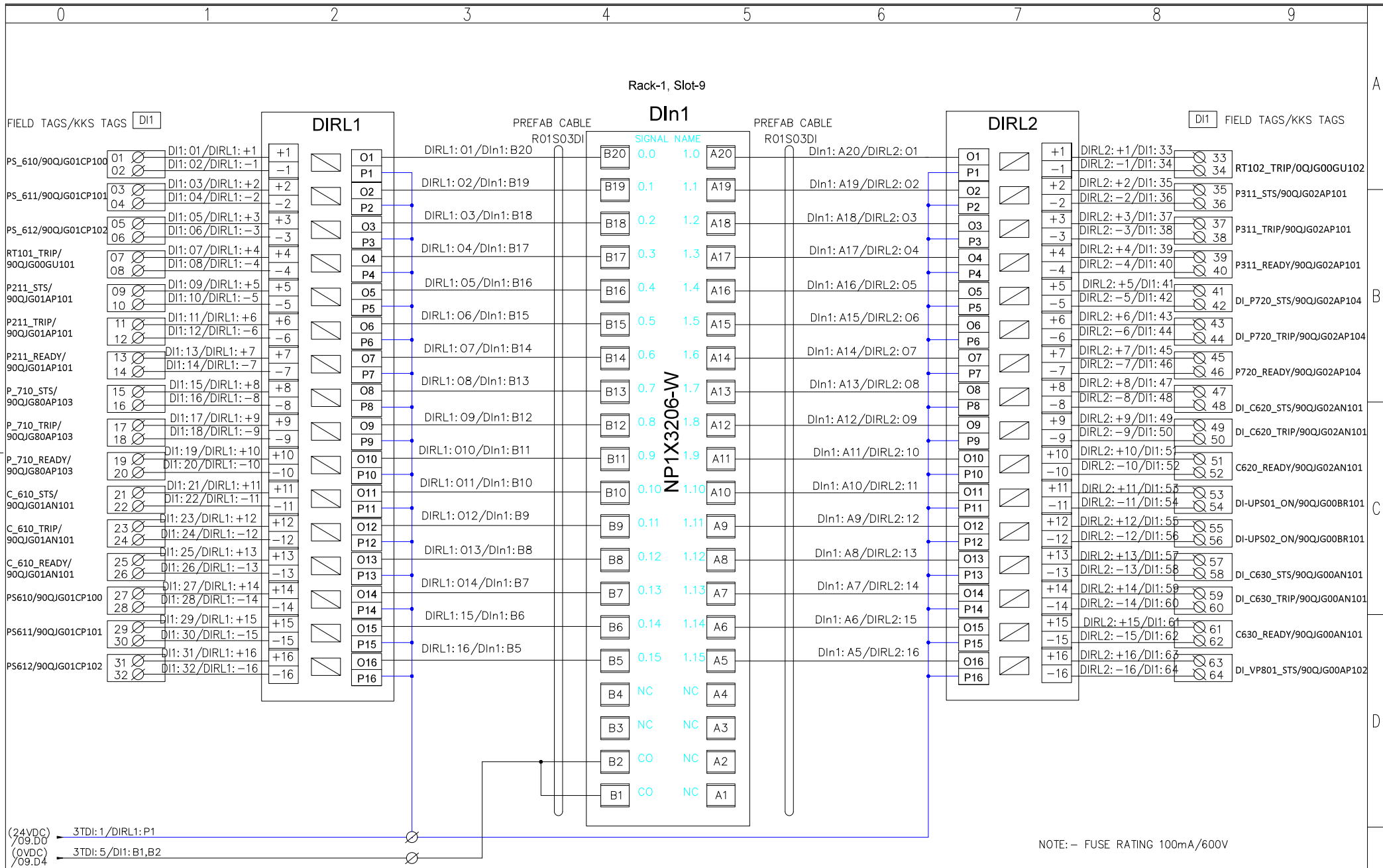
Rack-1, Slot No.-'8', NP1AXH8I-MR MODULE

NP1AXH8I-MR



AS BUILT				05.06.2024	PAGE DESCRIPTION	8 CHANNEL ANALOG INPUT MODULE			DOC TITLE	WIRING DRAWING			
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AS BUILT				05.06.2024	PAGE DESCRIPTION	32 CHANNEL DIGITAL INPUT MODULE			DOC TITLE	WIRING DRAWING			
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REV	R5	FOR APPROVAL	30.12.2022	NP	CHD GP			PAGE SIZE	A3	SCALE	1:1	SHEET: 15 OF 35 167	
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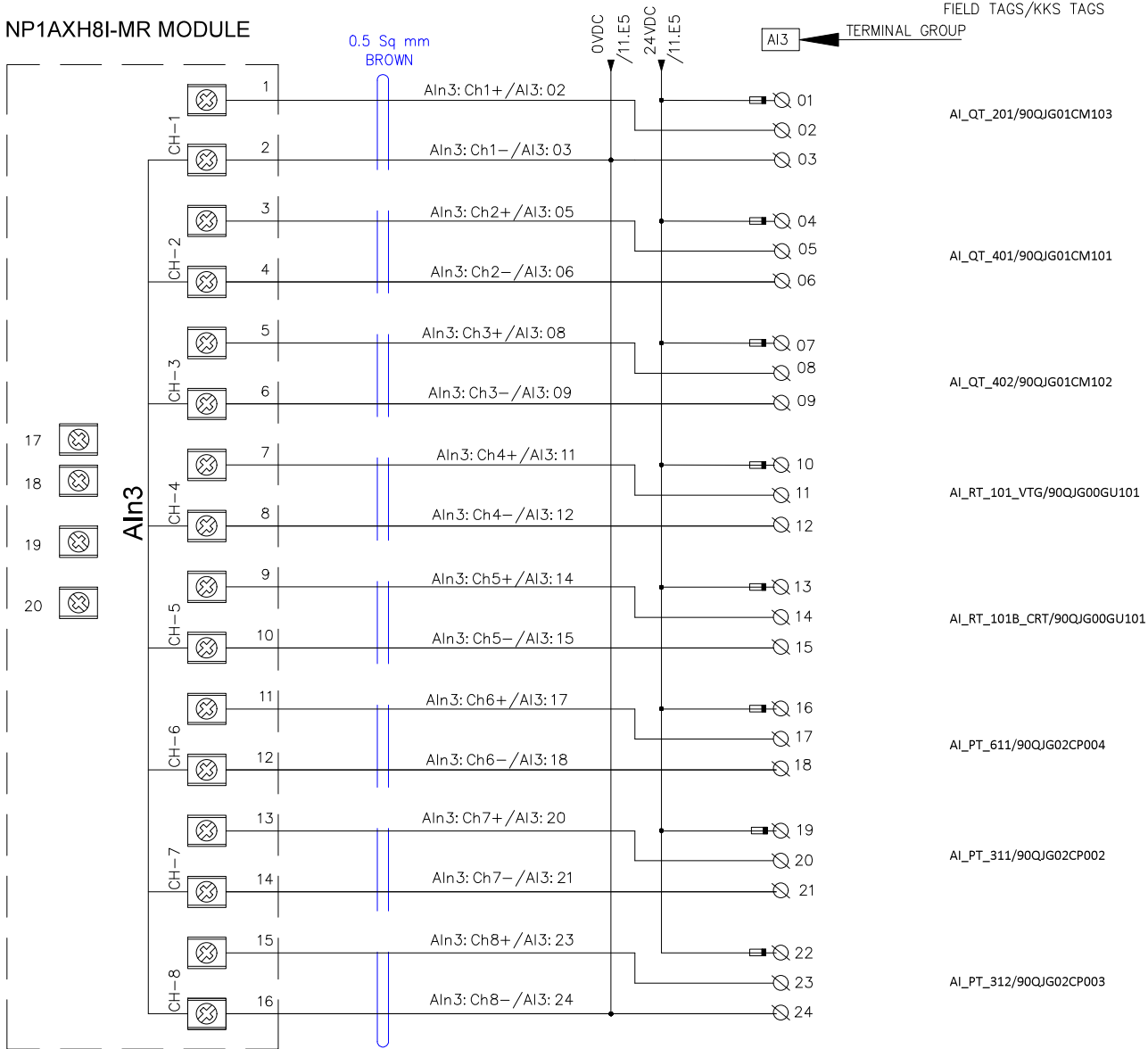
RACK-2 IO MODULES WIRING INDEX		
SHEET NO.	SLOT NO.	PAGE DESCRIPTION
17	5	8 CHANNEL ANALOG INPUT MODULE
18	6	8 CHANNEL ANALOG INPUT MODULE
19	7	8 CHANNEL ANALOG INPUT MODULE
20	8	32 CHANNEL DIGITAL INPUT MODULE
21-22	9	32 CHANNEL DIGITAL OUTPUT MODULE

AS BUILT 05.06.2024					PAGE DESCRIPTION	RACK-2 WIRING INDEX			DOC TITLE	WIRING DRAWING			 FUJI ELECTRIC INDIA PRIVATE LIMITED DOC. NO.: FEI/BHEL-U/-WD SHEET: 16 OF 35 168
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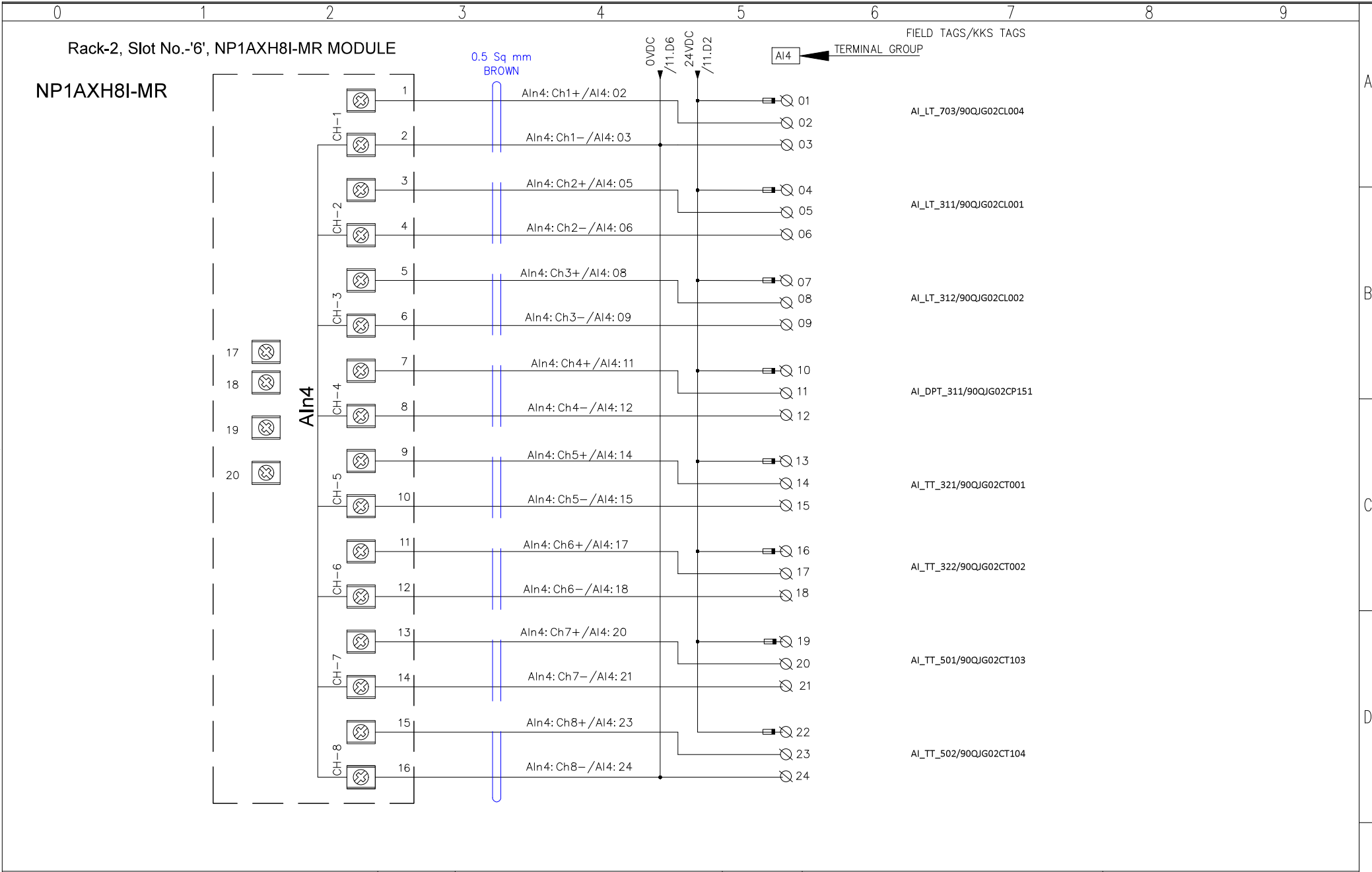
NP1AXH8I-MR

Rack-2, Slot No.-'5', NP1AXH8I-MR MODULE



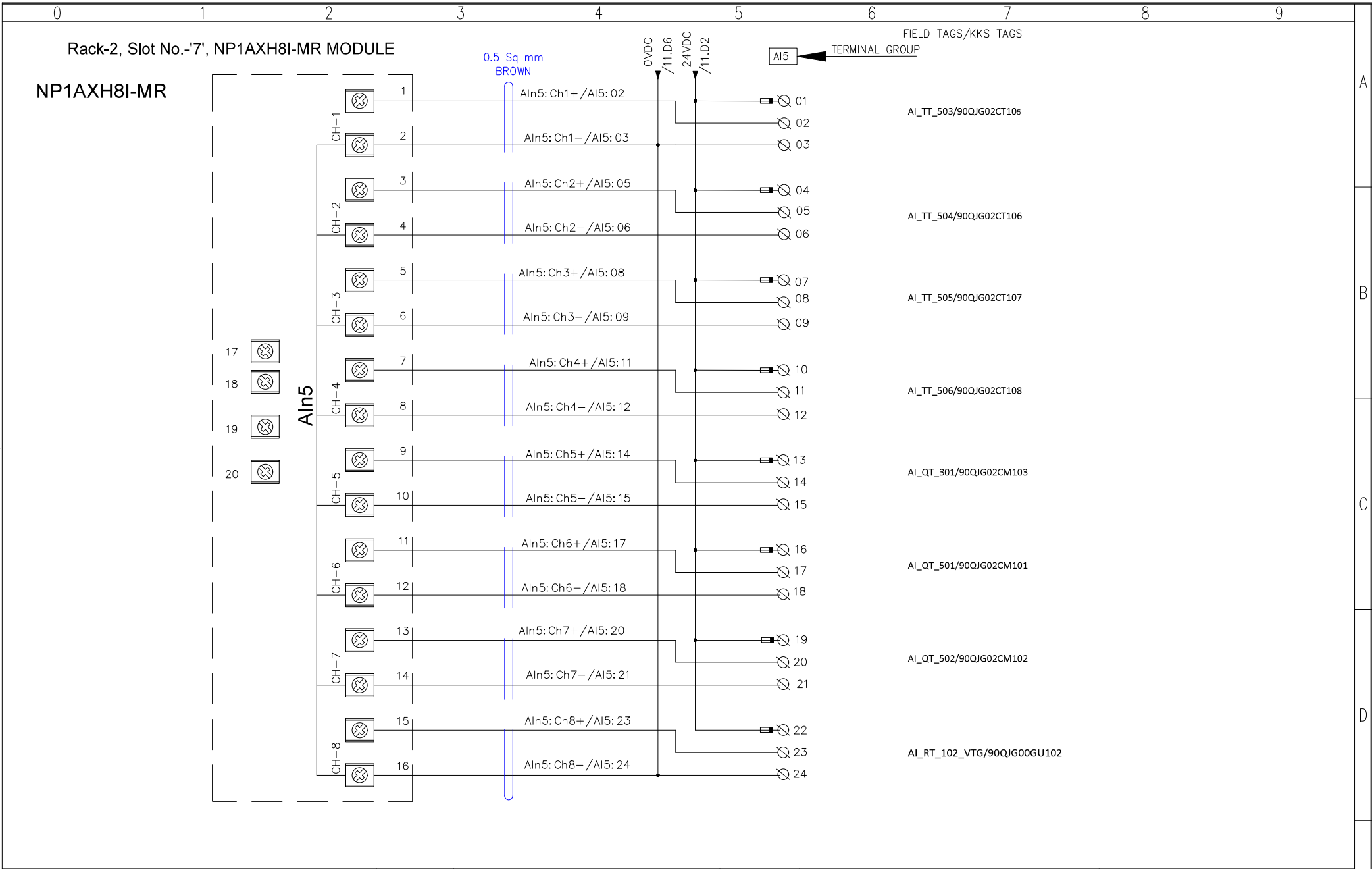
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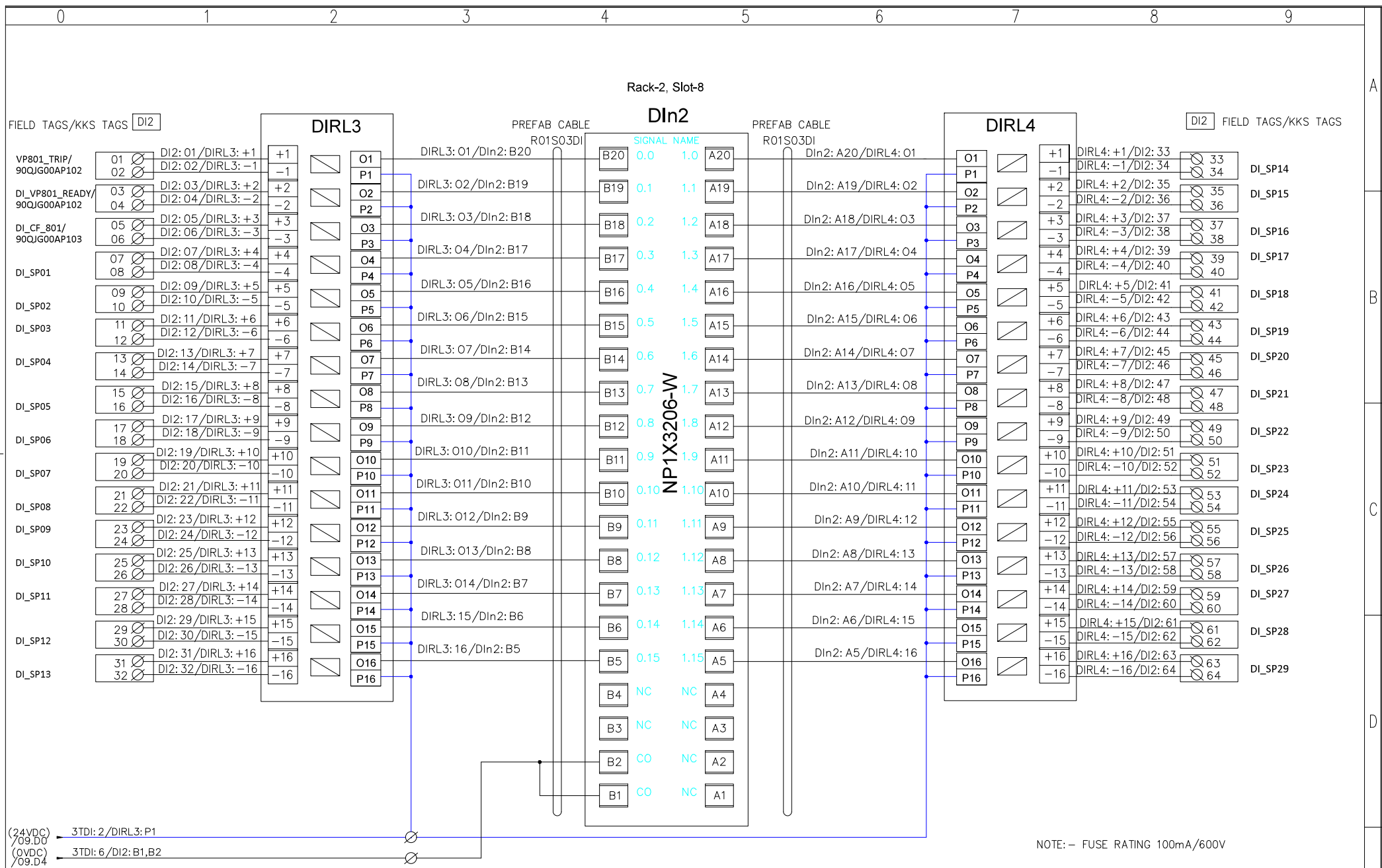
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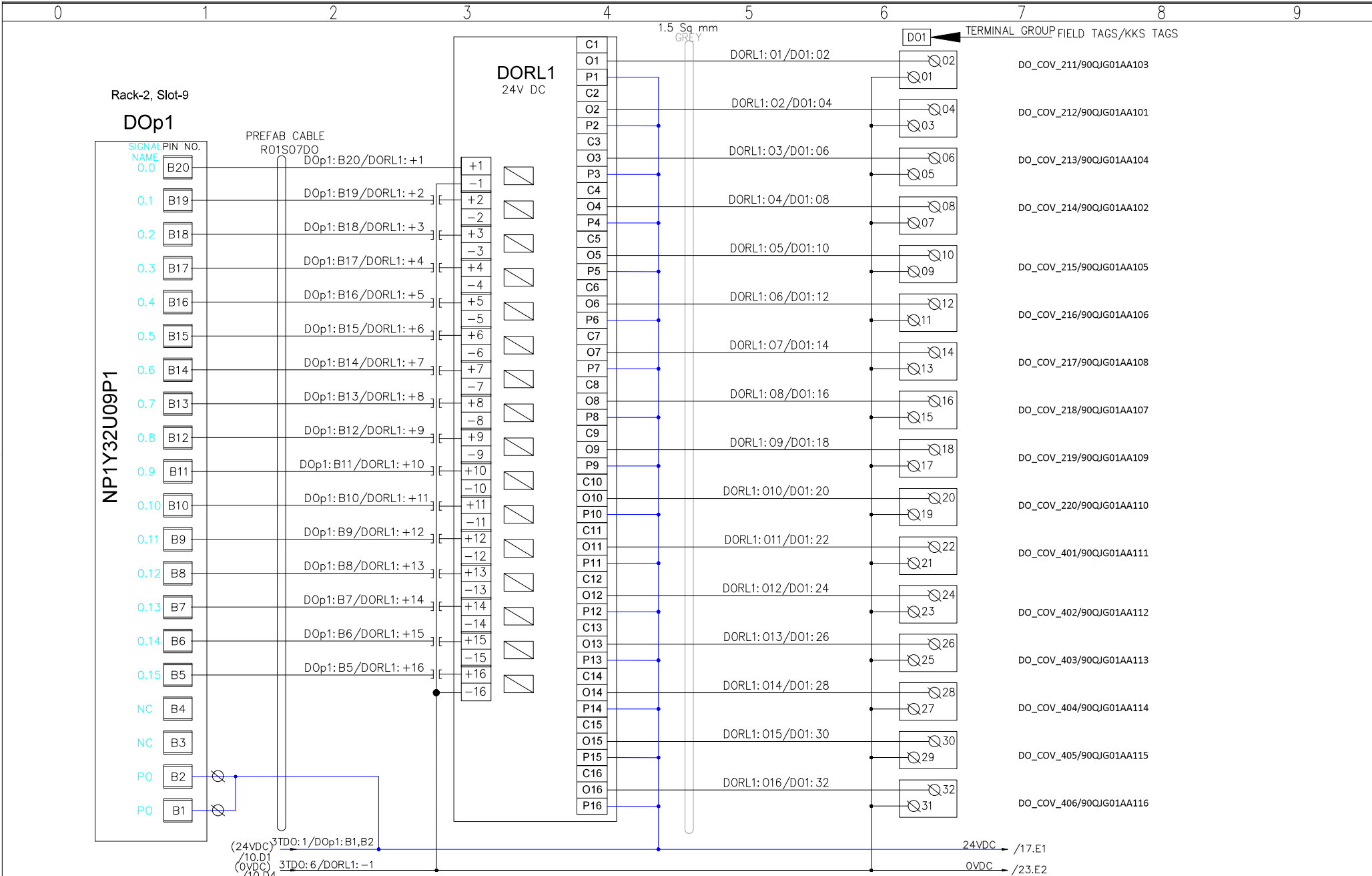
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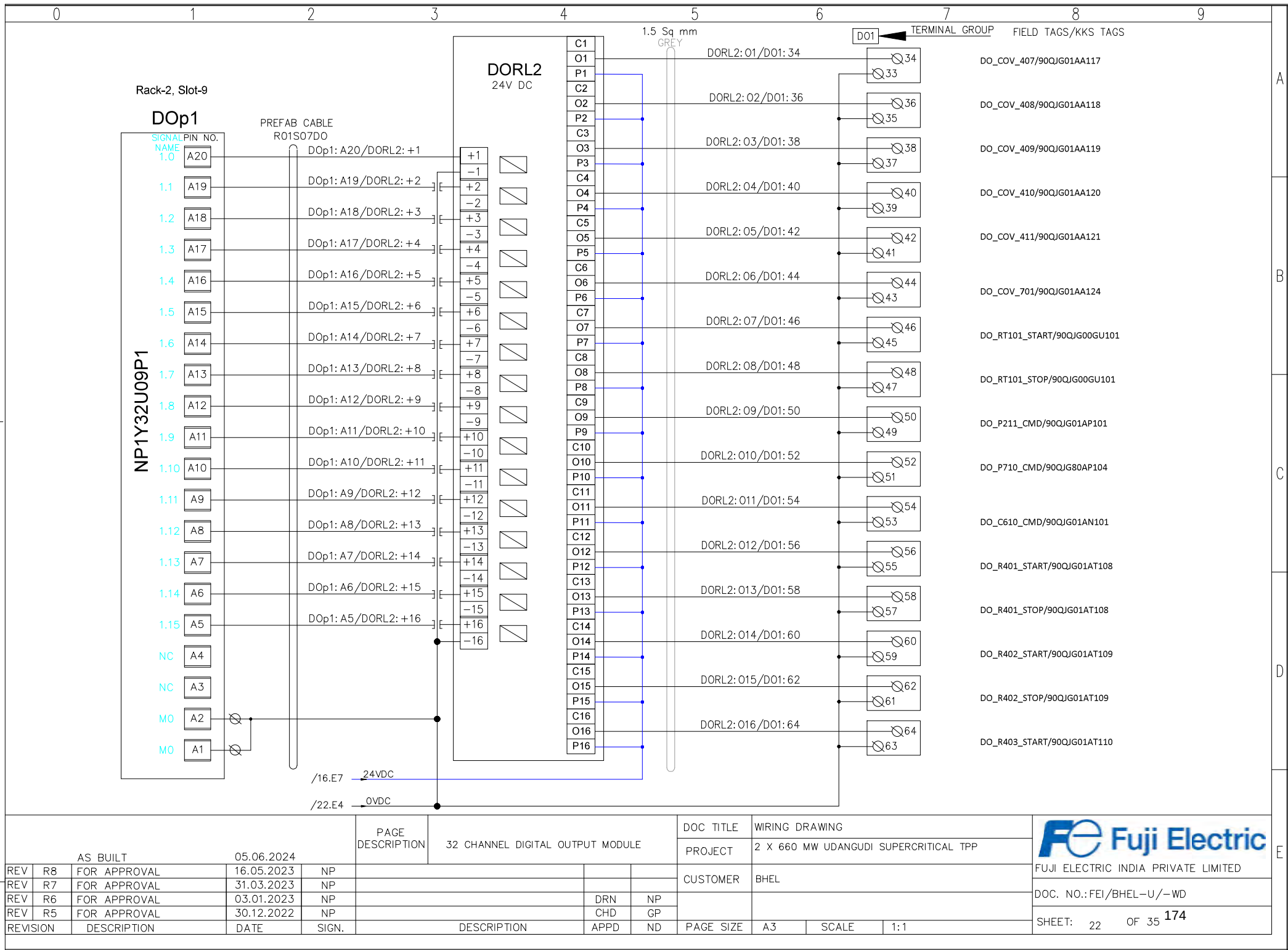
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AS BUILT				05.06.2024	PAGE DESCRIPTION	32 CHANNEL DIGITAL OUTPUT MODULE			DOC TITLE	WIRING DRAWING			
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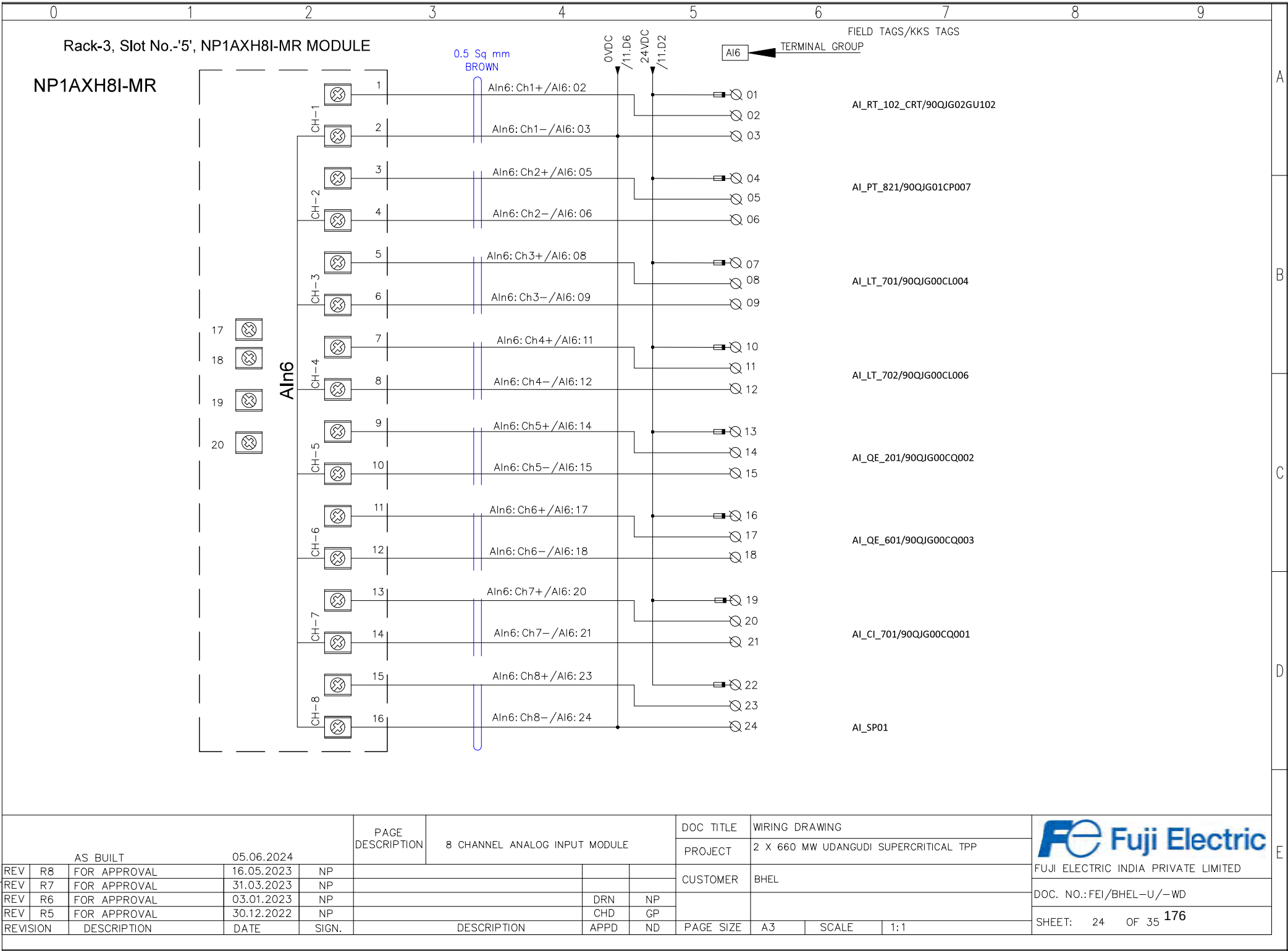
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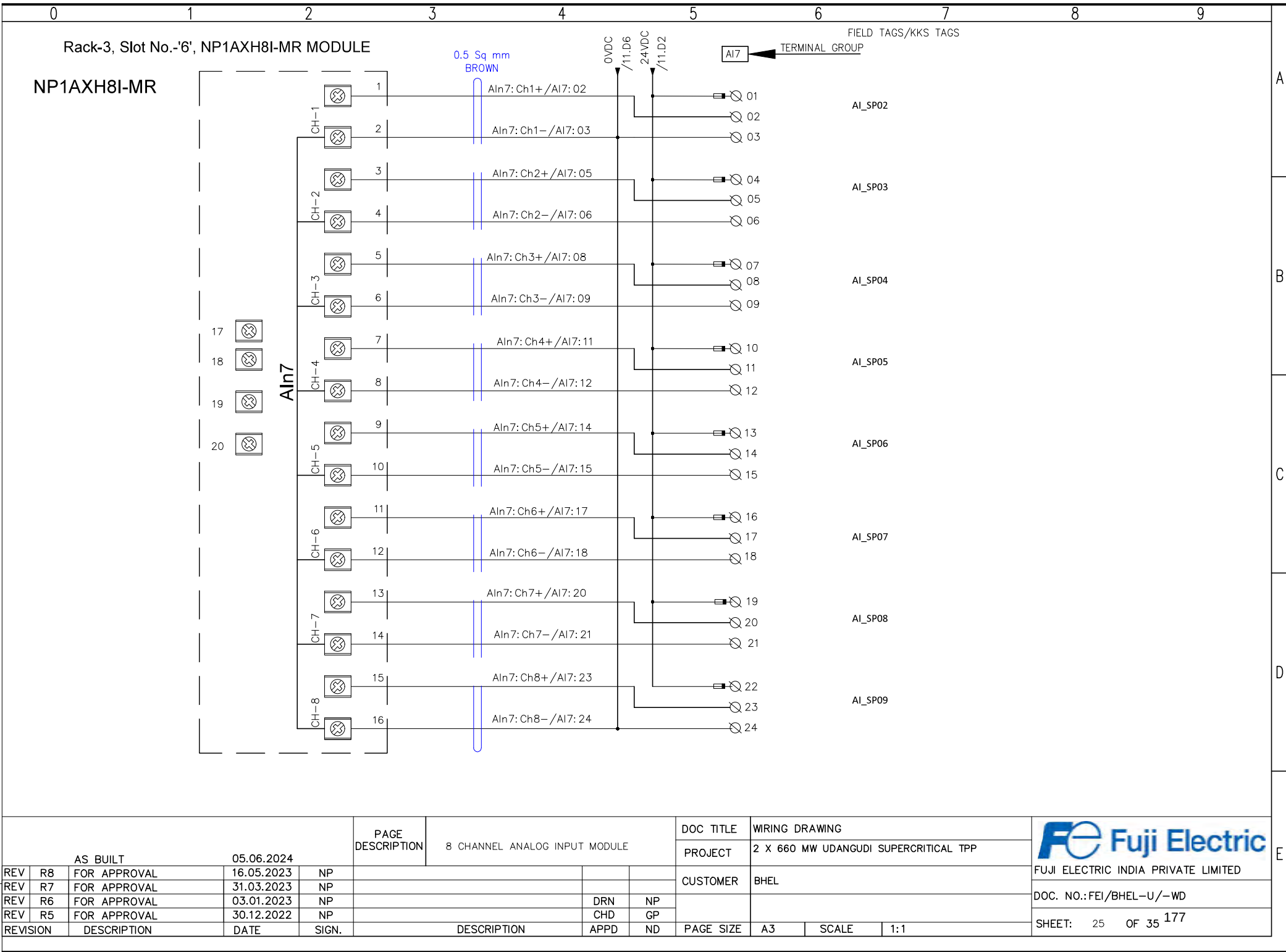
RACK-3 IO MODULES WIRING INDEX		
SHEET NO.	SLOT NO.	PAGE DESCRIPTION
24	5	8 CHANNEL ANALOG INPUT MODULE
25	6	8 CHANNEL ANALOG INPUT MODULE
26	7	8 CHANNEL ANALOG INPUT MODULE
27-28	8	32 CHANNEL DIGITAL OUTPUT MODULE
29-30	9	32 CHANNEL DIGITAL OUTPUT MODULE

AS BUILT 05.06.2024					PAGE DESCRIPTION	RACK-2 WIRING INDEX			DOC TITLE	WIRING DRAWING			 FUJI ELECTRIC INDIA PRIVATE LIMITED DOC. NO.: FEI/BHEL-U/-WD SHEET: 23 OF 35 175
									PROJECT	2 X 660 MW UDANGUDI SUPERCRITICAL TPP			
REV	R8	FOR APPROVAL	16.05.2023	NP				CUSTOMER	BHEL				
REV	R7	FOR APPROVAL	31.03.2023	NP									
REV	R6	FOR APPROVAL	03.01.2023	NP		DRN	NP						
REV	R5	FOR APPROVAL	30.12.2022	NP		CHD	GP						
REVISION		DESCRIPTION		DATE	SIGN.	DESCRIPTION		APPD	ND	PAGE SIZE	A3	SCALE	

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A

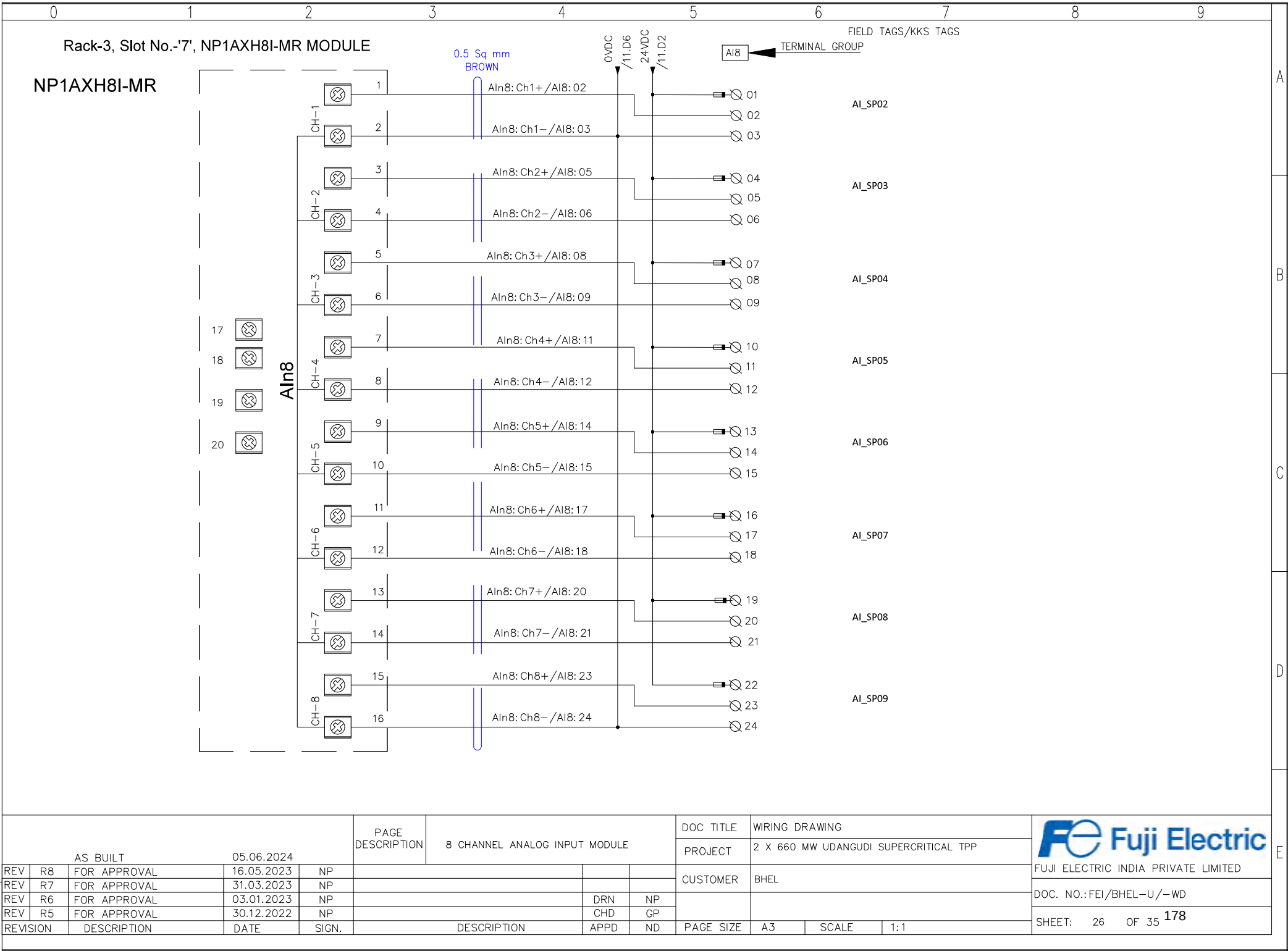
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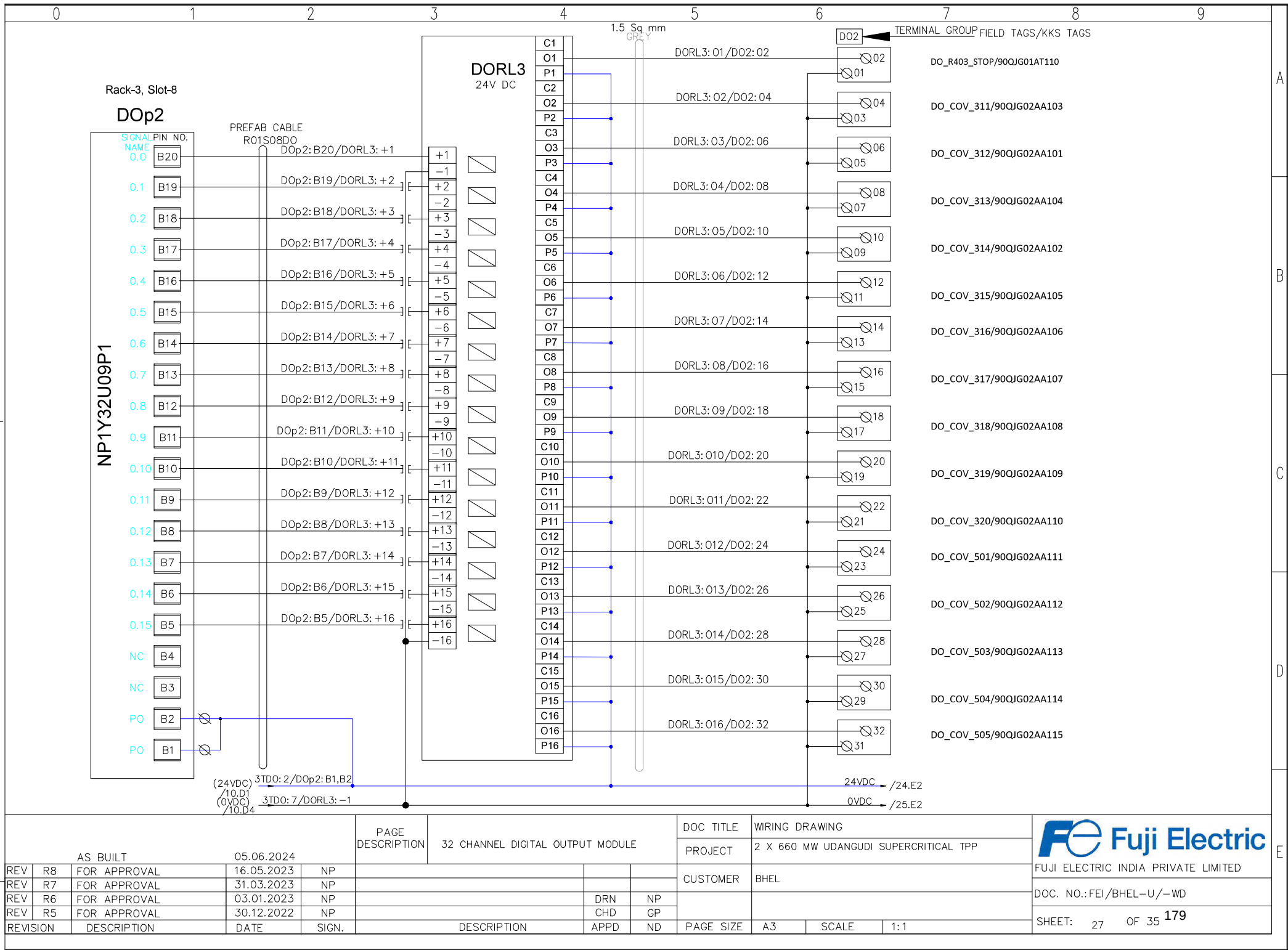
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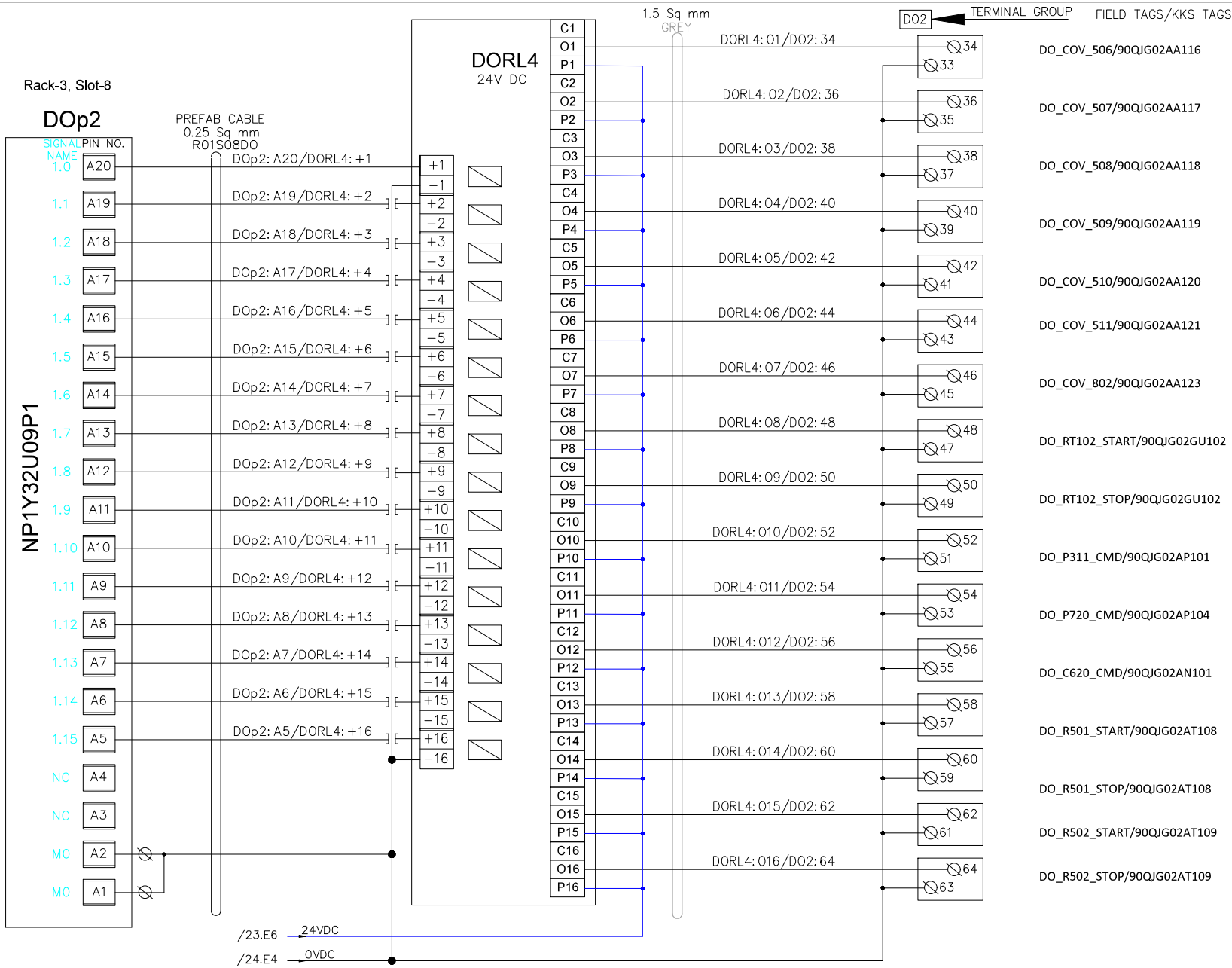
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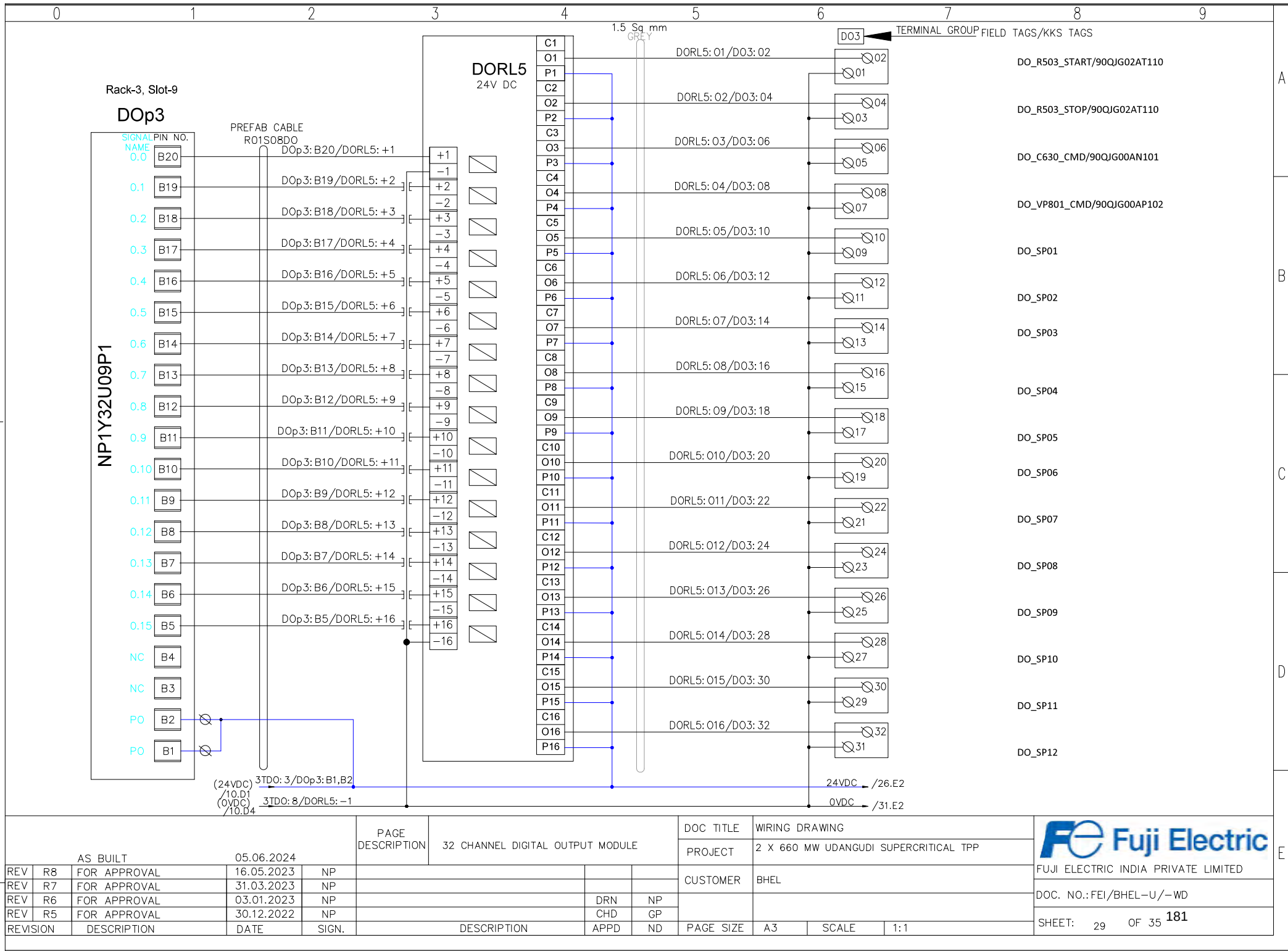
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REV	R7	FOR APPROVAL	31.03.2023	NP								DOC. NO.: FEI/BHEL-U/-WD	
REV	R6	FOR APPROVAL	03.01.2023	NP	DRN NP						SHEET: 27 OF 35 179		
REV	R5	FOR APPROVAL	30.12.2022	NP	CHD GP								
REVISION		DESCRIPTION		DATE	SIGN.	DESCRIPTION		APPD	ND	PAGE SIZE	A3	SCALE	1:1

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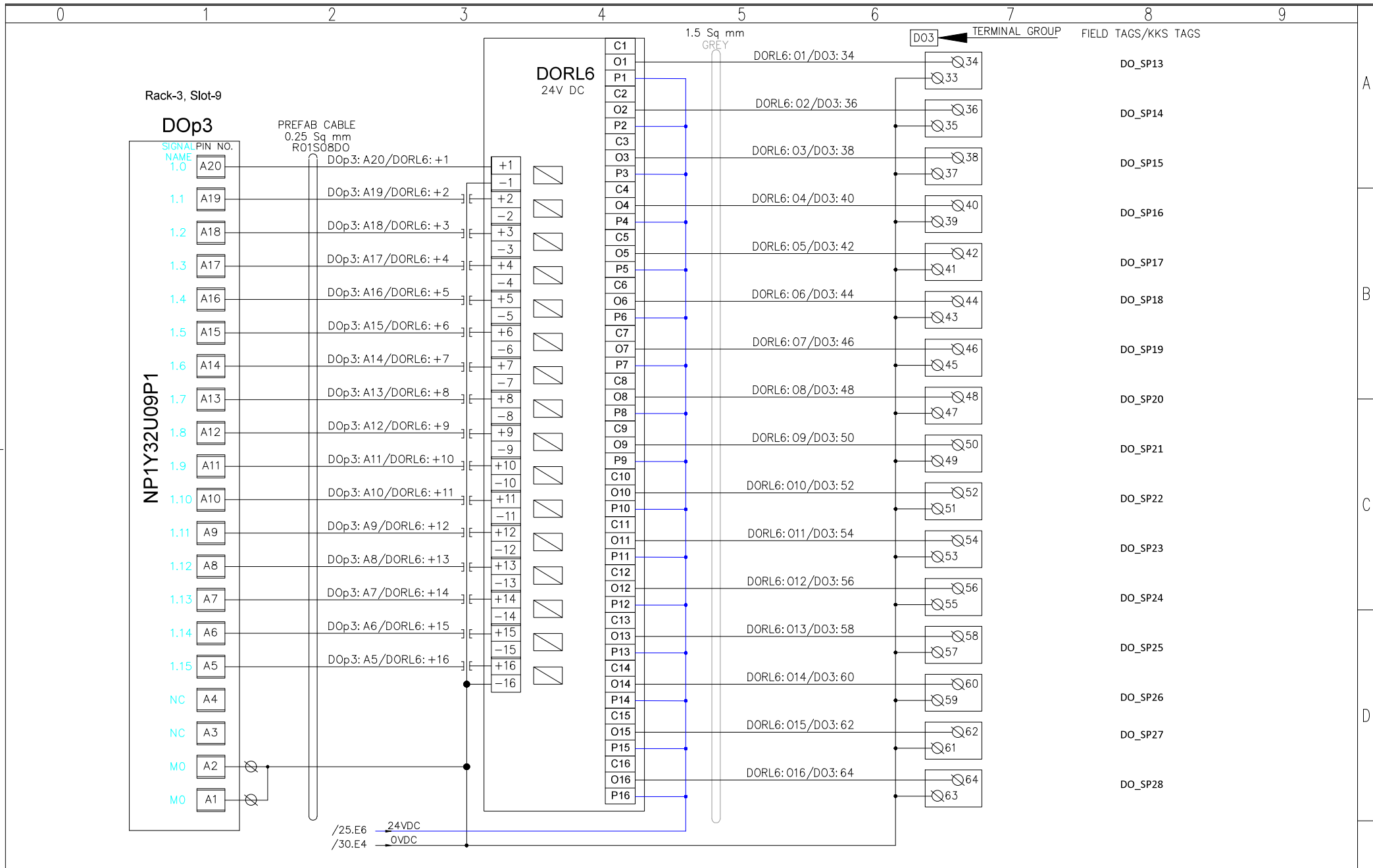
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REV	R5	FOR APPROVAL		30.12.2022	NP				CHD	GP								
REVISION	DESCRIPTION			DATE	SIGN.	DESCRIPTION				APPD	ND	PAGE SIZE	A3	SCALE	1:1	SHEET: 28 OF 35 180		

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REV	R5	FOR APPROVAL	30.12.2022	NP			CHD	GP					
REVISION	DESCRIPTION		DATE	SIGN.	DESCRIPTION		APPD	ND	PAGE SIZE	A3	SCALE	1:1	SHEET: 29 OF 35 181

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AS BUILT					PAGE		DOC TITLE		PROJECT			CUSTOMER		FUJII ELECTRIC INDIA PRIVATE LIMITED	
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REV	R7	FOR APPROVAL	31.03.2023	NP											
REV	R6	FOR APPROVAL	03.01.2023	NP			DRN	NP							
REV	R5	FOR APPROVAL	30.12.2022	NP			CHD	GP							
REVISION		DESCRIPTION	DATE	SIGN.	DESCRIPTION	APPD	ND	PAGE SIZE	A3	SCALE	1:1	SHEET:	30	OF 35	182

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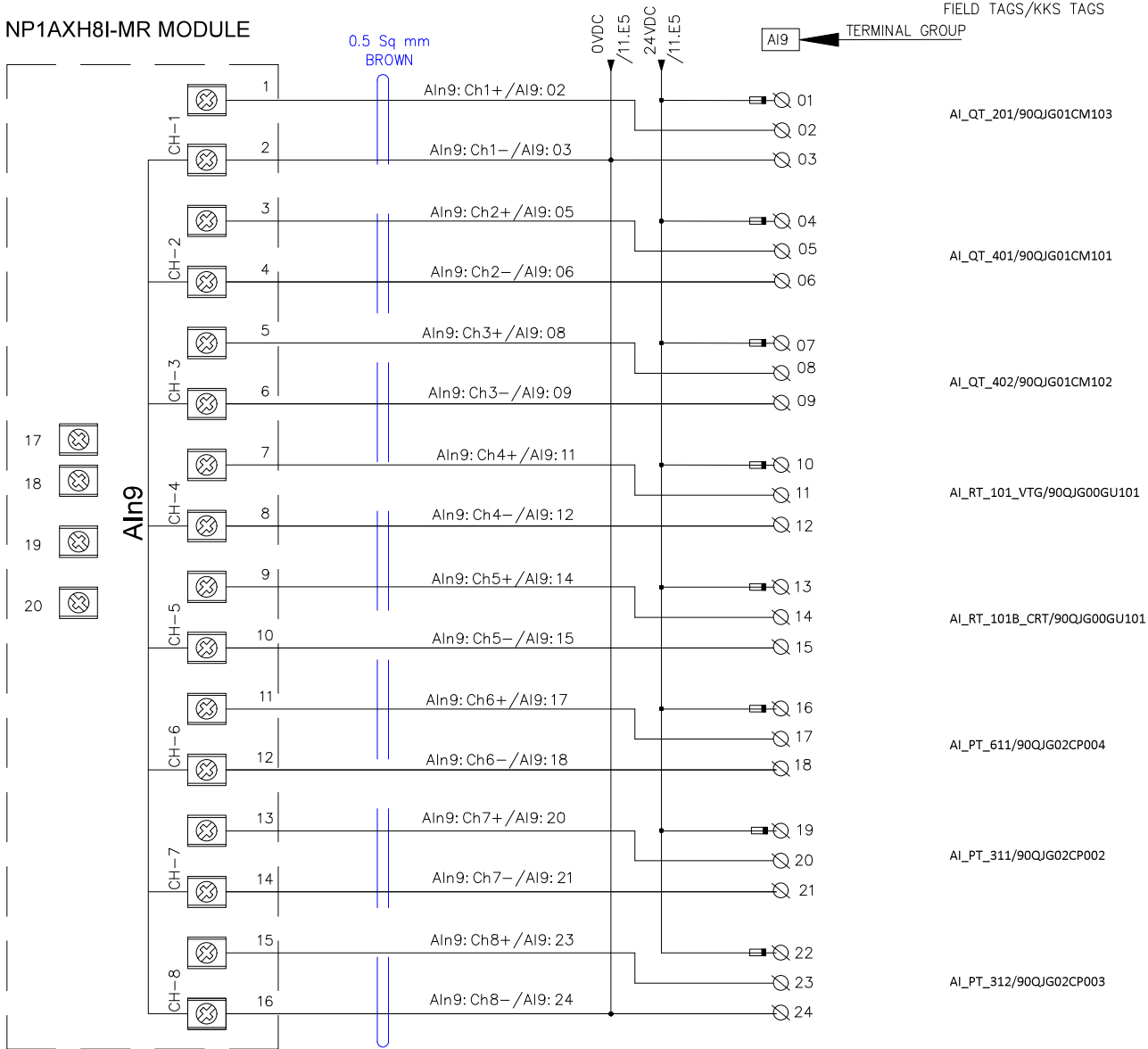
RACK-4 IO MODULES WIRING INDEX		
SHEET NO.	SLOT NO.	PAGE DESCRIPTION
32	5	8 CHANNEL ANALOG INPUT MODULE
33	6	32 CHANNEL DIGITAL INPUT MODULE
34-35	7	32 CHANNEL DIGITAL OUTPUT MODULE
	8	1 Channel Ethernet interface module (NP1L-ET1)
	9	1 Channel Ethernet interface module (NP1L-ET1)

AS BUILT 05.06.2024					PAGE DESCRIPTION	RACK-2 WIRING INDEX			DOC TITLE	WIRING DRAWING				
									PROJECT	2 X 660 MW UDANGUDI SUPERCRITICAL TPP				
REV	R8	FOR APPROVAL	16.05.2023	NP				CUSTOMER	BHEL			FUJI ELECTRIC INDIA PRIVATE LIMITED		
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REVISION		DESCRIPTION	DATE	SIGN.	DESCRIPTION			APPD	ND	PAGE SIZE	A3	SCALE	1:1	SHEET: 31 OF 35 183

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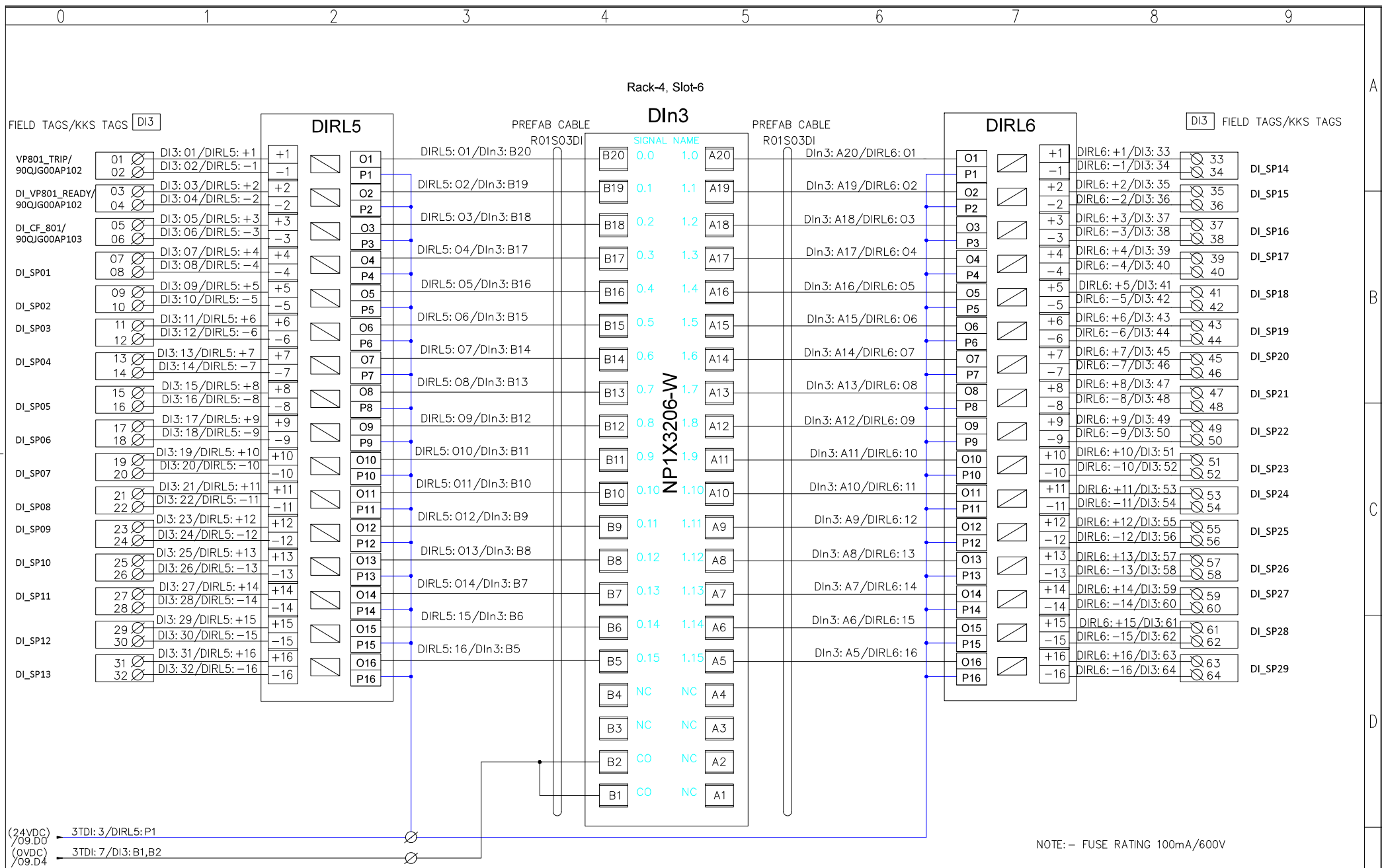
Rack-4, Slot No.-'5', NP1AXH8I-MR MODULE

NP1AXH8I-MR



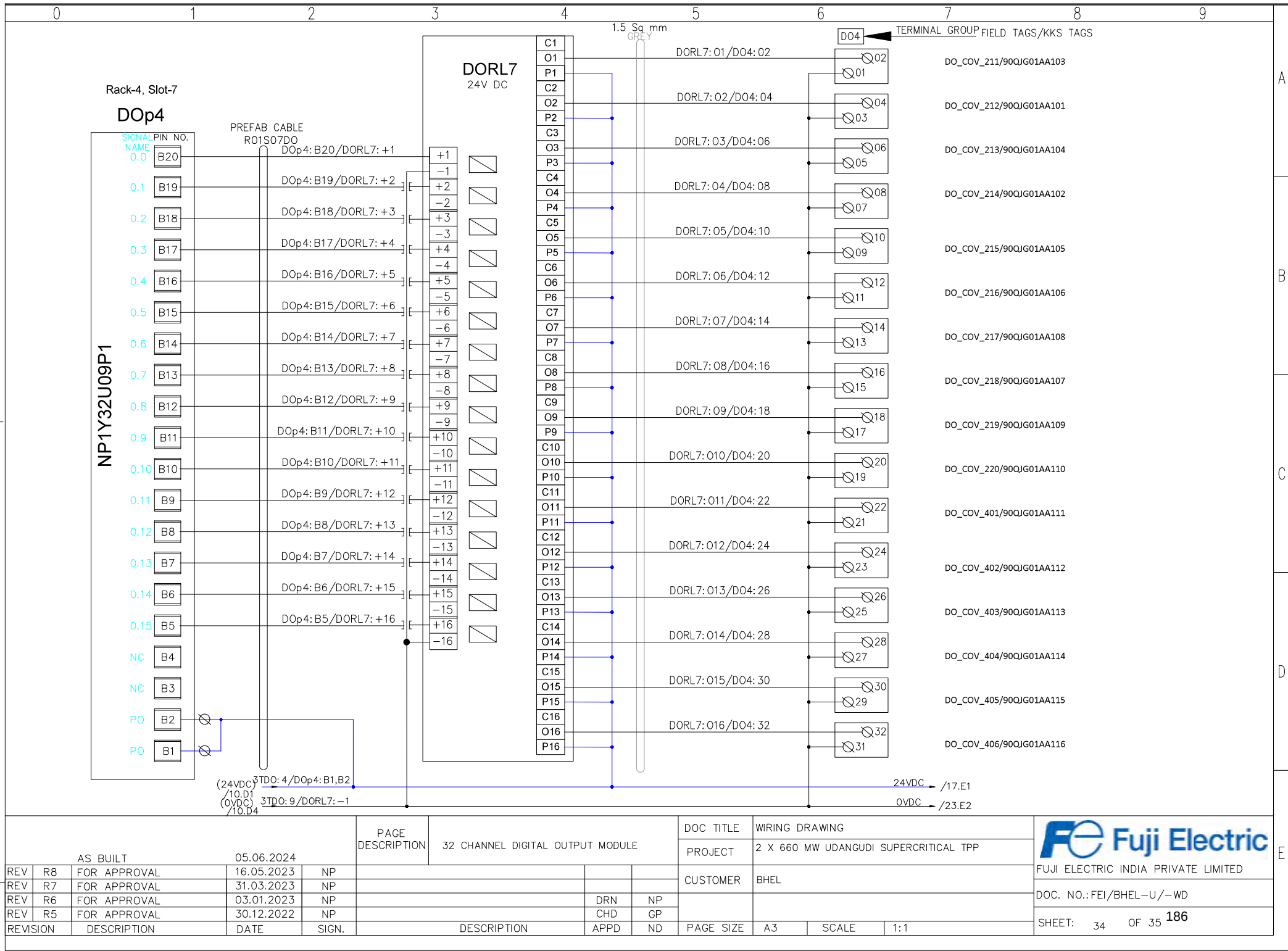
AS BUILT					PAGE DESCRIPTION	8 CHANNEL ANALOG INPUT MODULE			DOC TITLE		 Fuji Electric		
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REV	R5	FOR APPROVAL	30.12.2022	NP			CHD	GP			SHEET: 32 OF 35 184		
REVISION	DESCRIPTION		DATE	SIGN.	DESCRIPTION		APPD	ND	PAGE SIZE	A3	SCALE	1:1	

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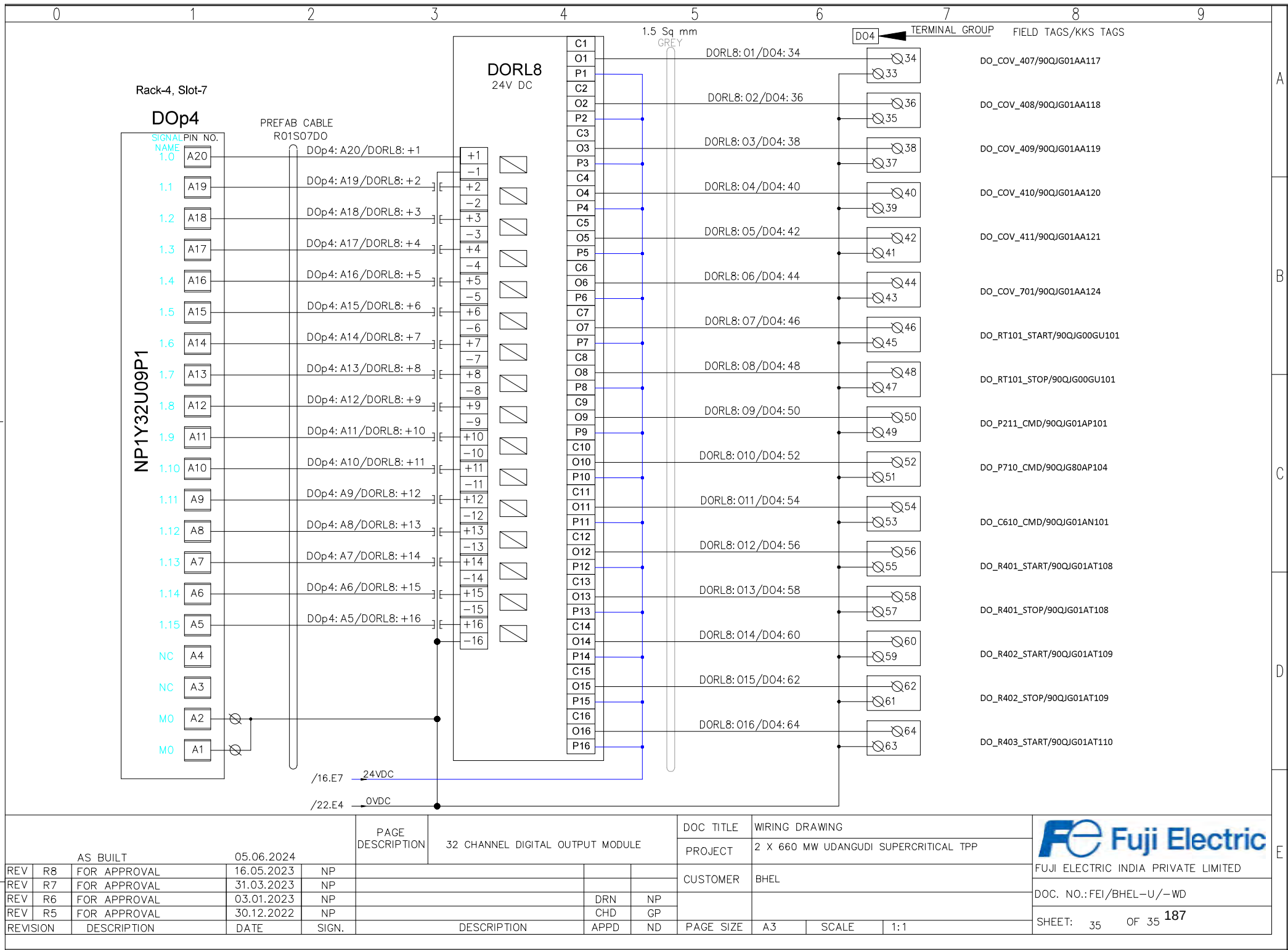
AS BUILT				05.06.2024		PAGE DESCRIPTION		32 CHANNEL DIGITAL INPUT MODULE		DOC TITLE		WIRING DRAWING				
										PROJECT		2 X 660 MW UDANGUDI SUPERCRITICAL TPP				
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								PROJECT	2 X 660 MW UDANGUDI SUPERCRITICAL TPP			
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	Client : Tamilnadu Generation and Distribution Corporation (TANGEDCO) P. O. No. : ANE/GGN/20230511/UDAN/0922/1 Rev-01 Project Name : PLC+SCADA For 2X660 MW Udangudi Supercritical TPP Document No. : FEI-AN-1000052921-BOM Document Name : Bill of Material	

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Project Information

Customer Name	Airox Nigen Equipment Pvt.Ltd.
End User	Tamilnadu Generation and Distribution Corporation (TANGEDCO)
Project Name/ Plant Name	PLC+SCADA For 2X660 MW Udangudi Supercritical TPP
Document No	FEI-AN-1000052921-BOM

Revision History

4					
3					
2	30.01.2024	Bill of Material	GP	PP	DB
1	19.04.2023	Enclosure BOM	GP	PP	DB
0	31.03.2023	Enclosure BOM	GP	PP	DB
Rev. No.	Release Date	Description	Prepared by	Reviewed By	Approved By

Revision No	3	Date of Revision	05.06.2024	Purpose	AS BUILT

	Client : Tamilnadu Generation and Distribution Corporation (TANGEDCO) P. O. No. : ANE/GGN/20230511/UDAN/0922/1 Rev-01 Project Name : PLC+SCADA For 2X660 MW Udangudi Supercritical TPP Document No. : FEI-AN-1000052921-BOM Document Name : Bill of Material	

Table of Contents

1.	FUJI Material List	4
1.1.	FEJ Hardware	4
1.2.	IT Hardware	5
2.	PLC Enclosure detailed BOM.....	6
2.1	PANEL-1	6
2.1.1.	<i>Common Panel specification</i>	6
2.1.2.	<i>Wiring specifications</i>	7
2.1.3.	<i>Panel Accessories</i>	8

Revision No	3	Date of Revision	05.06.2024	Purpose	AS BUILT

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1. FUJI Material List

1.1. FEJ Hardware

Sr. No.	Identification Tag	Specification	Catalogue No.	Make	Qty.	Unit
1.1.1.	PS 1-8	I/p 230V AC, O/p 35W Power Supply 2 slot type	NP1S-22	Fuji	8	No.
1.1.2.	RACK 1	Hot plug baseboard with station No. setting switch for 13 slot, processor bus 3 slots	NP1BP-13D	Fuji	1	No.
1.1.3.	RACK2-4	Hot plug base board with station No. setting switch for 11 Slot processor bus 3 slots	NP1BS-11D	Fuji	3	No.
1.1.4.	CPU 1-2	32K steps · Max. No. of I/O points: 8192 points (SPH300)	NP1PS-32R	Fuji	2	No.
1.1.5.	IM1-4	SX Bus duplex connection unit(SX Communication)	NP2L-BH1	Fuji	4	No.
1.1.6.	DIn 1-3	24 V DC, 32 Points, 4mA , 1 to 100ms variable connector type Digital Input Module	NP1X3206-W	Fuji	3	No.
1.1.7.	DOP 1-4	Tr. Source 12 to 24V DC, 32 point, 0.12 A/point, 3.2 A/ common ,connector type Digital Output Module	NP1Y32U09P1	Fuji	4	No.
1.1.8.	Aln 1-9	Multi range, high speed type, Current input : 8 channels, Resolution: 14 bits, Screw terminal type Analog Input module	NP1AXH8I-MR	Fuji	9	No.
1.1.9.	ET1-4	Ethernet interface module 10 BASE-T/100 BASE -TX	NP1L-ET1	Fuji	4	No.

Revision No	3	Date of Revision	05.06.2024	Purpose	AS BUILT

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1.2. IT Hardware

Sr. No.	Identification Tag	Specification	Catalogue No.	Make	Qty.	Unit
1.2.1	Tellus Compact USB Key	Runtime License for SCADA		Fuji	2	No.
1.2.2	Reporter	V-Server		Fuji	1	No.
1.2.3	SCADA/OWS Work-Station	1. Display- 24" LED, Resolution - 1920*1080 (Full HD) Input-VGA & HDMI, 60Hz 2. Processer- Intel core i5-12500 3. RAM – 8 GB 4. Interface – LAN- 10BASE-T/100BASE-TX/1000BASE-T,RJ45 X 3 5. Internal HDD- 512GB Display port - HDMI x 2	OptiPlex 7010	DELL	2	No.
1.2.4	Printer	A3 Colour Laser Jet Printer	SC2020	Xerox	1	No
1.2.5	ETH 1-2	Unmanaged Industrial Grade 8 port Ethernet Switch	-	Ebrix	2	No.
1.2.6	LIU 1-2	4 Port Fully Loaded LIU Box	LIU101001	ASPL	2	No.
1.2.7	Patch Cord	Fiber Optic Patch Cord	LIU-PC0021	ASPL	2	No.
1.2.8	FO 1-2	Industrial Media Converter SC MM,e-Brix	EB1011SC	Ebrix	2	No.

Revision No	3	Date of Revision	05.06.2024	Purpose	AS BUILT

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2. PLC Enclosure detailed BOM

2.1 PANEL-1

Sr. No.	Identification Tag	Specification	Catalogue No.	Make	Qty.	Unit
1	PLC SYSTEM FOR H2 GENERATION PLANT	Enclosure Size : 2000 (H) X 1200(1200) (W) X 800 (D) mm with Front & Rear Door along with Base plinth (100 mm)	-	RITTAL	1	Set

2.1.1. Common Panel specification

- Panel Earth Busbar (FG) : 25 X 6 mm Tinned coated Cu with threaded holes
- Signal Earth Busbar (SG) : 25 X 6 mm Tinned coated Cu with threaded holes.
- Side Supports channel : 6 Nos (Size : 750 (L) X 60mm (W)) for support the mounting plates
- Cable ferrule sleeve should be proper size to avoid loose from lug. (white color – black font)
- All marking label, Tags should be weatherproof. (Yellow background with Black font)
- Louvers with removable wire mesh

Revision No	3	Date of Revision	05.06.2024	Purpose	AS BUILT

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2.1.2. Wiring specifications

Potential	Wire Specification	Wire Color	Wire Make	Terminal Color	Remarks
230 VAC Phase	1.5/2.5/4 sq.mm single core multistrand	RED	Reputed	RED	
230 VAC Natural	1.5/2.5/4 sq.mm single core multistrand	Black	Reputed	Black	
230V Electrical Earth	2.5 sq.mm single core multistrand	Green	Reputed	Green	
+ 24 VDC	4/2.5/1.5/0.5 sq.mm single core multistrand	Blue	Reputed	Blue	Fuse terminal in Gray color
0 VDC	4/2.5/1.5/0.5 sq.mm single core multistrand	White	Reputed	White	
DI Signal Cables	40 pin FCN Cable			Grey	DI Relay to DI module
DO Signal Cables	40 pin FCN Cable			Grey	DO Module to DO Relay
AI Signal Cables	0.5 sq.mm single core multistrand	Brown+White	Reputed	Grey	AI Module to AI Field Terminal

Revision No	3	Date of Revision	05.06.2024	Purpose	AS BUILT

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2.1.3. Panel Accessories

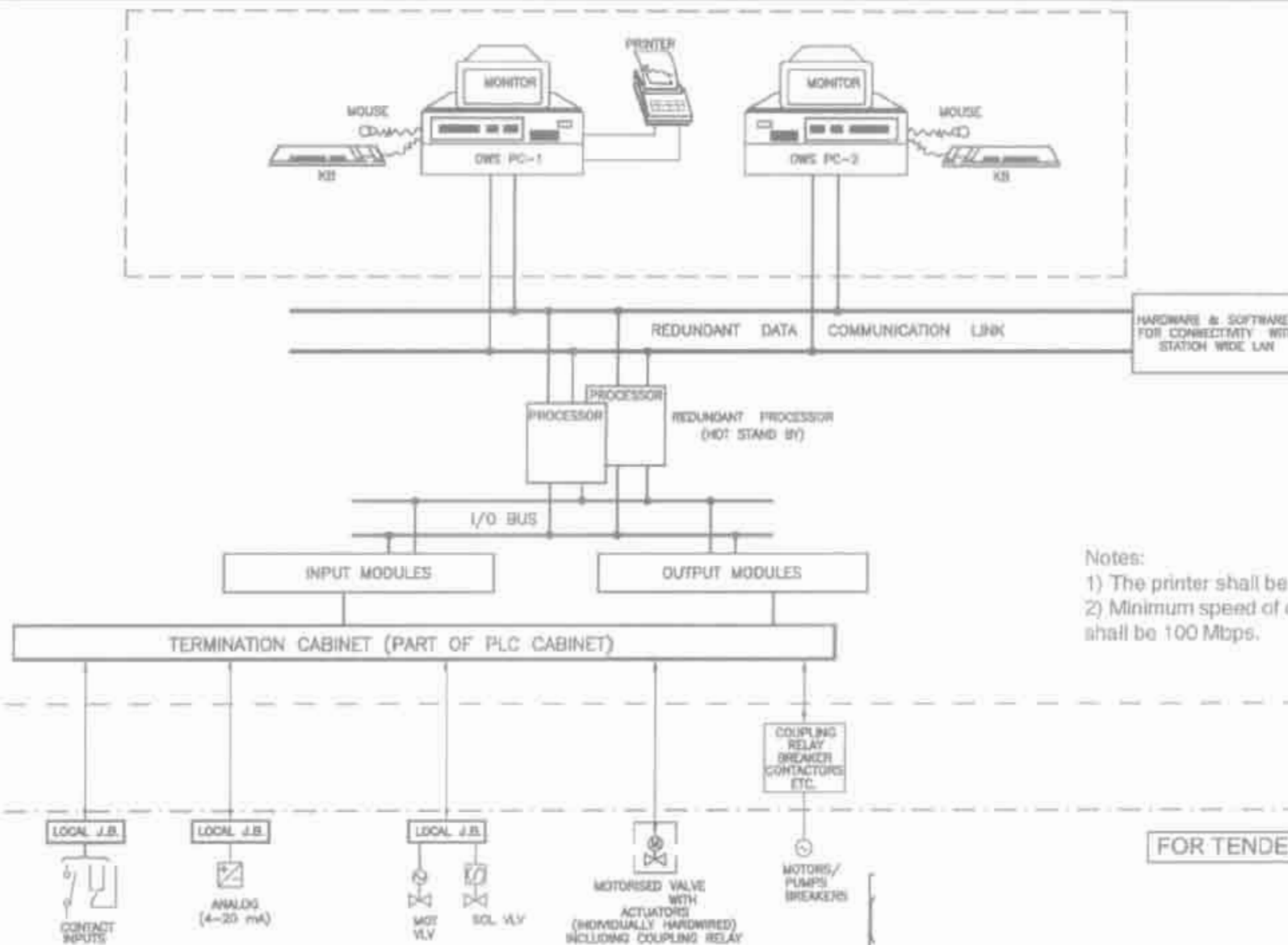
Sr. No.	Identification Tag	Specification	Make	Qty.	Unit
2.1.3.1	1T 1-2, 3	4 sq mm Incoming terminal for Non-UPS 230 VAC supply (Red, Black & Green)	Connectwell	3	No.
2.1.3.2	1TP 1-4, 1TN 1-4	4 sq mm Fused terminals with 6A glass fuse	Connectwell	4	No.
2.1.3.3		4 sq mm Standard terminals	Connectwell	4	No.
2.1.3.4	2T1-3	6 sq mm Incoming terminal for UPSA-230 VAC supply (Red, Black & Green)	Connectwell	3	No.
2.1.3.5	2TP 1-12, 2TN 1-12	4 sq mm Standard terminals	Connectwell	24	No.
2.1.3.6	3TL 1-5, 3TM 1-5	4 sq mm Standard terminals(BLUE+WHITE)	Connectwell	10	No.
2.1.3.7	DS1-2	Door limit switch	Siemens	2	No.
2.1.3.8	CFL1-2	5W	Philips	2	No.
2.1.3.9	SOC	5A Utility Socket	Anchor	1	No.
2.1.3.10	FAN1-2	4" Fan with Filter(Reputed make)	Elettro	2	No.
2.1.3.11	Filters	6" Filters Louvers	Electro	4	No.
2.1.3.12	2PS1,2PS2	20A,24V DC Power Supply, 220VAC/24VDC	Meanwell	2	No.
2.1.3.13	OD1	20A Oring Diode	UL	1	No.
2.1.3.14	1MCB1	AC 10A, 2P (Supply to Utility CFL 1-2, FAN 1-2)	Siemens	1	No.
2.1.3.15	2MCB1	AC 20A 2P (UPS Incomer)	Siemens	1	No.
2.1.3.16	2MCB4-11	AC 2A 2P (Supply to Rack PS)	Siemens	8	No.
2.1.3.17	2MCB12	AC 6A 2P (SPARE)	Siemens	1	No.
2.1.3.18	2AMCB2-3	AC 6A 2P (2PS1-2 Incomer)	Siemens	2	No.

Revision No	3	Date of Revision	05.06.2024	Purpose	AS BUILT

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2.1.3.19	3MCB1	DC 16A, 2P (Supply to FIELD)	Siemens	1	No.
2.1.3.20	3MCB2	DC 2A 2P (Supply to Eth Switches)	Siemens	1	No.
2.1.3.21	3TAIP	4 sq mm Fused terminals with 6A glass fuse	Connectwell	9	No.
2.1.3.22	3TAIN	4 sq mm Standard terminals	Connectwell	9	No.
2.1.3.23	3TDIP-N,3TDOP-N	4 sq mm Standard terminals	Connectwell	16	No.
2.1.3.24	DI1-3	4 sq mm Field terminals (2 sets of 33 Double level STANDARD terminals)	Connectwell	66	No.
2.1.3.25	DO1-4	4 sq mm Field terminals, 24VDC Supply (3 sets of 33 Double level standard terminals)	Connectwell	99	No.
2.1.3.26	DIRL1-6, DORL1-8	16- Channel 1C/O relay board for DI&DO, 24VDC COIL	UL	14	No.
2.1.3.27	AI1-9	4 sq mm Double level Field terminals for AI1-9 (9 sets of 8 DL terminal, one level with Fuse)	Connectwell	72	No.
2.1.3.28		4 sq mm Field terminals for AI1-9 (9 sets of 8 standard terminals)	Connectwell	72	No.
2.1.3.29	SPARE	4 sq mm Double level terminals	Connectwell	5	No.
2.1.3.30		4 sq mm Standard terminals	Connectwell	10	No.
2.1.3.31		4 sq mm Fuse terminals	Connectwell	5	No.
2.1.3.32		16- Channel 1C/O relay board, 24VDC COIL	UL	3	No.
2.1.3.33		Other Panel Accessories (AS PER DRAWINGS)		As Req.	

Revision No	3	Date of Revision	05.06.2024	Purpose	AS BUILT



Notes:

- 1) The printer shall be a network printer;
- 2) Minimum speed of communication bus shall be 100 Mbps.

FOR TENDER PURPOSE ONLY

DESCRIPTION

M E C C&I ARCH.
Cleared by



TITLE :
2X660 MW UDANGUDI STPP

SPECIFICATION NO. PE-TS-435-168-A001

SECTION : I

**TECHNICAL SPECIFICATION FOR HYDROGEN
GENERATION PLANT**

SUB-SECTION: IIA

REV. NO. 00

SECTION – IIA

GENERAL TECHNICAL REQUIREMENT (MECHANICAL)

	DOCUMENT TITLE: DESIGN PHILOSOPHY OF HYDROGEN PLANT ALONG WITH SINGLE LINE FLOW DIAGRAM FOR		DOCUMENTS NO: PE-DC-435-168-A001	
			DEPTT: MECHANICAL AUXILIARY	
			REV. NO. 1	DATE: 22/10/2018
	2 X 660 MW UDAN GUDI STPP.			

1.0

SCOPE

The scope of this design philosophy covers the basis of design, system description, equipment selection aspects and control philosophy for HYDROGEN GENERATION PLANT of capacity 2 x 15 Nm³/hr which is common for the station.

2.0

REFERENCE DOCUMENT



- i) Drive Control Philosophy, # PE- DM-435-145-I002.
- ii) Control System for Mechanical Auxiliary Packages, # PE-DM-435- 145-1900

3.0

DESIGN BASIS

Hydrogen generation plant will be designed to maintain hydrogen purity at gas manifolds 99.998% and moisture content 0.05 g /m³ (max) and dew point of (-) 70 deg. C. 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 shall be **bipolar** design.

4.0

GENERAL OPERATION CRITERIA / PHILOSOPHY:

- i) Designed for Continuous duty as well for two shift or one shift operation.
- ii) Designed for parallel operation of both streams.
- iii) Flexibility to operate electrolyser in part load from 20% to 100% of the rated capacity.
- iv) Complete operation from PLC based local control panel.
- v) 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.
- vi) Set pressure to be maintained with the help of back pressure regulating valve.
- vii) Automatic operation of standby compressor as and when required.
- viii) To provide alarm & tripping of compressor based on suction conditions.

5.0

CONSTRUCTION DETAILS OF EQUIPMENT

Electrolyser cells:

- i) Electrolyser cells shall be of bipolar design.
- ii) Cells in electrolyser shall be connected to each other. The cells in electrolyser shall be of corrosion resistant material.
- iii) 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.
- iv) All measuring instruments, controllers, and control valves shall be provided.
- v) Safety devices will be provided on each collecting pipe to release gas pressure in case it goes above the limits.
- vi) It will be designed so that it can be cleaned and maintained easily. Cells module will be part of the gas generating station.
- vii) 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.
- viii) Electrolyser cells, hydrogen gas purifications system, compressor skid including instrumentation are part of the vendor's standard manufacturing skid system.

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			DEPTT: MECHANICAL AUXILIARY	
			REV. NO. 1	DATE: 22/10/2018
	2 X 660 MW UDAN GUDI STPP.			

6.0 Rectifier:

Two nos. of rectifier (one for each electrolyser) to cater 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.

7.0 Demineralized water tank

Two numbers tank of Capacity adequate for 5 days normal requirement of hydrogen gas generation on continuous basis at rated capacity of Hydrogen generation Plant. Tank will be fitted with drain connections, level transmitters, level indications. The Tank shall be of HDPE construction. Water level shall be controlled via a solenoid valve with float type level switch assembly mounted at tank top.

8.0 DM Water Pump

Used for feeding water into the system. Normally, the interval of feeding water is about 2 hours and finished in 10 minutes. The feed water pump capacity shall be decided suitably by the Contractor & pressure shall be 16-18 bar (g). This high pressure is required in order to pump water into system.

9.0 KOH mixing tank: -

- i) Capacity - Suitable to fill one electrolyser
- ii) Material – HDPE
- iii) Accessories as applicable - Removable cover, instruments as required
Pump- Suitable to pump alkali up to the cells with discharge flexible hose, pressure gauge at pump discharge etc.

10.0 De-oxy unit

The de-oxy unit shall be capable of removing oxygen as impurity from the hydrogen gas to achieve the hydrogen purity of 99.998%.

11.0 Gas Cooler

A gas cooler for H₂ coming out of the de-oxy unit shall be provided to cool the hot H₂ gas.

12.0 Hydrogen Storage tank

Two Nos (2) of H₂ storage Tanks shall be considered between the H₂ Generator and Compressor for stability of pressure which acts as buffer cum suction pot. The volume of the tank shall be suitably decided by the Contractor and its working pressure shall be minimum 16 bar (g). The M.O.C shall be 16 MnR (SA 516 Gr. 70). Design pressure of the Buffer Vessel shall be 32 bar (g). Capacity of each tank shall be minimum 400litres

13.0 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/cm² (g)
- iv) Type Preferably Oil free, Diaphragm type.
- v) Diaphragm type with triple diaphragm failure detection system. The side and oil side diaphragms shall be of Stainless Steel.
- vi) Drive cage Constant speed Square cage flame proof type Electric motor suitable for group-IIC location as per IS:2148 or Class-I Div. II of NEC.
- vii) Activated carbon filters 2x100% and required in case of oil lubricated compressors

All metal to metal joints shall be provided with "O" rings of suitable grade material. 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

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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.

All suitable auxiliaries (as applicable) such as built in relief valves, Pressure and temperature gauges after every compressor stages, mechanical lubricator, 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 standby 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.

14.0 Drying system for Hydrogen gas

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

15.0 Back Pressure regulating valve:

One number spring loaded disc. Operated self-actuating type backpressure regulating valve to maintain 150 Kg/cm² (g) pressure on the compressor discharge. It will be provided with accessories such as Pressure sensing element, controller etc.

16.0 Cylinder Manifold:

One dual filling cylinder filling manifold, arrangement for two banks of minimum six cylinders each to permit connection and removal of cylinder (water capacity – 46.7 liters (approx.) without interruption or filling. Accessories such as isolating valves, safety valves, pressure gauges, temperature gauge, pressure switch (to shut off compressor beyond set pressure), "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 4 no's cylinders with accessories such as isolating valves, safety valves, pressure gauges etc.

17.0 Flushing System

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

18.0 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.

19.0 Piping:

- All pipe to conform to ASTM or equivalent pressure piping code, and seamless type.
- All high pressure joints shall of ferrule/welded construction.

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iii) All hydrogen vents will be fitted with flame arrestor.

20.0 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 be less than 30 air changes per hour. The exhaust air shall be discharged at a suitable height from the room.

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.

21.0 HYDROGEN AND NITROGEN GAS CYLINDERS

12 Nos. of Hydrogen storage cylinders shall be supplied to store the hydrogen gas. The hydrogen storage cylinders shall be suitably designed for 150kg/cm² (g) working pressure. The geographical volume of each cylinder shall be 46.7 litres (approx). The cylinders shall be as per IS: 3224 and IS: 7285. The total cylinder capacity is adequate for flushing the system.

4 Nos. of Nitrogen gas cylinders shall be supplied and installed in Gas flushing manifold. Cylinder capacity (water capacity – 46.7 liters (approx.)). The cylinders shall be as per IS: 3224 and IS: 7285. The total cylinder capacity is adequate for flushing the system.

22.0 CODES AND STANDARDS.

All the codes and standards shall be as per manufacturer's standard practices.

23.0 CONTROL AND INSTRUMENTATION

PLC based monitoring and control system with hot standby processor shall be provided for plant. All electronic devices like Switches/Transmitters/Controller/Analyser/Solenoid valves which are located in Hydrogen Generation Plant shall be made intrinsically safe by providing suitable type of Transformer isolated barrier/Zeener barrier of standard make. Otherwise such instruments shall be provided with explosion proof enclosure suitable for hazardous area described in National Electric Code (USA), Article 500, Class-I, Division-I or EN 60 079-14 or shall comply with essential requirements of AT EX directives. All fittings, cable glands etc. shall be strictly as per NEC recommendation article, 500 to 503 as approved by Chief Controller of Explosives, India and other statutory authority.

24.0 COOLING WATER

The DM water shall be used in closed circuit with chiller unit for cooling of equipment. Chiller unit consist of two nos. Air cooled chillers, one number Chiller water storage tank of adequate capacity, two nos. chilled water recirculation pumps complete with drive motors along with strainers and all other necessary instruments, isolation valves, piping, flanges, pipe fittings etc.

25.0 Notes:-



- 1) The intent of this design memorandum is to cover the basic design criteria for "Hydrogen generation Plant" for subject project A brief description and salient feature of the various sub system of "Hydrogen generation Plant are defined here for the basis of design. However, the detailed specification requirement as described in the TECHNICAL SPECIFICATION/CONTRACT shall be met in totality without any deviation.
- 2) All relevant design standards and design criteria shall also be included in the design Memorandum as per Technical specification, Vol. II, Section 2, Sub section 2.18, cL No. 2.0.0 and Section 4.
- 3) Scope of supply and control/operation philosophy shall be as per specification, Vol. II, Section 2, sub section 2.18.

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	2 X 660 MW UDAN GUDI STPP.			

- 4) Design Requirement shall be as per specification, Vol. II, Section 2, sub section 2.18, cl. No. 4.0.0
- 5) Technical Requirement shall be as per specification, Vol. II, Section 2, sub section 2.18, cl. No. 5.0.0.
- 6) Details regarding control and operation of Hydrogen Generation Plant shall be as per specification, Vol. II, sub section 4.2, cl. No. 1.1.18.
- 7) Details regarding instruments required for Hydrogen Generation Plant shall be as per specification, Vol. II, sub section 4.3, cl. No. 5.0.0.
- 8) Control and operation philosophy shall be updated as per specification, Vol. II, section 4, sub section 4.5.
- 9) Complete requirements shall be as per specification, Vol. II, section 4, sub section 4.10, cl. No. 16.0.0. Same requirements shall be complied by sub vendor also without any deviation. However, hydrogen generation plant control shall be PLC based from the hydrogen generation system local control room with remote monitoring from the central control room in the main plant DCS as per specification, Vol. II, section 4, sub section 4.5.
- 10) Complete cables (Power, control & trailing) shall be provided as per Technical specification. All the cables shall be armored only.
- 11) Temperature transmitters shall be provided for all control applications as per specification, Vol. II, sub-section 4.3, Cl. No. 5.2.0.
- 12) Dual redundant sensors shall be provided only for instrument which are mounted outside Manufacturer standard skids. However, BHEL shall follow the contract specification requirement to the extent possible.
- 13) Redundant sensors shall be provided only for instrument which are mounted outside manufacturer standard skids. However, BHEL shall follow the contract specification requirement to the extent possible.
- 14) "Hydrogen piping system shall be designed in accordance with the ASME B31.12 - Hydrogen Piping and pipelines, other applicable codes and regulations and the special requirements for Hydrogen services". "Piping, tubing, fittings, valves, accessory equipment, gaskets and thread sealants shall be suitable for hydrogen service at the pressures and temperature encountered and shall maintain their integrity under elevated temperatures during fire conditions." "Selection' of piping joints shall consider the potential for leaks, mechanical strength, material and fire safety acceptability".
- 15) Instruments used for Hydrogen application shall be Flame proof/Explosion proof for NEC class 1, Division 1 area as per Technical specification.
- 16) All primary Instruments, hardwires & JB's etc. used for measurement for Hydrogen shall be intrinsically safe and explosion proof as per NEC. article 500, class 1, Division 1 area I.
- 17) Complete instruments shall be provided as per specification, Vol. II, section 4, sub section 4.10, cl. No. 16.0.0. However, hydrogen generation plant control shall be PLC based from the hydrogen generation system local control room with remote monitoring from the central control room in the main plant DCS as per specification, Vol. II, section 4, sub section 4.5.

**VOLUME II****SECTION - 2.18****HYDROGEN GENERATION PLANT & CYLINDERS****1.0.0 GENERAL**

This section is intended to specify the detailed specification of the various mechanical equipments of the Hydrogen Generation Plant and Cylinders as covered in this specification.

The Hydrogen Generation Plant and Cylinders and associated accessories shall be designed, manufactured, inspected, tested, including supervision of erection, testing and commissioning to well established engineering practices, safety codes and other relevant codes and standards.

Compliance with this specification shall not relieve the Contractor of the responsibility of furnishing material and workmanship to meet the specified conditions.

2.0.0 CODES AND STANDARDS

The Hydrogen Generation Plant and all associated piping and systems shall be designed, manufactured, inspected, tested, to well established engineering practices and safety codes of the latest applicable Indian / British / American / DIN / ISO standards.

ANSI B 31.3	ASME code for process piping
BS: 5156	Diaphragm valves
AWWA C-504/BS 5155	Butterfly valves
IS 5120/ IS 9173	Pumps
IS 5312	Non return valve
IS 803	Storage tanks
OSHA, NEC, NEMA, ASTM, API 618	H2 Compressors
IS:7241	Glossary of terms used in cylinder technology
IS:7285	Specification for seamless steel cylinders for permanent and high pressure liquefiable gas cylinders
IS:8198	Steel cylinders for compressed gases (Atmospheric Gases, Hydrogen, High pressure liquefiable gas cylinders and dissolved acetylene gases)

3.0.0 SCOPE OF SUPPLY

The Hydrogen Generation plant will include but shall not be limited to the following:

- Two (2) nos. of Hydrogen Gas Generator / Electrolyser Units of Specified Capacity.
- One (1) no Common DM Water Storage Tank of required capacity with all necessary accessories and Instruments.
- One no KOH Tank for each Hydrogen gas Generator with necessary drain, vent, Chemical Filling line , Inlet, Outlet lines and all necessary Instruments.



- One no Motor Driven Electrolyser DM Pump for each Hydrogen gas Generator with all necessary Valves, Instruments and accessories for each stream.
- One no Dryer of Regeneration type for each Hydrogen Generator with necessary moisture traps, regeneration system, drains etc.
- Adequate nos. of Hydrogen storage tank with all accessories, Instruments and safety Equipments for each tank.
- Suitable nos. of Nitrogen Cylinders to Purge the Hydrogen Generator, with Nitrogen Cylinder Manifold, Valves, Instruments and Piping to Purge the Hydrogen Generator.
- Hydrogen piping manifold with necessary valves, Instruments, etc,
- All integral and interconnecting piping, valves , all types of pipe support, including pipe racks, etc for the entire Hydrogen Generation Plant .
- Any other equipment / accessory/component necessary for the effective, safe and efficient operation of Hydrogen Generation plant.

4.0.0 DESIGN REQUIREMENTS

The function of the Hydrogen Generation Plant system is to safely generate Hydrogen Gas of specified purity and store in the cylinders for use in Turbine Generator.

The Hydrogen Generation Plant shall be of 2 x 100% streams each of suitable Capacity of modular manifolds at 99.998 % (max) and dew point of -70°C. The moisture content in hydrogen shall not exceed 0.05 gm/m³. The complete hydrogen generation plant system equipments, layout shall be designed as per the guidelines of explosive authority (chief controller of explosives) of India and other statutory authorities for the design and installation of the plant. The hydrogen generation equipment (Electrolyser) shall be of **bipolar** design. The Production of each Electrolyser shall be variable between 20 and 100 percent. All the Piping and Valve material shall be of SS 316L grade.

Hydrogen Gas is generated by electrolysis of water, with KOH as the electrolyte. The water used here is DM Water, which is fed from a DM Water Storage Tank to Electrolyte Making Tank where the electrolyte will be mixed to form a solution of the required strength (28% KOH solution). The electrolyte solution is then pumped with the help of 1 x 100% electrolyte making pump to the Hydrogen Generator where the actual electrolysis process takes place. AC power will be supplied to silicon rectifier, which shall provide DC power to operate a battery of cells. By electrolytic process of water, each cell shall produce two (2) parts of hydrogen and one (1) part of oxygen.

The hydrogen thus generated from each battery of cells is passed through a catalytic hydrogen purifier to remove any traces of O₂ present.

Moisture from hydrogen shall be separated through an adequately sized Dual Tower Desiccant Dryer and then passed through a Hydrogen storage Tank of suitable capacity manufactured to IS or equivalent standards. From the Hydrogen storage tank, the gas shall be compressed and stored in the cylinders. The hydrogen cylinders shall be used for the generator cooling. Nitrogen Manifold is provided for adequate purging of the system.

5.0.0 TECHNICAL REQUIREMENTS

Hydrogen is proposed to be generated along with oxygen by electrolytic dissociation of water into its basic constituents:

The generated hydrogen gas output shall be regulated to a set value of an automatic control system, which regulates the electrical input. The plant utilising this process shall take up less space and there shall not be any problems in respect of water contamination, air pollution or



noise etc. The basic components of the hydrogen generation plant are as following, but not limited to the same.

5.1.0 Electrolyser

The Electrolyser shall be of modular type having Bipolar type Cells and shall be connected to each other to form a single unit. The cells and Electrodes in the Electrolyser shall be of corrosion resistant Material. The electrodes of the cells shall be such as to distribute the current evenly on the entire surface of the electrodes. Between the anodes and cathodes there shall be a diaphragm of woven pure asbestos for separating the gases generated in this space.

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 parameters. All measuring instruments for Pressure, Temperature, controllers and control valves shall be provided. Safety devices will be provided to release the gas pressure, in case it goes above the limits.

The Electrolyser Cells shall have Diaphragms in between the electrodes in such a manner to prevent mixing of the Oxygen and Hydrogen gases. The design shall take care of avoiding or minimizing the Carryover of Electrolyte downstream of Electrolyser. The Cells shall be designed in such a way that they can be cleaned and maintained easily.

Sampling of H₂ gases from each cell with sight glass shall be provided for safe sampling & handling.

The mixing, filling, replenishing of electrolyte shall be required only during maintenance periods and not during normal operation.

The Electrolyser shall be protected against accidental grounding, arcing or electrical shock.

The level of electrolyte shall be automatically controlled.

5.2.0 Rectifier

For each electrolyser, transformer-rectifier set adequately sized to cater to the load demand shall be provided. The rectifier equipment shall be complete in all respects with air-cooled rectifier transformer, thyristor converter, electronic control and annunciation, filter choke etc. mounted on suitable panels.

5.3.0 Caustic Solution Tank

The electrolyte is typically stored in carboys and then drained or poured into the Caustic solution Tank with the aid of funnel provided for this purpose. The tank shall be of HDPE construction with flape type cover, half type. The outlet of transfer pump is connected to electrolyte during initial filling or make-up when gravity of electrolyte falls below a recommended density through quick coupler.

5.4.0 Hydrogen Dryer or purifying unit

The Purified Hydrogen from the catalytic Hydrogen Purifier shall be passed through a Dual Tower Desiccant Dryer unit filled with high performance molecular sieve and with heaters and related RTD of suitable Design to remove any moisture present in the Hydrogen gas. The Dryer shall have all necessary filters, valves, instruments etc.



5.5.0 Hydrogen Storage tank

Two Nos (2) of H₂ storage Tanks shall be considered between the H₂ Generator and Compressor for stability of pressure which acts as buffer cum suction pot. The volume of the tank shall be suitably decided by the Contractor and its working pressure shall be minimum 16 bar (g). The M.O.C shall be 16 MnR (SA 516 Gr. 70).

Design pressure of the Buffer Vessel shall be 32 bar (g).

Capacity of each tank shall be minimum 400litres

5.6.0 H₂ Charging Manifold

Minimum 2 nos of Hydrogen Gas Cylinder Manifold for cylinders shall be provided.. Each manifold shall be capable of simultaneous filling minimum 6 cylinders. Sufficient quantity of high pressure manifold valves, pressure gauges, non-return valves, high pressure unions for filling connection, temperature gauges, high pressure safety valves, water seal posts, high pressure brass fittings, copper pig tails for cylinder manifold, flash back arrestors, adaptors, regulators, and all necessary copper piping shall be part of cylinder manifold filling of hydrogen at a maximum filling pressure of 150 – 160 Kg/Sq.cm (g) shall be provided. The safety valve set pressure is 150/160 bar (g).

5.7.0 Catalytic Hydrogen Purifier

The hydrogen gas from the Electrolyser shall flow to the catalytic hydrogen purifier, which shall be capable of removing oxygen as impurity from the hydrogen gas to achieve the hydrogen purity of 99.998%.

5.8.0 DM Water & Electrolyte Mixing System

The electrolyte used shall be 28% KOH solution. In electrolyzer, water is consumed continuously, hence DM water system shall be considered.

Electrolyte making pump

Used for making electrolyte, pumping electrolyte into system or drawing electrolyte back into electrolyte tank.

Electrolyte Making Tank

It is used for making electrolyte by mixing with water. The volume of the electrolyte making tank shall be decided suitably by the Contractor. The M.O.C shall be SS304.

DM Water Pump

Used for feeding water into the system. Normally, the interval of feeding water is about 2 hours and finished in 10 minutes. The feed water pump capacity shall be decided suitably by the Contractor & pressure shall be 16-18 bar (g). This high pressure is required in order to pump water into system.

DM Water Storage tank

Two numbers 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. The Tank shall be of HDPE construction. Water level shall be controlled via a solenoid valve with float type level switch assembly mounted at tank top.

**5.9.0 Gas Washer**

The gases coming out of separators shall be hot and saturated with lye containing water vapour. The gases shall be washed by DM water being circulated by a pump. The heat absorbed by the circulating water shall be dissipated by heat exchangers.

5.10.0 Gas Holder

Two gas holders for hydrogen shall be provided so that hydrogen gas flow to the holder from gas washer. However if Hydrogen storage cylinder exists between the generator and compressor, gas holder shall not be required.

5.11.0 De-Oxy Unit

The hydrogen gas from gas holder shall flow to de-oxy unit. The de-oxy unit shall be capable of removing oxygen as impurity from the hydrogen gas to achieve the hydrogen purity of 99.998%.

5.12.0 Gas Cooler

A gas cooler for H₂ coming out of the de-oxy unit shall be provided to cool the hot H₂ gas.

5.13.0 Hydrogen Compressors

A quantity of three (3), two-stage triple diaphragm hydrogen compressors is proposed for the compression of the hydrogen product. Each unit will be designed to compress required capacity of hydrogen gas. Two-stage triple diaphragm compressors proposed in this system incorporate a unique combination of simple design features to provide the best compressor benefits available in the market today for preserving the purity of the hydrogen product.

5.14.0 Quality Standards

The hydrogen gas produced shall conform to IS: 1090 Gr.I

5.15.0 Location

The Hydrogen Generating equipment shall be located indoor in a building specified.

The Building Areas shall be considered for classification in accordance with NFPA 70 and NFPA Documents referenced therein. Equipments supplied for areas which are classified hazardous or potentially hazardous shall comply with the requirements of NFPA 70 and referenced NFPA documents. Equipments with standard electrical protection maybe installed in separate unclassified areas as defined by NFPA70 and NFPA documents referenced therein.




ANNEX 2.18.1
SPECIFIED DESIGN DATA

S.NO	Description	Units	Data
1.0	H₂ Generator and Accessories No. required / service Capacity Type Location	Nm ³ /hr	Two (1W+1S) Not less than 12Nm ³ /hr Electrolyser Indoor
2.0	Electrolyser Type		Bi Polar
3.0	DM Water Tank Type Orientation		Cylindrical Horizontal / Vertical
4.0	Lye Tank Type		P.V.C (High density) pre-fabricated with suitable mixing arrangement
5.0	Gas Washer Type		Direct cooling & washing by DM Water
6.0	Gas Holder Type Capacity	min.	Vertical Rising Bell (or) Any suitable arrangement 5 minutes hold up
7.0	De-Oxy-Unit Type Purity required at the outlet of the De-Oxy-Unit		Contractor to indicate 99.998% Hydrogen
8.0	Gas Cooler Type Orientation Gas temperature required at the outlet of cooler	°C	Shell & Tube (or) Any suitable type Vertical / Horizontal 40
9.0	Coalescence cum Activated Carbon Filter Type Rated flow Rated pressure Oil traces at down stream Accessories	Nm ³ /hr. Kg/cm ² (a) ppm	1 No. Pre-filter + sibmicron (duly assembled) Contractor to indicate 150 0.2 max. Drain valves & clogging indicator
10.0	Drying System for H₂ Gas Type Orientation		Moisture separating column type with automatic drain system Vertical



S.NO	Description	Units	Data		
11.0	Compressor and Accessories No of compressor Type	No's	3(2W+1S) two-stage triple diaphragm		
	Rated flow	Nm3/h	Contractor to indicate		
	Rated pressure Cylinder Manifold Type	Kg/cm2(g)	150 Dual filling		
12.0	Purity Testing Instruments Gas analyser Recorder		Contractor to indicate Contractor to indicate		
13.0	Cylinder Pressure Testing Facility Cylinders		Contractor to indicate		
			H2 Storage Cylinder (Minimum Requirem ent)	CO2 Storage Cylinder (Minimum Requirem ent)	N2 Storage Cylinder (Minimum Requirem ent)
1	Number of cylinders (minimum)		As per clause 6.0.0		
2	Fluid handled		Hydrogen gas	CO2 Gas	N2Ga4
3	Purity		99.998%	99.9%	99.9%
4	Material of cylinders		Manganes e steel	Manganes e steel	Manganes e steel
5	Bottom shape of cylinders		Convex inwards so that the Cylinders can be kept in standing position.		

- Note:** 1. Suitable audio visual alarming devices shall also be included in the purity testing instrument system to give audio visual alarm where the purity of the hydrogen gas decreases below 99%.
2. The specified data is indicative and shall be minimum requirements for the equipment supplied.



7.0.0 GENERAL PLANT DESIGN REQUIREMENTS

7.1.0 General

The design of the coal based thermal power plant and associated auxiliaries shall generally conform to the following requirements and shall be new and unused.

The plant shall be constructed considering prudent engineering practices and optimal utilization of resources. These shall be complete and include all the equipment and systems necessary to ensure high level of reliability, availability, efficiency, safety and maintainability over their lifetime. It is also necessary to consider various precautions to safeguard the operating and maintenance personnel

The Plants and Electric Lines shall be suitable for full range of ambient and other environmental conditions as prevailing at site. The design of the power plant shall ensure that the plant can, in the state of normal operation, adapt itself to load, frequency, power factor, ambient variations within the allowable range of design

The auxiliary systems and plant facilities shall be designed for serving the whole power plant with adequate redundancy. Secondary system component shall be designed generally for 100% redundancy in order to achieve high reliability and availability of the power plant.

The life span to be considered for the design of equipment and component selection shall be at least **40 years**. The civil structures shall be designed for a design life of 50 years.

The various parts and systems of the power plant shall be designed to achieve the object of providing integrated and coordinated power plant operations. For the design of the power plant, it is necessary not only to consider the requirements of operation, but also, by suitably planning the layout, the convenience for inspection, cleaning, maintenance and repair are ensured.

The various parts or components or assemblies of equipment and systems shall be of proven materials with well established physical and chemical properties appropriate to the service as intended. It is required that the equipment shall be of a rustproof, moisture proof and waterproof type to ensure continuous trouble free operation

All materials, components and equipment shall be tested at all stages of procurement, manufacturing, erection, commissioning as per comprehensive Quality Assurance Programme to be agreed mutually between the Owner and the equipment supplier.

In the design of the power plant and selection of equipment, the specific requirements of this project and likely occurrences of abnormal operating conditions have to be taken into consideration to ensure that the power plant can, under these circumstances, operate continuously, safely and with high efficiency. The selection of materials shall be suited to local conditions.

Equipment installed outdoors shall be capable to operate in all-weather conditions and withstand the work site environment. For equipment in operation or in standby that may be influenced by direct sunshine, shelter or cover shall be provided.

The equipment must operate without vibrations that may affect its operation, that of other machinery or of civil works under every condition.

Corresponding parts throughout shall be made to gauge and be interchangeable wherever possible. In case required, the supplier shall provide the necessary references for all kinds of equipment.



All equipment performing similar duties shall be of the same type and manufacture in order to limit the stock of spare parts required and maintain uniformity of plant and equipment to be installed.

The Station shall comply with all applicable environmental stipulations of Ministry of Environment and Forests (MOEF) in regard to ambient air quality, gaseous emissions, liquid effluent discharges, solid waste disposal and any other stipulation of the Central Pollution Control Board (CPCB) and State Pollution Control Board (SPCB) in this regard. TANGEDCO have applied for the MOEF clearance with 100% imported coal and it will be given to contractor during the detailed engineering stage. Contractor has to fulfill the requirement of the MOEF without any cost implication. TANGEDCO have already obtained the Environmental & CRZ clearance for coal jetty, coal conveyor and seawater intake and outfall system and the approval letter is attached in Volume III – Attachments to Tender Documents. Contractor shall fulfill the MOEF CRZ clearance requirements as applicable for his scope of work.

Areas where a potential flammable atmosphere may exist shall be classified in accordance with the provisions of latest version of relevant IS. Certified equipment shall be used in the designated hazardous areas. To the extent practicable, equipment requiring operator's attention and/or electrical equipment shall not be installed in hazardous areas.

The equipment should be adequately protected against environmental elements, such as humidity, dust etc., and the influences that other equipment may have, such as heat radiation, induced vibrations, etc. The supply shall include protective cabinets for parts exposed to the open air or sensitive parts requiring such protection.

As the plant site in the coastal area, the environment is likely to be corrosive and the materials of construction for all exposed metal/ concrete surfaces shall be so chosen as to withstand the corrosive environment. Also suitable weather protection shall be provided to all exposed surfaces. Suitable anti-corrosive measures shall be provided for under-ground piping where the same is absolutely necessary.

All stand-by auxiliaries shall be designed for auto start up, on failure of running auxiliaries with minimum time delay and without runback on unit load.

All heavy parts of the plant must be provided with some convenient arrangement for aligning and for handling during erection and overhaul. Any item of plant required to be stripped or lifted during period of maintenance and weighing one tonne or more shall be marked with its approximate weight.

7.2.0 Standards and Codes of Practice

All equipment, systems and works covered under these specifications shall be in accordance with all the latest applicable statutes, regulations, codes and standard specified as well as all such standards, statutes, regulations and safety codes applicable in the locality where the equipment will be installed. Contractors may familiarize themselves with all such requirements before preparation of bids. Complete design including pressure parts, piping, valves and fittings shall meet or exceed all the requirements of the latest versions of Indian Boiler Regulations (IBR), Indian Standards / ASME codes.

The design, construction and testing of all equipment, facilities, components and systems shall be in accordance with latest version of relevant standards and codes issued by Bureau of Indian Standards (BIS) and/or reputed international standards and codes. A non-exhaustive list of reputed international standards is given below:

- a) American National Standards Institute (ANSI)
- b) American Petroleum Institute (API)



- c) American Society of Mechanical Engineers (ASME)
- d) American Society of Testing and Materials (ASTM)
- e) American Water Works Association (AWWA)
- f) American Welding Society (AWS)
- g) British Standards (BS)
- h) Cooling Technology Institute (CTI)
- i) Deutsches Institute for Normung (DIN), Germany
- j) Gosstandart of Russia (GOST) standards
- k) Heat Exchange Institute (HEI), USA
- l) Hydraulic Institute Standards (HIS), USA
- m) International Electro-technical Commission (IEC)
- n) Institute of Electrical and Electronics Engineers (IEEE)
- o) International Organisation for Standardisation (ISO)
- p) Japanese Industrial Standards (JIS)
- q) National Electric Code (NEC), USA
- r) National Electrical Manufacturers Association (NEMA), USA
- s) Central Electricity Authority (Construction of Electrical Plants & Electric Lines) Notification of 20 th August 2010
- t) National Fire Protection Association (NFPA), USA
- u) Occupational Safety & Health Administration (OSHA)
- v) Tubular Exchanger Manufacturers Association (TEMA), USA
- w) VDE association for Electrical, Electronic and Information Technologies (VDE), Germany

Other international Standards, equivalent or superior to the above Standards can also be adopted. However, in the event of any conflict between the requirements of the international standards or codes and the requirements of the BIS standards or codes, the latter shall prevail. In the event of any conflict between the requirements of equivalent codes and standards, and the requirements of IBR, the latter shall govern unless specified elsewhere in the specifications

The Plants and Electric Lines shall also be designed to comply with the requirements stipulated in

- a) Central Electricity Authority (Installation and Operation of Meters) Regulations.
- b) Central Electricity Authority (Technical Standards for Connectivity to the Grid) Regulations



- c) Central Electricity Authority (Measures relating to Safety and Electricity Supply), Regulations as and when these are notified by the Authority.
- d) Central Electricity Authority (Safety Requirements for Construction, Operation and Maintenance of Electrical Plants and Electric Lines) Regulations as and when these are notified by the Authority.
- e) Central Electricity Authority (Grid Standards) Regulations as and when these are notified by the Authority.
- f) Central Electricity Authority (Technical standards for Construction of Electrical Power Plants and Electric Lines) Regulations 2010
- g) Indian Electricity Grid Code issued by Central Electricity Regulatory Commission (CERC) and
- h) Applicable State Grid Code issued by appropriate Regulatory Commission

All material and equipment supplied and all work carried out as well as calculation sheets, drawings, quality and class of equipment, methods of inspection, constructional peculiarities of equipment and parts and acceptances of partial plants, as far as these are beyond the special requirements of the specifications, shall comply in every respect with the technical codes of the above listed codes and Standards

It shall be the responsibility of the Contractor to take all approvals required and get the boiler registered under the IBR. In all other cases where IBR does not govern, IS/ASME, Japanese, American, British, German or other international standards established to be equivalent or superior to IS/ASME shall be acceptable with the approval of the Owner at the time of detailed engineering..

Where there are no standards or regulations, or the standard is not sufficient to meet the need of design and supply, for such items relating to the power project, the Contractor shall carry out the design, manufacture, supply and installation on the basis of good engineering practice with Owner's approval.

During the period of Contract execution, if any standards change, the Contractor shall be responsible to notify the Owner and provide the basis for the prospect that it would not cause the lowering of quality, performance and service life of the power plant due to alteration of the standard. Upon mutual agreement, the amended standard can then be followed.

Further requirements about applicable standards and codes are specified in the detailed technical specifications.

7.3.0 Plant Operational Requirements

- i) The unit shall give Maximum Continuous Rating (MCR) under the following conditions:
 - Maximum cooling water temperature
 - Worst fuel quality stipulated for the unit
 - Grid frequency variation of (-) 5% to (+) 3% (47.5 Hz to 51.5 Hz)

The Unit shall be designed for continuous operation under VWO condition.

The unit shall be capable of base load operation. However, the unit shall also be capable of regular load cycling and two-shift operation. The steam turbine shall be designed for a minimum of 4000 hot starts, 1000 warm starts and 150 cold starts during its life.



- ii) The steam flow through steam turbine under valves wide open (VWO) condition shall correspond to 105% of steam flow corresponding to MCR output.
- iii) The unit shall be designed for constant pressure and sliding pressure operation. The unit shall be designed to operate at constant pressure from zero to 40% rated load, sliding pressure mode from 40% to rated load. The throttle reserve shall be adjustable to minimum 0% for pure sliding pressure mode of operation. Unit shall also be capable to operate in modified sliding pressure mode of operation.
- iv) The design shall cover adequate provision for quick start up and loading of the unit to full load at a fast rate. The unit shall have minimum rate of loading or unloading of 3% per minute above the control load (i.e. 50% MCR).
- v) The unit shall be capable of automatically coming down to house load and continue to operate at this load in the event of sudden external load throw off.
- vi) Unit shall be designed to give maximum possible efficiency for the fuel stipulated and other site specific conditions.
- vii) The unit shall operate continuously with HP Heater out of service with max. specified cooling water temp, 3% make up and normal aux. steam requirement being tapped from CRH line. The power output of the unit under this operating condition shall commensurate with Steam Generator capacity as specified above.
- viii) HP-LP bypass operation under rated steam conditions with Bypass valve open to full capacity of the HP-LP Bypass system (i.e 60% of the BMCR flow) and turbine on house load.
- ix) The equipments and auxiliaries shall be suitable for continuous operation in the frequency range of 47.5 Hz to 51.5 Hz. All the auxiliary equipment and the drive motors shall be capable of delivering satisfactorily their rated output continuously for voltage variation, frequency variation and combined voltage & frequency variation as indicated else where in the specification

All the equipments and auxiliaries should be designed to cater to the above operating conditions with adequate margin as per standard practice prevailing in the fossil fired power plants.

x) Mode of Operation

The plant shall be designed for an availability of more than 90%.

Plant Operation and Service Life

Load Ramps

The Facility shall be capable of the following normal and emergency ramp rates for sliding pressure operation.

	Normal	Emergency
Sliding pressure	3% / min	5% / min

**Start Up:**

The facility shall meet the following maximum required start up times from the initial conditions

Cold Start : 7 hrs from lighting the burners to full load
Warm Start : 4 hrs from lighting the burners to full load with start-up bypass system
Hot Start : 1.5 hrs from lighting the burners to full load.

Low Load Operation

The facility shall provide safe and stable long-term operation with the controls in full automatic mode without any supplemental oil firing in the range of 40% to 100% of unit load.

The unit and the auxiliaries shall be designed for maximum reliability and availability; operability and maintainability. The Contractor shall specifically state the design features incorporated to achieve the high degree of reliability and availability.

7.4.0 Vibration

Vibration shall be reduced to the minimum as far as possible to well with in the limit of the standard where it cannot be completely eliminated. Amplitude and frequency limitation in the design and supporting structure shall be considered.

Special care shall be taken to avoid operating equipment making resonance with foundations, packing, duct, platform, piping or other components.

Unless otherwise stated or agreed by the Owner each rotating machine has to comply with the requirements for designation as 'good' stipulated by ISO /ASME std for the respective group of machinery. If the vibration is higher than stipulated as 'satisfactory' the Owner has the right to reject the corresponding equipment, subject to the conditions specified elsewhere.

7.5.0 Noise levels

The plant shall be designed and constructed to reduce the operating noise level as much as possible and when the plant is operating at all loads, the noise pressure levels specified in Section 18-Environmental Requirements shall not be exceeded.

- (a) Noise level at the Station boundary shall not exceed the Ambient Air Quality Standard in respect of noise as notified by MOE&F and any other stipulation of the state PCB and central PCB in this regard.
- (b) Noise level for the continuously operating equipment shall not be more than 85 dBA at a distance of 1 metre and at a height of 1.5 metre from any equipment. For short term exposure, noise levels shall not exceed the limits as stipulated in the Occupational Safety & Health Administration (OSHA) Standard.
- (c) The noise level in the offices and the control room shall not more than 50 dB(A).
- (d) Equipment/ machines shall be provided with acoustic enclosures, wherever required so as not to exceed the permissible noise limits.

7.6.0 Units of Measurement

For all the technical tables and diagrams, calculation results, drawings, test data and scales adopted in the design and provided for the power plant, the standard international



unit system (SI) as per International Standardization Organization (ISO) shall be uniformly employed.

SI system shall be employed for all the first-class plant layout and arrangement drawings of equipment made especially for the project. In spite of the employment of British Standard in the layout or drawings and single item standard drawings made with other measuring units, the principal dimensions and demarcation points on these drawings shall also be converted into SI system to be directly marked onto them.

7.7.0 Safety

Special importance shall be assigned to all aspects related with the safety of personnel operating, assembling and maintaining the equipment, including other persons who are likely to come in contact with same.

The possibilities of human failure must be foreseen. Provisions shall be taken to avoid damage caused by human error, or to ensure that such damage both to persons as well as to the equipment is the least possible.

Rotating or any other moving part of the machinery, hot parts or any part that may cause accident to the staff must be adequately protected, in accordance with the safest method known.

Areas where a potential flammable atmosphere may exist shall be classified in accordance with the provisions of latest version of relevant IS. Certified equipment shall be used in the designated hazardous areas. To the extent practicable, equipment requiring operator's attention and/or electrical equipment shall not be installed in hazardous areas.

Insulation along with aluminum cladding shall be provided for all the equipment/surfaces (excluding coal pulverisers) having skin temperature more than 60°C considering wind velocity of 0.25 m/sec. (0.5 m/sec where the heat loss is not the criteria)

Bright paints used will be agreed upon with the Owner to protect personnel, so that anything representing a potential danger will stand out: such as elements in movement, suspended hot, with electric tension, etc.

It should be possible to carry out frequent maintenance operations required by the equipment without interrupting its operation and without danger to the personnel.

Access stairs to the equipment must be safe, with anti-skid rungs and handrail. Normal circulation areas of the equipment shall be protected to keep personnel from falling or shall be surrounded by strong guardrails, platforms should have kicking plates to keep loose objects placed on the floor from dropping off, entrances and large openings in the equipment shall be provided with lids or doors affixed in such a way as to open them also from the inside.

Every equipment or parts of equipment that must operate under certain conditions of maximum pressure, temperature, speed, position etc., should have devices to keep such limits from being exceeded and, if necessary, to stop the operation of the machine (Safety valves, limit switches, thermal switches, etc.).

For protection against the possible failure of the above devices, additional safety elements shall be provided such as stroke limiting stops, diaphragms, bolts, etc. and/or links or other dimensioned rupture elements so that in case of failure, when exceeding extreme operating conditions, additional safety is provided to the equipment.

Inside air and gas ducts, ladders have to be installed for inspection of dampers, venturies, etc.



In designing an area where combustible gases are likely to accumulate, due consideration shall be given to provide safety measures to allow the gas to continuously diffuse or leak off to prevent explosion. The electric equipment in those areas shall be of the fireproof and explosion proof type. Suitable grounding shall be provided on the casing of electrical apparatus which might be energized.

Draining of water and venting of steam shall be performed with respect to the safe mode of discharge, and is not allowed to be carried out at or near the places where people exit and at the exit of the plant.

7.8.0 Fire Protection and Precautions

The Contractor shall adopt necessary methods to minimize fire hazards.

The fire protection system shall in general follow the recommendation of Tariff Advisory Committee of India and the system and equipment shall meet with their approval.

The design of power plant shall include a complete set of composite fire monitoring, protection, and fighting system to identify, isolate, and distinguish fires as well as minimizing potential fire hazards.

A warning alarm for the power plant and alarm for evacuation shall be provided. The alarm is to be audible in the normal working areas of personnel. The selection of the alarming device shall be such that it is audible about the normal background noise of the plant. Visual alarm shall be provided in addition to audio alarms in high noise areas.

During the construction phase of power plant, the Contractor adopts advanced and safe working practices and a set of guidelines to keep the site in a clean condition to reduce the possibility of fire. The basic guiding ideology is to adopt two methods: fire prevention and fire control shall adopt to improve conditions in designing the layout, to reduce potential fire danger, ensure the safety of personnel, ensure the safety of the important and main equipment of the power plant.

Use fire proof or fire resistant materials, ensuring that, isolating combustible material is not used or stored in possible fire source area of the power plant.

The end connection type of hydrant shall fit in with local fire brigade requirements to ensure the manual device in power plant to be compatible with the fire control device of local fire brigade.

7.9.0 Signs

Safety colors, safety symbols and safety signs must comply in construction, geometrical form, color and meaning with the ISO Recommendation 507 of the ISO committee TC 80 'Safety Colors'. All signs should give the identification number. All signs shall be in the English language.

The signs should be of a material which is weather-resistant and of sufficient durability for the conditions prevailing on site. Indian regulations and codes are to be considered.

The positions for the signs must be chosen so that they are within the field of vision of the persons to whom they apply. The signs should be permanently attached. Temporarily dangerous areas (e.g. construction sites, assembly areas) may also be marked by movable signs. The safety signs must be mounted or installed in such a manner that there is no possibility of misunderstanding.

All Necessary Traffic signs, Information sign, Emergency sign, Mandatory signs, Warning sign, Prohibition sign viz No Smoking, No Entry, Do Not Start, etc., shall be provided at appropriate area in the entire power project area.



7.10.0 Package, Storage and Store House

The Contractor should provide all the specifications and instructions for the self purchased and fabricated equipment during the planning period of the Contract. These specifications should include the cleanliness and maintenance requirements of materials during fabrication and the protection measures for the equipment from damage during transportation. Loss of materials during storage should be avoided before installation. The instruction should be worked out especially to suit the particular work site program.

All materials and equipment should be packaged according to the typical environmental conditions during storage. In case of severe conditions, these materials and equipment should be packaged carefully by taking a full and appropriate preventive measure to protect from any damage or wear.

The Contractor and his appointed Subcontractor for installation should guarantee jointly that a good supplementary storage will be carried out within the equipment site controlled by them.

Three classes for storehouse are described as follows:

Storehouse class A items: Special measures are taken to protect the stored goods and the temperature, humidity, are controlled within a specified range.

Storehouse class B items: Goods are stored with temperature uncontrolled.

Storehouse class C items: It is an outdoor storage with a drainage system on the ground.

For storehouses of class A and B they should be fireproof, heat resisting, waterproof and well ventilated. They should not be wet and should be provided with good drainage system and preferably with a brick laying or concrete ground. For storehouses of class C, they should not be wet and should be well drained, preferably with a brick laying or crushed stone ground, should be protected from rainfall, salt corrosion, ash and other adverse conditions with a temporary cover or tent if possible

Component surfaces should not be contacted directly with the ground or ground laying material. There should be a layer of oilcloth or wax or other similar materials between the machine surface and ground surface.

All components shall be inspected for their painting, storing, sealing etc. and any damage or wear should be repaired during acceptance and storage periodically. The inspection interval is determined by the component function, applied protection measure and storehouse class.

Many components are provided with a drying agent or sealed in a coverage (polyethylene or insulating cover) containing drying agent. The drying condition shall be inspected during storage in an interval of every 4 weeks.

7.11.0 Painting, Insulation, Anti-dewling

Anti corrosive coatings and painting shall be carried out as a pre-treatment to all equipment and parts. The paint system used should coordinate with the painted objects and surrounding conditions of project.

Anti corrosive coatings and painting shall comply with ISO 12944 classification C5M for all equipments and structural steel which are outside the plant boundary and ISO 12944 classification C4 for all equipments and structural steel which are inside the plant boundary

In multi-layer painting system, different painting layers should be selected to make the painting coordinate. If multi-layer painting system is used, various painting layers should have distinct colors so that the later layer can be distinguished from the former one.



After the equipment or apparatus finished preliminary or full painting, it can be supplied to field. After the installation is finished, ground coat must be painted.

Entire painting procedure should be supplied in order to repair the injures of painting coat after the equipment is delivered to field.

Color strip indication system should be used for pipes. These strips should be painted on the joint of pipes, entrance, valves of pipe. This pipe without outside protection layer should be marked by some color in whole length.

The principal color of field equipment should be determined by the Owner and Contractor during execution stage.

The specified requirements shall be applied to the whole equipment and facilities of the Power project Contract.



8.0.0 LANGUAGE TO BE USED

English shall be used as the general Contract language English translations shall be provided for any code and standards not in English language.

Name plates of equipment and instrument scale, etc. shall be marked in English as required for start-up, testing and training etc.

Documents for training shall be provided in English.



9.0.0 QUALITY ASSURANCE, SHOP INSPECTION AND TESTING

9.1.0 General

This section contains general requirements for inspection of material, parts, equipment and workmanship of the plant during manufacture, assembling to demonstrate compliance with specification, codes and standards to ensure overall reliability of plant operation and performance.

The Owner and/or authorized Representatives shall, at any time, be allowed free and ready access to the Contractor's premises and those of his suppliers as well as to the site installation and the Contractor has to make the plant items available for the purpose of inspecting the specified equipment components and obtaining information as to the progress of the work. Failure on the part of the Owner, at this or any other time, to discover or reject materials or work which do not meet specified requirements shall not be deemed an acceptance thereof nor a waiver of defects therein.

The approval of the Owner shall not prejudice the right to reject equipment if it does not give complete satisfaction in service.

The cost of travel expenses, boarding and lodging expenses of the inspection have to be borne by the EPC contractor. This includes inspection in India and foreign countries.

9.2.0 Scope

All materials, components and equipments covered under this specification shall be tested at all stages of procurement, manufacturing, erection, commissioning as per a comprehensive quality assurance programme. The requirements of minimum quality plans to be followed by the Contractor in respect of various equipment are specified in detailed technical specification. The Contractor shall draw his own quality plans in line with these requirements and his standard practices and implement such programme after approval by the Owner.

Manufacturing quality plan shall detail out, for all the components and equipments, various tests/inspection to be carried out as per the requirements of this specification and standards mentioned therein and quality practices and procedures followed by Contractor's quality control organization, the relevant reference document and standards, acceptance norms and inspection documents raised etc. during all stages of material procurement, manufacture, assembly and final testing/performance testing. The detailed manufacturer's quality assurance plan shall be subject to approval after award of contract.

The Contractor has primary responsibility for ensuring the quality of items of equipment supplied under the contract and remains accountable when manufacture or erection is subcontracted. It is therefore a requirement of the specification that work is only subcontracted to companies with effective quality control organizations and that the Contractor monitors the performance of these by the attendance at tests of experienced inspectors employed by the Contractor. The Contractor shall, at the appropriate time, prove that his material and / or equipment comply with all the requirements of this Section, such proof being the successful completion of tests and inspections. Routine test and type test certificates shall be submitted for each item of equipment, wherever applicable.

All materials, components and equipment supplied under the contract shall be subject to inspection by the Owner, his representative, Inspectors of Boilers (India) or his authorized Agency or any other Inspector of the Government, should they so require during manufacture, erection and after completion. The necessary inspection charges of the authorized agency of Inspection of Boilers (India) shall be borne by the contractor. The inspection and tests shall include but shall not be limited to the requirements of this section of the specification. Further requirements to be applied are specified in the detailed specification.



The Contractor along with quality plan, shall also furnish copies of the reference documents/plant standards/acceptance norms/test and inspection procedure etc. referred by him in quality plans. These quality plans and reference documents/standards etc. will be subject to Owner's approval after award of contract.

No materials/equipment shall be dispatched from the manufacturer's works before the same is either accepted subsequent to pre-dispatch final inspection including verification of records of all previous tests/inspections by the Owner's Engineer /authorized representatives, or such pre-dispatch final inspection is waived by the Owner and dispatch is authorized after review of test reports.

All materials used or supplied shall be accompanied by valid and approved material certificates and test and inspection reports duly approved by the Owner. These certificates and reports shall indicate the acceptable identification number of the material they proposed to certify. The material certified shall also have the identification details stamped on it.

All material used for equipment construction including castings and forgings etc. shall be of tested quality as per relevant codes/standards. Details of results of the test conducted to determine the mechanical properties, chemical analysis and details of heat treatment procedures recommended and actually followed shall be recorded on certificates and time temperature chart. Tests shall be carried out as per applicable material standards and/or agreed details.

All welding shall be carried out as per welding procedure drawn and qualified in accordance with requirements of ASME Section IX. Welding procedures shall be submitted to the Owner for approval prior to carrying out qualification test in the presence of Owner's representative.

All welders/welding operators employed on any part of the contract either in the Supplier's works or at site or elsewhere shall be qualified as per ASME Section-IX.

Test results of qualification tests and specimen testing shall be furnished to the Owner for approval. However, wherever required by the Owner, tests shall be conducted in presence of Owner's Engineer/ authorized representative.

All the heat treatment results shall be recorded on time temperature charts and verified with recommended regimes.

All the sub-vendors proposed by the Contractor for procurement of major bought out items including castings, forgings, pumps, heat exchangers, semi finished and finished components/equipment-(list of which shall be drawn up by the Contractor along with his offer and finalized with the Owner) shall be subject to Owner's approval.

The type and extent of inspection of items shall be in accordance with the relevant International/Indian Standards/Indian Boiler Regulations and other standards approved by the Owner, supplemented or amended by the requirements of this section of the specification or as specified elsewhere in the Specification.

9.3.0 Inspection Program and Test Notifications

Before manufacture commences and not later than 45 days after award of contract, the Contractor shall submit an outline of his proposed inspection program, which shall include all major stages during manufacturing. The inspection and test program shall include for the various items the designation No., name of equipment, part of equipment, the kind of test, test standard, company which carries out the test, place, date and witnesses by the Contractor, third party or Owner's Representative. The detailed manufacturer's quality assurance plan shall be subject to approval after award of contract



The Owner will return a copy of the Contractor's proposed inspection program indicating those inspection stages for which notification is required. Notification shall be by Fax or email in a format to be agreed and shall be sent prior to the intended test in accordance with 'General Conditions of Contract'. If the Owner intends to be represented at the test he will provide at least 24 hours' notice and if his representative does not attend on the notified date, the test may proceed unless an alternative date has been requested by the Owner.

9.4.0 Test Certificate Documentation

The results of all tests shall be certified by the manufacturer, Contractor or independent agency as appropriate.

Document files containing material certificates, welding procedures, test report etc. shall be compiled for each item of plant and shall be suitably identified (including equipment classification reference) and bound.

Three copies of each document file containing inspection reports and certificates of site erection testing activities of a particular item of plant or system shall be supplied to the Owner prior to commissioning.

Copies of the performance and acceptance test reports shall be prepared and distributed as specified in Clause 'Performance and acceptance test data and reports' of this Section. All documentation as required by IBR shall also be prepared and submitted.

9.5.0 Codes and Standards

9.5.1 General

The type and extent of inspection shall generally be in accordance with that specified in the standard used for design and construction of the item of equipment supplemented or amended by the requirements of this section of the specification. The Contractor should provide the copy of relevant codes and standard to the Owner if requires by the owner.

9.5.2 Reference to Codes and Standards

Reference to special codes and standards, where designated either directly or as "relevant", is intended to provide a measure of performance, safety, in-shop and on-site testing, and methods of construction and/or installation which must be equaled or exceeded in order to be considered acceptable for use under this specification. If more than a single degree of quality or accuracy is permitted within the scope of particular code or standard, the highest quality shall be applicable and the degree of accuracy commensurate with the intended function shall be selected, but with the understanding that the final decision will be made by the Owner.

In all instances, the finally accepted applicable code or standard shall be the version last published.

9.5.3 Alternative Standards

Where no appropriate standard is available, tests shall be conducted in accordance with the manufacturer's standard practice, subject to the approval of the Owner.

In such cases the Contractor shall submit to the Owner, complete data and a suggested procedure for the testing to be performed. Commencement of manufacture before receipt of the Owner's approval shall be at the Contractor's risk.



If the proposed procedures are accepted, the Contractor shall provide the Owner with four additional copies in English before any test is performed.

9.5.4 Derating Standards

The Contractor's attention is drawn to the climatic conditions in the site area. Derating factors shall apply in accordance with the relevant and approved standards if not specified in the contract documents.

9.6.0 Services prior to and During Inspection and Testing

In accordance with and in addition to specified standards the Contractor shall submit procedures for material testing, manufacture, quality control and performance testing right from the procurement phase of raw materials to the finished product. Manufacture commenced before receipt of the Owner's approval of material specifications and testing procedures shall be at the Contractor's risk.

No inspection shall be valid unless the Contractor and manufacturer are in possession of relevant approved drawings and procedures for the item to be tested. The Contractor on request shall supply the Owner's representative with a copy of drawings and procedures at the time of the test.

All instruments and apparatus required for the inspection or used for the performance of tests shall be subject to the approval of the Owner at his discretion and shall be calibrated to an agreed standard in approved laboratories. The cost of making such calibrations shall be borne by the Contractor in all cases.

If the Contractor wishes to apply for a concession in respect of a departure from an approved procedure or standard, this shall be made in writing with full information substantiating the technical acceptability of the proposed change. The Owner's decision shall be final. Concessions granted shall not absolve the Contractor from any of his responsibilities under the Contract.

9.7.0 Testing During Manufacturing

The minimum testing requirement for mechanical, electrical and C&I items to be conducted at manufacturer's works are specified under respective sections.



VOLUME II
SECTION 2.20
PIPING, VALVES AND FITTINGS

1.0.0 GENERAL

This section is intended to provide the scope, design, constructional and functional requirements for all power plant piping, valves and fittings.

2.0.0 SCOPE OF SUPPLY

The scope of supply shall include but not limited to, the following:

High pressure/ power cycle piping

- High pressure piping covering complete main steam, hot reheat and cold reheat Piping between boiler and turbine nozzles, HP & LP bypass piping.
- Complete auxiliary PRDS and auxiliary steam piping system.
- All extraction steam piping.
- Complete feed water piping including booster pumps suction, interconnection between booster pumps and main pumps, boiler feed discharge piping upto economiser, recirculation, BFP warm up and leak off.
- Spray piping system for reheater/ superheater attemperation, HP & LP bypass system and auxiliary PRDS system.
- Condensate piping system.
- Condenser make up water system.
- Heater drains and vents piping including necessary flash tanks.
- Steam drains including necessary flash tanks.
- Valve gland sealing piping system.
- Miscellaneous line drains and vents including necessary flash tanks.
- Complete safety valve exhaust piping for safety valves on steam generator, HP piping, Aux. PRDS, heaters and deaerator etc.
- Start up vents, safety valves, pneumatic relief valves (PRVs), flash tanks and all vents from the respective equipments and pipes upto a level of one meter above the boiler house/ TG building roof. Silencers shall be provided for start up vents, lowest safety valve and PRV'S. All drains from respective equipments and pipelines shall be connected to the drain manifold of the flash tanks.
- Complete chemical dosing system piping.
- Any other piping system to make the power cycle piping complete.
- Complete steam blowing and chemical cleaning of piping including provision of temporary piping as required.
- Piping systems shall be complete with fittings/accessories, specialities, blow-down valves, vent valves, drain valves and safety valves along with their escape piping, drain piping and steam traps, expansion joints, insulation, hangers, supports, restraints/guides, snubbers and auxiliary steel etc. The drain system shall be complete along with drain pipes, unit flash tank, drain valves, root valves, relief/safety valves, control valves, motorised valves, gate/ globe valves, non return valves, break-down orifices, steam traps etc.

**Low pressure piping and valves etc.**

The scope of low pressure piping including miscellaneous piping shall cover piping systems for the following services from the terminal points within the main plant area as specified elsewhere:-

- Condenser cooling water system, Auxiliary cooling water system, closed cooling water system
- Condenser make up, boiler fill and deaerator fill systems
- DM water supply and distribution system
- Condensate polishing system
- Condenser on load tube cleaning system
- Condenser air evacuation system
- Drain water system
- Chemical dosing system
- Service water systems, Potable/ drinking water system
- Air preheater wash system
- Sea water intake and outfall system
- Cooling tower blow down and make up system
- Fire water piping system
- Fuel oil unloading, storage and forwarding piping systems
- Effluent system
- Ash slurry system
- Instrument air and Service air piping system
- Sludge system

All interconnection piping within and between the equipments and any other piping system

Piping systems shall be complete with fittings/ accessories and specialities, expansion joints, all isolating and regulating/ control valves, hand operated and/or motorized/pneumatic/ hydraulic actuators, surface painting/ protection, hangers, supports, trestles, restraints/ guides, snubbers and auxiliary steel etc as required.

Power cycle control valves

All the control valves as required complete with pneumatic actuators and accessories, which shall include but not be limited to the following:

- Desuperheating spray water control valves for superheater, reheater and auxiliary steam supply
- HP and LP heaters normal and emergency level control valves
- BFP recirculation control valves
- Deaerator level control valves
- Deaerator pressure control valves
- Condensate recirculation flow control valves



- Condenser normal make up control valves
- Condenser emergency make up control valves
- Feed water control valves (low load)
- Condensate recirculation control valve
- Excess condensate dump control valve
- Deaerator overflow control valve
- Boiler drain control valves

The power cycle control valves shall be complete along with suitable type of bypass valves. Each control valve shall be provided with arrangement of upstream and downstream isolation valves (hand/ pneumatically/ electrically operated). All other control valves not specifically included above but required for completeness of the system shall also be in the scope of the Contractor.

All other valves with in the system / Equipment / package.

3.0.0 DESIGN CRITERIA

The pipe work shall be designed and erected in accordance with ANSI / ASME B31.1 'Power piping', and the relevant codes and standards of ASTM & AWWA or an expressly approved equivalent standard and Indian Boiler Regulations wherever applicable.

All the piping system including main steam piping system, cold reheat steam piping system, hot reheat steam piping system and HP & LP bypass steam piping system shall after erection be subjected to hydrostatic test pressure as per IBR no:374. In view of the above, piping support system / selection of spring hangers for the above piping shall also be designed for hydrostatic pressure of the respective piping system without any requirement of additional / temporary supports during hydraulic testing of piping system.

All the power cycle pipe thickness shall be calculated as per ASME B31.1 and IBR-350 and maximum of thickness values calculated as per ASME B31.1 and IBR-350 shall be considered. Corrosion allowance as per IBR-350 shall be considered in power cycle pipe thickness calculation.

The present specification shall prevail against that of the code whenever the former is more restrictive.

The supply must be in accordance with the latest editions of the approved Standards as agreed by the Owner / Owner's Representative, incorporating any other features as required by this Specification and in accordance with the Piping Materials Specification. The requirement of Indian Boiler Regulation (IBR) shall be complied with as far as applicable.

All pipe components manufactured by the Contractor and parts on which he has worked, are to be marked clearly with an item number, specification number and material. This marking shall be permanent.

Sizes of pipelines shall be selected such that the velocity of fluid in pipes does not exceed the following limits under conditions of maximum possible volumetric flow :

Steam :

Superheated steam	75 m/s
Saturated Steam	40 m/s



Wet steam / Exhaust steam 30 m/s

Water and Condensate lines:

Pump suction lines (without feed water suction line)	1.5 m/s
Pump discharge lines	2.5 m/s
Feed water discharge lines	6.0 m/s
Feed water suction lines	1.0 m/s

Air lines:

Delivery line for reciprocating compressors	20 m/s
Suction line for reciprocating compressors	20 m/s
Suction and delivery lines for rotary compressors	20 m/s

Oil lines:

Lube and Control oil lines	1.0 m/s
Pump suction line for HSD/HFO	0.8 m/s
Pump discharge line for HSD/HFO	1.8 m/s

Pipe line under gravity flow shall be restricted to a flow velocity of 1 m/sec generally. Channels under gravity flow shall be sized for a maximum flow velocity of 1.2 m/sec.

The following "C" Value shall be used in HAZEN William's formula for calculating the friction loss in piping systems.

i) Carbon Steel pipe	: 100
ii) C.I Pipe / Ductile Iron	: 100
iii) Rubber lined steel pipe	: 120
iv) PVC I HDPE pipes	: 140
v) GRP pipes	: 150
vi) RCC Conduits	: 100

All rules of the art considering technical and economic parameters shall be carefully followed, namely:

- Lower values of velocities than those stated above shall be used to determine line size if dictated by considerations of pressure drop, NPSH, surges, water hammer, etc.
- The design flows considered in line sizing shall not be less than the rated capacities of equipment to which the piping is connected such as pumps, blowers, compressors, valves, flow limiting orifices, etc., or the system heat and/or mass balance diagrams.
- For lines conveying liquids, the design pressure must be equal to maximum operating pressure including the pressure reached during transients (water hammer.)
- The calculation of the pipe work shall consider also the highest possible temperature that can occur during any mode of operation together with the highest corresponding pressure.
- For the design of safety valves installed downstream of reducing stations, H.P. bypass valves or equivalent control valves, the maximum throughput of the fully open reducing or bypass valve, including injection water quantity, is to be taken as the basis for calculation.



- Sizes of Boiler feed pump suction piping shall be selected to meet the NPSH requirements of the pumps under transient conditions prevailing on loss of steam supply to feed water tank. Similarly for all pumps, NPSH requirements shall be satisfied in line sizing.
- The calculation of wall thickness required for pipelines subject to internal and / or external pressure shall be based on the formulae and recommendations as given in the applicable codes. Adequate allowances shall be made towards thinning due to bending, weakening at branch connections, threading, commercial tolerances on pipe wall thickness, corrosion and erosion, etc. and the same shall be subject to approval by Owner / Owner's representative.
- The pipe thickness for CW pipe shall be arrived for full vacuum conditions.
- In case of carbon steel materials, the nominal wall thickness of pipeline shall be not less than the minimum acceptable values given below, Contractor to furnish calculation justifying thickness selection :

NB mm (inch)	15 (1/2)	20 (3/4)	25 (1)	-	40 (1.5)	50 (2)	-	80 (3)	100 (4)
Min. thickness mm	3.73	3.91	4.55	-	5.08	5.54	-	5.54	6.02
NB mm (inch)	150 (6)	200 (8)	250 (10)	300 (12)	350 (14)	400 (16)	450 (18)	500 (20)	-
Min. thickness mm	7.11	8.18	9.27	9.53	9.53	9.53	9.53	9.53	-

- > NB 600 mm to NB 950 mm – 10.00 mm
- > NB 950 mm to NB 1200 mm – 12.00 mm

Sizes of NB 32 (1 1/4"), NB 65 (2 1/2"), and NB 125(5") shall not be used in the piping system. Minimum thickness for stainless steel pipes shall be Sch 40S as per ANSI B36.19.

- In addition to the required wall thickness in accordance with calculations, a corrosion allowance of 1.6 mm must be added for unprotected water lines where corrosion is to be expected.

4.0.0 DESIGN AND CONSTRUCTION OF PIPEWORK AND ACCESSORIES

The pipe work and its accessories shall be designed and arranged so that all parts can be mounted and replaced without difficulty. All important parts, such as valves must be accessible from the floors / platforms.

The platform must be able to withstand the weight of the valve removed as well as the weight of the appropriate number of persons handling the valve, and must be sized adequately providing both working space for the men and space for the valve.

For piping systems with a nominal pressure of more than 40 bar (g), drainage and venting facilities must be fitted with double valves.

The pipes with nominal diameter upto and including 40 mm can be arranged at site according to lengths and specification. The pipes with nominal diameter more than 40 mm can be installed according to the erection drawing designed. Pipe can be pre-fabricated or manufactured according to pipe length and specifications.

No tubes with nominal diameters less than 25 mm shall be used, except for impulse measuring lines, dosing pipelines and instrument piping.



The nominal size of the takeoff connections for instruments shall not be less than 15 mm for service conditions not exceeding either 62 bar(g) or 425°C and 25 mm for service conditions which exceed either of these limits.

For all system parts subject to acceptance retests relevant provision shall be made so that they can be separated to allow for those retests.

None of the forces and moments transmitted by the pipes to adjacent machines, apparatus and platforms must exceed the maximum permissible values, given by the manufacturers of these items.

Trench piping shall not be used unless found unavoidable.

To the extent that steam or hot water can remain or flow in pipe sections isolated for repair purposes, dump pipes with hand operated shut-off valves capable of being locked open or closed shall be provided for the safety of personnel.

Piping systems shall be protected against excess pressure caused by thermal expansion of locked-in fluids.

Valve sizes for vents and drains shall be 25 NB minimum. Vent lines, which are normally operated, shall be terminated at a minimum height of 3.0 M above the highest service platform.

For vents, pipes and any upward facing atmospheric exhaust, weather hoods and silencers as necessary shall be provided.

Manholes/Inspection chamber of adequate size shall be provided at approx. 100M interval for large diameter CW piping.

For tanks and pressure vessels, piping material for drains and vents shall be the same as that of the vessel. Suitable drains shall be provided upstream and downstream of valves to facilitate maintenance in the circuit safely.

In addition, plugged drain and air release bosses shall be welded at appropriate places in the piping to facilitate hydrostatic testing.

Steam traps should be avoided as far as possible. If provided, steam trap installation shall include a permanent strainer, upstream and downstream isolation valves and a globe valve as free drain. Steam traps shall be of the bimetallic or thermodynamic type, selected to suit the service conditions.

The Contractor shall furnish and install suitable thimbles at all points where pipelines pass through building floors and walls.

The Contractor shall provide effective flashing rings with rain-tight hoods for all pipes passing through the roofs or exterior walls.

All piping shall be cleaned and kept clean and free from all foreign matter before and during erection. The Contractor shall submit a detailed description of proposed steam blowing and other cleaning procedures for all pipelines, and no part of this work shall be started until these procedures have been approved. The Contractor shall furnish, install and dismantle all temporary pipes, hangers, anchors, etc. required for cleaning of all piping systems.

As many welds as possible shall be carried out in the workshop. Supports for H.P piping systems shall also be welded in the workshop.



Pipes from water drains, air vents and safety valves shall be grouped together where possible and routed to easily observed points equipped with covered funnels or to flash tanks.

So far as practicable, hangers and supports shall be standardized and the number of types and component assemblies shall be reduced to the minimum. Each pipe hanger and support component shall be of steel suitable for the maximum temperature that it shall attain during plant operation. Spring support assemblies shall be equipped with a means of locking the springs against movement. Rigid supports, clamps and restraints shall be used as far as possible.

The use of counterweights as a substitute for support spring assemblies shall not be permitted.

Sliding surfaces shall be constructed of non corrodible materials that do not rely on coatings such as paint, galvanizing, etc. for corrosion protection. Excessive friction shall be prevented.

Before plant start-up, all supports shall be checked to confirm that spring load indicators have assumed the proper cold load position and that all hangers and supports which do not incorporate springs are in the correct position. For springs which do not assume the proper cold load position, length of hanger tie rods to be adjusted in such a way that springs assume the correct cold position. After all required adjustments have been made, all threads shall be fully engaged and locked and all spring ties shall be disengaged

Seawater intake, Outfall and ACW Piping

The complete seawater piping for seawater intake, outfall piping, CT make-up water system, Auxiliary cooling water piping and the feedwater system to desalination plant shall be of HDPE/GRP. Actual piping MOC shall be referred from the respective section. Accordingly Bidder shall consider.

Pipeline shall be mainly underground with concrete encasement of 250 mm. Top of the buried pipe shall be atleast 1.5 meters below the ground level, Buoyancy effect shall be considered while selecting the depth. Suitable air release valves shall be provided. Transient analysis shall be conducted for piping from the Intake Pump house to the Cooling Tower & Desalination Plant.

Design Requirements for GRP pipe and fittings

Sl.No.	Design parameters	Sea water
1.	Stiffness Class	5000
2.	Vacuum	760mmHg
3.	Inner liner thickness	1 mm
4.	Resin type for inner Liner	Vinylester
5.	Glass type	ECR
6.	Resin type for Exterior Liner	Isophthalic
7.	Aggregate type	Silica Sand
8.	Exterior Layer thickness	0.5 mm
9.	Minimum initial specific stiffeners STIS	5000 N/m ²
10.	Ring bending strain	1.3



The size of the manhole shall of the minimum 600mm.

Design requirements for HDPE:

The Intake & outfall pipe shall be buried below the sea bed and shall be covered with rip-rap to prevent movement by currents and waves. The pipes shall be designed considering scour protection, hydrodynamic forces and buoyancy forces.

The HDPE pipes shall be of suitable diameter with rating of SDR 26 or better, PE 100 material. The intake pipes shall be provided with man holes at every 100 m distance. The size of the manhole shall of the minimum 600 mm. The HDPE pipe shall be conformed with IS 4984/ ISO 4427/ ISO 4437./ASTM D 3350.

Materials used for the manufacture of high-density polyethylene pipe and fittings shall comply with all requirements of ASTM D3350. The high-density polyethylene material shall be cell class of PE345664C or ASTM D3350 and shall be assigned a Plastics Pipe Institute (PPI) recommended designation of PE3408. Pipe Manufacturer shall be a member in good standing of the Plastics pipe institute.

The Flanges, fasteners, supporting structures, clamps, etc for the pipes shall be duplex stainless steel of PREN > 38. The fasteners for connecting concrete anchor blocks shall be of suitable material for sea water.

The minimum design pressure of sea water intake and outfall pipe shall be 6 kg/cm² (g). However higher value shall be considered based on the system requirement. Pipe shall also be designed for full vacuum conditions.

Actual piping MOC shall be referred from the respective section. Accordingly Bidder shall consider.

5.0.0 PIPING LAYOUT CONSIDERATIONS

A minimum 2.5 meter headroom shall be maintained to the lowest point of all piping components or insulation in walking areas and 8.0 meter above roadways unless otherwise approved by the Owner / Owner's Representative. A minimum passageway of 1.5 m shall be considered for access between and around all equipments and a 150 mm minimum clearance shall be provided between piping, including insulation if applied, and any point of adjacent equipment or piping including flanges and/or pipe supports.

Suitable Walkways of 750mm width for maintaining pipes and cables shall be provided on the pipe rack along with access ladders at suitable intervals.

50% extra space for the routing of future pipes for stage –II shall be provided in the pedestals and pipe rack. While designing the pipe rack / pedestal, extra 50 % load shall be taken in order to meet the future pipes. Number of the future pipes will be finalized during detailed engineering.

Additional clearance shall be provided, where required, for pipe movement due to thermal expansion. All valves, instruments, strainers, orifices, valve motor drives and other piping accessories shall be provided with adequate space for access and removal of parts for maintenance.

Bracket supports and other protruding attachments which constitute a hazard to operating personnel shall be elevated to a minimum of 2.5 m from the operator's access elevation.

All horizontal runs of outdoor piping shall be supported by pipe racks with a slope of 1:500 applicable for steam lines only and a minimum ground clearance of 8.0 m shall be considered



for road crossing. Steam lines inside building shall be laid with a slope of 1:100. These drain valves shall be lockable.

The instruments shall be positioned to allow easy observation. A 250 mm minimum clear space shall be provided from the bottom surface of pipe to trench bottom or finished grade.

All lines shall be provided with vent and drain connections at all high and low points, respectively, as per layout constraints with suitability for operation. All piping shall be arranged to permit complete drainage when a particular unit or system is shutdown. Condensate & water lines shall also be provided with vent & drain lines for hydro test conditions. Drain points shall have a suitable isolating valve. All such drain connections shall be piped to a suitable collection point

5.1.0 Piping Flexibility Analysis

Steam piping systems shall be designed and analysed using CAESAR II software (latest version) in such a way that no excessive stresses, forces, moments or deflections can take place. This static analysis shall be done for plant operating, shut down, hydro test and occasional loading (e.g. Wind, Seismic, Safety valves popping up & Water / steam hammer conditions). As a general guidance a line shall be subjected to comprehensive stress analysis if it falls under any of the following categories.

1. All lines at design temperature above 100 Deg.C
2. All lines 100 NB and larger connected to sensitive rotating equipments.
3. All piping subjected to vibration
4. All relief lines connected to pressure relief valves and rupture discs
5. CW Supply and Return Line near pump and condenser.
6. Sea water intake, outfall and CT Makeup pipes.
7. Other lines which in the option of Owner or Owner's Representative requires a formal analysis.

Pipe sagging shall be restricted to 2.5mm and piping rotation to less than 1 degree. The calculations shall be based on design pressures, temperatures and weights of valves. In addition, the water weight for hydrostatic testing and the insulation weight shall also be taken into account.

The calculations shall determine the maximum combined pipe stresses and the forces, moments, and deflections at all points of support, anchors and restraints. In all calculations, the manufacturing tolerance (12.5% for OD pipes) shall be taken into account.

The design shall take into account possible maximum values, e.g. the maximum head of the pumps in the system as well as exceptional operating conditions, such as over pressures, vibrations and water hammer.

There shall be sufficient allowance for thermal expansion and displacement without excessive stresses. The thermal expansion of the pipe work shall be carefully analyzed and appropriate pipe routing and location of the supporting equipment to be decided to prevent the piping from causing excessive forces & moments at the anchoring points.

5.2.0 Pipe Supports and Hangers

Pipe supports shall be designed according to the layout requirements. Spring shall be used for pipe supports where restriction of vertical movement of pipe creates excessive stress in the piping system. Otherwise rigid supports like rod hangers, clamps, saddle supports etc. shall be used.



The supporting devices shall ensure that the finished system shall provide an uniform continuous slope for draining. Loads imposed on the building structure shall, in all instances, be subject to the approval of the Engineer.

All supports for piping, cables and fitting supplied under this Contract are to be clamped to building steelwork in preference to bolting, screwing or welding. Under no circumstances shall any part of the building steel work be drilled, cut welded without prior permission of the Owner / Owner's Representative in writing. No point of passage of pipes through or walls is to be used as a point of support except with the approval of the Engineer.

Sling supports shall not be dependent for flexibility on the flexure of supporting rods or straps.

All outdoor installation supports and hangers shall be suitably coated to withstand the local environmental conditions.

All spring supports shall be designed and fabricated to forestall the complete release of the piping load in the case of spring failure.

Supports for horizontal piping shall be spaced to prevent excessive sag, bending and shear stress in the piping, with special consideration given where components, such as flanges and valves, impose concentrated loads.

For standard and heavier wall thickness piping, the maximum spacing between supports on straight run of the piping shall be in accordance with ANSI B 31.1.

Vertical supports shall be spaced in such a way that no pipe load is transferred to attached equipment under cold position and also to prevent the pipe from being over stressed from the combination of all loading effects.

5.3.0 Fabrication & Erection of Piping Systems

The plant piping systems shall be fabricated, erected and tested in accordance with the requirements of ASME, ANSI, and API Standards.

All piping to be adequately supported during construction so that excessive moments or loads are not placed on equipment or other piping. The piping is to be installed to permit free expansion and contraction without damage to joints or supports.

Piping bending, wherever required, is to be fabricated with a minimum of five (5) diameter radius. The joint spacing between bevelled ends of pipe shall be maintained between 1.5 and 2.5 mm. Butt welding & end preparation for pipe connections with pipe and flanges shall be as per ANSI B 16.25.

All joints in high pressure and low pressure piping shall be of the fully butt welded type except at points where flanged connections are essential to permit dismantling of pipework for maintenance purposes or for matching flanged item of plants.

Interconnecting joints in all pipes shall be made by butt-welding. Such joints shall be made without the use of backing rings. The welds shall be performed entirely in Gas Tungsten Arc Welding (GTAW) process but where this is not practicable, a combination of GTAW for the root run, and Shielded Metal Arc Welding (SMAW) for the subsequent runs, is acceptable. Consumable insert rings may be used where considered necessary.

All flanged joints shall meet the requirements of ANSI B 16.5 or the equivalent Approved Standard. All flanges shall be machined on the edge and spot faced at the back to receive bolts, washers and nuts. For high pressure services flange faces must be of serrated finish. Blank flanges are to be solid steel and machined all over. Flanges having pressure ratings



less than 10 bar shall not be used. All flange jointing material unless specified, shall be subjected to the approval of the Owner / Owner's Representative.

Socket welded connections shall be used on oil piping services less than 50 mm nominal size. The use of socket welded connections on other piping services shall be subjected to the approval of the Owner / Owner's Representative and restricted to the areas where the temperature or pressure cycling or severe vibration is not expected to occur or where the service may not accelerate crevice corrosion.

Screwed connections shall only be used on galvanised pipes for air services and only when the pipe is less than 50 mm nominal size. In case of threaded joints in piping, all screw threads shall be of the ISO metric form and the diameter and pitch of thread for all bolts, studs and nuts shall conform to the ISO standards. Threaded joints are used in galvanised steel pipes only. Threaded joints, which are to be seal- welded shall be made up without the use of any joint compound or sealing tape. Threaded joints, which are not to be seal- welded shall be made leak-tight by use of suitable joint compound. Backing off of the make-up threaded joints to facilitate fit-up to alignment is not permitted.

At all points where pipes pass through concrete floors or brick or other walls, suitable floor collars or wall boxes are to be provided and fixed. The floor collars shall have raised curbs of suitable height, which shall not be less than 75 mm. The wall boxes shall be flush fitting and be of neat design and approved finish.

The Contract shall include fixing of all necessary components for the protection against weather of such holes in an approved manner. Where pipes pass through roofs, the pipe collar shall stand up less than 200 mm above the top of the roof and hood shall shroud it to within 25 mm of the finished roof level. After the collars, boxes or other fittings been fixed in position, the floors, walls and structures shall be made good by the Contractor.

If service pipes run adjacent to each other, they are, wherever possible, to pass through a box. Where pipes of varying bore pass through a common box, a neat plate cover shall be provided between the pipes and the box. In the case of flanged pipework, boxes shall be large enough to permit the passage of the flange.

Where pipes are laid in covered trenches this Contract shall include for the supply and fixing of all the necessary pipe supports, clamps, packing and fixings, etc.

During erection the Contractor shall be responsible for providing temporary trench covers for the protection of the pipes in the trench and for the safety and convenience of his employees and those of other contractors working or having normal access in the vicinity of trench areas.

The Contractor shall be responsible for maintaining the trenches clean and dry, and shall hand over same to the Owner in clean and dry condition at the time of taking over of plant.

5.4.0 Cleaning, Packing and Handling of Piping Systems

The Contractor shall take all necessary precautions to ensure that the interior of all piping is kept clean during erection and free from any injurious matter.

All piping except water and air piping shall be chemically cleaned, pickled and purged with an air blast to clean the pipe inner surface. The outside of all pipes shall also be cleaned similarly. Carbon steel and ferritic alloys piping shall be cleaned after hot working or heat treatment. Cleaning shall be accomplished by either of the following methods.

- a) Degreasing making use of alkalis
- b) Pickling in hot sulphuric acid along with suitable inhibitor, followed by washing in cold and hot water.



- c) Cleaning by means of power driven wire brushes. The brushes shall be of the same material as the metal being cleaned. Both inside and outside surfaces shall be cleaned.
- d) Grit-blasting the inner and outer surfaces using silicon carbide or steel shots. All grit shall be subsequently removed.

After cleaning (by any of the above methods), the pipes shall be protected by means of an outdoor preservative. All pipes shall be capped using plugs or plastic caps. All bevels, threads, flange faces and other sealing surfaces shall be suitably protected with wood or plastic to prevent damage to these surfaces.

Suitable connections shall be made, where necessary, on all pipe runs to facilitate the removal of dirt and debris and the cleaning of each pipe run in accordance with the requirements specified elsewhere.

All steam piping to turbines shall be blown through with steam in accordance with the Inspection and Testing Requirements. The Contractor shall install and subsequently remove any temporary piping, fittings, supports or instrumentation required to carry out the blowing through operation. The terminals of piping being blown through shall be adequately fixed in order to take the resultant thrusts. The anchor, whether temporary or permanent, shall be designed to take the thrust and any loads imposed on the building steelwork and shall receive the prior approval of the Owner / owner's Representative. Target plates shall be used to ascertain that the system is rid of impurities.

5.5.0 Testing of Piping Systems

The following tests shall be conducted in the piping systems to check for cracks and the welding joint quality.

5.5.1 Hydrostatic Test

All pipework shall be tested hydraulically to at least 1.5 times the design pressure for at least 2 hours. After the hydraulic test, a leak test with air to 1.1 time the design pressure for at least 24 hours shall be performed.

The hydrostatic test of the pipe work shall be carried out with skids isolated from the pipe work. Skids shall be tested separately before installation and connection to pipe work.

The hydrostatic test pressure shall not be applied until the piping system and the testing medium have reached thermal equilibrium.

During the tests, hydrostatic pressure shall be monitored and corrections shall be made to compensate for thermal expansion or contraction. By this procedure, the test pressure shall be kept within specified test pressure. All joints are visually examined for leakage during the test.

Tested systems shall be vented and drained immediately upon successful completion of the test.

All stainless steel lines are emptied and dried immediately after hydrostatic tests are completed. To avoid the possibility of pitting due to chlorine contents in water, demineralised or otherwise suitably treated water shall be used as the testing medium.

5.5.2 Pneumatic Test

Pneumatic testing of a piping system is done



- i) When the piping system is so designed that it cannot be filled with water or other liquid testing medium.
- ii) When the piping system is to be used in services where traces of the testing medium cannot be tolerated.
- iii) When the piping system cannot be completely drained and dried out.
- iv) When hydrostatic testing would contaminate, or adversely affect chemical handled during the process.
- v) When the testing fluid would affect or damage internal lining.

Pneumatic tests shall meet the following requirements:

- Air test shall be performed with clean, dry air. The source shall be equipped with appropriate pressure relief valves and gauges. The pneumatic test pressure shall not be less than 1.2 or more than 1.5 times the design pressure of the piping system.
- No repair welding shall be performed on a pressurised system.

5.5.3 Radiographic Test

Radiographic inspection shall be carried out in accordance with the requirements of ANSI B31.1 and ASME V for checking piping weld quality.

Random radiography shall be carried out in accordance with ASME V Article 2 for all full penetration butt welds. Weld repairs made as a result of radiographic examination shall be radiographed after welding. Repairing a particular area more than two times is not permitted and the component shall be rejected. Prior approval shall be obtained from the Owner / Owner's Representative before taking up major weld repairs (When depth of repair exceeds 20% of thickness or 25 mm whichever is smaller). Mapping of major weld repairs is also required.

All welds shall be subject to 100% non destructive testing.

Radiography shall be carried out as follows:

- i) For piping 2½ inch NB or smaller, a single elliptical exposure which encompasses the entire weld circumference.
- ii) For piping 3 inch NB or larger, the double-wall-single-image technique shall be used with at least three exposures at 120° to each other.

The radiographic film recording shall be performed in accordance with the ASTM E94-77. The Radiographic Procedures and Standards of Acceptability shall be in accordance with ASME V and as specified in the appropriate design requirements:

- Gamma isotope double wall IR-192.
- Film used shall be fine-grained, a high contrast, direct type.
- Intensifying screen shall be 'lead'.
- Image quality indicators shall be of the wire type (DIN 54109) selected to give the required level of sensitivity.

6.0.0 GUIDELINES FOR SELECTION AND ERECTION OF VALVES

6.1.0 Scope of Specification

This specification covers the guidelines for selection of valves and technical requirements for materials, installation and tests of general and special purpose valves, valve drives and related accessories. General-purpose valves include gate, globe, piston lift check, swing



check, butterfly, plug, Ball and Diaphragm valves. Valve drives include pneumatic (diaphragm and cylinder), electric (motor and solenoid) actuators and hydraulic.

6.2.0 Valve Selection Criteria

Valve selection criteria based on mode of flow regulation is given below.

Type of valve	On-Off	Throttling	Diverting (Directional Change)
Globe – Straight/Angle/Oblique pattern	Yes	Yes	No
Globe – Multiport pattern	No	No	Yes
Piston	Yes	Yes	No
Parallel Gate – Conventional/Conduit/Knife	Yes	No	No
Wedge gate – with bottom cavity	Yes	No	No
Wedge gate – without bottom cavity (rubber seated)	Yes	Moderate	No
Plug – Non lubricated/Eccentric plug	Yes	Moderate	Yes
Plug – Lubricated/Lift plug	Yes	No	Yes
Ball	Yes	Moderate	Yes
Butterfly	Yes	Yes	No
Pinch	Yes	Yes	No
Diaphragm – weir type	Yes	Yes	No
Diaphragm – straight through	Yes	Moderate	No

Following is the valve selection criteria based on the fluid properties.

Type	Liquid			Special Applications
	Neutral (water, oil etc)	Corrosive (Acid, alkaline etc)	Slurry	
Globe – Straight pattern	Yes	No	No	
Globe – Angle pattern & Oblique pattern	Yes	No	No	
Globe – Multiport pattern	Yes	No	No	
Piston	Yes	No	No	
Parallel Gate - Conventional	Yes	No	No	Less pressure drop
Parallel Gate – Conduit gate	Yes	No	No	Water with sludge or debris



Type	Liquid			Special Applications
	Neutral (water, oil etc)	Corrosive (Acid, alkaline etc)	Slurry	
Parallel Gate – Knife gate	Yes	No	No	
Wedge gate – with bottom cavity	Yes	No	No	
Wedge gate – without bottom cavity (rubber seated)	Yes	Yes	No	
Plug – Lubricated & Non lubricated	Yes	Yes	No	
Plug – Eccentric/Lift plug	Yes	Yes	Yes	
Ball	Yes	Yes	No	
Butterfly	Yes	Yes	No	
Pinch	Yes	Yes	Yes	Powder as the nature of fluid
Diaphragm – weir type/ Straight through	Yes	Yes	Yes	No

For reasons of plant standardization the Contractor shall standardize the valves, to reduce number of types and manufacturers to a minimum. Installation and testing of the valves shall be in accordance with the applicable standards. The requirement of this clause shall apply if they are more stringent than the approved standards.

All valves shall be suitable for the media and for the service conditions and those performing similar duties shall be interchangeable. All valves must meet maximum design demands for pressure and temperature of the piping system.

If the media handled are polluted, the shut off devices used in discharge lines (e.g. drains on vessels) and possibly also in vent lines should consist of gate valves.

The maximum permissible forces for actuation handwheels are 300 N for wheels with diameter up to 400 mm and 600 N for larger diameters. Differential pressures requiring higher forces for actuation of handwheels shall entail fitting the valve with gears. For calculation of the gears or all other actuators the design pressures shall be taken as differential pressures. Large valves that are frequently operated or hard to operate manually shall be motorized.

Valves that are required to be motor operated shall be provided with hand operated equipment for closing and opening of the valves during power failure and shall have a suitable arrangement for de-coupling when the valves are being motor operated.

Gear operator shall be of totally enclosed. Bevel gear in grease case with grease nipples for gate and globe valves and totally enclosed helical worm gear in grease case with grease nipples for ball, plug and butterfly valves.

Where required, valve spindles shall be lengthened so that the hand-wheel is at a minimum height of one metre above the level of the floor. Where necessary they shall be provided with



headstocks and pedestals of rigid construction. The actuation of valves by means of chain drives is not permissible.

On all valves where the hand wheels are liable to be dangerously hot to touch thermal insulation shall be provided on the ring and spokes.

All valves shall be closed by rotating the handwheel in clock wise direction when looking at the face of the hand wheel. The face of each handwheel shall be clearly marked 'open and 'shut', with arrows indicating the direction of rotation to which each term refers.

Plastic or bakelite valve handwheels shall not be accepted. Valves with solid handwheels are not acceptable since all valves must be capable of being locked by means of a chain and padlock in the open and closed position.

All valves must be suitable for outdoor installation with due consideration of the special climate and environmental conditions at the site.

Unless otherwise agreed, all valves shall be fitted with the spindle in the vertical position. Eye bolts shall be provided where necessary to facilitate handling heavy valves or parts of valves.

Valves of sizes NB 50 and above shall be provided with position indications.

Fire safe valves shall be supplied with antistatic devices.

Materials used must confirm to the applicable standards. Materials for screws, bolts and nuts must have the operating temperature limits closely observed.

All valves of the relevant pipe work systems must be suitable for pickling.

For cold water lines ductile iron shall be allowed. In no case shall grey cast iron be allowed.

Unless otherwise required by virtue of the valve's function, bodies shall have an internal cross section corresponding to the nominal diameter of the connection.

Integral bypass arrangement for gate valves shall be provided wherever necessary. In that case, bypass valve shall be a globe valve and bypass attachment to main valve body shall not be screwed. The integral bypass valve shall also be motorized if the connected main valve is provided with motor actuator.

Gate valves and swing check valves of the H.P. piping systems shall be equipped with self-sealing lid covers. Gate valves with self-sealing lid covers shall be equipped with a safety device at the body. If discs are used they must be capable of being dismantled and changed under operating conditions.

Connecting flanges shall be in accordance with the applicable standards with regard to both the connection dimensions and the minimum thickness of the material.

The transition from the flat rear surface of the flange (nut contact faces) to where the welding begins must have no sharp-edged machined grooves.

The spindle must be made in one piece: the length of thread must be such that the threaded bush is fully engaged in any position of the moving part. The connection between the spindle and the cone must be sufficiently flexible. For H.P. globe valves and globe valves for throttling purposes of NB 50 or less the spindle and cone must be made in one piece.

In case of metallic sealing elements there must be difference in hardness between the body seat and the sealing element, the sealing element having the higher hardness values.

All globe valves shall be equipped with throttling cones with parabolic characteristics.



Each valve shall be marked on the body with the material diameter, the nominal pressure, type of valve and an arrow showing the flow direction whenever only one is possible.

No traps which incorporates internal screens or check valves shall be used unless specifically required by the specifications or approved by the Owner.

Condensate drainers shall be of the ball-float type.

For safety valves, pressure relief valves, bursting discs and other safety devices against excess pressure the directives of appendix II of the code ANSI B31. 1: 'New Mandatory Rules for the design of Safety Valve Installations' shall apply as well as requirements of Indian Boiler Regulations (IBR) wherever applicable.

6.3.0 Requirements of General Purpose Valves

a) Gate and Globe Valves

All gate and globe valves, except bronze body valves, shall be screwed outside and yoke designed with rising stems. Bronze body valves shall have union type bonnets and rising stems.

Bonnets joints shall be of the bolted, flanged type for class rating upto 600#. Pressure seal bonnets shall be provided for class rating above 600#. The bypass shall be integral with the main valve and shall be of welded connection.

Valves shall be provided with back-seating construction and shall be suitable for re-packing at full pressure with the valve in the open position. Gate valves for pressure above 40 bar shall have double wedge type discs. Globe valves shall have plug type discs. All valves shall have replaceable seat rings.

b) Check valve

Check valves shall be designed for mounting in horizontal or vertical piping runs. Check valve shall be of a non slam type with a swing disc and, in special cases, of the tilting disc type or guided piston lift type used upto 2". Check valves are placed in line with a gate valve or a globe valve where guaranteed tightness is required. As far as possible, mounting check valves in vertical position to be avoided.

c) Butterfly valves

Butterfly Valves shall be used in place of gate or globe valves for low-pressure liquid or gas service upto 300# class rating. Valves are to be designed for minimum pressure loss when open and capable to withstand the full pressure of the line when closed and cause minimum vibration when used for throttling of flow.

- Butterfly valve Up to 100NB shall be without gear, above 100NB to 500NB shall be gear operated and above 500NB shall be motor (electrically) operated.

d) Ball Valves

Ball valves may be used for low pressure liquid / air service. Each ball valve shall be provided with an operating lever.

e) Instrument Root Valves

Instrument shut-off valves shall be Globe type construction, no bonnet, outside screw, rising stem, with vent plugs and flanged or socket weld ends.



6.4.0 Requirements of Special Purpose Valves

Special purpose valves include valves operated with motor, pneumatic and solenoid actuators. These valves are mainly meant for remote operation in critical controls of fluid pressure, flow and temperature. The special valves shall have provision for hand operating gear.

a) Motor operated valves:

Electrically operated valves are preferred for non-safeguarding service. Local operation shall be provided on all valves. Every selector switch shall be lockable in "local" or "remote" or "hand" positions and each shall be provided with a padlock and two keys. Valve motors shall be supplied from the 400 V, 3-phase system.

Electric actuators shall have torque-limiting devices effective throughout full travel, the torque at which these operate being readily adjusted, and travel limit switches for controls and also for the operation of remote indicating lights.

The speed of operation of all power-operated valves is to be selected to suit the operating conditions of the system and to minimise pressure surges. Actuators shall have adequate power and control systems to operate the valves accurately under all system operating conditions.

All motorized valves shall be equipped with four limit switches, for automatic control and position indication purposes. Two torque switches are equipped, one for acting in the opening direction and the other in the closing direction. Limit switches shall not be used as mechanical stops. The materials of the limit switches shall be corrosion resistant to chemicals present in the plant environment by hermetically sealed snap acting single pole double throw type, able to switch faultlessly 125 V DC/24V DC/ 230V AC.

b) Pneumatic actuated valves:

Pneumatic actuators may be of the following types:

- Spring opposed diaphragm motor type
- Spring less opposed diaphragm motor type
- Piston operated type

Air actuators shall be designed to produce the required stem forces with supply air pressures of 5.5 - 7 bar (g). Piston actuators shall be used where stem forces dictate their use.

Diaphragms shall be of moulded rubber, neoprene or other suitable materials and diaphragm housings shall be of pressed steel construction.

Piston actuators use cast pistons and cylinders with O-ring seals. Air cylinders are manufactured in accordance with BS 4862 or approved equivalent.

The cylinders, unless otherwise specified, shall be required to be supplied with protective gaiters - bellows type to protect the piston rod seals. Cylinder seal materials are to be selected by considering higher ambient temperatures.

c) Solenoid actuated valves:

Solenoid coils are rated at 125 V DC for continuous energizing and designed to operate satisfactorily within 0.80 to 1.1 of rated DC voltage and in 55°C ambient temperature.

Solenoid valves shall operate on the "ON-OFF" principle. The use of economy resistors is not allowed. Solenoids shall be installed in a vertical orientation.



d) Safety and relief valves:

Safety & safety relief valves are provided to relieve the pressure in excess of the design pressure building up in the system.

All relief valves are direct spring loaded, angle body types of a design suitable for their respective operating conditions. Relief valves for compressed air, steam services shall be of the "safety" type. Relief valves for water or oil shall be of the liquid relief type having a slow opening and closing action. All relief valves shall be arranged for field adjustment of the set pressure and provided with lifting levers.

e) Control valves:

Control valves are meant for regulating pressure, temperature & flow parameters in the system. Control valve stations are generally designed with a gate valve at its upstream and downstream with a globe vent valve and a globe type bypass valve. Manual bypass valve is provided where manipulation can provide satisfactory control or where it is required for the safe plant shutdown following failure of the control valve. Bypass valves are not provided in cases where manual control cannot sensibly be achieved.

Trim of control valves shall be designed to avoid erosion, excessive noise and vibration while handling flashing condensate.

Control valves shall have stainless steel stems, guide bushing, inner valves, seat rings, stem lock pins and stuffing box parts hardened with stellite or other equivalent seating surfaces.

Flow control valves shall be especially designed to meet high pressure drop applications with stainless steel stems, stellite, or other equivalent hardening, seats and discs.

Control valves shall be fitted with approved indicators, showing accurately the amount of valve opening, and shall have electric position transmitters with 4-20 mA output equivalents to 0-100% opening. All valve seats and faces shall be renewable and be made from materials that are corrosion and wear resistant. Noise levels for control valves shall be restricted to 85 dBA at 1 m.

f) Pressure reducing valves:

Pressure reducing valves shall be designed for perfectly stable, quiet and non-vibratory operation over its full range and shall be suitable for continuous duty at the operating temperature.

In case of electrical or hydraulic valve operator is provided, on failure of the operating mechanism, the valve shall not close automatically and the valve opening shall be readily adjustable by hand. A pressure relief valve shall be provided at the discharge of each reducing valve, capable of discharging the maximum flow of the reducing valve without build-up of pressure.

Pressure & Temperature gauges shall be provided upstream and downstream of each reducing valve and this valve is operated by sensing the downstream pressure with the set pressure.

6.5.0 General requirements of installation of valves

All regularly operated isolation valves and control valves shall be accessible from a permanent floor or access platform. For operator convenience, valves shall have 1.0 m clear approach space. The stems of all valves for outdoor service shall have weatherproof protection covers of approved construction.



Sufficient overhead access and clearance shall be provided to enable the valve internals to be withdrawn and also for the complete valve to be removed by means of lifting tackle if necessary. Pipe work systems shall be designed and supported so that valves can be isolated for maintenance purposes without shut down of the system whenever feasible and practical.

Unless otherwise specified, manually operated gate, globe, or butterfly valves shall be hand wheel operated and plug valves or ball valves shall be wrench-operated. Manual gear operators shall be provided, as required, depending on the size and pressure rating of the valve. All gear operators shall be of the totally enclosed type, self-locking, with position indicators. All valves shall be equipped with a locking facility, which permits locking in the open or closed position.

All valves shall be fitted with indicators such that it may be readily seen whether the valves are open or shut, and the extent of opening. In case, the valves fitted with extended stems, indicators shall be provided both on the valve and at the extended stem hand wheel. Where remote indication is required, the valves shall be equipped with limit switches mounted on the valves for electrical signal of valve positions "open" and "shut" or position 0 to 100% as required.

Valves and related accessories shall be subjected to hydrostatic testing and seat leak testing as per the requirement of the applicable codes and valve pressure classes as per B16.34 / API 598 / BS 5146. All motor actuators shall be supplied with type and routine test reports.

The shut off valves in the vent line from the safety valves shall be locked open by a approved master key system.

All isolation valves shall be designed to withstand the differential pressure across them when closed.

The drains from each filter separator and other liquid drainage points shall be fitted with a non-return valve and manual isolating valve. The drains shall be grouped and connected to a common drain header leading to the condensate tank.

Vents and thermal reliefs shall discharge to the vent system. The capacity and the design of the vent system shall be as per the recommendations of API standards.

Whenever there is a risk of pressure above design point safety valves shall be provided.

7.0.0 MATERIAL REQUIREMENTS FOR PIPING COMPONENTS AND VALVES

The main materials and special requirements specified under this title shall be seen as the minimum requirement.

The following guideline represents minimum requirements. In case of intended deviations 'Deviation from Enquiry Documents' applies.

7.1.0 Piping Material Specifications

SL NO	SERVICE	SIZE	PIPE	FITTINGS	FLANGES	GASKETS	END JOINT
1	HP steam system – HP Steam to steam turbine, HP steam upto	<= 50 NB	ASTM A335 P91	ASTM A182 F91	ASTM A182 F91-	Spiral wound	Socket welded
		> 50 NB	ASTM	ASTM A234	ASTM	Spiral	Butt



SL NO	SERVICE	SIZE	PIPE	FITTINGS	FLANGES	GASKETS	END JOINT
	PRDS		A335 P91	WP91	A182 F91-	wound	welded
2	Steam Temperature above 550° C & upto 605 ° C	<= 50 NB	ASTM A335 P91	ASTM A182 F91	ASTM A182 F91-	Spiral wound	Socket welded
		> 50 NB	ASTM A335 P91	ASTM A234 WP91	ASTM A182 F91-	Spiral wound	Butt welded
3	Steam Temperature above 500 and upto 550° C	<= 50 NB	ASTM A335 P22	ASTM A182 F22	ASTM A182 F22	Spiral wound	Socket welded
		> 50 NB	ASTM A335 P22	ASTM A234 WP22	ASTM A182 F22	Spiral wound	Butt welded
4	Steam Temperature above 400 and upto 499° C	<= 50 NB	ASTM A335 P11	ASTM A182 F11	ASTM A182 F11	Spiral Wound SS316	Socket Welded
		> 50 NB	ASTM A335 P11	ASTM A234 WP11	ASTM A182 F11	Spiral Wound SS316	Butt welded
5	Temperature below 400° C (LP steam system, Auxiliary steam system, Fuel oil, Feed water, Condensate CEP suction, Nitrogen Filling)	<= 50 NB	ASTM A106 Gr B	ASTM A105	ASTM A105	Spiral Wound SS316	Socket Welded
		> 50 NB	ASTM A106 Gr B	ASTM A234 WPB	ASTM A105	Spiral Wound SS316	Butt welded
6	DM water distribution system/ Portable water system & LP chemical dosing system	<= 50 NB	ASTM A312 TP 316L	ASTM A182 Gr F316L	ASTM A182 Gr F316L	EPDM/ Teflon	Socket Welded
		> 50 NB	ASTM A312 TP 316L	A 403 Gr WP316L	ASTM A182 Gr F316L	EPDM/ Teflon	Butt welded
7	Closed cycle cooling water system	<= 50 NB	ASTM A53 Gr B ERW / IS1239 part I Heavy ERW	ASTM A105/IS1 239 Part II	ASTM A105	EPDM/ Teflon	Socket Welded
		Above 50 NB and upto 450 NB	ASTM A 53 Gr B ERW / IS1239 part I Heavy ERW upto 150NB & IS3589	ASTM A234 WPB/IS1 239 Part II up to 150NB	ASTM A105	EPDM/ Teflon	Butt welded



SL NO	SERVICE	SIZE	PIPE	FITTINGS	FLANGES	GASKETS	END JOINT
			ERW above 150NB				
		Above 450 NB	ASTM A134-A283 Gr C ERW / IS 3589	Same as parent pipe	ASTM A105 / IS2062 Plate fabricated	EPDM/ Teflon	Butt welded
8	Instrument Air system	<= 50 NB	ASTM A53 Gr. B (ERW)/ IS1239 Part I Heavy ERW Galvanized	ASTM A105/IS1239 Part II Galvanized	ASTM A105 Galvanized	EPDM/ Teflon	Threaded
		> 50 NB	ASTM A53 Gr. B/IS1239 ERW Part I Heavy up to 150NB Galvanized	ASTM A234 WPB / IS 1239 Part II up to 150NB Galvanized	ASTM A105 Galvanized	EPDM/ Teflon	Threaded
9	Service air / service water	<= 50 NB	ASTM A53 Gr B ERW/ IS1239 Part I Heavy ERW	ASTM A105/IS1239 Part II	ASTM A105	EPDM/ Teflon	Socket Welded
		> 50 NB & Upto 450 NB	ASTM A53 Gr B ERW/IS1239 ERW Part I up to 150NB.	ASTM A234 WPB/ IS 1239 Part II up to 150NB	ASTM A105	EPDM/ Teflon	Butt welded
		450 NB & Above	ASTM A134-A283 Gr C ERW	ASTM A234 WPB	Plate fabricated from MS IS 2062 Plate	EPDM/ Teflon	Butt welded
10	Lube Oil, Waste oil and Control / Hydraulic Oil (Upstream of Filter) / LDO & HFO	<= 50 NB	ASTM A106 Gr B	ASTM A105	ASTM A105	Spiral Wound SS316	Socket Welded
		> 50 NB	ASTM A106 Gr B	ASTM A234 WPB	ASTM A105	Spiral Wound SS316	Butt welded
11	Lube Oil, Waste oil and Control / Hydraulic Oil (Downstream of Filter)	<= 50 NB	ASTM A312 TP316	ASTM A182 Gr F316L	ASTM A182 Gr F316L	Spiral Wound SS316	Socket Welded
		> 50 NB	ASTM A312 TP316	ASTM A403 GRWP316	ASTM A182 Gr F316L	Spiral Wound SS316	Butt welded
12	Sea water intake and outfall / CT	All	HDPE	HDPE	HDPE With Backing Ring	EPDM	Fusion welded



SL NO	SERVICE	SIZE	PIPE	FITTINGS	FLANGES	GASKETS	END JOINT
	Makeup and Desal plant feed water/ ash recovery water Actual piping MOC shall be referred from the respective section. Accordingly Bidder shall consider.						
13	Sea water intake and outfall / CT Makeup and Desalplant feed water/Auxiliary cooling water system/ Low and High Pressure Sea water Actual piping MOC shall be referred from the respective section. Accordingly Bidder shall consider.	All	GRP	GRP	GRP	-	Butt and Wrap for Aboveground / Bell and Spigot for Below ground.
14	Condenser cooling water system	<= 50 NB	ASTM A312 TP 316 L	ASTM A182 Gr F316L	ASTM A182 Gr F316L	EPDM/ Teflon	Socket Welded
		Above 50 NB (including Above ground CW pipe)	IS1239 part I, ERW, Heavy, glass flake coating (1 mm) / ASTM A312 TP 316 L upto 150NB & IS3589 fabricated from IS 2062 ,with Polyurethane	ASTM A234 WPB glass flake coating (1 mm) up to 350NB and fabricated from parent pipe with	ASTM A105 up to 150 glass flake coating (1 mm) up to up to 350NB and fabricated from IS2062 Plate with Polyurethane lined 400NB and	EPDM/ Teflon	Butt welded



SL NO	SERVICE	SIZE	PIPE	FITTINGS	FLANGES	GASKETS	END JOINT
			lined inside 150NB and Above	Polyurethane lined inside 400NB and Above	Above		
		Above 900 NB (below ground)	IS3589 fabricated from IS 2062 with corrocoat or polyurea coating of 1500 microns DFT and Outside of pipes shall be provided with 250 mm thick RCC encasement	- -	-	-	-
15	Chemical lines in Desalination plant.	ALL	CPVC	-	-	-	-

Note: At the welding joints, corrocoat coating shall be applied after welding.

7.2.0 Valve Material Specifications

SL. NO.	SERVICE	SIZE	BODY/ BONNET	DISC	STEM	HAND WHEEL	VALVE ENDS
1	HP steam system – HP Steam to steam turbine, HP steam upto PRDS	>65NB < 50 NB	ASTM A182 Gr. F91 ASTM A182 Gr.F91	ASTM A182 Gr. F91 ASTM A182 Gr F91	ASTM A182 Gr. F6a ASTM A182 Gr.F6a	ASTM A47 Gr. 32510 ASTM A47 Gr.32510	BUTT WELDED. SOCKET WELDED
2	Steam Temperature above 550° C & upto 605 ° C	>65NB < 50 NB	ASTM A217 C12A/ ASTM A182 Gr.F91	ASTM A182 Gr. F91 ASTM A182 Gr F91	ASTM A182 Gr. F6a ASTM A182 Gr.F6a	ASTM A47 Gr. 32510 ASTM A47 Gr.32510	BUTT WELDED. SOCKET WELDED
3	STEAM LINES (TEMP >500 °C AND <550 °C)	>65NB < 50 NB	ASTM A217 WC9/ ASTM A217 C12A ASTM A182 Gr.F22	ASTM A217 WC9/ ASTM A217 C-12A ASTM A182 Gr F22	ASTM A182 Gr. F6a ASTM A182 Gr.F6a	ASTM A47 Gr. 32510 ASTM A47 Gr.32510	BUTT WELDED. SOCKET WELDED
4	STEAM LINES (TEMP>400 °C AND <499 °C)	>65NB < 50 NB	ASTM A217 WC6 ASTM	ASTM A217 WC6 ASTM	ASTM A182 Gr. F6a ASTM A182	ASTM A47 Gr. 32510 ASTM A47	BUTT WELDED. SOCKET



SL. NO.	SERVICE	SIZE	BODY/ BONNET	DISC	STEM	HAND WHEEL	VALVE ENDS
			A182 Gr.F11	A182 Gr F11	Gr.F6a	Gr.32510	WELDED
5	LP steam system, Auxiliary steam system, Fuel oil, Feed water, Condensate CEP suction, Nitrogen Filling	>65NB < 50 NB	ASTM A216 Gr WCB ASTM 105	ASTM A216 Gr WCB ASTM A182 Gr F6a	ASTM A182 Gr F6a ASTM A182 Gr F6a	ASTM A47 Gr 32510 ASTM A47 Gr 32510	BUTT WELDED SOCKET WELDED
6.	Lube Oil, Waste oil and Control / Hydraulic Oil (Upstream of Filter) / LDO & HFO	>65NB < 50 NB	ASTM A216 Gr WCB ASTM A105	ASTM A216 Gr WCB ASTM A 182 Gr. F6a	ASTM A479 Type 410-2 ASTM A479 Type 410-2	ASTM A47 Gr 32510 ASTM A47 Gr 32510	BUTT WELDED SOCKET WELDED
7.	Lube Oil, Waste oil and Control / Hydraulic Oil (Downstream of Filter)	>65NB <50NB	ASTM A 351 CF3M ASTM A 182 F 316 L	ASTM A 351 CF3M ASTM A 182 F 316 L	ASTM A479 Type 410-2 ASTM A479 Type 410-2	ASTM A47 GR. 32510 ASTM A47 GR. 32510	BUTT WELDED SOCKET WELDED
8.	INSTRUMENT AIR	>65NB < 50 NB	A216 Gr. WCB GALV. A105 GALV.	A351 Gr. CF 8M SS316	ASTM A479 Type 410-2 ASTM A479 Type 410-2	ASTM A47 GR. 32510 ASTM A47 GR. 32510	FLANGED RAISED FACE SCREWED
9	SERVICE AIR SERVICE WATER	>65NB < 50 NB	A216 Gr. WCB A105.	ASTM A216 Gr WCB ASTM A 182 Gr. F6a	ASTM A479 Type 410-2 ASTM A479 Type 410-2	ASTM A47 GR. 32510 ASTM A47 GR. 32510	FLANGED RAISED FACE SOCKET WELDED
10	SEA WATER	>65NB < 50 NB	A 439 Gr.D2 - NI RESIST A182 F316L	A 439 Gr.D2 - NI RESIST A182 F316L	DUPLEX SS DUPLEX SS	ASTM A47 GR. 32510 ASTM A47 GR. 32510	FLANGED RAISED FACE SOCKET WELDED
11	Condenser cooling water system	>600NB	CI-IS 210 FG-260 or ASTM A-216 CLB or Fabricated steel as per ASTM A-515 Gr. 60/80 / IS:2062 Gr. B or	CI-IS 210 FG-260 or ASTM A-216 CLB or Fabricated steel as per ASTM A-515 Gr. 60/80 / IS:2062 Gr.or	DUPLEX SS		



SL. NO.	SERVICE	SIZE	BODY/ BONNET	DISC	STEM	HAND WHEEL	VALVE ENDS
		>65NB UP TO 600NB	equivalent. Fully ebonite lined A 439 Gr.D2 - NI RESIST	equivalent. Fully ebonite lined A 439 Gr.D2 - NI RESIST	DUPLEX SS	ASTM A47 GR. 32510	FLANGED RAISED FACE
		< 50 NB	A182 F316L	A182 F316L	DUPLEX SS	ASTM A47 GR. 32510	SOCKET WELDED
12	DM Water / DMCW/ CCCW / Potable water /LP chemical dosing system	>65NB	ASTM A 351 CF3M	ASTM A 351 CF3M	ASTM A479 Type 410-2	ASTM A47 Gr 32510	FLANGED RAISED FACE
		< 50 NB	ASTM A 182 F316L	ASTM A182 F316L	ASTM A479 Type 410-2	ASTM A47 Gr 32510	SOCKET WELDED

Piping and valve specification also given in the respective package section. In case of contradiction between the respective package section and the piping section, superior of the respective package section and the piping section shall be provided.

8.0.0 BURIED PIPING

8.1.0 Excavation for Pipe Trenches

The trench shall be cut true to the line leveled with the help of sight rails provided at every 30 m, at change of direction, gradient and at any suitable distance as directed by the Owner.

If the trench is excavated below the required level indicated in the drawing, the extra depth shall be filled with concrete or approved equivalent material as directed by the Owner.

The trench shall be excavated so as to provide an average cover of 1500 mm or equal to the diameter of the largest pipe to be laid in the trench unless otherwise shown in drawings. The average cover shall be reckoned from top of the pipe of the largest diameter to be laid in the trench, to the finished grade. The width of the trench, shall be sufficient to give free working space on each side of the pipe. The free working space shall conform to IS:783. Generally it shall not be less than 150 mm on either side or 1/3 of dia of pipe whichever is greater.

No excavated material shall be deposited within 1.5 meters from the excavated trench.

The dredged material shall be disposed off shore as per the regulations for sea water intake piping

In case of road cutting, all material i.e. metal, bricks, etc. shall be taken out carefully and kept separately for reuse and road work shall be redone up to the original level prior to cutting the road with the excavated road materials after laying & testing of the pipeline. The Contractor shall provide suitable signs and barricades to prevent accidents. Contractor shall also provide reasonable bypass when a road is cut for laying pipeline. The dykes affected due to laying of the pipes, shall be redone conforming to the original specifications by the Contractor.



During excavation if some obstacle is met with, same shall be reported to the Owner and dealt with as instructed by him.

The Contractor shall dewater, shore or do whatever might be required to excavate the trench, install the pipe in it and backfill the trench, in accordance with the specifications. Dewatering shall be done in advance of the laying of the pipe to allow adequate inspection of padding of the bottom if required and dewatering shall be continued throughout during laying of the pipe and backfilling of the trench.

In muddy/slushy ground, the bed shall be provided with a layer of a sand or lean concrete as directed by the Owner.

The trench shall follow the gradient of pipeline as specified in the drawing. The Contractor shall keep the trench in good condition, until the pipe is laid and tested. All materials to shore the trench in order to prevent caving are to be furnished and removed by the Contractor.

In case pipe is lowered in caved trench and back-filled before being inspected by the Owner, the Contractor shall re-excavate the trench for inspection and backfill it.

8.2.0 Sand bedding:-

Sand bedding of adequate thickness with fine sand to be provided as per AWWA M11

8.3.0 Corrosion Protection Tape coating

Materials

All underground steel pipes shall be protected with external corrosion Protection Tape.

Coating shall be coal tar based tape coating materials confirming to AWWA C203. Tape shall be coal tar component supported on fabric of organic / inorganic fibres. The fibre shall be thoroughly coated and completely covered on both sides with coal tar component. The tape shall be supplied in standard width and rolls shall be wound on hollow cores of standard diameter. The material shall have enough mechanical strength and dimension stability. As far as possible the fabric shall be thin, flexible, uniform and composed of glass fibres in an open structure bonded with a suitable inert material compatible with coal tar.

The primer shall be a coal-tar or suitable resin product. The primer shall consist of chlorinated rubber synthetic plasticizer and solvents. These primers shall be suitably compounded to produce a liquid coating which may be applied by brushing or spraying and which shall produce effective bond between the metal and subsequent coating of coal tar tape. Primer should not contain benzol or other toxic and/or highly volatile solvents, added pigments or inert fillers or other substances and shall show no tendency to settle out in containers.

Where the soil is corrosive in nature, Cathodic protection shall be given. If soil resistivity is greater than 5000 ohm-cm, cathodic protection is generally not required

Application Procedure

Cleaning, blasting and protection after blasting

Before the metal is blast cleaned, all oil and grease on the surfaces shall be thoroughly removed by flushing with a suitable solvent (such as xylene or 1,1,1 trichloroethane) and wiping with clean rags. The use of dirty or oily rags or dirty solvent shall not be permitted. All foreign matter not removable by blast cleaning shall be removed by suitable means. Blast cleaning operations shall remove all rust, scale and other impurities from the surface, exposing base material, presenting a greyish matte appearance. Slight shadows, strata or discoloration caused by rust stains or mill scale oxides need not be removed. Blasted



surfaces that rust before a priming coat has been applied shall be cleaned of all rust by buffing or wire brushing, or shall be reblasted. Adequate air separators shall be used to effectively remove all oil and free moisture from the air supply to the blaster.

After being cleaned, the pipe shall be protected from and be maintained free of oil, grease and dirt that might fall on the pipe before it has received its coal tar tape. During blast cleaning, any pipe found to show pits shall be set aside immediately, pending examination by the Owner for acceptance, reconditioning or rejection.

Priming and Application of coal tar tape

All blasted surfaces shall be primed immediately following blasting and cleaning. The surfaces be dry at the time the primer is applied and no primer shall be applied during rain unless the pipe to be primed is protected from the weather by suitable housing.

The use of coal tar primer that has become fouled with foreign substance or has thickened through evaporation of the solvent oil shall not be permitted. The application of primer shall be hand brushing, spraying or other suitable means and shall be in accordance with instructions for application, as supplied by the manufacturer. The apparatus to be used for application of the primer shall be acceptable to the Owner. Spray gun apparatus to be used shall include a mechanically agitated pressure pot and an air separator that shall remove all oil and free moisture from the air supply.

After application, the primer coat shall be uniform and free from floods, runs, sags, drips, holidays or bare spots. Any bare spots or holidays shall be recoated with an additional application of primer. All runs, sags, floods or drips shall be removed by scraping and cleaning, and the cleaned area shall be retouched or remedied by reblasting and repriming. Suitable measures shall be taken to protect the wet primer from contact with rain, fog, mist, spray, dust or other foreign matter until completely hardened and tape applied.

The minimum and maximum drying times of the primer or the period between application of primer and application of coal tar tape, shall be in accordance with instructions issued by the manufacturer.

If the coal tar tape is not applied within the allowed maximum time after priming, the pipe shall be reprimed with an additional light coat of primer or the entire prime coat shall be removed by reblasting and the pipe reprimed.

The cleaning and priming operation may be carried out in the Contractor's workshop or on site. The entire pipe length shall be cleaned but the ends of the pipes shall be left without coating for a distance of 230 mm for joints, which shall be coated and wrapped manually on site after laying, welding and testing the pipes.

Tape application should follow as soon as the primed surface is tacky. Tape shall be wrapped in accordance with the manufacturer's recommendation in a manner that shall meet the adhesion and holiday detection requirement. In no case the overlap per single wrap is less than 12.5 mm. Two coats of coal tar tape coating shall be applied. A suitable primer as per manufacturer's recommendation shall be applied between the wraps. Air pockets or bubbles between the pipe and tapes or between tapes are to be avoided and tape shall be in perfect contact with the primed steel.

8.4.0 Laying of Underground Piping

General

After prefabrication, coating and trenching, the Contractor shall lay the underground piping in accordance with the following clauses and as per the approved piping arrangement drawings.



The Contractor shall be responsible for correct layout and gradient of the line.

Lowering & Laying

The pipes shall be lowered either by mechanical methods or by hand when the trench is ready and bottom of the trench is graded as per required pipe laying conditions and specifications.

By machine

The shop coated pipe, already transported to the pipe laying site/convenient length of pipe assembly coated and wrapped near the trench after hydrostatic testing shall be placed on clean square cut skids suitably spaced so as to keep the pipe away from touching the ground. The pipe may be lowered down in the trench by the launcher cranes, with sufficient care to protect the coating of the pipeline. Bare cables, chains hooks etc. shall not be permitted to come in contact with the coating.

At tie in welds and other places, the Contractor shall clean, prime, coat and wrap manually. Also short sections of pipelines which are impracticable to shop treat may be hand treated but only on the prior written approval of the Owner.

By Hand

The pipe may be lowered with the help of tripods and chain pulleys blocks into the trench immediately after the coating. However if in the opinion of the Owner that the temperature condition do not allow direct lowering, then the pipe shall be set down on clean square cut skids. The skids shall be so spaced as to keep the pipe away from touching the ground.

Method & Time of lowering pipe

Under favourable temperature, conditions and using methods which shall not damage coating, the pipe may be lowered into the trench.

Pipe previously set on skids, because of unfavourable temperature conditions shall be lowered into the trench normally in the cool of the morning and only when the temperature of the pipe is below the softening point of the coating materials.

All skid marks and other places of damages shall be thoroughly examined to ensure proper patching where necessary, before the pipe is finally lowered into the trench.

Handling of Coated Pipes

Coated pipes shall not be placed in trench until cave in plugs, hard clods, stones, skids, welding rods etc. have been removed there from. Where the trench has a hard or jagged bottom, sufficient fine dirt or sand shall be placed therein, before the pipe is lowered.

Coated pipe shall not be handled or moved by means of cable or chains or by prying with skids or bars. It shall be tied and lowered by using lowering belts of a standard width and designs for the size of pipe being handled.

Coated pipe shall not be dragged along the ground or otherwise handled in a manner that shall be detrimental to the coating.

Lining up & Welding

The ends of the pipe line shall be kept securely closed to prevent entry of any foreign material/ moisture after lowering into the trench.

Before making joints the pipe shall be carefully laid so as to be perfectly aligned in both plan and profile and the end closures provided shall be removed.



Tie-in shall be made in the coolness of the morning or when the ambient temperature is not exceeding 29°C or softening temperature of the coating material whichever is less. All bevelling, aligning and welding shall be in accordance with the welding specifications.

Free access shall be provided for the welding of the circumferential joints by increasing the width and depth of the trench at these points. There should be no obstruction to the welder from any side so that a good welded joint is obtained.

8.5.0 Draining

All lines and equipment shall be completely drained after the hydrostatic test of a system has been completed. High point vents shall be open to prevent excessive vacuum and permit complete draining.

If it becomes necessary to leave a system filled with the testing medium for any abnormal length of time, suitable arrangement such as venting shall be made to provide for possible liquid expansion with change in ambient temperature.

8.6.0 Backfilling

After testing and inspection of the pipeline to the entire satisfaction of the Owner, the trench shall be backfilled with the same material as the pipe bed above the top of the pipe. No trench shall be backfilled without the approval of Owner.

Backfilling with the excavated material shall be done in layers of 200 mm, well watered and rammed to avoid any settling afterwards.

The Contractor shall place soil over the trench to such a height as to provide adequately for future settlement of the trench backfill.

If due to exigencies of the work, some portion of the pipeline is backfilled without approval of the Owner, the Owner shall have the right to order uncovering of the pipe for examination .

The backfill material shall be free from stone pieces.

Surplus excavated soil or rubbish material shall be removed by the Contractor to a place designated by the Owner.

When the trench has been dug through roads all backfill shall be thoroughly compacted. In certain cases, special compaction methods may be required by the Owner. This shall be done by the Contractor and part of the EPC work.

When the trench has been dug through unlined ditches the backfill shall be thoroughly compacted in 150 mm layers for a distance of 1.50 m beyond the outside banks of the ditch on either side. The banks of the ditch shall also be compacted in 150 mm layers .

After the roads have been already graded, if they are trenched or otherwise disturbed by the Contractor during laying of the pipelines. The Contractor shall restore the road to its original level and condition. In the event, the Contractor is required to place extra fill, gravel, or other special material it shall be borne by him and shall part of the EPC work.

8.7.0 Clean up of Surroundings

As soon as the backfill is completed, the Contractor shall immediately clean up the adjoining area by removing all surplus and defective material and dispose of all refuse such as spurs, sheet iron, and broken skids etc. to the complete satisfaction of the Owner.



8.8.0 Thrust blocks should be provided at all direction changes for GRP/HDPE Buried pipes .

9.0.0 DOCUMENTATION

9.1.0 Drawings, Data / Documents To Be Submitted Along With Offer

9.1.1 Completely filled up technical schedules and data sheets of tender documents

9.1.2 Details of similar job executed in last five years

9.1.3 Mandatory spares

9.1.4 Start up and commissioning spares

9.1.5 3 years Operation and maintenance spares

9.1.6 Special Tools and tackles for erection & maintenance

9.2.0 Drawings, Data / Documents to be furnished by the successful Bidder

9.2.1 Piping specification for Supply and erection

9.2.2 QAP for shop and field works

9.2.3 Piping general arrangement drawings

9.2.4 Stress analysis report

9.2.5 Isometric drawings

9.2.6 Datasheets and GA drawings for valves and piping specialties

9.2.7 Specification for Pipe supports and stress analysis.

9.2.8 Specification for insulation

9.2.9 Pipe Thickness calculation

9.3.0 Any other drawings required for review during the detailed engineering stage, same shall also be submitted by contractor.



Occupied Area : 24.0°C ± 1.0°C 50 ± 5%

Equipment Room : 21.0°C ± 1.0°C 50± 5%

- The outdoor design data shall be taken from ISHRAE/ASHRAE Hand book
- Fresh air for air conditioned area shall be provided with 1 AC/hr or 35 m³/hr/person which ever is higher
- Bidder shall collect the actual data from the meteorological department pertaining to site location and design for plant accordingly
- Bidder shall adopt the Thoothukudi Metrological data (No. Of years shall be minimum of 20 years) and design condition shall be arrived based on the guidelines mentioned in ASHRAE .The design condition subject to the owner's approval

3.2.0 Ventilation System

Design & Technical Requirements

Room	Basis of Airflow rate: Air changes per hour
Evaporative cooled areas - T.G building operating floor, mezzanine floor, ground floor , MCC room / Switch gear room, Electrical room and Cable spreader room	6
MCC room / Switch gear room/ GIS room	15
Battery Rooms	30
Chemical house	20
Air Compressor building	15
Diesel generator room	30
Sea water intake pump house, CW pump house, Fuel Oil unloading / Forwarding pump house and all other pump houses	15
SWAS room (Non-AC areas)	15
AC Plant room	15
Workshop and Stores	6
Toilets in all buildings	15
Pantry in all buildings	15
Elevator machine room	15
Hydrogen generation plant room	20
Electro chlorination plant room	20

Supply and Exhaust Ventilation System

Area to be ventilated	Supply air system	Exhaust air system
TG Hall	Filtered Supply air ventilation system from air washer through ducting	Roof exhaust fans

Supply Air Ventilation System

Area to be ventilated	Supply air system	Exhaust air system
Various rooms like cable spreader room, switchgear room, battery charger room, SWAS room (Non AC) etc, in TG	Filtered Supply air ventilation system from air washer through ducting	Gravity dampers



Area to be ventilated	Supply air system	Exhaust air system
Building.		
ESP Switchgear Building	Filtered Supply air ventilation system from UAF through ducting	Gravity dampers
All other MCC rooms/Switchgear, cable spreader rooms,	Wall mounted supply fans with pre filters	Gravity dampers
GIS Building	Centrifugal fan with pre filter and fine filters along with ducting for supply air system, exhaust by gravity dampers will be provided for GIS building to maintain positive pressure and to prevent ingress of duct particles inside GIS building.	Gravity dampers. Exhaust fan inter linked with SF6 gas detector shall be provided for emergency purpose.

Simple Exhaust Ventilation System

Area to be ventilated	Supply air system	Exhaust air system
DM Plant Room	Fresh air through intake louvers	Wall mounted exhaust fans
Battery Room (2x50% capacity axial flow belt driven)	Fresh air through intake louvers	Wall mounted exhaust fans
Chemical house of PT Plant, workshop and stores, pantry in all buildings, Hydrogen generation plant room, Electro chlorination plant room	Fresh air through intake louvers	Wall mounted exhaust fans
All Pump houses	Fresh air through intake louvers	Wall mounted /Roof exhaust fans
Elevator machine room/ AC Plant room/ Compressor building	Fresh air through intake louvers	Wall mounted exhaust fans
Diesel generator room	Fresh air through acoustically treated intake louvers	Roof/Wall mounted exhaust fans
Toilets in all buildings	Through door undercuts/door louvers	Wall mounted Propeller type exhaust fans

3.3.0 General Design Requirement

- 3.3.1 Relevant Indian/International standards such as ISHRAE, ASHRAE SMACNA, etc., as applicable to HVAC system and latest issues of these applicable codes and standards shall be adopted.
- 3.3.2 10% margin in equipment capacity over peak heat load calculated considering solar load and all internal loads due to equipment, lighting, fresh air, occupants, etc have to be considered for air conditioning and ventilation system.
- 3.3.3 For sensible and latent heat load, 5% factor of safety shall be considered. .
- 3.3.4 All windows in the air-conditioned area shall be provided with light coloured venetian blind.



TITLE :
2X660 MW UDANGUDI STPP

SPECIFICATION NO. PE-TS-435-168-A001

SECTION : I

**TECHNICAL SPECIFICATION FOR HYDROGEN
GENERATION PLANT**

SUB-SECTION: IIB

REV. NO. 00

DATE :

SECTION – IIB

GENERAL TECHNICAL REQUIREMENT (ELECTRICAL)



SECTION-3.16: MOTORS

1.0.0 INTENT OF SPECIFICATION

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

2.0.0 CODES AND STANDARDS

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

a) IS: 325	Three phase induction motors
b) IS: 12615	Energy efficient induction motors
c) IS: 900	Code of practice for installation and maintenance of induction motors
d) IS: 996	Single-phase AC induction motor for general purpose
e) IS: 1231	Dimensions of three-phase foot-mounted induction motors
f) IS: 2223	Dimensions of flange mounted AC induction motors
g) IS: 4029	Guide for testing three-phase induction motors
h) IS: 8789	Values of performance characteristics for three-phase induction motors
i) IS: 13555	Guide for selection and application of 3-phase AC induction motors for different types of driven equipment
j) IS: 5571	Guide for selection of electrical equipment for hazardous areas
k) IS: 12065	Permissible limits of noise level for rotating electrical machines
l) IS: 12075	Mechanical vibration of rotating electrical machines
m) IS 60034-5	Degree of protection provided by Integral design of rotating electrical machines
n) IS 60034-8	Terminal marking and direction of rotation
o) IS 60079-1	Equipment protection by flame proof enclosure
p) IS 60034-1	Rotating electrical machines.
q) IS 60079	Explosive atmospheres
r) IS/IEC 60529	Degrees of protection provided by enclosures (IP code)
s) IEC 60034	Rotating electrical machines.
t) IS 3177	Code of practice for Design, Manufacture, Erection and testing of Cranes and Hoists

3.0.0 TECHNICAL REQUIREMENTS

3.1.0 Design ambient temperature

Motors shall be suitable for an ambient temperature of 50 degree C and relative humidity of 95% and shall deliver the rated output without exceeding its guaranteed temperature limits.

3.2.0 Supply voltage

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

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



- Frequency variation : (+) 3% and (-) 5%
- Voltage variation for LT motors : ($\pm$) 10%
- Voltage variation for HT motors : ($\pm$) 6%
- Combined variation of voltage and frequency : 10% (absolute sum)

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

3.3.0 System Parameters

Sl. No.	Description	11 kV and 6.6 kV System	LT System
1.	Voltage level	6.6 kV : Above 200 kW and upto 2000 kW 11 kV: Above 2000 kW	240 V : up to 0.2 kW 415 V: >0.2 kW and up to 200 kW.
2.	System earthing	Earthed through resistance, limiting earth fault current to 300 Amps	415 V system solidly grounded.
3.	Fault withstand rating of motor terminal box (Breaker operated)	50 kA for 0.2 sec for 11 kV and 31.5 kA for 0.2 sec for 6.6 kV	415 V system : 50/65 kA for 0.2 second

3.4.0 Type

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

3.5.0 Duty

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

3.6.0 Design margin

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

The motor characteristics shall match the requirements of the driven equipment so that adequate starting, accelerating; pull up, breakdown and full load torques are available for the intended service.

Service shall be considered as 1.0 only.



3.7.0 Method of Starting

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

3.8.0 Efficiency

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

3.9.0 Temperature rise

- Winding Insulation shall be Class F.
- Temperature rise of air cooled motors shall not exceed 70°C over air temperature of 50°C by resistance method, while delivering its maximum rated output.
- Temperature rise of water cooled motors shall not exceed 80°C over inlet cooling water temperature by resistance method, while delivering its maximum rated output.

3.10.0 Starting voltage

- a) Motors shall be capable of starting and accelerating the load at following starting voltage, with direct on-line starting, without exceeding specified winding temperatures.
 - HT Motors (up to 1000 kW) : 85% of rated voltage
 - HT Motors (> 1000 kW up to 4000 kW) : 80% of rated voltage
 - HT Motors (> 4000 kW) : 75% of rated voltage
 - LT motors : 80% of rated voltage
- b) During fast changeover of power supply source, vector difference between the motor residual voltage and the incoming supply voltage shall be about 150% of the rated voltage and the motors shall withstand voltage stress and torque stress developed during that time, which may last for a period of one (1) second.
- c) The motor shall be capable of operating at full load at a supply voltage of 75% of the rated voltage for 5 minutes.

3.11.0 No. of Starts

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

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



3.12.0 Starting current

- Locked rotor current of HT motors for applications other than listed below shall be limited to 600% of the full load current, and is subject to IS tolerance.
- For energy efficient LT motors, locked rotor current shall be as per IS: 12615.
- Locked rotor current of the VFD controlled AC motors shall be limited to 300% of the full load current, and is subject to IS tolerance.
- Locked rotor current of the BFP motors shall be limited to 450% of the full load current of the motor, and is subject to IS tolerance.

3.13.0 Locked rotor withstand time

- The locked rotor withstand time for HT motors under hot conditions at 110% rated voltage shall be more than the starting time at minimum permissible voltage specified above by atleast three seconds or 15% of the accelerating time whichever is greater. Provision of speed switch shall be avoided to the extent possible. In case the speed switch is required, it shall be indicated by the bidder in his offer
- For the LT motors having starting time up to 20 seconds at minimum permissible voltage, the locked rotor withstand time under hot condition at highest voltage limit shall be at least 2.5 seconds more than the starting time.
- For the motors having starting time more than 20 seconds and up to 45 seconds at minimum permissible voltage, the locked rotor withstand time under hot condition at highest voltage limit shall be at least 5 seconds more than the starting time.
- For motors having starting time more than 45 seconds at minimum permissible voltage, the locked rotor withstand time under hot condition at highest voltage limit shall be more than starting time by at least 10% of the starting time.
- Speed switches mounted on the motor shaft shall be provided in cases where above requirements are not met.
- When a speed switch is mounted on the motor shaft, the same shall remain closed for speeds lower than 20% and open for speeds above 20% of the rated speed. The speed switch shall be capable of withstanding 120% over speed in either direction of rotation.

3.14.0 Torque Requirements

- Accelerating torque at any speed with the lowest permissible starting voltage shall be at least 10% motor full load torque.
- Pull out torque at rated voltage shall not be less than 205% of full load torque.
- Motors subjected to reverse rotation shall be designed to withstand the stresses encountered when starting with non-energized shaft rotating at 125% of rated speed in reverse direction.

3.15.0 Enclosure

- a) Motors shall have IP 55 degree of protection.
- b) For hazardous location, the enclosure of motors shall following have flame proof construction conforming to applicable standard.
 - Fuel oil area Group – IIB
 - Hydrogen generation plant area : Group – IIC)



3.16.0 Cooling

- LT motors shall be totally enclosed fan cooled (TEFC), type IC411. The cooling shall be effected by self-driven bi-directional centrifugal fan protected by fan cover.
- HT motors can be totally enclosed fan cooled (TEFC) or totally enclosed tube ventilated (TETV) or closed air circuit air cooled (CACA-IC6A1A1) type.
- Motors rated >3000 kW can be closed air circuit water cooled (CACW).
- Motors with CACA/CACW heat exchangers shall have dial type thermometer with adjustable alarm contacts to indicate the following:
 - Hot and cold air temperatures of the closed air circuit for CACA motors.
 - Hot and cold, air and water temperatures for CACW motors.
- The Alarm switch contact rating shall be minimum 0.5 A at 220 V DC and 10 A at 230 V AC.

3.17.0 Winding

- Winding shall be class F insulation with temperature limited to class B. Insulation shall be Non-hygroscopic, oil resistant, and flame resistant. Winding, fittings and hardware shall be corrosion resistant. Winding shall be tropicalized and suitably varnished, baked and treated for operating satisfactorily in humid and corrosive atmosphere.
- For the VFD operated drives, insulation shall be designed to take care of stresses due to high DV/DT. Motors shall be wound with dual coated winding wires and impregnated with VPI process. Further for such application, insulated bearings shall be provided to avoid circulating current caused by shaft induced voltages.
- Space heaters rated for 240 V AC, 50 Hz supply shall be provided for motors rated 30 kW and above to maintain windings in dry condition when motor is standstill.
- For HT motors, insulation shall be Vacuum Impregnated (VPI).
- HT motors shall withstand one minute power frequency voltage test or 1.2/50 micro sec lightning impulse Voltage wave of $4U+5$ kV (U =Line voltage in kV) test on main insulation as per IEC 60034-15. The coil inter-turn insulation shall withstand steep front impulse withstand voltage as per IEC 60034-15.
- For HT motors, 12 nos. simplex or 6 nos. duplex RTDs (two per phase), each having D.C. resistance of 100 ohms at 0°C, embedded in the stator winding at locations where highest temperatures may be expected, shall be provided. The material of the ETD's shall be platinum.

3.18.0 Bearings

- Motor shall be provided with antifriction bearings, unless sleeve bearings are required by the motor application. Bearings shall be provided with seals to prevent leakage of lubricant or entrance of foreign matters like dirt, water etc. into the bearing area.
- Sleeve bearings shall be split type, ring oiled with permanently aligned, close running shaft sleeves. Grease lubricated bearings shall be pre-lubricated and shall have provisions for in-service positive lubrication with grease nipple and relief holes. For sleeve bearings, the bearing housing shall be preferably in end shield itself.
- Vertical shaft motors shall be provided with thrust and guide bearings. Thrust bearing of tilting pad type is preferred. However, if anti-friction bearings can take vertical thrust, thrust and guide bearings are not required.



- Lubricant shall not deteriorate under all service conditions. The lubricants shall be limited to normally available types. For motors rated 30 kW and above re-lubrication facility shall be provided.
- For motor with forced lubrication, a shaft driven oil pump shall be provided along with an electrical auxiliary pump. Alternatively, two motor driven pumps may be provided, one working and one standby. All necessary auxiliaries and accessories shall be provided to complete the system. A pressure gauge and pressure switch for low oil pressure warning and to start the standby oil pump automatically shall also be provided. A motor driven jacking oil pump may be provided, for heavy shaft loads.
- Flow switches shall be provided for monitoring oil flow of forced lubrication bearings, if used. Alarm switch contact rating shall be minimum 0.5 A at 220 V DC and 10 A at 230 V AC.
- For bearing temperature measurement, duplex RTDs shall be provided for each bearing and shall be wired up to the terminal box.
- Each bearing shall be provided with dial type thermometer.
- For all VFD operated motors shall have insulated bearings to prevent flow of shaft currents.
- For motors rated above 1000 KW having shaft length more than 1.5 M shall have insulated bearings to prevent flow of shaft currents.
- All the motors rated <15 kW shall be provided with sealed ZZ bearings.
- Lub oil pressure transmitters shall be provided to DCS for remote monitoring. Lub oil pressure very low trip to HT equipment shall be 2 out of 3 logic.

3.19.0 Terminal Boxes

- Separate terminal boxes of IP 55 degree of protection shall be provided for stator leads. For single core cables, gland plate shall be non-magnetic material. Terminal box of HT motors shall be capable of being turned 360° in steps of 180°. Terminal box of LT motors shall be capable of being turned 360° in steps of 90°. The terminal boxes shall be split type with removable cover with access to connections.
- Terminals for motors shall be stud type, thoroughly insulated from the frame. The terminals shall be clearly identified by phase markings, with corresponding direction of rotation marked on the non-driving end of the motor.
- The terminal box shall be capable of withstanding maximum system fault current for 0.2 sec for all breaker operated motors and shall be provided with explosion vent.
- For contactor operated LT motors, the terminal box shall be capable of withstanding the fault current for 0.2 sec minimum and operating time of MPCB/MCCB.
- Removable gland plates of thickness not less than 2.5 mm sheet steel or 3 mm aluminium (for single core cables) shall be provided for cable boxes.
- Cable spreader box shall be provided for larger cable sizes.
- Cable boxes of HT motors shall be phase segregated type. The terminals of three phases shall be segregated by barriers of metal or fiber glass. For HT motors, cable box design shall be suitable for accommodating cable termination kits.
- Separate terminal box for space heaters shall be provided.
- A separate terminal box of IP 55 degree of protection shall be provided for temperature detectors.
- Motors rated >1000 kW shall be provided with neutral current transformers of PS class on each phase for differential protection in neutral side terminal box. The three phases shall be connected to form the star point after passing through the CTs. The CT details shall be



finalized during detail engineering. Neutral terminal box shall have IP 55 degree of protection.

- The secondary leads of CT shall be wired to separate auxiliary terminal box of IP 55 degree of protection
- All the accessory terminal boxes shall be located on the same side of the main (power) terminal box.
- For LT motors, terminal box shall be located on top, unless otherwise specified.

3.20.0 Earthing Terminals

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

3.21.0 Noise and Vibration

- Motors shall be selected with low noise levels in accordance with IS 12065.
- The peak amplitude of the vibration shall also be within the specified limits of IS: 12075.
- All HT motors shall be provided with vibration pads for mounting vibration detectors.

3.22.0 Name Plates

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

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

- Temperature rise in °C under rated condition and method of measurement.
- Degree of protection.
- Bearing identification no. and recommended lubricant.
- Location of insulated bearings.

3.23.0 Canopy

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

4.0.0 DC MOTORS

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

5.0.0 INSTALLATION

Installation shall be carried out as per IS: 900.

6.0.0 PAINTING

Painting shall be carried out by an approved process. Pretreatment shall conform to applicable standard. The equipment shall be subject to a coat of red oxide primer paint. All inside and



outside surface shall be painted with epoxy based paint. The final thickness of paint film on steel shall not be less than 100 microns. Finish shade shall be 631 of IS: 5 (smoke grey).

7.0.0 TESTING AND INSPECTION

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

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

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

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

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

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

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

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

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



8.0.0 DRAWINGS & DOCUMENTS

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

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



SECTION-3.17: ELECTRICAL ACTUATORS

1.0.0 INTENT OF SPECIFICATION

This section covers the requirements of motor operated electrical actuators.

2.0.0 CODES AND STANDARDS

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

3.0.0 TECHNICAL REQUIREMENTS

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

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

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

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

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

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

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

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

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

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

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



- 3.11.0 The actuator shall be complete with motor, reduction gears, change gears, terminal compartment, switch compartment with limit switches and torque switches, local position indicator, position transmitter for remote position indicator, thermistor, space heaters, cable glands, mechanical position indicator, hand wheel for manual operation, valve attachment etc.
- 3.12.0 Each actuator shall have a hand wheel fitted on it for emergency operation. The hand wheel shall be designed such that it is declutched automatically when the power supply to the motor is restored. The material of the hand wheel shall be either malleable iron or steel. The hand wheel shall have adequate clearance from housing for each gripping and operation. Actuators offered shall be with self-locking worm.
- 3.13.0 Two number adjustable torque switches (one for open and one for close) each with 2 NO and 2 NC potential free contacts shall be provided. It is required to have calibration for the torque switches so that the switches can be easily set to any value desired.
- 3.14.0 Two numbers of position limit switches (one for open and one for close) each with 2 NO and 2 NC potential free contacts shall be provided. Two auxiliary limit switches (one for open and one for close) with 2 NO and 2 NC potential free contacts shall also be provided. The limit switches shall be of independently adjustable type. Limit switches and actuating mechanism shall be rust proof suitable for damp atmospheres. Limit switch compartment shall be weather proof and spacious enough for easy setting. The limit switches shall be suitable for the following ratings, both 240 Volts AC, 10 A and 220 V DC, 0.5 Amps.
- 3.15.0 Each actuator shall have a space heater in the limit switch compartment suitable for 240 V AC 50 Hz single phase supply.
- 3.16.0 The wiring from the limit switches, torque switches etc. shall be brought out in a separate terminal box of adequate size, so as to easily terminate the control cables.
- 3.17.0 Actuators shall be supplied with integral starter which shall have sophisticated electronic controls with field programming feature. It shall be designed for remote control from DCS/Respective control system. Required interposing relays for receiving open/close/stop command from DCS/Respective control system shall be provided. Potential free contacts and transducers shall be provided to provide status indication at remote DCS/Respective control system..
- 3.18.0 A three position selector switch (marked as LOCAL-OFF-REMOTE) and push buttons OPEN-STOP-CLOSE (for local operation) with indication lamps for running OPEN and running CLOSE shall be provided.
- 3.19.0 The Remote command signal (OPEN-STOP-CLOSE) from DCS/Respective control system/Control panel shall be isolated from control electronics through opto-isolator.
- 3.20.0 The following individual sStatus annunciation LED's and fault annunciation LED's shall be provided locally (Integral to actuator) to annunciate the following for easy local monitoring.
- Actuator in local mode
 - Actuator in remote mode
 - Actuator running in OPEN direction
 - Actuator running in CLOSE direction
 - Actuator in inching mode.
 - Actuator in self-retaining mode
 - Limit switch OPEN trip
 - Limit switch CLOSE trip
 - Control voltage availability
- 3.21.0 The following individual fault annunciation LED's (Colour-Red) shall be provided locally. (Integral to Actuator)



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

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

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

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

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

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

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

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

4.0.0 TESTING AND INSPECTION

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

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

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

5.0.0 DRAWINGS & DOCUMENTS

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

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

DATA SHEET-A		
SL NO.	DESCRIPTION	2X660 MW UDANGUDI SUPERCRITICAL STPP
A	General	
1	Manufacturer & country of origin	
2	Motor type	Squirrel cage induction AC motors
3	Efficiency class	For all LT motors, it shall be IE3 class as per IS 12615 except for VFD controlled LT motors, it shall be IE2 class as per IS 12615
4	Type of starting	DOL
5	Maximum acceptable kW rating of LV motor	>0.2 kW and up to 200 kW. LT motors rated up to 125 kW shall be controlled through MPCB/MCCB and contactor. LT motors rated more than 125 kW shall be controlled through air circuit breaker.
6	Rating up to which Single phase motors permitted.	up to 0.2 Kw
7	Installation (Indoors/ Outdoors)	indoor/outdoor
8	Degree Of Protection	IP 55
9	Name of the equipment driven by motor & Quantity	
10	Maximum Power requirement of driven equipment	
11	Rated speed of Driven Equipment	As per system requirement
12	Design ambient temperature	50 deg C
B	Design and Performance Data	
1	Frame size & type designation	DURING DETAILED ENGINEERING
2	Type of duty	All the motors shall be rated for S1 duty for continuous operation. Motors of crane and hoist application shall be intermittent duty. The motors shall be suitable for bus transfer schemes provided on the 11 kV/6.6 kV/415 V systems without any injurious effect on its life.
3	Rated Voltage	240/415 V
4	Rated Frequency	50 Hz
5	System fault level at rated voltage	50 kA for 1 sec.
6	LV System grounding	solidly grounded
7	Permissible variation for	
a	Voltage	±10%
b	Frequency	+3% to -5%
c	Combined voltage & frequency	10%
8	Rated output at design ambient temp (by resistance method)	As per system requirement
9	Synchronous speed & Rated slip	As per system requirement
10	Minimum permissible starting voltage	80% of rated voltage During fast changeover of power supply source, vector difference between the motor residual voltage and the incoming supply voltage shall be about 150% of the rated voltage and the motors shall withstand voltage stress and torque stress developed during that time, which may last for a period of one (1) second. c) The motor shall be capable of operating at full load at a supply voltage of 75% of the rated voltage for 5 minutes.

11	TYPE OF STARTER PROVIDED IN MCC	DOL
12	Starting time in sec with mechanism coupled	
a	At rated voltage	As per manufacturers standard
b	At min starting voltage	
13	Locked rotor current as percentage of FLC (including IS tolerance)	For energy efficient LT motors, locked rotor current shall be as per IS: 12615. Locked rotor current of the VFD controlled AC motors shall be limited to 300% of the full load current, and is subject to IS tolerance
14	Torque	
a	Starting	
b	Maximum	
15	Permissible temp rise at rated output over ambient temp & method	Winding shall be class F insulation with temperature limited to class B
16	Noise level at 1.0 m (dB)	Motors shall be selected with low noise levels in accordance with IS 12065.
17	Amplitude of vibration	The peak amplitude of the vibration shall also be within the specified limits of IS: 12075.
18	Efficiency & P.F. at rated voltage & frequency	
a	At 100% load	Premium efficiency (IE3) IS: 12615 .
b	At 75% load	
c	At starting	
C	Constructional Features	
1	Method of connection of motor driven equipment	As per system requirement
2	Applicable Standard	as per relevant standard
3	DOP of Enclosure	IP55
4	Method of cooling	LT motors shall be totally enclosed fan cooled (TEFC), type IC411. The cooling shall be effected by self-driven bi-directional centrifugal fan protected by fan cover. The Alarm switch contact rating shall be minimum 0.5 A at 220 V DC and 10 A at 230 V AC.
5	Class of insulation	All motors shall have class F insulation but limited to class B temperature rise
6	Main terminal box	

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

12	Kind of bearings	Motor shall be provided with antifriction bearings, unless sleeve bearings are required by the motor application. Bearings shall be provided with seals to prevent leakage of lubricant or entrance of foreign matters like dirt, water etc. into the bearing area. • Sleeve bearings shall be split type, ring oiled with permanently aligned, close running shaft sleeves. Grease lubricated bearings shall be pre-lubricated and shall have provisions for inservice positive lubrication with grease nipple and relief holes. For sleeve bearings, the bearing housing shall be preferably in end shield itself. • Vertical shaft motors shall be provided with thrust and guide bearings. Thrust bearing of tilting pad type is preferred. However, if anti-friction bearings can take vertical thrust, thrust and guide bearings are not required. • Lubricant shall not deteriorate under all service conditions. The lubricants shall be limited to normally available types. For motors rated 30 kW and above re-lubrication facility shall be provided. For bearing temperature measurement, duplex RTDs shall be provided for each bearing and shall be wired up to the terminal box. • Each bearing shall be provided with dial type thermometer. • For all VFD operated motors shall have insulated bearings to prevent flow of shaft currents. Lub oil pressure transmitters shall be provided to DCS for remote monitoring. Lub oil pressure very low trip to HT equipment shall be 2 out of 3 logic.
13	Direction of rotation when viewed from NDE	motor shall be bi-directional
14	Paint Shade & type	Painting shall be carried out by an approved process. Pretreatment shall conform to applicable standard. The equipment shall be subject to a coat of red oxide primer paint. All inside and outside surface shall be painted with epoxy based paint. The final thickness of paint film on steel shall not be less than 100 microns. Finish shade shall be 631 of IS: 5 (smoke grey).
15	Net weight of motor	
16	Outline mounting drawing No (To be enclosed as annexure)	DURING DETAILED ENGINEERING
D	Characteristic curves/ drawings	
1	(To be enclosed for motors of rating >55KW)	
2	Torque speed characteristic	
3	Thermal withstand characteristic	
4	Current vs time	
5	Speed vs time	
E	Tests on motors	

NOTE:

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

	TITLE : GENERAL TECHNICAL REQUIREMENTS FOR LV MOTORS	SPECIFICATION NO. PE-SS-999-506-E101 VOLUME NO. : II-B REV NO. : 00 DATE : 29/08/2005 SHEET : 1 OF 1

GENERAL TECHNICAL REQUIREMENTS

FOR

LV MOTORS

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

बी एच ई एल 	TITLE : GENERAL TECHNICAL REQUIREMENTS FOR LV MOTORS	SPECIFICATION NO. PE-SS-999-506-E101
		VOLUME NO. : II-B
		SECTION : D
		REV NO. : 00 DATE : 29/08/2005
		SHEET : 1 OF 4

1.0

INTENT OF SPECIFIATION

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

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

2.0

CODES AND STANDARDS

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

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

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

3.0

DESIGN REQUIREMENTS

3.1

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

3.2

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

3.3

Starting Requirements

3.3.1

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

3.3.2

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

	TITLE : GENERAL TECHNICAL REQUIREMENTS FOR LV MOTORS	SPECIFICATION NO. PE-SS-999-506-E101
		VOLUME NO. : II-B
		SECTION : D
		REV NO. : 00 DATE : 29/08/2005
		SHEET : 2 OF 4
The limiting value of voltage at rated frequency under which a motor will successfully start and accelerate to rated speed with load shall be taken to be a constant value as per Data Sheet - A during the starting period of motors.		
3.3.3 The following frequency of starts shall apply i) Two starts in succession with the motor being initially at a temperature not exceeding the rated load temperature. ii) Three equally spread starts in an hour the motor being initially at a temperature not exceeding the rated load operating temperature. (not to be repeated in the second successive hour) iii) Motors for coal conveyor and coal crusher application shall be suitable for three consecutive hot starts followed by one hour interval with maximum twenty starts per day and shall be suitable for minimum 20,000 starts during the life time of the motor		
3.4 Running Requirements		
3.4.1 Motors shall run satisfactorily at a supply voltage of 75% of rated voltage for 5 minutes with full load without injurious heating to the motor.		
3.4.2 Motor shall not stall due to voltage dip in the system causing momentary drop in voltage upto 70% of the rated voltage for duration of 2 secs.		
3.5 Stress During bus Transfer		
3.5.1 Motors shall withstand the voltage, heavy inrush transient current, mechanical and torque stress developed due to the application of 150% of the rated voltage for at least 1 sec. caused due to vector difference between the motor residual voltage and the incoming supply voltage during occasional auto bus transfer.		
3.5.2 Motor and driven equipment shafts shall be adequately sized to satisfactorily withstand transient torque under above condition.		
3.6 Maximum noise level measured at distance of 1.0 metres from the outline of motor shall not exceed the values specified in IS 12065.		
3.7 The max. vibration velocity or double amplitude of motors vibration as measured at motor bearings shall be within the limits specified in IS: 12075.		
4.0 CONSTRUCTIONAL FEATURES		
4.1 Indoor motors shall conform to degree of protection IP: 54 as per IS: 4691. Outdoor or semi-indoor motors shall conform to degree of protection IP: 55 as per IS: 4691 and shall be of weather-proof construction. Outdoor motors shall be installed under a suitable canopy		
4.2 Motors upto 160KW shall have Totally Enclosed Fan Cooled (TEFC) enclosures, the method of cooling conforming to IC-0141 or IC-0151 of IS: 6362. Motors rated above 160 KW shall be Closed Air Circuit Air (CACA) cooled		
4.3 Motors shall be designed with cooling fans suitable for both directions of rotation.		

	TITLE : GENERAL TECHNICAL REQUIREMENTS FOR LV MOTORS	SPECIFICATION NO. PE-SS-999-506-E101
		VOLUME NO. : II-B
		SECTION : D
		REV NO. : 00 DATE : 29/08/2005
		SHEET : 3 OF 4
4.4.	Motors shall not be provided with any electric or pneumatic operated external fan for cooling the motors.	
4.5	Frames shall be designed to avoid collection of moisture and all enclosures shall be provided with facility for drainage at the lowest point.	
4.6	In case Class ‘F’ insulation is provided for LV motors, temperature rise shall be limited to the limits applicable to Class ‘B’ insulation. In case of continuous operation at extreme voltage limits the temperature limits specified in table-1 of IS:325 shall not exceed by more than 10°C.	
4.7	Terminals and Terminal Boxes	
4.7.1	Terminals, terminal leads, terminal boxes, windings tails and associated equipment shall be suitable for connection to a supply system having a short circuit level, specified in the Data Sheet-A. Unless otherwise stated in Data Sheet-A, motors of rating 110 kW and above will be controlled by circuit breaker and below 110 kW by switch fuse-contactor. The terminal box of motors shall be designed for the fault current mentioned in data sheet “A”.	
4.7.2	unless otherwise specified or approved, phase terminal boxes of horizontal motors shall be positioned on the left hand side of the motor when viewed from the non-driving end.	
4.7.3	Connections shall be such that when the supply leads R, Y & B are connected to motor terminals A B & C or U, V & W respectively, motor shall rotate in an anticlockwise direction when viewed from the non-driving end. Where such motors require clockwise rotation, the supply leads R, Y, B will be connected to motor terminals A, C, B or U W & V respectively.	
4.7.4	Permanently attached diagram and instruction plate made preferably of stainless steel shall be mounted inside terminal box cover giving the connection diagram for the desired direction of rotation and reverse rotation.	
4.7.5	Motor terminals and terminal leads shall be fully insulated with no bar live parts. Adequate space shall be available inside the terminal box so that no difficulty is encountered for terminating the cable specified in Data Sheet-A.	
4.7.6	Degree of protection for terminal boxes shall be IP 55 as per IS 4691.	
4.7.7	Separate terminal boxes shall be provided for space heaters.. If this is not possible in case of LV motors, the space heater terminals shall be adequately segregated from the main terminals in the main terminal box. Detachable gland plates with double compression brass glands shall be provided in terminal boxes.	
4.7.8.	Phase terminal boxes shall be suitable for 360 degree of rotation in steps of 90 degree for LV motors.	
4.7.9	Cable glands and cable lugs as per cable sizes specified in Data Sheet-A shall be included. Cable lugs shall be of tinned Copper, crimping type.	
4.8	Two separate earthing terminals suitable for connecting G.I. or MS strip grounding conductor of size given in Data Sheet-A shall be provided on opposite sides of motor frame. Each terminal box shall have a grounding terminal.	
4.9	General	

	TITLE : GENERAL TECHNICAL REQUIREMENTS FOR LV MOTORS	SPECIFICATION NO. PE-SS-999-506-E101
		VOLUME NO. : II-B
		SECTION : D
		REV NO. : 00 DATE : 29/08/2005
		SHEET : 4 OF 4
4.9.1 Motors provided for similar drives shall be interchangeable. 4.9.2 Suitable foundation bolts are to be supplied alongwith the motors. 4.9.3 Motors shall be provided with eye bolts, or other means to facilitate safe lifting if the weight is 20Kgs. and above. 4.9.4 Necessary fitments and accessories shall be provided on motors in accordance with the latest Indian Electricity rules 1956. 4.9.5 All motors rated above 30 kW shall be provided with space heaters to maintain the motor internal air temperature above the dew point. Unless otherwise specified, space heaters shall be suitable for a supply of 240V AC, single phase, 50 Hz. 4.9.6 Name plate with all particulars as per IS: 325 shall be provided 4.9.7 Unless otherwise specified, the colour of finish shall be grey to Shade No. 631 and 632 as per IS:5 for motors installed indoor and outdoor respectively. The paint shall be epoxy based and shall be suitable for withstanding specified site conditions. 5.0 INSPECTION AND TESTING 5.1 All materials, components and equipments covered under this specification shall be procured, manufactured, as per the BHEL standard quality plan No. PED-506-00-Q-006/0 and PED-506-00-Q-007/2 enclosed with this specification and which shall be complied. 5.2 LV motors of type-tested design shall be provided. Valid type test reports not more than 5 year shall be furnished. In the absence of these, type tests shall have to be conducted by manufacturer without any commercial implication to purchaser. 5.3 All motors shall be subjected to routine tests as per IS: 325 and as per BHEL standard quality plan. 5.4 Motors shall also be subjected to additional tests, if any, as mentioned in Data Sheet A. 6.0 DRAWINGS TO BE SUBMITTED AFTER AWARD OF CONTRACT a) OGA drawing showing the position of terminal boxes, earthing connections etc. b) Arrangement drawing of terminal boxes. c) Characteristic curves: (To be given for motor above 55 kW unless otherwise specified in Data Sheet). i) Current vs. time at rated voltage and minimum starting voltage. ii) Speed vs. time at rated voltage and minimum starting voltage. iii) Torque vs. speed at rated voltage and minimum voltage. For the motors with solid coupling the above curves i), ii), iii) to be furnished for the motors coupled with driven equipment. In case motor is coupled with mechanical equipment by fluid coupling, the above curves shall be furnished with and without coupling. iv) Thermal withstand curve under hot and cold conditions at rated voltage and max. permissible voltage.		

	TITLE MOTORS DATA SHEET – C 2 x 660MW UDANGUDI STPP	SPECIFICATION NO.
		VOLUME II B
		SECTION D
		REV NO. 00 DATE 21.05.18
		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			

	TITLE MOTORS DATA SHEET – C 2 x 660MW UDANGUDI STPP	SPECIFICATION NO.
		VOLUME II B
		SECTION D
		REV NO. 00 DATE 21.05.18
		SHEET 2 OF 2

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 $\geq 55\text{KW}$)	
	a) Torque speed characteristic	
	b) Thermal withstand characteristic	
	c) Current vs time	
	d) Speed vs time	

NAME OF VENDOR			SEAL	REV.	
NAME	SIGNATURE	DATE			

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

(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



TITLE :
2X660 MW UDANGUDI STPP

SPECIFICATION NO. PE-TS-435-168-
A001

SECTION : I

TECHNICAL SPECIFICATION FOR HYDROGEN
GENERATION PLANT

SUB-SECTION: IIC

REV. NO. 00

SECTION – IIC

GENERAL TECHNICAL REQUIREMENT (CONTROL AND INSTRUMENTATION)

**VOLUME – II****SUB-SECTION 4.3****DESIGN REQUIREMENT****1.0.0 DESIGN REQUIREMENT**

- 1.1.0 The Instrumentation and control systems shall be provided for safe, reliable and efficient operation of the thermal power project. In general a consistent control and instrumentation philosophy is to be applied throughout the power project. Adequate redundancy are to be ensured, so that no single point failure of the I&C systems/ equipments in the power project does not result in the overall reduction of the plant output. In general all I&C systems/ equipments should be of modern and compact design, incorporating proven technology and modern industrial practice.
- 1.1.1 The minimum target reliability of each piece of equipment like each electronic module/card, Power supply, Peripheral etc. considering its failure rate/mean time between failures (MTBF), meantime to repair (MTTR), such that the availability of the complete C&I system is assured for 99.7%.
- 1.1.2 The design of the control systems and related equipments shall adhere to the principle of 'Fail Safe' operation wherever safety of personnel / plant equipment is involved. 'Fail Safe' operation signifies that the loss of signal, loss of excitation or failure of any component shall not cause a hazardous condition. However, it shall also be ensured that the C&I system design with respect to control and protection functions is 'Fault Tolerant' to single faults such that the occurrence of false trips and degradation of functions are avoided / minimised. The types of failure which shall be taken into account for ensuring operability of the plant shall include but not limited to;
- a) Failure of sensor or transmitter,
 - b) Failure of main and/or redundant controller, other electronic modules,
 - c) Loss of motive power to final control element,
 - d) Loss of control power.
 - e) Loss of instrument air
- 1.1.3 Standardization concepts shall be applied wherever possible to rationalize operation, maintenance and reduce spare parts. The choice of hardware shall also take into account for sound maintainability principles and techniques. The same shall include but shall not be limited to the following:
- a) Standardization of parts.
 - b) Minimum use of special tools.
 - c) Grouping of functions.
 - d) Interchangeability.
 - e) Malfunction identification facility/self surveillance facility.
 - f) Easy modular replacement.
 - g) Fool proof design providing proper identification and other features to preclude
 - h) Improper mounting and installation.
 - i) Appropriate derating of electronic components and parts.
- 1.1.4 The design, manufacture, assembly, testing as well as performance of the equipment shall conform to the latest edition of relevant IEC/ISA and other international codes/specifications. The I & C equipment and systems shall be designed, manufactured & installed to meet the specification requirements, and perform accurately and safely under the operating and environmental conditions existing in the power project. The Instrumentation and control equipment shall be designed suitably that are subjected to saline atmosphere.



- 1.1.5 All control and instrumentation functions shall be shown on the piping and instrumentation diagrams. The symbols to be used shall be in accordance with ISA / ISO standard. The identification system (tag numbers) shall be in accordance with the KKS identification system, and shall be subject to approval by the Owner. All measurements and alarms shall be listed. Complete schematic control diagrams shall be provided for all instrumentation. Functional application and also specific control (modulating/interlock) application (by short text) for each measurement along with signal destination shall be indicated in Process and Instrumentation Diagram (P&ID). All reference engineering documents shall also be indicated in the P&ID.
- 1.1.6 **BLANK**
- 1.1.7 The system will have 1:1 redundancy with respect to the processor modules, power supply modules, communication modules and network interface.
- The system will be designed in such a manner that in the event of failure of the primary controller, the entire configuration of the failed controller will be instantaneously and automatically transferred to the back-up controller without operator's intervention. Mode changeover in either direction will be bumpless.
- Dual redundant power supplies to be provided for all the I&C panels. Loss of single power supply shall be alarmed in DCS for corrective action by the operator
- 1.1.8 Measurement system (MS), Closed Loop Control System (CLCS) and Open Loop Control System (OLCS) will all be configured with redundancy at processor modules, communication modules, data bus and power supply modules.
- 1.1.9 Redundant Input and output modules shall be provided for all the drive level interface (both OLCS/CLCS). For the inputs, dual or triple measurement as described in clause 2.1.0 of Section 4.8 and Clause 2.1.0 of Section 4.9 shall be provided and the individual measurements (dual or triple) shall be wired to separate input modules. No redundancy at I/O card level is required which are executing purely Data acquisition/Monitoring functions. I/O's redundancy shall be truly redundant and not engineered I/O redundancy. For measurement system, redundancy at sensor level and I/O module level is not envisaged. Logics for the redundant drives shall not be in the same processor.
- 1.1.10 The Measurement system shall have the following features:
- Linearization for temperature measurement i.e. mv Vs Deg. C
 - Square root extraction for flow measurement, where the measurement is in differential pressure.
 - Integration for totalizing the flow measurement, whenever applicable.
 - Compensation for variation in pressure or temperature or density for flow/ level measurement. E.g.: Feed water flow.
 - Limit value monitor for generation of contacts for alarm/interlock purpose.
Eg.: Boiler Tube metal, Bearing, winding temperature measurements
 - Each of the analog transmitters shall be Smart type with the following:
 - 4-20mA DC signal with 24V DC interrogation.
 - HART protocol based digital communication
 - All these Transmitters shall be hooked up to a PC based Centralised Calibration system (HART System), which shall have Diagnostic and Configuration software. This system shall be located in Computer room.
 - All contact inputs shall be interrogated with 24 / 48 V DC



- 1.1.11 Where redundant sensors are provided redundancy at I/O card level is not required. Redundant sensors will be provided for all control applications.
- 1.1.12 The communication sub system will be a real time reliable communication network between control processors, operator stations, printers and engineering station.
- 1.1.13 The plant bus and communication bus shall have dual redundancy
- 1.1.14 Triple Sensors for unit/equipment and protection trip are applicable for main plant equipments and equipments which will affect plant availability.
- 1.1.15 Dual redundant sensors shall be provided as a minimum in 1 out of 2 logic for all other closed loop and open loop controls used for protection.
- 1.1.16 Sequence of event recording system shall be integral to DCS
- 1.1.17 A consistent control and instrumentation philosophy shall be applied throughout the plant and be implemented in terms of a range of equipment exhibiting a minimum diversity of type and manufacture. Range of the instrument shall be so selected that max. operating value lies in 65-75% of the full scale range.
- 1.1.18 Control & Instrumentation shall be provided such that no single failure can cause a unit trip, loss of load/overall power output or even a forced outage of the power station. Modular redundant control systems shall be provided for all plant safety critical control and protection systems.
- 1.1.19 For hazardous area, the I & C systems to be designed as per the relevant area classification and applicable standards.
- 1.1.20 In the interest of a neat and clear, space-saving layout of the installation, easy maintenance, simple starting-up, operational checks and fault-recognition, a system made up of standard sub-assemblies with plug-in modules design shall be provided. The Systems shall have a decentralized design to a large extent. In the case of power supply failure no reprogramming shall be necessary and no controller parameter shall be lost.
- 1.1.21 To ensure smooth and optimal maintenance including efficient spare parts management of various I&C instruments/equipments like vibration monitoring analysis systems, all 4-20mA electronic transmitters/ transducers, control hardware, control valves, actuators and other instruments/ local devices etc. being furnished by the Bidder for SG, TG, BOP including its auxiliaries and systems like fuel system, circulating water system, chemical dosing system, Hydrogen Generation Plant (if applicable), Desal/WTP, cooling water system, electro chlorination system, effluent treatment plant, compressed air system, fire protection system, mill reject system, HVAC, potable water system, emergency DG facility etc. and other plant auxiliaries for similar applications, the Bidder shall ensure that they are of the same make, series and family of hardware. Bidder shall furnish a composite list of bought-out items along with proposed sub-vendors for each of the same.
- 1.1.22 The operator stations in the local and remote control rooms shall be housed in the enclosed control desk with interior lighting, louvers with brass mesh, space heater and telephones. The control desk shall be constructed of 2mm thick CRCA with IP 32 protection class for air conditioned environment and IP-44 for other indoor applications.



3.0.0 MAINTENANCE REQUIREMENT

- 3.1.0 To ensure easy maintenance Make of all I&C equipments like control valve, actuator, all electronic transmitters, control hardware, local devices, other instruments etc shall be uniform to the extent possible.
- 3.2.0 Selection of a particular Make and model of instruments shall be such to permit maximum interchangeability, easy maintenance and repair and to maintain minimum inventory.
- 3.3.0 Maintenance platforms and access ladders for all the instrumentation equipment installed at inaccessible heights. Sufficient maintenance space shall also be provided against each instrumentation equipment area with safety barricades in the platforms and handrails in the ladders.
- 3.4.0 Easy access shall be provided for all components in the equipment and system offered to reduce the maintenance period.



- 3.5.0 Adequate number of test equipment like test sockets, test cables, digital voltmeters, 3-pen recorders, signal generators, card extenders, etc., shall be provided by the Bidder to facilitate ease in maintenance.
- 3.6.0 Necessary maintenance equipment tools and special erection tools which are not specifically mentioned in the specification but are normally required for ease in maintenance and to have minimum down time, shall be included in the Bidder's scope.
- 3.7.0 Standardization concept shall be used in selecting the components for the systems.
- 3.8.0 Provision shall be made for isolating sub-systems/modules, which are identified to be faulty, thus enabling on-line replacement without taking equipment off-line.
- 3.9.0 All the documentation shall be in English Language.

4.0.0 AVAILABILITY REQUIREMENT

- 4.1.0 Adequate redundancy shall be built in at various levels to increase the system availability and reliability.
- 4.2.0 To ensure high reliability of the trip circuit and to avoid spurious tripping of the plant, multiple input logic system, (e.g., 2 out of 3 logic) shall be provided for important and vital trip functions.
- 4.3.0 The equipment / instrument shall employ state of art technology to guard against obsolescence, Bidder to ensure the supply of spare part for period of 15 years.
- 4.4.0 Control valves/dampers shall be driven to the fail safe position or hold position in case of control system failure, as required. This arrangement is necessary to avoid system upsets and subsequent loss of operation.
- 4.5.0 The total system availability for plant DCS shall be above 99.7%. The Bidder shall submit detailed calculations, which with the help of a schematic of various sub-systems connected in series or parallel as the case may be and the MTBF and MTTR values for the various equipments shall show that availability of 99.7% is possible.
- 4.6.0 The I&C system shall be designed with extensive self-diagnostics and trouble shooting features. Adequate facility shall be provided for quick repair/maintenance and on-line replacement of faulty modules. This shall not result in spurious trip. Where a major equipment/unit trips likely to be inhibited when the card is pulled out, Bidder shall identify it during detailed engineering stage.

5.0.0 GENERAL TECHNICAL REQUIREMENTS

- 5.1.0 As a minimum the following pressure measurement points are to be provided by the Bidder,
- Pressure gauges at the suction, discharge of the pumps, compressors and fans, common header of pumps and fans, inlets and outlet of heat exchangers, de-super heaters, pressurized vessels, and other main equipment outlet and inlet.
- Pressure gauges at the discharge of compressors and at the air receiver tank.
- Pressure switches at suction, permissive and trip of pumps and fans/blowers, discharge pressure low for auto-start of standby pumps and pre-trip alarm conditions.
- Pressure switches at the discharge of the compressor and in the lube oil circuit. Differential pressure switches across the inlet air filters.



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

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

Differential pressure switches across bag filters.

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

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

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

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

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

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

DP Type flow transmitter shall be used at MB outlet.

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

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

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

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

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

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

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

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

Temperature gauge at the silo fluidizing blower common discharge header.



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

Temperature gauge at the inlet of RO skid.

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

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

Temperature transmitters shall be provided for all control applications.

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

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

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

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

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

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

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

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



Flow switches at the ejector outlet line.

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

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

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

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

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

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

Vortex flow meter at the discharge of the compressors

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

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

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

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

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

Radar type level transmitters shall be used for condensate storage tank

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

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

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

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

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

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

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



VOLUME – II
SUB-SECTION 4.4
CODES AND STANDARDS

1.0.0 CODES AND STANDARDS**1.1.0 Temperature Measurement**

- a) Instrument and apparatus for temperature measurement – ASME PTC 19.3
- b) Temperature Measurement Thermocouples – IEC 60584 – 3 / ANSI – MC 96.1 – 1982.
- c) Thermometer-element-Platinum resistance – IEC 751 / DIN 43760.

1.2.0 Pressure Measurement

- a) Instrument and apparatus for pressure measurement – ASME PTC 19.2.
- b) Instrument Accuracies - IS 3624 / ASME

1.3.0 Flow Measurement

- a) Instruments and apparatus for flow measurement (Flow nozzle assembly)- ASME PTC 19.5 (1972) Interim supplement, Part-II, BS 1042.
- b) Instruments and apparatus for flow measurement (Orifice plate)- ISO 5167 Part – 1 / BS 1042.

1.4.0 Electronic Measuring Instruments and Control Hardware

- a) Automatic null balancing electrical measuring instruments – ANSI C 39.4.
- b) Safety requirements for electrical and electronic measuring and controlling instrumentation – ANSI C 39.5 / 1974.
- c) Compatibility of analog signals for electronic industrial process instruments ISA-S 50.1: ANSI MC 12.1.
- d) Dynamic response testing of process control instrumentation – ISA –S26.
- e) Surge withstand capability (SWC) tests – ANSI C37.90.1-1989 / IEC-255-4.
- f) Electro-Magnetic Compatibility Tests – IEC 801
- g) Tests for electronic equipments – IEC 68
- h) RF compatibility standard-IEC 61000
- i) Safety Integrity level – IEC 61508
- j) Electronic Cards, Subassemblies and Components

- a) Unpackaged

- i) Vibration : IEC-68.2.6
 - ii) Shock : IEC-68.2.27
 - iii) Drop & Topple : IEC-68.2.31

- b) Packaged

Vibration, Drop & Static Compression - NSTA

- c) Electromagnetic Compatibility

- i) Electrical Fast Transient : IEC-801.4
 - ii) Surge Withstand : IEC-255.4
 - iii) Radiated Electromagnetic Field : IEC-801.3
 - iv) Electrostatic Discharge : IEC-801.2
 - v) Electromagnetic Emission : VDE 0871, Class B

**1.5.0 Enclosures**

- a) Classification of hazardous area – IEC 79
- b) Degree of protection for enclosures – IEC 60529.
- c) Electrical Instruments in Hazardous Area – ISA RP 12.11
- d) Purged and pressurized enclosure for electrical equipment in hazardous location – NFPA Article 496 Volume-4, 1978.
- e) Environmental conditions for process measurement and control systems – ISA S71.04
- f) Classification of hazardous area - NFPA Art. 500, Vol.70-1984.
- g) Electrical Instruments in hazardous dust locations - ISA-RP 12.11
- h) Intrinsically safe apparatus - NFPA Art.493 Vol.4.1978
- i) Purged and pressurized enclosure for electrical equipment in hazardous location - NFPA Art. 496 1982.

1.6.0 Sampling System

- a) ASME PTC 19.11 Steams and Water Sampling, Conditioning, and Analysis in the Power Cycle.
- b) Stainless steel material of tubing and valves for sampling system - ASTM A269-82 Gr TP316.
- c) Submerged helical coil heat exchangers for sample coolers ASTM D 11-98.
- d) Water and Steam in power cycle - ASME PTC 19.11(2008).
- e) Standard methods of sampling system - ASTM D 1066-69.

1.7.0 Interlocks, Protections, Symbols

- a) Turbine water damage prevention – ASME-TDP-1-1980.
- b) Boiler safety interlocks – Applicable NFPA 85 sections.
- c) Instrumentation Symbols and Identification– ISA – S5.1.
- d) Binary logic diagrams for process operations – ISA – S5.2.
- e) Graphic symbols for distributed control/shared display instrumentation – ISA – S5.3
- f) Relays and relay system associated with electric power apparatus - IEEE std.3.13.
- g) Surge withstand capability tests - ANSI C.37.90a - 1974 and IEEE Std. 472 - 1974.
- h) General requirements & tests for switching devices for control and auxiliary circuits including contactor relays - IS-6875 (Part-I) 1973.

1.8.0 Annunciations

- a) Specifications and guides for the use of general-purpose annunciations – ISA RP 18.1.

1.9.0 Control Valves

- a) Control Valve Sizing – ISA-75.01.
- b) Control Valve capacity test – ISA-75.02.
- c) Face to face dimensions of Control Valves – ANSI B16.10.
- d) Control valve seat leakage classification – ANSI / FCI 70.2
- e) Valves flanged threaded and welding end - ASME B 16.34

1.10.0 Cables

- a) Thermocouple extension wires / cables – ANSI MC96.1.
- b) Colour coding of Instrument cables – BS-5308, Part-2.
- c) Specification for PVC insulated cables – IS 5831 / 8130/ 1554/ 10810 / equivalent IEC standards.
- d) Guide for design and installation of cable system in power generating station (insulation, jacket materials) IEEE Standard 422 / NEMA VE-1, and NEC.
- e) FRLS tests - IEC 332 / IEC 754 / IEEE 383 / SS-4241475 / ASTM D2863/ 43



- f) Requirements of vertical tray flame test – IEEE 383.
- g) NFPA 70.
- h) IS 13882 : Optical Fibre Cable
- i) Oxygen index test as per ASTM D 6863
- j) Temperature index test as per ASTM D 6863
- k) Smoke generator test as per ASTM D 6843
- l) Drum for electrical cables .
- m) Acid gas generation test as per IEC754-1
- n) Swedish Test as per SEN 4241475

1.11.0 Instrument testing

Safety Requirement For Electrical and Electronic Measuring And Controlling Instruments as per ANSI C 39.5 – 1974

1.12.0 Process connection and tubing

Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service as per ASTM A 269

- a) Codes for pressure piping power piping ANSI B31.1
- b) Seamless carbon steel pipe ASTM A-106.
- c) Forged and Rolled Alloy steel pipe flanges, forged fittings, valves and parts - ASTM A-182.
- d) Material for socket welded fittings - ASTM A-105.
- e) Seamless ferrite alloy steel pipe - ASTM A-335.
- f) Pipe fittings of wrought carbon steel and alloy steel - ASTM A-234.
- g) Composition bronze or metal castings - ASTM B-62.
- h) Seamless copper tube, bright annealed ASTM B-168.
- i) Seamless copper tube - ASTM B-75.
- j) Dimensions of fittings - ANSI B-16.11
- k) Valves flanged and butt welding ends - ANSI B16.34.
- l) Nomenclature for Instrument tube fittings ISA-RP-42.1 - 1982.
- m) Seamless carbon steel pipe - ASTM - A106.
- n) Material for socket weld fittings - ASTM - A105.
- o) Dimensions of fittings - ANSI B16.11
- p) Code for pressure piping, welding, hydrostatic testing - ANSI B31.1.

1.13.0 Annunciations

Specifications and guides for the use of general-purpose annunciators - ISA RP 18.1.

1.14.0 DCS and other Control system

a. Interlocks, protections, symbols

- Instrumentation Symbols and Identification– ISA – S5.1.
- Binary logic diagrams for process operations – ISA – S5.2.
- Graphic symbols for distributed control/shared display instrumentation – ISA – S5.3
- Instrumentation Loop Diagram - ISA-S 5.4
- Graphic Symbols for Process Displays - ISA-S 5.5
- Functionally Safety – Safety Instrumented system of process section – IEC 61151
- Fossil fuel power plant steam turbine bypass system – ANSI/ISA – 77.13.01
- Human system interface design review guide lines – NUREG - 700

b. Communication system

- Logical link control - IEEE 802.2
- Local Area Network: CSMA/CD Access Method and physical layer - IEEE 802.3
- Local Area Network: Token Passing Bus Access Method - IEEE 802.4



- Information Processing System – Open System interconnection,
 - Basic Reference Model and connectionless Mode transmission - ISO 7498
 - Internal organization of network layers - ISO 8648
 - For power system monitoring, control and associated communications. - IEC 60870 - 5-101
- c. Hardware Testing of Digital Process computers - ISA RP-55.1- 1983**
- d. Standard Digital Interface For Programmable Instrumentation - IEEE - 488.2 - 1990**
- e. Electromagnetic compatibility Tests –**
- Voltage and current surge – IEC 1000-4-5, EN 61000-4-5,
 - Fast transient bursts – IEC 1000-4-4, EN 61000-4-4,
 - Damped oscillatory wave – IEC 1000-4-12, EN 61000-4-12,
 - Ring wave – IEC 1000-4-12, EN 61000-4-12.
- f. Electrostatic discharge Tests – IEC 1000-4-2, EN 61000-4-2**
- g. Magnetic and Electromagnetic fields –**
- Power frequency magnetic fields – IEC 1000-4-8, EN 61000-4-8,
 - Pulse magnetic fields – IEC 1000-4-9, EN 61000-4-9,
 - Damped oscillatory magnetic field – IEC 1000-4-10, EN 61000-4-10,
 - Ring wave – IEC 1000-4-12, EN 61000-4-12.
 - Radiated radio-frequency electromagnetic field – IEC 1000-4-3, EN 61000-4-3,
 - Immunity to conducted disturbances, induced by radio- frequency fields – IEC 1000-4-6, EN 61000-4-6,
- h. Emission test RF radiated fields – CISPR 11/EN 55011.**
- 1.15.0 Instrument switches & contacts – BS 6134**
- 1.16.0 Cable trays & conduits - IEEE 422 / NEMA VE-1 / NFPA-70**
- 1.17.0 Surge protection system**
- Surge Withstand capability Test as per ANSI C 37.90.1 (1989), R1994
- 1.18.0 Sample coolers for SWAS - ASTM D 11**
- 1.19.0 Others**
- Printed Circuit Boards – IEC 326 C
 - General requirements and tests for printed for wiring boards – IS 7405 (Part 1)
 - Edge socket connections – IEC 130 – 11
 - Dimensions of attachment plugs & receptacles ANSI C73/1973
 - Direct acting Electrical indicating Instruments IS 1248/1968
- 1.20.0 NFPA 72 – National fire alarm code (Latest edition)**
- In addition to the codes and standards specifically mentioned in the relevant technical specifications for the equipment / plant / system, all equipment parts, systems and works covered under this specification shall comply with all currently applicable statutory regulations and safety codes of the Republic of India, as well as of the locality



where they will be installed, including the following:

- Indian electricity act
- Indian electricity rules
- Indian Explosives Act
- Indian Factories Act and State Factories Act
- Indian Boiler Regulations (IBR)
- Regulations of the Central Pollution Control Board, India
- Regulations of the Ministry of Environment & Forest (MoEF), Government of India
- Pollution Control Regulations of Department of Environment, Government of India
- State Pollution Control Board.
- Rules for Electrical installation by Tariff Advisory Committee (TAC).
- Building and other construction workers (Regulation of Employment and Conditions of services) Act, 1996
- Building and other construction workers (Regulation of Employment and Conditions of services) Central Rules, 1998
- Explosive Rules, 1983
- Petroleum Act, 1984
- Petroleum Rules, 1976
- Gas Cylinder Rules, 1981
- Static and Mobile Pressure Vessels (Unified) Rules, 1981
- Workmen's Compensation Act, 1923
- Workmen's Compensation Rules, 1924
- Any other statutory codes / standards / regulations, as may be applicable.

Unless covered otherwise in the specifications, the latest editions (as applicable as on date of bid opening), of the codes and standards given below shall also apply:

- Bureau of Indian Standards (BIS)
- Japanese Industrial Standards (JIS)
- American National Standards Institute (ANSI)
- American Society of Testing and Materials (ASTM)
- American Society of Mechanical Engineers (ASME)
- American Petroleum Institute (API)



16.0.0 HYDROGEN PLANT SYSTEM

16.1.0 Control Philosophy

Hydrogen Plant shall be controlled and monitored from the H2 local control room, through the PLC, Redundant Processor, power supply, communication module, redundant communication link all hardware, software, other interfaces, cables and field sensors / instruments / erection hardware envisaged to control and monitor it.

H2 plant local control room shall be provided with Two (2) no. 24" LED type Operator station for control and monitoring the H2 plant system locally in addition to remote monitoring from the central control room in the main plant DCS. Local annunciation panel with minimum amount of conventional hardwired pushbutton stations and indicators shall be provided for the safe shutdown of the plant.

Operator station in the H2 plant local control room shall be provided with the access to monitor the main plant operations

Operational requirement

- a) Operation of the pumps, Transformer Rectifier, Electrolyser, Compressor and other equipments shall be performed from the operator station located at the H2 plant Building (air conditioned area) as well as remote monitoring in central control room of the main plant.
- b) All conditions used for tripping the Transformer Rectifier, Electrolyser, Compressor and pumps etc., shall be provided with pre-trip annunciation in the operator station
- c) All initiating devices, relays and other hardware required to achieve annunciation, control and interlock system shall be provided by the bidder.

Important safety interlocks

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

Special Instrument requirement

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

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

Booster Pump by pass valve shall be motorised

Differential Pressure Transmitters and gauges across each electrolyser.



Flow transmitter along with flow control valve shall be provided at the inlet of each electrolyser to regulate the flow of water according to generation rate of H₂.

Pressure transmitters shall be provided in the H₂ tank.

Duplex PT100 shall be provided in each cell.

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

28% HCL tank Level transmitter and Local level Indicator

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

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

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

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

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

Process instruments & logic control connected with heater circuit and Hydrogen detection System

H₂ Leak detection system in all parts of Hydrogen plant buildings shall be provided for the system

H₂ Purity analyser system shall be provided for the system

O₂ & Moisture analysers shall be provided

Hydrogen flow meter shall be provided at the outlet of H₂ manifold

Level transmitter shall be provided for DM water tank

Redundant level switches shall be provided for final product (H₂) tank

Zener protection for all the digital/analogue signals involved in the process of Hydrogen plant shall be incorporated.

16.2.0 Lay Out of Local Control Room

- Separate battery room and UPS room shall be provided
 - The control room & remote I/O panel rooms shall be Air conditioned
 - The control room shall be provided with pantry room , Locker room , Toilet etc.,
 - The required modular furniture's and cabins for operators.
-



2.0.0 DRIVE CONTROL PHILOSOPHY

2.1.0 Bi-Directional Drives (Inching or Open/Close)

All bi-directional drives are provided with non integral starters. All these drives shall be operable from Remote i.e. from Central Control Room (CCR) / local control panel. Local operation of the drives shall be possible through open / close push buttons in the MCC.

Necessary electrical protections shall be realized in the MCC, whereas process interlocks and protections shall be realized in DCS. Drive control philosophy shall be subject to approval by Owner during detailed engineering.



Following signal exchange shall take place between DCS & integral starter of actuator.

1. Valve open, close & stop commands.
2. Integral starter disturbance (Loss of power/control supply, Thermal O/L, Local/off/Remote S/S in Local or Off mode etc.)
3. Valve Status feed back by means of end position limit switch, torque switch contacts (open/close).
4. Position feed back (4-20 mA, two-wire electronic type) for inching drives.

The analog/digital commands shall be from redundant output cards.

Following signal exchange shall take place between DCS & valve actuator, DCS & MCC for the non- integral bidirectional drives

Between DCS & MCC

1. Valve open, close & stop commands.
2. MCC disturbed
3. Remote Selected
4. EPB operated.

Between DCS & Valve actuator

1. Valve Status feed back by means of end position limit switch, torque switch contacts (open/close).
2. Position feed back (4-20 ma, two-wire electronic type) for inching drives

For each contact/signal, independent wires shall be used for the cabling, ie. One terminal of each contacts/signals shall not be shorted to create a common terminal.

2.2.0 Unidirectional LT Drives

Unidirectional LT drives shall be operable only from Remote i.e. from CCR / local control room or panel. In addition, Local push button shall be provided for emergency stopping of drive.

Remote start / stop commands, generated in DCS / local control room or panel shall be wired to MCC through interposing relays housed in respective MCC.

Emergency stop of the drive shall be envisaged for selected applications from the local push button provided near the drive. The stop push button (Stay put type) shall be provided with a press to lock and turn to release type, keyless mechanism with a protection cover. Under locked position the drive operation is inhibited from remote. The local emergency stop pushbutton shall be wired directly to MCC.

Necessary electrical protections for the drive shall be realized at MCC, whereas process interlocks and protections are realized in DCS / local control room or panel.

Life saving equipments like lube oil pump shall have emergency ON push button at CCR and local which is directly connected to MCC to tackle any DCS controller failure

Following signal exchange shall be envisaged between MCC & DCS/ local control panel:

- Drive start & stop commands
- Drive On & Off feedbacks
- MCC disturbed (Thermal Overload relay operated, MCC control power supply fail, local PB operated)



The analog/digital commands shall be from redundant output cards.

Current measurement shall be provided in DCS / Local Control Panel for monitoring for all drives rated 30KW and above & for critical drive rated less than 30KW. The Current Transducers shall be 4 -20mA, isolated output type, provided in MCC. Auxiliary power supply to these transducers shall be from the control supply of the respective switchgears. The local start push button shall be connected to the DCS so that the drive can be started on checking the process permissive through DCS another contact of local push button (Stop) shall be connected to DCS for alarming LPB latched condition in DCS.

For each contact/signal, independent wires shall be used for the cabling, ie. One terminal of each contacts/signals shall not be shorted to create a common terminal. Two stop commands from independent two DO cards placed in different racks shall be paralleled upto UCR terminals for redundancy

2.3.0 Solenoid Operated Drives

Solenoid operated drives shall be operated from remote CCR / Local Control Panel. Local operation of these drives is not envisaged. All solenoid valves are powered at 24V unless otherwise specified.

Trip solenoid valves of BMS and Turbine protection system shall be of 220 V DC. The solenoid valves shall have two coil (latch and release coil) for nozzle valves, trip valves etc. And air lock relays are preferred

Remote open / close commands shall be generated from DCS / Local Control Panel and shall be issued to the solenoid through interposing relays in DCS / Local Control Panel. The contact rating of IPR in DCS/Local control panel shall match the impedance and current rating of solenoid coil in the field used for different services.

Necessary process interlocks shall be realized in DCS / Local Control Panel.

The following signal exchange shall be envisaged between solenoid operated drive and DCS / LCP.

Valve open / close command

Valve Status feedback from the drive by means of limit switches (wherever available) for process/logic.

For each contact/signal, independent wires shall be used for the cabling, ie. One terminal of each contacts/signals shall not be shorted to create a common terminal. Depending on application two open/close commands from independent two DO cards placed in different racks shall be paralleled upto UCR terminals for redundancy

2.4.0 Unidirectional HT Drives

The switchgear has two modes of operation i.e. "Service and Test".

'Service' mode is the normal mode of operation. In service mode, the drive is operable from the plant DCS/ local control room or panel.

The 'TEST' position is envisaged to test the switch gear from local during maintenance / commissioning

Remote start / stop commands, generated in DCS / local control panel shall be wired to switchgear through interposing relays housed in respective switchgear.



Local push button shall be provided for only emergency stopping of drive. The stop push button (Stay put type) shall be provided with a press to lock and turn to release type, keyless mechanism. Under locked position the drive operation is inhibited from remote. The local emergency stop pushbutton shall be wired directly to switchgear.

Necessary electrical protection for drive shall be realized at switchgear, whereas process interlocks and protections are realized in DCS / local control room or panel.

Following signal exchange shall be envisaged between Switchgear and DCS / local control panel:

Drive start & stop commands

Drive status feedbacks by means of ON & OFF contacts (in service/test position of switchgear)

Master trip relay operated (Electrical trip).

SWGR disturbed (control power supply failure, trip coil unhealthy, local push button operated)

SWGR available (Breaker in service position, breaker spring charged, SWGR in remote)
SWGR Breaker in test position

The analog/digital commands shall be from redundant output cards.

Another contact of local push button (Stop) shall be connected to DCS for alarming LPB latched condition in DCS. Motor current – Current transducers 4 -20 Ma type shall be mounted in the SWGR for monitoring the current in DCS / local control panel. Auxiliary power supply to these transducers shall be from the control supply of the respective switchgears. For HT drives and driven equipment bearing temperature and motor winding temperature measurement shall be provided.

For each contact/signal, independent wires shall be used for the cabling, ie. One terminal of each contacts/signals shall not be shorted to create a common terminal. Two stop commands from independent two DO cards placed in different racks shall be paralleled upto UCR terminals for redundancy. In case of LOPs of fans/pumps, all oil pumps of turbine and auto start drives, the start command shall also be from 2 different DO cards for redundancy.

2.5.0 Analog Drive

Analog drive is hooked up & interfaced to DCS / Local Control Panel. A drive control function residing in Processing Units is used to position the pneumatically operated control valves. Interlock and protection Open / Close Commands originating from field or generated internally in control logics are interfaced with the drive control function residing in processors.

Control Valve actuator design shall take care of fail safe condition i.e. bringing valve to full open / full close or stay put mode, on signal air failure or air supply failure respectively.

Auto / Manual operator control and display for various control loop shall be provided.

MMI Control displays have the following functionality:

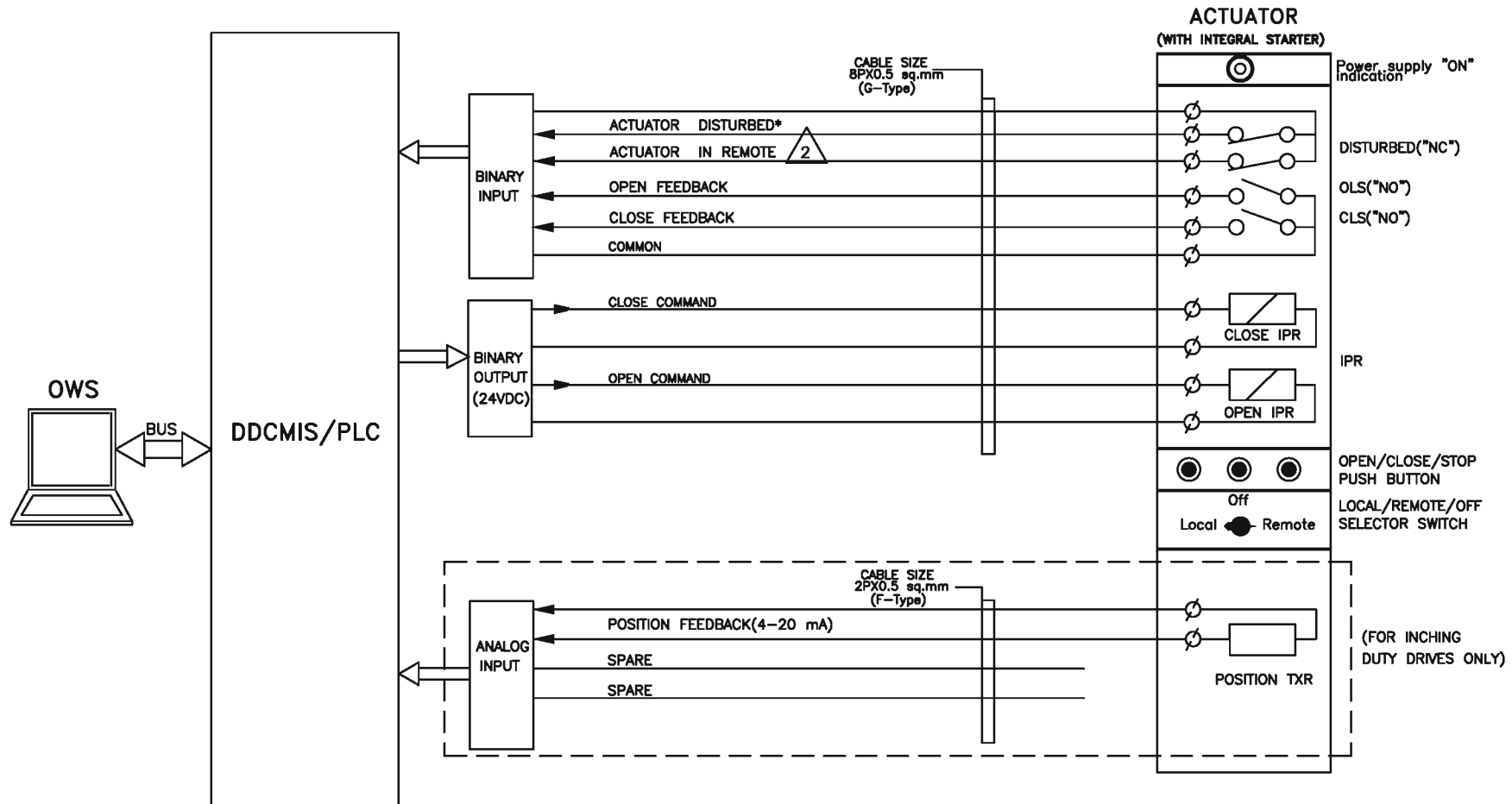
- Auto / Manual selection with control device “Raise / Lower Buttons”.
- Set point indication with “Raise / Lower Buttons”.
- Indication for deviation between set point and measured value.
- Measured value indication.



- Final control element position feedback indication.

For each contact/signal, independent wires shall be used for the cabling, ie. One terminal of each contacts/signals shall not be shorted to create a common terminal. Two output commands from independent two AO cards placed in different racks shall be paralleled upto UCR terminals for redundancy.

DCS INTERFACE FOR BIDIRECTIONAL DRIVE(WITH INTEGRAL STARTER)



NOTE:

1) Position Feedback of Bidirectional Inching duty drives in vicinity may be grouped together in the field during cable engineering. Junction Boxes and Single Trunk cable of higher size may be used to connect.

2) Redundancy of I/Os shall be as per contract specification requirement.

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

* DISTURBED= Loss of Power supply (1 Phase/3 Phase)/
Loss of control supply / Motor thermostat trip /
Thermal over load / Local/Off/Remote Sel. switch in
local or off mode / Torque open/close cut off / Stop
PB optd.



PROJECT: 2X660 MW TANGEDCO UDANGUDI
STAGE I STPP

TITLE DDCMIS INTERFACE FOR
BIDIRECTIONAL DRIVE

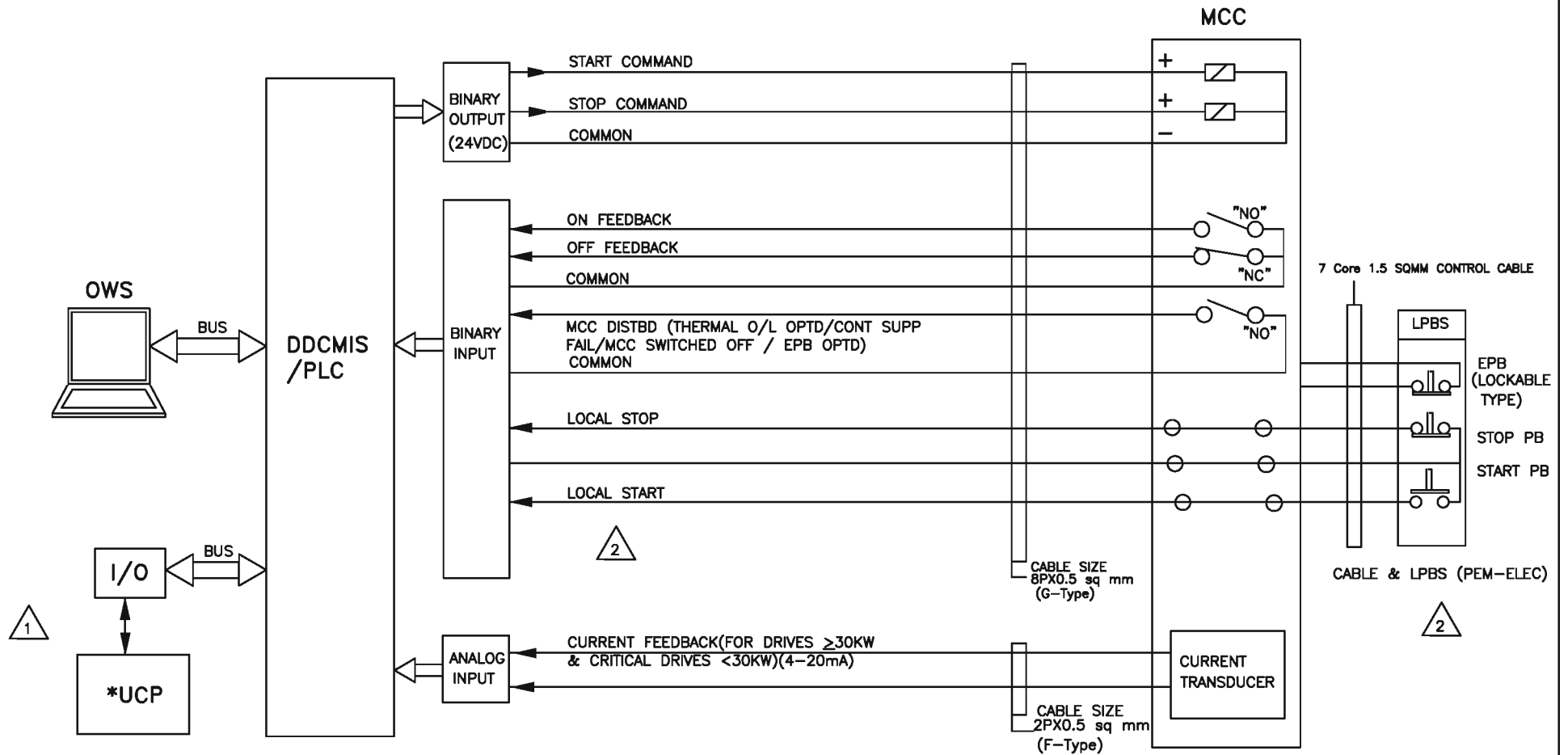
DRG.NO. PE-DM-435-145-1002

DATE 08.10.2018

REV.NO. 02

SHT 7 OF 11

DCS INTERFACE FOR UNIDIRECTIONAL LT DRIVE



* As Applicable

NOTE:

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



PROJECT: 2X660 MW TANGEDCO UDANGUDI
STAGE I STPP

TITLE DDCMIS INTERFACE FOR
UNIDIRECTIONAL LT DRIVE

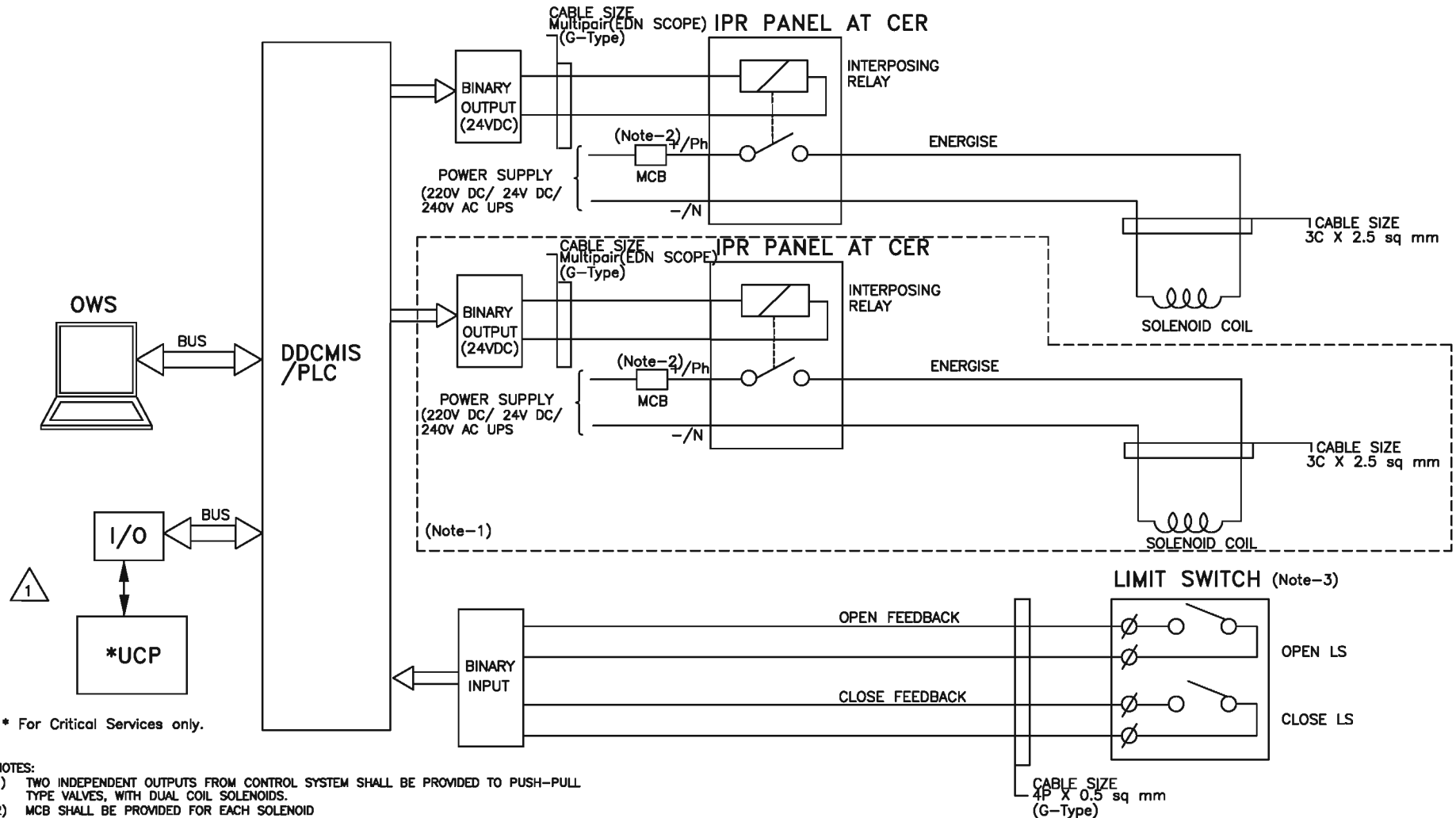
DRG.NO. PE-DM-435-145-1002

DATE 08.10.2018

REV.NO. 02

SHT 8 OF 11

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



NOTES:

- 1) TWO INDEPENDENT OUTPUTS FROM CONTROL SYSTEM SHALL BE PROVIDED TO PUSH-PULL TYPE VALVES, WITH DUAL COIL SOLENOIDS.
- 2) MCB SHALL BE PROVIDED FOR EACH SOLENOID
- 3) FOR ON/OFF TYPE, SOLENOID ACTUATED VALVE. RELAY CONTACTS SHALL BE WIRED AS FEEDBACK WHEREVER LIMIT SWITCH FEEDBACKS ARE NOT AVAILABLE. 1 CONTACT FOR SINGLE COIL & 2 CONTACT FOR DUAL COIL (OPEN LIMIT SWITCH & CLOSED LIMIT SWITCH.
- 4) BHEL WILL TAKE CARE OF DE-ENERGISE TO TRIP PHILOSOPHY FOR FAIL SAFE CONTROL SYSTEM (WHEREVER REQUIRED)
- 5) REDUNDANCY OF IO SHALL BE AS PER SPECIFICATION REQUIREMENT.
- 6) FEEDBACK OF SOLENOID DRIVES IN VICINITY MAY BE GROUPED TOGETHER IN THE FIELD USING JUNCTION BOXES & SINGLE TRUNK CABLE OF HIGHER SIZE MAY BE USED TO CONNECT TO THE DCS.



PROJECT: 2X660 MW TANGEDCO UDANGUDI
STAGE I STPP

TITLE DDCMIS INTERFACE FOR
SOLENOID DRIVE

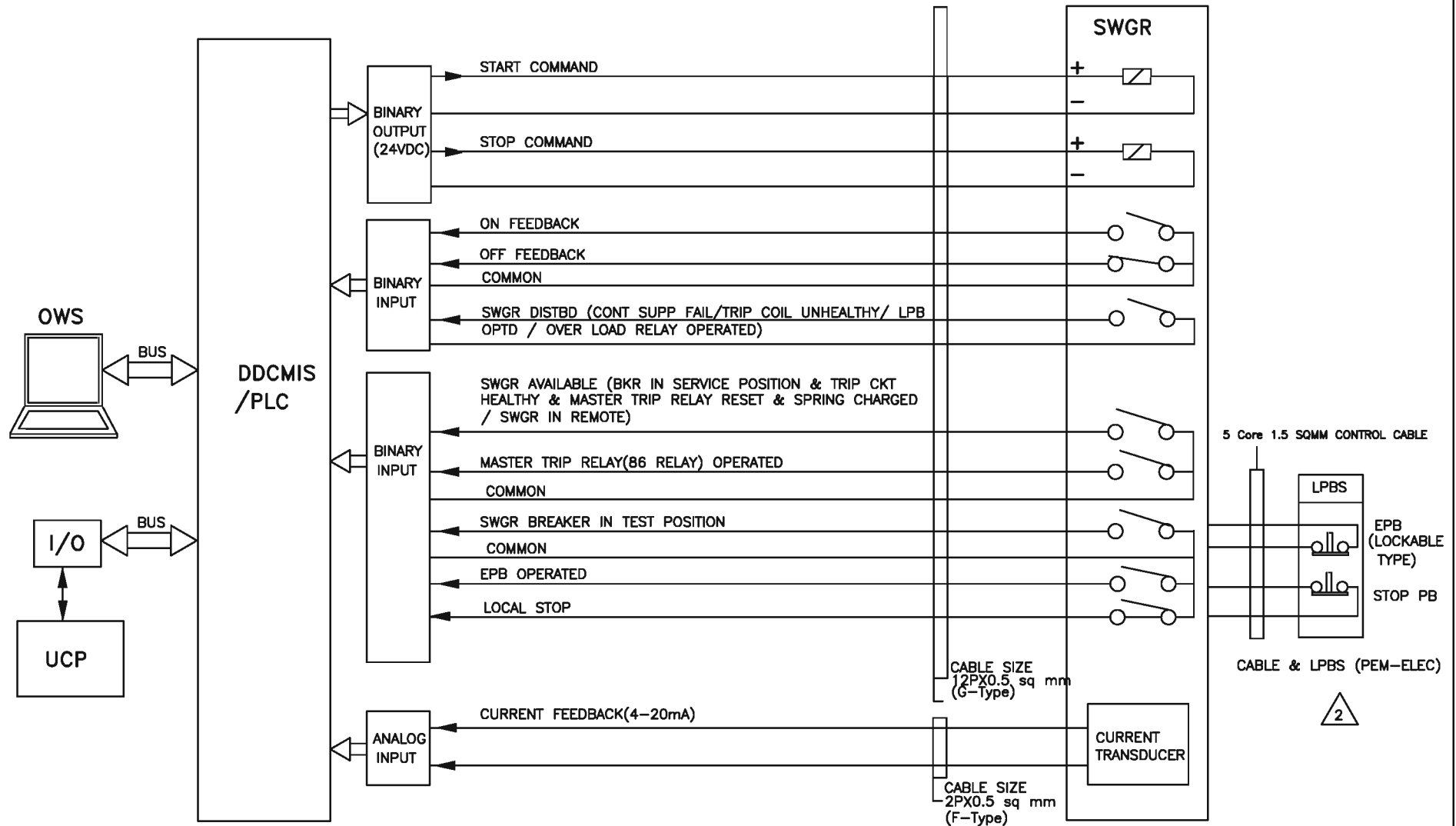
DRG.NO. PE-DM-435-145-1002

DATE 08.10.2018

REV.NO. 02

SHT 9 OF 11

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



NOTE:

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

2



PROJECT: 2X660 MW TANGEDCO UDANGUDI
STAGE I STPP

TITLE DDCMIS INTERFACE FOR
UNIDIRECTIONAL HT DRIVE

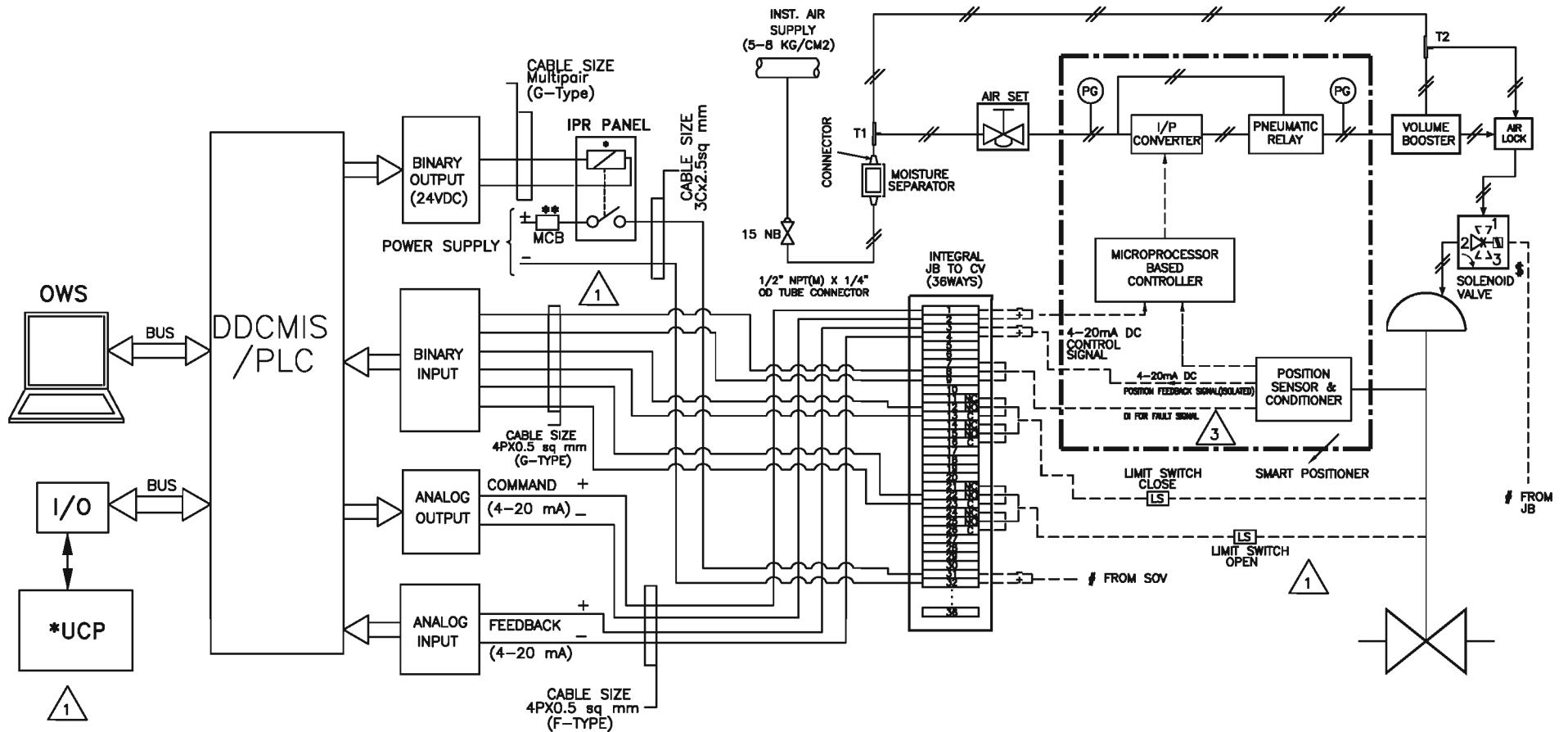
DRG.NO. PE-DM-435-145-1002

DATE 08.10.2018

REV.NO. 02

SHT 10 OF 11

DCS INTERFACE FOR ANALOG DRIVE (WITH SMART POSITIONER)



* As Applicable

NOTES:

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



PROJECT: 2X660 MW TANGEDCO UDANGUDI
STAGE I STPP

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

DRG.NO. PE-DM-435-145-1002

DATE 01.12.2018

REV.NO. 03

SHT 11 OF 11



CUSTOMER'S SPECIFICATION OF PLC

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

	TITLE: SPECIFICATION FOR PROGRAMMABLE LOGIC CONTROLLER SYSTEM	SPECIFICATION NO. PES-145-36	
		VOLUME II-B	
		SECTION D	
		REV. NO. 04	DATE: 20.05.2016
		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 & commissioning, site acceptance test of the Programmable Logic Controller(PLC) System comprising of PLC Control panel/Remote I/O panel (housing Processors, I/O cards, power supply packs etc.), Engineering Workstations(EWS)/ Operator workstations(OWS), Printers, Annunciation system, cables and all other equipment and accessories required for completeness of the system as mentioned in different sections of this specification.

2. GENERAL

- 2.1. The offered PLC shall be of Industrial Grade and all the hardware/software shall be from Original Equipment manufacturer (OEM).
- 2.2. The PLC shall be capable of receiving binary and analog signals from the field and providing command output to MCC/SWGR/Drive etc. through Input/output modules and operator initiated commands from HMIS/control panel. PLC shall be capable of performing Boolean logic and modulating functions for control, protection and annunciation of the equipment and systems, providing supervisory information for alarm, various types of displays, status information, trending, historical storage of data etc., performing self-monitoring and diagnostic functions.
- 2.3. The system shall be redundant in processor, power supply (bulk, rack) and communication interfaces unless otherwise specified. Redundancy of I/O modules shall be as specified in the Datasheet-A&B. 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. The system shall include self-diagnostic features not limited to the following:-
 - Memory Faults, both PROM and EPROM
 - Processor Faults
 - Communication Faults
 - I/O interface or address faults
 - Voltage signal discrepancy on input and output
 - Power supply faults
 - Output loop check
 - Channel level diagnostics such as fault monitoring, contact bounce filtering etc.

	TITLE: SPECIFICATION FOR PROGRAMMABLE LOGIC CONTROLLER SYSTEM	SPECIFICATION NO. PES-145-36	
		VOLUME II-B	
		SECTION D	
		REV. NO. 04	DATE: 20.05.2016
		SHEET 2	OF 9

- 2.4. 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.
- 2.5. The mimic shall be displayed on the OWS screen and may also be provided on the control desk/panel (as per Datasheet-A&B).
- 2.6. 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.
- 2.7. It shall be possible to configure OWS as EWS without any additional hardware.
- 2.8. The PLC system shall be sized to meet process/system requirements as per the approved P&IDs and Control write-up.
- 2.9. The PLC system shall be designed to ensure that no single device failure should result in failure of any other device.
- 2.10. 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.
- 2.11. Bidder shall provide all software on CDs along with required dongles, software licenses. Bidder shall provide software licenses for all software being used in the supplied system. The software licenses shall be in the name of customer/owner. The software/licenses shall be hardware / machine-independent so that same software /licenses is usable. All licenses shall be valid for the continuous service life of the plant. Software modification and up gradation, as applicable till the system is handed over to customer, shall also be in the bidder's scope without any cost implication.

Bidder shall periodically inform the plant owner/customer about the software upgrades/new releases that would be taking place after the system is handed over to customer.
- 2.12. All PCs used as HMIs like OWS/EWS/Storian/SER etc. shall be provided with industry proven antivirus software with perpetual license (free version not acceptable).

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 & IS.
- 3.1.2. PLC shall conform to IEC: 61131
- 3.1.3. The offered PLC shall comply with safety standards as per Data sheet-A&B.

	TITLE: SPECIFICATION FOR PROGRAMMABLE LOGIC CONTROLLER SYSTEM	SPECIFICATION NO. PES-145-36	
		VOLUME II-B	
		SECTION D	
		REV. NO. 04	DATE: 20.05.2016
		SHEET 3	OF 9

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 2.5 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 name plate of SS316 or three ply lamicoid, with engraved lettering.

3.2.4. Vendor shall indicate earthing details during detailed engineering.

3.2.5. 25 x 6 mm Copper ground bus to be provided for each panel.

3.2.6. 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.

3.2.7. 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-A&B for PLC system". Project specific paint shade, if applicable, shall be followed.

3.2.8. Panel internal wiring shall be as per NEC and NEMA standard.

3.2.9. TB points in terminal block shall be cage clamp type/screw type as per Datasheet-A&B.

3.2.10. 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.



TITLE:

SPECIFICATION FOR PROGRAMMABLE LOGIC CONTROLLER SYSTEM

SPECIFICATION NO. PES-145-36

VOLUME **II-B**SECTION **D**

REV. NO. 04

DATE: 20.05.2016

SHEET 4

OF 9

3.3. PROCESSORS

- 3.3.1. The microprocessors shall be 32 bit minimum, 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. Dedicated redundant link to establish hot redundancy between processors shall be considered. 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. Memory capacity shall be sufficient for complete system operation and have a capability for at least 20% expansion in future.
- 3.3.9. Memory shall be non-volatile, preferably EEPROM type. However, in case volatile memory is provided, battery backup shall be provided for a minimum of three months to keep the stored program intact. Battery drain indication shall be provided at least 1 week before the battery gets drained and same shall be annunciated in OWS. The batteries shall be lithium or Ni-Cd type.

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 unless indicated in the Datasheet-A&B:-
- Analog Input Module(4-20mA): 16
 - Analog Output Module: 08
 - RTD Module: 4
 - Thermocouple module: 8
 - Binary Input Module: 32
 - Binary Output Module: 32

	TITLE: SPECIFICATION FOR PROGRAMMABLE LOGIC CONTROLLER SYSTEM	SPECIFICATION NO. PES-145-36	
		VOLUME II-B	
		SECTION D	
		REV. NO. 04	DATE: 20.05.2016
		SHEET 5	OF 9

- Analog Input/output combined: 08
- Binary Input/output combined: 32

- 3.4.2. On line module replacement (hot swappable): All modules 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. Each I/O shall be protected against the reversal of polarity of the power voltage to I/O.
- 3.4.4. 10% spare capacity shall be ensured in each card channel assignment .Overall minimum 20% spare channels shall be provided. Spare channels/cards/slots shall be fully wired up to panel Terminal Block.
- 3.4.5. Output command to MCC/Switchgear shall be through coupling relays, whose mounting location shall be as per Data sheet A & B. The contact rating shall be 5A, 230VAC/0.5A,220VDC . The power rating shall not be less than 6VA. In case coupling relays are located in PLC Panel, the same shall be in PLC bidder's scope of supply.
- 3.4.6. 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-6 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 monitor/TFT with keyboard and mouse shall be as per Data Sheet-A&B. Monitor shall have graphic display facility.
- 3.6.3. The OWS shall be with Windows based operating system having necessary Engineering/Configuring software.
- 3.6.4. Specification of OWS.



TITLE:

SPECIFICATION FOR PROGRAMMABLE LOGIC CONTROLLER SYSTEM

SPECIFICATION NO. PES-145-36

VOLUME **II-B**SECTION **D**

REV. NO. 04

DATE: 20.05.2016

SHEET 6 OF 9

3.6.4.1 The specification of OWS shall be given under specification of equipment/field instruments

3.7. PRINTER

Printers shall be provided as per Data Sheet-A&B.

3.8. COMMUNICATION WITH PLANT DCS/ THIRD PARTY SYSTEM

- 3.8.1. The PLC system shall be provided with hardwired/serial interface for communication with plant DCS. Hardwired outputs from PLC shall be isolated. Necessary isolators shall be part of PLC.
- 3.8.2. 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.
- 3.8.3. Communication to DCS shall be using OPC (Data access 2.0)/MODBUS on TCP/IP Protocol. Alternatively the serial communication shall be MODBUS RTU on RS 485 network. Please refer Datasheet-A&B.
- 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

	TITLE: SPECIFICATION FOR PROGRAMMABLE LOGIC CONTROLLER SYSTEM	SPECIFICATION NO. PES-145-36	
		VOLUME II-B	
		SECTION D	
		REV. NO. 04	DATE: 20.05.2016
		SHEET 7	OF 9

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 etc. at PLC end for connectivity to other system. The bidder's terminal point shall be

- (i) LIU in case of Fibre optic connection.
- (ii) Ethernet port (for TCP/IP protocol) or PLC panel TB (for MODBUS on RS-485) in case of copper medium connection.

Fibre optic cable between PLC and other systems shall be single mode only.

- 3.8.6 Bidder shall consider the required hardware/software to interface PLC with Numerical relays using IEC-61850 protocol, as per Datasheet-A&B.

- 3.8.7 Bidder shall consider the required hardware/software to interface PLC with Master clock System (Plant area) for time synchronization, as per Datasheet-A&B.

3.9. POWER SUPPLY Scheme

- 3.9.1. PLC Panel and I/O Cabinets: PLC system shall be powered with 2x100% UPS. For further details, refer UPS specification attached elsewhere. 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 from UPS of PLC panels.

- 3.9.3. Each OWS and associated HMI peripherals e.g printers, switches etc. shall be provided with a feeder from 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.
- Power distribution scheme for PLC system, HMI & peripherals, Remote I/O etc.
- Block logic diagrams/ Ladder diagram mimic.
- Annunciation list.
- PLC control room layout drawing.
- List of soft signal exchange with Plant DCS.
- List of mandatory spares, as applicable.
- Quality plan
- Factory Acceptance Test.
- Data Sheet-C
- Screen shot of graphics/mimics.
- Power supply scheme for PLC system, HMI & peripherals, Remote I/O etc.

	TITLE: SPECIFICATION FOR PROGRAMMABLE LOGIC CONTROLLER SYSTEM	SPECIFICATION NO. PES-145-36	
		VOLUME II-B	
		SECTION D	
		REV. NO. 04	DATE: 20.05.2016
		SHEET 8	OF 9

4.2. For Information:

- Cable schedule and cable interconnection drawing(in BHEL approved format)
- 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 IS, 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.

	TITLE: SPECIFICATION FOR PROGRAMMABLE LOGIC CONTROLLER SYSTEM	SPECIFICATION NO. PES-145-36	
		VOLUME II-B	
		SECTION D	
		REV. NO. 04	DATE: 20.05.2016
		SHEET 9	OF 9

7.2. Mandatory Spares

The bidder shall offer along with 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 along with 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 15 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.

8.3. Applicability of sea worthy packing shall be as per Datasheet-A&B.

9. 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

	<u>DATA SHEET FOR PLC SYSTEM</u>		SPECIFICATION NO.:	
			VOLUME II B	
			SECTION D	
			REV. NO. 02	DATE: 20.05.2016
			SHEET 1	OF 2
Data Sheet No.: PES-145-36-DS2-0				
Data Sheet-A&B				
DATA SHEET – A (TO BE FILLED BY PURCHASER)			DATA SHEET – B (TO BE FILLED BY BIDDER)	
GENERAL	PROJECT	UDANGUDI (2 X660 MW)		
	SERVICE	HYDROGEN GEN PLANT		
	QUANTITY	☐ UNITISED ☒ COMMON		
	LOCATION	☒ INDOOR ☐ OUTDOOR ☒ AC ☐ NON-AC*		
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 DC ☐ 48 V DC ☐ 110 V AC ☐ OTHERS		
	LOCATION OF COUPLING RELAYS FOR COMMAND INTERFACE	☐ MCC ☐ PLC PANEL		
	OWS REQUIREMENT	☐ ONE ☒ TWO ☐ _____ ☐ DESKTOP VERSION ☐ SERVER VERSION ☒ WORK STATION VERSION REQUIREMENT OF OWS IN REMOTE LOCATION ☐ YES ☒ NO QUANTITY _____		
	MONITOR TYPE	☐ 19" ☐ 22" ☒ 24" TFT/ MONITOR ☐ GIU ☐ OTHERS		
	PRINTER	INKJET ☐ A3__NOS ☐ A4__NOS LASER B/W ☐ A3__NOS ☐ A4__NOS COLOR INKJET ☐ A3__NOS ☐ A4__NOS COLOR LASER ☒ A3__NOS ☐ A4__NOS		
PROGRAMMING / CONFIGURATION FACILITY	A) ☒ HAND HELD ☒ LAPTOP B) ENGINEERING SOFTWARE ☐ ONE OWS ☒ ALL OWS ☐ _____			
SAFETY STANDARD	☐ SIL-3 ☐ SIL-2 ☐ NIL			
	COMPUTER FURNITURE (INDUSTRIAL GRADE)	APPLICABLE ☒ YES ☐ NO		
ENGINEERING SPARES	SPARE LIST	☐ START UP & COMMISSIONING ☒ MANDATORY SPARE ☐ RECOMMENDED		
	SPARE LIST ATTACHED	☒ YES ☐ NO		
REDUNDANCY IN HARDWARE	CPU	☒ YES ☐ NO		
	POWER SUPPLY CARD	☒ YES ☐ NO		
	COMMUNICATION CARD	☒ YES ☐ NO		
	I/O CARD	☒ YES ☐ NO		
	OTHER ELECTRONICS	_____		

	DATA SHEET FOR PLC SYSTEM		SPECIFICATION NO.:	
			VOLUME II B	
			SECTION D	
			REV. NO. 02	DATE: 20.05.2016
			SHEET 1	OF 2
Data Sheet No.: PES-145-36-DS2-0				
Data Sheet-A&B				
DATA SHEET – A (TO BE FILLED BY PURCHASER)			DATA SHEET – B (TO BE FILLED BY BIDDER)	
No. of CHANNELS PER CARD	ANALOG INPUT	8 NOs ☒ 16 NOs		
	ANALOG OUTPUT	☒ 8 NOs ☐ 16 NOs		
	BINARY INPUT	16 NOs ☒ 32 NOs		
	BINARY OUTPUT	16 NOs ☒ 32 NOs		
	RTD**	4 NOs		
	THERMOCOUPLE**	8 NOs		
	ELECTRONIC CARD ISOLATION	☐ GALVANIC ☒ OPTICAL ☐ OTHER		
TERMINAL BLOCKS (TB)	TYPE	☒ CAGE CLAMP ☐ SCREW		
	ORIENTATION	☒ HORIZONTAL ☐ VERTICAL		
PANEL	QUANTITY	BIDDER TO INDICATE		
	CLASS OF PROTECTION	-----		
	REMOTE I/O PANEL	☐ YES ☒ NO AC REQUIREMENT ☐ YES ☐ NO PANEL FITTED AC ☐ YES ☐ NO		
	COLOUR#	-----		
	PAINTING SCHEDULE	☐ AS PER SECTION D ☐ CUSTOMER SPECIFIC		
	BACK-UP DESK	☒ YES ☐ NO		
	MIMIC ON PANEL	☒ YES ☐ NO IF YES, THEN ☒ PANEL MOUNTED GUI ☐ ACRYLIC		
	CONTROL HARDWARE	☒ PB ☐ INDICATORS ☒ FACIAS 60 Nos. ☐ OTHERS		
	CONFORMAL COATING	☐ YES ☐ NO		
	COMMUNICATION WITH OTHER SYSTEM	HARDWIRED	☐ YES ☒ NO	
PURPOSE		☐ CONTROL ☒ MONITORING		
MEDIUM		☐ UTP ☒ FIBRE OPTIC ☐ OTHERS		
TIME SYNCHRONIZATION SIGNAL FORMAT		☐ RS-485 ☒ IIRIG-B ☐ NTP		
PROTOCOL FOR SOFTLINK		☐ MODBUS ☒ OPC IF MODBUS THEN ☐ RS-485 ☐ ETHERNET		
NUMERICAL RELAYS USING IEC-61850 PROTOCOL		APPLICABLE ☐ YES ☐ NO		
PACKING	SEA WORTHY PACKING	APPLICABLE ☐ YES ☒ NO		
CUSTOMER TRAINING	TRAINING	☒ REQUIRED ☐ NOT REQUIRED		
	NO OF MAN DAYS	----- MAN DAYS		
	LOCATION	☐ VENDOR'S WORK ☐ PROJECT SITE ☐ OTHERS		
SUPERVISION	SUPERVISION FOR COMMISSIONING AT PROJECT SITE	☐ REQUIRED ☒ NOT REQUIRED		
	NO OF MAN DAYS	----- MAN DAYS		

*IF THE LOCATION IS INDOOR, KINDLY SPECIFY IF PLC PANEL IS PLACED IN AC OR NON-AC ENVIRONMENT.

**SHALL NOT BE APPLICABLE IF TEMPERATURE TRANSMITTERS ARE ENVISAGED.

PROJECT SPECIFIC PAINT SHADES, IF APPLICABLE TO BE USED.

\$\$ CHECK & REPLACE WITH MAIN UPS SLD IF POWER SUPPLY IS NOT APPROVED BY CUSTOMER.



ALARM ANNUNCIATION

Some alarm annunciations are of interest to the operating personnel only if the corresponding part of the assembly or units is in the start-up, operating or shut-down condition. These linked annunciations are usually made up of signals showing conditions and process monitoring criteria. The alarms shall be inactive when the relevant unit or equipment is supposed to be out of operation. Hardwired back panel annunciation system for BOP plants is envisaged ~~whereas for main plant in central control room, LVS based annunciation system is preferred.~~

1.0.0 ANNUNCIATION SYSTEM

1.1.0 General Requirements

Alarm annunciation system for presenting alarms with BTG package or with Unit DCS shall be integrated & part of Unit DCS system as mentioned below:

- a) NA
- b) NA
- c) For the Hydrogen gen system HW annunciation system shall be driven by Digital output channels or diode auctioning of input signals. For other relay based control systems, stand alone solid-state annunciation system shall be provided.

1.2.0 Scope of Supply

Requirement of annunciation system are specified on a system basis. Bidder shall be fully responsible for engineering and furnishing a fully operational system complete in all respects meeting the intent and requirements of this specification. All equipment and accessories required for completeness of the system shall be furnished by the bidder within the quoted price, whether these are specifically mentioned herein or not.

Annunciation system offered shall be from reputed, experienced manufacturer of specified type and range of equipment whose trouble free performance has been proven at least for two years in not less than two pulverized coal fired utility power stations of reheat type. The evidence regarding experience shall be furnished.

The annunciator components shall be designed for 50 deg.C ambient temperature and 90 percent highest average monthly humidity.

The windows shall be in multiple groups as required. The arrangement on the panels will be decided and advised when panel layouts are finalised. Each window shall be 50 mm high and 75 mm wide and shall be provided with sixteen high intensity LEDs wired in parallel, and capable of replacement from the front. The life expectancy of these LEDs shall be minimum of 100,000 hours.



Sets of push buttons, namely, Silence 'Acknowledge', 'Reset', System Test and Lamp Test shall be provided for Annunciation system on control panel/control desk/UCP/BUP. In addition, set of Annunciation PBs shall also be provided on Operator control desk in parallel to Annunciation PBs provided on Unit control panel/desk.

The system shall be so designed that during the lamp test, the existing fault annunciation is automatically disconnected from the lamp test circuit. Also any additional fault occurring during the lamp test shall automatically be isolated from the lamp test circuit & annunciated in the normal way.

In the case of group annunciation windows, the group alarm shall be annunciated every time any of the inputs associated with the group go into alarm status. Facility shall exist in the system to specifically identify the particular input in alarm state within the group.

A separate annunciation shall be provided on each panel to indicate mains supply failure for which 220V DC feeder shall be provided by bidder.

Integral Audio Visual Annunciation System with facia windows (approx. 60 nos. (min.) for each package having high intensity 16 nos. LED shall be provided in backup control desk for the BOP Packages as covered in Clause 1.0.0 of Section 4.2

The system shall be designed for bidding purposes that up to 30% of the windows will be group alarms with each group consisting of about four (4) inputs. Input sizing and provision of group alarm modules with retransmission facility shall be affected in line.

1.3.0 Annunciation Sequence

The sequence of annunciation for main control panels shall be as follows:-

Sl. No.	Condition	Visual	Audible
1	Normal	OFF	OFF
2	Alarm	Fast Flash	ON
3	Silence PB actuated	Fast Flash	OFF
4	Return to normal		
	a) before acknowledge	Slow Flash	ON(different tone)
	b) after acknowledge	Slow Flash	ON(different tone)
5	Alarm Acknowledge		
	i) before return to Steady normal	OFF ON	
	ii) after return to Slow normal	ON Flash	(different tone)
6	Return to abnormal (alarm)	Fast Flash	ON



7	Reset	OFF	OFF
8	System test	Fast Full Operational Sequence	
9	Lamp test	ON	

Note : Pitch and volume of the tone generators for the audible alarms shall be adjustable. Three sets of hooters buzzers, beacon lamps etc shall also be provided above control panel sections. Each audible device shall be driven by separate tone generator. Hooters and Buzzers provided on the panel shall be electronic with adjustable volume and pitch control. Operator interface push button stations shall be provided in appropriate sets on panels as per functional groupings desired. Push button stations shall also be provided in Operator interface.

Annunciation system shall be designed to ensure during LED / System test, existing fault annunciation is automatically excluded from test program with latching of status at card level. Once test command is removed, the system should display once again the faults annunciations.

LED box assemblies:

LED boxes shall have removable impact polystyrene windows of snap ON type. Inscriptions shall be black lettering on white background/film inserts with character height of typically 5 mm with 16 characters per line and 4 lines per window. LED illumination shall ensure clear readability.

1.4.0 Stand Alone Annunciation System

Stand alone Visual Alarm Annunciation System shall consists of requisite Buffer Terminal Cabinets, Input sharing networks, Remote annunciator logic cabinets with logic cards, power supplies in completely redundant mode, panel mounted lamp box assemblies, set of operator interface devices such as push buttons, audible devices, prefabricated FRLS interconnecting cables with connectors for signal transmission from logic cards to lamp windows as per actual length as required.

Panel type logic cabinet/cabinets to be furnished under this specification, shall receive cables from all contacts. Spring loaded type termination shall be provided for each contact input. This cabinet shall also contain the input logic cards and all other logic cards. The necessary contact interrogation and contact bounce filtering to provide a delay of 15 milli seconds shall also be provided. Modular construction shall be employed. All printed circuit boards shall be of epoxy fiber glass construction. All contacts shall be gold plated. Solid state CMOS Logic circuits/microprocessor based system shall be furnished for all windows.

The driver circuits for LEDs shall be provided with current limiting features and regulate current to LEDs and shall protect against short circuits in the LED circuit. Spurious alarms shall not be generated when system is switched ON.

The logic cards shall be provided with optical isolation feature for all input signals. Solid State Logic circuits shall be capable of meeting surge withstand capability in accordance with ANSI C37.90a or IEEE Standard 472-1974. The logic cabinet shall be constructed of 3 mm MS sheet. Cable entry shall be from the bottom. The logic cabinet shall be provided with anti-vibration mounting. 20% spare completely wired in slots with all internal and external cabling shall be furnished. The system shall require adding of additional logic cards only for these spare capacity to be implemented. To utilise this expansion capacity, prefabricated cables with requisite connectors to windows shall also be furnished as part of the system.



Each window or a group of windows shall be provided with Solid State CMOS Logic Cards, which shall be mounted separately in cabinets. Jumper switch shall be provided on each card so as to make it suitable for contacts that either open or close.

The flash frequencies among annunciation windows distributed in various panel sections shall be highly regulated to offer uniform flashing rate throughout the control room. The flasher module for this function shall also be uniformly distributed within the logic cabinet to approximate the finally decided window distribution in control panel sections. Generally not more than 30 points are expected to be hooked up to one flasher module.

The Buffer terminal cabinet with their auctioneering diodes shall receive field inputs on rows of terminals. The diode matrix shall be mounted on plug in type printed circuit boards and shall offer clear isolation of input status signals to annunciation system & other control system. The Diode matrix card shall be designed for a maximum of eight inputs per card.

Multipin sockets for the prefabricated plug in cables and the terminal block shall be interconnected through Diode matrix by cabinet internal wiring. Prefabricated plug in cables with connectors shall be furnished for interconnection of signals from Buffer cabinets to Visual Annunciation System cabinets, Control system. Signals used for HW Annunciation shall not be multiplied/ diode auctioneered, it shall be thru control system's digital output only.

1.5.0 Terminals and Wiring

Separate terminal blocks with twenty (20) percent spare terminals shall be provided for contact input termination and 240V AC supply. Terminals for each point shall be suitable for connecting two (2), size upto 2.5 sq.mm copper, 650 grade PVC insulated, single strand, flexible, single/multicore conductors.

Wiring inside panels shall be of copper, 650V grade PVC insulated, flexible conductor. Both ends of wiring shall have numbered ferrules for identification.

Cables

Prefabricated cables with plug-in connectors for connecting IPR/logic cabinet to annunciator windows (VAS) as well as interconnection among IPR/logic cabinets, shall be supplied and installed by the BIDDER. All the interconnecting cables shall be FRLS type. All terminations on his equipment shall however be executed by the Bidder. Bidder shall clearly specify if any special type of cables (e.g. Screened cables) are required for field connection.

Cable Specification

1. Reference : IS-1968, part-I
2. Insulation : Any polymeric/Elastomeric material conforming to IS-5831/IS-6380

1.6.0 Power Supplies

The cabinet shall be furnished with a system of duplex receptacles fed from the 240 V AC UPS power supply.

The logic and other power supplies requirements shall be derived by the BIDDER internally in the logic cabinets/IPR cabinets.

Redundant solid-state power supplies shall be furnished for the logic levels. Contact interrogation, and lamp drives. The outputs of the supplies shall be short circuit proof and diode auctioneered to ensure continuity of power within the system even with one power supply failure. The system shall also be furnished with "Earth fault" detection and monitoring equipment.



Bidder shall ensure that the interrogation voltage levels for Visual Annunciation System and DAS portion of the Distributed System are matched.

Factory Tests

Annunciation system shall be factory tested under various stages of manufacture and also on full completion with total system with its attendant subsystems fully integrated as per owner approved Quality Assurance Plan. The tests shall include but not limited to the following :

Type tests

1. Enclosure test as per IS-2147
2. Surge withstand capability (SWC) test as per ANSI C37.90a IEEE-472 1974.
3. Damp heat cycling tests as per IS-2106 Part-II-1962 or equivalent international standards.
4. Noise immunity test

Routine test

1. Burn-in power on test
2. Complete operational tests
3. Insulation resistance, high voltage, tests and continuity test of panel and cubicle wiring
4. Short circuit test for current limiting functions.
5. Under voltage/over voltage tests



VOLUME II
SUB-SECTION 4.12
FIELD INSTRUMENTS SPECIFICATION

1.0.0 TECHNICAL REQUIREMENT FOR INSTRUMENTATION

1.1.0 Field Instruments

- a) Analog outputs signals from field instrumentation to the control systems are 4-20 Ma DC signals. Instrumentation can be self-powered, or loop powered from the control systems. Self-powered analog signals shall be true “isolated from ground” signals.
- b) Field switches will be micro switch type with auto reset. Switches will have NO and NC contacts. Switch contacts shall be snap acting, 2 Nos of SPDT, hermetically sealed, potential-free with a minimum contact rating of 230 V AC 5A/ 24V DC 1A.
- c) Transmitters will be used to provide the required 4 to 20Ma signals for all controllers and receivers. Transmitters will be of the electronic, two-wire type, capable of driving an output impedance of 600 ohms minimum at 24 V dc, and will be generally powered from the control system I/O cards. All the transmitters supplied shall be SMART type with HART capability. All the transmitter shall be provided with 5 digit local indicators
- d) SMART transmitters' calibration shall be carried out through a PC based system to be located in the computer room.
- e) Pressure and differential pressure transmitters accuracy shall be within + 0.04% or better of FSR for BTG package, + 0.065% or better of FSR for BOP packages and + 0.2% for remote seal type transmitter. Repeatability shall be +0.05% of span or better. Errors caused by change in ambient temperature shall not exceed 0.01% of span per °C change. Stability 0.15% for five years.
- f) The plant instrument air supply pressure shall be:
 - 1. Maximum supply pressure 7 kg/cm²
 - 2. Minimum supply pressure 4.5 kg/cm²
- g) All instruments and analyzers shall employ EMI, RF protection in the system design.
- h) Instrument tags should be permanently attached to the device. If this is not possible, the instrument tag should be fastened to the instrument with stainless steel wire.
- i) Speed switches and the actual device should drive transducers, if possible.
- j) All instrumentation mounted inside, away from direct exposure to the elements, shall be as a minimum IP-44 construction unless it is in an environmentally controlled environment (e.g the control room). If the instrument is mounted in an environmentally controlled environment the instrument shall be as a minimum IP-32 construction.
- k) All instrumentation mounted outside shall be as a minimum IP-65 construction. IBR certification shall be provided for instruments / valve / Erection hardware wherever applicable.
- l) Vibration switch (alarm, trip) and oil level switch to be provided for the cooling towers.
- m) Transmitters and switches shall be grouped depending on the location. Individual instruments shall be mounted on stanchion or pipe mounted.



- n) For saline applications and other applications which are corrosive in nature, the wetted part material to be selected which shall meet the process applications, preferably diaphragm seal to be used. Hastelloy C wetted part material and SS316L impulse piping / root valve material to be considered for the above applications.
- o) All field instruments junction boxes & local panels located in hazardous area shall be explosion proof as per the relevant applicable standards.
- p) Reverse rotation switches to be provided for High Pressure Boiler Feed pumps, Main condenser cooling Water pumps, Condensate extraction pumps and sea water intake pumps
- q) The following metric engineering units shall be used for all instrumentation devices :
 - 1. Pressure – kg/cm²g
 - 2. Temperature - °C
 - 3. Steam flow – kg/hr / T/hr
 - 4. Liquid flow – m³/hr (Feed Water flow (in kg/hr or T/hr)
 - 5. Distance – meters (m) or millimeters (mm)
 - 6. Differential pressure – mmH₂O
- r) For speed varying pumps/fans, speed measurement in 4 – 20 mA shall be connected to DCS.
- s) Required Water analyzers for ACW pump discharge header mainly FRC (Free residual chlorine) analyzers shall be considered at CW /ACW common header return line.
- t) Wireless transmitters :
For CW sump level, Raw water reservoir level, Turbine oil tank, coal bunkers, Ash Silo, LDO/HFO tank, DM water tanks, CS tank, Acid and alkali applications, only non contact type level transmitters like Ultrasonic or Radar based shall be provided by the bidders as per the specification and as approved by owner.

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

1.1.1 Pressure Instrumentation

- a) Pressure transmitters are electronic, analog 2-wire transmitters with isolated 4-20Ma DC output signals.
- b) Pressure transmitters will be supplied with integral mounted two valve manifolds.
- c) All pressure transmitters shall be capable of withstanding their body rating conditions without permanent damage or loss of calibration.
- d) Differential pressure transmitters of the capacitance type, regardless of the applied service, shall be capable of withstanding a differential pressure equal to full process



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

- e) Differential pressure transmitters will be supplied with integral mounted three valve manifolds for air service and 5 way valve manifold for steam & water service. For pressure and differential pressure transmitters, overall Accuracy: + 0.04% or better of FSR for BTG package & + 0.065% or better of FSR for BOP packages. Accuracy shall be + 0.2% for remote seal type transmitter.
- f) Pressure gauges will be generally 150mm dial, solid front safety case type with blowout back, 1/2" NPT bottom connection, drawn stainless steel case, 316SS bourdon and socket, stainless steel movement, micrometer pointer. Pulsation dampers will be provided for pulsating pressure services. Liquid filled gauges shall be used for all pump discharges, vibrating or pulsating services. Pigtail ressu shall be used for the steam service where gauges are mounted close to the tap.
- g) Pressure switches will generally be snap acting type, DPDT action, with individual "on" and "off" points to be on a calibrated scale or dial. Pressure switches will have amphoral connection. Repeatability shall be +/- 0.5% or better. Pressure sensor shall be 316 SS with over range protection. Die cast aluminum with stored enamel black finish and epoxy coating for corrosive atmosphere.
- h) Dual type control switches such as pressure switches having two sets of contacts with independently adjustable set points shall not be used where set point adjustment and deadband are a problem (e.g. low pressure and vacuum applications). If a potential problem exists, two single purpose switches shall be used. Switch differential shall be adjustable.
- i) The indicating type switches are not acceptable. If application requires indication and switching function, then a separate blind switch and a gauge to be used.
- j) All the switches are internally connected and brought to the surface with Amphenol male/female connection. Cabling need not be terminated inside the switch. Cable ends are to be soldered in connector and to be inserted for easy maintenance.
- k) Condensate pots for pressure transmitters and siphons for gauges shall be used for steam and high temperature applications. Chemical seals to be used for highly corrosive and viscosity applications
- l) The switches shall have the following:

Contact rating	:	230V AC, 5A / 24V DC 1A.
Repeatability	:	±0.5% FSR
- m) Turn down ratio to be 100:1
- n) Response time for pressure and differential pressure transmitter shall be 100 ms.
- o) Protection for gauges fitted in the vibration lines/equipments shall be provided

1.1.2 Temperature Instrumentation

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



- b) The Mv signal of thermocouple shall be used as input to the DCS. Cold junction compensation shall be achieved in the DCS
- c) Thermocouples shall have duplex elements and ungrounded measuring junction.
- d) An extension nipple / union / nipple of sufficient length to extend beyond lagging and connection head shall be furnished for each thermocouple assembly. Terminal blocks shall be marked with polarity and connectors shall be resistant to heat, vibration and galling. The cap shall provide a weather tight enclosure and a chain shall be provided to prevent loss of cap. The cap shall be made of cast aluminium.
- e) RTDs of Duplex type furnished by the Supplier shall be of the three-wire type made with 100 ohm platinum resistance elements. They shall be certified to meet the requirements of the International Temperature Scale, calibrated to the IEC-751 standard ($\alpha = 0.00385 \text{ Ohms/Ohm/}^\circ\text{C}$). The RTDs shall be contained in an insulated material and a sheath or sleeve of stainless steel SS-316 and shall be so mounted that they can withstand the greatest shocks and vibrations that can be imposed upon them in the system piping without deterioration. Specific information shall be furnished concerning type and accuracy of bridge circuits to be used with the RTDs. RTDs shall be directly connected to DCS without any transmitters
- f) Unless specified otherwise, each temperature element and thermometer shall be provided with a 1" socket weld type, 316 stainless steel tapered thermowell suitable for the requirements of the given application. Temperature element process connection shall be $\frac{1}{2}$ NPTM.
- g) Temperature transmitters of SMART type are to be provided for all temperature measurements that are used in any CLCS. For thermocouple, cold junction compensation shall be implemented within the transmitter.
- h) Thermocouples will be of duplex MI type in ISA, K(chromel-Alumel), Platinum-Rhodium/Platinum with sheath OD 6 mm. RTD will be Duplex, Pt 100 ohm, 3 wire type as per DIN standard 43760 or equivalent. Thermo wells will be ASME PTC 19.3 latest revision with process connection M 33x2 for threaded connection and flanged connection for Air and Gas system & tanks.
- i) Thermowell immersion length will generally be between $\frac{1}{3}$ and $\frac{1}{2}$ the distance to the center of the pipe. Where thermo wells are installed in lines smaller than 4 inches, the piping shall be expanded to 4 inch size to accommodate the thermo well. Thermowell shall be drilled from solid bar stock.
- j) All thermo well in a high velocity line or duct shall have an ASME PTC 19.3 calculation for determination of the wells resonant frequency. Thermo wells that do not meet the acceptance criteria shall be resized or relocated as necessary.
- k) Thermocouple extension wire is to be solid, shielded, twisted pairs.
- l) If intermediate terminal blocks are required in a thermocouple measuring circuit, they need not be the same material as the thermocouple.
- m) Dial thermometers shall be bimetallic, minimum 150mm dial, every angle form, hermetically sealed with external recalibration adjustment, $\frac{1}{4}$ " OD SS stem, $\frac{1}{2}$ " NPT connection and SS case.
- n) Temperature switches shall be actuated by filled bulb-type elements equipped with standard-length armored capillary tubing. All the switches are internally connected and brought to the surface with Amphenol male/female connection.
- o) Temperature gauges shall have $\pm 1\%$ accuracy and overage protection of 125%.



p) Switches shall have the following:

Max. contact rating : 230V AC, 5A
Repeatability : $\pm 0.5\%$ FSR
Contact type : snap acting
Over all accuracy 0.1% of calibrated span

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

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

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

1.1.3 Flow Instrumentation

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

b) Flow elements will be accompanied by IBR certification.

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

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

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

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

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

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

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

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



- k) Variable area flow indicators to be provided at the common outlet header of the identical equipment, CW blow-down etc. Carbon steel body with SS 316 float and scale shall be provided. Accuracy shall be minimum $\pm 1\%$.
- l) Flow switches to be provided at the common outlet header of the identical equipment. Carbon steel body with SS 316 element and contacts shall be provided.
- m) Algebraic summation of steam flow and water flow shall be mass balanced for calculating the system efficiency by providing necessary required flow transmitters and process lines
- n) Accuracy for mass flow shall be 0.15% of measured value for liquid.
- o) Accuracy for Vortex flow meter and turbine flow meter shall be 0.5% of full scale range.

1.1.4 Level Instrumentation

- a) Differential pressure type level transmitters are electronic, analog 2-wire transmitters with isolated 4-20 Ma dc output signals. Radar and ultrasonic level transmitters will be 24V DC powered, with isolated 4-20 Ma dc output signals powered from the transmitters.
- b) Constant head chambers shall be furnished for all differential pressure-type level transmitters used with pressurized vessels. Reservoir piping connections shall be $\frac{1}{2}$ inch outlet and a $\frac{1}{2}$ inch inlet socket-welded type suitable for the pressure and temperature encountered.
- c) Transparent gauge glasses will be used for low-pressure applications. Transparent or reflex gauges will be used for high-pressure applications. All gauge glasses will be equipped with gauge valves, including a safety ball check.
- d) Level switches shall generally be cage float / Displacer type, rated for ANSI B31.1 requirements.
- e) Non contact type level measurement shall be provided for CW sumps and for CW make-up applications.
- f) Electronic level indicator of discrete type based on electric conductivity of water and steam with 50mm gap between successive electrodes in the measuring range shall be provided in addition to level transmitter. The **vessel** holding electrodes **shall be IBR certified**.

1.1.5 Control Valves

- a) Control Valves are defined as Pneumatic operated modulating valves.
- b) Control valves for regulating service will be pneumatically operated and provided with characterized plugs. In general, equal percentage characteristics will be provided for throttling service; linear characteristics for pressure reducing applications and quick opening characteristics for On/Off service.
- c) Control valves will be designed to prevent cavitation, flashing on the downstream side of valve or piping. For cavitation /flashing services, valves with anti-cavitation trims will be provided. Hardened trim material shall be provided for control valves subjected to DP > 7 Kg/cm² and for flashing applications 17 – 4 PH material is recommended.



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

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

1.1.6 PH Measurement

- a) Micro processor based system supporting HART Protocol with system accuracy of ± 0.02 Ph, auto span and zero calibration, manual zero and span calibration, integral indicator, automatic ultrasonic cleaner, iso-potential adjustment having flow type cells.
- b) Output shall be isolated 4-20 Ma DC linear signal. Accessories shall include preamplifier, screened junction box for electrode.
- c) The Ph shall have built-in reference chambers.
- d) Stability: $\pm 0.02\%$ pH per week
- e) Repeatability: $\pm 0.02\%$ pH
- f) Self diagnostics feature shall be available.
- g) For Ph measurement, reference calomel / silver, silver-chloride electrode shall be of rugged and sealed construction moulded in glass coupled polypropylene. Electrical connection shall be made directly on to the outer end of the element ensuring better electrical performance of the electrode.
- h) Annunciation contacts from the electronic module shall be high and low, 2 SPDT, snap action micro switch, ratings of 5A 240V AC, 0.2 A, 220V DC.

Wherever, variations in sample temperature may occur, automatic temperature compensation device shall be provided.

1.1.7 Conductivity Measurement

- a) Micro-processor based system supporting HART protocol with an accuracy of $\pm 0.25\%$, auto zero and span calibration, integral indicator having flow line (screwed) type cell. Housing for cell and analyzer shall be weather and water proof. Output shall be isolated 4-20 Ma DC linear signal.
- b) The conductivity sensors shall have built-in reference chambers.
- c) The conductivity cell shall in general be of flow through type or insertion type depending upon the area of application.
- d) Conductivity transmitter shall have local indication and provision for automatic temperature compensation up to 100 deg. C.
- e) Condenser cooling water conductivity to be remotely monitored for the blow-down purpose.
- f) Stability: $\pm 1\%$ of full scale per month non cumulative
- g) Repeatability: $\pm 0.3\%$ of span.
- h) Conductivity comparator with dual cell input and 4 – 20 mA DC isolated with HART outputs for required parameters. Self diagnostics feature shall be available

**1.1.8 Silica Measurement**

- a) Micro-processor based system with an accuracy of +/-1% of span or 2ppb whichever is minimum, response time better than 10 min for 90% change, six numbers of sample streams having features like auto zero & span calibration with manual provision also, ambient temperature compensation and integral indicator.
- b) Self diagnostic features shall include alarm for no reagent, calibration fault and silica concentration low/high. Analyzer housing shall be weather and water proof. Output shall be isolated 4-20 Ma DC linear signal.
- c) 3 channel instrument is preferred. Auto sampling facility with necessary valves & solenoids in the sample lines shall be provided
- d) All chemical reagents for twelve months of operation of analyser shall be supplied with addition to commissioning requirement.
- e) One cycle time shall be maximum of twelve minutes.

Liquid handling unit comprising of valves, manifolds, tanks (if required), power supply unit, pressure reducer etc.

1.1.9 DO₂ (Dissolved Oxygen) Measurement

- a) The dissolved oxygen analyzer shall be of continuous flow through solid State/micro-processor based system based on electro-chemical type with an accuracy of +/-1% of span or 1ppb whichever is minimum, response time better than 15s for 90% change, ambient temperature compensation and integral indicator.
- b) Self diagnostic features shall include alarm for transmitter fault, no reagent, calibration fault, high cell current as a minimum. Analyzer housing shall be weather and water proof. Output shall be isolated 4-20 Ma DC linear signal.
- c) Annunciation contacts from the electronic module shall be high and low, 2 SPDT, snap action micro switch, ratios of 5A 240V AC, 0.2 A, 220V DC.

The field mounted cabinets for DO₂ analyzer system shall have the following:

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

1.1.10 Phosphate Measurement

- a) Micro-processor based system with an accuracy of +/-4% of span or 2ppb whichever is minimum, response time better than 3 min for 90% change, six numbers of sample streams having features like auto zero & span calibration with manual provision also, ambient temperature compensation and integral indicator.
- b) Self diagnostic features shall include alarm for no reagent, calibration fault and silica concentration low/high. Analyzer housing shall be weather and water proof. Output shall be isolated 4-20 Ma DC linear signal.
- c) All chemical reagents for twelve months of operation of analyser shall be supplied with addition to commissioning requirement.



- b) Manual overriding
- c) Liquid handling unit comprising of valves, manifolds, thermometers, power supply unit, pressure reducer etc.

1.1.14 Turbidity Analyzer

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

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

1.1.15 H₂ Gas Analyser (Microprocessor based):

H₂ Gas analysers shall be provided with the following features

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

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

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

**1.1.16 Vortex flow meter**

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

1.1.17 Solenoid Valves

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

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

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

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

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

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

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

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

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

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

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

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

**1.1.18 Position Transmitters / Positioners**

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

1.1.19 I/P Converter

Two wire type I/P convertors with an accuracy of +0.25% accepting 4-20 mA dc signals from control system and converting to 0.2 to 1 kg/cm² air pressure to operate valve positioner of all final control elements; Housed in cast aluminum casing (with polyurethane paint); NEMA 4 or equivalent degree of protection for enclosure. Material of accessories will be SS. I/P convertors shall have fail freeze (stay put) feature also. Process connection shall be 1/4" NPT (F) and Electrical connection shall be 1/2" NPT (F). Zero/span adjustment facility shall be provided. The I to P converters shall retain the pneumatic signal (last value) even in failure of control signal and shall have self volume boosters. Necessary air lock devices and pressure switches for air pressure low alarming shall be provided.

1.1.20 ~~Air Filter Regulators~~

~~Air filter regulator along with gauges shall be provided in each of the~~

- ~~a) Air supply line to valve positioners /power cylinders~~
- ~~b) Air supply line to electric to pneumatic converters~~
- ~~c) Air supply line to pneumatic interlocked block valves~~

1.2.0 Vibration Monitoring and Analysis System (VMAS)**1.2.1 General**

The vibration monitoring and analysis system shall provide critical analysis of health of rotating machines on continuous on-line basis and shall guide the plant maintenance personnel regarding the nature of fault and the maintenance action required.

The analysis system shall acquire both the vibration and process information from the data acquisition software plus programmed rules to provide clear analysis and recommendations for effective machinery management. It shall be an extensive and accurate knowledge base to enable quick determination of the condition of a machine by providing alarm notification or advisory of the machinery malfunction.

The analysis system shall be able to specifically evaluate the available data while checking for the presence of the most frequently occurring machine mal functions such as

- a) High synchronous vibration
- b) Shaft bow
- c) Fluid induced instability (WHIRL and WHIP)
- d) Radiant pre-load force(Including mis alignment)
- e) Vector change
- f) Rotor hub
- g) Loss rotating parts
- h) Compressor surge
- i) Electric motor non-uniform air gap
- j) Gear mesh problems pump cavitations



1.2.2 Design and Functional Requirement

Unit Vibration monitoring & analysis system for each unit and Vibration monitoring system of BOP systems shall be provided.

Vibration monitoring system of BOP systems shall be interfaced with the Unit Vibration monitoring & analysis system

The vibration monitoring and analysis system shall provide condition monitoring and analysis of the bearings of all critical machines, equipments with HT drives and their driven equipment. Vibration monitoring & analysis system shall be in accordance with API 670 standard.

The vibration monitoring system shall be complete with proximity type vibration sensors, signal conditioning cards, amplifiers, special cables, vibration monitor (if required) etc. together with all necessary equipment and accessories.

Vibration sensors shall be provided for measurement in both X (horizontal) and Y (vertical) axis at 90° angle to each other for each bearing. Sensitivity of the pick-up shall be minimum 15 mv/mm/s. All outdoor mounted vibration pick-ups, amplifiers, junction boxes and other equipments shall be provided with IP-65 protection class.

For bearings of high speed machines (≥ 1500 rpm) accelerometer type sensor and or low speed machines (< 1500 rpm) velocity type sensor shall be provided. Necessary, one or two stage integrators for obtaining vibration measurement in terms of displacement shall be provided in the system.

Vibration monitoring system shall provide the vibration measurement in the form of 4-20 Ma DC signals to be directly connected by hardwired cable to plant DCS for monitoring. Limit value generation (soft) for alarm and protection applications for the auxiliaries and their drive equipment shall be carried out in DCS/PLC.

Vibration monitoring and analysis system shall be an independent microprocessor based system (PC based). The system shall be interfaced with the plant DCS through redundant communication link. The system shall interface with plant DCS for any process signals which may be required to perform condition monitoring functions through soft link.

All the turbine supervisory vibration parameters of TG & TD BFP shall also be fed to VMAS for analysis.

1.2.3 VMAS Hardware/ Software/ Interfacing Requirement

Vibration analysis system for each unit & one Common VMAS shall include all hardware and software as required for proper functioning of the system including but not limited to the following:

- a) One (1) no Server with necessary Engineering Station & 24" Video Display unit for configuring the VMS modules and for maintenance activities
- b) One (1) no user station (With PC, 24" Video Display Unit, Keyboard/ Mouse and Colour Laser Printer)
- c) Vibration analysis software with all relevant User's license.
- d) One No. lap top PC with condition monitoring/machine management software and data collection from VMAS through necessary interface system cable shall also be supplied.
- e) Server & User PCs operating licenses.
- f) Bulk data storage and retrieval facility
- g) Redundant OPC communication link with all necessary hardware and software.
- h) System cables etc.



The vibration analysis system shall be able to carry out the following tasks:

To determine the exact nature of fault in the rotating machines like misalignment, shaft crack, bearing looseness, dynamic un-balancing of rotor etc. indicating the magnitude of vibration and phase angle information and the corrective action to be undertaken by maintenance personnel. For example, in case of dynamic un-balancing of rotor, the system shall provide the guidance about the approximate mass needed to be added to the rotor with the direction information.

To provide the guidance about predictive maintenance requirement of the machines. Predictive maintenance requirement guide shall also include the "Period of safe operation of machines available at any given point of time".

Shall be capable of collecting data both asynchronously and synchronously (with a Keyphasor signal) and store the data in the original time domain format.

The analysis system shall be able to carry out the following types of analysis to meet the tasks of analysis system detailed above. The system shall not require the intervention of vibration expert to determine the nature of the fault:

On line spectrum/harmonic analysis of the vibration measurements.

The system shall have facility to generate and analyze the following:

- a) Bode Plot
- b) Time wave form
- c) Orbit Analysis
- d) Shaft centerline
- e) Cascade Plot
- f) Water fall
- g) Bar graph
- h) Current values
- i) Spectrum
- j) Alarms – amplitude and spectral
- k) Data collection during start up and coast down
- l) Operating point for pumps and fans

The analysis software should be capable of outputting direct message on video monitor of the exact nature of fault.

The system shall have facility to store bulk data for 5 years duration with facility for retrieval of the same. The system shall have facility to share all the data in the hard disk/ back up media and provide user friendly utilities to retrieve and analyze stored data.

The system shall be provided with redundant UPS power supply. The power supply provision shall be such that on failure of one power supply the other power supply shall cater to the requirement of the equipment so as never to hinder the functioning of the system in any manner due to power supply failure.

Configuration Software:

The monitoring system shall be software configurable using any standard Windows TM 95/98 and Windows TM NT host computer. The configuration software shall provide a list that establishes the Modbus register locations of all data exportable from the monitoring system. The optional display software shall provide displays including Bargraph displays, trend information, machine train diagrams with real-time values of measurements tagged on the diagram, as well as access to the system events and alarm events lists.



VOLUME II
SUB-SECTION - 4.23
C&I DATA SHEET

SPECIFICATION FOR INSTRUMENTS EQUIPMENT TO BE SUPPLIED ARE AS FOLLOWS:

A MAN MACHINE INTERFACE AND PERIPHERALS

1. OPERATOR'S & ENGINEERING WORK STATION

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

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

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



S.N.	FEATURES	QUALIFYING MINIMUM REQUIREMENTS
		console). Internal smart cover lock & sensor for securing internal components. Kensington slot on chassis for physically securing the chassis. For OEM: ISO 9001:2000, 14001 For Desktop: OS certification (WLP 2.0 from Microsoft website), DMI 2.0 certification (from DMTF website) , EMI / FCC compliance, energy star compliance & UL compliance For Monitor: EMI / FCC compliance, Energy star compliance, MPR II Compliance
20.	Compliances	MS Windows 7/64 bit or higher (Latest)
21.	OS Certification	3 years comprehensive on – site, backed by manufacturer support, with OEM certified spare parts.
22.	Onsite Warranty	MS (Professional) office latest (English) license with media & documentation / multi user shall be separate one.
23.	Software required	Anti Virus & fire wall Norton / McAfee / Trend Micro corporate Edition for PC's Laptop supplied through this P.O
24.	Software updates	MATLAB, AUTO CAD, ORACLE, Photo shop (all latest with their individual license and products)
25.	Preferable Make	Shall be given for not less than 3 years, at no extra cost from the owner HP/DELL /IBM-Lenova (Work Stations)

2. LAPTOP COMPUTER FOR MOBILE COMPUTING

S.NO.	FEATURES	QUALIFYING MINIMUM REQUIREMENTS
1.	Processor	Intel Core I-7 processor or latest at the their ordering
2.	Installed memory	4 GB or (latest configuration)
3.	Display	15.0 LED based latest
4.	Operating System	Microsoft Windows 7/64 bit latest at the through of supply
5.	Processor manufacturer	Intel
6.	Processor type	Pentium mobile
7.	Display size	15.6"
10.	Display Tech	LED based
11.	Display Max. Resolution	1280X1024 or better
12.	Hard Drive Capacity	SATA II – 500 GB or solid state drive or latest
13.	Storage Controller type	EIDE
14.	Installed RAM	4 GB upgraded up to 16 GB or higher
15.	RAM technology	DDR SDRAM
16.	Max Supported RAM	16 GB or Higher
17.	Installed Cache memory	1024 KB



S.NO.	FEATURES	QUALIFYING MINIMUM REQUIREMENTS
9.	Mouse	Optical mouse
10.	Form Factor	5 U with option for rack mountable kit
11.	Ethernet	1GB 10 / 100 / 1000 with Ethernet controller
12.	Slots and Bays	2 Full size PCI – Express X 4 / 8, 2 full size 64 bit / 100 Mhz, 1 full size 64 bit 133 Mhz, 1 full size 64 bit 66 Mhz , total 6 PCI slots , 6 Hot swap HDD bays
13.	Operating system	(For data base server) Windows Latest server software or Linux Enterprise edition.(For web server) Windows Latest server, Linux Enterprise edition.
14.	Security	Mechanical side panel key lock (locks hot-swap disks on hot-swap models) / optional U-bolt support via knock out / power on password / boot sequence control / operation without keyboard and mouse
15.	RAID support	RAID 5 Support
16.	Compliances	For OEM: ISO 9001:2000, 14001
17.	Redundant Power supply	Hot swap redundant
18.	Warranty	3 yrs comprehensive on site, backed by manufacturers support, with OEM certified spare parts.
19.	Preferable Make	HP/DELL /IBM

For all PC's, general MS Windows latest, MS Office, MS Visual studio, Adobe Acrobat, Antivirus (Professional) software shall be included in all the PC's including the application software to suit the project specific requirement.

4. MONITOR

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

**5. KEY BOARD**

01. Type	:	Flat, spill proof membrane type or positive depression type.
02. Different keys	:	a) Soft and user defined function keys for software/ programming including text correction, scan rate alteration, zooming/ flashing color selection etc. b) Panel select keys for alarm summary, control loop display, overview, trend, graphic, operator guide message etc. c) Standard Alphanumeric keys d) Alarm acknowledge keys e) Cursor keys f) Mode loop mode / loop status switching keys g) Multiple loop setting change keys h) Print-out command keys i) Other keys as required to operate the system j) Multiple loop output change keys k) Soft and user defined function keys for process mimics
03. Key lock	:	Lockable type push button mounted on keyboard
04. Life Expectancy	:	50 million cycles per key
05. Version	:	To suit industrial application

6. PERSONAL COMPUTERS (MIS AND OTHER SYSTEM) PLANT WIDE NETWORK

01. CPU	:	Latest intel i7 processor
02. Type	:	Tower
03. Main Memory	:	4 GB DDR @ 800 MHz expandable to 8GB / higher
04. Drives	:	DVR – RW
05. Hard Disk	:	500 GB SATA or solid drive 256 GB or higher
06. Monitor	:	24" LED type for MIS Stations 21" LED type for LAN
07. Communication port	:	2 serial plus one parallel, 4 USB
08. Expansion slot	:	5
09. Connectivity	:	Ethernet LAN
10. Operating system	:	Latest windows software (64 bit)
11. Softwares	:	Latest version of MS office, (profession) Client's Software and other softwares as required
12. Features	:	101 keys keyboard and mouse
13. Accessories	:	Furniture's, Mouse pad
14. Preferable Make	:	HP/DELL /IBM-Lenova

7. LASER PRINTER

01. Type	:	Electro-photographic laser, tabletop / latest
02. Printer Memory	:	256 MB (min.)
03. Speed	:	Monochrome 24 ppm - A4 Color 20 ppm - A4
04. Resolution	:	1200 x 1200 DPI in color
05. No. of color (Basic)	:	4 (four) minimum
06. Duty cycle	:	Monochrome 75000 pages / month
07. Power supply	:	240 V, 50 Hz, 1 phase
08. Ambient temperature	:	0-50° C
09. Humidity	:	95% non-condensing.



10. Size of paper	: Letter, A4 (25 Reams of paper), Legal, Ledger, A3 (20 Reams of paper)
11. Print media	: Plain paper, transparencies, thick stock, glossy stock, envelopes
12. Accessories	: i) Adapters ii) Connector Cable iii) Multiplexer switch (4 point)

8. DOT MATRIX PRINTER**(LATEST MODEL)**

01. No. of Needles	: 24 Pin
02. Printing speed	: 300 characters per second (approx.)
03. Character dimension	: 9 x 8
04. Buffer	: 80 KB (Min)
05. Local memory	: RAM with battery backup
06. Interface	: Serial / parallel / USB for High speed
07. Power supply	: 240 V, 50 Hz, 1 phase
08. Ambient temperature	: 0-50 °C
09. Humidity	: 95% non-condensing.
10. Size of paper	: Fanfold, A4, A3
11. Character sets	: ASCII, IBM (Sets 1 & 2), Italics, user defined
12. Transfer distance	: 200 Mtrs. (minimum)
13. Print features	: Graphic printout, emphasized, double width, underlined, subscript, superscript, double strike, backspace, margin etc.
14. Reliability	: MTBF more than 8000 Hrs.
15. Noise level	: Less than 60 dBA
16. Ribbon life	: 2 million characters
17. Diagnostics	: Self diagnostic. LED error code display, Audio alarm – paper exhausted
18. No. of copies	: Minimum Original plus 3 (three)
19. Accessories	: i) Ribbon ii) Printer stand iii) Table top receiving tray iv) Interface cable v) Paper tear box. vi) 20 Reams of 132 column computer sheets and 10 Reams of 80 column computer sheets

9. DIGITAL NETWORK PRINTER WITH COPIER

01. Type	: Laser, tabletop / latest
02. Printer Memory	: 256 MB (min.)
03. Speed	: Monochrome 20 ppm - A4 10 ppm – A3
04. Resolution	: 600 x 600 DPI
05. No. of color (Basic)	: Monochrome
06. Duty cycle	: Monochrome more than 75000 pages / month
07. Power supply	: 240 V, 50 Hz, 1 phase
08. Ambient temperature	: 0-50 °C
09. Humidity	: 95% non-condensing.
10. Size of paper	: Paper weight of 45 to 165 g/M ²
11. Networking Capability	: USB / Ethernet
12. Coping	: Max Original Size – A3, Continuous Coping (1-999)
12. Accessories	: i) Adapters ii) Connector Cable iii) Duplex Unit.



- 8) The hooter sounds will be different for each of the unit of power plant, when there is common control room for multiple units.
- 9) Shift/Unit in-charge can call alarm area of any LVS of that unit on his OWS.

Other Features

- a) LVS shall be designed for continuous viewing (24 hours in a day) under normal room ambient lighting without any need to darken the room. Suitable darkening of the projection screen for light absorption shall be provided for this purpose.
 - b) Adjustment of the projections shall be performed. Suitable mounts on installation and all other components shall be adjusted in the factory and shall not require further adjustment at site. Maintenance work on the LVS shall be confined to easy replacement of the lamps and cleaning of the fans, which shall be performed in few minutes by the purchaser's staff without any special training. Suitable means (operating hours displays etc.) shall be provided to indicate the need of replacement of lamp. Power switch shall be provided for isolation during replacement of the lamps.
 - c) The LVS and its accessories shall be designed in such a way that the brightness in the centre of the screen and the edges of the screen is uniform and there is no perceivable difference in the quality of the picture on the centre and on the edges of the screen. If any extra hardware has to be provided for achieving the above feature, same shall be provided by the Contractor's at no extra cost.
 - d) The screen should be flicker free and there shall not be any screen burn in due to display of same information for a long time.
 - e) Auto brightness adjustment between each screen.
10. The hardware/software of the control unit shall be such that the command execution time of any control command from the LVS shall be same or better than the execution time from the OWS. If during any stage of the contract, the command response times as stated in specifications are not achieved, the Contractor's shall upgrade the hardware/software of the control unit in order to achieve the same at no extra cost to the purchaser.
 11. In the event of failure of LVS interfacing with SG & TG package, any of the other LVS shall be capable of being used in place of the failed LVS. The Contractor's shall provide a suitable network/switching facility for this purpose.

The exact arrangement of LVS shall be decided during detailed engineering. Suitable facility shall be provided to the operator for transferring the screens, without any need of changing of hardware/wiring or software.

12. Master control unit shall be capable of projecting displays over a part of screen to multiple screens. Any communication of windows shall be possible. Facility for overlays shall be provided.

B. PLC HARDWARE

1. HIGH LEVEL ANALOG INPUT MODULES

01. Number of inputs/module	:	16
02. Types of input (Linear)	:	4-20 mA and 1-5 V
03. Accuracy	:	0.1% or better
04. A/D Converter	:	Integrating, 15 bit + Sign or better



- 05. Temperature effect : 0.01% / Deg.C or better
- 06. CMRR : 60 db (at 50 Hz) or better
- 07. NMRR : 20 db (at 50 Hz) or better
- 08. Stability : 0.03% / year or better
- 09. Diagnostics :
 - i) Limit check
 - ii) A/D converter fault
 - iii) Channel fault
 - iv) Wire break
 - v) Short circuit
 - vi) Auto gain correction

2. LOW LEVEL ANALOG INPUT MODULES

- 01. Number of inputs/module : 16
- 02. Types of input : Thermocouples (K, R, S, T etc.)
[Grounded & Ungrounded] RTD (Pt -100
Ohm & Pt – 1000ohm)
[Two wire, three wire] Configurable
- 03. Cold junction compensation : On module / local RTD
- 04. Accuracy : 0.1% or better (Linearized)
- 05. A/D converter : Integrating, 15 bit + sign or better
- 06. Temperature effect : 0.01% / Deg.C or better
- 07. CMRR : 60 db (at 50 Hz) or better
- 09. NMRR : 20 db (at 50 Hz) or better
- 09. Stability : 0.03% year or better
- 10. Diagnostics :
 - i) A/D converter fault
 - ii) Channel fault
 - iii) Wire break
 - iv) Short circuit
 - v) Auto gain correction

3. BINARY INPUT MODULE (SLOW SCAN)

- 01. Number of inputs/module : 32
- 02. Types of input : 24/48V DC
N.O/N.C/ch.over contacts
- 03. Input current : 5-10 mA
- 04. Maximum switching Frequency : 100 Hz
- 05. Diagnostics :
 - i) Input simulation
 - ii) Wire break detection
 - iii) Short circuit

4. BINARY INPUT MODULE (FAST SCAN SOE)

Same as item 3 but resolution 1 m sec.

5. SMART TRANSMITTER INTERFACE MODULES

- 01. Number of inputs/module : 16
- 02. Types of input : From Smart Transmitters.
- 03. Protocol : HART or any proven compatible protocol.
- 04. Communication : Bidirectional
- 05. Accuracy : 0.1% or better
- 06. Function :
 - I) Signal processing
 - ii) EU conversion
 - iii) Alarm, Diagnostic etc.
 - iv) Configuration TX. database
 - v) Rearranging & TX. Calibration
- 07. Diagnostics :
 - i) Limit check



- ii) Channel fault
- iii) Wire break
- iv) Short circuit

6. PULSE INPUT MODULE

Generally same as Binary input modules but with 8 inputs/module (maximum) and leading / trailing edge detection. Minimum pulse width 1 m sec.

7. ANALOG OUTPUT MODULES

- 01. Number of points/module : 8
- 02. Types of output (Linear) : 4-20 mA
- 03. Accuracy : 0.4% or better
- 04. Load : 750 Ohms (min.) [Current]
1 K Ohm [Voltage]
- 05. Diagnostic :
 - i) Channel fault
 - ii) Retention of memory on DEMUX failure
 - iii) A / D converter fault.
- 06. Others : Any special type required to operate specific control vale, the Contractor to specify and submit the catalogue / technical specification for such AO module

8. BINARY OUTPUT MODULES

- 01. No. of points/module : 32
- 02. Type of output : Relay with 1 change-over contact
- 03. Contact rating : 60 VA
- 04. Contact voltage rating : 60 Volts
- 05. Switching frequency : 2 Hz
- 06. Contact life : 1 million operations

9. CENTRAL PROCESSING UNIT (CPU)

- 01. Type : Microprocessor based
- 02. Word length : 32 / 64 bits (Preferably 64 bits)
- 03. Register add cycle time : 1 microsecond (typical)
- 04. Instruction cycle time : 75 microseconds (maximum)
- 05. I/O address capability : 256 points (minimum)
- 06. Memory : NV RAM - 640 KB (minimum)
- 07. Whether redundant : Yes
- 08. Whether fall back :
 - Transparent : Yes
- 09. Control Function :
 - a) Logical functions like AND, OR, EX-OR, Timer, counter etc.
 - b) Load/Data transfer etc.
 - c) Outputting, driving, interfacing, scanning, data validation etc.
 - d) Diagnostic/monitoring
 - e) Data/signal Exchange
 - f) Sequencing, step-checking etc.
- 10. Power supply : 24 V D.C.
- 11. Mounting : Sub-rack
- 12. Configuration : From hand-held station through front plug
- 13. Diagnostics : Invalid command checking,
(Automatic periodic illegal address detection,
routine check and memory parity check, watch



14. Indication : dog timer) time-out checking, processor status display LED, processor fault.
: Processor status and fault display

C. MACHINERY MONITORING SYSTEM

i) Vibration Monitor

01. Sensitivity : 100 mV/mil or better
02. Frequency Response : User programmable
03. Accuracy : $\pm 0.5\%$ of full scale
04. Transducer Supply Voltage : -24 V DC (Typical)
05. Alarm Adjustment : Digitally adjustable over full scale for alert and danger set-points.

ii) Thrust Position Monitor

01. Sensitivity : 100 mV/mil or better
02. Accuracy : $\pm 0.5\%$ of full scale
03. Transducer Supply Voltage : -24 V DC (Typical)
04. Alarm Adjustment : Digitally adjustable over full scale for alarm set points
05. Repeatability : $\pm 0.5\%$ or better

iii) Case Expansion Monitor

01. Sensitivity : 100 mV/mil or better
02. Accuracy : $\pm 0.5\%$ of full scale
03. Transducer Supply Voltage : -24 V DC (Typical)
04. Alarm Adjustment : Digitally adjustable over full scale for alert and damager set-points.

iv) Tachometer/ RPM Monitor

01. Sensitivity : 100 mV/mil or better
02. Accuracy : ± 1 RPM for speed output. and within ± 20 RPM/min for rotor acceleration output.
03. Transducer Supply Voltage : -24 V DC (Typical)
04. Alarm set points : Over speed and under speed Set points
05. Alarm Adjustment : Digitally adjustable over full scale for over speed / under speed set points.
06. RPM Range : 1 to 99,999 rpm
07. Accuracy and Resolution : ± 1 rpm

v) Eccentricity / Key Phasor Monitor

01. Input signal : Two proximity probes, one for eccentricity and one for key-Phasor
02. Frequency response : 0 to 10 Hz
03. Accuracy : $\pm 0.5\%$ of full scale

vi) Temperature Monitor

01. Input : 3 wire RTDs (Pt 100) as per DIN43760 K/T type thermocouple Sensor selection programmable



02. No. of channels	:	12 / 16 / 24
03. Range	:	0 – 200 / 600 Degrees Centigrade or as per application
04. Accuracy	:	+/- 1 °C
05. Display	:	LCD display, 3 ½ digits
06. Input Scan rate	:	12 Channel / sec or fast. (Any channel Skip provision shall be made)
07. Display Dwell Time	:	1 to 25 sec adjustable
08. Display Mode	:	Auto / Manual selection of channels Alarm and Trip set points independent for the selected channel.
09. Alarm display	:	To be provided for Alarm (Flashing) & Trip (steady) for each Channel
010. Sensor status Display	:	For open/short condition.(On Digital display)
011. Fail Safe Condition	:	During sensor open / short condition the Alarm / trip output of the respective channel should not energize the common relays.
012. Keys	:	4 No. Reset, Mode, Next, Previous(Min)
013. Common Output relays	:	4 No. (configurable for any channel or group of channels for alarm or trip) for 12 / 16 channels 6nos. for 24 channels.
014. Contact configuration	:	2 'NO' contacts per relay
015. Contact Rating	:	5A at 220V AC resistive (24V DC, 1A)
016. Set point programming	:	through front panel keys (membrane Type)
017. Set point / relay memory	:	non volatile (w / o battery backup)
018. Power supply	:	230V AC +/- 10%, 50Hz
019. Mounting	:	Flush panel in a powder coated cabinet
020. Termination	:	Plug & socket with best connection (for power supply and Input)
021. Environment	:	up to 600 °C bad environment with high humidity
022. Communication connectivity	:	soft link with DDC MIS through HART or standard protocol
023. Configuration & diagnostics from DDC MIS	:	through HART Protocol or standard protocol

vii) VIBRATION PICK-UPS

01. Type	:	Proximity type
02. Mounting	:	The Proximity Probe shall be mounted outside the machine case using protective housing with adjustable sleeves (stingers) that will be extended to the shaft surface.
03. Frequency response	:	0 - 10 KHz
04. Linear Range	:	Begins at 10 mils from probe face.
05. Linearity	:	Within ±1 mil of a straight line.
06. Temperature sensitivity	:	3% of span for 60° C change or better
07. Relative Humidity	:	95% non condensing
08. Module Housing	:	Fibre glass
09. Enclosure class	:	IP-65
10. Power supply	:	24V DC from monitoring units
11. Accessories	:	i) Non conductive mounting plates for housing ii) Extension cables (S.S armored) iii) Suitable junction boxes etc.

**D. CONTROL BOARD****I. Control Desk / Console / Panel Construction**

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

**E. FIELD INSTRUMENTS****I. PRESSURE**

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

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

A. Pressure Transmitter

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



- f) Companion flange with nuts, bolts and gaskets.
- g) Hand held configuration kit for diagnostics and calibration of Smart Transmitter locally or in remote.
- h) 3/4" ET cable gland
- i) Flushing facility at process end diaphragm.
- j) Reverse polarity protection required.
- k) Three way SS manifold for (gauge) vacuum

B. Differential Pressure Transmitter

- 01. Working Principle : Smart
- 02. Type : 2-Wire
- 03. Output signal : Simultaneous transmission of digital and 4-20 mA DC signal isolated linear standard protocol -HART.
- 04. Signal Processing Unit : Silicon solid-state electronic circuitry
- 05. Measuring element : Capsule/Diaphragm
- 06. Measuring element Material : AISI-316 (Stainless Steel)
- 07. Static Pressure/ Overload Pressure : Maximum line (or static) pressure on either side without permanent deformation or loss of accuracy
- 08. Turn-down ratio : 100: 1 minimum
- 09. Span and Zero : Locally adjustable, non-interacting
- 10. Enclosure class : IP-65 (Explosion proof for NEC Class-1, Division 1 area)
- 11. Zero suppression / Elevation : At least 100% of Span
- 12. Output Indicator (Digital display) : LCD type in % and Engineering units
- 13. Nameplate : Tag number and Service engraved in stainless steel tag plate
- 14. Body : Forged Carbon Steel (SS for DM Water)
- 15. Ambient temperature : 0 - 85 °C
- 16. Operating Voltage : 18 - 36 Volts DC
- 17. Load : 750 Ohms at 24 Volts DC
- 18. Performance:-
 - i) Accuracy : ± 0.025 % of calibrated span or better
 - ii) Repeatability : ± 0.05 % of calibrated span or better
- 19. Sealing/Isolation : 6 meters SS armoured capillary with suitable fill fluid and flange remote seal diaphragm of SS 316 or suitable material as per application, for corrosive, viscous and dirty fluid application. Flange size and pressure rating as per application.
- 20. Accessories :
 - a) Universal mounting bracket suitable for 2" pipe and wall mounting.
 - b) High tensile carbon steel U-bolts.
 - c) Installation accessories as per relevant installation drawing.
 - d) Syphons for steam and hot water services.
 - l) 1/2" NPT 5-valve stainless steel manifold, constructed from SS316 bar stock.
 - e) Companion flange with nuts, bolts and gaskets.
 - f) Hand held configurator kit for diagnosis and calibration of Smart Transmitter.
 - g) 3/4" ET cable gland



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

C. Pressure Switch

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

D. Differential Pressure Switch

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



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

E. Pressure Gauge and Differential Pressure Gauge

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



- Accuracy of ± 1.6 % of span or better for Differential Pressure gauge
14. Operating ambient Temperature : 0 - 50 °C
15. Safety Feature : Blow out disc. /diaphragm at the back
16. Accessories : a) Snubbers and Glycerin filled for pulsating fluid applications and at pump discharge.
b) Stainless steel 316 Diaphragm with Teflon coated seals for corrosive, viscous and solid-bearing or slurry type process fluids.
c) 3-Way stainless steel Gauge cock for pressure gauges. Process connection 1/2" NPT.
d) 5-valve SS316 manifold constructed from barstock for differential pressure gauge. Process connection 1/2" NPT.
e) Union, nut & tail piece and other Installation accessories as required.
17. Applicable standard : IS-3624 / 1996
18. Electrical Contact rating : 240V, 5A AC/ 220V, 0.5A DC (for gauges with alarm contact). Number of Contacts:2 SPDT
19. Nameplate : Tag number, service engraved in stainless steel tag plate

II. LEVEL

A. Radar Level Transmitters

01. a) Type : 1. Guided wave Radar type transmitter of TDR type 2-10 GHz for liquids
2. Radar type transmitter of FMCWR type 24-26 GHz, drop in antenna for coal level
- b) Probe : Coaxial
- c) Probe material : SS 316 / SS 316L
02. calibration range : as per application
03. Process medium : as per application
04. Process temperature : as per application
05. Static Pressure : Capable of working in vacuum also
06. Power supply : range to be specified by the bid (Loop power available = 24V DC)
07. Reverse polarity protection : required
08. Output : 4 to 20mA, 2wire & HART
09. Accuracy : $\pm 0.03\%$ of measure distance or ± 3 mm
010. Stability : Contractor specify
011. Communication : Communication / configuration shall be possible either through integral key pad and display or through hand communicator. If integral key pad is not available, one number hand held communicator common for all the transmitters shall be supplied
012. Load limitation : max 600 ohm at 24V
013. Span & zero : adjustable
014. Flange mounting : yes
015. Environmental protection : IP 66 or better
016. Process connection : traditional flange with 1/4" – 18 NPT on flange with process adapters (Flange & drain vent- 316SST)
017. Electronic housing : Aluminium alloy
018. Electrical connection : Preferably 1/2" – 14 NPT with gland.

**B. Capacitance Type Level Transmitter**

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

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

C. Ultrasonic Level Transmitter

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



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

D. Level Switch

- 01. Type : External cage float operated. Magnetically coupled.
- 02. Float Material : AISI-316 stainless steel
- 03. Other wetted parts : AISI-316 stainless steel
- 04. External Cage : Carbon steel / Stainless steel as per process requirements, welded type / flanged construction. Cage pressure rating shall equal or exceed the rating of the main vessel.
- 05. External cage mounting : Side – Side with drain valve.
- 06. External cage connection : 25 NB socket weld to vessel or RF flanged.
- 07. Switch housing : Epoxy coated die-cast aluminum alloy with neoprene gasket conforming to IP-65. (Explosion proof for NEC Class-1, Division 1 area).
- 08. Type of switch Configuration : 2 SPDT (two nos.) Snap acting magnetically operated hermetically sealed.
- 09. Contact rating : 5A, 240V/AC, 0.5A, 220V DC
- 10. Accessories : a) Counter flange, nuts & bolts, suitable gasket etc.
b) Steel globe type drain valve.
c) $\frac{3}{4}$ " ET cable gland
d) Stainless steel alpha-numeric engraved for service and tag.
- 11. Preferred feature : Switch operating point marked on cage
- 12. Temperature rating : As per application

E. Conductivity Type Level Switch

- 01. Type : Conductivity discrimination.
- 03. Mounting : Flanged – on standpipe.
- 04. Probe MOC : Stainless steel with high purity ceramic.
- 05. Probe rating : > Maximum design pressure of vessel.
- 06. Input : four independent channels with selectable switching threshold for water conductivity.
- 07. Relay Output : Four isolated output relays for HI, LO, HI-HI, LO-LO.
- 08. Contact type & rating : 2SPDT @ 0.5A 220V DC / 5 A 240V AC
- 09. Local Display : Colored LEDs for HI, LO, HI-HI, LO-LO. Power & fault.
- 10. Power supply : Dual (90-250) V AC, 50 Hz, 1Ph.
- 11. Enclosure : IP-65, corrosion resistant & wall mounting type (Explosion proof for NEC Class-1, Division-1 area).
- 12. Accessories : Teflon (PTFE) cable having Teflon wrapped individual cores and necessary sheathing shall be used to connect the probe with electronics
- 13. Test pressure : Two times rated pressure
- 14. Cable connection : $\frac{3}{4}$ " ET Compression gland

**F. Capacitance Type Level Switch**

01	Type	:	Capacitance type
02	Probe	:	a) Rod or suspended electrode b) Rope type probes may be used only where required probe length is greater than 3 meters.
03.	Probe Mounting	:	Stainless steel 1 1/2" ANSI RF Flange / 3/4 "NPT (M)
04.	Material of construction	:	316 SS
05.	Insulation	:	PTFE Part/Full as per service.
06.	Enclosure	:	Powder/Epoxy coated Die cast Aluminium with neoprene gasket conforming to IP-65. (Explosion proof for NEC Class-1, Division 1 area).
07.	Ambient temperature	:	0-60 °C.
08.	Mounting	:	On Tap
09.	Supply voltage	:	(90-250) V AC, 50 Hz / 18-36 V DC
10.	Relay output	:	2 SPDT @ 0.5 A 220V DC / 5A 240V AC
11.	Response time	:	100 msec or better
12.	Cable connection	:	3/4" ET Compression gland
13.	Accessories	:	Counter flange, Cable gland, prefab cable and stainless steel name plate engraved with alpha-numeric.

G. Level Switch (Ultrasonic Type)

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

H. Level Switch (Radar Type)

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

I. Conductivity Type Electronic Level Indicator

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



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

J. Level Gauge (Float & Tape)

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

K. Silo pilot

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

Electronics

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

III. FLOW INSTRUMENTS**1. Mass Flow Meter****A Sensor**

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



3. Vortex Flow Meter

A. Sensor

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

B. Transmitter

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

4. Electro-Magnetic Flow Meter

A. Sensor

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

B. Transmitter

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



13. Nameplate : Tag number, service engraved in stainless steel tag plate
14. Accessories : a) As required for field mounting
e) Handheld configurator
f) Mounting U-bolts, nuts, bolts, prefab cable etc.
g) 3/4" ET cable gland

5. Ultra sonic type Flow Meter

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

- i) Ultrasonic Flow meter shall be dual path transit time clamp-on type.
- ii) The flow meters shall be of proven reliability, accuracy and repeatability requiring a minimum of maintenance. They shall comply with relevant international standards and shall be subject to approval.
- iii) All accessories required for mounting/erection of these instruments shall be furnished, erected and installed as necessary for completeness of the system though not specifically asked for. Also the equipment shall include necessary cables, flexible conduits, junction boxes required for the purpose.
- iv) Flow meters shall be provided with suitable environment protection devices/structures such that they shall be suitable for continuous operation in the operating environment of a coal fired utility station without any loss of function or departure from the specification requirements.

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

**6. Rotameter**

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

7. Orifice Plate

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

8. Flow Nozzle

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

9. Sight Glass

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



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

- 10. Gauge Glass** : flow element shall have 3 pair of differential pressure tapping
- 01. Type : Reflex
 - 02. Glass : Toughened borosilicate. Resistant to mechanical and thermal shocks.
 - 03. Body material : SS-304 / 316 / Carbon steel – As per process requirements (Flanged Connection)
 - 04. Pressure rating : Twice the maximum working pressure
 - 05. Temperature rating : 300 °C
 - 06. Bolts and nuts : Rust proof alloy steel
 - 07. Accessories : Suitable ball check valves of SS- 304/316 body, gaskets, companion flange etc.

11. Flow Switches

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

IV TEMPERATURE INSTRUMENTS

1. Thermocouples

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



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

2. Resistance Temperature Detector

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

3. Field Mounted Temperature Transmitters

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



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

4. Thermo Well

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

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

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

5. Temperature Switch

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



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

6. Temperature Gauge

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



3. Oxygen Analyzer

01. Type	:	In-situ, Zirconium sensor, micro-processor-based transmitter, field repairable to measure % O ₂ in flue gas from boiler. Electronic units & Probe shall be separate. Head mounted electronic type is not to be supplied.
02. Range	:	0.1-10% / 0.25-25% by volume
03. Output	:	Simultaneous transmission of digital & 4-20 mA DC linear / Isolated for the range assigned HART protocol.
04. Probe Length	:	1800mm (approximate depending on duct size)
05. Process Temperature	:	850 ° F approx. / as per application
06. Measurement Reference	:	Instrument Air
07. Accuracy	:	± 1% of F.S. or better
08. Response Time	:	Less than 5 (five) seconds
09. Amplifier Housing	:	IP-65
10. Calibration	:	Automatic periodic
11. Calibration Frequency	:	Once every 24 hours
12. Power Supply	:	(90-250) V, 50 Hz, 1 Phase
13. Material for Gas Carrying Components	:	Stainless Steel
14. Read Out	:	Local indicating Meter
15. Protection	:	Automatic cell protection against reducing atmosphere
16. Alarm Facility	:	1 - HI and 1 - LO independently adjustable over span through keypad. Contact rating 5A at 230V AC / 0.5A 220 V DC (minimum). Potential free SPDT contacts for two alarm levels. Set points programmable through keyboard
17. Preferred Features	:	a) HI and LO alarm LED visible from front. b) Power Supply On/Failure LED visible from front c) Display for faulty sensor
18. Accessories	:	a) Mounting flanges, adaptor plate and protection shield b) Gasket, nuts and bolts c) Cable with conduit from cell to amplifier (as required) and other special cables (if any) d) Automatic calibration kit (complete with all accessories and standard Gas Cylinders) zero and span. For mid range value i.e 6% of O ₂ with 94% of N ₂ Standard gas cylinders to be supplied for each analyser in addition to zero and span gas cylinders e) All tubings and fittings for connecting calibration gas cylinders and auto units. f) All tubings and fittings to connect to Boiler side instrument / Service air header available at '0' m for purging. g) Cylinder ownership certificates, pressure test and explosion proof certificates to be given for refilling the gases by owner for future calibration.
19. Load resistance	:	500 ohms or more
20. Sensor heater control	:	



- Circuit if required : To be provided with thermocouple fixed nearer to the sensor for feedback of heater temperature to be furnished.
21. Display : 3½" or more, seven segment backlit LCD.
22. Parameters to be displayed : % O₂, Cell temperature, cell mV, Alarm set points and alarms.
23. Analyzer Electronics Mounting : Wall mounting
24. Environmental Protection : IP – 65 or better
25. Zirconia cell protection at the end of probe : Stainless steel diffuser assembly to be provided or better.
26. Probe protection : SS shrouding with adequate required thickness to be provided to safeguard the probe from erosion of flue gas.
27. Calibration facility : Auto / manual calibration for behaviour of Zirconia sensor or periodical basis to be made available. Zero span gas cylinders required for calibration and all necessary accessories shall be indicated.
28. Configuration : shall be possible from the converter itself. If separate HART communicator is essentially required for configuration, 1 no. HART communication shall also be supplied common for all analyzers.

4. Co & Moisture Analyzer

01. Type : Insitu Probe type combined analyzer
02. Gases to be measured : CO, and Moisture
03. Principle of measurement : Infrared absorption
04. Flue gas Temperature : 140 Deg C / 300 Deg C 850 ° F
05. Ambient temperature : 60 ° C
06. Mounting : Across duct. Transmitter and receiver using flange
07. Measurement range : 0-6000 ppm fully selectable
08. Units of measurement : PPM, mg / m³ and mg / Nm³
09. Power Supply : (90-250) V, 50 Hz, 1 Phase
10. Display : Back lit LCD
11. Measurement of averaging : 10 sec to 60 minutes
12. Accuracy : ± 2% of measurement or 5 ppm whichever is greater or better
13. Repeatability : 1% of full scale
14. Response time : 30 seconds or better for 90% of full scale
15. Zero & Span drift : Less than 2 ppm in 24 hours
16. Calibration : Zero and Span calibration in manual and automatic mode. Automatic calibration interval shall be fully selectable.
17. Analog output : 4-20 mA DC (in 500 ohm resistor) to DCS for each channel with HART
18. Alarm output : 2 SPDT potential free contacts rated at 5A 230V AC / 0.5 A 220 V DC Alarm set points programmable through keyboard
19. Input normalization : Required—online [With pressure and temperature sensor] and also provision for key pad entry of inputs
20. Probe material : Stainless Steel 316L
21. Enclosure : Corrosion resistant epoxy coated Aluminium housing rated to IP-65 for Transceiver and control unit.



08.	Response Time	:	less than 5 minutes
09.	Operating Ambient Temperature	:	0 - 50 ° C
10.	Ambient Humidity	:	Up to 95% relative humidity
11.	Mounting	:	Panel
12.	Calibration	:	Fully automatic two point, plus Manual Initiation on demand
13.	Power Supply	:	(90-250) V, 50 Hz, 1 Phase
14.	Alarm Facility	:	2 HI and 2 LO independently adjustable over span. (ZSPDT micro switch)
15.	Accessories (Preassembled, pre-wired and pre-tubed in enclosure)	:	i) Phenolic tag plate etc. ii) Sample conditioning system & filter. iii) Pressure regulator & flow meter iv) Automatic calibration kit v) Reagents and consumables vi) Special cables upto transmitter with flexible conduit vii) Others as required

9. Chloride Analyser

i.	Type	Continuous flow through sample type- Microprocessor based
ii.	Analyser power supply	240V AC, 50 Hz
iii.	Analyser output	a) 4-20mA DC spare output. b) 4-20mA DC isolated output for DCS.
iv.	Accuracy	Better than + 5 microgram/litre of full scale.
v.	Sensitivity	0.1 ppm.
vi.	Range	: Contractor to specify for process requirement & rerangible.
vi.	Annunciation contacts:.	
	a) Number	2 SPDT
	b) Type	Snap action micro switch.
	c) Rating	5A, 240V, AC, 0.2A, 220V DC.
	d) Mounting	Flush.
vii.	Terminal points	All component piped & wired.
viii.	Accessories	a) Flow regulator. b) Flow gauges. c) Sample rate set valves. d) Other accessories as required to make the system complete

G. ELECTRICAL SYSTEMS METERS AND ACCESSORIES

A. Push Button

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



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

B. Illuminated Push Button

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

C. Selector Switch

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

D. Indicating Lamp

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



09. Legend : Engraving

E. Indicating Meters (A.C)

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

F. Indicating Meters (D.C)

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

G. Auxiliary Relay

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

H. Coupling Relay

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

**I. Distribution Boards**

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

J. Electrical Junction Box

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

K. Cable Gland

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

L. Cable Tray

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

M. Digital Display Unit

To display the digital value of any analog process parameter with sign and decimal point of any analog input assigned through operator. Accuracy shall be $\pm 0.25\%$ of reading; type of display – LED; Seven segment or dot matrix as option; five digits, sign and decimal point; Range & offset – programmable or configurable; digit size shall be minimum of 50mm; colour of display shall be Red or Green; enclosure shall be IP32 or equal; all DDUs shall be mounted on the Unit Control Panel. The DDUs common for both Units shall be mounted in the Center of Control room with suitable arrangement. Which will be decided during detail engineering

N. Hybrid Recorders

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



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

O. Interposing Relays (IPR)

Electro magnetic type IPRs with plug-in type connections, suitable for channel / rail mounting in cabinets; coil rating 24V D.C; 2 set of silver plated Change over contacts rated for 0.2A 220VDC. Freewheeling diode across relay coil (copper) and self reset type status indicator flag (electronic) shall be provided. All relays shall be mounted in IPR cabinet & relay base (silver plated) internally wired to the external cabling termination block in IPR cabinet. Wiring connection shall be cage-clamp & termination shall be suitable for 0.5 sq. mm to 2.5 sq. mm size wiring. Facility to simulate relay operation manually shall be provided. Relays of different contact interrogation voltages shall be separated by a barrier in IPR cabinet. Accessories like name plate (SS) with tag & service inscription, relay base mounting rail/channel, nuts & bolts, etc. shall be supplied. In each cabinet, a DC Voltmeter shall be provided to check the Field Interrogation voltage.

H. CONTROL VALVE, FITTINGS AND ACCESSORIES

1. Control Valve

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



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

2. Solenoid Valve

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

3. Power Cylinders (Pneumatic)

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



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

4. Air Filter Regulator

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

5. Seamless Stainless Steel Tube

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

6. Stainless Steel Tube Fittings

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



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

7. G.I. Pipe

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

8. G.I. Pipe Fittings

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

9. C.S. Pipe

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

10. C.S. Pipe fittings

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

11. A.S. Pipe

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

12. A.S. Pipe Fittings

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



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

13. C.S. Globe Valve

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

14. S.S. Globe Valve

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

15. Condensate Pot

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

16. Instrument Manifolds**Technical Particulars**

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



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

17. Air Header**TECHNICAL PARTICULARS**

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

18. S.S. Pipe

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

I. CONTROL AND INSTRUMENT CABLE**1. Thermocouple Compensating Cable**

01.	Conductor	:	Solid conductor
02.	Conductor size	:	16 AWG
03.	Type	:	KX, TX, RX (as required)
04.	Conductor Insulation	:	HRPVC Type-C (IS-5831,1984) 0.6 mm thick
05.	Voltage grade	:	600V (peak value)
06.	Twisting	:	Pair twisted with lay of 75 mm
07.	Twisting Direction	:	All Pairs in the same direction. Lapped to form bunch with mylar tape.
08.	Individual Pair & Overall Shield	:	Aluminium mylar tape with a thickness of 2.35MIL and 25% overlapped edges.
09.	Drain wire	:	Annealed Tinned copper wire, Stranded. Size 0.5 Sq. mm. (No. of strands / size:- 7 / 0.3mm)
10.	Inner Sheath	:	Extruded FRLS PVC Type ST2 of IS-5831,1984 Thickness as per IS-1554 Part-I 1976
11.	Armoring	:	G.I. Wire/Strip as per IS-3975
12.	Outer Sheath	:	Extruded FRLS PVC (anti rodent, anti termite & moisture resistant properties) Type ST2 of IS-5831, 1984



13. Rip Cord : Thickness as per IS-1554 Part-I 1976
14. Temperature Range : Yes
15. Insulation at 20^o C : Up to 85 °C
16. Capacitance at 800 Hz : 100 MOhms / Km [Min]
17. Codes & Standards : 70 nf / km [Typical]
a) IEC 332-1
b) ANSI MC 96.1
c) IS-8784-1987
18. Tests : a) Oxygen Index: Min.29 at room temp. (ASTM-D-2863)
a) Acid Gas Gen.: Max.20% by weight as per IEC 754 Part-I
b) Temp Index : Min 250 DEG C at 21Oxy. Ind. (ASTM-D-2863)
c) Smoke Density Rating: Max.60% (ASTM-D-2843).
d) Flammability Test : as per IEC 332 Part-I
e) Swedish Chimney Test-S-424-1475
f) Insulation Test Core to core :1.0 KV r.m.s for1 Min
g) Insulation Test Core to armour :1.0 KV r.m.s for1 Min
h) Insulation Resistance 100 M Ohm / Km Min
i) Type test for material

2. Instrumentation Pair Signal Cable

01. Conductor type : Stranded (7) annealed tinned copper
02. Conductor size : 0.5 Sq.mm
03. Resistance : 39 Ohms / Km (max.) at 20 °C
04. Conductor Insulation : HRPVC Type-C (IS-5831,1984) 0.6 mm thick
05. Voltage grade : 600V (peak value.)
06. Twisting : Twin twisted with lay of 75 mm
07. Twisting Direction : All pairs in the same direction. Lapped to form bunch with mylar tape.
08. Individual Pair & Overall Shield : Aluminium mylar tape with a thickness of 2.35MIL and 25% overlapped edges.
09. Drain wire : Annealed Tinned copper wire, Stranded. Size 0.5 Sq. mm. (No. of strands / size:- 7 / 0.3mm)
10. Inner Sheath : Extruded FRLS PVC
Type ST2 of IS-5831,1984
Thickness as per IS-1554 Part-I 1976
11. Armoring : G.I. Wire/Strip as per IS-3975
12. Outer Sheath : Extruded FRLS PVC (anti rodent, anti termite & moisture resistant properties)
Type ST2 of IS-5831, 1984
Thickness as per IS-1554, Part-I 1976
13. Rip Cord : Yes
14. Temperature Range : 85 °C
15. Insulation at 20 Deg.C : 100 MOhms/Km [Min]
16. Capacitance at 800 Hz : 70 nf/km [Typical]
17. Codes & Standards : a) IPCEA-S-61-402
b) IEC 332-1
c) ASTM-B-33
d) IS-8130-1984



18. Tests :
- Oxygen Index: Min.29 at room temp. (ASTM-D-2863)
 - Acid Gas Gen.: Max.20% by weight as per IEC 754 Part-I
 - Temp Index: Min 250 ° C at 21Oxy. Ind. (ASTM-D-2863)
 - Smoke Density Rating: Max.60% (ASTM-D-2843).
 - Flammability Test: as per IEC 332 Part-I
 - Swedish Chimney Test-S-424-1475
 - Insulation Test Core to core: 1.0 KV r.m.s for1 Min
 - Insulation Test Core to armour: 1.0 KV r.m.s for1 Min
 - Insulation Resistance 100 M Ohm / Km Min
 - Type test for material
 - Fire resistance test to IS 5831 for 20 Minute CPVC insulation & sheath of electrical cable.
 - Rodent & termise proof
 - Thermal Stability of 200 OYC to IEC 54o for 100 Nos.

3. Fiber Optic Cable

A	Fiber:	
1	Type	Multile single mode/Multi-Mode Fiber to avoid usage of any repeaters.
2	Core Diameter	62.5 ± 3 microns
3	Cladding Diameter	125 ± 2 microns
4	Fiber Proof test	As per Manufacturer"s standard
5	Coating Diameter	As per Manufacturer"s standard
6	Number of Fibers/core	Four OR Six (Colour Coded) with min. 100% spare core (Fibers)
7	Standard	As per Manufacturer"s standard
B	Numerical Aperture	0.275
C	Bandwidth & Attenuation:	
1	Bandwidth @ 850 nm	160 MHz-Km min
2	Attenuation @ 850 nm	4.0 dB/Km max
D	Cable Construction: Optic Fibre cable shall be galvanised corrugated steel taped armoured, fully water blocked with central dielectric material	
1	Outer Colour	Black
2	Outer Jacket	Polyethylene 1.0 to 1.5mm thick, Flame retardant & UV resistant.
3	Inner Jacket	Core-locked flame retardant polyethylene
4	Filler / Strength member	As per Manufacturer"s standard
5	Central Strength member	Glass reinforced plastic (GRP) and Buckle resistant



E	Stripping Ability	All layers easily removed with Commercially available tools
F	Installation:	
1	Minimum bending radius	As per IEC/EIA & other international standard
2	Maximum Tensile Load	As per IEC/EIA & other international standard
3	Method of laying	Directly laid in cable trays / duct bank / clamped with available structure
4	Pulling	Ordinary cable grips
G	Storage Temperature	- 20⁰ C to 60⁰ C
H	Operating Temperature	- 20⁰ C to 65⁰ C
I	Test Specification (EIA – STD – RS - 445 or Equivalent):	
1	Impact Resistance	50 impacts
2	Crush	440 N/Cm
J	Moisture Resistance	Water blocking layer
K	F.O. Cable Testing	All Fiber Optic Cables shall be Tested as per IEC/EIA & other international standard using Optical Time Domain Reflector (OTDR) meter

4. Data cable:

Data transmission cables are control & signal cables used in electronics of computer system, electronic control equipment etc. in power plant data processing system. The cable has an overall screening which suppresses external electrical influences and ensures precise pulse transmission. The screen braiding of tinned copper wires is wrapped around the core or inner sheath.

i) Min. bending radius for flexing	: 15x cable diameter.
ii) Temp. Range	: (-30 to +80) deg. centigrade
iii) Loop resistance	: Max. 78.4 ohm/km.
iv) Inductance	: 0.65 mH / Km.
v) Coupling	: 200 pF / Km.
- Co axial and fibre optic cables are also used as data cables.

NOTE: All cables near high temperature zone shall be high temp cables, which shall be terminated at a junction box in normal temperature zone. Thermocouple extension cables and copper conductor cables for high temperature applications shall be with insulation of individual conductor and outer sheath of extruded FEP (i.e. Teflon) as per VDE 0207 Part 6 and ASTM D 2116. The thickness of insulation shall be 0.5 mm nominal (i.e. 0.4 mm minimum). These cables shall be single / Multipair twisted & shielded.



5. Specification For Co-Axial Cables Cable-C

Co-axial cables are used for high frequency equipments and systems for transmission and reception purposes and computers. Co-axial cable should have minimum following characteristics:-

Construction	:	Solid silica coated, annealed copper conductor.
Di-electric	:	Low loss solid polyethylene foam, semi and spaced construction.
Outer conductor	:	Braided or longitudinal tube of Copper or Aluminium giving 100% coverage with slight overlap.
Outer sheath	:	PVC Diameter over Di-electric : 7.24 sq.mm. Outer diameter : 10.29 sq.mm. Nominal impedance : 75 ohms Nominal capacitance : 20.5 pF/ft.
Nominal attenuation	:	8 dB at 1000 MHz Per 100 ft.

6. Extension Cables

1.	Applicable Standards	:	ANSI MC96.1; IS:1554 (Part-I) IS:5831-1984
2.	Type	:	Single / Multipair twisted and shielded type as per ANSI MC96.1
3.	Conductor Size	:	.31sqmm, solid alloy (16 AWG)
4.	Conductor Diameter	:	1.29 mm
5.	Insulation	:	PVC insulated, heavy duty, Self extinguishing type. Colour coded extruded PVC inner sheathed with overall PVC sheathed Type ST2 FRLS as per Insulation of each wire with high grade 0.6 mm 85 deg.C PVC Type C as per IS: 5831, voltage grading shall be 1.5 kVVDE 0207 PART 4 / IS: 5831.
6.	Lay	:	Twisted pairs within 75 mm max. lay.
7.	Shield	:	Single pair cable assembly only. Multiple pair - each pair and cable assembly. Each conductor shall be individually and overall shielded. 2.35 MIL thick combination aluminium Mylar tape and 7 strand 20 SWG drain wire. Hundred percent cover over insulated conductors, shield tape on pair assembly shall be applied in such a way as to give total shield isolation from all other pair shields
8.	Intermediate Sheath	:	Soft extruded PVC, IS:5831 Type 4



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

Power Cylinders (Pneumatic)

Mounting Type	:	a) Fixed position mounting (End mounting). b) Trunnion mounting
Control Signal	:	0.2 to 1 Kg/Sq. cm. from I/P converter for modulating purposes. 24V/48VDC operated solenoid valve operating on pneumatic line. The Pilot solenoid will have separate coils for open closing purpose.
Supply Air Selection	:	0-7 Kg / Cm ² . Based upon thrust / torque, stroke length, angular movement, full-scale travel time, repeatability, space factor etc. Provision for air-to-open and air-to-close operation.
Casing	:	IP-65.
Accessories (as required)	:	a) Air lock relay b) Hand wheel. c) Air filter regulator with gauge. d) Volume Booster. e) Limit Switches. f) Positioner with Input, Output and supply pressure gauges. g) Pilot Solenoid Valve (Double Coil type) h) Position Transmitter (4-20 mA DC linear output, LVDT or non contact type).
Fail-safe operation	:	Stay put, open or close position on pneumatic / electrical power supply failure as per process safety criteria.
Repeatability	:	Better than 0.5% of full travel.
Hysteresis	:	Less than 0.1% of full travel

J. Miscellaneous Instruments**01. Nucleonic Type Density Meter (For Ash Handling Plant):-**

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



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

05. Zero Speed Switch

Type : Microprocessor Based
Body : Cast Iron
Contact rating : Continuous 10 Amp. (240 V AC)
No. of contact : 2 NO + 2 NC
Reset facility : Manual Reset
Type of enclosure : Die Cast Aluminum
Degree of protection : Explosion proof for NEC class 1, Division 1 area
Accuracy : +/- 5%
Repeatability : +/- 1%
Differential : +/- 5%
Accessories : Canopy

06. Chute Block Switch

Type : RF Based
Sensor Material : SS 316
Mounting : Flanged
Insulation Material : PTFE
Contacts : 2 NO + 2 NC
Type of enclosure : Die Cast Aluminum
Degree of protection : IP 66
Electrical Connection : ¾ " ET
Repeatability : 0.05%
Local Indication : To be provided
Accessories : a) Neoprene Gasket and Stud Bolt
b) SS Tag plate, Nickel plated brass double Compression type cable gland

07. Dew Point meter

Type : 2 Wire Loop Powered Dew point Transmitter
Overall Range : -60°C to +20°C Dew point
Accuracy : ± 2°C Dew point
Material : SS316 (wetted parts)
Features : AUTOMATIC CALIBRATION
• Can be Configured for Linear 4-20mA signal in °C & °F Dew point, ppm(v), ppb(v), g/m3
• Temperature Compensation
• Failure Diagnostics
• Long Term Stability
• Fast Response
• IP 66 / NEMA4X Protection
• Supplied with Calibration Certificate Traceable to National & International Humidity Standards
• Sensor protection with sintered filter
• Local LCD Display for Dew Point

08. Junction Boxes

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



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

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

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

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

09. Recorders (Chartless)

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

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

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

Selection of scan time for individual channel is required.

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



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

10. Digital Indicator

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

11. Receiver Indicators (Single/Dual Channel)

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

12. Temperature Scanner

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



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

13. Humidity & Temperature Sensor with LCD display for AC Plant

Humidity Sensor	
Measurement range	: 0-100%r.h.
Range of use	: 0-100%r.h.
Measurement accuracy at 23° C 0-100% r.h.	: +2%
Temperature dependency	: <0.05% r.h./ ° C
Output signal, linear (terminal I1)	: DC4-20mA = 0-100%r.h.
Temperature Sensor	
Range of use	: 0-50° C & -35 to 35° C
Sensing element	: Pt1000 class A
Measurement accuracy at 15-35° C	: +0.5K
Output signal, linear (terminal I2)	: DC4-20mA = 0-50° C & -35 to 35° C
General Sensor Data	
Power supply	
Operating voltage	: AC 24V +20%
Degree of Protection & Safety Class	
Degree of protection of housing	
With enclosed cable gland	IP 65 to IEC 529
Safety class	: III to EN 60 730
Environmental Condition	
Temperature (housing with electronics)	: -40 to 70° C
Humidity	5 to 95% r.h. (noncondensing)
Location	: In each AHU room and Control room

	SPECIFICATION FOR MOTORISED VALVE ACTUATOR		SPECIFICATION NO.:	
			VOLUME II B	
			SECTION D	
			REV. NO. 00	DATE: 25.04.18
			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	2 X 660 MW UDANGUDI TPP		
	OFFER REFERENCE			
	* TAG NO. SERVICE			
	* DUTY	☐ ON / OFF ☐ INCHING		
	* LINE SIZE (inlet/outlet): MATERIAL			
	* VALVE TYPE	☐ GLOBE ☐ GATE ☐ REG. GLOBE ☐ BUTTERFLY		
	* OPENING / CLOSING TIME			
	* WORKING PRESSURE			
	AMBIENT CONDITION	SHALL BE SUITABLE FOR CONTINUOUS OPERATION UNDER AN AMBIENT TEMP. OF -20 to 70 DEG C AND RELATIVE HUMIDITY OF 0-95% IN HOT HUMID AND TROPICAL ATMOSPHERE AND HIGHLY POLLUTED AT PLACES OF COAL DUST AND FLY DUST		
	VALVE SEAT TEST PRESS	BIDDER TO SPECIFY		
	REQUIRED VALVE TORQUE	BIDDER TO SPECIFY		
	ACTUATOR RATED TORQUE	BIDDER TO SPECIFY		
	CONSTRUCTION AND SIZING	CONSTRUCTION	TOTALLY ENCLOSED, WEATHER PROOF, DUST TIGHT SUITABLE FOR OUTDOOR USE WITHOUT CANOPY, NEMA6/IP:68	
MECHANICAL POSITION INDICATOR		TO BE PROVIDED FOR 0-100% TRAVEL		
BEARINGS		DOUBLE SHIELDED, GREASE LUBRICATED ANTI-FRICTION.		
GEAR TRAIN FOR LIMIT SWITCH/TORQUE SWITCH OPERATION		METAL (NOT FIBRE GEARS). SELF-LOCKING TO PREVENT DRIFT UNDER TORQUE SWITCH SPRING PRESSURE WHEN MOTOR IS DE-ENERGIZED.		
SIZING		OPEN/CLOSE AT RATED SPEED AGAINST DESIGNED DIFFERENTIAL PRESSURE AT 90% OF RATED VOLTAGE. FOR ISOLATING SERVICE THREE SUCCESSIVE OPEN-CLOSE OPERATIONS OR 15 MINS. WHICHEVER IS HIGHER. FOR INCHING SERVICE - 150 STARTS/HR MINIMUM.		
HANDWHEEL	* REQUIRED	☒ YES ☐ NO		
	* ORIENTATION	☐ TOP MOUNTED ☐ SIDE MOUNTED		
	* TO DISENGAGE AUTOMATICALLY DURING MOTOR OPERATION.			
ELECTRIC ACTUATOR	ACTUATOR MAKE/MODEL	BIDDER TO SPECIFY		
	MOTOR MAKE / MODEL / TYPE / RATING (KW)	BIDDER TO SPECIFY		
	@ MOTOR TYPE	SQUIRREL CAGE INDUCTION MOTOR, STARTING CURRENT LIMITED TO SIX TIMES THE RATED CURRENT-INCLUSIVE OF I.S. TOLERANCE		
	ACTUATOR APPLICABLE WIRING DIAGRAM	☒ ENCLOSED (BIDDER TO CONFIRM) A: ☐ DRG. NO. 3-V-MISC-24227 R00 B: ☐ DRG. NO. 3-V-MISC-24550 R00 C: ☒ DRG. NO. 3-V-MISC-24283 R00 D: ☐ DRG. NO. 4-V-MISC-90271 R11 E: ☐ For Thyristor based Integral starter, Bidder/Vendor to furnish wiring diagram		
	COLOUR SHADE	☐ BLUE (RAL 5012) ☒ SIEMENS GRAY RAL 7030		
	PAINT TYPE (## Refer Notes)	☐ ENAMEL ☒ EPOXY ☐		
	SHAFT RPM	BIDDER TO SPECIFY		
	OLR SET VALUE	BIDDER TO SPECIFY		
	@ STARTING / FULL LOAD CURRENT	BIDDER TO SPECIFY		
	NO. OF REV FOR FULL TRAVEL	BIDDER TO SPECIFY		
	@ PWR SUPP TO MTR / STARTER	415V +/- 10%, 3 Phase, 3 Wire 50HZ +/- 5%		
	@ CONTROL VOLTAGE REQUIREMENT	TO BE DERIVED FROM THE POWER SUPPLY TO THE STARTER ☐ 230 V ☒ 110 V		

	SPECIFICATION FOR MOTORISED VALVE ACTUATOR		SPECIFICATION NO.:	
			VOLUME	II B
			SECTION	D
			REV. NO.	00
			DATE:	25.04.18
		SHEET	2	OF 4

Data Sheet A & B

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

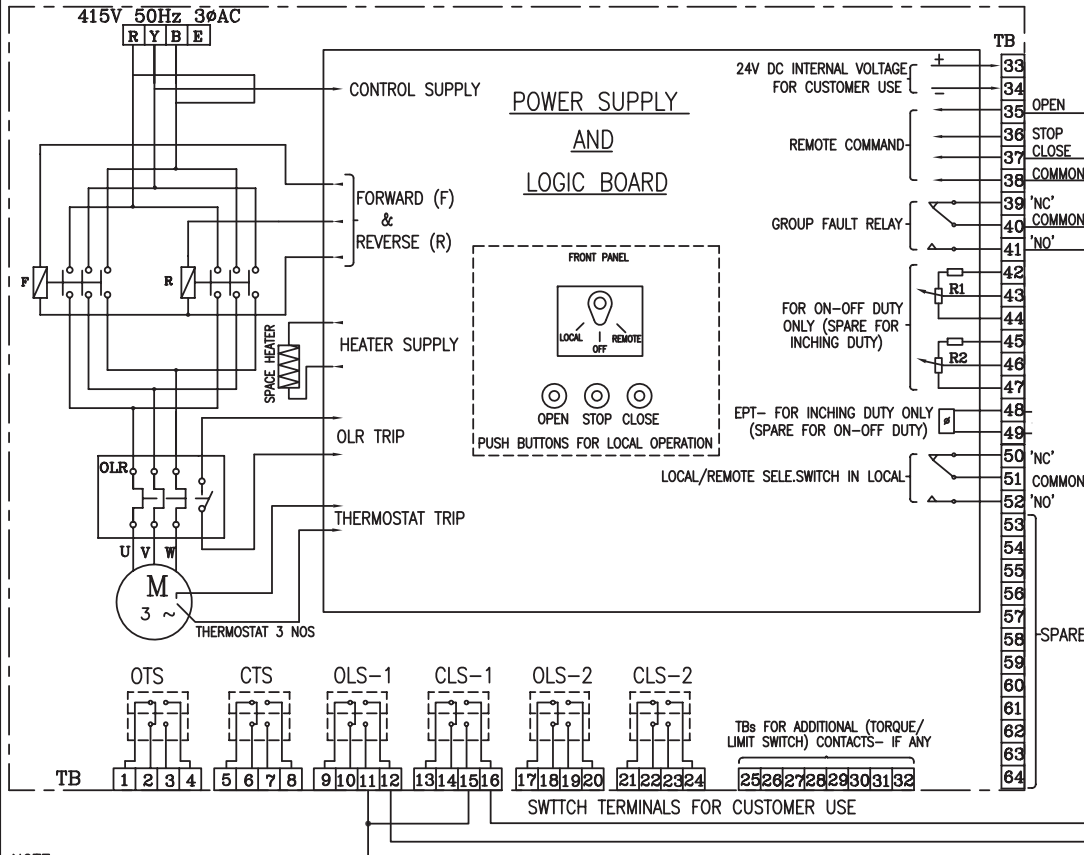
	@ ENCLOSURE CLASS OF MOTOR	☐ IP 68 ☐ FLAME PROOF		
	@ INSULATION CLASS	CLASS-F TEMP. RISE LIMITED TO CLASS-B		
	@ WINDING TEMP PROTECTION	☒ THERMOSTAT (3 Nos.,1 IN EACH PHASE) ☐ -----		
	SINGLE PHASE / WRONG PHASE SEQUENCE PROTECTION	REQUIRED		
INTEGRAL STARTER	INTEGRAL STARTER	☒ REQUIRED ☐ NOT REQUIRED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

	SPECIFICATION FOR MOTORISED VALVE ACTUATOR		SPECIFICATION NO.:	
			VOLUME II B	
			SECTION D	
			REV. NO. 00	DATE: 25.04.18
			SHEET 3	OF 4
Data Sheet A & B				
DATA SHEET-A (TO BE FILLED BY PURCHASER)			DATA SHEET-B (TO BE FILLED-UP BY BIDDER)	
POSITION TRANSMITTER	POSITION TRANSMITTER (For inching duty & other specific applications)	REQUIRED for regulating/inching duty only.		
	MFR & MODEL NO.	BIDDER TO SPECIFY		
	TYPE	☐ ELECTRONIC (2 WIRE) R/I CONVERTER ☒ ELECTRONIC (2 WIRE) contactless inductive type		
	SUPPLY	☒ 24V DC ☐		
	OUTPUT	☒ 4-20mA		
	ACCURACY	$\pm 1\%$ FS		
SPACE HEATER	@SPACE HEATER	REQUIRED		
	@ POWER SUPPLY (NON INTEGRAL)	240V AC, 1 PH., 50 Hz		
	@ POWER SUPPLY (INTEGRAL)	BIDDER TO SPECIFY		
	@ RATING			
TERMINAL BOX	ACTUATOR/MOTOR TERMINAL BOX	REQUIRED		
	ENCL CLASS ACTUATOR/MOTOR T.B.	☒ IP 68 @ ☐ NEMA6		
	@ EARTHING TERMINAL	REQUIRED		
	PLUG & SOCKET (9 PIN) (FOR COMMD, LS/TS FEED BACK, PoT)	☒ REQUIRED ☐ NOT REQUIRED ☐ ☒ 2 NOS. ☐		
CABLE GLANDS	@ POWER CABLE GLAND	SIZE:-----		
	@ SPACE HEATER CABLE GLAND	SIZE:-----		
	OTHER CONTROL CABLE GLANDS-1	☐ 1No. for BFV of CW PUMP (Cable size 2Px1.5mm ²)		
	OTHER CONTROL CABLE GLANDS-2	1 no suitable for 8P X 0.5 sq mm Additional 1 no suitable for 2P X 0.5 sq mm (inching duty only)		

	SPECIFICATION FOR MOTORISED VALVE ACTUATOR		SPECIFICATION NO.:	
			VOLUME II B	
			SECTION D	
			REV. NO. 00	DATE: 25.04.18
			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)	
WEIGHT	TOTAL WEIGHT (ACTUATOR + ACCESSORIES)	BIDDER TO SPECIFY	_____ Kg.	
NOTES: SCOPE: DESIGN, MANUFACTURE, INSPECTION, TESTING AND DELIVERY TO SITE OF ELECTRIC ACTUATOR FOR INCHING OR OPEN / CLOSE DUTY. CODES & STANDARDS: DESIGN AND MATERIALS USED SHALL COMPLY WITH THE RELEVANT LATEST NATIONAL AND INTERNATIONAL STANDARD. AS A MINIMUM, THE FOLLOWING STANDARDS SHALL BE COMPLIED WITH: IS-9334, IS-2147, IS-2148, IS-325, IS-2959, IS-4691 AND IS-4722 - TEMPERATURE RISE SHALL BE RESTRICTED TO 70 DEG. C FOR AMBIENT TEMPERATURE OF 50 DEG C. - CABLE GLANDS OF DOUBLE COMPRESSION TYPE, BRASS MATERIAL SHALL BE PROVIDED. - 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. - THE MOTOR SHALL OPERATE SATISFACTORILY UNDER THE +/- 10% SUPPLY VOLTAGE VARIATION AT RATED FREQUENCY, -5% TO +3% VARIATION IN FREQUENCY AT RATED SUPPLY VOLTAGE, SIMULTANEOUS VARIATION IN VOLTAGE & FREQUENCY THE SUM OF ABSOLUTE PERCENTAGE NOT EXCEEDING 10%. - THE MOTOR SHALL BE SUITABLE FOR DIRECT ON LINE STARTING. \$\$ TORQUE SWITCH & LIMIT SWITCH SHALL ACT INDEPENDENT OF EACH OTHER. TANDEM OPERATION IS NOT ACCEPTABLE. ## EPOXY PAINT IS RECOMMENDED FOR COASTAL AREAS. - IT SHOULD BE POSSIBLE TO OPERATE THE ACTUATOR LOCALLY. LOCKABLE LOCAL/REMOTE SELECTION SHALL BE PROVIDED ON THE ACTUATOR. - POSITION INDICATOR SHALL BE PROVIDED FOR 0 TO 100 % TRAVEL - WIRING SHALL BE SUITABLE VOLTAGE GRADE COPPER WIRE 1.5 SQ. MM. - THE MOTOR SHALL BE CAPABLE OF STARTING AT 85 PERCENT OF RATED VOLTAGE AND RUNNING AT 80 PERCENT OF RATED VOLTAGE AT RATED TORQUE AND 85 PERCENT RATED VOLTAGE AT 33 PERCENT EXCESS RATED TORQUE FOR A PERIOD OF 5 MINUTES EACH. - THE ACTUATORS SHALL BE DESIGNED TO BE SELF-LOCKING UPON LOSS OF POWER. MOTOR SHALL BE DESIGNED TO CLOSE IN 30 SECS. FROM FULL OPEN POSITION AND SHALL HAVE ADEQUATE CAPACITY TO OPEN AND CLOSE UNDER FULL UNBALANCED DESIGN PRESSURE. - THE INTEGRAL STARTER WHICH SHALL HAVE SOPHISTICATED ELECTRONIC CONTROLS WITH FIELD PROGRAMMING FEATURE. IT SHALL BE DESIGNED FOR REMOTE CONTROL FROM DCS/RESPECTIVE CONTROL SYSTEM. REQUIRED INTERPOSING RELAYS FOR RECEIVING OPEN/CLOSE/STOP COMMAND FROM DCS/RESPECTIVE CONTROL SYSTEM SHALL BE PROVIDED. POTENTIAL FREE CONTACTS AND TRANSDUCERS SHALL BE PROVIDED TO PROVIDE STATUS INDICATION AT REMOTE DCS/RESPECTIVE CONTROL SYSTEM. - THE REMOTE COMMAND SIGNAL (OPEN-STOP-CLOSE) FROM DCS/RESPECTIVE CONTROL SYSTEM/CONTROL PANEL SHALL BE ISOLATED FROM CONTROL ELECTRONICS THROUGH OPTO-ISOLATOR. - THE FOLLOWING INDIVIDUAL STATUS ANNUNCIATION LED'S (COLOUR-GREEN) SHALL BE PROVIDED LOCALLY (INTEGRAL TO ACTUATOR) TO ANNUNCIATE THE FOLLOWING FOR EASY LOCAL MONITORING. ACTUATOR IN LOCAL MODE ACTUATOR IN REMOTE MODE ACTUATOR RUNNING IN OPEN DIRECTION ACTUATOR RUNNING IN CLOSE DIRECTION ACTUATOR IN INCHING MODE. ACTUATOR IN SELF-RETAINING MODE LIMIT SWITCH OPEN TRIP LIMIT SWITCH CLOSE TRIP CONTROL VOLTAGE AVAILABILITY				
NOTES* = TO BE FILLED BY MPL (LEAD AGENCY). @= TO BE FILLED BY ES				

3-V-MISC-24283

DRAWING NO.



NOTE:-

- 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
- CTS - TORQUE SWITCHES FOR CW ROTATION (CLOSE)
- OTS - TORQUE SWITCHES FOR CCW ROTATION (OPEN)
- OLS-1, OLS-2 - LIMITSWITCHES FOR POSITION OPEN
- CLS-1, CLS-2 - LIMITSWITCHES FOR POSITION CLOSE
- EPT - ELECTRONIC POSITION TRANSMITTER (CONTACTLESS TYPE, FOR INCHING DUTY)
- R1-R2-POTENTIOMETER 2 x 100 OHMS (FOR ON-OFF DUTY)
- FOR COMMANDS & EPT EITHER INTERNALLY GENERATED 24 VDC OR EXTERNAL SUPPLY OF 24VDC CAN BE USED
- M - MOTOR 3Φ 415V 50 Hz AC SUPPLY
- TORQUE SWITCH BYPASS WITH LIMITSWITCH BOTH ON OPEN & CLOSE DIRECTION TO BE DONE INTERNALLY.

REV	DATE	ALTERED
		CHD & APPD

CAUTION: The information on this document is the property of BHARAT HEAVY ELECTRICALS LTD. It must not be used directly or indirectly in any way detrimental to the interest of the company.

TYPE OF PRODUCT

ELECTRICAL VALVE ACTUATORS (AC) WITH INTEGRAL STARTERS
2 X 800 MW UPPLUR TPP
(DRAWN FOR INTERMEDIATE POSITION OF VALVES)



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

DEPT VL
CODE -



SCALE
NTS

WEIGHT (KG).
-

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

CARD CODE
U 01

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

REFERENCE INFORMATION
-

DRAWING NO.
3-V-MISC-24283

REV
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CONTACT DEVELOPMENT DIAGRAM

OTS	1-2	OPEN AT OVER TORQUE DURING OPENING TRAVEL
CTS	3-4	CLOSE AT OVER TORQUE DURING OPENING TRAVEL
	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.	VALVE POSITION
	FULL OPEN	INTERMEDIATE
		FULL CLOSE
		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)				



SECTION-3.15: UNINTERRUPTED POWER SUPPLY SYSTEM

1.0.0 INTENT OF SPECIFICATION

This section covers the requirements of 230 V UPS system.

2.0.0 SCOPE OF WORK

The scope of work shall include supply, installation, testing and commissioning of the parallel redundant UPS with voltage stabilizer for the following:

- a) UPS for each Unit-1 for main plant.
- b) UPS for each Unit-2 for main plant.
- c) UPS for switchyard.
- d) UPS for coal handling plant
- e) UPS for Ash handling plant
- f) UPS for Water treatment plant
- g) UPS for fuel oil system.
- h) UPS for cooling water pump house.
- i) UPS for seawater intake pump house.
- j) UPS for other auxiliary plants such as H2 plant, AWRPH, Ash Silo, FOPH etc.
- k) ~~UPS for service building and Admin building.~~
- l) Commissioning spares and consumables
- m) Mandatory spares
- n) Tools & tackles
- o) Any other equipment required for the system

3.0.0 CODES AND STANDARDS

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

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

4.0.0 DESIGN REQUIREMENTS

4.1.0 UPS system shall be Digital type. It shall provide uninterrupted power supply to critical AC loads such as Control & Instrumentation system, DCS system, Respective control system, etc.

4.2.0 UPS, which shall be located in air-conditioned area, shall be designed for design ambient temperature of 30°C. Other equipment shall be designed for design ambient temperature of 50°C.



4.3.0 Each UPS shall be parallel redundant UPS system consisting of 2X100% chargers, 2X100% inverters, 2X100% Battery, SMPS based voltage stabiliser, Static bypass and Maintenance bypass, UPS DB, MCCB box for battery, interconnecting cables among UPS & voltage stabiliser etc.

4.4.0 Single Line Diagram for UPS Distribution is enclosed in Section-7 of Volume-II.

4.5.0 UPS shall be located in Air conditioned room.

4.6.0 Battery shall conform to the requirements stated in 'Battery section of this specification.

4.7.0 UPS battery shall be rated for 60 minutes back up

4.8.0 UPS shall have following features:

- Digital Technology
- True on-line double conversion
- High frequency PWM design
- Programmable power walk-in
- High efficiency
- High input power factor
- Constant voltage & frequency
- Pure sine wave output power with no break output during normal to battery operation
- Wide frequency synchronizing range
- Wide input range
- Soft start capability
- 100% nonlinear load handling capability
- LED mimic
- LCD Display
- RS 232 /RS 485 Interface complete with Communication software
- Permissible harmonics at rated continuous load +/- 2% for linear loads & 3% for non-linear loads.

4.9.0 UPS shall be suitable for connecting to a 415 V, 3 phase, 4 wire, 50 Hz system with a symmetrical fault level of 50 kA rms. Nominal voltage output shall be 230 V, 50 Hz, Single phase with +/- 1% resolution.

4.10.0 Variation in inverter output voltage and frequency shall not exceed specified limits for the load variation between zero and the rated output of the UPS and also for the following input supply variation.

- For the input power supply condition of 415 V +/- 10% and 50 Hz +3%, -5%
- For the DC input voltage over the range corresponding to battery float / boost charge operation and battery operation and battery discharge operation up to battery end cell voltage.

4.11.0 The changeover from inverter to by-pass transformer shall not be more than 5 m.second.

4.12.0 The design shall provide for high availability of equipment by ensuring high mean - time - between failures (MTBF) and low mean-time-to-repair (MTTR).

4.13.0 The UPS shall have an over load capacity of 125 % rated capacity for 10 minutes and 150 % rated capacity for 10 sec. The inverter shall have sufficient I^2t capability to clear fault in the maximum rated branch circuit. The sizing of UPS shall be based on the power factor of the loads being fed subject to a maximum of 0.8.



- 4.14.0 On failure of one UPS, the other UPS shall take over the 100% load automatically without any interruption and on failure of both UPS, voltage stabiliser shall take over the power supply distribution and shall supply the power without any interruption.

5.0.0 TECHNICAL REQUIREMENTS

- 5.1.0 The UPS system including the stabilized bypass shall be galvanically isolated from input power supply system by providing double wound Isolation transformers. A rectifier shall have a double wound transformer at its input.
- 5.2.0 Transient / surge protection circuit shall be provided in the input circuit to rectifiers to protect the UPS from surge & voltage spikes.
- 5.3.0 The UPS shall be provided with automatic sequence and power walk in circuits with adjustable time delay such that the rectifiers and inverters can start operating automatically when incoming AC power is restored allowing the UPS to be loaded automatically.
- 5.4.0 The inverters shall operate satisfactorily for variation of DC bus voltage from fully discharged condition of the battery to rapid charge voltage of the battery and inverter output load current waveform having a relative harmonic.
- 5.5.0 It shall be possible to vary the inverter output voltage steplessly within $\pm 5\%$ of the specified output voltage. This adjustment shall be possible to be made when the inverter is in operation.
- 5.6.0 UPS shall be provided with current limit circuit to avoid excessive loading beyond its permissible overload withstand capability. The UPS shall be designed to permit ready access to power switching and control modules and PCBs. The locations of components, test points and terminals shall be such that they are accessible for circuit checking adjustment, trouble shooting, and maintenance from the UPS without removal of any adjacent module or assembly.
- 5.7.0 The stabilized bypass supply shall have a continuous current rating equivalent to the rated output of the UPS unit and be capable of conducting a current ten times the rated output for the duration more than the fault clearing time of the type of fuse provided. The load transfer devices shall comprise of continuous rated elements in both inverter and stabilized bypass supply.
- 5.8.0 The inverters shall be phase locked to the stabilized bypass power supply as long as stabilized bypass supply frequency remain within $+ 3\%$ to $- 5\%$ of nominal. When bypass supply frequency variation exceeds the above limits, the inverters shall be delinked from mains. Free running frequency tolerance limit shall not exceed $\pm 1\%$. Facility shall also be provided for adjustment of synchronizing frequency from 1% to 5% in the steps of 0.5%.
- 5.9.0 All electronic power devices including thyristors, transistors, diodes etc., shall be rated under operating conditions for approximately 200% of the maximum current carried by the device. All other electrical components such as transformers, reactors, breakers, contactors, switches, bus bars etc., shall be rated for atleast 125% of the maximum required rating. No electronic device shall be subjected to PIV greater than 50% of the rated value.
- 5.10.0 All the thyristors, diodes and other electronic devices of UPS shall be protected with high speed semiconductor fuses. It co-ordination characteristics between fuse and semi-conducting power devices shall be furnished.
- 5.11.0 Radio Frequency Filters shall be provided at the input and output of UPS to reduce radio frequency interference.
- 5.12.0 All PCBs shall be provided with a transparent epoxy coating for environmental protection and tropicalisation. They shall be suitably located away from heat sources.



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

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

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

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

6.0.0 MODE OF OPERATION

6.1.0 Normal Mode

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

6.2.0 Emergency Mode

- a) Upon failure of the normal AC source, the loads shall continue to be supplied by inverters which, without any switching shall obtain their power from storage battery. In case of failure of the main supply, battery shall supply back up DC power to UPS system for duration of sixty (60) minutes.
- b) Upon restoration of the normal AC source, the rectifier/battery chargers shall power the inverters and simultaneously recharge the battery. This shall be automatic causing no interruption to critical loads.
- c) On failure of an inverter due to any one of the following faults the entire load shall be automatically transferred to the other inverter.
 - Excess inverter output voltage
 - Very low inverter output voltage
 - Failure of inverter.
- d) On failure of one inverter, the faulty one shall be isolated from load instantaneously and the other inverter shall continue to feed the load. In case, the other inverter also fails, automatic change over to standby transformer shall be effected through electronic switches.
- e) Parallel operation (load sharing) shall start automatically when the fault condition clears. If the transfer was due to the inverter failure the retransfer (parallel operation) shall be manually initiated.
- f) The entire load shall be automatically transferred to the alternate AC source through electronic switch within a maximum of four (5) milliseconds under the following conditions :



- Battery discharged completely
 - Initiation of manual control switch.
 - Failures of both the inverters
 - Inverter output voltage is more than +/- 5 % of the rated value
 - The load current exceeds specified over load rating and time.
- g) In case of failure of both inverters, electronic transfer switch shall changeover within five (5) milliseconds to connect the alternate AC source to the load. On restoration, the retransfer shall be manually initiated.
- h) Retransfer of load shall be accomplished automatically by synchronizing the inverter to the alternate source and allowing the inverter to ramp into the load and then disconnecting the alternate source.
- i) Manual transfer facility through electronic transfer switches shall be provided in either direction.
- j) In case of maintenance requirement, it shall be possible to isolate inverters and electronic bypass switches from load and connect alternate AC source to the load through manually operated, make before break manual transfer switch.

7.0.0 EQUIPMENT DETAILS

7.1.0 Charger

7.1.1 Charger shall have following features:

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

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

7.1.3 The rectifiers / chargers shall be designed to completely charge the battery in a maximum time of 8 hours for lead acid batteries, after complete discharge. Facilities shall be provided to initiate battery rapid charge operation by Manual & Automatic means. An auto charging sequence should be provided for the boost and float charging based on current sensing. In addition to above, the charging shall be transferred from boost to float mode after preset time adjustable through 0-24 hour's timer. Rectifier shall have protection & interlocking against single phase input & reverse phase sequencing.

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

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

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



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

- 7.1.7 The DC rectifiers shall sense the battery charging current and adjust the DC bus voltage to maintain the charging current to preset level. A separate current limit circuit shall also be provided for adjustment of battery current. The rectifiers shall be protected against reverse battery connection at DC link voltage bus. Subsequent to a discharge cycle when battery is connected to rectifier, the battery current shall be monitored, controlled and limited to set value automatically irrespective of the inverter input current.
- 7.1.8 The battery may be taken out of service for maintenance, during which period it shall be possible for the inverter to continue operation by drawing power from the rectifier. Ripple content shall not exceed 1.5%. Ripple current relay shall be provided to indicate the charger capacity failure.
- 7.1.9 Battery shall be provided with a sensitive earth leakage protection.
- 7.1.10 The chargers shall be current limiting and shall be provided with surge suppression networks for both float and boost charging. All equipment and devices required to protect the chargers from short circuits e.g. fast acting semiconductor fuses, trip fuses and micro switch with alarm contacts etc., shall be provided. Rectifier shall have protection & interlocking against single phase input & reverse phase sequencing.

7.2.0 Inverter

- 7.2.1 Inverters shall have following features:

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

- 7.2.2 Inverters shall be PWM controlled IGBT (Insulated gate bipolar transistor), filters, necessary oscillators, voltage regulators, current limiting and surge suppression networks. Two nos. 100% capacity Inverters shall be provided. In addition the inverters shall have features of soft start, wave shaping, transient recovery etc. Any other equipment required for normal operation of the inverter shall be included irrespective of whether specified or not.
- 7.2.3 The inverter input voltage shall match with the battery and rectifier charger output voltages and shall be designed to operate over the entire range of variation of input DC voltage to accommodate decrease in battery voltage during discharge and to accept voltage increase under battery boost charge or equalizing charge conditions. The output from the inverter shall be 230 V AC, sine wave 1 phase.
- 7.2.4 The inverters shall always work on their internal oscillators or frequency variations with plant AC electrical system. Output voltage frequency shall be controlled simultaneously for both the inverters through common control bus. The plant AC electrical system shall provide a signal to each inverter to control the frequency and phase relationship of its output during normal operations. When this signal to an inverter deviates more than one hertz from the desired 50 Hz frequency, the inverter shall transfer automatically to its internal oscillator which shall maintain inverter frequency at 50 Hz. Within 0.5%. During operation on its internal frequency signal source, an inverter shall continuously monitor the frequency of the plant auxiliary AC electrical system.
- 7.2.5 Upon restoration of the plant auxiliary AC electrical system to 50 Hz. operations, inverter shall automatically adjust the phase relationship between its output and the plant auxiliary AC electrical system and return to the plant auxiliary AC electrical system as its output frequency



and phase relationship signal source. During operation on its internal oscillator and inverter shall inhibit transfer of the electronic transfer switch to the alternate source. The automatic adjustment of the phase relationship between the inverter output and plant auxiliary AC system shall be accomplished at a controlled rate which shall not exceed one hertz per second. The inverters shall include a separate voltage distribution and voltage monitoring system for all command and interlock logic.

- 7.2.6 Selective protection shall be provided for each individual drive card and its associated interlock logic. The two inverters shall be designed for normal continuous parallel operation. To maintain specified output at maximum ambient temperature, inverters may be provided with cooling air fans as required. Fan cooling, if envisaged, shall be achieved with 2 x 100% cooling banks. One cooling fan bank shall be in operation while the other shall remain on standby. In case of failure of running bank / one fan, the standby bank shall start automatically. The power supply for the fans shall be tapped from the inverter output.
- 7.2.7 All the fuses used in inverter power and control circuits shall be fast acting semiconductor type, operating in less than 5 m.second. Indications and alarms shall be provided to enable fault to be located and rectified at the earliest. Lamps to indicate fault / trouble / failure of each sub group shall be provided on the cubicle front and lamps for each logic card shall be provided on the card itself.

7.3.0 Electronic Transfer Switch

- 7.3.1 The electronic transfer switches shall use SCRs and other electronic devices, for automatic transfer of load from the Normal source to the Alternate source. The transition shall be "make before break" in both directions. The continuous capacity of each electronic switch shall be equal to the full load capacity of one inverter. Maximum transfer time including sensing shall not be more than ¼ cycle. The voltage failure shall be sensed at the output of the electronic switch. Failure shall cause the electronic switch to transfer. The load from the working inverter shall be transferred to the alternate source, i.e. second inverter or auxiliary power supply source by electronic switches, whenever the output voltage of the inverter deviates more than +10% from nominal. However transfer shall not be made to the alternate source on over current conditions. Transfer shall be permitted only if voltage of the alternate source is within $\pm 2\%$ of nominal. .
- 7.3.2 The electronic switch shall be provided with fuses in both 'normal' and 'alternate' power source. Provision for annunciation of failure of fuse or failure of alternate source shall be made. The switch shall be provided with surge suppression networks and shall also be rated to withstand transient voltages up to 150% of rated voltage. The short time rating of the switch shall be 150% of the rated full load current for two minutes.

7.4.0 Bypass Switch

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

7.5.0 Transformer and Voltage Stabiliser

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

The transformer shall be dry type, double wound, Class F insulated with copper conductor limiting temperature rise to class B limits, enclosed in CRCA sheet steel panel 2 mm thick. The cooling shall be by means of natural convection. Transformer connection shall also be



considered, provided the connection has minimum unbalance on the primary side. The transformer shall be adequately rated for the duty involved. The actual value may be slightly increased to take care of any losses in the voltage stabilizer.

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

7.6.0 UPS Enclosure & Accessories

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

7.7.0 Metering & Protection

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

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

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

7.8.0 UPS AC Distribution Board

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

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



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

- Shunt trip release
- Auxiliary contact set of 1 NO + 1NC
- Fault signalling contact set of 1 NO + 1NC
- Insulation shields to isolate the connection between each pole.
- Finger protection plate to prevent accidental contact.
- The compartment door shall be interlocked with handle of MCCB

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

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

7.8.5 Painting

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

8.0.0 TESTING & INSPECTION

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

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

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

8.3.0 Following tests shall constitute type tests on the panel.

- Degree of protection Test for Panel
- Vibration Test of the Electronic Card Rack/Panel



- Environmental Tests on the Electronic Cards
- RFI Test
- Surge Withstand capability Test

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

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

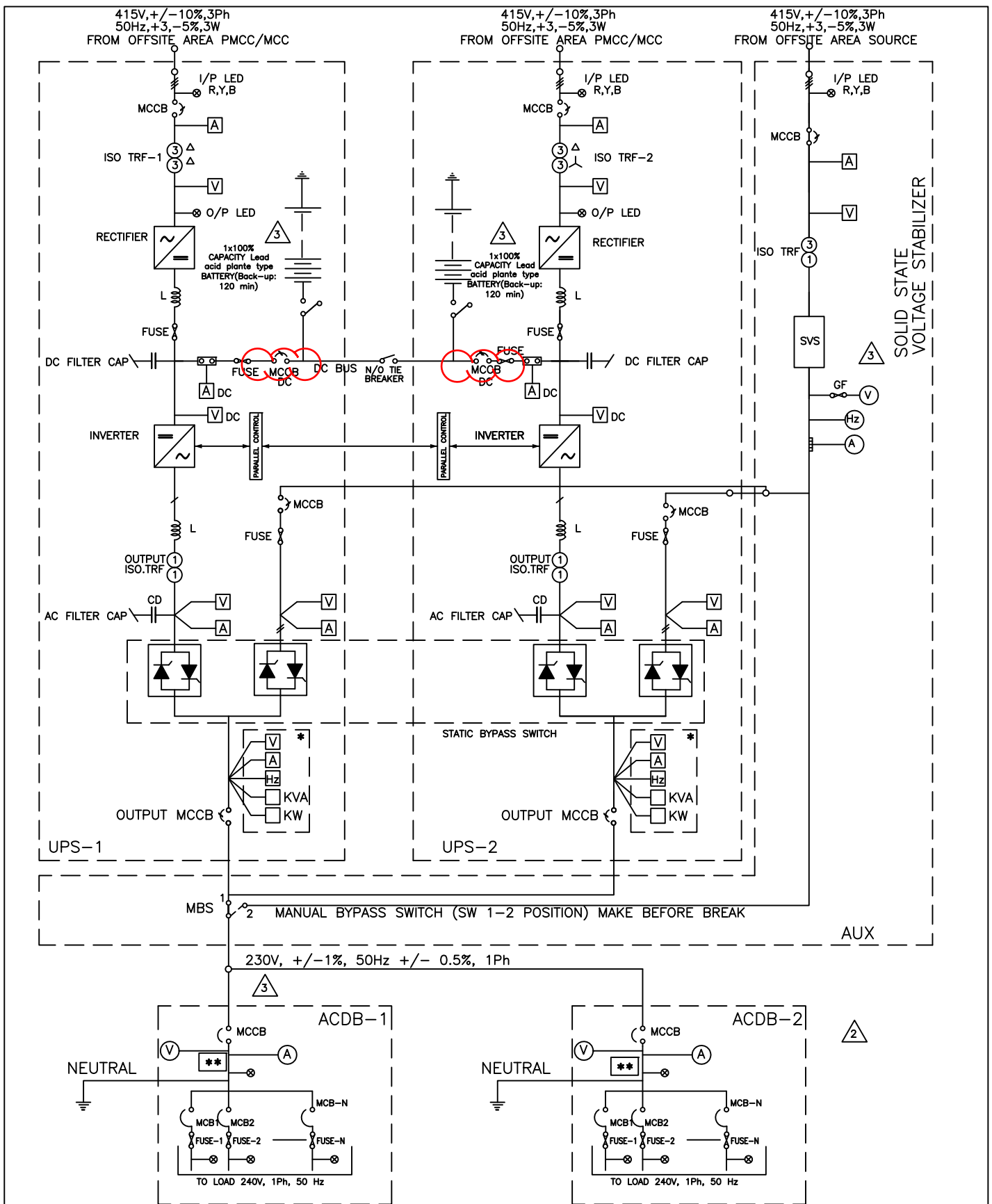
8.5.0 **Site tests shall include the following:**

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

9.0.0 **DRAWINGS & DOCUMENTS**

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

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



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

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



PROJECT:- 2X660 MW UDANGUDI TPP-STAGE I

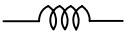
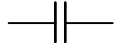
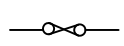
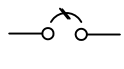
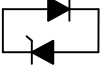
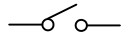
TITLE:- UPS SCHEME
FOR OFFSITE

DRG. No.	PE-DG-435-145-1004		
REV. No.	00	DATE	24.03.2018
SHEET	3	OF	5

GENERAL NOTES:

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

LEGEND:

	ISO. TRF		INDUCTOR
	CAPACITOR		FUSE
	INVERTER		MCCB
	STATIC BYPASS SWITCH		SELECTOR SWITCH



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

DRG.
No.

PE-DG-435-145-I004

TITLE:-
UPS SCHEME
NOTES & LEGEND

REV.
No.

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DATE

24.03.2018

SHEET

4

OF

5



SECTION-3.14: BATTERY

1.0.0 INTENT OF SPECIFICATION

This section covers the requirements of Battery.

2.0.0 SCOPE OF WORK

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

- a) 2 numbers lead acid Plante battery for 220 V DC system of Unit-1
- b) 2 numbers lead acid Plante battery for 220 V DC system of Unit-2
- c) 2 numbers lead acid Plante battery for 220 V DC of switchyard
- d) 2 numbers Lead acid Plante battery for 48 V DC of EPABX at each location
- e) 2 numbers lead acid Plante battery for 24 V DC of I&C system of Unit-1(If applicable)
- f) 2 numbers lead acid Plante battery for 24 V DC of I&C system of Unit-2(If applicable)
- g) 2 numbers lead acid Plante battery for main plant UPS of Unit-1.
- h) 2 numbers lead acid Plante battery for main plant UPS of Unit-2.
- i) Lead acid Plante battery for 220 V DC systems of auxiliary plants such as CHP, AHP, WTP, Sea water intake PH, Fuel oil PH, AWRPH, Ash silo etc.
- j) Lead acid Plante battery for UPS systems of auxiliary plants such as Switchyard, CHP, AHP, WTP, Sea water intake PH, H2 plant, Fuel oil PH, AWRPH, Ash silo etc.
- k) Lead acid Plante battery for UPS systems of Service building and Admin building.
- l) Lead acid Plante battery for Diesel generator set
- m) Battery impedance tester
- n) Battery earth fault locator
- o) Battery Health monitoring system
- p) Commissioning spares and consumables
- q) Mandatory spares
- r) Tools & tackles
- s) Any other equipment required for the system

3.0.0 CODES AND STANDARDS

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

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



- i) IS: 6071 Specification for synthetic separators for lead acid batteries.

4.0.0 DESIGN REQUIREMENTS

4.1.0 Each battery shall be sized to cater to 100% load plus 10% design margin. The ageing factor and electrolyte temperature correction factors shall also be considered for the site ambient temperature.

4.2.0 Type of battery shall be as follows.

- 220 V Unit battery for main plant : Lead acid Plante type
- UPS battery for each Unit (main plant) : Lead acid Plante type
- Switchyard battery for 220 V system : Lead acid Plante type
- Switchyard battery for 48 V system : Lead acid Plante type
- Main plant I&C battery for 24 V system : Lead acid Plante type
- Communication battery for 48 V system : Lead acid Plante type
- UPS battery for Switchyard : Lead acid Plante type
- UPS battery for Auxiliary plants : Lead acid Plante type
- 220 V battery for auxiliary plants : Lead acid Plante type

4.3.0 The duty cycle imposed on the 220 V battery shall be for duration of **two hours**. The loads shall include the following.

- Loads for two hours (Seal oil pumps, Scanner air fans, indicating lights, continuously energized coils, Annunciation, Relays, emergency lighting etc.)
- Momentary loads for a duration of up to 1 minute (switchgear operation (Trip coil / Closing coil), Solenoid valves, starting current of emergency DC motor, emergency steam sop valves, inrush current of supervisory safety, system for fuel, turbine and generator controls)
- Loads for two hour (Emergency oil pump, Jacking oil pump, etc.)

4.4.0 The duty cycle imposed on the UPS battery shall be for duration of two hours.

4.5.0 The duty cycle imposed on the 48 V battery for communication system shall be for duration of **ten hours**.

4.6.0 The duty cycle imposed on the 24 V battery shall be for duration of two hours.

4.7.0 Batteries shall normally be permanently connected to the load in parallel with a charger and shall supply the load during emergency conditions when AC supplies fail. Batteries shall be suitable for a long life under continuous float operations and occasional discharges.

4.8.0 The following items shall be provided for the Battery.

- Insulators (if applicable)
- Long/short connectors with insulated cover
- Inter row connectors with insulated cover (if applicable)
- Interbank connectors with insulated cover (if applicable)
- Vent plug
- Level indicator and float guide
- Battery take-off
- Fasteners
- Cell number plates

4.9.0 End take off connections from positive, negative and tap cell terminals of the battery shall be suitable for single core cables having XLPE insulated stranded aluminium conductors.



Necessary supports for termination of these cables on the batteries shall be provided by the Contractor.

- 4.10.0 All the inter cell, inter row and interbank connectors supplied along with the battery shall be capable of continuously carrying the maximum discharge current of the respective batteries and through fault short circuit current which the battery can produce and withstand for the period declared.
- 4.11.0 Insulated mild steel racks suitably treated/coated with alkali /acid resistant compound mounted on the insulators shall be provided for the batteries.
- 4.12.0 Battery racks and other supporting/interconnecting accessories shall be as per layout arrangement to be approved by Owner during contract engineering stage. The cells shall be supported on insulator fixed on to the rack with adequate clearance.
- 4.13.0 Each battery bank shall be supplied with microprocessor base battery health monitoring system (BHMS). It shall be capable of calculating the net charge of Battery bank, deterioration of batteries in battery bank during the charge/discharge cycles and actual efficiency of the batteries. It shall continuously monitor each cell in the battery bank to identify deterioration in the cell prior to failure and Identify the net charge in the battery bank by monitoring charging and discharging currents. It shall identify the faulty cell by monitoring cell's parameters and create audio and visual alarms whenever battery fault occurs. Remote monitoring of battery health at DCS/SAS/EMS system through modem communication shall be provided.
- 4.14.0 Following accessories shall be provided for the Batteries as applicable.
- Electronic Syringe type Hydrometer with temperature measurement and with built in memory.
 - Cell testing voltmeter with built in memory.
 - Acid resistant funnel
 - Acid resistant jug.
 - Rubber apron and gloves
 - Insulated Spanners
 - Wall mounted teak wood rack/ Acid resistance rubber insulated Steel rack for above items
 - Lifting device for cell

5.0.0 TECHNICAL REQUIREMENTS

5.1.0 Lead acid Plante Battery

- 5.1.1 The cell capacity shall be specified at 10 hour discharge rate. The nominal voltage per cell shall be 2.0 V and the end voltage of cell shall be not less than 1.85 V. AH efficiency of battery shall be not less than 90%. Battery sizing shall be carried out as per IEEE: 485.
- 5.1.2 Batteries shall be Lead-Acid Plante, Type F – HDP as per IS 1652.
- 5.1.3 Battery Containers shall be made of fire retardant polypropylene / fire retardant transparent styrene acrylo nitrile (SAN) polymer. Containers shall be robust, heat resistance, leak proof, non-absorbent, acid/alkaline resistant, non-bulging type and free from flaws such as wrinkles, cracks, blisters, pin holes etc. The electrolyte shall be prepared from battery grade sulphuric acid and distilled water
- 5.1.4 Batteries shall have thick plates designed for maximum durability during all service conditions including high rate of discharge and rapid fluctuations of load. Cells shall be fitted with electrolyte level indicator floats enclosed in transparent tub covers. Vent plug shall be provided which shall be anti-splash type.



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

6.0.0 TESTS

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

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

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

- 6.4.0 Type tests shall comprise the following:

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

- 6.5.0 Acceptance tests shall comprise the following:

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

- 6.6.0 Site tests shall comprise the following:

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

9.0.0 DRAWINGS & DOCUMENTS

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

- Battery sizing calculation
- Technical data sheet
- General arrangement, layout drawing and section
- Battery room layout
- Rating factor & Battery selection table



- Erection and commissioning procedures
- Operation and maintenance manual
- Test reports
- Sub-vendor list
- Manufacturing quality plan
- Field quality plan



VOLUME II
SUB-SECTION 4.21
C&I ERECTION

1.0.0 TECHNICAL REQUIREMENT**1.1.0 Panels**

Panels and control desk shall be freestanding type and fabricated preferably from 2.5 mm thick cold rolled steel sheet. Angle iron framework shall use a minimum section of 50 × 50 × 6 mm angle. The finish shall include sand blasting, grinding, chemical cleaning, and surface finishing by suitable filter and two coats of high-grade lacquer with wet sanding between coats. Two coats of paint in panel color shall be given for non-glossy high stain finish. Panel face final color in general shall be RAL 7035. A final coat of paint shall be given at site.

Panels and control desk shall have removable hinged doors, generally at the back for easy maintenance and accessibility of the instruments. Doors shall be double leaved type with handle and shall be provided with lock and key. Adequate illumination shall be provided inside the panel. All light fittings shall be suitable for 230V, 50Hz A.C.

The local panel construction shall be suitable for the site condition and shall meet IEC requirements in accordance with electrical area classification. Pressurization or purging shall be as per NFPA 496 or equivalent.

No process fluid except air shall be piped to the control panel.

Mounting heights

1. Annunciators (top row)
2. Miniature and subminiature instruments (next 3 rows)
3. Electric push buttons (last row)

Control room panels shall have IP protection of IP 32 if mounted in an air- conditioning room and IP-45 if mounted inside a room and IP-55 if mounted outside.

1.2.0 Cable Trays

All I&C cables / tubes shall run on perforated cable trays. These cable trays shall be made out of galvanized MS and shall be of sheet steel of 2.5 mm thick. The width shall be so selected that 60% of tray space is available for future use of the complete installation.

Suitable cable clamps shall be supplied for binding the cables / tubes at every 500 mm. Cable tray shall be provided with Hot dip galvanized finish. Cable tray shall be provided with the perforation as per manufacture standards. Suitable cable tray cover shall be provided for all trays.

Cable tray shall be continuous and solid grounded. Cable tray shall not have sharp edges, Burrs or projection which is injurious to insulation or outer sheath of the cable.

The supporting arrangement of cable tray system shall be able to withstand the weight of the cable and cable tray system. The supporting interval shall not be more than the recommended span for the above loading for the type cable tray selected. The tray shall not overhang by more than one meter from the support at the dead end.



1.3.0 Process Impulse Lines /Tubes & Fittings

Impulse lines for instruments shall be ½" OD tubing of SS316 material according to ASTM A-269. All fittings to be used for tubing shall also be SS316, double compression type of standard make. Impulse pipes for high pressure applications shall be used with material and rating as same as that of the process line. Size and thickness of piping/tubing shall be suitable for the design pressure and temperature conditions as per ANSI16.11. Compression tube fittings are used in low pressure process systems. Socket weld tube fittings shall be used in high pressure process systems

For impulse pipes/tubes and fittings, IBR certificate shall be provided as applicable. The bidder shall provide thermal insulation (preferably mineral wool) for sampling pipes for the purpose of personnel protection so that temperature outside the insulation is 60 deg. C. Tubing shall be complete with union connections and end fittings at supply and receiving ends. Nipple shall be provided for root valves size more than ½" and the nipple size shall be same as the root valve size. Reducer / adapter shall be provided to suit instrument connection, where nipple, root valve size is more than ½". Bulk head fitting socket welded type to be provided at instrument rack/enclosure.

Impulse pipes, fittings and air supply and signal piping/tubing shall be supplied for all the instruments under the scope of this specification. Instrument piping shall be designed for maximum design pressure and temperature of the process. Pressure measurement connection shall be ½" or 12mm pipe depending on the temperature and pressure conditions of the fluid. Instrument on Vacuum system at CEP inlet should have vent lines connected to high point in the condenser. Instrument air tubing shall be SS.

Minimum bending radius of instrument sensing line is 3 times the tube diameter. Independent impulse lines shall be installed between the flow elements and the transmitter in case of dual/triple redundant

Instrument sensing lines are sloped in their horizontal runs, a minimum of ½" per foot. In general, liquid and steam lines slope from their process tap connection down to the instrument. In general, gas and non-condensing vapor lines slope from their process tap connection up to the instrument.

Instrument sensing lines shall be routed as directly as practicable from the process root valve to the instrument. The length of instrument tubing from the root valve to the instrument shall be limited to maximum of 12 meters for compressible fluids and 15 meters for non-compressible fluids. Wherever it is not possible to access the main root valve a additional root valve shall be provided near to the instrument.

Instrument sensing lines shall be grouped together as much as possible to benefit from the use of common support members and to present a finished installation that is routed in a neat and orderly manner.

The maximum process temperature for all transmitters shall be limited to 80°C. To dissipate the excess heat, a minimum of 1 meter of tubing for each 30°C of excess heat shall be installed to isolate the process media from the instrument. An additional isolation valve shall be used at the instrument for isolation on those instruments without valve manifolds

Funnel with drain header shall be provided in the racks for blowing/draining out the process fluid in the impulse tubings. The size of the drain header shall be 1". When instruments are mounted local to the tapping point and are not mounted in the rack, or panel or enclosure, the drains shall be connected to the nearest floor level or plant drain.



The erection hardware shall meet the following specifications:-

Item	Specification
a) Impulse Piping	
i) High pressure and high temperature services (Medium: Steam & Water and furnace region)	Seamless Alloy Steel Piping to ASTM A335 GR.P22 (schedule 160 for high pressure & high temperature)
ii) Low pressure and low temperature services Gr.B (Medium: Steam & Water)	Seamless carbon steel piping to ASTM A106
iv) Steam and Water Analysis system	Seamless stainless steel piping to ASTM A312 Gr. TP-321
v) Seamless copper tubing	ASTM B-75
b) Fittings	
i) Material for socket weld fittings	ASTM A105 ASTM A182 Gr. F22 6000/3000 lbs
ii) Dimensions of fittings	ANSI B16.11
iii) Fittings for steam and water analysis	ASTM A182 Gr. F-321

1.4.0 Instrument Valves and Manifolds

Bidder shall supply instrument valves (miniature type) and valve manifolds as per the Instrument Installation / Mounting diagrams.

Body material and rating shall be SS316 whichever is better and shall be forged type. Valve trim material shall be SS316.

Double root valve shall be provided under the conditions of pressure ≥ 40 bar.

a) Valves	
i) 3-way valves	SS body/Forged CS body stellited internals and SW ends as per requirement for 2500 lb/600 lb ASA ratings.
ii) 3-valve/5- valve manifolds	FAS body/FCS body 316SS stellited internals with NPT(F) SCRD ends for 2500 lb/1500 lb/600 lb ASA ratings.
iii) 2-valve manifolds	FCS body, 316SS stellited internals, NPT (F) SCRD ends.



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

1.5.0 Instrument Support / Structural Steel

Bidder shall supply instrument stands (stanchions) and other structural steel material required for supporting the Junction boxes, cable trays, impulse lines and instruments.

All field mounted instrument tubing shall be supported with steel angles/channels of a minimum 1/8" thickness fabricated to present a neat appearance. Sharp corners in the support material to be avoided

1.6.0 Transmitter Enclosures

- a) Transmitter Enclosures shall be free standing, enclosed type offering protection against dust, moisture and vermin. Enclosures shall be suitable for outdoor installations, in Udangudi Supercritical Thermal Power Project.
- b) The enclosures shall comprise of rigid welded structural frames enclosed with cold rolled sheet steel of thickness not less than 3 mm.
- c) Instrument piping inside the enclosure shall conform to the specification and in line with typical installation drawings enclosed with the specification.
- d) Blow down header shall be provided inside the enclosure as called for.
- e) Bulkhead connection shall be provided to receive and terminate the impulse pipes from root valves.
- f) Instrument tubing, fittings and isolation, drain valves shall be to ANSI code for pressure piping. Piping/tubing shall be subjects to hydrostatic tests at 1.5 times maximum system pressure.
- g) Support angles shall be provided for valve manifolds, wiring trays etc. Enclosures shall be complete with necessary bulk head fittings, junction boxes, drain header and other accessories as needed on the basis of approved hook up drawings.
- h) Sufficient spacing among adjacent transmitters shall be maintained to offer easy accessibility and operational convenience. The enclosure shall be designed with sizes to suit the grouping and to completely include all the hardware for hooking up the transmitters to the process on the basis of approved installation diagrams. A maximum of five (5) transmitters are envisaged to be grouped in one enclosure.



- i) Hydrostatic tests for piping/tubing and functional checks for correct wiring shall be carried out.
- j) The doors shall be the three-point locking type constructed of not less than 10 gauge steel. Doors shall have concealed quick removal type pinned hinges and locking handles. Doors locks shall accept the same key. Module assemblies shall be fabricated by bolting together two or more modules to form one continuous rigid structure. End covers shall then be added to complete the end closure. Gaskets shall be used between all mating sections to achieve NEMA type-12 dust proof enclosure rating for the modules and a NEMA type-4 water proof and dust tight rating on the terminal boxes. All enclosures shall have access doors on front and backsides.
- k) The quality of the erection hardware/equipment used for complete instrumentation and control equipment shall meet all the requirements indicated in the other clauses.

1.7.0 Mountings for Vibration Transducers

Vibration transducer mounting design and location shall be acceptable to the Owner and to the vibration transducer manufacturer and shall be installed in accordance with API 670. The Bidder shall provide drawings to the vibration monitoring system supplier to indicate the arrangement and dimensions of bearing housings, shaft supports, reinforcing struts, ribs, and adjacent structures. These drawings shall be in sufficient detail to allow the vibration monitoring system supplier to select and locate the vibration transducers.

1.8.0 Junction Boxes

Bidder shall supply junction boxes wherever required. These shall be of Industrial grade Fibre glass Reinforced Polyester (FRP) to weather proof, with cable entering on bottom and side entry shall be provided.

These boxes shall have terminals suitable for min 2.5 mm² cable termination (klip on) mounted on rails. 30% spare terminals shall be supplied in each junction box.

Junction box shall be provided with double compression glands.

Telephone socket shall be provided in junction boxes. Each junction box shall have a minimum of 20% or 2 nos., whichever is more, spare entry duly provided with plugs (weather proof/explosion proof, as applicable). Protection class shall be IP-65 minimum for JB and enclosures.

In general junction boxes shall be designed in accordance with NEC, Article 370, paragraphs 18, 19 and 20 or equivalent standards. Junction boxes for use in outdoor or damp locations shall be galvanized malleable iron or steel coated inside and outside. The enclosure shall conform to NEMA-4 with hinged door lockable type. Conduit and cable shall enter the lower portion of the box in such a manner that all terminals strips are above conduit entry points.

2.0.0 ERECTION SERVICES

2.1.0 Instrument Air Supply System

Dry instrument air shall be distributed to various equipments of I&C system like control valves, Analyzer purging, pneumatic On-Off dampers. The Bidder shall supply total Instrument air requirement Calculations, and design of Air compressor system along with the bid. On collection of water in the drains of instrument air lines, mechanical automatic drains and periodically solenoid operated drains (with electronic timer - 15m, 30m, 60m and 2 Hours & Timing adjustable) are to be provided.



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

2.2.0 Installation of Instruments

All electronic instruments shall be generally installed on supports as per installation standards. No instrument shall be installed in such a way that it depends for support on the impulse pipes, hand rails, floor grills, process pipes or structure in the passage.

Field mounted instruments shall be mounted on brackets, subpanels, or placed on a suitable pedestal. They shall be easily accessible from grade, ladder or platform. All local indicators shall be readable from grade or operating level and if used for manual control, shall be visible from the related valve.

Wherever possible, local mounted instruments shall be mounted at approximately 1.35 meters above the platform or floor in an accessible position. Instruments shall be mounted as close to the sensing points as possible (<15 mtrs).

2.3.0 Instrument Tubing Installation

All primary piping / tubing shall be installed in the best workman-like manner and shall follow installation standard in each case. Where there is no installation standard, the decision of the Engineer-in-Charge shall be followed.

Horizontal and vertical lines shall be installed using spirit levels and plumb and shall be supported to permanent structure at every 1.5 meters.

All threaded joints shall be jointed using Teflon tapes and no other tube-jointing compound shall be used except on higher temperature services where graphited sealing compounds shall be used. Brand of Teflon tape, insulation tape, graphite compound is to be approved by the engineer in charge.

Tubing shall be bent with correct size tubing bender wherever possible to avoid the use of fittings. Tubing cutter shall always be used to cut tubing. The use of short length of tubing in long runs shall be avoided. Wherever required coils shall be provided.

All tubing shall be run in such a manner as to give the maximum protection against mechanical damage. Tubing runs shall be grouped together where possible. Tubing shall be arranged so that couplings can be tightened without disturbing lines.

Tubes installed but not connected, shall have the ends closed in an approved fashion to prevent the entry of foreign material. For a period of up to one-week, adhesive tape may be used for longer periods, caps or plugs shall be used.

All reasonable precautions shall be taken to prevent foreign material entering pipelines before and during erection. All lines shall be blown through with filtered air before connection to instruments.

No tube shall be left with mechanical strain on it.

On tubing to pipe connections and in making up screwed pipe joints, Teflon tape shall be applied to make thread in a manner to insure tape is not over the end of the male fittings.

2.4.0 Piping Supports

Piping and tubing shall be adequately supported and fixed at distances not exceeding those in the following table:



Single Tubing / Pipe Maximum distance between Supports 3/8" OD and less Continuous to 3/4" Nom. size 2 Meters (6 ft.) 3/4" to 1" Nom. size 3 Meters (9 ft.). All field mounted instrument tubing shall be supported with steel angles/channels of a minimum 1/8" thickness fabricated to present a neat appearance. Sharp corners in the support material to be avoided.

2.5.0 Process Connection and Installation

Installation of pressure instruments at locations subject to excessive vibration shall be avoided. An additional block valve and vent valve shall be required adjacent to the transmitter. Means shall be provided for venting pressure from the line and gauge, so that gauges may be removed safely. Primary injection testing shall be incorporated together in a manifold.

Approved ball valves shall be used where temperature conditions permit. The valves shall be rated for not less than the line pressure on the main pipeline. If the pressure piping is of such length that the isolating valve is inaccessible from the instrument location, a suitable valve shall also be fitted at the instrument itself.

All pressure instruments shall be installed vertically. Those for steam must be tapped directly from above, for pressure transmitters and switches, there shall also be a condensing leg. The same applies to gas and vacuum measurements, but adequate provision should be made to ensure no condensation can take place along the line, i.e. The slope shall be adequate to drain any condensate back to the main lines (sloping upwards from the sensing point). Tapping points for liquids shall be made at an angle of 45° from the bottom of the main pipe and these are to be sloped downwards from the sensing point.

SIZE OF TAPPING POINT STUB, NO. AND SIZE OF ROOT VALVES FOR DIFFERENT TYPE OF MEASUREMENTS

Sl. No	Qty. of Root	Root Valve Size	Root Valve Service Conditions
A. Pressure & Differential Pressure Measurement			
(i)	2	25	>=62 bar OR 425 degree C
(ii)	1	15	< 62 bar AND 425 degree C
B. Level Measurement			
B1-Level Gauge and Switch			
(i)	2	25	>=62 bar OR 425 degree C
(ii)	1	15	< 62 bar AND 425 degree C
B2-Level Transmitter (Displacement Type)			
2	25	>=62 bar OR 425 degree C	
1	15	< 62 bar AND 425 degree C	
B3-Standpipe For Level Measuring Instrument			
2	25	>=62 bar OR 425 degree C	
1	15	< 62 bar AND 425 degree C	
C-Flow Measurement			
2	25	>=62 bar OR 425 degree C	
1	15	< 62 bar AND 425 degree C	
D. Sampling System Measurement (Steam & Water Service)			
2	25	>=62 bar OR 425 degree C	
1	15	< 62 bar AND 425 degree C	

Transmitters, temperature switches, pressure switches and the like shall be supported independent of the pressure connection; the type of support shall depend upon the make of instrument and location. When installing pressure instruments, care must be taken to avoid the possibility of imposing stresses from the pressure piping, conduit etc. which may cause malfunction.



When the pressure impulse line is liquid filled, the measuring unit shall be compensated for static head. The head correction shall be stated on the all process connections, pressure impulse lines and instrument arrangements shall be fully detailed and to the approval of the Engineer-in-charge.

2.6.0 Laying and Termination of cables

Multicore / multipair cables shall always be installed on trays or ducts and properly clamped. At every vertical drop to/from junction boxes they shall be clamped at frequent intervals as per instruction of Engineer in charge. They shall be connected inside the junction boxes strictly according to the numbering systems mentioned in the junction box schedule.

The accessories like double compression cable glands, cable lugs, cable tags (SS), cable ties and accessories required for the cable termination shall be included in scope of supply. Insulated lugs and ferrules with proper identification shall be used for all I&C cables.

At bends, minimum radius shall be maintained as per manufacturer's standard. Multicore/Multipair cables to be laid from instrument location to control room as per required standard. Identification tags shall be provided on either end of individual cores, Multicore/paircables including unused cores as per wiring diagram/cable/junction boxes schedules. PVC ferrules shall be used, for identification of cores. SS tag plates shall be used for identification of cable/junction boxes.

All cables shall be cut, after the exact site measurements are taken, between ends and the cable drums shall be so selected before cutting the lengths, as to avoid any wastage. Meggering should be done for each drum and length. While terminating the leads at the field instruments, a 300mm length loop shall be provided to facilitate easy removal of instruments.

In the field, the cables shall be laid in the overhead ducts / trays as per layout drawings. While laying cables in ducts/trenches or burying them, care shall be taken to ensure that two signal cables like alarm, analyzer cables, special cables compensating cables, etc. are separated from other power supply cables. Separation of low signal cables and power supply cables in trays/ducts shall be done as shown in the tray/duct drawing. Jointing of cables are not permitted.

At each road crossing and other places where cables enter pipe sleeves, adequate bed of sand shall be given so that the cables do not slack and get damaged by pipe ends after pack filling. All cables shall be laid in accordance with the layout drawings and cable schedule and tubing schedule. Multicore/Multipair cables shall be bent in a large radius as per manufacturer's standards.

Cables shall be rigidly supported on structural steel and masonry individually or in groups as required using individual cast or malleable iron galvanized clips, multiple cable supports or cable trays. If drilling of steel must be resorted to, approval must be secured and steel must be drilled where the weakening of the structure will be minimum. Cable shall be supported at every 500mm. In case no such supports are available, the bidder shall provide suitable supports for the cable wherever required.

No cable shall be terminated or left with mechanical strain on it in any conduit or trenching. Where cables are run through conduit the entry and exit shall be smooth and free from burrs. The use of conduits shall be kept to a minimum, as far as possible. Cables must be pulled into ducts/conduit in a way that ensures there is no damage to the cable.

All multicables laid in ducts shall be properly dressed and tied with nylon wire of 3 mm diameter. All cables finally entering JB's/cabinets shall run through flexible PVC conduits for approximately 500mm.



VOLUME II
SUB-SECTION 4.22
C&I TESTING AND COMMISSIONING

1.0.0 ERECTION, FIELD TESTING AND COMMISSIONING

- 1.1.0 The Bidder shall select and adopt methods and procedures for equipment erection to suit the nature of equipment and erection, involved according to the best modern industrial practice and his own experience.
- 1.2.0 The Bidder shall arrange for the transportation and handling of cabinets and desks from stores to work site suitably without any damage. If any damage is observed before handling, this shall be brought to the notice of the OWNER
- 1.3.0 Before installation of cabinets and desks, the necessary openings and inserts required to be made on the floor by the Bidder shall be checked and then after proper alignment, the cabinets and desks shall be installed on the floor by the Bidder. All necessary civil work to be carried out for this shall be in Bidder's scope of supply. The cabinets and desks shall be cleaned by blowing air to remove dust or foreign particles.
- 1.4.0 Nameplates shall be installed for all the I&C equipments bearing the service description, instrument number and calibrated range.
- 1.5.0 The data base covering the instrument No. type, application, process parameters, range, set point, calibrated/feasible range & span, maximum admissible value, recommended periodicity of calibration, other information for all the instruments, final control elements etc., for the unit, BOP, etc., shall be given in soft form.
- 1.6.0 All cables shall be tested for insulation level. Cable ends shall be properly cleaned. The entry to and exit from pipes shall be smooth and free from burr where cables are run through pipes. Cable shall be pulled into the pipes in such a way that there shall be no damage to the cables. Flexible conduits shall be provided wherever necessary. Cable in hot areas shall have proper heat protection. A minimum distance of 300 mm shall be kept between instrument / signal cables and power cables. Each tray shall be filled with a maximum of two layers for instrument and control cables and one layer for power cables providing 20% spare space in the number of layers specified. Instrument Cable Trays, shall be erected vertically as far as possible to avoid dust accumulation. All the cables laid shall be tied individually to the Tray. Thermocouple cables shall be run completely independent of all other cables with minimum separation as per relevant standard and with cross over at right angles. The cabling accessories shall include terminal blocks, splicing materials, crimping tools, cable support grips, insulating tapes, GI flexible conduits, conduit fittings, GI perforated covered trays, supports, accessories, and cadmium plated trays & cable glands.
- 1.7.0 The Bidder shall get prior approval as per approved quality assurance plan of the Owner Representative before any installation work starts. If any work is carried out by the Bidder before prior approval from Owner Representative and modification is sought by Owner Representative later, then the work shall be redone by Bidder without any cost / material implications to the Owner Representative. Impulse / sample piping, air supply and pneumatic tubing, cable trays and equipment shall be supported rigid enough to prevent vibration and anchored sufficiently to prevent strains on equipment installed. Supporting clamps shall be provided at least at every one meter distance for better rigidity. Impulse / sampling piping shall be provided with adequate slope, (preferably 1:10). Hanger and supports shall be so installed as not to interfere with free expansion and contraction of the piping and tubing between anchors. Suitable vibration dampeners, etc., shall be provided wherever necessary. In addition, care shall be taken that the arrangement of impulse / sampling piping, air supply and pneumatic tubing from detrimental sagging, mechanical injury, abuse due to unusual



service conditions from sources other than those due to pressure, temperature and vibrations. All impulse lines of joints shall be welded type unless otherwise specified.

- 1.8.0 The Bidder shall set up his own instrument laboratory. The calibration equipment shall cover complete range and shall have the desired accuracy of less than 0.1% or better. The Bidder shall follow the standard procedures for calibration of various instruments and as set by the manufacturer of instruments and as instructed by the Owner including any requirements of field calibration. First, the calibrations shall be carried out independently by the Bidder and later in the presence of Owner who shall certify the same. Proper documentation in this regard shall be maintained and handed over to the Owner
- 1.9.0 All the instruments shall be calibrated for the entire range of the instrument for which it is designed. Calibration shall include test for repeatability. After first commissioning, the instruments shall be tested for calibration again to check whether the instrument maintains its zero and maximum of the range. All instruments and control equipment shall be calibrated to read correctly to the satisfaction of Owner. All switches shall be tested for the actuation of both normally open and normally closed contacts at the desired set points and also for the fixed / differential settings. All the float / displacer operated level switches shall be tested for the movement of the float and linkages to make to break the switch contacts by filling up with water before installation. For such tests, necessary testing set up required shall be arranged by the Bidder. Air leak tests shall be performed on all flue gas impulse / sample lines, air supply and pneumatic lines. Necessary equipment such as portable compressor, connecting pipes, materials, cables and test gauges shall be provided by the Bidder. All the welding shall be carried out as per the relevant codes with electrodes approved by the Engineer-in-Charge. Only qualified welders approved by the Engineer-in-charge shall carry out the welding. IBR grade of welder will be required wherever IBR grade welding is involved. After IBR welding, radiography as per the required standard to be done by qualified welder. All threaded joints shall be jointed using teflon tapes and no other pipe jointing compound shall be used except on higher temperature services where graphited sealing compounds shall be used. Brand of Teflon tape, insulation tape, graphite compound is to be approved by the engineer in charge. Tubing shall be bent with correct size tubing bender whenever possible to avoid the use of fittings. Tubing cutter shall always be used to cut tubing. The use of short length of tubing in long runs shall be avoided. All tubing shall be run in such a manner as to give the maximum protection against mechanical damage. Tubing runs shall be grouped together where possible. Tubing shall be arranged so that couplings can be tightened without disturbing lines. Pipes or tubes installed but not connected, shall have the ends closed in an approved fashion to prevent the entry of foreign material such as caps or plugs. All cables finally entering JBs / cabinets shall run through flexible PVC conduits for approximately 500mm. Field mounted instruments shall be mounted on brackets, subpanels, or placed on a suitable pedestal. They shall be easily accessible from grade, ladder or platform. All local indicators shall be readable from grade or operating level, and if used for manual control, shall be visible from the related valve. Wherever possible, local mounted instruments shall be mounted at approximately 1.35 meters (4' 6") above the platform or floor in an accessible position. When an instrument is located at a distance of 2.5 meters or more from its pressure connection, an additional block valve and a vent valve shall be provided adjacent to the instrument. Vent valves shall be arranged, if necessary, with drain lines to ensure that operation of these valves does not create a hazard. If the pressure piping is of such length that the isolating valve is inaccessible from the instrument location, a suitable valve shall also be fitted at the instrument itself. All pressure instruments shall be installed vertically. Those for steam must be tapped directly from above, for pressure transmitters and switches, there shall also be a condensing leg. The same applies to gas and vacuum measurements, but adequate provision should be made to ensure no condensation can take place along the line, i.e. the slope shall be adequate to drain any condensate back to the main lines (sloping upwards from the sensing point). Tapping points for liquids shall be made at an angle of 45° from the bottom of the main pipe and these are to be sloped downwards from the sensing point. An exception is made in the case of the tapping point for fuel oil or corrosive fluid in which the pressure instrument shall not have direct contact with the process fluid. Glycerine or other suitable liquid shall be used as a medium to separate the fuel oil from the pressure instrument. When the pressure impulse line



is liquid filled, the measuring unit shall be compensated for static head. The head correction shall be stated on the unit.

- 1.10.0 Pipes shall be bent using pipe benders and any hot bending will be totally rejected. Pipe shall be cut, using pipe-cutting devices. Hot cutting will not be allowed.
- 1.11.0 Hydro test shall be performed for all other impulse lines / sampling lines / sensors. Necessary equipment such as hydro test pumps and temporary piping to the required point, fill pump etc., materials such as temporary gaskets, miscellaneous fasteners, etc. tools and tackles including test pressure gauges, etc. are to be provided by the Bidder. For all electrical actuators of the valves, functioning, setting and performance of limit switches / torque switches of various positions shall be checked before and after installation of the actuators. The position transmitters for inching applications shall also be calibrated. Pneumatic actuators shall be calibrated at site. PG test points shall be provided on the process line at various location by the Bidder.
- 1.12.0 Chipping of foundations, alignment, as required for instrumentation installations.
- 1.13.0 Fabrication and erection of stanchions/supports for all local instruments, junction boxes, etc. Fabrication and erection of suitable supports for surface mounted instruments.
- 1.14.0 Fabrication and erection of structural steel plates, angles, pipes, required for supporting ducts, trays, local instruments, etc., complete with bolts and nuts. (GI bolts and nuts shall be used wherever applicable or directed).
- 1.15.0 Painting of all stanchion/structures meant for instrumentation work (ducts, trays, pipe/ angle, supports, etc. as per specification). Colour and codes shall be strictly followed as per guidelines/ specifications as per direction of the Engineer-in-charge.
- 1.16.0 Earthing of the Instrumentation panels on the separate earthing pits (by others).
- 1.17.0 Double compression cable glands, cable lug, ferrules, cable identification tags, trefoil clamps for single core cables, cable dressing materials etc.
- 1.18.0 Cable sealing compound to prevent water entry wherever cables enters from outdoor to indoor areas.
- 1.19.0 Supporting structures for cable trays, cable racks, etc. using mild steel sections like channels, angles, flats, chequered plates etc. shall be in bidder's scope
- 1.20.0 Excavation & refilling of soil for buried cable trench / earthing with necessary materials.
- 1.21.0 GI Cable tray with all accessories and its MS supports.
- 1.22.0 Minor civil works like drilling, chipping and punching holes and openings in concrete floors, slabs, brick walls, fabrication of supporting structures, drainage of water from cable trenches and cleaning of all debris due to instrumentation installation.
- 1.23.0 Primary impulse tubing, laying of all types of cables, glanding and wiring and all kinds of pipe/tube fittings.
- 1.24.0 Fabrication and installation of primary tubing for pressure and differential pressure instruments complete with manifolds as per standards.
- 1.25.0 Erection & supply of the PVC instrument ducts(if required for the internal wiring of GCP cables), and perforated cable trays generally as per drawing including bends, tees, supports and opening wherever required, including provision of covers wherever required. No jumping of cables will be allowed.



- 1.26.0 Laying of multi-core / pair cables for all applications on perforated trays with proper tagging, dressing clamping, glanding and terminations (including proper termination of shields) at both the ends.
- 1.27.0 Laying of multi/single pair cables in trenches wherever required.
- 1.28.0 Interconnection wiring/tubing of various field mounted instruments, viz., transmitters, transducers, positioners etc.
- 1.29.0 Identification of each cable by proper tags at every 10 meters on the main tray as per cable schedule.
- 1.30.0 Fabrication of nipples from pipes and threading of the same wherever required.
- 1.31.0 Tapping/threading of coupling wherever required for special instruments.
- 1.32.0 Welding electrodes required for the complete of the job shall be in bidder's scope..
- 1.33.0 Completion/updating of Owner's drawings/documents as per the work done at site. This should be done before applying for completion certificate.
- 1.34.0 Pre-commissioning service and commissioning assistance during start-up of plant, wherever required.
- 1.35.0 Provision of copper wire, GI wires to panel earth bus, laying and grounding of the same to the system earth pits.
- 1.36.0 Fabrication and erection of canopy (single) for instruments, wherever required.
- 1.37.0 Minor modifications/repairs required to be done on the existing instruments namely, replacement of damaged signal tubes, tapping of damaged threads on couplings, tees and other fittings.
- 1.38.0 Identification of each cable by proper tag plate/ferrules at instrument ends, inside junction boxes and inside control room outside JB's by tagging the cables with SS tags as per the cable schedule.
- 1.39.0 Drilling holes on all Panels etc. for cables/ glands/ grommets, if required, after obtaining approval from the owner. Unused holes to be plugged after completion of job.
- 1.40.0 Grounding of shield for all shielded cables to respective instrument earth bus provided in the thermocouple head/junction boxes.
- 1.41.0 Sealing of switches with standard lead seals after final setting in the presence of Engineer-in-charge.
- 1.42.0 Painting of welded joints etc. as per the engineer in charge's instruction.
- 1.43.0 Excavating roads, laying cable road crossing sleeves and refilling and finishing wherever required.



2.0.0 LOOP TESTING

- 2.1.0 The action of the controller is set as prescribed. Controller settings for various modes of operation (Proportional band, reset and rate action) are at nominal value. For current signals, 4 – 20 mA shall be injected and checked the loop for 0%, 25%, 50%, 75% and 100% of full-scale inputs. For temperature loops with thermocouples, a known milli volt signal shall be injected and the output display shall be checked for input signals of 0%, 25%, 50%, 75% and 100%. For temperature loops with RTDs, a known resistance shall be injected in the control cable through decade resistance box and Output display shall be checked for 0%, 25%, 50%, 75% and 100%. For field mounted switches for alarms / interlocks, the action shall be simulated by disconnecting the wires / shorting the terminals and the function of the associated system shall be checked. Any equipment required by the Bidder for testing, calibration and commissioning shall be brought by the Bidder at site. The list of such equipment shall be furnished along with the offer
- 2.2.0 Prior to taking the instruments in service, all impulse lines, sampling lines and air supply lines shall be blown as required with the establishment of adequate line pressure and temperature conditions to keep the lines thoroughly clean. On-line i.e., without removing control valves from the pipe, calibration of the positioners and stroking of control valves / control dampers shall be carried out as required during control system tuning. Pre-commissioning checks, individuals loop checks, power initialisation, verification of system functioning, trouble shooting final solutions to application and / or instrument problems, etc., is Bidder's responsibility. All the required software and hardware changes shall be incorporated as required for successful commissioning to Owner satisfaction. Any other tests as may be directed by the Owner Representative. After delivery of the equipment, the Bidder shall locate all the equipment including electronic cards in its final position, check all the power wiring, grounding and interconnection cables, all in accordance with manufacturer's recommendations. The Bidder shall perform initialisation of system power, field loading of system configuration / software and data base, demonstration of system functionality to verify conformance with manufacturer's instructions and specifications, tuning of control loops, implementation of any configuration changes including hardware, software and additional tapping's / instruments, cabinets as required and providing general trouble shooting and final solutions to application and / or instrument problems.
- 2.3.0 The Bidder shall take care to complete all pre-commissioning activities and simulation tests after erection to suit the over all start up of respective plant equipment. The controllers shall be tuned as per the process requirement. The list of set points, alarms / Interlocks, settings for the controllers shall be furnished in the standard format and handed over to the Owner.. Control loops shall be put in auto mode as per the operational requirement of different phases. Processor, Bus Worst loading conditions calculation and other control system performance requirements shall be proved at the time of commissioning. Before taking over of the plant by the OWNER , all the system and auto control loops shall run satisfactorily for at least one month at varying loads without disturbing any adjustment. During this period, supervision and maintenance of the system shall be the scope and responsibility of the Bidder. The performance test shall be carried out for the system offered and certificates to these effects shall be approved by the OWNER .

3.0.0 INSPECTION, TESTING, GUARANTEE & SPECIAL TOOLS / TACKLES

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



before proceeding with the test. Bidder shall submit a detailed quality assurance program for individual I & C equipments / instruments for Owners for approval.

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

3.2.1 Factory Acceptance Test (FAT):

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

FAT shall be preceded by a 'Pre- FAT Inspection/ Test' to be carried out by Bidder/Vendor. Pre-FAT inspection / test shall be carried out as per approved FAT procedure detailed above and shall submit 'Pre- FAT Inspection/ Test' report for Owners review and approval. Owner shall witness the actual FAT on the basis of successful completion of 'Pre- FAT Inspection/ Test'.

3.2.2 Site Test (SAT):

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

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

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

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

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



INSTRUMENTATION & CONTROL CABLES

1.0.0 GENERAL

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

Signal cable	:	600V, 0.5 Sq.mm for single pair, screened 600V, 0.5 Sq mm for multipair, individual pair and overall shielded.
Control Cable	:	1100V Screened with overall screen 1100V 1.0 Sq mm for 2 Cores 1100V 1.0 Sq mm for multi core
Power cable	:	2.5 Sq.mm for 2/3 Cores

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

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

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

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

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

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

All panel wiring shall have sufficient spares for future expandability.

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

2.0.0 INSTRUMENTATION CABLES

Instrumentation cables shall be 600VAC grade, stranded high conductivity annealed, tinned copper, twisted pair (with min. 20 twists for meter) extruded PVC insulated with overall and / or individual screening, extruded PVC inner sheathed, galvanized steel wire armoured, only extruded outer sheathed with FRLS PVC compound. The conductor size shall be 0.5 sq.mm. Pair cables can be used for RTDs. Instrumentation cables carrying digital signals shall have



overall screening along with drain wire and analogue signal carrying cables shall have each pair screening and overall screening along with each pair drain wire and overall drain wire. Colour coding for the identification of pairs shall be as per BS-5308 Part-2.

3.0.0 CONTROL CABLES

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

4.0.0 FIBRE OPTIC CABLES

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

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

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

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

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

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

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

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



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

5.0.0 Design requirements

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

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

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

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

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

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

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

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

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

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

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

6.0.0 Construction

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

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



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

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

7.0.0 Packing and Marking

Packing

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

Cable Reeling Drums

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

The wood used for the construction of the drums shall be of durable quality, properly seasoned and treated with Copper Nephthenates or Zinc Nephthenates for preserving the wood (Refer IS 401). Wood preservatives anti-termite treatment shall be applied to the entire drum. Wooden drums shall comply with IS 10418. All ferrous parts shall be treated with suitable rust preventive coating to avoid rusting during transit and storage.

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

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

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

Marking

Marking on outer sheath:

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

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

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



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

NOTES :-

1. IMPULSE PIPES SHALL BE OF SEAMLESS AND ANNEALED CONFORMING TO ANSI B36.10 IN LINE WITH THE MAIN PIPE MATERIAL.
2. PIPE FITTINGS SHALL BE OF FORGED MATERIAL CONFORMING TO ANSI B16.11-1991.
3. SNUBBER SHALL BE PROVIDED FOR PUMP DISCHARGE PRESS MEASUREMENTS.
4. IN CASE OF STEAM SERVICE SYPHON SHALL BE MADE BY BENDING THE TUBE OR PIPE.
5. VALVE MANIFOLDS & SNUBBER SHALL BE OF FORGED SS-316.
6. FOR SEA WATER APPLICATION SS316L FITTINGS TO BE PROVIDED.
7. 25NB x 15NB WELDED REDUCER SHALL BE USED FOR ROOT VALVE OF 25NB SIZE.
8. ROOT VALVES SHALL BE AS FOLLOWS:
 - i) FOR PRESS <40 ATA & TEMP <425 DEG C, ONE(1) NO. 15NB, ROOT VALVE OF SUITABLE CLASS SHALL BE USED.
 - ii) FOR PRESS >40 ATA & TEMP <425 DEG C, TWO(2) NO. 15NB, ROOT VALVE OF SUITABLE CLASS SHALL BE USED.
 - iii) FOR PRESS >40 ATA & TEMP >425 DEG C, TWO(2) NO. 25NB, ROOT VALVES OF SUITABLE CLASS SHALL BE USED.
9. HORIZONTAL PIPE RUNS SHOULD HAVE A SLOPE IN THE DIRECTION  SHOWN OF 1:20 AS MINIMUM.
10. FOR PRESSURISED STEAM & WATER SERVICE THE ASSOCIATED INSTRUMENT SHOULD BE MOUNTED BELOW THE TAPPING POINT. FOR VACUUM/AIR/GAS SERVICE, THE ASSOCIATED INSTRUMENT SHOULD BE MOUNTED ABOVE THE TAPPING POINT.
11. SEAMLESS PIPE/SEAMLESS TUBE/CAPILLARY LENGTH SHALL BE SUCH THAT THE GAUGES/TRANSMITTERS/SWITCHES ARE MOUNTED IN ACCESSIBLE AREA.

LEGEND :-

A/R - AS REQUIRED

NPTF - NATIONAL PIPE THREAD FEMALE

NPTM - NATIONAL PIPE THREAD MALE

SW - SOCKET WELD

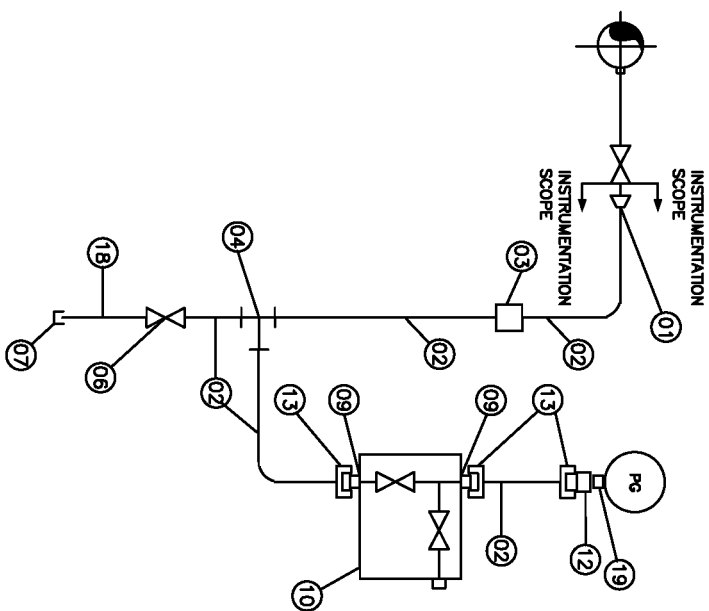
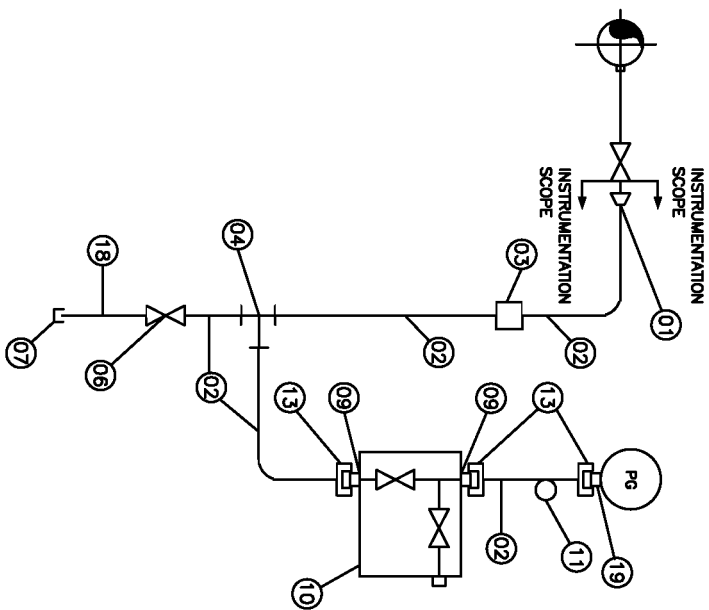
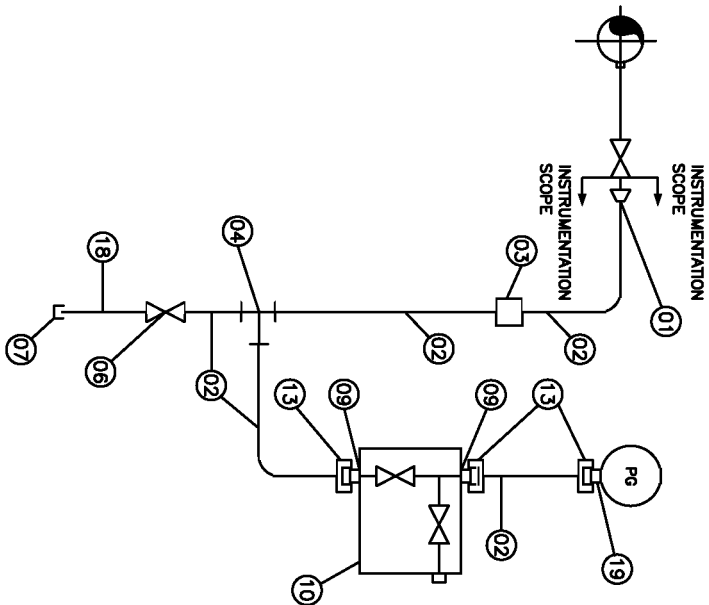


TITLE :-

INSTRUMENT INSTALLATION DIAGRAM

NOTES

DRG. NO.	PE-DG-899-145-1XXX		
REV. NO.	00	DATE	05.11.13
SHT	2	OF	9

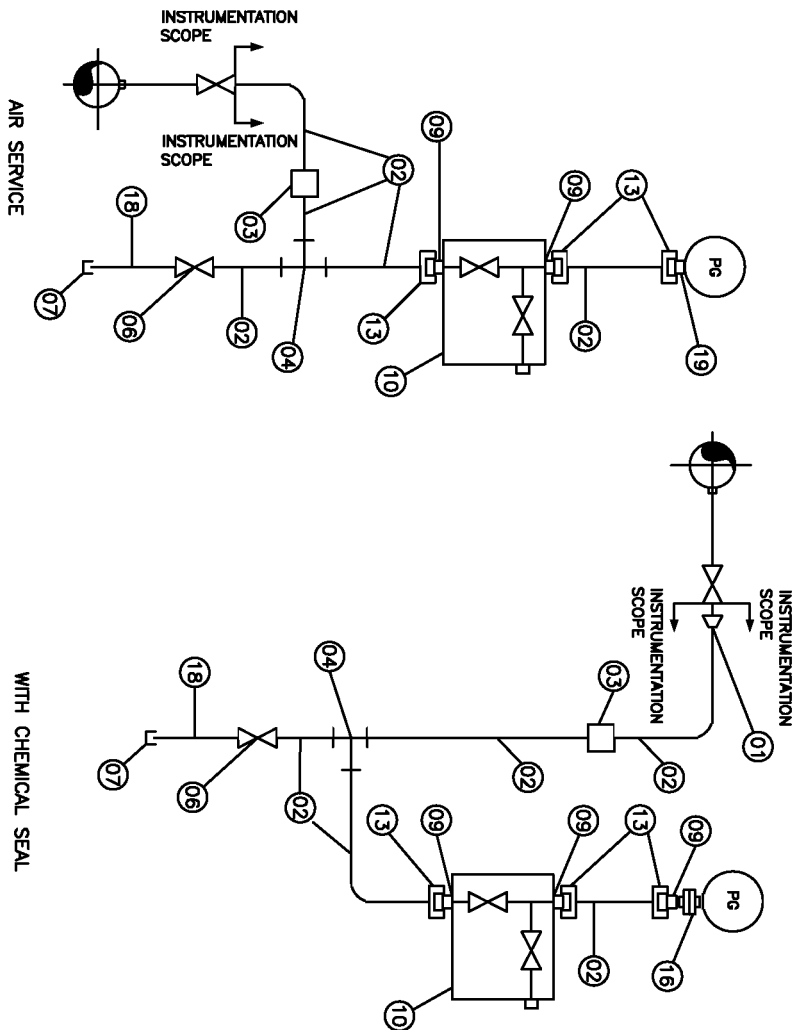


TITLE :-

INSTRUMENT INSTALLATION DIAGRAM

PRESSURE GAUGES

DRG. NO.	PE-DG-899-145-IXXX		
REV. NO.	00	DATE	05.11.13
SHT	3	OF	9

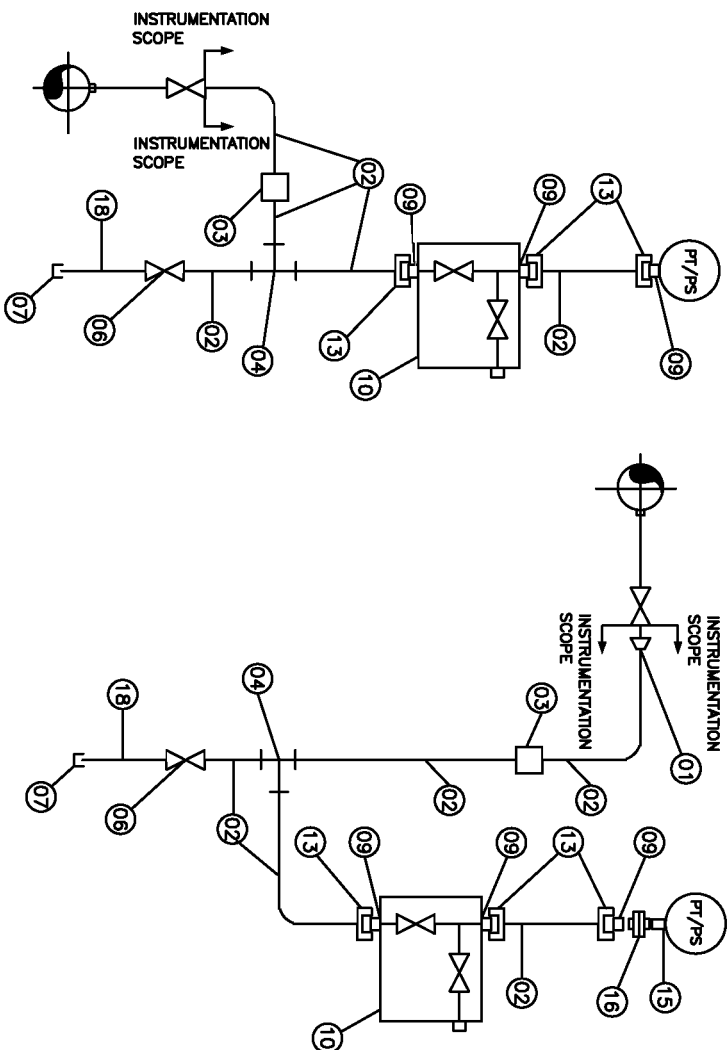


ITEM NO	ITEM/DESCRIPTION	MATERIAL	SIZE	QTY			
				WATER	STEAM	PULSA TING	AIR CHEM ICAL
01	REDUCER (IF APPLICABLE)	SAME AS MAIN PIPE	1" X 1/2"SW	01	01	01	00 01
02	SEAMLESS PIPE	SAME AS MAIN PIPE	1/2"	A/R	A/R	A/R	A/R A/R
03	FORGED COUPLING	SAME AS MAIN PIPE	1/2" SW	A/R	A/R	A/R	A/R A/R
04	FORGED TEE	SAME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



TITLE :-
INSTRUMENT INSTALLATION DIAGRAM
PRESSURE GAUGES

DRG. NO.	PE-DG-999-145-XXXX		
REV. NO.	00	DATE	05.11.13
SHT	4	OF	9



AIR SERVICE

WITH CHEMICAL SEAL

(FOR VISCOUS NON-CORROSIVE FLUID ONLY)

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

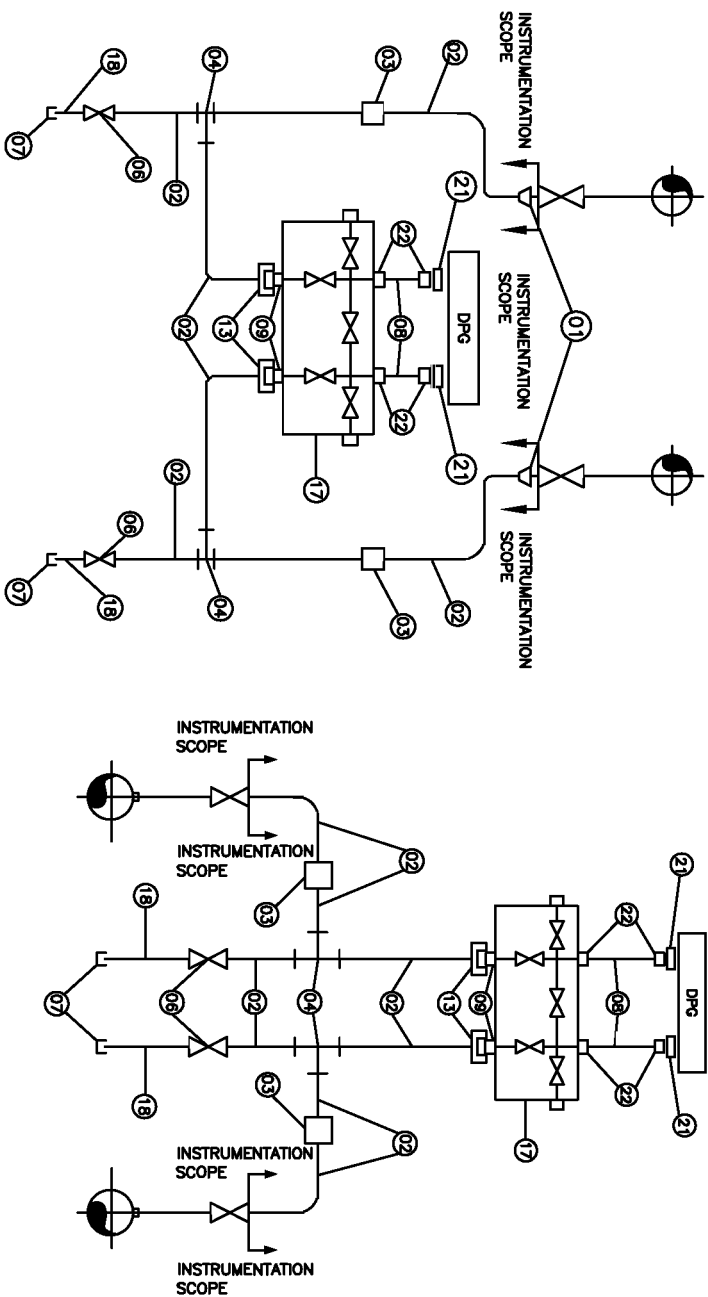


TITLE :-

INSTRUMENT INSTALLATION DIAGRAM

PRESSURE SWITCHES/TRANSMITTERS

DRG. NO.	PE-DG-899-145-IXXX		
REV. NO.	00	DATE	05.11.13
SHT	6	OF	9



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

WATER SERVICE

AIR SERVICE

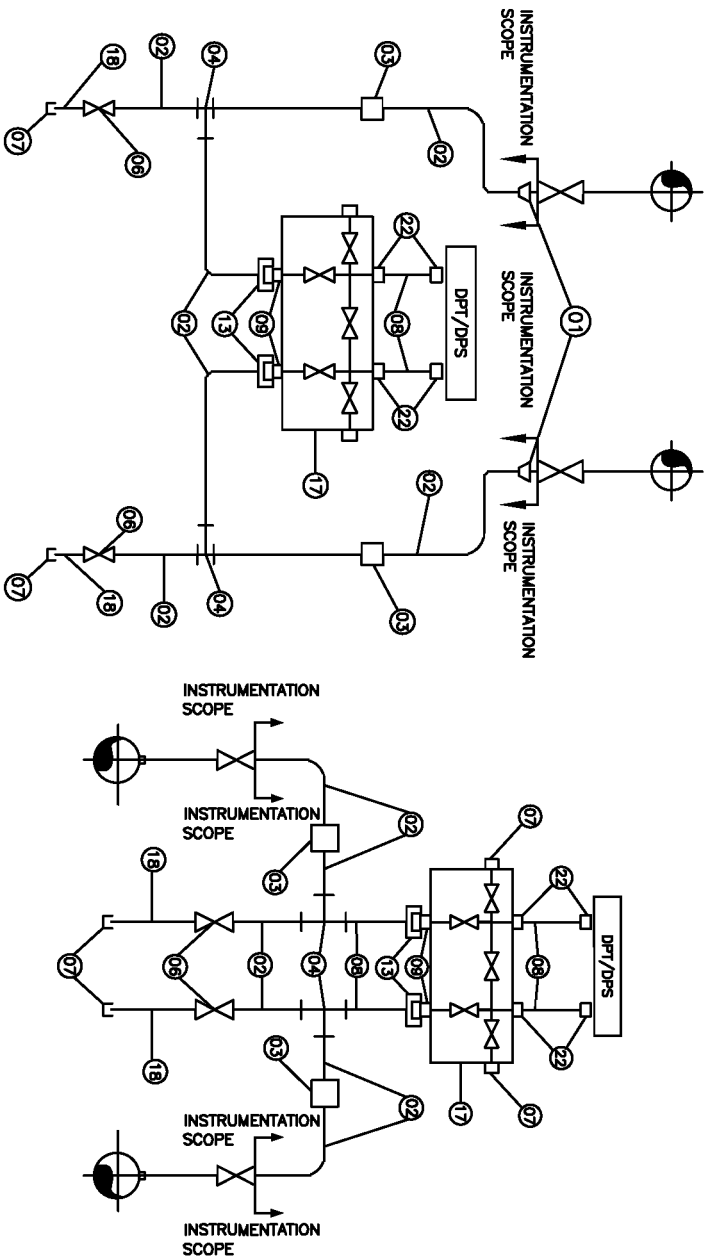
TITLE :-

INSTRUMENT INSTALLATION DIAGRAM

DIFFERENTIAL PRESSURE GAUGES



DRG. NO.	PE-DG-999-145-10XX		
REV. NO.	00	DATE	05.11.13
SHT	7	OF	9



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

TITLE :-

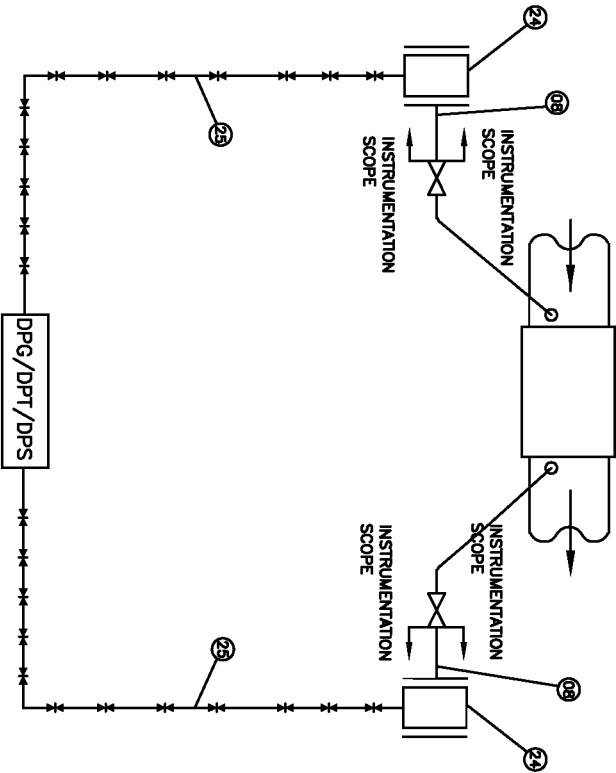
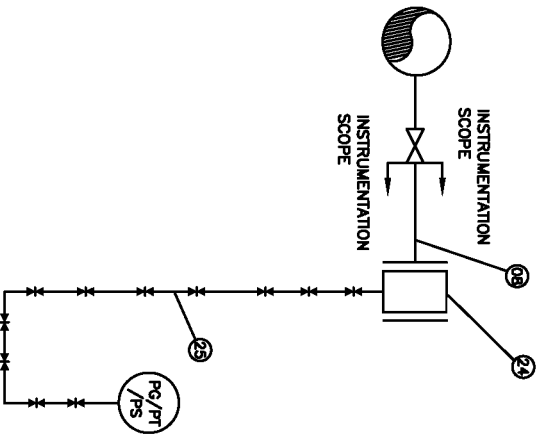
INSTRUMENT INSTALLATION DIAGRAM

DIFFERENTIAL PRESSURE SWITCHES/TRANSMITTERS



DRG. NO.	PE-DG-899-145-IXXX		
REV. NO.	00	DATE	05.11.13
SHT	8	OF	9

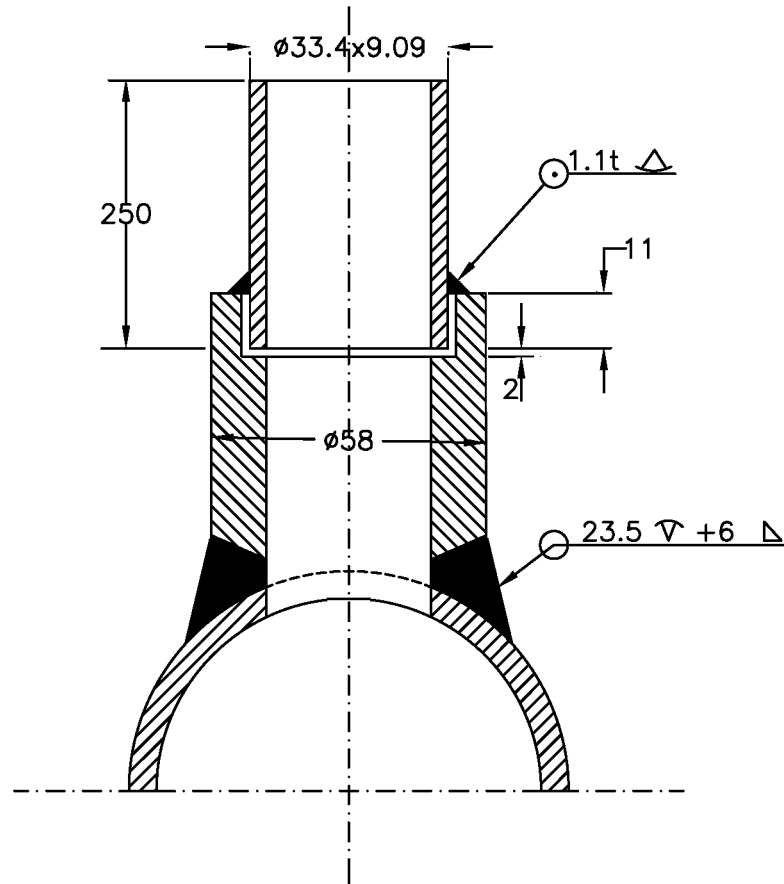
ITEM NO	ITEM/DESCRIPTION	MATERIAL	SIZE	QTY	
				Pg./Ps./Pt	Dpg./Dps./Dpt
24	FLANGE SUPPLIED WITH Pg/PS PT/Dpg/Dps/DPT TO SUIT 1/2" OR 1" NB PIPE	SAME AS MAIN PIPE	1/2" SW	01	02
08	SEAMLESS PIPE	SAME AS MAIN PIPE	1/2"	A/R	A/R
25	SS ARMORED CAPILLARY TUBE (MINIMUM 5M IN LENGTH)	SS316	-	A/R	A/R



TITLE :-
INSTRUMENT INSTALLATION DIAGRAM
 WITH CAPILLARY TUBES

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

INSTRUMENT INSTALLATION DRAWING



NOTE :

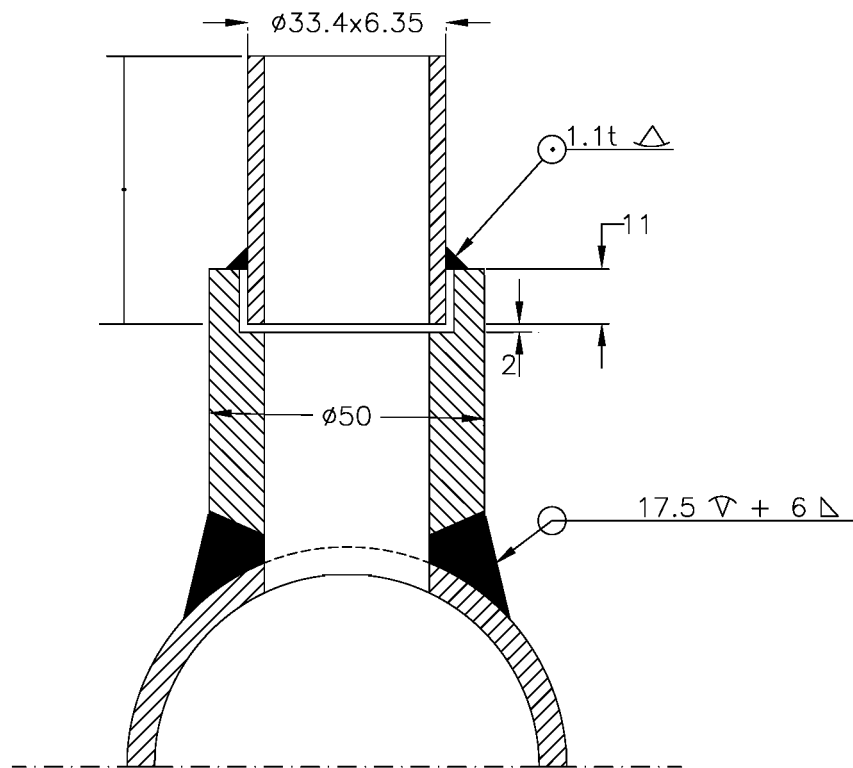
1. MATERIAL OF THE BOSS AND NIPPLE SHALL BE THE SAME AS THE PIPE INTO WHICH IT IS WELDED AND CONFORM TO ANSI B16.11.
2. THE LENGTH OF NIPPLE SHOULD BE 250 MM.
3. STUB LENGTH SHALL BE 64mm UPTO 200Nb PIPE, 45mm ABOVE 200Nb PIPE SIZE.
4. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE INDICATED
5. EDGE HOLE MUST BE CLEAN AND SQUARE OR ROUNDED SLIGHTLY ($1/64$ " RADIUS) FREE FROM BURRS, WIRE EDGES OR OTHER IRREGULARITIES



TITLE :
INSTRUMENT STUB DETAILS
FOR PRESSURE MEASUREMENT

(TEMP > 500 DegC AND CLASS 9000 #)

DRG. NO.
PE-DG-435-145-I101
REV. 00
SH. 02 OF 10



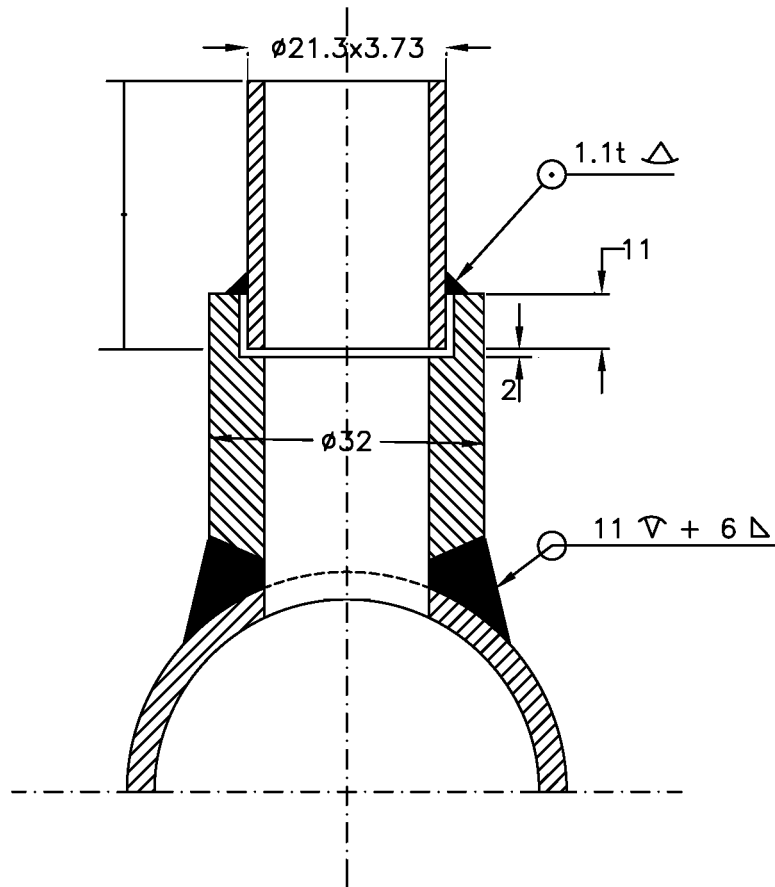
NOTE :

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. STUB LENGTH SHALL BE 64mm UPTO 200Nb PIPE, 45mm ABOVE 200Nb PIPE SIZE.
4. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE INDICATED
5. EDGE HOLE MUST BE CLEAN AND SQUARE OR ROUNDED SLIGHTLY (1/64" RADIUS) FREE FROM BURRS, WIRE EDGES OR OTHER IRREGULARITIES



TITLE :
INSTRUMENT STUB DETAILS
 FOR PRESSURE MEASUREMENT
 (TEMP < 500 DegC, CLASS 6000#)

DRG. NO.
PE-DG-435-145-I101
 REV. 00
 SH. 3 OF 10



NOTE :

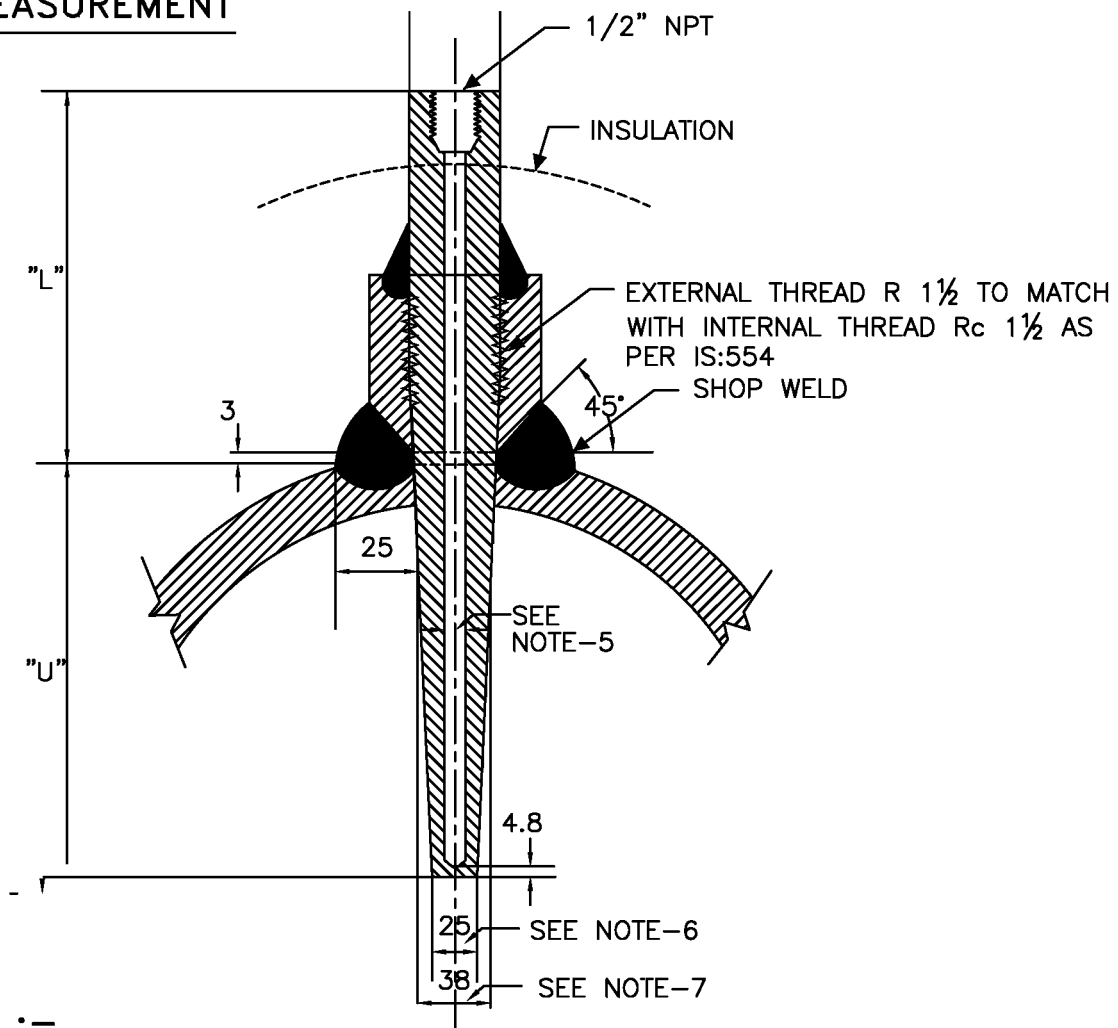
1. MATERIAL OF THE BOSS AND NIPPLE SHALL BE THE SAME AS THE PIPE INTO WHICH IT IS WELDED AND CONFORM TO ANSI B16.11.
2. THE LENGTH OF NIPPLE SHALL BE 250 MM.
3. STUB LENGTH SHALL BE 64mm UPTO 200Nb PIPE, 45mm ABOVE 200Nb PIPE SIZE.
4. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE INDICATED
5. EDGE HOLE MUST BE CLEAN AND SQUARE OR ROUNDED SLIGHTLY (1/64" RADIUS) FREE FROM BURRS, WIRE EDGES OR OTHER IRREGULARITIES
6. FOR PU COATED PIPE REFER SHT NO-9.



TITLE :
INSTRUMENT STUB DETAILS
FOR PRESSURE MEASUREMENT
 (SYSTEM PRESS UPTO 40Kg/Cm², TEMP<400 DegC)

DRG. NO.
PE-DG-435-145-I101
 REV. 00
 SH. 4 OF 10

TEMP. MEASUREMENT



NOTES :-

1. THIS TYPE OF TEMPERATURE BOSS SHALL BE USED FOR THE PROCESS PRESS EQUAL/ ABOVE 40 KG/CM²(g) AND FOR PROCESS TEMP EQUAL/ABOVE 400 DegC EVEN IF THE PROCESS PRESSURE IS LESS THAN 40 Kg/Cm²(g)
2. THE MATERIAL OF THE BOSS SHALL BE SIMILAR TO PIPING MATERIAL.
3. MATERIAL OF THE THERMOWELL SHALL BE OF 316SS.
4. THERMOWELL SHALL BE DRILLED BAR STOCK TYPE.
5. INTERNAL BORE OF THE THERMOWELL SHOULD BE SELECTED BASED ON THE NORMAL SIZE OF THE SENSING ELEMENT AS PER ASME PTC-19.3.
6. THE BOTTOM DIAMETER OF THE THERMOWELL TYPICALLY SHOWN HERE SHALL BE SUBJECT TO VARIATION BASED ON THE INTERNAL BORE OF THERMOWELL AND THICKNESS OF THERMOWELL MATERIAL TO WITHSTAND THE PROCESS PRESS AND TEMP AS PER ASME PTC-19.3.
7. THERMOWELL SHALL BE SUITABLE TO MATCH THE STUB DIMENSIONS AS PER Rc 1 1/2.
8. ORIENTATION OF STUB ON VERTICAL/ HORIZONTAL PIPES SHALL BE 90° TO THE CENTRE LINE OF THE PIPES, FOR PIPE SIZE LARGER THAN 4". HEIGHT OF STUB SHALL BE 64mm FOR PIPE OD < 200Nb AND 45mm FOR PIPE OD ≥ 200Nb.
9. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE INDICATED



TITLE :

INSTRUMENT STUB DETAILS

(APPLICABLE FOR PIPE SIZE ABOVE 4")

[(i) PROCESS PRESS EQUAL/> 40 Kg/Cm² (g) &
(ii) PROCESS PRESS < 40 Kg/Cm² (g), TEMP EQUAL/>400 DegC]

DRG. NO.

PE-DG-435-145-I101

REV. 00

SH. 5

OF 10



DOCUMENT TITLE

KKS NUMBERING 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**.

	DOCUMENT TITLE
	KKS NUMBERING PHILOSOPHY
4X270MW TPP BHADRADRI TPP, TELANGANA	

ANNEXURE-1

List of System / Sub-System Codes used in Power Plant:

- 1) Mill Reject Handling System: EUA

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

	DOCUMENT TITLE KKS NUMBERING PHILOSOPHY	
	4X270MW TPP BHADRADRI TPP, TELANGANA	

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*

		<u>N1</u>	<u>N2 N3</u>
Motorised (<i>on/off duty</i>)	-	0	01 to 50
Motorised (<i>inching duty</i>)	-	0	51 to 99
Pneumatic (Control)	-	1	01 to 50
Motorised (<i>thyrestor Control</i>)	-	1	51 to 99
Sol. Operated	-	2	01 to 99
(Open / Close duty (Valves, NRVs, Gate)			
Hydraulic	-	3	01 to 99

	DOCUMENT TITLE			
	KKS NUMBERING PHILOSOPHY			
	4X270MW TPP BHADRADRI TPP, TELANGANA			
	NRV (Without actuation) Manual Manual Relief & Safety Valves Reserve Reserve	- - - - - -	4 5 6 7 8 9	01 to 99 01 to 99 01 to 99 01 to 99 01 to 99 01 to 99
ii) Field Instruments	Field Transmitters & Analog Signals Field Switches & Binary Signals PG Test Point Gauges Automatic Turbine Tester (ATT)-HWR (Reserved for protection Signals used by Hardwar)	- - - - - -	0 1 4 5 2	01 to 99 00 to 99 00 to 99 00 to 99 00 to 99 00 to 99
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.				



TITLE :
2X660 MW UDANGUDI STPP

SPECIFICATION NO. PE-TS-435-168-
A001

SECTION : III

TECHNICAL SPECIFICATION FOR HYDROGEN
GENERATION PLANT

SUB-SECTION:

REV. NO. 00

SECTION – III



TITLE : 2X660 MW UDANGUDI STPP	SPECIFICATION NO. PE-TS-435-168-A001	
	SECTION : III	
	SUB-SECTION:	
	REV. NO. 00	

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



TITLE : 2X660 MW UDANGUDI STPP	SPECIFICATION NO. PE-TS-435-168-A001	
	SECTION : III	
	TECHNICAL SPECIFICATION FOR HYDROGEN GENERATION PLANT	
	SUB-SECTION:	
	REV. NO. 00	

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.



TITLE :
2X660 MW UDANGUDI STPP

SPECIFICATION NO. PE-TS-435-168-A001

SECTION : III

**TECHNICAL SPECIFICATION FOR HYDROGEN
GENERATION PLANT**

SUB-SECTION:

REV. NO. 00

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:- 2X660 MW UDANGUDI STPP

HYDROGEN GENERATION PLANT

TENDER ENQUIRY REFERENCE:-

NAME OF VENDOR:-

SL NO	VOLUME/ 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 separately for each deviation. In no event bidder should club cost of withdrawal of more than one deviation else cost of withdrawal of such deviations which have been clubbed together shall be considered as NIL.
13. In case nature of cost of withdrawal (positive/negative) is not specified it shall be assumed as positive.
14. In case of discrepancy in the nature of impact (positive/ negative), positive will be considered for evaluation and negative for ordering.