

Tamil Nadu Generation and Distribution Corporation Ltd.

**North Chennai TPP - Stage-III - 1x800 MW
Supercritical Thermal Power Station Project**

TECHNICAL SPECIFICATION


FOR

GYPSUM DEWATERING EQUIPMENT

SPECIFICATION NO.: PE-TS-485-571-A901, Rev 00



**BHARAT HEAVY ELECTRICALS LIMITED
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT
PROJECT ENGINEERING INSTITUTE BUILDING
SECTOR-16A, PLOT NO. 25, NOIDA, UTTAR PRADESH, INDIA**

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	GYPSUM DEWATERING EQUIPMENT TECHNICAL SPECIFICATION	SECTION	
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**GYPSUM DEWATERING EQUIPMENT
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SECTION - I

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SECTION-I


SUB-SECTION-A

INTENT OF SPECIFICATION

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INTENT OF SPECIFICATION			


1.0 INTENT OF SPECIFICATION

- 1.1 This specification covers Supply part, Services part and Mandatory Spares; comprising of design (i.e. Preparation and submission of drawing /documents including “As Built” drawings and O&M manuals), engineering, manufacture, fabrication, assembly, inspection / testing at vendor’s & sub-vendor’s works, painting, maintenance tools & tackles, first fill and top-up of lubricants & consumables, mandatory spares along with spares for erection, start-up and commissioning, forwarding, proper packing, shipment and delivery at site, assembly AND Services part covers supervision services for erection & commissioning, trial run at site and carrying out Performance Guarantee tests at site, training of customer’s personnel at manufacturer’s works covering design familiarization, training on product design features etc. (6 man-days including lodging and boarding), training of customer’s O&M staff covering all aspects of the GDS-Operation & Maintenance, Troubleshooting etc. (6 days) at Site & handover of the package in flawless condition to the customer complete with all accessories for the total scope defined as per BHEL NIT & tender technical specification, amendment & agreements till placement of order of **Gypsum Dewatering Equipment**, a sub-assembly of the Flue Gas Desulphurization (FGD) package of **North Chennai TPP Stage-III - 1x800 MW of M/s TANGEDCO**.
- 1.2 Two (02) Sets of Gypsum Dewatering Equipment (1 working + 1 standby) shall be provided.
- 1.3 The contractor shall be responsible for providing all material, equipment & services, which are required to fulfil the intent of ensuring operability, maintainability, reliability and comprehensive 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/ demonstration testing of the **GYPSUM DEWATERING EQUIPMENT**.
- 1.4 The Bidder shall offer only proven design, which meets the Provenness criteria indicated in the NIT. Necessary documentary evidences shall be submitted along with the bid. If bidder doesn’t meet the specified provenness criteria, their bid may not be considered for further evaluation.
- 1.5 It is not the intent to specify herein all the details of design and manufacture. However, the equipment shall conform in all respects to the highest standards of design, engineering and workmanship and shall be capable of performing the required duties in a manner acceptable to the 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.
- 1.6 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 items required for completion of the equipment for its safe, efficient, reliable and trouble free operation and maintenance shall also be in supplier’s scope unless specifically

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excluded and notwithstanding that they may have been omitted in drawings / specifications or schedules.

- 1.7 The general term and conditions, instructions to tenderers and other attachment(s) referred to elsewhere are made part of the tender specification. The equipment materials and works covered by this specification is subject to the compliance to all attachments referred to in the specification. The bidder shall be responsible for and governed by all requirements stipulated herein.
- 1.8 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 **within 10 days of receipt of tender documents**. In absence of any such clarification(s), in case of any contradictory requirement, the more stringent requirement as per the 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.
- 1.9 The bidder's offer shall not carry any section like clarification, interpretations and /or assumptions.
- 1.10 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/it's customer.
- 1.11 In the event of any conflict between the requirements of two clauses of this specification & requirements of different codes/ standards and between respective clauses of sub-section C & sub-section D, more stringent clause as per the interpretation of the owner /purchaser shall apply.
- 1.12 In case, all the above requirements are not complied with, the offer may be considered as incomplete and would become liable for rejection.
- 1.13 For definition of words like Contractor, bidder, supplier, vendor, Customer/ Purchaser / Employer, consultant, please refer relevant clause of General Conditions of Contract (GCC).

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SECTION: I
SUB-SECTION: B
PROJECT INFORMATION



ANNEX - 1.1
PROJECT INFORMATION

1.0	General		
1.1	Project Title	:	1 x 800 MW North Chennai Coal Based Super Critical Thermal Power Project Stage III.
1.2	Plant capacity	:	800 MW
1.3	Type of project	:	Brown field
1.4	Owner	:	Tamil Nadu Generation and Distribution Corporation Limited (TANGEDCO)
1.5	Plant site location	:	In the premises of North Chennai Thermal Power Station (NCTPS)
1.6	Location co-ordinates	:	80° 19' E to 80° 20' E Longitude 13° 13' N to 13° 18' N Latitude
1.7	Nearest Village	:	Ennore & Puzhuthivakkam Village
1.8	Nearest Town & City	:	Chennai (35 Km)
1.9	State Capital	:	Chennai (35 Km)
1.1	Nearest Railway Station	:	Athipattu Pudunagar (~ 5 Km) on Chennai – Vijayawada Line
1.11	Nearest Airport	:	Chennai (~ 60 Km)
1.12	Nearest Seaport	:	Ennore (~ 3 Km)
1.13	Nearest Road access	:	All weather road from Pattamandri on the Thiruvottiyur – Ponneri highway
2.0	Meteorological Condition		
2.1	Climate	:	Tropical, very dry and hot summer, dry and cold winter and good rain-fall in monsoon accompanied with strong wind
2.2	Site Elevation	:	(+) 10.0 Meter above Mean Sea Level
2.3	Ambient Temperature		
a.	Annual Maximum Mean Temperature	:	45 °C
b.	Annual Minimum Mean Temperature	:	15 °C
c.	Design ambient temperature	:	30 °C
2.4	Relative Humidity		
a.	Maximum	:	90%
b.	Minimum	:	36%
c.	Design	:	75%
2.5	Annual Rainfall		



	Maximum	:	2540 mm
	Average	:	1600 mm
	Minimum	:	1175 mm
2.6	Basic Design Wind Pressure	:	As per IS: 875 (Latest Edition)
2.7	Wind Speed	:	11.8 kmph (Avg), 50 m/s (max)
2.7	Seismic zone	:	Zone: III as defined in IS:1893-2002
2.8	Design ambient temperature for Electrical equipment	:	50 °C



ANNEX- 1.3

SERVICE WATER ANALYSIS

The Service water (make-up water) water quality is mentioned below:

Sr. No.	Parameter	Unit	Result
1	Temperature	°C	35
2	pH	-	7.5 – 8.2
3	LSI		0 -0.2
4	Alkalinity (mg/l)		< 100
5	Hardness		< 80 PPM
6	Chloride as CaCO ₃ (mg/l)		< 350
7	Sodium		< 170 PPM
8	Suspended Solids		<10
9	COD		NIL



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TECHNICAL SPECIFICATION

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TECHNICAL SPECIFICATION

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SPECIFIC TECHNICAL REQUIREMENT

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1.1	FUNCTION
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The purpose of the specification is to provide details of the complete Gypsum Dewatering Equipment (GDWE) for **North Chennai TPP Stage-III - 1x800 MW**, under the scope of this tender.

1.2	TECHNICAL INFORMATION	
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1.2.1	Quantity of Gypsum De-Watering Equipment (GDWE)	Two (2) Sets (One working + One standby) common for Stage-III - 1x800 MW
1.2.2	Capacity of the Vacuum Belt Filter (VBF) in GDWE	17.15 Tones per hour (wet cake) minimum at the outlet of Vacuum Belt Filter for each Belt Filter
1.2.3	Moisture content	10% (max)
1.2.4	Chloride content	100 ppm (max)
1.2.5	Gypsum purity	≥ 90% [by BHEL]


2.1	SCOPE OF SUPPLY & SERVICES
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The specification covers Supply part, Services part and Mandatory spares comprising of design (i.e. Preparation and submission of drawing /documents including "As Built" drawings and O&M manuals), engineering, manufacture, fabrication, assembly, inspection / testing at vendor's & sub-vendor's works, painting, maintenance tools & tackles, first fill and top-up of lubricants & consumables, mandatory spares along with spares for erection, start-up and commissioning, forwarding, proper packing, shipment and delivery at site AND services part covers supervision services for erection & commissioning, trial run at site and carrying out Performance guarantee tests at site, training of Customer's Engineering Personnel at manufacturer's works covering design familiarization, training on product design features etc. (6 man-days including lodging and boarding) , training of Customer's O&M staff covering all aspects of Operation & Maintenance, Troubleshooting etc. (6 days) at Site & handover in flawless condition of the package to the customer complete with all accessories.

Design: Broadly includes basic engineering, detail engineering, preparation and submission of engineering drawings/ calculations/ datasheets/ quality assurance documents/ field quality plans, storage instructions, commissioning procedures, Erection & assembly Drawings, operation & maintenance manuals, performance guarantee test procedures and assisting BHEL in obtaining time bound approval from customer.

Supply: Broadly includes manufacturing/fabrication, shop floor testing, stage inspections, final inspections, painting, packing & forwarding.

Services: Broadly includes supervision services for erection & commissioning, trial run at site and carrying out Performance Guarantee tests at site, training of Customer's Engineering Personnel at manufacturer's works covering design familiarization, training on product design features etc. (6 man-days including lodging and boarding), training of Customer's O&M staff covering all aspects of Operation & Maintenance, Troubleshooting etc. (6 days) at Site & handover in flawless condition of the package to the customer.

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2.1.1 The scope of supply for Gypsum Dewatering Equipment shall include but not limited to the following: *(Wherever (*) is marked, one (1) set means complete requirement for both the Gypsum Dewatering Equipment)*

2.1.1.1 Primary Hydro Cyclone: Two (2) sets

- i. Hydrocyclone clusters
- ii. Anchor bolts, nuts and washers
- iii. Flanges for inlet and overflow
- iv. A variety size of vortex finders for the entire hydro cyclone
- v. Accessory piping within the skid
- vi. Piping, valves, instruments as per the terminal points defined elsewhere in the specification

2.1.1.2 Secondary hydro cyclone: Two (2) sets

- i. Hydrocyclone clusters
- ii. Anchor bolts, nuts and washers
- iii. Flanges for inlet and overflow
- iv. A variety size of vortex finders for the entire hydro cyclone
- v. Accessory piping within the skid
- vi. Piping, valves, instruments as per the terminal points defined elsewhere in the specification

2.1.1.3 Vacuum belt filters complete with Accessories including discharge hood, driving motors (IE3) inverter duty with VFD and inverter panel: Two (2) numbers.

2.1.1.4 Vacuum receivers with Anchor bolts, nuts and washers: Two (2) numbers

The extraction system of the filtrate complete with piping, valves, instruments and accessories along with associated supports, fasteners, gaskets etc., as applicable. Required instruments and any safety device shall be supplied.


2.1.1.5 Vacuum pumps with drive (IE3 motor), all connection bolts/nuts/washers for installation, required instruments and any safety device: Two (2) numbers

The system shall be complete with valves, instruments and accessories along with associated supports, fasteners, gaskets etc. with drive (IE3 motor). Also, bidder to include all connection bolts/nuts/washers for installation. Required instruments and any safety device shall be supplied.

Bidder to include the same in the P&ID scheme and submit the same for the approval of BHEL/ Customer.

2.1.1.6 Vent fan including enclosure and its complete arrangement from VBF till exhaust: Two (2) numbers

2.1.1.7 Complete arrangement for cloth and cake washing (excluding tanks & their Instruments), pumps with motors (IE3), associated piping, valves, spray nozzles & accessories: One (1) set*

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One (1) no. of belt filter wash tank and One (1) no. cake washing tank are envisaged for both the belt filters. Each tank shall be provided with 2 nos. (1 working + 1 standby) of wash pumps. Suitable arrangement for the washing of belt filter cloth and gypsum cake including piping/ valves/ instruments etc. shall be provided by the bidder.

The Scope of supply of Wash tank(s) with inlet/outlet nozzle and its instrumentation is in BHEL's scope. Inlet piping along with associated instruments/ valves from process/clarified water Terminal point (TP) outside the building, to the tanks inlet nozzles, Process/clarified water Outlet piping from the tanks outlet nozzles for cake wash and belt wash comprising of the wash pumps, their motors (IE3) along with associated instruments/ valves etc. shall be in the bidder scope.

However, bidder scope shall be limited to the Engineering as per clause 2.1.1.9 (ii) (g) of this sub-section for the overflow and drain of the tanks.

2.1.1.8 Coupling with guards, wherever applicable: One (1) set*


2.1.1.9 Piping, Valves and accessories

(i) Complete engineering and supply of interconnected piping (slurry, air and water pipes) along with valves, rubber lining (wherever applicable, shall be supplied in erectable condition i.e., no rubber lining to be done at Site), instruments, valves, supports, gaskets, fasteners and accessories which is integral to Gypsum Dewatering Equipment – One (1) set* which is broadly defined below:

- a. Slurry piping from Primary hydro cyclones underflow to Vacuum Belt Filters.
- b. Filtrate piping from Vacuum belt filters to Vacuum receivers.
- c. Air piping from vacuum receivers to vacuum pumps to atmosphere.
- d. Vacuum pumps seal water / drain water pipes to/ from wash tanks. Supply of seal water to vacuum pumps shall be provided through clarified water pump as specified in P & ID. Seal water drain from vacuum pump shall be routed back to clarified water tank.
- e. Process/clarified water piping from TP outside building to wash tanks.
- f. Instrument air piping from TP outside building up to equipment related to the system.

(ii) Scope of below-mentioned interconnected piping (slurry, air and water pipes) along with valves, rubber lining (wherever applicable), instruments, valves, supports, gaskets, fasteners and accessories which is non-integral to Gypsum Dewatering Equipment is **limited to engineering only** and supply shall be made by BHEL. Engineering in bidder's scope includes layout & routing of pipes, preparation of isometric drawing and BOQ:

- a. Gypsum bleed pump outlet to the inlet flange of Primary hydro cyclones along with recirculation piping to feed tank.

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- b. Primary hydro cyclones over flow to Inlet of secondary waste water hydro cyclone feed tank.
- c. Secondary waste water hydro cyclone feed tank outlet to inlet flange of secondary hydro cyclones along with recirculation piping to feed tank.
- d. Secondary hydro cyclones underflow to filtrate water tank.
- e. Secondary hydro cyclones overflow to inlet flange of wastewater storage tank
- f. Associated drains of vacuum belt filters to filtrate receiver tank.
- g. Overflow and drain piping of cake wash tanks and cloth wash tanks.

2.1.1.10 Expansion Joints at suction and discharge of each pump/other equipment, as applicable: One (1) Set*

2.1.1.11 Instruments/Valves for the entire Gypsum Dewatering Equipment including integral piping as defined at 2.1.1.9 above (minimum requirement for each Gypsum Dewatering Equipment is given in the P&ID): One (1) set*

2.1.1.12 Electrical part includes but not limited to

- i. Local control panel, if required
- ii. LV, HT Motors (as applicable)
- iii. Junction Box
- iv. Instruments
- v. Push buttons

2.1.1.13 All motors shall be provided with suitable double compression cable gland.

Sizes of cables shall be informed by BHEL during detail engineering. Bidder to provide suitable gland with respect to sizes of cables.

Bidder shall provide cable glands and lugs for all the Equipments in his scope. Cables shall be terminated using double compression type cable glands and solderless crimping type tinned copper cable lugs.


Bidder shall provide junction box. The Junction box shall have provision for installing glands of suitable size on the bottom of the box.

2.1.1.14 Control System: Control system shall be DDCMIS/ DCS, which shall be in BHEL scope. Each equipment shall be furnished with required instrumentation and electrical accessory devices mounted and connected to a junction box.

2.1.1.15 **SIGNALS [Refer Electrical/C&I portion/ P&IDs of this specification, as well]**

2.1.1.15.1 Alarm Signal:

- a) Bearing temperature high: Bidder shall supply bearing Temperature Transmitter for initiating alarm for "Bearing temperature high". Bearing temperature transmitter shall be provided with

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local display also. Bearing temperature transmitter (with 2V3 logic) shall be provided for HT motors (> 200 KW) at both the driving and non-Driving ends.

- b) Vibration Monitoring System, is envisaged for HT Motor, which is in BHEL scope. However, for mounting of vibration sensors/probe on DE & NDE Bearing, vendor to provide vibration pad (of dimension of 80mm x 80mm x 10mm each) for mounting of sensors with a provision i.e. M6x1 threaded hole, 13 mm deep, pre-drilled in each pads. Bidder to provide Single notch/slot (of dimension 30 mm x 15 mm x 3 mm) on the circumference of coupling of Motor for mounting of key phasor, there shall be space and provision in the assembled machine train for mounting the phase marker bracket supplied by BHEL. *(These details shall be confirmed with BHEL during detail engineering.)*

2.1.1.15.2 Interlock signal:

- a) Belt filter wash tank level low.
- b) Cake wash tank level low.

- 2.1.1.16 Lubricants & Consumables: All the first fill and one year's toppings requirements of consumables such as grease, oil, lubricants, servo fluids etc. which will be required to put the equipment covered under the scope of specifications into successful commissioning/initial operation and to establish completion to facilities should be provided by the supplier. Refer Clause 7.0 of this sub-section for details.

- 2.1.1.17 Suitable Painting and rust prevention during shipment and construction.

- 2.1.1.18 Seaworthy packing & forwarding to project site. Refer project information specified elsewhere in the specification. This is applicable where the equipment/component is coming through sea route. Otherwise, packing specification of equipment of Indian origin will be followed.

2.1.2 Services to be provided by the bidder:

(i) Detailed Erection and commissioning procedure shall be submitted by successful bidder for carrying out the erection and commissioning at site by BHEL.

(ii) Supervision for Erection & Commissioning, trial run at site.


(iii) Performance guarantee tests at site & handover of the package in flawless condition to the customer.

(iv) training of customer/ client O&M staff covering all aspects of the GDWE- Operation & Maintenance (6 days) at Site.

(v) Training of customer at manufacturer's works (6 man-days) including lodging and boarding

(vi) For supervision services, visits shall be planned by BHEL site team and prior intimation shall be sent to supplier for visit to site. Bidder shall be informed around 10 days in advance for the requirement of visit at site. Visiting team shall consist of one or two expert of bidder as deemed necessary.

- 2.1.3 Mandatory spares as defined as Annexure-II, Sub Section-D of Section I.

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2.1.4 Recommended spare parts list to be furnished (not part of scope of supply)


2.1.5 Any other items required not covered above but required for the completeness of the equipment/system; it shall be included in the offer and shall be supplied by the Bidder/Supplier. Bidder shall refer to the P&IDs enclosed in Annexure-IV, Sub-Section-D of Section-I for the items under the bidder's scope. All the items indicated in the P&IDs are minimal requirements.

2.2 PROCESS DESCRIPTION	
1.	Common Gypsum Dewatering Equipment is envisaged for Stage-III - 1x800 MW. The dewatering equipment shall receive the gypsum slurry from Gypsum Bleed pump (BHEL Scope). Gypsum Dewatering Equipment shall be suitable for handling slurry from the FGD absorber unit. Two sets of primary hydrocyclone (1W+1S) with accessories shall be in bidder scope. Primary hydrocyclone underflow shall be taken to Vacuum Belt Filter (VBF) inlet.
2.	The overflow from the primary sets of hydro-cyclone shall be taken to a secondary waste water hydro-cyclone feed tank (BHEL Scope). Secondary Waste Water Hydro cyclone feed tank pumps (BHEL Scope) shall transfer the slurry from tanks to secondary hydro cyclone. Two sets of Secondary hydro cyclones (1 working + 1 stand by) and its accessories shall be in bidder scope.
3.	The underflow from the secondary hydro-cyclone shall be taken to the filtrate water tank. The over flow from the secondary hydro-cyclone shall be taken to a waste water storage tank.
4.	One no. of belt filter wash tank & One no. of cake wash tank along with rubber lining (BHEL Scope) are envisaged for both the belt filters. Each tank shall be provided with 2 nos. of pumps of suitable requirement.

2.3 TERMINAL POINTS	
1.	Primary hydro cyclone feed slurry will be provided by BHEL at the inlet flange of the primary hydro cyclone.
2.	Primary hydro cyclone overflow launder outlet flange. Further piping by BHEL to secondary waste water hydrocyclone feed tank.
3.	Secondary hydro cyclone feed slurry will be provided by BHEL at the inlet flange of secondary hydro cyclone.
4.	Secondary hydro cyclone underflow launder outlet flange and overflow launder outlet flange. Further piping by BHEL to waste water storage and filtrate water tank.
5.	Process/Clarified water & instrument air will be provided at one location, located at 5 m from GDW building boundary. Further piping from terminal point to GDW Equipment utilities are in bidder's scope.
6.	Please refer enclosed P&IDs, typical layout & preliminary elevation drawing of GDWE building for the details in the scope.


2.4 For Electrical scope, refer Electrical specification (Sub-section- C3, Section-I).

2.5 For Control & Instrumentation (C&I) scope, refer C&I specification (Sub-section- C4, Section-I).

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3.0 CODES & STANDARDS AND OTHER REQUIREMENTS


- 3.1 The design and manufacturing of vacuum belt filter shall follow the latest applicable Indian / International (ASME / EN /Japanese) Standards.
- 3.2 The performance tests shall be carried out in accordance with ASME PTC 40 (2017) code.
- 3.3 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:
- a) Indian Electricity Act
 - b) Indian Electricity Rules
 - c) Indian Explosives Act
 - d) Indian Factories Act and State Factories Act
 - e) Indian Boiler Regulations (IBR)
 - f) Regulations of the Central Pollution Control Board, India
 - g) Regulations of the Ministry of Environment & Forest (MoEF), Government of India
 - h) Pollution Control Regulations of Department of Environment, Government of India
 - i) State Pollution Control Board.
 - (j.) Rules for Electrical installation by Tariff Advisory Committee (TAC).
 - (k.) Building and other construction workers (Regulation of Employment and Conditions of services) Act, 1996
 - (l.) Building and other construction workers (Regulation of Employment and Conditions of services) Central Rules, 1998
 - (m.) Explosive Rules, 1983
 - (n.) Petroleum Act, 1984
 - (o.) Petroleum Rules, 1976,
 - (p.) Gas Cylinder Rules, 1981
 - (q.) Static and Mobile Pressure Vessels (Unified) Rules, 1981
 - (r.) Workmen's Compensation Act, 1923
 - (s.) Workmen's Compensation Rules, 1924
 - (t.) Safety Rules for Construction and Erection
 - (u.) Safety Policy
 - (v.) Any other statutory codes / standards / regulations, as may be applicable.
- 3.4 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:
- a) Bureau of Indian standards (BIS)
 - b) Japanese Industrial Standards (JIS)
 - c) American National Standards Institute (ANSI)
 - d) American Society of Testing and Materials (ASTM)
 - e) American Society of Mechanical Engineers (ASME)
 - f) American Petroleum Institute (API)
 - g) Standards of the Hydraulic Institute, U.S.A.
 - h) International Organization for Standardization (ISO)

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- i) Tubular Exchanger Manufacturer's Association (TEMA)
- j) American Welding Society (AWS)
- k) National Electrical Manufacturers Association (NEMA)
- l) National Fire Protection Association (NFPA)
- m) International Electro-Technical Commission (IEC)
- n) Expansion Joint Manufacturers Association (EJMA)
- o) Heat Exchange Institute (HEI)
- p) IEEE standard
- q) JEC standard


- 3.5 Other International/ National standards such as DIN, JIS, VDI, EN, BS, GOST etc. shall also be accepted for only material codes and manufacturing standards, subject to the BHEL Customer's approval, for which the bidder shall furnish, adequate information to justify that these standards are equivalent or superior to the standards mentioned above. In all such cases, the bidder shall furnish specifically the variations and deviations from the standards mentioned elsewhere in the specification together with the complete word-to-word translation of the standard that is normally not published in English.
- 3.6 Two (2) English language copies of all national and international codes and/or standards used in the design of the plant and equipment shall be provided by the Contractor to the Employer within two calendar months from the date of the Notification of Award.
- 3.7 In case of any change in codes, standards & regulations between the date of bid opening and the date when vendors proceed with fabrication, the BHEL shall have the option to incorporate the changed requirements or to retain the original standard. It shall be the responsibility of the Contractor to bring to the notice of BHEL such changes and advise BHEL of the resulting effect.

4.0	DETAILED TECHNICAL SPECIFICATION
4.1	DETAILED SPECIFICATION
4.1.1	Bidder shall supply two stage Gypsum Dewatering Equipment consisting of primary hydro cyclones, vacuum belt filters (VBF) and secondary hydro cyclones for dewatering of gypsum from absorber(s) to less than 10% moisture at the design capacity specified elsewhere in the specification.
4.1.2	Bidder shall supply 2x100% Gypsum Dewatering Equipment with each stream sized to dewater 17.15 TPH (Wet cake) at outlet of VBF produced by FGD absorber unit operating at design point. All other stipulations with respect to sizing and design of the dewatering Equipment, auxiliaries and other systems shall be in line with this specification.
4.2	Hydro-cyclones
4.2.1	Two (2) sets of primary hydro cyclones are envisaged, each set shall be sized to dewater the gypsum slurry produced by the unit operating at design point.
4.2.2	Each set of primary hydro-cyclone shall be provided with 10% spare hydro-cyclones. The capacity defined in the previous clause shall be met with spare hydro-cyclones out of service.
4.2.3	The primary hydro-cyclone shall be installed directly above the belt filters. The overflow of the hydro-cyclones shall be taken to Waste Water storage tank via secondary waste water hydro-cyclone feed tank and secondary hydro cyclone as shown in the relevant P&IDs.


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4.2.4	Both primary and secondary hydro-cyclones shall be of modular construction. It shall be possible to remove and replace individual hydro-cyclone with the set in service. Individual isolation valve shall be provided for each hydro-cyclone for this purpose.
4.2.5	The hydro-cyclone shall be of proven design. The primary hydro-cyclone shall be made up of polyurethane or urethane materials. The feed chamber shall be provided with a minimum rubber lining thickness of 12 mm. The liners shall have a minimum wear life of not less than 8000 hours.
4.2.6	Two (2) sets of secondary hydro cyclones are to be installed. Each set of secondary hydro-cyclone shall be sized to process the maximum discharge from the secondary waste water hydro-cyclone feed tank pumps. A minimum 10% spare hydro-cyclones shall be provided in each set. Secondary Hydro-cyclones shall be of modular construction and of proven design. The secondary hydro-cyclone shall be made up of polyurethane or urethane materials. It shall be possible to remove and replace individual hydro-cyclone with the set in service. Individual isolation valve shall be provided for each hydro-cyclone for this purpose.
4.2.7	All Hydro Cyclones clusters shall be made of polyurethane or urethane material only.
4.3	Vacuum Belt Filters
4.3.1	Two (2) nos. of Vacuum Belt Filters each of capacity 17.15 TPH (wet cake) at the outlet of each VBF are envisaged. Each vacuum belt filter shall be sized to meet the following requirements, all occurring together, with an inlet solid concentration of not more than 45% or outlet of hydro-cyclones whichever is minimum: <ul style="list-style-type: none"> ▪ Outlet Moisture: 10% (maximum) ▪ Chloride content: 100 ppm (maximum)
4.3.2	The Vacuum Belt Filters shall have the following characteristics: <ol style="list-style-type: none"> a) Very rigid frame and rolls, no deformation whatsoever may occur. b) All rolls shall be installed perfectly horizontally c) There shall be no vacuum under the slurry deposition zone. d) Deposit thickness control and directional stability control e) The slurry shall be put on the belt in counter current relative to the rotation of the band. f) The vacuum chambers shall be easily opened for inspection and cleaning.
4.3.3	The filter cloth shall be polyester as per the proven design of the supplier.
4.3.4	The complete frame of the filter and all parts in contact with gypsum shall be made of 'SS 316L' corrosion resistant material.
4.3.5	In case, the contractor offers a design with an underlying belt for carrying the filter cloth, the same shall be endless, factory vulcanized rubber belts with minimum 38mm thickness. The belt shrouds and the sealing belts shall provide a leak tight arrangement to prevent overflow of gypsum slurry.
4.3.6	The vacuum box shall ensure tight sealing with the belt/cloth and shall be of proven design.
4.3.7	The belt filter shall have an automatic cloth tracking mechanism and shall be provided with all required instrumentation as per the bidder's proven practice. The belt filter shall have an automatic cloth tensioning mechanism. Pull chord switches shall be provided for each vacuum belt filter. Four (04) no.'s of Belt sway switches shall be provided for each vacuum belt filter. Cake thickness sensors with double redundancy shall be provided for each vacuum belt filter which shall control the speed of the vacuum belt filter in turn.


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4.3.8	Differential Pressure indicator shall be provided at the discharge line of Belt filter wash Pump for each vacuum Belt filter. Flow indicator shall be provided for cloth washing line of each vacuum belt filter. Flow indicator shall be provided for cake washing line of each vacuum belt filter as per the relevant P&ID.		
4.3.9	The filter shall be provided with minimum 2 stages of cake washing for removing impurities in the gypsum. For cake washing only clarified water shall be used. One stage of cloth washing arrangement shall also be provided.		
4.3.10	The filtrate from belt filter, cake washing & cloth washing shall be taken to separate receiver tank. Each belt filter shall have an independent vacuum pump.		
4.3.11	Gypsum cake from each belt filter shall be discharged through a hopper onto belt conveyor being provided by the Employer. Hopper means discharge chute only, Gypsum cake from each belt filter shall be discharged through a chute arrangement onto belt conveyor indicated in GA drawing.		
4.3.12	A 2 m (min.) wide platform shall be provided around each belt filter for easy approach & maintenance or it may provide a common platform of 3.3m (approx.) width. In case, common platform for VBF is provided, a movable platform along with access ladder shall be provided for approaching components on other side of VBF. The elevation of discharge point of vacuum belt filter shall be as per the Gypsum Dewatering Building Drawing provided in the Annexure-IV Sub Section-D of Section-I.		
4.3.13	The service factor of the gear unit (if any) shall be minimum 1.5.		
4.3.14	Piping and wiring within the skid shall be in the bidder's scope.		
4.3.15	All client end connection flanges shall be ANSI B 16.5/AWWA.		
4.4	Vacuum System		
4.4.1	The filtrate from each belt filter, cake washing & cloth washing shall be taken to a common or separate receiver tank(s) as per the supplier's proven practice. Each belt filter shall be provided with an independent vacuum pump sized to meet the requirements of the belt filter operating at its maximum capacity. An additional 10% margin over the above shall be provided in each vacuum pump.		
4.4.2	Each Vacuum pump shall have its own piping system, which connects the pump with the associated vacuum belt filter. Bidder to provide Equipment layout & General Arrangement (GA) of the Components in Gypsum dewatering building along with the offer.		
4.4.3	The vacuum pump shall be of low speed liquid ring type of proven design. The design of the vacuum pumps shall avoid cavitation under all operating conditions. The seals shall be of proven design.		
4.4.4	Silencers shall be provided, if required, to limit the noise level to values stipulated elsewhere in this specification.		
4.4.5	The vacuum receiver and pump internals shall be suitably lined to protect against the corrosive environment. The material selected for vacuum pumps & vacuum receivers shall be proven for similar application and shall be subject to approval of BHEL/CUSTOMER.		
4.4.6	Each vacuum receiver tank(s) shall be provided with slide plate type pneumatic vacuum breaker. The plate shall be stainless steel with a min. thickness of 3 mm.		
4.4.7	The filtrate extraction pump shall be capable of pumping filtrate water with solid concentration of not less than 10% and particle lumps of 6-7 mm. A 10% margin shall be provided in each of the pump.		
4.5	COMMON REQUIREMENTS FOR PUMPS (Vacuum, Cake/Cloth Wash)		

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4.5.1	All the pump wear parts in contact with the slurry shall be provided with replaceable rubber/ elastomer liners suitable for the fluid handled. The Bidder can also offer a hi-chrome alloy line pump if the Bidder has previous experience of the same for similar applications. The material used by the contractor shall be proven in previous installations.
4.5.2	All the slurry pumps shall be provided with motorized suction and discharge valves. As per bidder's proven practice, pneumatic can be provided. In addition, flushing water lines with motorized/ pneumatic valves shall be provided for each pump for automatic flushing of the pump after each shut down. The flushing water for the pumps shall be taken from the process water supply. The process water lines shall be provided with pneumatic/motorized valves as per the proven practice of the Bidder.
4.5.3	The pump shall be provided with seals of proven type and shall be designed for minimization of seal water consumption. The shaft shall be supported on heavy-duty ball/roller bearings.
4.5.4	All pumps shall be designed to withstand a test pressure of 1.5 times the maximum possible pump shut off pressure under maximum suction pressure conditions.
4.5.5	Product water flushing lines and drains are to be supplied for each pump handling the prevailing water to avoid corrosion if the pump is out of operation for extended periods.
4.5.6	Pumps must be carefully set to ensure that the net positive suction head available under all operating conditions will be adequate. The NPSH Values are to be referred to the least favorable operating conditions- lowest atmospheric pressure, lowest level of water on the suction side of the pump and highest temperature of the pumped fluid. An adequate safety margin of normally greater than 1 m to the max NPSH required shall be provided.
4.5.7	All pumps shall be fitted with suction and discharge pressure gauges. Pressure gauges shall be with diaphragm seal for slurry application. Pressure gauges for other medium shall be with gate valves. All the wetted parts shall be SS 316 or equivalent.
4.5.8	Venting valve shall be fitted to all pumps at suitable points on the pump casing unless the pump is self-venting due to the arrangement of the suction and discharge nozzles. Drainage facilities shall be provided on the pump casing or adjacent pipe work to facilitate the dismantling of pumps.
4.5.9	Pumps not to be damaged during reverse rotation at up to 150% of design RPM, at full discharge head in the event that a pump trips while the other operating pump remain on line.
4.5.10	Pumps shall have stable head-capacity characteristics curve from run-off to shut-off. Shut-off head should be 115% of Best Efficiency Point (BEP).
4.5.11	Selection of Duty point should preferably be at BEP (Best Efficiency Point) or slightly at the left of BEP. Selection of Duty point beyond 115% of BEP will not be acceptable. It should be noted that head variation is due to level variation in tank. Pump has to run in the system without compromising its NPSH requirement at lowest water level in tank. Hence, when tanks are filled-up and are at normal water level, pump will operate at the right of BEP, pump's operating zone should be considered accordingly.
4.5.12	External flushing is required to remove the accumulated particles and all related information should be mentioned in datasheet.
4.5.13	Pump should have adjustment provision of axial clearance between casing and impeller for maintenance of performance at best efficiency when there is wear in between impeller and casing.

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4.5.14	In case rubber or nonmetallic linings are used, these will be two piece molded under pressure and adjusted to the screwed metallic clamping which have been welded to the casting.
4.5.15	Each pump will have a coupling of adequate size, designed for full load and capable of supporting start-up on overload moments. Each half of the coupling will be factory mounted and locked to its shaft. The coupling must be able to accept the adjustment of the impeller.
4.5.16	The pumps shall have mechanical seals of cartridge type with self-lubrication sliding ring cartridges. The static part will be mounted on the seal plate with circumferential ring (O-ring) or another flexible sealing ring. Built-in seal design will not be accepted.
4.5.17	The sealing areas shall be designed in such a way so that solids do not precipitate in them or affect the cooling or affect the adjustment and mechanical functioning of the seals. Seals which do not need jet cleaning are preferred.
4.5.18	Pump induced vibration due to flow pulsations shall be avoided through suitable design.
4.5.19	Each rotating equipment shall be first statically balanced and then dynamically balanced according to ISO 1940 (in the case of impellers this shall be done before and after mounting of the service rotor shaft).
4.5.20	Coupling halves shall be machine matched to ensure accurate alignment. Couplings must have a rated capacity of at least 120% of the maximum potential power transmission requirement.
4.5.21	All rotating parts such as coupling shall be covered with suitable protective guards. Guards shall be easily removable type. Coupling shall be of flexible type made of cast steel. The bidder shall furnish both halves of the coupling. Both the Coupling halves shall be bored and keyed to fit shafts of the pump and the motor by bidder. The coupling between shafts shall be so designed that they become tight during pump operation.
4.5.22	A common base plate shall be provided for pump assembly & Motor and the same shall be rigidly constructed, adequately braced and provided with finish pads for mounting pump.
4.5.23	Pump manufacturer is to supply base plate along with Foundation bolt & Nut, "Taper wedge" and the necessary fastener for Pump and Motor with Base plate.
4.5.24	Nameplate: All equipment shall be provided with name plates indicating the item number and service name. Nameplates shall be of 304 Stainless steel plate and placed at a readily visible location. Nameplate of main equipment shall have enough information, which will be confirmed during engineering phase. Stainless steel nameplates for all instruments and valves shall be provided.
4.5.25	Rotation arrows shall be cast in or attached with stainless steel plate on each item of rotation equipment at a readily visible location.
4.5.26	Unless otherwise specified, all equipment items where the weight exceeds 15 kg shall be provided with suitable lifting lugs, ears or ring bolts or tapped holes for lifting rings. Minimum shock factor for lifting lugs shall be 2.0. The position of lifting lugs and reference dimension shall be shown on GA and/or outline drawings. NDT shall be conducted for lifting lugs. When any spreader bars are required for lifting and laydown, the bidder shall provide spreader bar with equipment.
4.5.27	Skid Mount/ Transportation: Equipment shall be fabricated as skid mount design as much as practical to minimize erection at the site.
4.5.28	Two pieces of stainless-steel earth lugs shall be provided with equipment diagonally. The position of earth lugs shall be shown on each GA and/or outline drawing.
4.5.29	Provide double nuts for anchor bolts.

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4.5.30	Bidder shall provide allowable vibration level on foundation in foundation drawings and/or general arrangement drawings.
4.5.31	If the driver/ driven equipment train is in the resonance condition or any vibration problems occur, the bidder shall solve the problems in a timely manner.
4.5.32	Bidder shall provide the mating flanges with the necessary gaskets.
4.5.33	All the surfaces of the carbon steel should be rust prevented before shipment for the period of at least 12 months for storage and construction.
4.5.34	Bidder to provide capacity of crane or hoist required for safe material handling and the details of heaviest component to be handled.
4.5.35	Bidder to provide Pipe & Valve Material as per the Annexure-VIII, Sub-Section-D, Section-I of the Specification.
4.5.36	A 1000 mm wide platform with suitable approach shall be provided by the bidder for each hydro cyclone.
4.5.37	A 1500 mm space provision around all the pumps shall be provided by the bidder.
4.5.38	Equipments requiring monitoring during regular operation shall be approachable from the ground floor through staircase. Staircase with minimum width of 1200 mm shall be provided for approach to elevated structures at 5 m height from the nearest platform. Below this height, a vertical ladder with minimum clear width of 600 mm may also be acceptable.
4.5.39	The list of all Bought out items with makes and country of origin and contact details of the manufacturers to be mentioned along with offer to be submitted. Acceptance of makes shall be subject to BHEL's / Customer's acceptance during the detailed engineering without cost and delivery implication to BHEL.
5.0	PIPING & INSTRUMENTATION DIAGRAMS (P&IDs)

The Piping and Instrumentation Diagram are enclosed in in Annexure-IV, Sub-Section-D, Section-I.

5.1 PROCESS PARAMETERS FOR PRIMARY HYDROCYCLONE						
Sl. No.	Parameters	Primary Cyclone Slurry	Hydro Feed	Primary Hydro Cyclone Over Flow	Primary Hydro Cyclone Flow	Hydro Under
a.	Total Flow (m ³ /hr.)	54.52		31.5(*1)	23.02 (*1)	
b.	Total Flow (t/hr.)	66.43		35.08 (*1)	31.35 (*1)	
c.	Operating Temp (C)	53		53	53	
d.	Design Temp (C)	70		70	70	
e.	Solid (wt. %)	30		16.6 (*1)	> 45 (*2)	
f.	Density (Kg/m ³)	1219		1114 (*1)	1362 (*1)	
g.	pH	4-7		4-7	4-7	
h.	Cl ⁻ (mg/l)	20000		20000	20000	
5.2 PROCESS PARAMETERS FOR SECONDARY HYDROCYCLONE						
Sl. No.	Parameters	Secondary Hydro cyclone – Feed Slurry		Secondary Hydro cyclone– Overflow	Secondary Hydro cyclone – Under flow	
a.	Total flow (m ³ /hr)	31.5 (*1)		19.69 (*1)	11.81 (*1)	
b.	Total flow (t/hr)	35.08 (*1)		20.17 (*1)	14.91 (*1)	
c.	Operating Temp (°C)	53		53	53	

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d.	Design Temp (°C)	70	70	70	
e.	Solid (% wt.)	16.6 (*1)	3 (*2)	35 (*1)	
f.	Density (kg/m ³)	1114	1024	1263	
g.	pH	4-7	4-7	4-7	
h.	Cl ⁻ (mg/l)	20000	20000	20000	
5.3 DATA SHEET OF BELT FILTER					
Sl. No.	Parameters	Belt Filter Feed Slurry	Product Gypsum	Filtrate	Washing Water**
a.	Total Flow (m ³ /hr)	23.02 (*1)			
b.	Total Flow (t/hr)-Wet	31.35 (*1)	15.585		
c.	Design Temp (°C)	70.0			
d.	Solid (% wt.)	>45 (*2)	>90 (*2)	<0.2	
e.	Density kg/m ³	1362 (*1)			
f.	pH	4~7	5~8		
g.	Cl ⁻ (mg/l)	<20000	<100 ppm (*2)		
h.	Vacuum Belt filter and the peripherals shall be designed at 17.15 TPH (wet cake) discharge of product gypsum a. **Quantity of water shall be finalized by the vendor. Property of process water/ Clarified water) is given below. b. Hydro cyclone backpressure shall not exceed 20m H.				
i.	(*1) shall be finalized by bidder. (*2) Shall be guaranteed by bidder.				



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GYPSUM DEWATERING EQUIPMENT
TECHNICAL SPECIFICATION
SPECIFIC TECHNICAL REQUIREMENT

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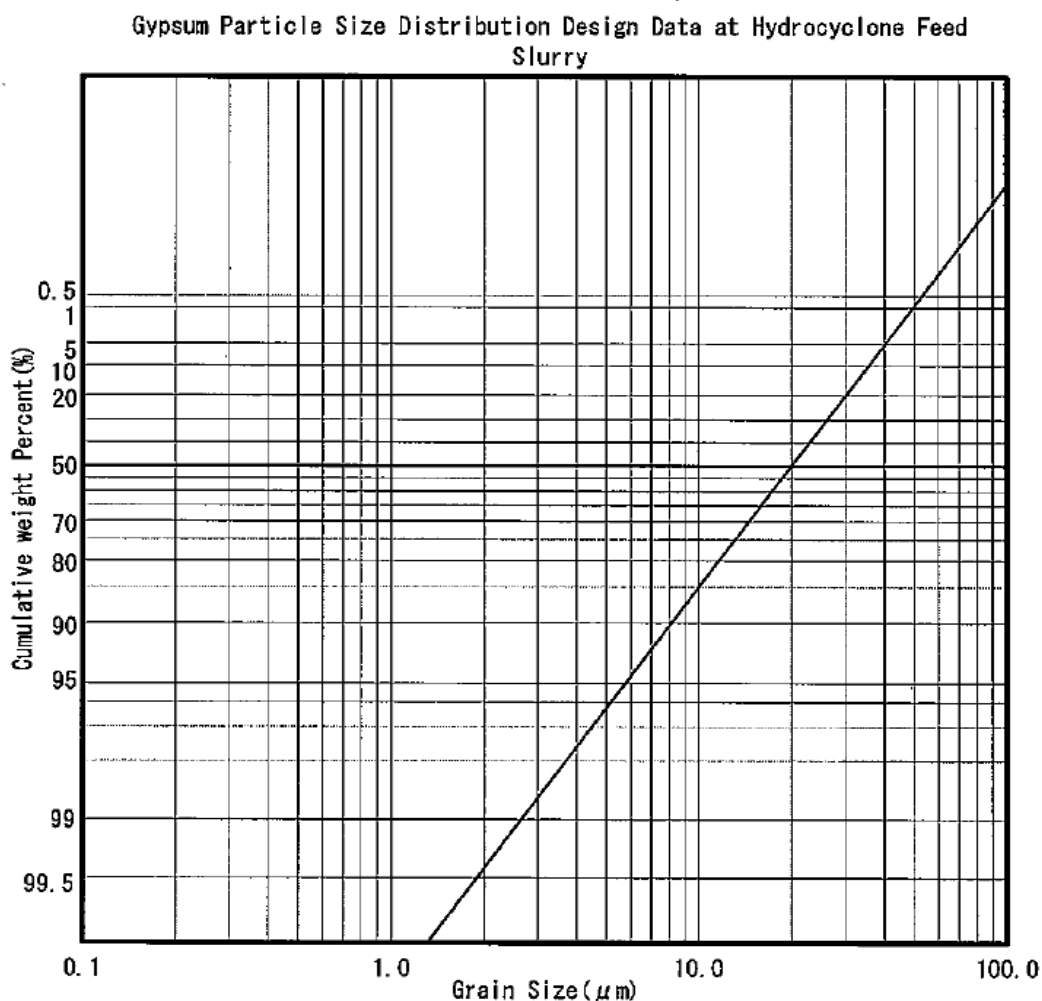
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5.4 GYPSUM PARTICLE SIZE AT HYDRO CYCLONE FEED SLURRY IS SHOWN BELOW:



Note:


1. Vendor to submit the PSD based on their design for PHC & SHC underflow and overflow
2. Gypsum particle size distribution (PSD) to be used for designing Hydrocyclones and Vacuum Belt Filter shall be as per the PSD curve provided in the tender specification. All guarantees of Gypsum dewatering Equipment performance shall be met by bidder as per the provided PSD only.

5.5 GYPSUM PARTICLE SIZE AT BELT FILTER FEED SLURRY:

Bidder to submit PSD graph design data at VBF inlet / PHC outlet.


5.6 DESIGN CONDITIONS OF PRIMARY & SECONDARY HYDRO CYCLONES:

1	Primary Hydrocyclone quantity	:	2 sets (1W+1SB)
2	Secondary Hydrocyclone quantity	:	2 sets (1W+1SB)
3	Primary Hydrocyclone capacity	:	60 m ³ /hr each
4	Secondary Hydrocyclone capacity	:	31.5 m ³ /hr each
5	Type of Hydrocyclone	:	Vertical
6	Material (MOC) of Cyclone Clusters	:	Polyurethane/Urethane
7	MOC of Feed Chamber	:	CS+12 mm rubber lining
8	MOC of Overflow Chamber	:	CS+12mm rubber lining
9	MOC of Underflow Chamber	:	CS+12mm rubber lining

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5.7	SERVICE WATER CHARACTERISTICS
<p>Same has been provided in Project Information. Note that Bidder to consider worst quality of process water as specified for designing the Gypsum Dewatering Equipment. Any treatment, if required for making water suitable for the system, shall be provided by the bidder.</p>	

6.0	SPARES, TOOLS & TACKLES
6.1	START UP & COMMISSIONING SPARES
	<p>Start-up & Commissioning Spares shall be part of the main supply of the GDWE. Start-up & commissioning spares are those spares which may be required during the start-up and commissioning of the equipment/system. All spares required for successful operation till commissioning of GDWE shall come under this category. Bidder shall provide an adequate stock of such start-up and commissioning spares to be brought by him to the site for the equipment erection and commissioning. The spares must be available at Site before the equipment's are energized. List shall be furnished by bidder along with bid as indicated at Section-III.</p>
6.2	MANDATORY SPARES
	<p>a) The list of mandatory spares considered essential by the BHEL's Customer/Employer is indicated in Annexure-II of Sub Section-D of Section-I in the specification. The bidder shall indicate the prices for each and every item (except for items not applicable to the bidder's design) in the 'Schedule of Mandatory Spares' whether or not he considers it necessary for the Employer to have such spares. If the bidder fails to comply with the above or fails to quote the price of any spare item, the cost of such spares shall be deemed to be included in the contract price. The bidder shall furnish the population per unit of each item in their Bid. Whenever the quantity is mentioned in "sets", the bidder has to give the item details and prices of each item.</p> <p>b) Whenever the quantity is indicated as a percentage, it shall mean percentage of total population of that item in the station (project), unless specified otherwise, and the fraction will be rounded off to the next higher whole number. One set for the particular equipment. e.g. 'set' of bearings for a pump would include the total number of bearings in a pump. Also the 'set' would include all components required to replace the item; for example, a set of bearings shall include all hardware normally required while replacing the bearings.</p> <p>c) The assembly / sub assembly which have different orientation (like left hand, right hand, top or bottom), different direction of rotation or mirror image positioning or any other regions which result in maintaining two different sets of spares to be used for subject assembly / sub-assembly shall be considered as different type of assembly/sub-assembly.</p> <p>d) The prices of mandatory spares indicated by the Bidder in the Bid Proposal sheets shall be used for bid evaluation purposes.</p> <p>e) The Employer reserves the right to buy any or all the mandatory spare parts.</p> <p>f) Wherever quantity is specified both as a percentage and a value, the Bidder has to supply the higher quantity until & unless specified otherwise.</p>

	North Chennai TPP Stage-III - 1x800 MW	SPECIFICATION No: PE-TS-485-571-A901
	GYP SUM DEWATERING EQUIPMENT TECHNICAL SPECIFICATION SPECIFIC TECHNICAL REQUIREMENT	SECTION : I
		SUB-SECTION : C1
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	Bidder to provide the split up price for mandatory spares during placement of order as per price format.
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6.3	RECOMMENDED SPARES:
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	In addition to the spare parts mentioned above, the bidder shall also provide a list of recommended spares for 3 years of normal operation of the plant. This list shall take into consideration the mandatory spares specified in this Sub-Section and should be independent of the list of the mandatory spares.
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6.4	SPECIAL TOOLS & TACKLES:
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	Any special tools & tackles required for the entire equipment to disassemble, assemble or maintain the units, they shall be included in the quotation and furnished as part of the initial supply of the machine. List of special tools & tackles shall be decided by bidder as per his proven practice. When special tools are provided, they shall be packaged in separate, boxes with lugs and marked as "Special Tools for (tag / item number)." Each tool shall be stamped or tagged to indicate its intended usage. Levers and eye bolts for the removal of parts to be serviced shall be submitted with special tools. List shall be furnished by bidder along with bid as indicated at Section-III.
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7.0	FIRST FILL OF CONSUMABLES
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7.1	Bidder's scope shall include supply and filling of all chemicals, lubricants, grease, filters and consumable items for operation up to commissioning including top up requirements. All lubricants proposed for the plant operation shall be suitable for all operating and environmental conditions that will be met on site consistent with good maintenance procedures as instructed in the maintenance manuals.
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7.2	Bidder shall also supply a quantity not less than 10% of the full charge or One (1) year of topping requirement (whichever is higher) of each variety of lubricants, servo fluids, gases, chemicals etc. (as applicable) used which is expected to be utilized during the first year of operation. This additional quantity shall be supplied in separate containers.
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7.3	Detailed specifications for the lubricating oil, grease, gases, servo fluids, control fluids, chemicals including items qualities and quantities required per month of the plant operation for the Customer/BHEL's approval herein shall be furnished within 2 months of placement of Order. On completion of erection, complete list of bearings/equipment giving their location and identification marks shall be furnished to BHEL along with lubrication requirements. Suitable standard lubricants as available in India are desired. Efforts should be made to limit the variety of lubricants to a possible minimum. As far as possible lubricants marketed by the Indian Oil Corporation shall be used.
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8.0	LIST OF REFERENCE DRAWINGS BY BHEL
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The drawings specified in Annexure-IV, Sub-Section-D, Section-I are being provided along with the tender specification for engineering, estimation and calculation purpose of the bidder.

9.0	PAINTS /PAINTING
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Bidder shall provide painting philosophy for BHEL/Customer approval. Bidder to also refer Details provided in Customer specification on the same.

	North Chennai TPP Stage-III - 1x800 MW	SPECIFICATION No: PE-TS-485-571-A901	
	GYPSUM DEWATERING EQUIPMENT TECHNICAL SPECIFICATION SPECIFIC TECHNICAL REQUIREMENT	SECTION : I	
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10.0	EXCLUSIONS
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Below are excluded from scope of the GDWE Supplier:


- a) All utilities such as instrument air and process water up to terminal point
- b) Control System (excluding Junction box)
- c) Lifting equipments for Material handling
- d) 3D Modeling
- e) Discharge chute.
- f) Tanks and their instruments
- g) Vibration Monitoring System for HT motors, if applicable
- h) Civil work

11.0	BID EVALUATION CRITERIA FOR POWER CONSUMPTION – Refer Annexure-IV of Price Schedule
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Bidder is required to quote Guaranteed Power Consumption (GPC) in the price schedule format issued along with tender. In case of non-submission of filled up format, the bid shall be liable for rejection. Value for power consumption quoted by the bidder in the specified format, shall be considered as final and any request by bidder for any change in quoted power consumption at a later date, shall not be considered by BHEL.

	North Chennai TPP Stage-III - 1x800 MW	SPECIFICATION No: PE-TS-485-571-A901	
	GYPSUM DEWATERING EQUIPMENT TECHNICAL SPECIFICATION SPECIFIC TECHNICAL REQUIREMENT	SECTION : I	
		SUB-SECTION : C 2	
		REV. 00	

SECTION: I
SUB-SECTION: C 2
CUSTOMER SPECIFICATION

	North Chennai TPP Stage-III - 1x800 MW GYP SUM DEWATERING EQUIPMENT TECHNICAL SPECIFICATION PROJECT SPECIFIC TECHNICAL REQUIREMENT	SPECIFICATION No: PE-TS-485-571-A901	
		SECTION : I	
		SUB-SECTION : C 2A	
		REV. 00	

SECTION: I
SUB-SECTION: C 2A

**CUSTOMER SPECIFICATION
PROJECT SPECIFIC GENERAL REQUIREMENTS**

**19.1.12 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.~~

19.2 DISCREPANCIES IN THIS TECHNICAL SPECIFICATION

~~Any contradiction between Various parts/ sections of this Technical Specification, between text and drawings, the document giving the more extended scope or requirement shall be considered to be within the Contractor's scope of supply.~~

20.0 FUNCTIONAL GUARANTEES, PENALTIES FOR SHORTFALL IN PERFORMANCE AND PERFORMANCE GUARANTEE TESTS**GENERAL**

~~The term "Performance Guarantees" wherever appears in the Technical Specifications shall have the same meaning and shall be synonymous to "Functional Guarantees". Similarly the term "Performance Tests" wherever appears in the Technical Specifications shall have the same meaning and shall be synonymous to "Guarantee Test(s)".~~

20.1 PERFORMANCE GUARANTEES / PERFORMANCE TESTS**20.1.1 General Requirements**

The Contractor shall guarantee that the equipment offered shall meet the ratings and performance requirements stipulated for various equipment covered in these specifications.

The guaranteed performance parameters furnished by the Bidder in his offer, shall be without any tolerance values whatsoever. All margins required for instrument inaccuracies and other uncertainties shall be deemed to have been included in the guaranteed figures. No tolerance or allowance on the test result will be permitted for instrument errors or inaccuracy, the method of testing or any other causes.

The Contractor shall conduct performance test and demonstrate all the guarantees covered herein. The various tests which are to be carried out during performance guarantee tests are listed in this Sub-section. The guarantee tests shall be conducted by the Contractor at site in presence of Owner on each unit individually.

All costs associated with the tests including cost associated with the supply, calibration, installation and removal of the test instrumentation shall be included in the contract price.

The performance tests shall be performed using only the normal number of Owner supplied operating staff. Contractor, vendor or other subcontractor personnel shall be used only for instructional purposes or data collection. At all times during the Performance Tests the emissions and effluents from the Plant shall not exceed the Guaranteed Emission and Effluent Limits.

It shall be responsibility of the Contractor to make the plant ready for the performance guarantee tests.



20.1.2 Test Instrumentation, Flow Measurement and their Calibration

All instruments required for performance testing shall be of the type and accuracy required by the code and prior to the test, the Contractor shall get these instruments calibrated in an independent test Institute approved by the Owner and submit the same to Owner prior to commencement of test. All test instrumentation required for performance tests shall be supplied by the Contractor and shall be retained by him upon satisfactory completion of all such tests at site. All calibration procedures and standards shall be subject to the approval of the Owner prior to commencement of test. The protecting tubes, pressure connections and other test connections required for conducting guarantee test shall conform to the relevant codes.

Tools and tackles, thermowells (both screwed and welded) instruments/devices including flow devices, matching flanges, impulse piping & valves etc. and any special equipment, required for the successful completion of the tests, shall be provided by the Contractor free of cost.

The Performance test shall be carried out as per the agreed procedure. The detailed PG test procedure shall be submitted within 90 days of the date of Notification of Award and finalization of the PG test procedure shall be done within 180 days from the date of Notification of Award.

The P&G test procedures shall be submitted for equipment/system & subsystem under Contractor's scope for all Guarantees as mentioned below, as per latest International codes / standard including correction curves, meeting the specification requirements along with sample calculations & detailed activity plan of preparation (including test instrumentation), conductance and evaluation of Guarantees.

The Contractor shall submit for Owner's approval the detailed Performance Test procedure containing the following:

- (a) Object of the test.
- (b) Various guaranteed parameters & tests as per contract.
- (c) Method of conductance of test and test code.
- (d) Duration of test, frequency of readings & number of test runs.
- (e) Method of calculation.
- (f) Correction calculations & curves.
- (g) Instrument list consisting of range, accuracy, least count, and location of instruments.
- (h) Scheme showing measurement points.
- (i) Sample calculation.
- (j) Acceptance criteria.
- (k) Any other information required for conducting the test.

20.1.2.1 Test Reports

After the conductance of Performance test, the Contractor shall submit the test evaluation report of Performance test results to Owner promptly but not later than one month from the date of conductance of Performance test. Preliminary test reports shall be submitted to the Owner after completing each test run. Four (4) hard copies and two (2) soft copies on CD-ROM of each test report of final conducted test on each equipment/plant/system shall be submitted to Owner for approval.



Performance Guarantee Tests on the equipment/systems not covered in this Sub-section shall be carried out as per the procedure/test codes specified in respective detailed specifications.

20.1.3 Acceptance of Guarantee Test Results

(i) For Category-I Guarantees

In case during performance guarantee test(s) it is found that the equipment/system has failed to meet the guarantees, the Contractor 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 Employer and re-conduct the performance guarantee test(s) with Employer's consent. In case the specified performance guarantee(s) are still not met but are achieved within the Acceptable Shortfall Limit as specified in Cl.20.1.4, of this sub-section & Vol I SCC Employer will accept the equipment/system/plant after levying Penalties as per Vol.I SCC. However, if, the demonstrated performance guarantee(s) continue to be beyond the stipulated Acceptable Shortfall Limit, even after the above modifications/replacements within ninety (90) days or a reasonable period allowed by the Employer, after the tests have been completed, the Employer will have the right to either of the following:

Reject the equipment / system / plant and recover from the Contractor the payments already made

OR

Accept the equipment /system/ plant after levying Penalties. The Penalties for shortfall in performance indicated in Vol.I SCC shall be levied separately for each unit. The rates indicated in Vol.I SCC per unit basis. The Penalties shall be pro-rated for the fractional parts of the deficiencies.

(ii) For Category-II Guarantees

In case during performance guarantee test(s) it is found that the equipment/ system has failed to meet the guarantees, the Contractor 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 Employer and re-conduct the performance guarantee test(s) with Employer's consent. In case the specified performance guarantee(s) are still not met even after the above modifications/replacements with in ninety (90) days or a reasonable period allowed by the Employer, after the tests have been completed, the Employer will have the right to Reject the equipment /system / plant and recover from the Contractor the payments already made.

Conformance to the performance requirements under Category-II is mandatory as compliance of limiting the SO₂ emission from the plant is a statutory requirement. If the stipulated guarantee is not met, the Purchaser at his discretion will reject the FGD Plant/ System and recover from the Contractor the payments made for the entire contract.



20.1.4 AMOUNT OF PENALTIES APPLICABLE FOR GUARANTEES

20.1.4.1 The rate of penalties and acceptable shortfall limits for different guarantees shall be as under and such penalties shall be deducted from the Contract Price.

Sl.No	Guarantee	Rate of Penalty	Acceptable Shortfall Limit with Penalty
i)	SO₂ Removal Efficiency: For shortfall in guaranteed SO₂ removal efficiency in percentage points under conditions stipulated in Cl. 20.2 of Vol.II Sec.1.	As specified in Vol.I SCC, AMOUNT OF PENALTIES APPLICABLE FOR GUARANTEES	(-)0.25% point from the guaranteed SO₂ removal
ii)	Auxiliary Power consumption of FGD and Auxiliaries: For increase in the auxiliary power consumption in KW guaranteed as per the requirements of Cl.20.2 of Vol.II Sec.1	As specified in Vol.I SCC., AMOUNT OF PENALTIES APPLICABLE FOR GUARANTEES	(+) 5% of the guaranteed auxiliary power consumption
iii)	Limestone Consumption: For increase in the limestone consumption of FGD system in T/hr under conditions stipulated in Cl.20.2 of Vol.II Sec.1	As specified in Cl.3.0.0 AMOUNT OF PENALTIES APPLICABLE FOR GUARANTEES, Vol.I SCC.	(+)10% of the guaranteed limestone consumption.

NOTE :

- (i) Each of the penalties specified above shall be independent and these penalties shall be levied concurrently as applicable.
- (ii) Contractor's aggregate liability to pay penalty for failure to achieve the performance guarantee shall not exceed Contract price.
- (iii) All these penalties for short fall in performance shall be deducted from the contract price.
- (v) The guaranteed values shall be referred with documents/drawings enclosed with Contractor's proposal.

20.1.4.3 LD for Non-fulfilment of Time Schedule

As per LD defined in SCC

~~20.1.4.4 Penalties for Inferior Civil Works~~

~~Any Civil Work carried out by the Contractor not meeting the requirements of relevant Technical Specifications for Civil/Structural/Architectural works covered elsewhere in bid documents, relevant Indian Standard Codes and Contract stipulations, the same will be considered as inferior quality Civil works by the Owner. The Contractor shall dismantle/demolish such inferior quality Civil works and reconstruct the same including supply of material, labour, etc. complete up to the satisfaction of the Owner/Company at no extra cost~~



~~to the Owner. No extension in the time will be granted by the Owner for any inferior quality Civil works and Penalties thereupon due delay of work, as stipulated in relevant sections of the bid documents, will be applicable.~~

~~For non-fulfillment of PG values the LD will be levied as indicated in above clause of this Section. The ceiling of LD for each unit shall be 10% of the contract value. The~~

20.1.5 GUARANTEES PARAMETERS

20.1.5.1 Guarantees Under Category-I

The Performance Guarantees which attract Penalties are as follows:

The following shall be guaranteed by the Bidder under guarantee point condition:

(i) **SO₂ removal Efficiency**

~~The Contractor shall guarantee their best SO₂ removal efficiency for inlet SO₂ concentration corresponding to worst coal and 100% (TMCR) unit load. The Contractor shall Guarantee that the SO₂ removal efficiency shall not be less than 95 % or the value specified under guarantee point conditions (as specified in table 20.2 of this section).~~

(ii) **Limestone consumption of FGD system**

~~The contractor shall guarantee the limestone consumption of FGD system in kg/h under guarantee point condition at 100 % (TMCR) unit load with worst coal firing, meeting an outlet guarantee of less than 100 mg/Nm³ (6% O₂, dry basis).~~

(iii) **Auxiliary Power Consumption**

~~The Contractor shall guarantee the total auxiliary power consumption for the FGD plant in normal operation at the guarantee point conditions (as specified in table 20.2 Section -1)~~

20.1.5.2 Guarantees under Category- II

~~SO₂ removal in treated flue gas: Maximum concentration of SO₂ in treated flue gas at the exit of FGD for the unit shall not exceed the guaranteed values.~~

20.1.5.3 Guarantees Under Category-III

The parameters/capabilities shall be demonstrated for various systems/ equipment shall include but not limited to the following:-

- a. ~~Minimum SO₂ removal efficiency of scrubber corresponding to the design conditions of the FGD plant.~~
- b. ~~Mist Outlet Droplet Content~~

~~The mist eliminator outlet droplet content shall be guaranteed to be < 20 mg/Nm³ at absorber outlet measured over a period of 24 hrs continuous operation.~~

~~Mist outlet-droplet content shall be measured as per applicable clauses in VDI Norm 3679 and the Contractor shall carry out the tests as per the test procedure approved by the Employer~~

- c. ~~Maximum pressure drop of flue gas across the FGD system, corresponding to the guarantee conditions of the FGD plant, mmwc (g)~~



- d. ~~Permissible range of plant load variation for design SO₂ removal efficiency of the FGD plant (MW or % of unit MCR)~~
- e. ~~Permissible maximum SO₂ concentration in the inlet flue gas for design SO₂ removal efficiency of the FGD plant, mg/Nm³.~~
- f. ~~SO₂ removal efficiency with one spray level out of service corresponding to guarantee conditions of FGD plant*(for multi-spray tower systems)~~

g. Gypsum purity.

The contractor shall demonstrate that the purity of the gypsum produced shall not be less than 90%, chloride content shall not be more than 100ppm and the moisture content shall not be more than 10% for the range of specified coal(s) and limestone.

h. 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 ~~Vol. II, Section 2~~ of 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 1.0m horizontally from the nearest surface of any equipment/ machine and at a height of 1.5m 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.

In addition to the above, the following parameters/capabilities shall also be demonstrated:-

(i) ~~Wet ball Mill capacity at rated fineness~~

~~The contractor shall demonstrate the guaranteed capacity of each limestone pulverizer under the following conditions:~~

- i) ~~Limestone fineness : 90% or higher (as per the requirement of the absorber) through 325 mesh (for spray tower Process) OR 90% or higher (as per the requirement of the absorber) through 200 mesh (for jet bubbling process).~~
- ii) ~~Limestone Quality : All available quality from the specified range.~~

~~Contractor shall demonstrate the above capacity with the originally installed grinding elements in nearly worn-out condition as mutually agreed for the purpose of ascertaining wear life of any of the wear parts.~~

(ii) ~~Wet ball Mill wear parts guarantee~~

~~Contractor shall demonstrate the life of wet ball Mill wear parts in line with requirements stipulated in section 2.0 of the Technical Specification. The establishment of the above guarantee shall be based on the operating records available at the Power station and will be computed for each pulverizer based on actual total hours of operation.~~

**(iii) ~~Wet ball Mill ball consumption~~**

~~Contractor shall guarantee ball consumption per ton of limestone throughput in line with requirements stipulated in Vol.II, Sec-2.1 of the Technical Specification. Contractor shall furnish the minimum ball diameter below which the balls shall be replaced.~~

(iv) Vacuum Belt Filter Capacity

Contractor shall demonstrate the capacity of the Vacuum Belt Filters to dewater the quantity of gypsum with the specified purity and moisture content as specified in Vol.II, Sec-2.3 of the Technical Specification.

(v) ~~Waste Water~~

~~The Contractor guarantees that the maximum purge flow rate to waste water treatment system for the complete plant shall be 10m³/hr averaged over a 24 hour period from the unit.~~

(vi) ~~Performance characteristics of booster fans (capacity, head developed, etc.).~~**(vii) ~~Margins in Booster Fan.~~**

~~Booster Fans - As specified in Cl. 5.4.0, Sec 2.1, Vol II of Technical Specifications~~

(viii) ~~GGH Leakage~~

~~The leakage through the GGH seals shall not exceed 1.5% of the hot gas inlet flow.~~

(ix) ~~Passenger cum Goods Elevator for FGD absorber & Limestone Grinding Building: Over load tests, travel and hoist speed checks.~~**(x) ~~Availability of FGD Plant~~**

~~The Contractor shall guarantee the maximum availability of FGD Plant for the range of coal and limestone specified inline with the requirements stipulated in this Sub-Section~~

(xi) ~~Air Conditioning System~~**A. ~~Following shall be demonstrated at Shop~~**

- ~~1) Capacity and static pressure of AHU fans at its rated duty point.~~

B. ~~Following shall be demonstrated at Site~~

- ~~1) Capacity (TR) of water cooled condensing units (D-X type) for A/C system of FGD control room building.~~
- ~~2) Guaranteed room conditions during summer for all the Air conditioned areas.~~
- ~~3) Vibration and noise level of condensing units & centrifugal fans of AHUs.~~

(xii) ~~Ventilation System~~**A. ~~Following shall be demonstrated at Shop~~**

- ~~1) Capacity and discharge pressure of pumps of UAF units at its rated duty point of Ventilation system.~~
- ~~2) Capacity and static pressure of UAF fans at its rated duty point of Ventilation system.~~

**B. Following shall be demonstrated at Site**

- 1) Vibration & Noise level of centrifugal fans & pumps of UAF units.

(xiii) Equipment Cooling Water System

- i) Vibration, noise and parallel operation without hunting & abnormal noise and with flow sharing within 10% of each other at the rated duty point shall be demonstrated at site.
- ii) Design heat load of plate type heat exchangers and Inlet & Outlet temperatures of the Plate type heat exchangers on the primary and secondary side to be demonstrated at site. Pressure drop across the Plate type heat exchanger on the primary & secondary water circuit to be demonstrated at site.

(xiv) Compressed Air System**A. Following shall be demonstrated at shop**

- i. Capacity & Discharge pressure of each air compressor.

B. Following shall be demonstrated at site:

- i. Dew point of air at the outlet of air drying plants of air compressor.
- ii. Pressure drop across air drying plant.
- iii. Vibration and noise level of air compressors, blowers of air drying plant (if applicable).

(xv) Particulate matter in flue gas

Bidder's design shall ensure that the particulate emission at chimney inlet shall not be more than 30 mg/Nm³ or as per the values specified for all the specified operating conditions.

(xvi) Capacity of lime & gypsum handling equipment

The Bidder shall demonstrate the capacity of bucket elevators/steep angle conveyor, Belt Conveyor and Lime Crusher capacity of any one set as per Owners Choice and as specified elsewhere in the specification.

(xvii) Capacity of limestone handling system and Gypsum Handling System:

The contractor shall demonstrate the rated capacities of each belt conveyor for limestone and gypsum and the associated equipment.

20.1.5.4 AUXILIARY POWER CONSUMPTION (PA)

The unit auxiliary power consumption shall be calculated using the following relationship.

$$P_a = P_u + T_L$$

P_a = Guaranteed Auxiliary Power Consumption.
 P_u = Power consumed by the auxiliaries of the unit under test.
 T_L = Losses of the transformers supplied by bidder based on works test reports.

While guaranteeing the auxiliary power consumption the bidder shall necessarily include all continuously operating auxiliaries under this package.

Any other equipment required for continuous operation of the system shall also be considered for calculation of auxiliary power consumption. Power consumption of all equipments provided on unitized basis shall be included in the unit auxiliary power consumption. For common



station auxiliaries, the power consumption shall be assigned to each unit based on unit load for the purpose of calculating the unit auxiliary power consumption.

The auxiliaries to be considered shall include all the auxiliaries required to run the system on a continuous basis meeting the requirements of the technical specification but not be limited to the following:

- ~~i. Absorber Recirculation Pump(s)~~
- ~~ii. Absorber Oxidation Air Blower(s)~~
- ~~iii. Absorber Oxidation Tank Agitators~~
- ~~iv. Gypsum Bleed Pumps~~
- ~~v. Limestone Gravimetric feeder, Wet ball mill and their integral Auxiliaries~~
- ~~vi. Limestone Slurry Pump(s)~~
- ~~vii. Vacuum Belt Filter, Vacuum Pump and its integral auxiliaries~~ **including Vent Fan**
- ~~viii. Power consumption of Booster water pump~~
- ~~ix. Process water pump(s)~~
- ~~x. Mist Eliminator Wash Water pump(s)~~
- ~~xi. DM Cooling (normally working) Water pump one(1) to supply cooling water on the primary (DM) side of the plate type heat exchangers in the closed loop Equipment cooling water system.~~
- ~~xii. Auxiliary Cooling (normally working) water pump one(1) to supply cooling water on the secondary side of the plate type heat exchangers in the closed loop Equipment cooling (unit auxiliary) water system.~~
- ~~xiii. Booster Fans.~~
- ~~xiv. Power consumption of Limestone Slurry Tank Agitators~~
- ~~xv. Power consumption of Filtrate Pump(s)~~
- ~~xvi. Power consumption of Belt Filter Wash Water Pump~~ **and cloth wash pump.**
- ~~xvii. Power consumption of Hydro-cyclone Waste Water Sump Pump and Waste Water Pump~~
- ~~xviii. Power consumption of all other continuous running Agitators~~
- ~~xix. Air Conditioning System~~
~~Power consumption at motor input terminals of working units (i.e. excluding stand-by) at its rated duty point of compressor and condenser fans of air cooled condensing unit, Air handling unit (AHU) fans for the Air conditioning system of FGD Control Room Building~~
- ~~xx) Guaranteed power consumption of single stream conveyors and associated equipments (vibrating screen, crushers, belt feeders, paddle feeders) for limestone and gypsum handling at rated capacities.~~

The equipments listed above for calculating auxiliary power consumption are indicative. Any other equipment required for continuous operation of the system shall also be considered for calculation of auxiliary power consumption.

Note :

1. The bidder shall furnish a list of equipments to be covered under auxiliary power consumption, which shall be subject to Employer's approval.
2. The equipments listed above for calculating auxiliary power consumption are indicative. Any other equipment required for continuous operation of the system shall also be considered for calculation of auxiliary power consumption.

~~20.1.5.5 METHOD OF COMPUTING TEST EFFICIENCY OF FGD~~

~~The performance tests shall be carried out in accordance with ASME PTC 40 (1991) code. NO tolerance or allowance on the test result shall be permitted for instrument errors or inaccuracy, the method of testing or any other causes. The details of the test shall, however be mutually agreed upon between the employer and the contractor.~~



20.1.5.6 METHOD OF COMPUTING AVAILABILITY

FOR CATEGORY-III

The Contractor shall guarantee 98 % availability of FGD plant for a continuous period of 120 days. An availability guarantee test shall be conducted to assure this level of availability for a period of 240 days as per the procedure indicated below.

Availability 'A' in %:

$$A = \frac{T_c}{T_k} \times 100\%$$

T_c – recorded time of FGD operation, expressed in hours,

T_k – recorded time of boiler operation, expressed in hours,

However, it is required that:

- (i) In order to calculate the FGD availability, operation hours will be counted except boiler start-ups when the operation hours counting will start on the moment of shut down of all oil burners,
- (ii) FGD will be regarded as a FGD in operation, when by-pass damper is closed and total flow of flue gas from boiler goes via FGD, and SO₂ content is below 100 mg/Nm³ (dry basis at 6% O₂) in cleaned flue gas for the range of specified coals & loads.
- (iii) If FGD is out of operation during the boiler operation time as a result of the Employer's decision, this time will not be counted as boiler operation time for calculating the FGD availability,
- (iv) Boiler operation hours will be counted based on the recorded boiler operation hours and the recorded data will be made available to the Contractor by the Employer.

Mandatory spares have been identified in the Employer. Contractor can use the mandatory spares supplied under the contract during this period in agreement with the Employer. However, if other additional spares are required for demonstration of availability demonstration guarantee, Bidder to should clearly indicate along with their offer.

If the calculated availability after 120 days availability test is lower than the guaranteed value, the Contractor will undertake actions as per clause **19.1.5.4** of this Sub-Section to achieve the guaranteed availability.

Recovery of Penalties

The Owner may, without prejudice to any method of recovery, deduct the amount for such Penalties from any amount due or which becomes due to the Contractor either under this or any other Contract, including en-cashing of appropriate value of Contract Performance Bank Guarantee. Payment of Penalties shall in no way relieve the Contractor from its contractual obligations to complete the works or from any of the obligations under the contract. Any delay in the levy or recovery of penalty shall not constitute waiver of the right of the Owner under the contract towards levy and recovery of penalty.

Test Condition

The performance test on FGD will commence after a minimum period of Seven hundred Twenty (720) hours of operation after completion of initial operation. During the interval between the commencement of initial operation and the commencement of performance test only routine maintenance shall be carried out.



The performance tests shall be carried out in accordance with ASME PTC 40 (1991) code, as amended/ revised. The test efficiency shall be based on the overall performance of the FGD system over a mutually agreed period of operation under the conditions given elsewhere in this specification and allowing the normal operation of the power unit.

20.2 DESIGN AND GUARANTEE CONDITIONS

Design and Guarantee conditions shall be referred in Annex 1.2.



4.6.0 Gypsum Dewatering System

Two stage gypsum dewatering system shall be provided, consisting of a primary stage of sets of hydro cyclones and secondary stage of vacuum belt filters for dewatering of gypsum from absorber up to less than 10% moisture.

The Bidder shall provide 2x100% gypsum dewatering system with each stream sized to dewater 110% of the maximum gypsum produced by the unit operating at Design point.

4.7.0 Primary Dewatering Hydro-cyclones

The primary hydro-cyclone shall be installed directly above the belt filters. The overflow of the hydro-cyclones shall be taken to Hydro-cyclone Waste Water tank. Secondary hydro-cyclone feed tank and secondary waste water hydro cyclone shall be included as shown in the tender drawing.

Hydro-cyclones shall be of modular construction. It shall be possible to remove and replace individual hydro-cyclone with the set in service. Individual isolation valve shall be provided for each hydro-cyclone for this purpose.

Each set of primary dewatering hydro-cyclone shall be sized to dewater the gypsum slurry produced by operating the unit at Design point with an additional 10% margin. The outlet water content in the gypsum shall be as per the requirement of the vacuum belt filters.

Each set of primary hydro-cyclone shall be provided with 10% spare hydro-cyclones. The capacity defined in the previous clause shall be met with spare hydro-cyclones out of service.

The hydro-cyclone shall be of proven design. The primary hydro-cyclone shall be made up of polyurethane or urethane materials. It shall be possible to remove and replace individual hydro-cyclone with the set in service. Individual isolation valve shall be provided for each hydro-cyclone for this purpose.

The hydro-cyclone shall be of proven design and shall be provided with replaceable rubber lining. The feed chamber shall be provided with a minimum lining thickness of 12 mm. The liners shall have a minimum wear life of not less than 8000 hrs.

4.8.0 Vacuum Belt Filters:

2x100% Vacuum belt filter shall be provided.

Each vacuum belt filter shall be sized to meet the following requirements, all occurring together, with an inlet solid concentration of not more than 45% or outlet of hydro-cyclones whichever is minimum.

The Vacuum belt filters shall be designed for continuous Operation.

Filters shall be suitable for high degree of separation/filtration. Filters shall be washable, reused.

The system shall be designed to handle slurry to the highest concentration.

Suitable Feed/ slurry distribution system shall be envisaged for dispersing the slurry across the complete width of the Horizontal belt filter.

Filter Pan, Scroll discharge and scroll drive mechanism.



To avoid spillage and overflow of the slurry from the filter, roller dam arrangement shall be envisaged.

Wash distributor shall be envisaged to distribute the wash liquor across the complete width of the Horizontal belt filter.

Required number of Flap dams shall be provided.

Vacuum pipe line with necessary isolation valve, pressure transmitters, vacuum box, vacuum pumps etc shall be provided for the system.

The vacuum box shall ensure tight sealing with the belt/cloth and shall be of proven design.

The vacuum box shall be suitably located so that it can be lowered or elevated automatically as well as manually to enable inspection/ cleaning.

The vacuum hose from the filtrate shall be connected to the moisture trap.

The belt shall be SBR of minimum 38 mm Thickness, shore Hardness 65 ± 5 A. Suitable arrangement shall be made to minimize the friction. Bidder shall also alternatively suggest suitable proven material.

The belt filter shall have an automatic cloth tracking mechanism and shall be provided with all required instrumentation.

Necessary limit switches, Safety trip switches, pressure relief valve etc shall be provided for the safe operation of the system.

The Basin below the filter shall be adequately sized and have proper slope to drain the filtrate/wash water.

The filter shall be provided with minimum 2 stages of cake washing for removing impurities in the gypsum.

Gypsum cake from each belt filter shall be discharged through a hopper onto belt conveyor. The elevation of discharge point of vacuum belt filter shall be atleast 5.0 m above GL.

A 2 m (min.) wide platform shall be provided around each belt filter for easy approach & maintenance.

The filtrate from belt filter, cake washing & cloth washing shall be taken to separate receiver tank.

Handling facilities for replacement of heavy components of the belt shall also be provided.

Gypsum generated from Vacuum belt filter shall be conveyed to storage area through series of conveyors.

4.9.0 Vacuum Pump

- Each belt filter shall be provided with an independent vacuum pump sized to meet the requirements of the belt filter operating at its maximum capacity. An additional margin of 10% (min.) over the above capacity shall be provided for each vacuum pump.
- The vacuum pump shall be of low speed liquid ring type of proven design. The design of the vacuum pumps shall avoid cavitations under all operating conditions. The seals shall be of proven design.



- Silencers shall be provided, if required, to limit the noise level to stipulated values.
- The vacuum receiver and pump internals shall be suitably lined to protect against the corrosive environment. The material selected for vacuum pumps & vacuum receivers shall be proven for similar application.
- Each vacuum receiver tank shall be provided with slide plate type pneumatic vacuum breaker. The plate shall be stainless steel with a min. thickness of 3 mm Filtrate System
- Water from vacuum receiver tank and the secondary waste water hydro cyclone underflow shall be taken to a filtrate tank for recirculation in to the system.
- 2x100% horizontal centrifugal pumps (Filtrate feed pumps) shall be provided for recirculation of filtrate water to absorber and Mill separator tank.
- 2x100% horizontal centrifugal pumps (Belt filter wash water pumps) shall be provided for wash water requirements of belt filter.
- The pump shall be capable of pumping of filtrate water with solid concentration of not less than 10% & particle lumps of 6-7mm.
- A 10% margin shall be provided in each of the pump.

4.10.0 Waste Water System

- The overflow of the primary hydro-cyclones shall be taken to a secondary hydro cyclone feed tank for feeding the secondary waste water hydro-cyclones.
- ~~The secondary hydrocyclone feed tank shall be sized to provide a minimum storage of 1 hr of primary hydro-cyclone overflow with unit operating at Design Point and no outflow from the tank~~
- ~~2x100% horizontal centrifugal pumps shall be provided to feed the secondary waste water hydro-cyclones. Each pump shall be sized to empty the full storage capacity of the tank in 6 hrs.~~
- Secondary Hydro-cyclones shall be of modular construction and of proven design. It shall be possible to remove and replace individual hydro-cyclone with the set in service.
- The secondary waste water underflow shall be taken to the adequately sized filtrate tank, while the overflow shall be taken to a waste water tank.
- ~~Waste water tank shall be sized for 8 hrs. storage of waste water with the unit operating at BMCR and no out flow from the tank. 2x100% horizontal centrifugal pumps shall be provided for pumping the waste water to waste water treatment plant.~~
- ~~Lime tank for neutralization shall be of 2 Cum capacity in carbon steel construction with epoxy painting. The tank shall be provided with SS dissolving basket, agitator of SS construction, drain, overflow and dosing connection.~~
- ~~All piping, valves & instrumentation upto the employer's terminal point shall be in the contractor's scope. Contractor shall provide the complete lime dosing system to correct the pH of the waste water by lime (83% purity) dosing shall be provided and after mixing of the effluent (using re-circulation system of the pumping system), the effluent shall be discharged once the waste water has been neutralized to desired pH. A pH monitor shall~~



~~chrome alloy line pump if the Bidder has previous experience of the same for similar applications. The material used by the contractor shall be proven in previous installations.~~

- ~~• For absorber recirculation service a Silicon carbide/hi-chrome impeller and SiC lining for casing can also be accepted if the manufacturer has supplied a similar pump for a previous installation for similar service.~~
- ~~• The material and thickness of the liners shall ensure a minimum service life of 2 years before replacement. All the wear parts of the pump shall be guaranteed for a minimum wear life of not less than 14000 hrs.~~
- ~~• The design of the shaft shall ensure that the operating speed is at least 20% above the critical speed of the shaft.~~
- ~~• The pump shall be provided with seals of proven type and shall be designed for minimization of seal water consumption. The shaft shall be supported on heavy duty ball/roller bearings.~~

4.14.0 Slurry Lines and Valves

- Slurry pipes shall be designed to keep the velocity above the settling velocity under all operating conditions. The Bidder may provide a recirculation line with motorized isolation valve for the above purpose.
- All the pipes handling slurry shall be provided with replaceable rubber lining of proven quality. The Bidder can provide slurry pipes of size lower than 3" made up of FRP material if it has previous experience of providing the same.
- The isolation valves provided in all the slurry lines shall be of knife gate type/butterfly type. Actuator shall be provided as per the scheme provided.
- Bidder shall provide all necessary arrangements for purging & flushing of all the process pipelines, equipments etc.

4.15.0 Process Water/ Slurry Storage Tanks & Pumps

- From the terminal point Bidder shall provide Booster Pumps of required capacity & head to feed process water storage tank designed for the entire FGD process (including absorber system and mist eliminator washing system, limestone grinding and slurry preparation system, gypsum dewatering ,etc.).
- Process water storage level shall be automatically controlled at operating level by controlling the water flow from the makeup water from terminal point. The process water storage tank shall be designed to store 15 minutes of total maximum water required for the entire FGD process for the unit operating at Design point.
- All the Process water tanks (Process water storage tank, Emergency water tank etc.) shall be designed, fabricated, erected and tested in accordance with the IS:803, latest edition. Additional Corrosion allowance of 1.5 mm on the minimum tank shell thickness as calculated by IS:803, latest edition shall be provided by the Contractor. The Tanks shall be provided with drain, manholes, over flow & inlet level control valves etc.
- 2x100% Process Water Pumps shall be provided for unit connected to Process water Storage tank along with all necessary piping, valves, control & instrumentation. The capacity of the pumps shall be such that it shall meet the maximum process water



requirement of unit. A further 10% margin shall be provided over the above capacity for all the above pumps.

- 2x100% Mist Eliminator Wash Water Pumps connected to the Process water Storage tank along with all necessary piping, valves, control & instrumentation shall be provided by the Contractor for Mist eliminator wash water system & Emergency spray water system. Alternatively, Contractor can use process water pumps for mist eliminator washing if it is the standard & proven practice of the Contractor or its Technology Collaborator. The capacity of the pumps shall be such that the total capacity of working pumps is sufficient to meet the maximum wash water requirements of mist eliminators of the absorber. A further 10% margin shall be provided over the above capacity for all the above pumps.
- The type of pumps shall be horizontal centrifugal type designed for continuous operation with semi open or closed impeller. Casing, Gland and Stuffing Box shall be of 2.5 Ni Cast Iron to IS:210 Grade FG 260 or equivalent. Impeller, Wearing rings (as applicable) shall be of Stainless Steel 316 grade and Shaft & Shaft sleeves shall be of SS-410 grade. Pump re-circulation line shall be provided for pumping system. Pumps shall be provided with accessories such as Y-type suction strainers, Coupling guard, drain plugs, vent valves etc.

4.16.0 ~~Gypsum storage Shed~~

~~The gypsum cake from the belt filter will be discharged through a hopper to a belt conveyor. The belt conveyor will transport the gypsum to the gypsum storage shed. Gypsum shed of 15 days storage shall be considered. Shed shall be provided with side protection. Adequate space inside shed for truck movement shall be provided. Dozer (1 No.) and Pay loader (1 no.) required for gypsum storage and loading into the truck shall be included in the Bidder's scope. Maintenance area with arrangement required for the Dozer (1 No.) and Pay loader (1 no.) shall also be included in Bidder's scope.~~

~~Alternatively, Gypsum can be stored in Eurosilos/equivalent (minimum 2 Nos. to be provided). The silos shall receive gypsum by belt conveyors. The silos shall be provided with rotating auger frame and slotted column internal mechanism for controllable storage and reclamation. Further, simultaneous filling and reclaiming in layers should be possible. Silos shall have a drainage system at bottom. Silos shall permit to unload gypsum directly into trucks. Bidder/sub-vendor shall provide evidence of having executed similar types silos in atleast two thermal power stations and which are in successful operations for atleast one year prior to date of bid opening.~~

~~Conventional type silos for gypsum storage are not acceptable.~~

4.17.0 ~~Tanks~~

~~All the slurry tanks (Slurry Tanks, Filtrate Tank, Secondary hydro cyclone feed tank, vacuum receiver tank, Waste water Tank etc.) shall be designed, fabricated, erected and tested in accordance with the IS:803, latest edition. Additional Corrosion allowance of 1.5 mm on the minimum tank shell thickness as calculated by IS:803, latest edition shall be provided by the Contractor. Tanks shall be made from IS:2062 quality mild steel plates of tested quality.~~

~~The tanks shall be of welded construction. Interior surface of the tanks shall be lined with the following:~~

- ~~Wastewater tank, Filtrate tank, Secondary hydro cyclone feed tank: Vinyl Ester based flake glass lining of minimum 3 mm thickness~~
- ~~Slurry tanks: Replaceable Chlorobutyl/ Bromobutyl rubber lining of minimum 4 mm thickness~~



~~The outside surface of the tanks shall be coated with paint as approved by the Employer.
Coarse-screen(s) at suction-side of slurry recirculation pumps shall be provided.~~

4.18.0 Approach

- Staircase with minimum width of 1200 mm shall be provided.
- ~~Platform with a minimum clear width of 1000 mm shall be provided all around the lowest absorber spray levels and mist eliminators. Similar platforms shall be provided at subsequent elevations if they are more than 3000 mm apart from each other. An adequately sized manhole with platform (min. 2 sq. m) shall be provided above each spray level. Ladders/staircase shall be provided for the access to the platform.~~
- ~~The absorber slurry recirculation pumps, gypsum bleed pumps and limestone feed pumps shall be mounted on the ground level. Suitable approach and platforms shall be provided for all the valves required during regular operation.~~
- A 1500 mm space shall be provided around all pumps, except absorber recirculation pumps, where a 2000 mm space shall be provided.
- A 1000 mm wide platform with suitable approach shall be provided around each hydro-cyclone.
- All other safety requirements as per the Factories Act, National Electricity code shall be complied with while developing Layout.



ANNEX – 2.3.1

SPECIFIED DESIGN DATA

SI.No.	Description	Unit	Data
A	WET BALL MILL		
1.	Quantity		2 x 100 %
2.	Capacity		Each Mill shall be able to feed 110% design requirement of the FGD Unit
3.	Limestone bond index (kWh/T)		13 (min)
4.	Orientation		Horizontal
5.	MOC of Shell		Outside Shell – Carbon Steel Inside Shell – Carbon Steel lined with 12-14 % High Chrome and manganese steel. (Bidder shall alternatively suggest Superior material / Lining)
6.	Ball MOC		Material of the balls shall be chosen to ensure that the balls do not lose their original shape and to ensure minimum ball consumption.
7.	Drive		Peripheral gear/ central drive
B	MILL SEPARATION TANK		
1.	Number of tank		1 (One)
2.	Number of Compartments		2
3.	MOC of tank		RCC with suitable Lining
C	MILL CIRCUIT PUMPS		
1.	Quantity		2 (1W + 1 S)
2.	Capacity		By Bidder
3.	Type		Horizontal Centrifugal
4.	Material of Construction		
5.	Casing/Housing		CD4MCuN
6.	Shaft , Rotor and sleeve		Rotor – Cr 30A Shaft – 42CrMo Sleeve – CD4MCuN
D	LIME SLURRY TANK		
1.	MOC		IS 2062 construction with replaceable chlorobutyl/bromobutyl rubber lining of minimum 4 mm thickness.
2.	Accessories		
a)	Agitator		Alloy 926 or better material



Sl.No.	Description	Unit	Data
b)	Level Measurements		Required
c)	Inlet, Outlet, Overflow, Drain,		Required
E	LIME SLURRY TRANSFER PUMPS		
1.	Capacity		Each pump to meet the requirement of FGD with 10% margin.
2.	Margin on Head		15%
3.	Solids Concentration		Max. 30% by weight or actual as per suppliers practice, whichever is minimum.
4.	Material of Construction		
a)	Casing/Housing		CD4MCuN
b)	Shaft, Rotor and sleeve		Rotor - Cr30A Shaft - 42CrMo Sleeve - CD4MCuN
c)	Gear Box		As Required for the System
d)	Service Factor		> 2.0
F	GYPSUM OR SLURRY BLEED PUMPS		
1.	Quantity per Unit		Minimum requirement specified
2.	Capacity		By Bidder
3.	Type		Horizontal Centrifugal
4.	Material of Construction		
a)	Casing		Duplex Stainless Steel PREN > 40
b)	Shaft, Rotor, sleeve and Wetted Parts		Duplex Stainless Steel PREN > 40
c)	Gear Box		As Required for the System
d)	Service Factor		> 2.0
G	HYDRO CYCLONES		
1.	Quantity		Mill area- 2 x 100% Primary - 2 x 100 % Secondary- 2x100%
2.	Capacity		To meet the requirement of the FGD Unit.
H	VACUUM BELT FILTER		
1.	Quantity		2 x 100 %
2.	Capacity		To meet the requirement of the FGD Unit.
3.	Gypsum Purity		≥ 90 %



Sl.No.	Description	Unit	Data
4.	Moisture Content		≤ 10 %
5.	Cholorde content		Less than 100 PPM
6.	Filter Frame		SS 316L
7.	Carrier Belt		SBR, 38mm thick
8.	Filter Cloth		PE
9.	Vacuum Box		SS 904L, jacketed
10.	Vacuum box lifting system		SS 316L with pneumatic cylinders,
11.	Spillage gutters		SS 316L
12.	Head and Tail Pulley		MSRL, SS 316 shaft
13.	Cloth Rollers		SS316L, SS 316 shaft
14.	Belt Rollers		MSRL, SS 316 shaft
15.	Belt support system		SS 316L
16.	Slurry Feeder		SS 904L
17.	Wash feeders		SS 904L
18.	Flap dams		EPDM flap
19.	Discharge Chute		SS 317L
20.	Spray Pipes with nozzles and valves at inlet		SS 316L
21.	Cloth Tracking system		To be provided
22.	Moisture Trap upstream of Vacuum pump		To be provided. MOC - FRVE
I	PROCESS WATER TANK & PUMPS		
1.	Capacity	m³	15 minutes of total maximum water required for the entire FGD process
2.	Code		IS 803
3.	MOC		IS 2062
4.	Corrosion allowance	mm	1.5
5.	Type		Above Ground Tank
	Process Water Pumps		2 x 100 %
1.	Type		Horizontal Centrifugal End suction Pumps
2.	RPM		1450
3.	Material of construction		



Sl.No.	Description	Unit	Data
a)	Casing		CI as per IS:210 FG 260
b)	Impeller		SS 316
c)	Shaft		SS 410
	Mist Eliminator Wash Water Pumps		
1.	Quantity		2 x 100 %
2.	Type		Horizontal Centrifugal End suction Pumps
3.	RPM		1450
4.	Material of Construction		
a)	Casing		2.5 Ni CI as per IS:210 FG 260
b)	Impeller		SS 316
c)	Shaft		SS 410
J	WASTE WATER PUMPS & FILTRATE WATER PUMPS		
1.	Quantity		2 x 100 %
2.	Type		Horizontal Centrifugal End suction Pumps
3.	RPM		1450
4.	Material of construction		
a)	Casing		Duplex SS
b)	Impeller		Duplex SS
c)	Shaft		SS 410
5.	Pipe Routing		On Existing Trestle/ Partly Underground
6.	Coating and Wrapping		AS Per IS:10221 and IS:15537
7.	Road Crossings		Hume pipes if Applicable
K	SUMP PUMPS		
1.	Service		Chemical Over flow/Floor Drains
2.	Capacity	m³/h	50
3.	Sump Dimension	m	Minimum 2x2x2 with corrosive resistance tiles.
4.	Quantity per sump		2 x 100 %
5.	Type		Vertical Centrifugal. The pump shall be capable of pumping of filtrate water with solid concentration upto 10% & particle lumps of 6-7mm. Sump pumps handling slurry shall be designed with a maximum concentration of 30% solid by weight.



5.0 PROVISIONS BY THE OWNER

Following are the provisions / supplies by the Owner:

- Graded land within the property line limits as indicated in the General Layout for FGD.
- Geotechnical investigation report
- Limestone and water for startup, testing and commissioning. However, Bidder shall indicate in the offer the quantity required in his offer exceeding which the supply by Owner will be on chargeable basis
- All utilities/services up to the terminal points as specified in the specification.
- Permits specifically identified as to be obtained by the Owner. Bidder shall specify the same in the offer submitted.

6.0 QUALIFYING REQUIREMENTS FOR EQUIPMENTS / SYSTEMS

The sub-vendors being engaged by the EPC contractor for the various packages in the scope of works shall have successfully executed similar such works in the last ten years. The credentials of such sub vendors shall be furnished to Owner/ Consultant for review and approval. Sub-vendors who are approved by Owner/Consultants shall only be engaged by the EPC contractor for the various packages under the scope of works.

7.0 SITE CONDITIONS

7.1 GENERAL

The Project Information is enclosed as Annexure 1

7.2 GEOLOGICAL CONDITIONS

7.2.1 Soil Profile

Geotechnical investigation is furnished in **Attachment 1** of this Technical Specification.

7.3 DESIGN REQUIREMENTS RELATED TO SITE CONDITIONS

7.3.1 Design Ambient Data

- **Design ambient conditions for FGD and auxiliaries**

Design ambient temperature : 30°C

Design ambient air relative humidity : 75%

*Basic conditions as per Schedule of Guaranteed shall also be applicable).

- **Design ambient Conditions for Electrical equipment sizing**

- For electrical equipment : 50 °C

- Relative Humidity Mean Maximum : 90%

- Relative Humidity Mean Minimum : 36%



7.3.2 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

7.3.3 Seismic Data

Seismic loads to be considered for design of structures shall be as per as per IS: 1893.

8.0 SITE WORK AND ERECTION REQUIREMENTS

8.1 CONSTRUCTION POWER

The construction power supply system by its design and nature shall be temporary system and not a part of permanent supply system. The Purchaser shall be providing 415V 3 Ph, 3 Wire and 50 Hz construction power supply at two (2) points. However bidder shall mention the construction power requirement at various phases of construction, in the bid document. Construction power supply shall be given on chargeable basis at the prevailing rates of Tamil Nadu TRANSCO.

The contractor shall provide metering equipment, comprising of CT, PT units, trivector meters of suitable accuracy and shall be responsible for periodic payment of bills for the energy consumed. Necessary protections for the construction power shall be provided to protect the Client's source from any fault in his system.

Bidder/Contractor may specify in the tender conditions itself, if there is any change in the construction power supply system maximum demand requirement. Bidder shall indicate 6 monthly maximum demand requirements.

Operation and maintenance of all construction power supply equipment is in the scope of Bidder.

Bidder/ Contractor shall maintain a power factor of 0.95 or better for the construction power used.

Distribution of 415V supply shall be done using underground cables. All cables being used for construction power shall be armoured only. For the areas like roads, nearer to buildings and areas where there are frequent vehicle movement the cable shall be routed in hume pipes or GI conduits. Buried cable shall be suitably identified by the route markers.

In any case, non-availability of power, its interruption and variation in supply voltage will not constitute a condition for claim for extra costs and time on part of the contractor. The contractor will be responsible for making all necessary arrangements to ensure that the uninterrupted construction power supply is available during critical erection and commissioning activities. For this purpose, required DG sets has to be arranged by contractor.

The Electrical installation shall be generally be carried out as per Indian Electricity Rules & Acts for road crossing, protective guarding shall be provided. The clearance for the lowest conductor from ground shall be decided keeping in view the vertical clearance required for movement of vehicle /crane, etc.

Adequate safety equipment shall be provided to all the workers, like hand gloves, head gear, etc. Meggers & Testers shall be provided in sufficient quantity. Earthing and Lightning protection system shall be provided as per IS and CEIG requirements.



All the working areas shall be adequately illuminated for safe working with proper fittings/fixtures. The wire shall be laid with proper fixing without any hindrances to personnel or vehicle movement.

After the completion of the job, the contractor shall remove the entire installation and make available the area to the owner.

8.2 CONSTRUCTION WATER

Construction water shall be provided by the Owner to the Contractor at chargeable basis. Bidder shall mention the construction water requirement at various phases of construction, in the bid document.

8.3 CONSTRUCTION COMMUNICATIONS

Any communication system which the Contractor might need is within the scope of the Contractor's supply.

8.4 ACCESS TO CONSTRUCTION SITE

Most transportation will have to be via sea or road. Heavy equipment if transported by rail have to unloaded at the nearest railway station (facility shall be checked by the contractor) and transported to site by other means. Any road transportation to the site will have to be through the existing plant access road and high ways.

8.5 SITE SAFETY & SECURITY

It's Contractor's duty to organize and constitute a safety system for providing protection to installation work, contracting material storage, warehouse, field office, accommodation etc., within the contractor's scope of supply and services.

Guards shall be provided by contractor for safety and security.

The Contractor is responsible for the storage of material and the upkeep of equipment at the working site. There shall be fencing for temporary storage and material storing yard with special duty personnel on duty day and night.

Temporary safe railings shall have safe lighting equipment to send out indications such as material warehouse, field or site office and accommodation.

The duty of the Contractor includes the site management and safety of the engineers.

8.6 FIELD SAFETY AND HEALTH ORGANIZATION

According to both, local safety and health regulations, field safety organization shall provide necessary tools, documentation and other measures especially with respect to handling of dangerous goods and fire risks and medical service.

Contractor shall be in charge of examining field safety under the control of a field safety engineers.

8.7 CLEANING ON SITE

Contractor shall be responsible to keep the construction site clean and remove any waste material or hazardous waste to an appropriated waste disposal site approved by authorities in a safe and orderly way.



8.8 LAYDOWN AND CONSTRUCTION

Space available within the site shall be utilized for Contractor's laydown and construction.

9.0 SPARE PARTS, WEAR AND TEAR PARTS

Spares for the FGD plant shall be divided into two categories namely:

- (a) Start-up and Commissioning Spares
- (b) Operation & Maintenance (O & M) Spares

Start-up and Commissioning Spares

Start-up and Commissioning spares are those which would be required during plant or equipment testing, start-up and commissioning. All spares used until the plant is finally handed over by the Contractor to the Owner come under this category. All start-up and commissioning spares as required shall be provided by the Contractor without any additional cost to the Owner. The list and details of start-up and commissioning spares shall be furnished by Contractor prior to award of Contract.

Contractor shall be responsible for the ready and timely availability for all the start-up and commissioning spares as required during various stages of testing, cleaning and commissioning upto handing over of each system of the plant.

O & M Spares

The spares required for 3 years trouble free operation of the plant shall be identified and listed by the bidder in his offer. Owner will review the list of spares specified and finalise the same including any additional spares that will be necessary for three (3) years trouble free operation to meet the plant O & M requirements. The spares for the plant shall be furnished by the Contractor and delivered during the commissioning of the FGD plant.

The spare parts must be able to replace the original part completely and have the same technical specifications in quality, material, inspection and mechanical aspects.

Contractors shall supply all measurement testing data of any spare part supplied, if applicable.

All spare parts supplied shall be packed and stored for a 5 years reservation based on the local climatic conditions. Small spare parts shall be packed and sealed by transparent plastic bags and drying agents will be used if necessary. Every spare parts shall have operation instructions and design marks of the factory when it is supplied.

When multiple spare parts are packed in one packing box or container, the general indication to the spare parts outside the packing boxes or containers shall include a detailed list. All packing boxes, containers, and other such tanks shall be marked properly and numbered clearly. All electrical equipment including switches, fuse connection easy melting and other similar apparatus shall be protected and insulated.

The identification of all spare parts shall be in the English language.

Spare parts shall be supplied 6 months before start of acceptance test .

Wear and tear parts, to be replaced by the Owner at his own cost, shall be marked separately.

Contractor's recommended/required spare part list shall be confirmed during detail design.

Contractor shall identify in the spare parts list, the items having a delivery time of more than 3 months



10.0 TRAINING REQUIREMENTS

10.1 GENERAL

The Contractor shall be responsible for the instruction and training of the Owner's operation and maintenance personnel and his O & M contractor in all aspects of plant design, construction, erection, commissioning, etc. and in such a way that operation, maintenance and if necessary repairs of all the power plant equipment and facilities specified can be handled competently by said personnel.

Such training of the Owner's personnel shall be performed

- In Contractor's and/or sub supplier's/manufacturer's home office and/or workshops.
- In similar capacity FGD operated power plant and such power plants which are under erection and commissioning as well as at the proposed similar Power Plant by using the training simulator.
- On the job site by the Contractor's and/or his sub-suppliers, supervisors and/or instructors deputed to the site for supervision of erection, commissioning, testing and trial operation and/or by specialized training instructors;
- At the FGD Plant by the supervisors deputed to the Plant during the Warranty Period;

In compliance with the provisions of the Contract and the requirements of this specification.

The personnel required for the safe and efficient plant commercial operation and maintenance of the various types of equipment installed shall be provided by the Owner in accordance with the recommendation to be made by the Contractor.

The training will be performed in English. Translators/interpreters shall be provided by the Contractor.

The Contractor's instructors shall use modern training techniques, procedures and aids and make available to the trainees all required notes, manuals, drawings, etc., to supplement the Operation and Maintenance Instruction Manuals.

The Contractor shall provide a detailed description about the recommended training services, including

- Number, category, seniority, required experience, profile required, etc. of the trainees
- Preliminary training program, showing
 - Training facilities, training aids places of training etc.
 - Training schedule
 - Specialty and details of lectures and training
 - Duration of training courses

for all kind of training activities, abroad, classroom, on the job site, at the proposed FGD Plant, etc.

The recommended training program should be based on the organizational and staff structures of coal fired power plants already in operation in India and should take into consideration not only the training for operation and maintenance staff, such as operators, skilled workers, foremen and technicians etc, but also for senior staff and key personnel employed for the management and organizational duties of the various power plant decisions,

such as for operation, maintenance, instrumentation and control, chemistry, administration, security, spare parts handling, scheduling and engineering, etc.



10.2 CONTRACTOR'S OBLIGATIONS AND TASKS

- 10.2.1 The Contractor shall make every effort to train the Owner's personnel and his authorized O & M contractors so that they can be qualified for the management, operation and maintenance of the Contract Plant.
- 10.2.2 The Contractor shall nominate a person in charge of organization and co-ordination activities for training.
- 10.2.3 The Contractor shall select instructors with proper experience and skillfulness and English speaking capability to train the Owner's personnel.
- 10.2.4 The training program will be carried out according to the requirements of each specialty. It will consist mainly of but not limited to the following:
- a) Systematic explanation in a classroom of specific subjects, such as the equipment performance, construction, main systems, auxiliary systems etc.
 - b) Visit to power plants with FGD;
 - c) Practical training in similar power plants which are under erection and commissioning.
 - d) Practical training on simulators and control rooms of FGD in similar power plants.
 - e) Supply of all necessary training documentation (such as books, manuals, drawings), equipment, tools and instruments etc. The Contractor will make best effort to achieve above item (c) and (d) with utility authority.
- 10.2.5 The Contractor will make available free of charge to the Owner's personnel working cloths, safety helmets, stationery etc. as needed by the training program.
- 10.2.6 The Contractor shall allow the Owner's personnel to carry back all the technical documents supplied during the training.
- 10.2.7 The Contractor shall make at the end of the training period an evaluation of the results obtained by each trainee. These results will be confidentially notified to the Owner.
- 10.2.8 The Contractor shall assist the Owner's personnel in arranging their entry visas and all the formalities staying in foreign countries for training. The Contractor shall also take all the necessary measures to ensure the safety of the Owner's personnel during their stay in the foreign country.
- 10.2.9 The Contractor shall appoint a person in charge of logistic coordination. This person shall take care for booking of rooms according to the requirements of the Owner and arranging for transportation (free of charge) from their living place to the training site.
- 10.2.10 The Contractor shall provide free medical services to the Owner's personnel, but excluding dentistry, buying glasses and tonic medicines.

10.3 OWNER'S RESPONSIBILITIES

- 10.3.1 The Owner shall appoint a person as official representative of the Owner's trainees.
- 10.3.2 The trainees shall understand the English language and shall follow the training courses with due diligence. During their stay abroad the Owner's personnel shall observe the Laws of that country and the rules/regulations of the factories/plants where the training will be conducted.

The official holidays or national holidays, Saturdays and Sundays shall be the holidays of the Owner's personnel.



- 10.3.3 For the successful completion of the training program, unless mutually agreed by the parties, the program cannot be interrupted for vacation leave.
- 10.3.4 The Owner shall take care, at his own cost, for:
- a. buying round trip air ticket between India and the place of training
 - b. arranging lodging and boarding for the Owner's personnel from their arrival abroad to the date of their departure.

10.4 TRAINING SCHEDULE AND PROGRAM

- 10.4.1 The Training program for the Owner's personnel will be defined during the liaison meeting.
- 10.4.2 Two (2) months before the arrival of the first group of the Owner's personnel in training site, the Owner shall inform the Contractor of the date when the Owner's personnel are expected to be sent to training site
- 10.4.3 Within 2 (two) weeks after receipt of the Owner's information mentioned above, the Contractor shall confirm its agreement or indicate difficulties, if any, for the staying of the personnel. Thirty (30) days before the arrival of the Owner's personnel in the training site the Owner shall inform the Contractor of the brief career of the personnel including names, date of birth, nationality, specialty, experience, qualification, position and knowledge of foreign languages, passport details etc., so that the Contractor can assist in arranging their entry visas.
- 10.4.4 The Contractor shall not charge the Owner with the costs for the training activities in the respective training sites.
- 10.4.5 In case the Owner fails to send his personnel to attend the above training, the Contractor shall reimburse the relevant amount to the Owner.

11.0 TAGGING

Components whose identity is important for operation and maintenance of the plant viz., all apparatus, signal tapping points, instruments and control equipment, cubicles, as well as the terminal boards, etc., installed in the latter shall be provided with permanently attached tag bearing the Owner's coding together with relevant text clearly inscribed. The inscription shall be approved by the Owner/Consultant. The tag shall be of engraved plate of sufficient rigidity and figures and letters embossed and painted. Such nameplates or labels shall be of white non hygroscopic material with engraved black lettering. The language of inscription shall be English. The method of implementation and labeling shall be informed for all components after award of contract. For equipment identification and tagging KKS numbering system shall be adopted.

12.0 PAINTING AND CORROSION PROTECTION

The painting specification for all the equipment shall be as specified in various sections of this specification Annexure 1.6. The detailed painting specification and colour scheme shall be firmed up by the Purchaser after award of contract. Necessary finish paints including touch up paints, if not applied at shop, should be supplied by the Bidder, in sealed containers for site application.

13.0 PROTECTIVE GUARDS

Suitable guards shall be provided for protection of personnel on all exposed rotating and/or moving machine parts. All such guards with necessary spares and accessories shall be designed for easy installation and removal for maintenance purposes.



14.0 QUALITY ASSURANCE

14.1 GENERAL

Contractor shall provide effective quality assurance according to ISO 9001 standard or other equivalent quality standard. The preliminary quality assurance program is part of the contract agreement. The program gives the description to all the management and regulations about the necessary quality assurance activities in relation to the execution of the contract.

Quality achievements shall be ensured by combined factors such as the application of quality system regulations, technical specifications (including acceptance regulation of quality control requirements), the examination of quality achievement, precautionary methods and the control of corresponding data.

All manufacturing, processing, testing and inspection operations affecting the equipment or material shall be subject to surveillance by Owner or Owner's Representative. These will be identified by customer Hold Point.

14.2 QUALITY ASSURANCE SYSTEM

The quality assurance system of the Contractor shall illustrate its organization process, duty and obligation, quality supervision and standards and subject to reexamination by the Owner.

The implementation of the system shall be ensured by the following:

the guidance and training of all staff by management council in application of the quality assurance program and the ordinary supervision through reexamination and management of the quality assurance program.

If an international joint venture is established, the responsibilities shall be specified so as to let the quality assurance group perform its duty, communicate with the Owner formally, and be responsible for the development of the quality assurance program. An agent should be involved to prepare a report book and introduce it to the quality assurance management staff. The report book illustrates the responsibilities to be fulfilled in management and supervision of the quality assurance program and examine the implementation of the quality assurance guarantee program by the staff of the international joint venture enterprise.

14.3 BASIC FILES

The basic working files influencing quality implementation and examination will be developed and kept updated in an orderly manner. The copies of these files should also be supplied to the construction site to be available for the Owner's representative to take examination.

14.4 PROJECT GUIDANCE AND MANUFACTURE DRAWINGS

Design shall be based as close as possible on the approved design. Some modifications can also be made in order to make major improvements in the manufacture and building technologies and to meet the special needs of the Owner.

Any improvements on the former design shall be checked and examined individually. Those results that have been discussed carefully shall be reflected in project directions and order files of Owner. The plan about the output and input of design, independent design check and evaluation and design changes shall be controlled and quality acceptance standards shall be established.

Quality assurance plan/ overhaul and test plan



The quality assurance plan to ensure necessary quality shall be included in the quality assurance system of the Contractor. This document shall outline overhaul and test principles and record the procedures and steps of the inspection and the requirements for authorizing the inspection as stipulated in the Contract.

The supply of the main elements of equipment to the Owner shall be included in the quality assurance plan and be submitted to the Owner for reexamination.

The Owner can challenge the inspection point and the required quality assurance records illustrated in the combined plan of inspection and test procedures that have been agreed upon. These and other inspection and test procedures used in the manufacturing period shall be illustrated in detail in a separate document for adjusting and formulating the plan.

The Contractor shall give Owner adequate notice 30 working days prior to each test. The confirmation of the inspection and test data shall be delivered to the Owner in less than 30 days.

Instruction manuals on operation procedures shall be supplied to the Owner.

The content of the instruction manuals ensures that special operation procedures are carried out in a controlled way. All the documents in relationship to the quality assurance plan shall be supplied to working site for the convenience of reexamination.

The detailed Quality Assurance plan for the project is enclosed as Annexure 1.7.

14.5 WORKING GUIDANCE

Working guidance shall control quality and production activities mainly and should be supplied to the working site for reexamination.

14.6 NONCONFORMITY POINT

Nonconformity terms shall be reexamined to make it acceptable or modified or renewed with the final goal of attaining the approved standards. The documents for correct operation shall be provided to manufacturing or construction site for inspection.

14.7 QUALITY GUARANTEE RECORD

Contractor shall keep the records for quality guarantee.

These records should prove that the system and equipment has satisfied the requirements of the contract; all staff, operation programs and equipment are qualified in special operation procedure, and that the supervision to the Subcontractor is in accordance with the contract requirements.

The specified quality assurance record that is as approved in the combination plan of inspection and test shall be provided to the Owner.

14.8 SUPERVISION

Contractor shall supervise Subcontractor's implementation of combining quality and production.

14.9 MATERIAL PURCHASE

Material shall be purchased according to project specification and stated standards. The related control data, such as, chemical analysis, mechanical performance, non-destructive tests shall be illustrated in these standards in detail.



Supervision activities shall be performed in Subcontractor's office in connection with the Contractor's orders and quality plan and standards.

Before the delivery of all goods, the goods shall conform to the random examination and parameter rightness examination and pass the check and acceptance of the records of documents of the Subcontractor to ensure that goods are up to standards.

14.10 STANDARD EQUIPMENT AND PARTS

Standard equipment and parts shall be manufactured by a company that has passed quality assurance inspection.

All parts must be manufactured by the standard criteria and quality assurance standards.

14.11 PRODUCTION CONTROL

Working guidance shall illustrate in detail about the program procedure, control files and the field procedures.

Inspections and acceptance tests shall be performed and recorded.

The corresponding type of quality management (ISO 9001, 9002 9003 or equivalent standards) shall be illustrated in Contractor's order in such detail that it corresponds to the type and scope of the equipment supply. The standard industrial products that are purchased with no reference to list or manufacturer's directions need not be illustrated.

In the procedure of planning inspection, adjustment, evaluating adjustment and the corresponding quality examination and confirmation, the production control of the Subcontractor should be supervised.

15.0 EQUIPMENT ERECTION, SITE TESTING, COMMISSIONING

This clause generally covers the standards, scope of works, documentation, scope of installation, testing and commissioning of various requirements to be adhered to during the execution of the mechanical, Civil , electrical works and Instrumentation & Control works.

Works shall be performed in accordance with this technical specification and various other drawings and schedules submitted and approved by the Owner during the execution and the instructions from Engineer-in-charge or his authorized representatives during the progress of the work. All consumables required for the job shall be ensured by the contractor .All necessary equipment & instruments required to carry out the works, recalibration of the instruments required during loop checking and commissioning shall be done by the contractor.

Field quality plans shall be submitted and shall detail out for all the equipment, the quality practices and procedure etc. to be followed by the Contractor's site quality control organization during various stages of site activities including receipt of materials/equipment at site, preservation and storage, pre-assembly, erection, pre-commissioning and commissioning. The Contractor shall provide all necessary means for execution of inspection and testing, according to the requirements.

16.0 SPECIAL TOOLS AND TACKLES

The Bidder shall supply a complete set of unused special tools and tackles, including tool box, as required for erection, maintenance, overhaul or complete replacement of the equipment and components under this Specification. The cost of this shall be included in the base price.



17.0 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.

18.0 DOCUMENTATION

a. Drawings, Data / Documents to be submitted along with BID

The bid document shall have complete information for the FGD plant offered clearly identifying and describing the plant design, implementation and operation concept.

All documentation, diagrams and drawings necessary for presentation of the desired results and for comprehension and clarification of the related technical and commercial matters shall be included in the technical offer and shall contain the following documents as a minimum requirement

- 1 Time schedule for engineering, manufacturing erections/installations, commissioning and Reliability Test Run
- 2 Construction approach, phases of construction, commissioning and operation
- 3 General arrangement of the various sections showing disposition of FGD unit, Limestone and gypsum storage silos, Sizing calculations, etc
- 4 Description of main features of the design concept
- 5 Description of major equipment, systems, civil works, including site development, Scrubber tank, Ball mill, Ducting, All pumps, blowers, Booster fan, Rotary drum filters, Hydro cyclones, Service water piping, Slurry piping, Effluent piping, agitators, tanks, Silos, Compressors, Air receivers, Service air Piping, Instrument air piping, etc
- 6 General information and technical documentation of process and auxiliary systems
- 7 Information on conditions of operation
- 8 Descriptive Data sheets, performance curves, catalogues for all pumps, fans, blowers, Compressors, AC and ventilation system Heat load calculations, Ducting layout, data sheets.
- 9 Documents on the quality assurance system of the bidder
- 10 Training program and schedule for the Corporation's personnel
- 11 Details of operation, maintenance and training
- 12 Standards, codes and regulations: listing of major standards, codes and regulations (local, international, supplier's own country) which will be applied for the design and construction of plant equipment and facilities, for civil works and for testing of equipment
- 13 Completely Filled in Technical Data sheets as per schedule(Part-II Section-7).
- 14 Sub –vendor list
- 15 Spare lists
- 16 Control System Configuration
- 17 Bill of Quantity for I&C items
- 18 Basic operational and control philosophy of the system offered
- 19 Drive control philosophy

b. Drawings, Data / Documents to be furnished by the successful Bidder

The Bidder shall submit the following data / information / documents/ drawings to the OWNER/CONSULTANT, who in turn shall review and furnish comments on only important drawings/ documents. Bidder shall furnish a list of data / drawings / documents which shall be submitted to the Owner/Consultant with due dates of submission



immediately after award of Contract. The Bidder on fortnightly basis shall update the list. All drawings shall be generated in AUTO CAD.

- Detailed design and drawings for FGD unit, lime and Gypsum storage silos, Electrical and Control room etc.
- Final version of all documents drawings submitted along with the offer.
- Detailed design documents for scrubbers, pipe & detailed Cross Section drawings including support arrangement details & anchoring arrangements details etc.
- Bidder to submit and obtain Owner's Engineer's approval of all drawings / documents design, detail engineering and construction before proceeding with construction and execution. A list of such drawings will be finalised at the time of Award and which will get updated as the detail engineering progresses. The below mentioned list is Preliminary which shall be finalized after award of contract.

Document	Category A – Approval I – Information
General	
• Complete list of documents with proposed submission deadlines	I
• Progress reports	I
• Erection and installation progress reports	I
• Quality assurance procedure and program	I
• List of subcontractors/ manufacturers	A
• Proposed inspection and testing programs	A
• Detailed program for commissioning	A
• Detailed program of Reliability Test Run	A
• Testing documents/Report of results of all tests	A
• As-built-documentation including drawings of all equipment	I
• Spare part lists	I
• Performance guarantee / test procedure	A
• Quality Assurance Plans	A
• Process presentation of FGD plant	I
Mechanical Engineering	
• Layout of FGD and Auxiliaries	A
• GA and Cross sectional drawing of Absorber/ Scrubber, Storage Silos	A
• GA Drawings and Data sheets for All Pumps, Booster fans, Ball mills, GGH, Hydro Cyclones, Rotary drum filter, blowers, Compressors, Crushers, Conveyors, Dampers, valves, etc	A
• Sizing calculations for Absorber, GGH, Limestone requirement, and Gypsum generation.	A
• Slurry balance diagram	A
• P&ID for FGD system and auxiliaries	A



Document	Category A – Approval I – Information
• PFD/P&ID for Lime Stone unloading, crushing & storage system	A
• PFD/P&ID for gypsum handling and storage system, waste water system.	A
• Data sheet for Drain/ Submersible pumps	I
• Data sheet for Electrical hoist/ Cranes, Bucket Elevators, Conveyors, etc	I
• Sectional and detail drawings of all components	I
• Heat load calculations, ducting layout, Data sheet for HVAC	A
• GA drawing for bucket elevators, hopper, conveyor, feeder, crane, hoist, etc	I
• GA drawing for compressor building layout, compressor, air receiver, air dryer etc	A
• Data sheets for Dampers, Valves, Expansion joints	A
• Valve & piping Schedule/ Damper Schedule	I
• Data sheet for Bucket Elevators, Conveyors, feeder, hoist, Cranes, etc	I
• Data sheet for compressor, dryer, filters etc	I
• Drive selection calculation for bucket elevators, conveyor, feeder, hoist, crane, etc	I
• Drive selection calculation for compressor and dryer.	I
• Sizing calculation for hopper & silo	A
• Sizing calculation for pumps, tanks	I
• Piping Layout of Hydrant/ Spray system	I
• P&ID indicating Instruments and the interlocks for Hydrant and Spray (MVWS) system	A
• Hydraulic calculation for Hydrant system, automatic High and Medium velocity spray system.	I
• Layout for Fire Detection and Alarm system	A
• Interface wiring diagram from DV LCP to existing fire alarm panel	A
• Schematic Drawing for fire detection and Alarm system	I
• Data sheet and GA drawings for Hydrants, Detectors, Fire alarm Panel, cabling, Extinguishers etc.	I
• Layout for Make-up water/ Service Water/ Potable/ Auxiliary Steam piping with Cross section and details.	A
• P&ID, data sheet Ducting layout, Wiring drawing of HVAC system	I
• Layout for Effluent Water piping with Cross section and details.	I
• Characteristic correction curves for Booster fans	I
• Gas flow rate Vs SO ₂ removal Efficiency	I
• Inlet SO ₂ concentration Vs SO ₂ removal Efficiency	I



Document	Category A – Approval I – Information
• Inlet Dust concentration Vs dust removal Efficiency	I
• Inlet gas temperature Vs Stack Temperature	I
• Gas flow rate Vs Pressure Drop	I
• Gas flow rate Vs Water Consumption	I
• Characteristic curves for all Pumps, Blowers, Cyclones etc	I
• CFD modeling procedure and reports	A
Electrical engineering	
• Main single line diagram	A
• Design basis report for electrical system	A
• Sizing Calculation for equipment like Transformers, Switchgear, NSPBD, Cables, UPS System, Battery , Earthing, lightning protection, Illumination, etc.	A
• Technical data sheet for all the electrical equipment	A
• General arrangement drawing for all the electrical equipment	A
• Schematic diagram / wiring for all the electrical equipment	I
• Characteristic curves for all the motors	I
• Electrical switchgear room layout, Battery room layout etc.	A
• Cable tray layout for all the area	I
• Earthing layout for all the area	I
• Lightning protection layout for all the area	I
• Lighting layout for all the area	I
• Cable schedule	I
• Interconnection diagram	I
• Catalogues	I
• Relay setting calculation for complete system	A
• List of make or vendors	A
• Spares list	I
• List of Special tools	I
• Quality plan	A
• Test reports	A
Control & Instrumentation Engineering	
• Master Drawing List – Instrumentation	A
• System Description and Configuration for FGD plant, VMAS, Fire Fighting system for FGD plant, HVAC for FGD plant (P&ID wise)	A
• Operation and Control philosophy – Description of closed loop and open loop control schemes along with control schemes/logics	A
• Vendor Data sheets for all the I&C items– Field instruments / analyzers / Detectors / local control panels / Flow elements / Control valves / Final control elements / Cables etc	A
• Vendor Data sheets for all the I&C items of VMAS , Fire detection and protection system, HVAC system	A



Document	Category A – Approval I – Information
• Control Room layout	A
• GA & IA drawings – Pump instrumentation, Local control panels, Junction Box, LIE / LIR	A
• Instrument Hook-up diagrams	A
• Drive Control philosophy	A
• Drive List	A
• Cable tray layouts	A
• Instrument Schedule	A
• Cable Schedule	I
• Cable Interconnection	I
• IO list (hardwire + Soft Link)	I
• Control valve / Flow element sizing calculations	A
• I&C power distribution and earthing scheme	A
• Quality Assurance Procedure (MQP) / Test certificates	A
• Performance guarantee / test procedure	A
• Bill of Quantity for instrumentation items	I
• Spare list (mandatory, recommended, commissioning, consumables)	I
PLC vendor drawings	
• PLC Hardware and Software design specification	A
• System Architecture	A
• Bill of Quantity for PLC	A
• Data sheets for PLC items	A
• GA & IA of cabinets, consoles	A
• FAT & SAT procedure	A
• IO assignment and Panel layout details	A
• Power Distribution and Earthing scheme	A
• Power Consumption Calculations	A
• UPS sizing calculations	A
• HMI displays and Graphics	A
• Closed loop control schemes – SAMA drawings	A
• Open loop control schemes – ISA format	A
• List of software and licenses	A
Other Instrumentation drawings / documents	
• O&M manuals	I
• As-built drawings	I



Document	Category A – Approval I – Information
Civil Drawings	
<ul style="list-style-type: none"> Detailed civil arrangement drawings of all buildings and RCC/steel structures, with Design Basis Report and foundation system 	A
Detailed drawings and documents	
<ul style="list-style-type: none"> Foundation for Absorber Tower. Lime Silos Gypsum Silos Building for Lime slurry preparation (Enclosing Ball mill, mill separator tank, Lime Slurry tank etc) Building for Gypsum Recovery system, compressors, Pipe trestle for supporting flue gas duct, and other piping Foundation for Pumps, Booster fans, Blowers, tanks and other miscellaneous equipments etc. Drains and trenches, collection pit Electrical Switch gear room, Battery room, cable trenches etc. PLC Control room AHU room Access Roads with storm water drains to various building/ structures from Plant road 	A
Other documentation	
<ul style="list-style-type: none"> Quality assurance manuals 	I
<ul style="list-style-type: none"> Manual of Codes and Standards 	I
Operating manual	
<ul style="list-style-type: none"> Operating procedures and instructions of the Plant with description of all systems, processes and functional groups As built documentation General and individual control concept description 	I
Service and maintenance manual	
<ul style="list-style-type: none"> Maintenance procedures and instructions with description of all equipment and facilities 	I

Purpose: A: for Approval
I: for Information

c. General Documents to be furnished by the successful Bidder

- a) Contract network schedule
- b) Flow diagram for all systems indicating equipment, piping valves, specialties and instrumentation including performance test scheme, technical write-ups
- c) Details of painting specification.
- d) Final technical data sheets for all equipment
- e) Installation drawings and manuals for all equipment/systems
- f) Integrated operation and maintenance manuals for the complete plant as well as for all individual equipment.



- g) Test certificates for type/routine and standard acceptance tests
- h) Detailed interface schedule for all terminal points identifying terminal point no., size, material, type of connection, design flow, pressure and temperature at the terminal points
- i) Detailed schedule of LOA to commissioning shall be furnished in the Bar chart.
- j) Lubricants list (with quantities for initial fill and make-up).
- k) Erection procedure.
- l) As-built drawings for all equipment/systems supplied under this contract and all structures / works executed under this contract incorporating all changes/modifications upto the time of commissioning / handling over to the Owner/consultant.
- m) Detailed write-up on all pre-commissioning and commissioning activities.
- n) Storage instructions for all equipment
- o) Drawings/data to be required /submitted to statutory authorities

All documents, data sheets, drawing, schedules, lists, etc., to be submitted by the Bidder against this Contract shall be submitted in soft copies on CD/DVDs in addition to the required number of prints/reproducible. Required number of copies for all revisions shall be arranged by BIDDER, the number of copies and the methodology shall be covered elsewhere in the specification.

d. Engineering Information Submission Schedule

Prior to the award of Contract, a Detailed Engineering Information Submission Schedule shall be tied up with the Bidder. For this, the bidder shall furnish a detailed list of engineering information along with the proposed submission schedule. The list would be a comprehensive one including all engineering data / drawings / information for all bought out items and manufactured items. The information shall be categorized into the following parts.

- i) Information that shall be submitted for the approval to the Consultant. /Owner before proceeding further and
- ii) Information that would be submitted for Consultant. /Owner's information only.

The Engineering Information Schedule shall be prepared month wise.

The schedule should allow adequate time for proper review and incorporation of changes / modifications, if any, to meet the contract without affecting the equipment delivery schedule. The early submission of drawings and data is as important as the manufacture and delivery of equipment and hardware and this shall be duly considered while determining the overall performance and progress.

18.1 TIME SCHEDULING, BASED ON CPM

- Overall time schedule for design, manufacture, supply, assembly and commissioning broken down for the principal plant components and all construction works, stating dates for completion of any preparatory work from others which may be necessary.
- Detailed erection, installation and commissioning schedule.
- The Project is scheduled to be commissioned in 20 months from the date of award of EPC contract.

The Contractor shall ensure that the final draft of all schedules, lists or data sheets / equipment are produced to a uniform format irrespective of whether the source of the above schedules, lists and data sheets is in the main Contractor or a Sub-contractor of the main Contractor. All documents shall carry a uniform numbering system.



All Contractor's drawings which are found to be incorrect during the construction period or which require changes owing to site constraints, shall be corrected by the Contractor to an "as built" condition to reflect any necessary changes.

The stipulations and requirements specified elsewhere in the specification shall also be followed with respect to preparation and submission of drawings.

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 Bidder in his Tender in accordance with his overall implementation schedule and will be defined finally during Contract negotiations.

18.2 LIAISON MEETINGS

The liaison meetings shall be organised by the contractor (once a month 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.

18.3 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	12	4	4	4
2.	Data, drawings, documents, write-ups, calculation				
	- Preliminary	12	4	4	4
	- Revised	12	4	4	4
3.	Approved drawings, documents etc.	12	4	4	4
4.	Instruction manuals for erection and O&M	12	4	6	2
5.	As built drawings including O &M manual				
	- Hard Copy	12	5	5	2
	- Soft Copy	4	3	-	1



18.4 MANUALS

18.4.1 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.

Payments will be withheld for non-compliance or for late delivery of the drawings, procedures and manuals. In particular the Contractor shall be held responsible for consequential damage to the plant where such damage is due to late delivery of the O&M manual resulting in non-familiarity of the operating technique.

The Contractor shall also note that while all documents, procedures and manuals shall be in the English language including that of the sub vender of the contractor, it is particularly important that the O&M manuals be in clear concise English.

All manuals shall be divided by systems or sections and cross-indexed as necessary.

18.4.2 Certification Manual

This manual shall contain the approved works certification documentation for FGD plant equipment and services as specified in the relevant codes and standards and in this specification and the Contractors Quality Manual. This manual shall also include all material tests certificates. Certificates and test procedures shall be specific to the plant supplied.

18.4.3 Design Manual

This manual shall contain all the design calculations and all equipment and system data sheets and design criteria required under the Contract.

18.4.4 Construction Manual

This shall include a comprehensive record of as built site construction tests and records. Again the manual(s) shall be compiled in separate parts to reflect the plant and services supplied.

18.4.5 Commissioning Manual

This manual shall include all the records, certificates and test results arising from the agreed pre-commissioning and commissioning procedures carried out on site. The performance tests and guarantee test results shall also be included. There is a particular requirement that all commissioned equipment values be recorded in this manual and subsequently incorporated into the O&M manuals.

18.4.6 Operating and Maintenance (O&M) Manuals

The Contractor shall provide the O&M Manual properly bound, within the time specified, to enable the Owner's staff to become fully acquainted with the operation, adjustment and maintenance of the FGD plant. The manuals shall contain full and explicit instructions in respect of the operation of the FGD plant under all operating conditions and the maintenance routines and requirements to be established to maintain the FGD plant in optimum performance. These instructions shall be in the English language and be as comprehensive as possible and the form in which they are to be set out shall be agreed with the Owner / Engineer. The instructions may be divided as appropriate into individual sections and sub-sections as necessary. All section and sub-sections shall be clearly indexed and cross-referenced as required for clarity.



The instructions shall be tailored to suit the specific requirements of the Operations and Maintenance functions and personnel, taking into account the staffing philosophy for the thermal power plants.

The instructions for the related parts shall be accurate and easy to understand and shall contain the necessary sequence of individual activities. The diagram and drawings associated with the instruction shall be clear and unambiguous.

It is an essential requirement that all information and plant data contained in the manual must be project specific and derived from the design, manufacturers / suppliers and commissioning data of the as-built FGD plant. Where the Contractor includes standard brochures the installed item of equipment shall be clearly identified. All sections shall contain an introductory description of the particular item/system including its function and operating criteria and any special features. On the basis of the commissioning and running experience of the FGD Plant, the instructions shall be amended to a final form within three months of the end of commissioning and, for this purpose, the Contractor shall supply the required number of printed copies of all approved amendments for insertion in the bound set of instructions.

The entire O&M manuals including that of the sub venders shall all adopt the same format paper size etc. The Bidder shall prepare manuals integrating all equipments supplied by the sub venders.

19.0 GENERAL REQUIREMENTS

19.1 GENERAL

19.1.1 General design requirements

The equipment of the entire supply, the main parts as well as auxiliary parts and accessories, must be designed in such a way as to ensure its proper operation, easy control, regulation, erection and maintenance under every working condition.

In the design, particular importance shall be assigned to simplicity, accessibility and solidity of the machinery and its parts. It is of particular interest to achieve simple assembly, easy access for maintenance and repair and simple and safe operation.

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

The works shall be designed to facilitate inspection, cleaning, maintenance and repair. Continuity of supply is of prime concern. The design shall incorporate every reasonable precaution and provision for the safety of all those concerned in the operation and maintenance of the works. The plant shall be designed to operate satisfactorily under all variations of load, pressure, and temperature, as may be met in normal usage under the variation in climatic conditions.

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.

In selecting materials and in manufacturing, it is necessary to take into consideration the anticipated operating conditions of components and the environmental state of the plant site. The selection of materials shall also ensure the effective service life of each of the components used in the FGD plant.



The selection of materials shall conform to the requirement of International Standards Organization. Where there is no sufficient information issued by ISO, it is permissible that the material supplying standards of the manufacturing factory of Contractor are adopted. For all the materials and equipment required by the plant, only new ones or those which have not been used before shall be supplied. This requirement means that the raw material of the equipment and that part of new materials may not be derived from recycled material.

19.1.2 Standards and Codes of Practice

The work must be performed according to the most recent relevant codes, and standards, accident prevention regulations and legal regulations.

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 International Organization for Standardization (ISO). IEC/IS recommendations apply to the electrical equipment.

Equipment and special guarantees not covered in the scope of ISO and IEC/IS, shall conform to internationally approved standards.

The Contractor is not only responsible for each piece of equipment being correct but also the completed plant must meet design operating condition and performance requirements.

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 plant, 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.

19.1.3 Vibration

Vibration shall be reduced to the minimum as far as possible where there is vibration. 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 VDI (Verein Deutscher Ingenieure) Specification 2056 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.

19.1.4 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 "Environmental Requirements"-must not be exceeded.



19.1.5 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 FGD 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.

In all correspondence, technical schedules, drawings and instrument scales, the following units shall be used:

Quantity	Name of Unit	Symbol
Length	Metre	m
Mass	Kilogram	kg
Time	Second	s
	Minute	min
	Hour	h
Temperature	Degree Celsius	°C
	Kelvin	K
Electric Current	Ampere	A
Luminous Intensity	Candela	cd
Area	Square metre	m ²
Volume	Cubic metre	m ³
	Litre	l
Force	Newton	N
Pressure (gauge or absolute)	Bar	bar
	Kilopascal	kPa
	Millimeter of water column	mmwc
	Kilo gram per square centimeter	Kg/Cm ²
Stress	Newton per square millimetre	N/mm ²
Velocity	Metre per second	m/s
Rotational speed	Revolutions per minute	rpm
Flow	Cubic metre per hr	m ³ /h
	Tons per hour	t/h
	Kilogram per second	kg/s
	Litre per second	l/s



Quantity	Name of Unit	Symbol
Density	Kilogram per cubic metre	kg /m ³
Torque, moment of force	Newton metre	Nm
Moment of inertia (mr ²)	Kilogram square metre	Kgm ²
Work, energy or heat	Joule	J
Heat capacity, Entropy	Joule per kelvin	J/K
Calorific value	kilo calorie per kilo gram	kcal/kg
Power, radiatn flux	Watt	W
Heat release rate	Watt per square metre	W/m ²
Thermal conductivity	Watt per metre kelvin	W/mK
Dynamic viscosity	Newton second per square metre	Ns/m ²
Kinematic viscosity	Metre squared per second	m ² / s
Surface tension	Newton per metre	N/m
Concentration	Parts per million	ppm
Electrical conductivity	Microsiemens per metre at 25°C	μ s/m
Frequency	Hertz	Hz
Electric charge	Coulomb	C
Electric potential	Volt	V
Electric field strength	Volt per metre	V/m
Electric capacitance	Farad	F
Electric resistance	Ohm	
Conductance	Siemens	S
Magnetic flux	Weber	Wb
Magnetic flux density	Tesla	T
Magnetic field strength	Ampere per metre	A/m
Inductance	Henry	H
Luminous flux	Lumen	lm
Illuminance	Lux	lx
Thermal resistivity	Kelvin metre per watt	Km / W



19.1.6 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 may 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.

All components with surface temperatures exceeding 60°C shall be fitted with insulation to protect personnel. The surface temperature shall not exceed 60°C in the condition of the ambient temperature is 40°C.

When it is required to limit the medium temperature drop due to the medium conveying in order to meet the requirements of anti-block, anti-dew and other process, it must be insulated from the point of view to control the medium temperature.

Bright paints will be used to 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.

Likewise, appropriate colors shall be selected for the equipment for the purpose of diminishing weariness of workers.

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

The equipment shall be provided with the necessary elements to keep possible failure of the main, auxiliary or control elements from causing serious consequences. For this purpose, protections shall be installed such as: stops in case of failure of shafts auxiliary suspensions that will keep parts from falling or coming loose because of centrifugal forces or others; stops to limit movement in case of failure of normal limiting devices, etc. Protections that will decrease or deviate liquid or gas escapes shall also be provided for the same purpose.

Brakes, gears, clutch and similar devices will be located preferable in the last stage of the transmission, so that they will remain operational even in case of failure in other stages.

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.

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.

Lubricated parts and parts containing lubricants should be protected against oil leakages, as well as against contamination with extraneous material, with oil seals, packings and similar devices.

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.,)

The operational certainty of these devices should be in relation with the importance and operational need to maintain the established limits. Resetting of these devices, either automatic or manual shall be agreed upon with the buyer in each case. These elements shall be installed in such a way as to make it easy to detect the device that caused the machinery to stop.

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.

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 providing 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.

The design of FGD 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 FGD 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.

Draining of water and venting of gas 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.

19.1.7 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 met with their approval.

The basic guiding ideology is to adopt two methods: fire prevention and fire control. The following design philosophy will apply:

- Ensure the safety of personnel;
- Ensure the safety of the important and main equipment of the FGD plant;
- Prevent fire from spreading;
- Limit the damage to equipment.

Fire precaution shall comply with the following principle:

To improve conditions in designing and layout and to reduce potential fire danger, and the spreading of fire by adopting the method of observation.

The following methods shall be adopted to prevent fire from occurring:

- Using as far as possible fire proof or fire resistant materials



- Ensuring that, isolating combustible material is not used or stored in possible fire source area of the FGD plant.
- Reducing the area where cleaning and examination are difficult in FGD plant arrangement.

The following methods shall be taken into account to control the spread of fire:

- Use of fire proof material
- use of fire detection sensors and/or fire proof construction materials;
- providing a set of effective fire extinguishing system;
- providing a set of effective fire detecting equipment;
- providing the fire detection device in civil construction;

The fire detection system should detect a fire quickly and reliably at the beginning of the fire and activate a special alarm device operation.

The designing of detection system shall prevent against erroneous operation.

The supplied fire detection system will be a combination system involving an automated and manual hydrant, water hose, take up reel and special fire extinguisher.

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

During the construction phase of FGD 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.

19.1.8 Markings, Labels

All elements should be properly marked at the workshop, in order to make assembly and maintenance work as easy as possible. Whenever necessary, markings should be indicated in the corresponding drawings and/or special drawings for markings. Marks should be unmistakable and as far as possible follow a logical system that will make it easy to find the marked element. Marks should be indelible and clearly visible. Marks made only with paint will not be accepted. Parts that are the same but are not interchangeable shall be marked so as to differentiate them. Wherever necessary the position of a part within the whole shall be marked.

19.1.9 Signs

General

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 of 25 years 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.



Information signs

Information signs should supply the necessary information to acquaint personnel with the physical arrangement and structure of site, buildings and equipment, e.g. floor numbers, load-carrying capacities including marking of floor areas, working loads of cranes, lifting gear and lifts, room identification etc.

In the choice of information signs in situations not covered by ISO Recommendation 507 the possibility of using pictograms should be considered. Pictograms are particularly suitable for the identification of rooms, areas and buildings in the non-technical areas of the plant, sanitary and amenities buildings, etc.,

Emergency signs

In the event of accidents, all necessary information should be available immediately to those affected. Thus, a sufficient number of signs of appropriate size should be installed, e.g. escape routes (including marking of floor areas), emergency exits, fire alarms, fire extinguishers, instructions for special fire-extinguishing agents, warnings against fire-extinguishing agents (CO₂), first aid equipment, first aid points, accident reporting points, telephones etc.,

Mandatory signs

Signs indicating obligatory actions must be provided and installed wherever certain action is necessary e.g. do not obstruct the entrance; keep right etc.

Signs should also indicate when the wearing of protective clothing and equipment is necessary and obligatory, e.g., protective goggles, protective clothing, helmets, head guards, breathing equipment, ear muffs etc.

Warning signs

Warning signs should refer to the existence or possible existence of danger, e.g. flammable substances, explosive substances, corrosive or noxious substances, suspended loads, general danger, width/height restriction, steps, risk of trapping, slipping, falling, etc. In addition to warning signs, appropriate black-yellow strip markings should also be used where necessary.

Local indicators

Easily visible indicators have to be arranged for: All dampers, valves, level indicators and flow indicators, dampers, mill classifier, etc.

19.1.10 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.

Packing

All equipment and instruments should be fully packed and protected from damage during transportation and field storage. The equipment instruments should be provided with through protecting measures before packing. All machine surfaces should be protected with planks or similar materials and reinforced with metal strips or plates from the outside.



Under actual conditions, all equipment such as motor, switch, Control device, instrument and component should be sealed at the joint with polyethylene insulation board and a corresponding drying agent should be provided.

For all piping ends as well as pipes and tanks, the openings should be protected from damage and sealed to avoid the invasion of ash, moisture and air. These protection measures should be kept intact before the start of installation or moving for periodic inspection. The cost spent for the moving, modification and replacement of the packing and protection device should be paid by the Contractor.

A waterproof enclosed packing list should be provided in each planks or packing case.

The name of articles in the packing case should be marked clearly on the packing list so as to be identified easily.

The articles in the case should be supported by wooden bars in order to be fixed safely and it should not be wedged individually with wooden pad. The marks outside the case should be printed with climate proof materials or paints so as to be protected from being removed during transportation.

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 marks should be painted or printed clearly and durably with characters of 40 mm height at minimum on both ends of the packing case. The labels should be well protected to prevent loss.

A mark indicating the correct lifting position should be shown in arrow on the packing case.

Field Storage and Cleaning.

The arrangement requirements of storehouse should be developed during the program contracting period to suit the field conditions and possible storage facilities. Equipment components should be packed and maintained to suit the needs of transportation and field storage. The detailed rules should be worked out in the contract to suit the general requirements and any special requirement of storehouse as well as the inspection requirements for special components.

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.

Classes for Storehouse:

Three classes for storehouse are described as follows:

- Storehouse class A: Special measures are taken to protect the stored goods and the temperature, humidity, ash are controlled within a specified range.
- Storehouse class B: Goods are stored with temperature uncontrolled.
- Storehouse class C: It is an outdoor storage with a drainage system on the ground.

No matter what class of storehouse is used, the following basic requirements shall be satisfied.

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.



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

After the store house/field are accepted, all components should be inspected as to whether the paint, seal and packing are mechanically damaged. All these damages should be repaired if these components will not be installed immediately.

The components stored in storehouse class C should be protected from rainfall, salt corrosion, ash and other adverse conditions with a temporary cover or tent if possible. A drainage device should be provided for this temporary cover or tent.

Inspection during Storage:

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.

Unpacking or inspection for outdoor package (class C) shall not be carried out during rainfall or big wind (salt corrosion is possible).

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 after 4 weeks and 8 weeks from acceptance, and then in an interval of every 12 weeks. If it is necessary to replace the drying agent during any inspection, a full inspection every 4 weeks shall be carried out until a successful inspection result is obtained and in the meantime, the conventional inspection shall be carried out continuously.

19.1.11 Painting, Insulation and Anti-dewling

Anti corrosive coatings and painting should 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.

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 different 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 principle color of field equipment should be determined by Owner and Contractor in contracting stage.

Further requirements with regard to painting, insulation, and anti-dewling are specified in the relevant sections in the detailed technical specifications. The specified requirements shall be applied to the whole equipment and facilities of the FGD Plant Contract.



19.1.12 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.

19.2 DISCREPANCIES IN THIS TECHNICAL SPECIFICATION

Any contradiction between Various parts/ sections of this Technical Specification, between text and drawings, the document giving the more extended scope or requirement shall be considered to be within the Contractor's scope of supply.

20.0 FUNCTIONAL GUARANTEES, PENALTIES FOR SHORTFALL IN PERFORMANCE AND PERFORMANCE GUARANTEE TESTS

GENERAL

The term "Performance Guarantees" wherever appears in the Technical Specifications shall have the same meaning and shall be synonymous to "Functional Guarantees". Similarly the term "Performance Tests" wherever appears in the Technical Specifications shall have the same meaning and shall be synonymous to "Guarantee Test(s)".

20.1 PERFORMANCE GUARANTEES / PERFORMANCE TESTS

20.1.1 General Requirements

The Contractor shall guarantee that the equipment offered shall meet the ratings and performance requirements stipulated for various equipment covered in these specifications.

The guaranteed performance parameters furnished by the Bidder in his offer, shall be without any tolerance values whatsoever. All margins required for instrument inaccuracies and other uncertainties shall be deemed to have been included in the guaranteed figures. No tolerance or allowance on the test result will be permitted for instrument errors or inaccuracy, the method of testing or any other causes.

The Contractor shall conduct performance test and demonstrate all the guarantees covered herein. The various tests which are to be carried out during performance guarantee tests are listed in this Sub-section. The guarantee tests shall be conducted by the Contractor at site in presence of Owner on each unit individually.

All costs associated with the tests including cost associated with the supply, calibration, installation and removal of the test instrumentation shall be included in the contract price.

The performance tests shall be performed using only the normal number of Owner supplied operating staff. Contractor, vendor or other subcontractor personnel shall be used only for instructional purposes or data collection. At all times during the Performance Tests the emissions and effluents from the Plant shall not exceed the Guaranteed Emission and Effluent Limits.

It shall be responsibility of the Contractor to make the plant ready for the performance guarantee tests.

**ANNEX - 1.6****CLEANING, PROTECTIVE COATING AND PAINTING****1.0 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. 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.

1.1 Codes and Standards

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

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

IS: 5	Colors for ready mixed paints and enamels.
IS: 101	Methods of test for ready mixed paints and enamels.
IS: 104	Ready mixed paint, brushing, Zinc Chrome, priming.
IS: 158	Ready mixed paint, brushing, bituminous, black, lead free, acid, alkali, water and heat resisting.
IS: 161	Heat resistant paints
IS: 1303	Glossary of terms relating to paints.
IS: 1477	Code of practice for painting of ferrous metals in buildings (Parts I & II).
IS: 2074	Specifications for ready mixed paint, Air drying, red oxide zinc chrome priming.
IS: 2338	Code of practice for finishing of wood and wood based materials: Parts 2 schedules.
IS: 2339	Aluminum paint for general purposes, in dual container.
IS: 2395	Code of practice for painting of concrete, masonry and plaster



	surfaces: Part 2 schedules.
IS: 2524	Code of practice for painting of non-ferrous metals in buildings (Parts I & II).
IS: 2932	Specification for enamel, synthetic, exterior (a) undercoating, (b) Finishing
IS: 3140	Code of practice for painting asbestos cement building products.
IS: 6158	Recommended practice for design safeguarding against Embrittlement of hot dip Galvanized Iron & steel products.
IS: 6159	Recommended practice for design & fabrication of Iron & steel products prior to Galvanizing & metal spraying.
IS: 6278	Code of practice for white washing and Color - Washing.
IS: 10221	Code of practice for coating & wrapping of underground mild steel pipelines.
IS: 33	Inorganic pigments and extenders for paints –Methods of sampling & test.
IS: 13183	Aluminum paint, Heat resistant - specifications.
IS: 144	Specification for ready mixed paint brushing, petrol resisting, Air drying for Interior paints of tanks and containers, Red oxide.
IS: 9954	Pictorial surface preparation standards for painting of steel surfaces.
IS: 11883	Specification for Ready Mixed Paint, Air Drying, Red Oxide Priming for metals.
IS: 9404	Color code for identification of pipelines used in the Thermal Power Plants.
IS: 12744	Specification for Ready Mixed Paint, Air Drying, Red Oxide-Zinc Phosphate Priming.
BS: 2015	Glossary of paint selected terms.
BS: 5252	Final coat color.
BS: 7079A1/S1	Specification for rust grades and preparation grades of uncoated substrates after overall removal of previous coating.
BS: 7079A2	Preparations grades of previously coated steel substrates.
BS: 7079GrC	Surface roughness characteristics of blast cleaned steel substrates.
BS: 7079GrD	Methods for surface preparation.
BS-4232	Surface Finish of Blast cleaned steel for painting.
ASTM	American Standard for Testing Material.
ASTM A 780	Standard practice for repair of damaged galvanized coatings.
AWWA	American Water Works Association.
ASA-A-13.1-1981	Scheme for identification of piping system (American National Standard Institution).
DIN	Deutsehes Institute for Normung
S1S-055900-1967	Surface preparation standards for painting steel surfaces. (Swedish standard Institution)
SSPC-SP	Preparation Specifications (Steel structures painting council, U.S.A.). National Association of Corrosion Engineers, U.S.A. (NACE).

1.2 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.

2.0 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.

3.0 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.

4.0 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.

5.0 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



Surface preparation methods	SIS 055900	DIN 55928 Part-4	BS 4232 only for blasting	SSPC-Vis
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.

6.0 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.

6.1 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 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.

6.2 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.



6.3 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.

6.4 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).

7.0 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 be 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-1.

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

8.0 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.

9.0 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.

10.0 Application

Health and safety of work

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

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

Methods

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

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

All prime coatings shall be applied by brush or airless spray or a combination of these methods, as approved by the coating manufacturer.

All doors, windows, stairways, handrails (if painted), bolts, flanges and equipment supports shall be finish painted by brush.

Spray guns should not be used outside in windy weather or near surfaces of a contrasting colour unless the latter is properly protected.



All cold-spray painting shall be done using standard equipment in accordance with accepted standards and methods.

Care has to be taken not to connect spraying devices for nitro and backelite paints simultaneously to oil based paints.

Paint applied to items that are not being painted shall be removed at the supplier's expense, leaving the surface clean, unstained and undamaged.

Dry film thickness (DFT)

To the maximum extent practicable the coats shall be applied as a continuous film of uniform thickness and free of pores. Overspray, skips, runs, sags and drips should be avoided. The different coats shall not be of the same colour.

For a composite paint or coating system consisting of several coats, the total DFT must be at least equal to the sum of the minimal DFT's for the individual coats. If, the paint system does not have the required minimum DFT those areas should be marked & repainted. If the occurrence of those areas is high, the complete surface must be repainted. It is also critically important to check the DFT of primers and intermediate coats and to correct them where necessary.

For paintings based on Zinc silicate the DFT is limited as well on minimum DFT as on maximum (150µm) because of the risk of mud cracking.

Consumption of paints

Has to be evaluated according to DIN 53220. The paints shall be tested as per IS - 101.

Each coat of paint shall be allowed to harden before the next is applied. For epoxy paint the hardening time normally is 12-14 hours. Suppliers' recommendations regarding hardening time of epoxy paints must be followed.

Particular attention must be paid to full film thickness at edges.

The minimum total dry film thickness of the paint systems shall be as recommended in the following tables below. The DFT is given in microns (millionths of a metre).

11.0 Protective coatings and paint systems

The colour coding for identification of pipelines should comply with IS-2379 & IS -9404.

The type and number of protective coats for any item requiring painting are to be in accordance with DIN 55928 and are to be at least of a quality as shown in the attached Annex-1- Paint System.

Alternative to the Annex-1- Paint System specified, are to be presented on the schedule Departure from Specification, as indicated elsewhere.

Generally, all parts shall receive the specified prime coat (s) at the supplier's works to ensure that no corrosion occurs during transport to the site and storage at the site.

Parts which cannot be damaged during transport shall receive the full number of coats.



Types of Substrate, Base metal:

- Ferrous (Surface Temperature during operation < 120° C, EN ISO 12944:1998)

To this group belongs carbon steel, low alloyed steel & high alloyed steel. All paint systems are inevitable for corrosion protection.

- Hot dip galvanized surfaces.

Hot dip galvanized surfaces do require painting in a wet, industrial, chemicals and/or marine environment

- SS (EN ISO 12944:1998 conditionally applicable)

In general, SS surfaces do not require painting unless in a chemical and/or marine environment. In case of chemical and/or marine environments determination of whether or not the surface requires painting depends on the chemical content of the base metal.

The following formula applies
 $W = Cr + 3.3 \times Mo + 22.45 N_2$

If $W < 23$, then the surface has to be painted.

If $W < 28$ & $W > 23$, then the surface to be painted if splash contact with the media (i.e. sea) is possible. This may also occur if there is a strong wind carrying drops to the surface.

If $W > 28$, then the surface need not be painted.

- Aluminium

By default such surfaces/components will not be painted. Exceptions are architectural/aesthetic reasons and high corrosive conditions, which shall be evaluated separately depending on aluminum alloys.

12.0 Galvanizing

Galvanizing works shall conform in all respect to B.S. 729, B.S. 3083 and B.S.C.P. 2008 and to DIN 50976 whatever requires the higher quality and shall be performed by the hot dip process, unless otherwise specified.

It is essential that details of steel members and assemblies which are to be hot-dip galvanized should be designed in accordance with B.S 4479.

Vent-holes and drain-holes should be provided to avoid high internal pressures and air-locks during immersion, which may cause explosions, and to ensure that molten zinc is not retained in pockets during withdrawal.

Careful cleaning of welds is necessary before welded assemblies are dipped. The welds and the surrounding metal should be cleaned separately, preferably be blast-cleaning, because the usual preliminary pickling cannot be relied on to remove the welding slag.

All defects of the steel surface including cracks, surface laminations, laps and folds shall be removed in accordance with B.S. 4360. All drilling, cutting, welding, forming and final fabrication of unit members and assemblies shall be completed, where feasible, before the structures are galvanized. The surface of the steelwork to be galvanized shall be free from paint, oil, grease and similar contaminants in accordance with DIN 55928, part 4 and DIN 50976. The weight of zinc coating per unit area has to be noted in the manufacturing documents in accordance with DIN 50976.



The minimum average coating weight shall be as specified in Table 1 of B.S. 729 or Table 2, DIN 50976, whatever requires higher quality.

Structural steel items shall be initially grit-blasted to B.S. 4232, second quality, (Sa 21/2) or by pickling in a bath and the minimum average coating weight on steel sections 5 mm thick and over shall be 900 g/m².

On removal from the galvanizing bath, the resultant coating shall be smooth, continuous, free from gross surface imperfections such as bare spots, lumps, blisters and inclusions of flux, ash or dross.

Galvanized contact surfaces to be joined by high-tensile friction-grip bolts shall be roughened before assembly so that the required slip factor (defined in B.S. 3294, part 1 and B.S. 4604, part 1) is achieved. Care shall be taken to ensure that the roughening is confined to the area of the mating faces.

Bolts, nuts and washers, including general grade high-tensile friction grip bolts (referred to in B.S. 3139, and B.S.4395 part 1) shall be hot dip galvanized and subsequently centrifuged (according to B.S. 729). Nuts shall be tapped up to 0.4 mm oversize after galvanizing and the threads oiled to permit the nuts to be finger-turned on the bolt for the full depth of the nut. No lubricant, applied to the projecting threads of galvanized high-tensile friction-grip bolt after the bolt has been inserted through the steelwork, must be allowed to come into contact with the mating faces of the steelwork,. A local remelting of the galvanized parts to achieve the nuts to be finger turned on the bolt is possible in accordance with DIN 50976.

Protected slings must be used for offloading and erection. Galvanized work which is to be stored at the works or on site shall be stacked so as to provide adequate ventilation to all surfaces to avoid wet storage staining (white rust).

Small areas of the galvanized coating damaged in any way shall be restored in accordance with DIN 55928, part A and DIN 50976 by:

- Cleaning the area of any weld slag rust and other impurities and by thorough wire brushing to give a metallic clean surface.
- Application of suitable number of coats of zinc-rich paint containing more than 90 % w/w of zinc in dried film. The dry film thickness shall exceed at least 50 % the thickness of the desired galvanization. In case of application of a low melting point zinc alloy repair rod, the rods shall be in accordance with DIN1707, the thickness of the alloy shall be at least as of the desired galvanization.

The restored area is not to exceed 1 % of the galvanized surface.

Surface restoration of parts in contact with drinking water is not allowed and the quality of the galvanization is to be in accordance with DIN 2444.

After fixing, bolt heads, washers and nuts shall receive two coats of zinc-rich paint. Connections between galvanized surfaces and copper, copper alloy or aluminum surfaces shall be protected by suitable preferably hydrophobe tape wrappings to the owner's approval.

13.0 Sprayed Metal Coatings

Corrosion protection may be also achieved by spraying of suitable metals as zinc and/or aluminum on the surfaces of structures. For special cases tin, copper, lead can be used as well. Methods of surface preparation have to conform to B.S. 2569 or to DIN 8567. A proper treatment of the surface followed by an immediate spraying is to apply to ensure adhesion of the sprayed metal. The surface has to be clean, free of impurities, rust, mill scale and rough enough to have binding properties to ensure good enticulation with the sprayed layer. Suitable



roughness can be achieved by blast cleaning acc. to BS 4232 or DIN 8567. Welds are to be cleaned and prepared with special care. All surfaces to be treated have to be dry and accessible.

Application of coatings, requirements for thickness, adhesion, composition of coating metals, and subsequent treatment have to conform to BS 2569, DIN 8565 and 8567.

Testing of the spray coated layers are to be carried out in accordance with DIN 8565.

The contractor has to specify the type, composition and thickness of the sprayed metal and of the sealing coating according to DIN 8565 including the corresponding warranties and tests if, sprayed metal coating will be applied.

Safety of work:

All precautions connected with this type of application of corrosion protection have to be in accordance with German regulation DVS 2307, page 1. 2.

Sprayed, unfused coating of metals and metallic compounds applied by combustion gas flame, plasma arc, detonation and similar processes, and the preparation of components, spraying techniques, sealing, finishing and inspection shall be according to B.S. 4761.

The hot galvanized surface has to be cleaned before the application of the coats to remove corrosion products, dirt, dust, grease.

The cleaning can be achieved by

- brush off
- washing with 1 - 1.5 % ammonia water with up to 0.1 % detergent added and followed by wet grinding to turn the foam to grey color,
- steam blasting.

14.0 Warning Notes / Signals

This Instruction serves the identification of the coated surfaces that are received from shop in assembled condition / module wise.

The warning note shall prevent any possible damage to the coated surfaces during transportation / assembly at site.

Eg.: Welding work OR Heat treatment work on the outside of coated or lined surfaces is prohibited.

15.0 Colour Code for Piping

- a. The colour code scheme is intended for identification of the individual group of the pipeline. The system of colour coding consists of a ground colour and colour bands superimposed on it. The colour coding for the identification of pipelines shall comply with **Annex – 1** of this specification.

Ground Colour shall be applied throughout the entire length for un insulated pipes. For insulated pipes, on the metal cladding or on the pipes of material such as non-ferrous metals, austenitic stainless steel etc., ground colour coating of minimum 2m length or of adequate length not to be mistaken as colour band shall be applied at places requiring colour bands. Colour band(s) shall be applied at the following location.

- i. At battery limit points
- ii. Intersection points & change of direction points in piping ways.



- iii. Other points, such as midway of each piping way, near valves, junction joints of service appliances, walls, on either side of pipe culverts.
 - iv. For long stretch/yard piping at 50 M interval.
 - v. At start and terminating points.
- b. Flow direction shall be indicated by an arrow in the location stated above and as directed by Engineer. Colors of arrows shall be black or white and in contrast to the color on which they are superimposed. The size of the arrows shall conform to IS:2379. Product names shall be marked at pump inlet, outlet and battery limit in a suitable size as approved by Engineer. As a rule minimum width of color band shall conform to 75 mm up to 300 NB and to 100 mm over 350 NB. Whenever it is required by the Engineer to indicate that a pipeline carries a hazardous material, a hazard marking of diagonal stripes of red and golden yellow as per IS:2379 shall be painted on the ground color.
- c. All uninsulated piping systems, hangers and supports shall have two coats of suitable primer coats and with suitable finish paints as per Annexure-3 Painting system. Shades shall be as per IS 5 or as indicated by Owner /Engineer. Service of the pipe/line designations shall be painted on all pipes at visible locations.

16.0 Identification of Vessels, Piping etc.

Equipment number shall be stenciled in black or white on each vessel, column, equipment and machinery after painting.

Line number in black or white shall be stenciled on all the pipelines of more than one location as directed by Engineer; size of letters printed shall be 150 mm (high) for column & vessels. 50 mm (high) for pump compressor and other machinery and shall be as per IS: 9404 for piping. The storage tanks shall be marked as detailed in the respective drawing.

17.0 Inspection and Testing

- a) All painting materials including primers and thinners brought to site for application shall be procured directly from manufacturer as per specifications and shall be accompanied by manufacturer's test certificates. Paint formulations without certificates are not acceptable. Engineer at his discretion, may call for tests for paint formulations. Contractor shall arrange to have such tests performed including batch wise test of wet paints for physical & chemical analysis. All costs thereof shall be borne by the contractor. The paints shall be tested as per IS: 101 / equivalent international standard and approved by the Owner.
- b) The painting work shall be subject to inspection by Engineer at all times. In particular, following stage wise inspection shall be performed and contractor shall offer the work for inspection and approval of every stage before proceeding with the next stage. The record of inspection shall be maintained in the registers. Stages of inspection shall be surface preparation, primer application and each coat of paint. In addition to above, record shall include type of shop primer already applied on equipment e.g. red oxide zinc chromate or zinc phosphate or Silicate primer etc.
- c) Any defect noticed during the various stages of inspection shall be rectified by the contractor to the entire satisfaction of Engineer before proceeding further. Irrespective of the inspection, repair and approval at intermediate stages of work, contractor shall be responsible for making good of any defects found during final inspection/guarantee period/defect liability period as defined in general condition of contract. Dry film thickness (DFT) shall be checked and recorded after application of each coat and extra coat of paint shall be applied to make-up the DFT specified without any extra coat to the Owner.

**18.0 Guarantee**

The contractor shall guarantee that the chemical and physical properties of paint materials used are in accordance with the specifications contained herein/to be provided during execution of work. The contractor shall produce test reports from the manufacturer regarding the quality of the particular batch of paint supplied. The Engineer shall have the right to test wet samples of paint at random for quality of the same. Batch test reports of the manufacturer's for each batch of paints supplied shall be made available by the contractor.

19.0 Standard Final Colour of Equipment and Piping**19.1 Standard Colour Code for Mechanical Equipment**

Sl. No.	Description	Ground Colour
A	Service Water System	Sea Green
B	Crane & Hoist	
1	EOT crane	Canary Yellow
C	Compressed Air Plant	
1	Air compressor	Sky Blue
2	Compressed air dryer	Sky Blue
3	Air receiver	Sky Blue
D	Chemical Dosing	Dark Admiralty Grey
E	Fire Protection System	Fire red
F	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:

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

19.2 Standard Colour Code for Electrical Equipment

1	Transformers	Olive grey for power transformers and pebble grey for service transformer	RAL 7002 for power transformers and RAL 7032 for service transformers
2	Bus ducts	pastel turquoise for indoor and olive grey for outdoor	indoor 6034 and outdoor 7002
3	Junction boxes.	Pebble grey	RAL 7032
4	HT/LT Switchboards, Distribution boards, Control & Relay panels		
	a) Indoor	Pebble grey	RAL 7032
	b) Outdoor	Pebble grey	RAL 7032
5	UPS Panel, charger panels	Light grey	Exterior RAL 7032 Interior Brilliant white



7	LT Motor	Pebble grey	RAL 7032
8	HT Motor	Pebble grey	RAL 7032
9	Lighting fittings	As per manufacturer's standard	As per manufacturer's standard
10	Cable trays	Galvanized	

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

19.3 Colour Coding for Identification of Pipelines used in Thermal Power Plants/FGD 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)	Potable water	Sea green	217	French blue	166	
d)	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	Transformer oil	Light brown	410	Light orange	557	
5	Fire services	Fire red	536	-	-	-
6	Effluent pipes	Black	-	-	-	-



19.4 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

- 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.
- All primers and finish coats shall be cold cured and air dried unless otherwise specified.
- 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.
- Technical data sheets for all paints shall be supplied at the time of submission of quotations.
- 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.
- Contractor will submit the final colour shade for all equipments & piping under his scope for final approval by client / consultant.



Painting Systems						
Cleaning, Protective Coating and Painting. - Systems designed as per ISO 12944 with service life of 10 yrs.						
Surface/ Location	Temp	Surface prep	Coat	No. of coats	Generic Type	Dft/Coat
Structural Steel work, piping (Oil + Water), tanks outside surface, transmission towers cranes, steel floors, galleries, stairways, Outdoor.	< 130 Deg	SA 3	Primer	1	Solvent based IZS - VS of 60%. Zn Dust - 1.77 kg/ltr minimum. Zn dust by weight - minimum 85%. Pot life 12 hrs / 21 Deg.- Paint to meet compositional & performance specifications for SSPC Paint 20 , Level 1	75
			Touch up	1	Two component Zinc rich Primer meeting performance and compositional specifications of SSPC Paint 20 Level2	(75)
			Mid coat	1	2 pack High build High Solid Lamellar MIO based Epoxy Mid coat.	200
			Finish	1	2 pack Acrylic Aliphatic Polyurethane top coat - with Gloss retention of at least 90% on QUVB exposure of minimum 1000 hrs.	75
					Total	350
Surface/ Location	Temp					
Structural Steelwork, piping, indoor and outdoor	130 to 200 Deg	SA 3	Primer	1	Solvent based IZS - VS of 60%. Zn Dust - 1.77 kg/ltr minimum. Zn dust by weight - minimum 85%. Pot life 12 hrs / 21 Deg.- Paint to meet compositional & performance specifications for SSPC Paint 20 , Level 1.	75
			Touch up	1	Two component Zinc rich Primer meeting performance and compositional specifications of SSPC Paint 20 Level2	(75)
			Sealer	1	Single pack Heat Resistant Silicon Acrylic Finish paint.	25
			Finish	2	Single pack Heat Resistant Silicon Acrylic Finish paint.	25
					Total	150
Alternative -2		SA 3	Primer	1	Solvent based IZS - VS of 60%. Zn Dust - 1.77 kg/ltr minimum. Zn dust by weight - minimum 85%. Pot life 12 hrs / 21 Deg.- Paint to meet compositional & performance specifications for SSPC Paint 20 , Level 1.	75
				1	Single pack Moisture Cured, Inorganic Silicate based heat resisting finish up to 400 Deg - Grey shade./ white/ Aluminium.	50
			Finish	1		50
					Total	175



Surface/ Location	Temp	Surface prep	Coat	No. of coats	Generic Type	Dft/Coat
Alternative-3			Finish	1	Single pack Heat Resistant Silicon Acrylic Finish paint. - either Aviation White/ Aviation Orange.	80
					Total	155
Surface/ Location	Temp	Surface prep	Coat	No. of coats	Generic Type	Dft/Coat
Structural Steel work Piping, Un-insulated Carbon Steel Indoor and Outdoor	200 to 400 mmmm mDeg C.	SA 3	Primer	1	Solvent based IZS - VS of 60%. Zn Dust - 1.77 kg/ltr minimum. Zn dust by weight - minimum 85%. Pot life 12 hrs / 21 Deg.- Paint to meet compositional & performance specifications for SSPC Paint 20 , Level 1.	75
			Touch up	1	Two component Zinc rich Primer meeting performance and compositional specifications of SSPC Paint 20 Level 2.	(75)
			Finish	2	Heat Resisting Silicon Aluminium Paint. VS to be min 28%.	20
					Total	115
Structural Steel work, Piping (Oil + water) , Tanks Indoor.	<130 Deg.C	SA 3	Primer	1	Solvent based IZS - VS of 60%. Zn Dust - 1.77 kg/ltr minimum. Zn dust by weight - minimum 85%. Pot life 12 hrs / 21 Deg.- Paint to meet compositional & performance specifications for SSPC Paint 20 , Level 1.	75
			Touch up	1	Two component Zinc rich Primer meeting performance and compositional specifications of SSPC Paint 20 Level2	(75)
			Mid coat	2	2 pack High build High Solid Lamellar MIO based Epoxy Mid coat.	100
			Finish	2	Two component Polyamide Cured Epoxy Coating.	25
					Total	325
Surface/ Location	Temp	Surface prep	Coat	No. of coats	Generic Type	Dft/Coat
Structural Steel work in the battery rooms, chlorination plant and water treatment plant, (extremely aggressive atmosphere)	Ambient	SA 3	Primer	1	Solvent based IZS - VS of 60%. Zn Dust - 1.77 kg/ltr minimum. Zn dust by weight - minimum 85%. Pot life 12 hrs / 21 Deg.- Paint to meet compositional & performance specifications for SSPC Paint 20 , Level 1	75
			Touch up		Two component Zinc rich Primer meeting performance and compositional specifications of SSPC Paint 20 Level2	(75)



Surface/ Location	Temp	Surface prep	Coat	No. of coats	Generic Type	Dft/Coat
			Mid coat	1	Two component, high build rust encapsulating, aluminium pigmented modified epoxy coating.	125
			Finish	1	Two component High Build high Solid Aliphatic Amine Cured Epoxy coating. - Min VS 85%	150
					Total	350
Steel Tanks inside Surface (Total) for Oil Storage	Normal	SA 2.5	Primer	1	Two component high build amine cured epoxy Primer with zinc phosphate pigment.	75
			Finish	2	Two component Self priming High Build Polyamine adduct cured epoxy coating.	125
					Total	325
Alternative-1			Finish	3	Two component Self priming High Build Polyamine adduct cured epoxy coating. (No primer required. Self priming coating post blasting)	125
					Total	375
Alternative-2			Finish	2	Two component High build high solid Solvent free epoxy coating - certified by CFTRI for Potable water usage. (Primer same as above)	150
					Total	300
Surface/ Location	Temp					
Steel Tanks inside Surface (Total) for Water Storage (Potable and Distilled Water)	Ambient	SA 3	Primer	1	Two component high build polyamide cured zinc phosphate Primer	75
			Finish	2	Two component Self priming High Build Polyamine adduct cured epoxy coating - certified by CFTRI for Potable water usage.	125
						325
Alternative 1			Finish	2	Two component High build high solid Solvent free epoxy coating - certified by CFTRI for Potable water usage. (No primer required. Self priming coating post blasting)	200
						400
Steelwork immersed in water such as inlet/	< 60 Deg C	SA 3	Primer	1	Two component High Build High Solid Rapid Curing Epoxy Zinc Phosphate Primer.	75



Surface/ Location	Temp	Surface prep	Coat	No. of coats	Generic Type	Dft/Coat	
outlet structures, dolphins, sheet piling			Finish	1	Two component High build High Solid Modified Epoxy coating.	500	
					Total	575	
			Wherever TAR based product is not to be recommended.				
			Finish	1	Two component High build High Solid Modified Epoxy coating	500	
					Total	500	
		Finish	1	Two component High build High Solid Modified Epoxy coating with Glass Flake.	500		
				Total	500		
Alternative 1							
Cast Iron Water pipelines - Outside surface, buried in Soil	< 60 Deg C	SA 3	Primer	1	Solvent based IZS - VS of 60%. Zn Dust - 1.77 kg/ltr minimum. Zn dust by weight - minimum 85%. Pot life 12 hrs / 21 Deg.- Paint to meet compositional & performance specifications for SSPC Paint 20 , Level 1	75	
			Finish	2	Polyamide Cured Coal Tar Epoxy, Vs min 65% black.	200	
					Total	475	
Alternate-1			Finish	1	Two component High build High Solid Modified Epoxy coating	500	
Alternate -2			Finish	1	Two component High build High Solid Modified Epoxy coating with Glass Flake	500	
Surface/ Location	Temp						
Steel Pipes - Inside surfaces such as cooling water lines.	< 60 Deg C	SA 3	Primer	1	Solvent based IZS - VS of 60%. Zn Dust - 1.77 kg/ltr minimum. Zn dust by weight - minimum 85%. Pot life 12 hrs / 21 Deg.- Paint to meet compositional & performance specifications for SSPC Paint 20 , Level 1.	75	
			Finish	2	Coal Tar Epoxy, Vs min 65% black.	225	
					Total	525	
Water Pipelines - Outside Surface, Indoor	< 60 Deg C	SA 3	Primer	1	Solvent based IZS - VS of 60%. Zn Dust - 1.77 kg/ltr minimum. Zn dust by weight - minimum 85%. Pot life 12 hrs / 21 Deg.- Paint to meet compositional & performance specifications for SSPC Paint 20 , Level 1.	75	




Surface/ Location	Temp	Surface prep	Coat	No. of coats	Generic Type	Dft/Coat
			Touch up	1	Two component Zinc rich Primer meeting performance and compositional specifications of SSPC Paint 20 Level2	(75)
			Finish	2	Two component High Build high Solid Aliphatic Amine Cured Epoxy coating. - Min VS 85%	100
					Total	275
Oil pipelines - Outside surface, above ground	< 100 Deg C	SA 3	Primer	1	Solvent based IZS - VS of 60%. Zn Dust - 1.77 kg/ltr minimum. Zn dust by weight - minimum 85%. Pot life 12 hrs / 21 Deg.- Paint to meet compositional & performance specifications for SSPC Paint 20 , Level 1.	75
			Touch up		Two component Zinc rich Primer meeting performance and compositional specifications of SSPC Paint 20 Level2	(75)
			Mid coat	2	Two component High Build high Solid Aliphatic Amine Cured Epoxy coating. - Min VS 85%	100
			Finish	1	2 pack Acrylic Aliphatic Polyurethane top coat - with Gloss retention of at least 90% on QUVB exposure of minimum 1000 hrs.	75
					Total	350
Surface/ Location	Temp					
Pumps, Motors, Turbine, Claddings, Steam Turbine Condenser, Indoor	Up to 90 Deg	SA 2.5	Primer	1	Catalysed Zn rich Primer with a VS of 60% min, complying to SSPC Paint 20 level 2.	75
			Finish	2	Two component High Build high Solid Aliphatic Amine Cured Epoxy coating. - Min VS 85%.	100
					Total	275
Alternative 1		SA 2.5	Primer	1	Catalysed Zn rich Primer with a VS of 60% min, complying to SSPC Paint 20 level 2.	75
			Mid coat	1	Two component High Build high Solid Aliphatic Amine Cured Epoxy coating. - Min VS 85%.	100
			Finish	2	2 pack Acrylic Aliphatic Polyurethane top coat - with Gloss retention of at least 90% on QUVB exposure of minimum 1000 hrs.	75



Surface/ Location	Temp	Surface prep	Coat	No. of coats	Generic Type	Dft/Coat
					Total	250
Heat Exchangers - Inside Surface.	Up to 60-Deg	SA 2.5	Primer	1	Solvent based IZS - VS of 60%. Zn Dust - 1.77 kg/ltr minimum. Zn dust by weight - minimum 85%. Pot life 12 hrs / 21 Deg. Paint to meet compositional & performance specifications for SSPC Paint 20 , Level 1.	75
			Finish	2	Coal Tar Epoxy, Vs min 65% black.	200
					Total	475
Instrument panels, Electrical cubicles and similar steel sheet – indoor (Can be used on Aluminium, steel, stainless steel and galvanized substrates.)	Ambient	Oil grease and contaminants must be removed	Primer	1	Two pack , high build siloxane modified epoxy primer with zinc phosphate pigment.	75
			Mid coat	1	Two component High Build Surface Tolerant Epoxy coating pigmented with Aluminium and Lamellar Micaceous iron oxide	100
			Top coat	1	Two component High Build high Solid Aliphatic Amine Cured Epoxy coating. - Min VS 85%	100
					Total	275
Surface/ Location	Temp					
Instrument panels, Electrical cubicles and similar steel sheet – outdoor (Can be used on Aluminium, steel, stainless steel and galvanized substrates.)	Ambient	Oil grease and contaminants must be removed	Primer	1	Two pack , high build siloxane modified epoxy primer with zinc phosphate pigment.	100
			Mid coat	1	Two component High Build Surface Tolerant Epoxy coating pigmented with Aluminium and Lamellar Micaceous iron oxide.	150
			Top coat	1	2 pack Acrylic Aliphatic Polyurethane top coat - with Gloss retention of atleast 90% on QUVB exposure of minimum 1000 hrs.	75
					Total	325
Substrate, base metal: Carbon steel, HDG acc ISO 1461 Or. Equiv. Non Insulated. - Outdoor	<120 Deg	Air blasting with Nonmetallic	Touch up	1	Two component Zinc rich Primer meeting performance and compositional specifications of SSPC Paint 20 Level2	(75)
			Primer	1	Two pack , high build siloxane modified epoxy primer with zinc phosphate pigment.	50



Surface/ Location	Temp	Surface prep	Coat	No. of coats	Generic Type	Dft/Coat		
		abrasive Powder	Mid coat	1	Two component High Build Surface Tolerant Epoxy coating pigmented with Aluminium and Lamellar Micaceous iron oxide	150		
			Finish	1	2 pack Acrylic Aliphatic Polyurethane top coat - with Gloss retention of atleast 90% on QUVB exposure of minimum 1000 hrs.	75		
					Total	275		
Substrate, base metal: Carbon steel, HDG acc ISO 1461 Or. Equiv. Non Insulated.- Indoor	<120 Deg	Air blasting with Nonmetallic abrasive Powder	Touch up	1	Two component Zinc rich Primer meeting performance and compositional specifications of SSPC Paint 20 Level 2.	75		
			Primer	1	Two pack, high build siloxane modified epoxy primer with zinc phosphate pigment.	125		
			Finish	1	Two component High Build high Solid Aliphatic Amine Cured Epoxy coating. - Min VS 85%.	100		
					Total	225		
				For Outdoor Application				
				Touch up	1	Two component Zinc rich Primer meeting performance and compositional specifications of SSPC Paint 20 Level2	(75)	
				Primer	1	Two pack , high build siloxane modified epoxy primer with zinc phosphate pigment.	125	
				Finish	1	2 pack Acrylic Aliphatic Polyurethane top coat - with Gloss retention of at least 90% on QUVB exposure of minimum 1000 hrs.	75	
							Total	200
					For Indoor Application			
Substrate, Stainless Steel - Non insulated.	< 120 Deg	Air blasting with Nonmetallic abrasive Powder	Primer	1	Two pack , high build siloxane modified epoxy primer with zinc phosphate pigment.	125		
			Finish	1	Two component High Build high Solid Aliphatic Amine Cured Epoxy coating. - Min VS 85%	100		
					Total	225		
				For Outdoor Application				
				Primer	1	Two pack , high build siloxane modified epoxy primer with zinc phosphate pigment.	125	

	North Chennai TPP Stage-III - 1x800 MW GYPSUM DEWATERING EQUIPMENT TECHNICAL SPECIFICATION (ELECTRICAL PORTION)	SPECIFICATION No: PE-TS-485-571-A901	
		SECTION : I	
		SUB-SECTION : C-3	
		REV. 00	

SECTION: I

SUB-SECTION: C-3

TECHNICAL SPECIFICATION (ELECTRICAL PORTION)

**TAMILNADU GENERATION AND DISTRIBUTION
CORPORATION LIMITED**

**1X800MW TANGEDCO NORTH CHENNAI TPP STAGE-III
(FGD SYSTEM AND AUXILIARIES)**

**GYPSUM DEWATERING EQUIPMENT
TECHNICAL SPECIFICATION
(ELECTRICAL PORTION)**



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



**TECHNICAL SPECIFICATION
FOR
GYPSUM DEWATERING EQUIPMENT
1X800MW TANGEDCO NORTH CHENNAI TPP
STAGE-III (FGD SYSTEM & AUXILIARIES)**

SPECIFICATION NO.	
VOLUME NO. :	II-B
SECTION:	I
REV NO.:	00 DATE: 01.07.22
SHEET: 1	OF 1

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The requirements mentioned in Section-I shall prevail and govern in case of conflict between the same and the corresponding requirements mentioned in the descriptive portion in Section-II.



**ELECTRICAL EQUIPMENT SPECIFICATION
FOR
GYPSUM DEWATERING EQUIPMENT
1X800MW TANGEDCO NORTH CHENNAI TPP
STAGE-III (FGD SYSTEM & AUXILIARIES)**

SPECIFICATION NO.

VOLUME NO.: **II-B**SECTION: **I**REV NO.: **00** DATE: 01.07.22

SHEET : 1 OF 1

SPECIFIC TECHNICAL REQUIREMENTS: ELECTRICAL

1.0 EQUIPMENT & SERVICES TO BE PROVIDED BY BIDDER/ PURCHASER

- a) Services and equipment as per "Electrical Scope between BHEL and Vendor".
- b) Any item/work either supply of equipment or erection material which have not been specifically mentioned but are necessary to complete the work for trouble free and efficient operation of the plant shall be deemed to be included within the scope of this specification. The same shall be provided by the bidder without any extra charge.
- c) Supply of mandatory spares as specified in the specifications of mechanical equipments.
- d) Electrical load requirement for **Gypsum Dewatering Equipment** (all AC & DC load at different voltage levels like 415V AC, 240 V AC, 220 V DC etc).
- e) All equipment shall be suitable for the power supply fault levels and other climatic conditions mentioned in the enclosed project information.
- f) Bidder to furnish list of makes for each equipment at contract stage, which shall be subject to customer/BHEL approval without any commercial and delivery implications to BHEL.
- g) Various drawings, data sheets as per required format, Quality plans, calculations, test reports, test certificates, operation and maintenance manuals etc shall be furnished as specified at contract stage. All documents shall be subject to customer/BHEL approval without any commercial implication to BHEL.
- h) Motor shall meet minimum requirement of motor specification.
- i) Vendor to clearly indicate equipment locations and local routing lengths in their cable listing furnished to BHEL.
- j) Cable BOQ worked out based on routing of cable listing provided by the vendor for "both end equipment in vendor's scope" shall be binding to the vendor with +10 % margin to take care of slight variation in routing length & wastages.

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

Refer "Electrical Scope between BHEL and Vendor".

3.0 DOCUMENTS TO BE SUBMITTED ALONG WITH BID

- 3.1 The electrical specification without any deviation from the technical/ quality assurance requirements stipulated shall be deemed to be complied by the bidder in case bidder furnishes the overall compliance of package technical specification in the form of compliance certificate/ No deviation certificate.
- 3.2 No technical submittal such as copies of data sheets, drawings, write-up, quality plans, type test certificates, technical literature, etc, is required during tender stage. Any such submission even if made, shall not be considered as part of offer.



**ELECTRICAL EQUIPMENT SPECIFICATION
FOR
GYPSUM DEWATERING EQUIPMENT
1X800MW TANGEDCO NORTH CHENNAI TPP
STAGE-III (FGD SYSTEM & AUXILIARIES)**

SPECIFICATION NO.

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4.0 LIST OF ENCLOSURES

- 4.1 Electrical Scope Between BHEL & Vendor (Annexure-I).
- 4.2 Electrical Load Data Format (Annexure-II).
- 4.3 Cable Schedule Format (Annexure-III).
- 4.4 Technical Requirements-Motors.
- 4.5 Data Sheet-A & C
- 4.6 Standard Quality Plan.
- 4.7 Technical Requirements –Earthing & Lightning Protection System
- 4.8 Technical Requirements- Cabling Accessories
- 4.9 Motor Sub Vendor List

REV-0, DATE:01.07.2022

ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR

PACKAGES: GYPSUM DEWATERING EQUIPMENT

SCOPE OF VENDOR: SUPPLY & SUPERVISION OF VENDOR'S EQUIPMENT

PROJECT: 1X800MW TANGEDCO NORTH CHENNAI TPP STAGE-III (FGD SYSTEM AND AUXILIARIES)

SECTION-I

S.NO	DETAILS	SCOPE SUPPLY	SCOPE E&C	REMARKS
1	11 kV / 3.3 KV / 415 V Switchgear	BHEL	BHEL	HT motor (If applicable), (Motor feeder) power supply shall be provided by BHEL For all LT motor & Auxiliary supply, 415 V AC (3 ph. 4 wire)/240 V AC (supply feeder) 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 BHEL 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	BHEL	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 etc.	Vendor	BHEL	
6	Cable trays, accessories & cable trays supporting system 100/ 50 mm cable trays/ Conduits/ Galvanised steel cable troughs for local cabling	BHEL Vendor	BHEL BHEL	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	a. Cable glands b. Lugs and bimetallic strip for equipment supplied by Vendor	Vendor Vendor	BHEL BHEL	a. Double compression Ni-Cr plated brass cable glands b. Solder less crimping type heavy duty tinned copper lugs for power and control cables.
8	Conduit and conduit accessories for cabling between	Vendor	BHEL	Conduits shall be medium duty, hot dip galvanised cold rolled mild steel

REV-0, DATE:01.07.2022

ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR

PACKAGES: GYPSUM DEWATERING EQUIPMENT

SCOPE OF VENDOR: SUPPLY & SUPERVISION OF VENDOR'S EQUIPMENT

PROJECT: 1X800MW TANGEDCO NORTH CHENNAI TPP STAGE-III (FGD SYSTEM AND AUXILIARIES)

SECTION-I

	equipment supplied by vendor			rigid conduit as per IS: 9537.
9	Lighting	BHEL	BHEL	
10	Equipment grounding (including electronic earthing) & lightning protection	BHEL	BHEL	
11	Below grade grounding	BHEL	BHEL	
12	LT Motors with base plate and foundation hardware.	Vendor	BHEL	Makes shall be subject to customer/ BHEL approval at contract stage.
13	HT Motor with base plate and foundation hardware (If applicable)	Vendor	BHEL	Makes shall be subject to customer/ BHEL approval at contract stage.
14	HT cable & Cable termination kit for HT Motor.	BHEL	BHEL	
15	Mandatory spares	Vendor	-	Vendor to quote as per specification.
16	Recommended O & M spares	Vendor	-	As specified elsewhere in specification
17	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	BHEL	
18	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.
19	Electrical Equipment & cable tray layout drawings	-	-	Vendor to furnish drawing (both in print form as well as in AUTOCAD) of Gypsum Dewatering Building layout clearly indicating all motors, panels, JB's etc. which require cabling along with their terminal box/location/ Foundation etc.
20	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.

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.	CONT ROL CODE	REMA RKS	LOAD No.	VERIFICATI ON FROM MOTOR DATASHEE T (Y/N)	KKS NO
	NAME PLATE	MAX. CONT. DEMAND (MCR)		RUNNING	STANDBY								SIZE CODE	NOs						
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21

ANNEXURE-II

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)/ CUSTOMER
 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 (CONTACTER CONTROLLED)

LOAD DATA (ELECTRICAL)	JOB NO.	485	ORIGINATING AGENCY		PEM (ELECTRICAL)	
	PROJECT TITLE	1X800MW TANGEDCO NORTH CHENNAI TPP STAGE-III (FGD SYSTEM & AUXALIRIES)	NAME	DATA FILLED UP ON		
	SYSTEM	Gypsum Dewatering Equipment	SIGN.	DATA ENTERED ON		
	DEPTT. / SECTION	MAUX	SHEET 1 OF 1	REV. 00	DE'S SIGN. & DATE	

983291/2022/PS-PEM-MAX**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)

983291/2022/PS-PEM-MAX

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 CODESPVC Copper

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

PVC Aluminium

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

XLPE Copper

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

XLPE Aluminium

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

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



SECTION-I

SECTION : 3.1- MOTORS

1.0.0 INTENT OF SPECIFICATION

This section covers the technical requirements of HT and LT 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, especially the Indian Statutory Regulation, 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: 9334 | Electrical motor operated actuators |
| n) IS 60034-5 | Degree of protection provided by Integral design of rotating electrical machines |
| o) IS 60034-8 | Terminal marking and direction of rotation |
| p) IS 60079-1 | Equipment protection by flame proof enclosure |
| q) IS 60034-1 | Rotating electrical machines. |
| r) IS 60079 | Explosive atmospheres |
| s) IS/IEC 60529 | Degrees of protection provided by enclosures (IP code) |
| t) IEC 60034 | Rotating electrical machines. |

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. The equipment shall operate in highly polluted environment.

3.2.0 Supply voltage

Motors rated up to and including 415V are termed as LT motors and the motors rated higher than 415V are termed as HT motors.

Motors shall be capable of delivering the rated output under following voltage and frequency variations without exceeding its guaranteed temperature limits.



- Frequency variation : (+) 3% and (-) 5%
- Voltage variation for LT motors : (±) 10%
- Voltage variation for HT motors : (±) 10%
- 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	HT System	LT System
1.	Voltage level	11 KV Above 2000 KW 6.6KV above 200KW & upto 2000KW	240 V : up to 0.2 KW 415 V : >0.2 KW and up to 200KW .
2.	System earthing	Earthed through resistance. Earth fault current : 300 Amps	415V: Solidly grounded.
3.	System fault level	50 KA for 3 sec for 11KV 40KA for 1sec for 6.6KV	50 KA for 1 second
4.	Fault withstand rating of motor terminal box (Breaker operated)	50 KA for 0.25 sec for 11KV 40KA for 0.25 sec for 6.6KV	50 KA for 0.25 second

3.4.0 Type

- AC Motors shall be squirrel cage induction type unless otherwise it is specified. All the motor shall be bi-directional.

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.
- Motors shall be suitable for installation in hot, humid and tropical atmosphere and polluted at places with coal ash and fly ash or any dusty chemical handling area.
- All LV motors above 10KW shall be with S1 duty.

3.6.0 Design margin

- Motor rating shall be selected higher than the maximum load demand of the driven equipment, as per the criteria stated in mechanical section of this specification, under entire operating range, including voltage and frequency variation.
- The motor name plate rating shall have 15% margin over duty point input (or) 10% margin over the maximum demand of driven equipment whichever is higher considering highest system frequency.
- 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.
- HT Motors will be controlled through vacuum circuit breaker.
- LT motors rated less than 90KW will be controlled through MPCB/MCCB and contactor. LT motors rated 90 KW and above will be controlled through air circuit breaker (ACB).

3.8.0 Efficiency

All the continuous duty motors shall be energy efficient type. For LT motors, it shall be IE3 class as per IS 12615. For HT motors, efficiency shall be more than 95%.

3.9.0 Temperature rise

- Winding Insulation shall be Class F.
- Temperature rise of motors shall not exceed 70°C over air temperature of 50°C 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 : 85% 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 will 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 80% of the rated voltage for 5 minutes.
- d) The motor shall be capable of withstanding the stresses imposed if started at 110% rated voltage.
- e) Motor shall not stall if the supply voltage drops to 70% of the rated voltage two (2) second duration

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

- Motor shall be designed for direct online starting at full voltage. Starting current shall not exceed 6 times full load current for all auxiliaries. No further tolerances are applicable on starting current specified above for HT motors.
- For LT motors, the applicable starting current shall be limited to 7.2 times of full load current including all 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.
- For the LT motors having starting time upto 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.
- The motors shall be designed to withstand 120% of rated speed for 2 minutes without any mechanical damage
- All motors shall be so designed that maximum in rush currents and locked rotor and pull out torque developed by them at extreme voltage and frequency variation do not endanger the motor & driven equipment.

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

3.15.0 Enclosure

- a) All motor enclosures shall conform to the degree of protection IP 55 unless otherwise specified. Motor for outdoor or semi outdoor service shall be of weather proof construction.
- b) For hazardous location, the enclosure of motors shall have flame proof construction conforming to applicable standard.



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) type.
- Motors rated >3000KW 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 5A at 240 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 240V AC, 50 Hz supply shall be provided for motors rated 30KW 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 1.2/50 microsec impulse Voltage wave of 4U+5 KV (U=Line voltage in KV). The coil inter-turn insulation shall be suitable for 0.3/3msec surge of 32KVp and 12KVp for 11KV & 6.6KV system respectively, followed by 1 min power frequency high voltage test of appropriate voltage on inter turn insulation.

Temperature Detectors

- All 11KV motors shall be provided with six (6) nos. duplex, or twelve (12) nos. simplex type winding temperature detectors, i.e. two (2) nos. duplex or four (4) nos. Simplex per phase.
- 11KV motor bearing shall be provided with duplex type temperature detectors.
- The temperature detector mentioned above shall be resistance type, 3 wire, platinum wound, 100 Ohms at 0°C.
- Leads of all simplex type motor winding RTDS and motor bearing RTDS shall be wired up to respective switchgear metering & protection compartment. From which one set of RTDS will be connected to numerical protection relay and another set shall be kept free for DCS/PLC connectivity.
- Five number of Temperature detectors / thermistors shall be provided for L.T. motors above 90 KW (3 numbers winding temperatures & 2 numbers bearing temperatures)



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.
- 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 30KW 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 10A at 230 V AC.
- For bearing temperature measurement, duplex RTDs shall be provided for each bearing and shall be wired upto the terminal box.
- Each bearing shall be provided with dial type thermometer.
- For all VFD operated motors and motors rated above 1000KW shall have insulated bearings to prevent flow of shaft currents.

3.19.0 Terminal Boxes

- For single core cables, gland plate shall be non-magnetic material. Terminal box shall be capable of being turned 360° in steps of 90°, unless otherwise approved. 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 0.25 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 fibre 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.
- Motor 1000 KW and above shall be provided with three differential current transformers mounted over the neutral leads within the enclosure. Loose 3 numbers CT for mounting on switchgear side shall be in bidder's scope. The arrangement shall be such as to permit easy access for C.T. testing and replacement. Current transformer characteristics shall match Owner's requirements to be intimated later to the successful bidder. 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.

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

Above 100 to 200 KW	: 75x10 mm GS flat
Above 55 KW to 100 KW	: 50x6 mm GS flat
Above 22 KW to 55 KW	: 50x6 mm GS flat
Above 5.5 KW to 22 KW	: 25x6 mm GS flat
Fractional HP LV Motors	: 8 SWG GS Wire

3.21.0 Noise and Vibration

- Motors shall be selected with low noise levels in accordance with IS 12065. Noise level for all motors shall be limited to 85db (A).
- 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. Motors shall withstand vibration produced by driven equipment.

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 Drain plug

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

3.24.0 Lifting provision

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

3.25.0 Dowel pins

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

4.0.0 INSTALLATION

Installation shall be carried out as per IS: 900.

5.0.0 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. Paint Shade for the Motor shall be RAL 7032 (Siemens Grey). Sufficient quantity of touch-up paint shall be furnished for application at site.

6.0.0 TESTING AND INSPECTION

- 6.1.0 Tests shall be performed in presence of Owner's representatives. Successful Bidder shall give atleast fifteen (15) days advance notice for witnessing the tests. Copies of certified reports of all tests carried out at the works shall be furnished. The equipment shall be dispatched from works, only after receipt of Owner's written approval of the test reports.
- 6.2.0 Routine and Type Tests are to be conducted for all HT motors and for LT motors above 60 KW rating in presence of customer's representative as per IS:325, IS:4722, IS:9283 and required copies of test certificates are to be furnished for approval.
- 6.3.0 Test certificates for Routine tests conducted as per IS:325, IS:4722, IS:9283 for motors of rating 60 KW and below shall be submitted for TANGEDCO review, approval and dispatch clearance.
- 6.4.0 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
- i) Measurement of vibration.
 - ii) Measurement of insulation resistance and polarization index
 - iii) Measurement of full load current.
 - iv) Test running of the motors, checking the temperature rise and identifying the hot spot etc.



7.0.0 OTHERS

- 7.1.0 The responsibility of co-ordination with electrical agencies and obtaining all necessary clearances shall be the contractor.
- 7.2.0 Canopy shall be provided for outdoor motors.
- 7.3.0 Contractor shall provide fully compatible electrical system, equipment, accessories and services.

8.0.0 SPECIFIC REQUIREMENTS

- 8.1.0 The following shall be considered for control & protection of motors.
- a) Motors below 18.5 KW: MPCB incomers
 - b) Above 18.5 KW but below 90 KW: contactor controlled with MCCB
 - c) 90 KW and above but 160 KW & below: ACB controlled with numerical relays
 - d) HT Motors shall have vacuum breakers
 - e) HV motors 1000KW above shall have differential protection
 - f) For motors 1000KW & above, neutral CT of CI. PS shall be provided as each box on separate terminal box
 - g) Key phasor arrangement shall be provided for all motors
 - h) All motors shall be provided with an emergency stop PB near motor as per Indian Statutory regularity.
 - i) Spacious platform shall be provided around motor area with min. of 300mm below the level of motor base plate.
 - j) Capillary type temp. Gauge cum shall be provided for DE/NDE of HV motors
 - k) After erection of electrical equipment at site, corrosion proof paint touch up to be done before test & commissioning of equipment.



SECTION-I

2.3.0 MOTORS

Item/ Components/ Sub-system	Tests/ Checks																	
	Visual	Dimensional	Make, Type, Rating, TC, General physical	Mechanical, Chemical properties	NDT, DP or MPI, UT	Metallography	Electrical characteristics	Welding/ Brazing (WPS/ PQR)	Heat treatment	Magnetic characteristics	Hydraulic, Leak, Pressure test	Thermal characteristics	Run out	Dynamic balancing	All tests as per IS:325/ IS:4722/ IS:9283	Vibration	Over speed	Tan delta, shaft voltage and polarisation
Plates for stator frame, end shield, spider etc.	Y	Y	Y	Y				Y										
Shaft	Y	Y	Y	Y	Y	Y		Y										
Magnetic material	Y	Y	Y	Y	Y		Y		Y		Y							
Rotor copper/ Aluminium	Y	Y	Y	Y		Y	Y	Y										
Stator copper	Y	Y	Y	Y			Y	Y			Y							
SC ring	Y	Y	Y	Y	Y	Y	Y	Y	Y									
Insulating material	Y		Y	Y			Y				Y							
Tubes for cooler	Y	Y	Y	Y	Y			Y		Y								
Sleeve bearing	Y	Y	Y	Y	Y			Y		Y								
Stator, Rotor coils	Y	Y	Y				Y	Y										
Castings, stator frame, terminal box and bearing housing etc.	Y	Y	Y	Y	Y			Y										
Fabrication and machining of stator, rotor, terminal box	Y	Y			Y			Y										
Wound stator	Y	Y					Y	Y										
Rotor complete	Y	Y					Y					Y	Y					



Item/ Components/ Sub-system	Tests/ Checks																	
	Visual	Dimensional	Make, Type, Rating, TC, General physical	Mechanical, Chemical properties	NDT, DP or MPI, UT	Metallography	Electrical characteristics	Welding/ Brazing (WPS/ PQR)	Heat treatment	Magnetic characteristics	Hydraulic, Leak, Pressure test	Thermal characteristics	Run out	Dynamic balancing	All tests as per IS:325/ IS:4722/ IS:9283	Vibration	Over speed	Tan delta, shaft voltage and polarisation
Stator, Rotor, Terminal Box assembly	Y	Y					Y											
Accessories, RTD, BTD, CT, Brushes, Diodes, space heater, antifriction bearing, cable glands, lugs, gaskets etc.	Y	Y	Y															
Complete motor (IS: 325/ IS:4722/ IS:9283)	Y	Y	Y											Y	Y	Y	Y	
Y =Test applicable, Y1 = for 11kV and 3.3kV motors only																		
Note																		
This is an indicative list of tests/ checks. The manufacture is to furnish the detailed Quality Plan indicating the practices and procedure followed along with relevant supporting documents during QP finalization. However QP approval is not envisaged for 415V motors upto 50 KW.																		

Site Tests :

The following minimum tests/ checks shall be conducted at site. Any other tests/ checks as per the manufacturer's recommendation shall also be carried out

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



LV MOTORS

DATA SHEET-A

SPECIFICATION NO.

VOLUME II B

SECTION II


REV NO. 00 DATE 28.09.2021

SHEET 1 OF 1

1.0	Design ambient temperature	:	50 °C
2.0	Maximum acceptable kW rating of LV motor	:	Upto 200KW
3.0	Installation (Indoors/ Outdoors)	:	As required
4.0	Degree Of Protection	:	IP55 (INDOOR), IPW55(OUTDOOR)
5.0	Cooling	:	TEFC
6.0	Details of supply system		
	a) Rated voltage (with variation)	:	415V ± 10%
	b) Rated frequency (with variation)	:	50 Hz (Variation: +3% To -5%)
	c) Combined voltage & freq. variation	:	10% (sum of absolute values)
	d) System fault level at rated voltage	:	50 kA for 1 sec
	e) Short time rating for terminal box	:	50 kA for 0.25 sec
	f) LV System grounding	:	Solidly
7.0	Class of insulation	:	Class 'F', with temp rise limited to class B.
8.0	Minimum voltage for starting (As percentage of rated voltage)	:	80% of rated voltage
9.0	Power cables data	:	Shall be given during Detailed engg.
10.0	Earth Conductor Size & Material	:	Shall be given during Detailed engg.
11.0	Space heater supply (30KW & ABOVE)	:	240 V, 1Φ , 50 Hz
12.0	Rating up to which Single phase motor	:	Acceptable upto 0.20 Kw
13.0	TYPE OF STARTER PROVIDED IN MCC	:	DOL
14.0	Locked rotor current		
	a) Limit as percentage of FLC	:	As per IS 12615
	b) Permissible tolerance, if any	:	
15.0	Additional tests	:	As per QP
16.0	Flame-proof motor		
	a) Enclosure suitable (As per IS:2148)	:	As per requirement
	b) Classification of Hazardous area (As per IS: 5572 part-I)	:	As per requirement
	c) Degree of protection	:	IP65
17.0	Makes	:	AS PER ANNEXURE-I
19.0	Paint shade	:	RAL 7032 (Siemens Grey).
20.0	Efficiency class	:	IE3

NOTE :1. Also detailed Customer spec. for Motors is to be referred as enclosed with technical spec.


983291/2022/PS-PEM-MAX

	TITLE	SPECIFICATION NO.
	LV MOTOR	VOLUME II B
	DATA SHEET - C	SECTION II
		REV NO. 00 DATE
	SHEET 1 OF 2	

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

NAME OF VENDOR			SEAL	REV.	
NAME	SIGNATURE	DATE			

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	TITLE	SPECIFICATION NO.
	LV MOTOR	VOLUME _____ II B
	DATA SHEET - C	SECTION II
		REV NO. 00 DATE
		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 $\geq 55KW$)	
	a) Torque speed characteristic	
	b) Thermal withstand characteristic	
	c) Current vs time	
	d) Speed vs time	

NAME OF VENDOR			SEAL	REV.	
NAME	SIGNATURE	DATE			

983291/2022/PS-PEM-MAX



FILE :
GENERAL TECHNICAL REQUIREMENTS

FOR

LV MOTORS

SPECIFICATION NO.
PE-SS-999-506-E101
VOLUME NO. : **II-B**
SECTION : **II**
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



GENERAL TECHNICAL REQUIREMENTS

FOR

LV MOTORS

SPECIFICATION NO.

PE-SS-999-506-E101

VOLUME NO. : II-B

SECTION : II

REV NO. : 00 DATE : 29/08/2005

SHEET : 1 OF 4

1.0 INTENT OF SPECIFICATION

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

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.



GENERAL TECHNICAL REQUIREMENTS

FOR

LV MOTORS

SPECIFICATION NO.

PE-SS-999-506-E101

VOLUME NO. : II-B

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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.


	<p style="text-align: center;">TITLE : GENERAL TECHNICAL REQUIREMENTS</p> <p style="text-align: center;">FOR</p> <p style="text-align: center;">LV MOTORS</p>	SPECIFICATION NO. PE-SS-999-506-E101
		VOLUME NO. : II-B
		SECTION : II
		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	







FILE :
GENERAL TECHNICAL REQUIREMENTS
FOR
LV MOTORS


SPECIFICATION NO.
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 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.

	MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS	STANDARD QUALITY PLAN			SPEC. NO :	DATE:
		CUSTOMER :			QP NO.: PE-QP-999-Q-006, REV-02	DATE: 17.04.2020
		PROJECT:			PO NO.:	DATE:
		ITEM: AC ELECT. MOTORS UPTO 55KW (LV (415V))	SYSTEM:	SECTION: II	SHEET 1 of 2	

S. NO.	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY	REMARKS			
					M	C/ N						D	M	C
1	2	3	4	5	6		7	8	9	*	**			
1.0	ASSEMBLY	1.WORKMANSHIP	MA	VISUAL	100%	-	MFG. SPEC.	MFG. SPEC.	LOG BOOK	P	-	-		
		2.DIMENSIONS	MA	VISUAL	100%	-	MFG. DRG./ MFG. SPEC.	MFG. DRG./ MFG. SPEC.	LOG BOOK	P	-	-		
		3.CORRECTNESS COMPLETENESS TERMINATIONS/ MARKING/ COLOUR CODE	MA	VISUAL	100%	-	MFG.SPEC./	MFG.SPEC.	LOG BOOK	P	-	-		
2.0	PAINTING	1.SHADE	MA	VISUAL	SAMPLE	-	MFG. SPEC/ APPROVED DATASHEET	MFG. SPEC/ APPROVED DATASHEET	LOG BOOK	✓	P	V	-	
3.0	TESTS	1.ROUTINE TEST INCLUDING SPECIAL TEST	MA	VISUAL	100%	-	IS-325 / IS-12615/ APPROVED DATA SHEET	IS-325 / IS-12615/ APPROVED DATA SHEET	TEST/ INSPN. REPORT	✓	P	V*	-	* NOTE -1
		2.OVERALL DIMENSIONS & ORIENTATION	MA	MEASUREMENT & VISUAL	100%	-	APPROVED DRG/ DATA SHEET	APPROVED DRG/ DATA SHEET	TEST/ INSPN. REPORT	✓	P	V*	-	* NOTE -1 & NOTE-2

BHEL						BIDDER/ SUPPLIER		FOR CUSTOMER REVIEW & APPROVAL			
ENGINEERING			QUALITY			Sign & Date		Doc No:			
Prepared by:	Sign & Date	Name	Checked by:	Sign & Date	Name	Seal		Sign & Date	Name	Seal	
HEMA KUSHWAHA		HEMA KUSHWAHA	KUNAL GANDHI		KUNAL GANDHI						
PRAVEEN DUTTA		PRAVEEN DUTTA	RITESH KUMAR JAISWAL		RITESH KUMAR JAISWAL						

	MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS	STANDARD QUALITY PLAN				SPEC. NO :				DATE:			
		CUSTOMER :				QP NO.: PE-QP-999-Q-006, REV-02				DATE: 17.04.2020			
		PROJECT:				PO NO.:				DATE:			
		ITEM: AC ELECT. MOTORS UPTO 55KW (LV (415V))		SYSTEM:		SECTION: II				SHEET 2 of 2			

		3.NAMEPLATE DETAILS	MA	VISUAL	100%	-	IS-325 / IS-12615 / APPROVED DATA SHEET	SAME AS COL. 7	TEST/ INSPN. REPORT	✓	P	V	-	
4.0	PACKING	SURFACE FINISH & COMPLETENESS	MA	VISUAL	100%	100%	AS PER MFG. STANDARD / (#)	AS PER MFG. STANDARD / (#).	INSPC. REPORT	✓	P	W	-	(#) REFER NOTE-8

NOTES:

1. Routine tests on 100% motors shall be done by the vendor. However, BHEL/ Customer shall witness routine tests on random samples. The sampling plan shall be mutually agreed upon.
2. For exhaust/ventilation fan motors of rating up to 1.5 KW, only routine test certificates shall be furnished for scrutiny.
3. In case test certificates for these tests on similar type, size and design of motor from independent laboratory are available, the same is valid for 5 years.
4. BHEL reserves the right to perform repeat test, if required.
5. After packing and prior to issue MDCC, photographs of items to be despatched shall be sent to BHEL for review.
6. In case of any changes in QP commented by customer at contract stage, same shall be carried out by bidder without any implication to BHEL/ Customer.
7. Project specific QP to be developed based on customer requirement.
8. For export job, BHEL technical specification for seaworthy packing to be followed.
9. Packing shall be suitable for storage at site in tropical climate conditions.
10. Latest revision/ year of issue of all the standards (IS/ ASME/ IEC etc.) indicated in QP shall be referred.

LEGENDS:


*RECORDS, IDENTIFIED WITH "TICK"(✓) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION,


** **M:** SUPPLIER/ MANUFACTURER/ SUB-SUPPLIER, **B:** MAIN SUPPLIER/ BHEL/ THIRD PARTY INSPECTION AGENCY, **C:** CUSTOMER,

P: PERFORM, **W:** WITNESS, **V:** VERIFICATION, AS APPROPRIATE




MA: MAJOR, **MI:** MINOR, **CR:** CRITICAL

D: DOCUMENTATION

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


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

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



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

BIDDER/ SUPPLIER	
Sign & Date	
Seal	

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


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

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


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

BIDDER/ SUPPLIER	
Sign & Date	Seal

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


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

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


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

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2.0	IN PROCESS																
2.1	STATOR FRAME WELDING (IN CASE OF FABRICATED STATOR)	1.WORKMANSHIP & CLEANNESS	MA	VISUAL	100%	-	MANUFACTURER'S DRG	GOOD FINISH	LOG BOOK			P/W	-	-			
		2.DIMENSIONS	MA	MEASUREMENT	100%	-	MANUFACTURER'S DRG	MANUFACTURER'S DRG	LOG BOOK			P	-	-			
2.2	MACHINING	1.FINISH	MA	VISUAL	100%	-	-DO-	GOOD FINISH	LOG BOOK			P	-	-			
		2.DIMENSIONS	MA	MEASUREMENT	100%	-	MANUFACTURER'S DRG	MANUFACTURER'S DRG	LOG BOOK			P	-	-			
		3.SHAFT SURFACE FLOWS	MA	PT	100%	-	MANUFACTURER'S STD./ASTM-E165	MANUFACTURER'S STD./APPROVED DATASHEET.	LOG BOOK	✓		P	V	-			
2.3	PAINTING	1.SURFACE PREPARATION	MA	VISUAL	100%	-	MANUFACTURER'S STD./APPROVED DATASHEET	MANUFACTURER'S STD./APPROVED DATASHEET	LOG BOOK			P	-	-			
		2.PAINT THICKNESS (BOTH PRIMER & FINISH COAT)	MA	MEASUREMENT BY ELCOMETER	SAMPLE	-	MANUFACTURER'S STD./APPROVED DATASHEET	MANUFACTURER'S STD./APPROVED DATASHEET	LOG BOOK			P	-	-			
		3.SHADE	MA	VISUAL	SAMPLE	-	MANUFACTURER'S STD./APPROVED DATASHEET	MANUFACTURER'S STD./APPROVED DATASHEET	LOG BOOK			P	-	-			
		4.ADHESION	MA	CROSS CUTTING & TAPE TEST	SAMPLE	-	MANUFACTURER'S STD./APPROVED DATASHEET	MANUFACTURER'S STD./APPROVED DATASHEET	LOG BOOK			P	-	-			


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1	2	3	4	5	6		7	8	9	.	..		
2.4	SHEET STACKING	1.COMPLETENESS	MA	MEASUREMENT	SAMPLE	-	MANUFACTURER'S STD.	MANUFACTURER'S STD.	LOG BOOK		P	-	-
		2.COMPRESSION & TIGHTENING	MA	MEASUREMENT	100%	-	MANUFACTURER'S STD.	MANUFACTURER'S STD.	LOG BOOK		P	-	-
2.5	WINDING	1.COMPLETENESS	CR	VISUAL	100%	-	MANUFACTURER'S STD./APPROVED DATASHEET	MANUFACTURER'S STD./APPROVED DATASHEET	LOG BOOK		P	-	-
		2.CLEANLINESS	CR	VISUAL	100%	-	MANUFACTURER'S STD./APPROVED DATASHEET	MANUFACTURER'S STD./APPROVED DATASHEET	LOG BOOK		P	-	-
		3.IR-HV-IR	CR	ELECT. TEST	100%	-	IS-325//IS-12615/IEC-60034 PART-1	IS-325//IS-12615/IEC-60034 PART-1	TEST/INSPC. REPORT	✓	P	V	-
		4.RESISTANCE	CR	ELECT. TEST	100%	-	IS-325//IS-12615/IEC-60034 PART-1	IS-325//IS-12615/IEC-60034 PART-1	TEST/INSPC. REPORT	✓	P	V	-
		5.INTERTURN INSULATION	CR	ELECT. TEST	100%	-	IS-325//IS-12615/IEC-60034 PART-1	IS-325//IS-12615/IEC-60034 PART-1	TEST/INSPC. REPORT		P	-	-
2.6	IMPREGNATION	1.VISCOSCITY	MA	PHY. TEST	AT STARTING	-	MANUFACTURER'S STANDARD	MANUFACTURER'S STANDARD	LOG BOOK		P	-	-
		2.TEMP. PRESSURE VACCUM	MA	PROCESS CHECK	CONTINUOUS	-	MANUFACTURER'S STANDARD	MANUFACTURER'S STANDARD	LOG BOOK		P	-	-
		3.NO. OF DIPS	MA	PROCESS CHECK	CONTINUOUS	-	MANUFACTURER'S STANDARD	MANUFACTURER'S STANDARD	LOG BOOK	✓	P	V	-
													THREE DIPS TO BE GIVEN

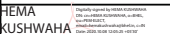



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2.7	COMPLETE STATOR ASSEMBLY	4.DURATION 1.COMPACTNESS & CLEANLINESS	MA	PROCESS CHECK VISUAL	CONTINUOUS 100%	-	MANUFACTURER'S STANDARD MANUFACTURER'S STANDARD	MANUFACTURER'S STANDARD MANUFACTURER'S STANDARD	LOG BOOK LOG BOOK	✓	P	V	-
2.8	BRAZING/COMPRESSION JOINT	1.COMPLETENESS 2.SOUNDNESS	CR	VISUAL MALLETT TEST & UT	100%	-	MANUFACTURER'S STANDARD MANUFACTURER'S STANDARD	MANUFACTURER'S STANDARD MANUFACTURER'S STANDARD	LOG BOOK TEST/INSPC. REPORT	✓	P	V	-
2.9	COMPLETE ROTOR ASSEMBLY	3.HV 1.RESIDUAL UNBALANCE	MA	ELECT. TEST DYN. BALANCE	100%	-	MANUFACTURER'S STANDARD MANUFACTURER'S SPEC./ ISO 1940	MANUFACTURER'S STANDARD MANUFACTURER'S DWG.	TEST/INSPC. REPORT LOG BOOK	✓	P	V	-
2.10	ASSEMBLY	2.SOUNDNESS OF DIE CASTING 1.ALIGNMENT 2.WORKMANSHIP 3.AXIAL PLAY 4.DIMENSIONS 5.CORRECTNESS, COMPLETENESS TERMINATIONS/ MARKING/ COLOUR CODE 6. RTD, BTD & SPACE HEATER MOUNTING.	CR	ELECT. (GROWLER TEST)	100%	-	MANUFACTURER'S SPEC. MANUFACTURER'S SPEC.	MANUFACTURER'S SPEC. MANUFACTURER'S SPEC.	TEST/INSPC. REPORT LOG BOOK	✓	P	V	-
			MA	MEAS. VISUAL MEAS. MEAS. VISUAL VISUAL	100%	-	MANUFACTURER'S SPEC. MANUFACTURER'S SPEC. MANUFACTURER'S SPEC. MANUFACTURER'S DRG/ MANUFACTURER'S SPEC. MANUFACTURER'S SPEC. MANUFACTURER'S SPEC.	MANUFACTURER'S SPEC. MANUFACTURER'S SPEC. MANUFACTURER'S SPEC. MANUFACTURER'S DRG/ MANUFACTURER'S SPEC. MANUFACTURER'S SPEC. MANUFACTURER'S SPEC.	LOG BOOK LOG BOOK LOG BOOK LOG BOOK LOG BOOK LOG BOOK	✓	P	V	-





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					M	C/N			9	.	**	D	M	C
3.0	TESTS	1.TYPE TESTS INCLUDING SPECIAL TESTS	MA	ELECT.TEST	1/TYPE/SIZE	1/TYPE/SIZE	IS-325//IS-12615/APPROVED DATASHEET	IS-325//IS-12615/APPROVED DATASHEET	TEST REPORT	✓	P	W*	-	* NOTE - 1
		2.ROUTINE TESTS INCLUDING SPECIAL TEST	MA	ELECT.TEST	100%	-	IS-325//IS-12615/APPROVED DATASHEET	IS-325//IS-12615/APPROVED DATASHEET	TEST REPORT	✓	P	√ ^s	-	^s NOTE - 2
		3.VIBRATION & NOISE LEVEL	MA	ELECT.TEST	100%	-	IS: 12075 / IEC 60034-14 & IS-12065	IS: 12075 / IEC 60034-14 & IS-12065	TEST REPORT	✓	P	√ ^s	-	^s NOTE - 2
		4.OVERALL DIMENSIONS AND ORIENTATION	MA	MEASUREMENT & VISUAL	100%	100%	APPROVED DRG/DATA SHEET	APPROVED DRG/DATA SHEET &	TEST/INSPC. REPORT	✓	P	W	-	
		5.DEGREE OF PROTECTION	MA	ELECT. & MECH. TEST	1/TYPE/ SIZE	-	IEC 60034-5/IS-12615	APPROVED DATASHEET	TC	✓	P	V	-	TC FROM AN INDEPENDENT LABORATORY, REFER NOTE-3
		6. MEASUREMENT OF RESISTANCE OF RTD & BTD	MA	ELECT. & MECH. TEST	100%	-	IS-325//IS-12615/IEC-60034 PART-1/IS: 12802	IS-325//IS-12615/IEC-60034 PART-1/IS: 12802	TC	✓	P	√ ^s	-	^s NOTE - 2
		7. MEASUREMENT OF RESISTANCE, IR OF SPACE HEATER	MA	ELECT. & MECH. TEST	100%	-	IS-325//IS-12615/IEC-60034 PART-1	IS-325//IS-12615/IEC-60034 PART-1	TC	✓	P	√ ^s	-	^s NOTE - 2
		8. NAME PLATE DETAILS	MA	VISUAL	100%	-	IS-325//IS-12615& DATA SHEET	IS-325//IS-12615 & DATA SHEET	TEST/INSPC. REPORT	✓	P	√ ^s	-	^s NOTE - 2
		9.EXPLOSION FLAME PROOF NESS (IF SPECIFIED)	MA	EXPLOSION FLAME PROOF TEST	1/TYPE	-	IS 2148 / IEC 60079-1	IS 2148 / IEC 60079-1	TC	✓	P	V	-	TC FROM AN INDEPENDENT LABORATORY, REFER NOTE-3
		10. PAINT SHADE, THICKNESS & FINISH	MA	VISUAL & MEASUREMENT BY ELKOMETER	SAMPLE	SAMPLE	APPROVED DATASHEET	APPROVED DATASHEET	TC	✓	P	W ^s	-	SAMPLING PLAN TO BE DECIDED BY INSPECTION AGENCY ^s NOTE - 2

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



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4.0	PACKING	SURFACE FINISH & COMPLETENESS	MA	VISUAL	100%	100%	AS PER MANUFACT. STANDARD / (#)	AS PER MANUFACT. STANDARD / (#)	INSPC. REPORT	✓	P	W	-	(#): REFER NOTE-8

NOTES:

- 1 DEPENDING UPON THE SIZE AND CRITICALLY, WITNESSING BY BHEL SHALL BE DECIDED.
- 2 ROUTINE TESTS ON 100% MOTORS SHALL BE DONE BY THE VENDOR. HOWEVER, BHEL/CUSTOMER SHALL WITNESS ROUTINE TESTS ON RANDOM SAMPLES. THE SAMPLING PLAN SHALL BE MUTUALLY AGREED UPON.
- 3 IN CASE TEST CERTIFICATES FOR THESE TESTS ON SIMILAR TYPE, SIZE AND DESIGN OF MOTOR FROM INDEPENDENT LABORATORY ARE AVAILABLE, THE SAME IS VALID FOR 5 YEARS.
- 4 BHEL RESERVES THE RIGHT TO PERFORM REPEAT TEST, IF REQUIRED.
- 5 AFTER PACKING AND PRIOR TO ISSUE MDCC, PHOTOGRAPHS OF ITEMS TO BE DESPACHED SHALL BE SENT TO BHEL PURCHASE GROUP FOR REVIEW.
- 6 IN CASE , ANY CHANGES IN QP COMMENTED BY CUSTOMER AT CONTRACT STAGE SHALL BE CARRIED OUT BY BIDDER WITHOUT ANY IMPLICATION TO BHEL/ CUSTOMER.
- 7 PROJECT SPECIFIC QP TO BE DEVELOPED BASED ON CUSTOMER REQUIREMENT.
- 8 FOR EXPORT JOB, BHEL TECHNICAL SPECIFICATION FOR SEAWORTHY PACKING TO BE FOLLOWED.
- 9 PACKING SHALL BE SUITABLE FOR STORAGE AT SITE IN TROPICAL CLIMATE CONDITIONS.
- 10 LATEST REVISION/ YEAR OF ISSUE OF ALL THE STANDARDS (IS/ ASME/ IEC ETC.) INDICATED IN QP SHALL BE REFERRED.

LEGENDS:

*RECORDS, IDENTIFIED WITH "TICK"(✓) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION,
 ** M: SUPPLIER/ MANUFACTURER/ SUB-SUPPLIER, B: MAIN SUPPLIER/ BHEL/ THIRD PARTY INSPECTION AGENCY, C: CUSTOMER,
 P: PERFORM, W: WITNESS, V: VERIFICATION, AS APPROPRIATE
 MA: MAJOR, MI: MINOR, CR: CRITICAL
 D: DOCUMENT

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SECTION-3.19: EARTHING & LIGHTNING PROTECTION SYSTEM

1.0.0 INTENT OF SPECIFICATION

SECTION-II

This section covers the requirements of Earthing & Lightning protection system. The scope shall include the following:

- Buried earth mat for the FGD system
- Embedded earth mat in the concrete floor of buildings.
- Equipment enclosure earthing for all electrical equipment
- Earthing of all metallic structures including cable racks
- Electronic earthing for all PLC/electronic equipment
- Lightning protection for the FGD system

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 version of the following Standards except where modified and /or supplemented by this specification.

- a) IS: 3043 Code of Practice for Earthing practice
- b) IS: 2062 Structural Steel (Standard Quality)
- c) IS: 1079 Specification for hot rolled carbon steel sheet and strips
- d) IS: 1730 Dimensions for steel plates, sheet, and strip for structural and general engineering purposes
- e) IS: 280 Specification for mild steel wire for general engineering purposes
- f) IS: 2629 Recommended practice for hot dip galvanizing on iron & steel
- g) IS: 816 Code of practice for use of metal arc welding for general construction of mild steel.
- h) IS: 4826 Specification for hot-dipped galvanized coatings on round steel wires.
- i) IS: 4759 Specification for hot-dip zinc coatings on structural steel and , allied products
- j) IS: 6745 Methods for determination of weight of zinc-coating on zinc coated articles.
- k) IEEE 80 IEEE Guide for safety in AC substation grounding
- l) IEC 62305 Protection of building and allied structures against lightning
- m) IEEE 142 Grounding of industrial & commercial power system.
- n) Indian Electricity Rules

3.0.0 TECHNICAL REQUIREMENTS

3.1.0 Earthing System

3.1.1 Bidder shall provide earth mat of spacing 5 m x 5m below switchgear/MCC room/Switchyard and transformers. Suitable number of earth electrodes shall be provided. Perimeter earthing shall be provided around the building. The above grade earthing works including connection of equipments shall be in bidder's scope. Earthing conductor for ground mat shall be minimum of 40 mm dia. M.S rod.

3.1.2 The earthing system shall meet the following requirements:

- Ensure adequate earth fault current for operation of earth fault protection



- Earthing conductors and connections shall withstand earth fault current for the duration of the fault
- 3.1.3 The mild steel earth grid shall be designed to withstand 25 years of corrosion. Corrosion rate shall be arrived at as per soil resistivity report.
 - 3.1.4 Buried earthing conductors shall have at least 1000mm of earth cover unless stated otherwise.
 - 3.1.5 Wherever earthing conductor crosses cable trenches, underground service ducts, pipes, tunnels, railway tracks etc., it shall be laid minimum 300mm below them and shall be circumvented in case it fouls with equipment / structure foundations.
 - 3.1.6 Earthing conductors or leads along their run on cable trench, ladder, walls etc. shall be supported by suitable welding / cleating at intervals of 750mm. Wherever it passes through walls, floors etc., galvanized iron sleeves shall be provided for the passage of the conductor and both ends of the sleeve shall be sealed to prevent the passage of water through the sleeves.
 - 3.1.7 Earthing conductor around the building shall be buried in earth at a minimum distance of 1500mm from the outer boundary of the building. In case high temperature is encountered at some location, the earthing conductor shall be laid minimum 1500mm away from such location.
 - 3.1.8 Earthing conductors crossing the road shall be laid 300mm below road or at greater depth to suit site conditions.
 - 3.1.9 Earthing pads shall be provided for the apparatus / equipment at accessible position. The connection between earthing pads and the earthing grid shall be made by two short earthing leads (one direct and another through the support structure) free from kinks and splices.
 - 3.1.10 Steel / RCC structures & columns, metallic stairs etc. shall be connected to the nearby earthing grid conductor by two earthing leads. Electrical continuity shall be ensured by bonding different sections of handrails and metallic stairs.
 - 3.1.11 Metallic pipes, conduits and cable tray sections for cable installation shall be bonded to ensure electrical continuity and connected to earthing conductors at regular interval. Apart from intermediate connections, beginning points shall also be connected to earthing system.
 - 3.1.12 Metallic conduits shall not be used as earth continuity conductor.
 - 3.1.13 Wherever earthing conductor crosses or runs along metallic structures such as gas, water, steam conduits, etc. and steel reinforcement in concrete it shall be bonded to the same.
 - 3.1.14 Flexible earthing connectors shall be provided for moving parts.
 - 3.1.15 A continuous earth conductor of 16 SWG GS wire shall be run all along each conduit run. The conductor shall be connected to each panel earth bus. All junction boxes, receptacles, switches, lighting fixtures etc. shall be connected to this 16 SWG earth conductor.
 - 3.1.16 50mm x 6mm galvanized steel flat shall run on the top tier and all along the cable trenches and the same shall be welded to each of the racks. Further, this flat shall be earthed at both ends and at an interval of 30m.
 - 3.1.17 Earthing connections with equipment earthing pads shall be bolted type. Contact surfaces shall be free from scale, paint, enamel, grease, rust or dirt. Two bolts shall be provided for making



earth connection. Equipment bolted connections, after being checked and tested, shall be painted with anti-corrosive paint / compound.

- 3.1.18 Connection between equipment earthing lead and main earthing conductors and between main earthing conductors shall be welded type. For rust protection, the welds shall be treated with red lead and afterwards coated with two layers bitumen compound to prevent corrosion.
- 3.1.19 Steel to copper connections shall be brazed type and shall be treated to prevent moisture ingress.
- 3.1.20 Resistance of the joint shall not be more than the resistance of the equivalent length of the conductor.
- 3.1.21 All ground connections shall be made by electric arc welding. All welded joints shall be allowed to cool down gradually to atmospheric temperature before putting any load on it. Artificial cooling shall not be allowed.
- 3.1.22 Metallic sheaths and armour of all multi-core power cables shall be earthed at both equipment and switchgear end. Sheath and armour of single core power cables shall be earthed at switchgear end only.
- 3.1.23 Earthing terminal of each lightning arrester and capacitor voltage transformer shall be directly connected to rod earth electrode which in turn, shall be connected to station earthing grid.
- 3.1.24 For electronic equipment such as PLC, chemical earthing pit shall be provided. The earth pit shall be tested and proven type and shall be guaranteed for service life of 25 years. The chemical earth pit shall comprise pipe electrode, crystalline conductive mixture, bentonite etc. constructed in a pit of not less than 3500mm depth. The pit shall be effective in all weather conditions and offer low resistance.
- 3.1.25 Size of the earthing conductor shall be as follows:

Sl.No.	Equipment	Size/ type of Earthing material
1.	Main earthing conductor	Mild steel rod of 40mm dia size
2.	Earth risers	Mild steel rod 40 mm dia
3.	Rod earth electrode	Mild steel rod 40 mm dia
4.	Treated earth pit	Minimum 65 mm dia galvanized steel pipe electrode as per IS:3043
5.	Electronic earthing	Chemical earth pit
6.	LT transformers (enclosure and neutral)	75X10mm GS flat
7.	HT Switchboards, HT motors, HT busducts	75X10mm GS flat
8.	LT Switchboards (PMCC & MCC), LT busduct	75X10mm GS flat
9.	All distribution boards	75X10mm GS flat
10.	Charger / UPS	50X6mm GS flat
11.	Lighting panels	25X6mm GS flat
12.	Cable trays	50X6mm GS flat
13.	Control Panel & Control desk	50X6mm GS flat
14.	Push Button & JB	8SWG GI Flat
15.	Column, structures, Cable tray, Fence,	50X6mm GS flat



SI.No.	Equipment	Size/ type of Earthing material
	Gate and bus duct enclosures	
16.	Crane, Rail, Rail tracks & other non-current carrying metal parts	50X6mm GS flat

- 3.1.26 All earth electrodes shall preferably be driven to a sufficient depth to reach permanently moist soil. Electrodes shall preferably be situated in a soil which has a fine texture and which is packed by watering and ramming as tightly as possible. The electrodes shall have a clean surface, not covered by paint, enamel, grease or other materials of poor conductivity.
- 3.1.27 Earth pits shall be located avoiding interference with road, building foundation, column, equipment foundation etc. The disconnect facility shall be provided for individual earth pits to check their earth resistance periodically. Proper symmetry and distance between earth pits shall be maintained as per applicable standards and procedures. Treated earth pits shall conform to relevant standard.
- 3.1.28 Construction of trench for earthing conductor shall include excavation, laying of conductor, back filling and compacting. Back filling material to be placed over buried conductors shall be free from stones and harmful mixtures. Back filling shall be placed in layers of 150mm. Minimum earth coverage of 300mm shall be provided between earth conductor and the bottom of trench / foundation / underground pipes at crossings.
- 3.1.29 On completion of installation, continuity of earth conductors and efficiency of all bonds and joints shall be checked. Earth resistance at earth terminations shall be measured in presence of Owner's representatives. Equipment required for testing shall be furnished by Contractor.
- 3.1.30 Electronic panels and equipment shall be grounded utilizing an insulated copper ground wire terminated at separate earth electrode.
- 3.1.31 Metallic frame of all electrical equipment shall be earthed by two separate and distinct connections to earthing system, each of 100% capacity. Steel RCC columns, metallic stairs, hand rails etc. of the building housing electrical equipment shall be connected to the nearby earthing grid conductor by one earthing.
- 3.1.32 Metallic sheaths, screens, and armour of all multi core cables shall be earthed at both ends. Sheaths and armour of single core cables shall be earthed at switchgear end only unless otherwise instructed by Owner.
- 3.1.33 Railway tracks within the plant area shall be bonded across fish plates and connected to earthing grid at several locations.
- 3.1.34 For prefabricated cable trays, a separate ground conductor shall run along the entire length of cable tray and shall be suitably clamped on each cable tray at periodic intervals. Each continuous laid out lengths of cable tray shall be earthed at minimum two places by G.S. flats to Owner's earthing system, the distance between earthing points shall not exceed 30 metre. Wherever earth mat is not available Contractor shall do the necessary connections by driving an earth electrode in the ground.
- 3.1.35 The LV neutral of LT Service transformer shall be directly connected to earth and also connected to neutral of LT switchgear. Each earthing lead from the neutral of the Transformers/NGR shall be directly connected to two electrodes in treated earth pits which in turn shall be connected to station earthing grid.



- 3.1.36 Neutral connections and metallic conduits/pipes shall not be used for the equipment earthing. Lightning protection system down conductors shall not be connected to other earthing conductors above the ground level.
- 3.1.37 All ground conductor connections shall be made by electric arc welding and all equipment earth connections shall be made by bolting with the earthing pads through flexible insulated cable leads. Ground connections shall be made from nearest available station ground grid risers. Suitable earth risers approved by Owner shall be provided above finished floor/ground level, if the equipment is not available at the time of laying of main earth conductor.
- 3.1.38 Resistance of the joint shall not be more than the resistance of the equivalent length of conductor. For rust protection the welds should be treated with red lead compound and afterwards thickly coated with bitumen compound.
- 3.1.39 Earthing conductors buried in ground shall be laid minimum 600 mm below grade level unless otherwise indicated in the drawing. Earthing conductors crossings the road shall be installed at 1000 mm depth and where adequate earth coverage is not provided it shall be installed in hume pipes. Earthing conductors embedded in the concrete floor of the building shall have approximately 50mm concrete cover.
- 3.1.40 A minimum earth coverage of 300mm shall be provided between earth conductor and the bottom of trench/foundation/underground pipes at crossings. Wherever earthing conductor crosses on runs at less than 300mm distance along metallic structures such as gas, water, steam pipe lines, steel reinforcement in concrete, it shall be bonded to the same.
- 3.1.41 Earthing conductors along their run on columns, walls, etc. shall be supported by suitable welding/cleating at interval of 1000mm.
- 3.1.42 Earth pit shall be constructed as per approved drawing. Electrodes shall be embedded below permanent moisture level. Minimum spacing between electrodes shall be 6000mm. Earth pits shall be treated with salt and charcoal. Earthing conductor around the building shall be buried in earth at a minimum distance of 1200mm from the outer boundary of the building.
- 3.1.43 Earthing of cabling system
- Armour of the HT cables and LT single core cables shall be earthed only at one end of cable.
 - Armour of other cables shall be earthed at both ends of cable.
 - Screen of HT power cables shall be earthed at one end only.
 - Screen of C&I screened control cables shall be earthed at one end.
 - Screen of electronic earthing system cables shall be earthed as per the requirements to be furnished to the Contractor during contract stage.
- 3.1.44 Installation of earth conductors in outdoor areas, buried in ground, shall include excavation of earth up to 600mm deep and 450mm wide, laying of conductor at 600mm depth, brazing / welding / cad welding, if required, of main grid conductor, joints as well as risers of length 500mm above ground at required locations and then backfilling. Backfilling material to be placed over buried conductor shall be free from stones and other harmful mixtures. Backfill shall be placed in layers of 150mm, uniformly spread along the ditch, and tampered utilizing pneumatic tampers or other approved means. If the excavated soil is found unsuitable for backfilling, the Contractor shall arrange for suitable soil from outside.



- 3.1.45 Installation of earth pit shall include excavation, construction of the earth pits including all materials required for construction of earth pits, placing the rod and fixing test links on pipe / rod / plate electrodes in test pits and connecting to main earth grid conductors.
- 3.1.46 Each lighting poles and lighting / lighting mast junction box shall be earthed by 25 x 3mm GS flat bonded to one (1) 20mm diameter MS earth electrode of 3m length driven vertically in the ground. The flat and electrode shall be supplied by the Contractor and price of these shall be included in the erection price of individual pole / mast. 14 SWG GI wire shall be taken from fixture to JB.
- 3.1.47 After completion of grounding system installation, the measurement of ground resistance shall be performed by the Contractor. Before measurement, the overhead ground wires shall be disconnected from the GIS Switchyard. The method of measurement shall be as per relevant standards / codes. The ground resistance of GIS Switchyard grounding system shall be not more than 1 ohm.

4.0.0 LIGHTNING PROTECTION SYSTEM

- 4.1.0 All areas of the FGD shall be provided with lightning protection as per IEC 62305. The lightning protection system for buildings shall consist of Galvanised Steel horizontal air terminations, copper clad steel rod vertical air terminations, down conductors, test link and earth electrodes.
- 4.2.0 Air termination network consisting of vertical or horizontal conductors or combination of both shall be provided for the building. Down conductors shall follow the most direct path possible between the air terminal network and the earth termination network. Each down conductor shall be provided with a test link for testing. An earth electrode shall be connected to each down conductor.
- 4.3.0 For Lightning protection, material & sizes shall be as follows:
- Vertical air termination : 20mm dia Galvanised MS Rod 1000mm long
 - Horizontal air termination : 25X6 mm Galvanised MS Strip
 - Down conductor : 25X6 mm Galvanised MS Strip
 - Test link : 150x50x6mm Galvanised MS Strip with Box
 - Earth Electrodes : Treated earth pit with pipe electrode as per IS:3043
- 4.4.0 The lightning protection system shall not come in direct contact with other equipment/systems such as cables, conduits, electrical equipment, underground metallic ducts etc. All metallic structures within 200 mm. vicinity shall be bonded to the lightning protection system.
- 4.5.0 All welded/brazed joints shall be coated with anti- corrosive paint for rust protection.
- 4.6.0 Lightning conductor when used above ground level and shall be connected through test link with earth electrode/earthing system. Down conductors shall be as short and straight as practicable and shall follow a direct path to earth. Down conductor shall not be connected to other earthing conductors above ground level.
- 4.7.0 Each down conductor shall be provided with a test link at 1500 mm above ground level for testing but it shall be in accessible to interference. No connections other than the one direct to an earth electrode shall be made below a test point. All joints in the down conductors shall be of welded type.



- 4.8.0 Down conductors shall be cleated on outer side of building wall/ welded to outside building columns at 1000mm interval.
- 4.9.0 Lightning conductor on roof shall not be directly cleated on surface of roof. Supporting blocks of PMCC/insulating compound shall be used for conductor fixing at an interval of 1500mm.
- 4.10.0 Thickness of galvanising shall be atleast 610gm/sq.m for all galvanised steel conductors.
- 4.11.0 Installation of lightning conductors on the roofs of buildings shall include construction of support, laying, anchoring, fastening and cleating of horizontal conductors, grouting of vertical rods wherever necessary, laying, fastening / cleating / welding of the downcomers on the walls / columns of the building and connection to the test links to be provided above ground level.
- 4.12.0 On completion of installation, continuity of earth conductors and efficiency of all bonds and joints shall be checked. Earth resistance at earth terminations shall be measured in presence of Owner's representatives. Resistance of individual earth electrode shall be measured after disconnecting it from the grid. Tests shall be carried out as per IS : 3043 for earthing installation including the following:
- a) Earth continuity checks
 - b) Earth resistance of the complete system, sub-system and earth pits



SECTION-3.17: CABLING ACCESSORIES

1.0.0 INTENT OF SPECIFICATION

SECTION-II

This section covers the requirements of cabling accessories. List of major items shall include the following:

- Cable joints & terminations
- Cable glands
- Cable lugs
- Camps
- Tags
- Conduits & Pipes
- Junction boxes

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 version of the following Standards except where modified and /or supplemented by this specification.

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

3.0.0 TECHNICAL REQUIREMENTS

3.1.0 Joints & terminations

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

3.1.2 Termination and jointing kits shall be suitable for the following types of cables as per IS.

- 11 KV unearthed grade cable
- 1.1 KV grade power cables

3.1.3 Termination kits shall be 'elastimold' or 'Push on type' or 'heat shrinkable type'. Jointing kits shall be 'Tapex type' or 'heat shrinkable type'.

3.1.4 Straight through joint and termination shall be capable of withstanding the fault level of 44KA for HT Cables.

3.1.5 Straight through joints shall be protected against mechanical damage, rodent and termite attack. It shall be suitable for directly buried cables.



3.2.0 Cable glands

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

3.3.0 Cable lugs

3.3.1 Cable lugs shall be of aluminium for aluminium cables and tinned copper for copper cables. Thickness of tinning shall be not less than 10 microns Type of end connection shall be solderless crimping type.

3.3.2 Cable lugs for conductors of power cables shall be "heavy duty" type. The type & size of cable lugs for power cables shall be selected according to the number and sizes of strands of the cable.

3.3.3 Solder less crimping of terminals shall be done by using corrosion inhibiting compound. Cable lugs for control cable termination shall be insulated. These lugs shall be pin type/flat type/ ring type/U Type to suit the terminals provided in the panels.

3.3.4 Type of cable lugs shall be as follows:

- Power cables with aluminium conductor : Aluminium crimping type.
- Power cables with copper conductor : Copper crimping type.
- Control Cables : Copper pin type /Copper screw type
- Special cables : pin type / maxi-termi type

3.4.0 Trefoil Cable Clamps

- Clamps required for single core cables carrying alternating current shall be suitable for holding three cables together in delta formation. Clamps shall be of FRP material.
- Clamps shall be of suitable sizes to firmly hold the cables of various outer diameters including tolerance in OD.
- Clamps should have been type tested for Short Circuit Withstand Test .
- For Trefoil clamps run spacing shall be 2000 mm and Axial spacing shall be Double the diameter of larger adjacent trefoils cable or 150 mm whichever is less. Supports shall also be provided at each bend

3.5.0 Omega Cable clamps

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



- For cables of up to 35 mm OD, cables shall be collectively clamped at 5000 mm interval for Horizontal runs and shall be collectively clamped at 1000 mm interval for Vertical runs. Supports shall also be provided at each bend.
- For cables supported along structures/ceiling, clamp spacing shall be 750 mm. Supports shall also be provided at each bend.

3.6.0 Strip Cable Clamps

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

3.7.0 Self-locking Clamps

- Clamps shall be of FRP material. Clamps shall have self-locking feature when the cord is looped. Clamps shall be provided with manual lock release.
- Clamp cord shall not move in the backward position once it has been locked, unless the lock release is applied.
- Type test certificates to ascertain the strength of clamps shall be submitted for Owner's approval.
- Not more than four (4) cables shall be clamped together, wherever collective clamping is permitted.
- Clamp length shall be selected such that not more than 80% of lockable length is utilized for clamping.
- Nylon self-locking tie strips for collective clamping (up to 35mm OD max. group of 4 cables) shall be 4 mm having Tensile strength 30 kg.
- Nylon self-locking tie strips for Individual multicore clamping (above 35mm OD up to 55mm OD) shall be 4 mm having Tensile strength 20 kg.
- Nylon self-locking tie strips for Individual multicore clamping (above 55mm OD) shall be 7 mm having Tensile strength 60 kg.

3.8.0 Tags

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

3.9.0 Junction Boxes

- 3.9.1 Junction box with IP 55 degree of protection, shall comprise of a case with hinged door constructed from FRP material. The junction box shall be provided with canopy. The boxes shall include brackets, bolts, nuts, screws, glands, lugs, M8 earthing stud etc.



- 3.9.2 Terminal blocks shall be of 650V grade, rated for 10A and in one piece moulding. It shall be complete with insulating barriers, clip-on-type terminal numbering on wiring diagrams. Terminal block shall be suitable for terminating 2Cx2.5mm² cable on both sides and arranged to facilitate easy termination. Cable entry shall be from bottom.
- 3.9.3 The boxes shall have provision for wall, column, pole or structure mounting and shall be provided with cable / conduit entry knockouts and terminals.


The list of approved make of the LT Motors are as mentioned below:

S. NO.	LIST OF MOTORS	
1	NON FLAME PROOF	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
11	FLAME PROOF	RAJINDRA ELECT INDUSTRIES

However, the final list of makes for the LT Motors is subjected to BHEL/Customer approval, during contract stage, without any commercial implications.

The list of make of CABLE LUGS & CABLE GLANDS are as mentioned below:	
CABLE LUGS	
1	DOWELLS
2	UNIVERSAL MACHINES LTD.
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

However, the final list of makes for the CABLE LUGS & CABLE GLANDS are subjected to BHEL/Customer approval, during contract stage, without any commercial implications.

	North Chennai TPP Stage-III - 1x800 MW GYP SUM DEWATERING EQUIPMENT TECHNICAL SPECIFICATION (C&I PORTION)	SPECIFICATION No: PE-TS-485-571-A901	
		SECTION : I	
		SUB-SECTION : C-4	
		REV. 00	

SECTION: I

SUB-SECTION: C-4

TECHNICAL SPECIFICATION (C&I PORTION)

1x800 MW NORTH CHENNAI FGD

**Tamil Nadu Generation and
Distribution Corporation Ltd.**

**C&I SPECIFICATION
FOR
GYPSUM DEWATERING EQUIPMENT**

S. No.	DESCRIPTION
1	TITLE SHEET
2	INDEX SHEET
3	C&I SPECIFIC TECHNICAL REQUIREMENTS
4	CUSTOMER SPECIFICATION
5	FIELD & MEASURING INSTRUMENT
6	LOCAL CONTROL PANEL AND DATA SHEET
7	ELECTRIC MOTOR ACTUATOR SPEC
8	LIST OF MANDATORY SPARES
9	SYSTEM CONFIGURATION & INSTRUMENT HOOK UP DIAGRAM
10	SIGNAL EXCHANGE
11	VARIABLE FREQUENCY DRIVE
12	TYPE TEST REQUIREMENT
13	STANDARD CHECKLIST FOR C&I INSTRUMENTS
14	KKS PHILOSOPHY
15	SUB VENDOR LIST OF C&I ITEMS

	1X800 MW NORTH CHENNAI FGD	
	SPECIFIC TECHNICAL REQUIREMENTS (C&I) GYPSUM DEWATERING EQUIPMENT	
<p style="text-align: center;"><u>Specific Technical Requirements (C&I) FOR GYPSUM DEWATERING EQUIPMENT</u></p> <ol style="list-style-type: none"> 1. GYPSUM DEWATERING EQUIPMENT (GDS) shall be operated from DCS (BHEL's scope). 2. DDCMIS system shall be time synchronized with master clock system preferably with SNTP protocol. 3. The Contractor shall provide Instrumentation along with necessary fittings, accessories and valve manifold etc for control, monitoring and operation of entire GDS except marked as BHEL's scope in P&ID attached in specification. All instruments shall be provided with durable epoxy coating for housing and all exposed surfaces of the instruments. 4. The requirements given below are to be read in conjunction with detailed Technical requirement as enclosed in the specification. Further in case of any discrepancy in the requirement 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/BHEL shall prevail without any commercial and delivery implication. 5. All local gauges as well as transmitters, sensors and switches for parameters like pressure, temperature, level, flow etc. as required for the safe and efficient operation and maintenance under the scope of specification shall be provided. The necessary root valves, impulse piping, drain cock, gauge-zeroing cocks, valve manifolds and all the other accessories required for mounting / erection of these field instruments shall be furnished even if not specifically asked for. The proposal shall include the necessary flexible conduits, junction boxes and accessories for the above purpose. Double root valves shall be provided for all pressure tapping where the pressure exceeds 40 Kg / Cm². 6. All field instruments shall be weatherproof, drip tight, dust tight and splash proof suitable for use under outdoor ambient conditions prevalent in the subject plant. All field-mounted instruments shall be mounted in suitable locations where maximum accessibility for maintenance is achieved. The enclosures of all electronic instruments shall conform to IP-65 unless otherwise specified (explosion proof for NEC class 1, division 1 area) and an anticorrosive 		

	1X800 MW NORTH CHENNAI FGD	
	SPECIFIC TECHNICAL REQUIREMENTS (C&I) GYPSUM DEWATERING EQUIPMENT	
<p>paint shall be applied to the field mounted enclosures / instruments. All the field instruments shall also be provided with SS tag nameplate and double compression type Nickel-plated brass cable gland. Gaskets, Fasteners, Counter and mating flange shall also be included wherever required with the field instruments.</p> <ol style="list-style-type: none"> 7. All instruments envisaged for sea water applications shall be provided with wetted parts of Super duplex SS. 8. Temperature Elements used for monitoring shall be provided with Temperature Transmitters. 9. All the instruments/sensors/transmitters/switches meant for redundant applications shall have completely separate and independent impulse pipes/ root valves etc. No redundant instrument shall share a single process tapping. There will be separate and independent tapping for every individual instrument. 10. All the instruments/drives shall be terminated on JB's/Panels in field. JB's/Panels shall be in Bidder's scope. 11. All transmitters shall be suitably grouped together and mounted inside (i) Local Instruments Enclosures (LIEs) in case of open areas of the plant and (ii) In Local Instrument Racks (LIRs) in case of covered areas. 12. All the transmitters / transducers supplied by Bidder shall be rack mounted. The transmitter racks shall be in Bidder's scope of supply. All transmitters shall be HART compatible. 13. Contacts less, electronic 2-wire position transmitters shall be provided for all inching type motorized valve and dampers. 14. Electric Actuators shall be of totally enclosed weather proof and dust proof construction with NEMA-6/IP 68 enclosure and shall be suitable for outdoor application without the necessity for a canopy. Actuators shall be provided with integral starters. 15. The solenoid operated valves shall have limit switches for open/ close feedback. 16. All final control elements like solenoid valve, on-off valves and actuators shall be provided as required. 		

	1X800 MW NORTH CHENNAI FGD	
	SPECIFIC TECHNICAL REQUIREMENTS (C&I) GYPSUM DEWATERING EQUIPMENT	
<p>17. Solenoid valves shall be selected to incorporate body construction, trim materials and internal arrangements suitable to the application and shall be acceptable to the Owner. Solenoid enclosures shall be NEMA-4 / IP 65 unless otherwise specified. Solenoid coils shall be Class-H High temperature construction and shall be suitable for continuous duty.</p> <p>18. All pneumatic operated regulating control valves shall be envisaged with smart positioner.</p> <p>19. Local control panel and VFD panel, as desired, required for operation shall be in bidder scope.</p> <p>20. 230 V AC UPS supply shall be provided by BHEL at a single point, further distribution to various instruments/Equipment's of the system shall be in bidder scope. Bidder to include necessary power distribution board in his scope. Any power supply other than the above, if required by any instrument/equipment has to be derived by the bidder from the above supply & all necessary hardware for the same shall be in bidder scope. Bidder to submit the UPS power requirement along with the bid.</p> <p>21. All the outdoor field instruments such as analysers/transmitters/meters etc. shall be provided with suitable Free standing cabinet(s)/panel/rack/canopy so that the equipment's are protected against rain/ sunlight etc. Vibration isolating pads of min. 15 mm thickness shall be furnished for all cabinets.</p> <p>22. All field instruments enclosure shall be IP65, local panel/cabinet enclosure shall be IP 55, unless otherwise specified.</p> <p>23. Separate moisture separator in the instrument airline for all required equipment.</p> <p>24. All the instruments/equipment/electrical items shall be provided & designed with maximum star rating as available in line with energy conservation policies notified by BEE, GOI at the time of supply.</p>		

	1X800 MW NORTH CHENNAI FGD	
	SPECIFIC TECHNICAL REQUIREMENTS (C&I) GYPSUM DEWATERING EQUIPMENT	
<p>25. 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.</p> <p>26. Bidder shall supply all necessary cable, cable trays, conduits, accessories, between DCS to field / MCC as per cable scope between BHEL and bidder defined in electrical specification.</p> <p>27. 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.</p> <p>28. Bidder to provide mandatory spares as per mandatory spares list, attached in the specification.</p> <p>29. Instrument installation and accessories required for the same shall be in Bidder's scope and shall be submitted after award of contract. However, any instrument/ analyser installation not covered in the same shall be subject to customer and BHEL approval during detailed engineering. Bidder to provide erection hardware including junction boxes, canopies, structural steel as required.</p> <p>30. Instrument installation shall be as per the attached "Standard Hook-up diagram of instrument."</p> <p>31. All approval/Inspection are to be carried out by Owner or owner appointed agency only.</p> <p>32. At least 20% spare unused terminals shall be provided everywhere including local junction boxes, instrument racks/enclosures, termination/marshalling cabinets, etc.</p>		

	1X800 MW NORTH CHENNAI FGD	
	SPECIFIC TECHNICAL REQUIREMENTS (C&I) GYPSUM DEWATERING EQUIPMENT	
<p>33. All Panels, junction boxes shall be of exterior color RAL 7035 and interior colour of glossy white only. Bidder shall note that the Analog and digital signals shall be wired to different junction boxes.</p> <p>34. Bidder shall follow KKS Tagging philosophy.</p> <p>35. Bidder shall provide ammeters, voltmeters, pushbuttons indicating lamp, mimic, electrical scheme, indicators, recorders and HW annunciations on the local control panels as per process requirement.</p> <p>36. All electronic/electrical instruments, junction box and control panel shall be suitable for area classification as per IEC/NEC codes. Certified intrinsically safe / explosion proof equipment shall be used, in general, in hazardous area.</p> <p>37. The make of the items shall be from sub-vendor list. However, the make/model of various instruments/items/systems shall be subject to approval of owner/purchaser during detailed engineering stage. No commercial and delivery implication in this regard shall be acceptable. In case of any conflict or repetition of clauses in the specification, the more stringent requirements among them are to be complied with.</p> <p>38. 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. In case of any conflict and repetition of clauses in the specification, BHEL discretion will prevail. The requirements given are to be read in conjunction with detailed Technical specification enclosed.</p> <p>39. Contractor shall furnish Instrument Schedule, I/O list, Drive list, Cable Schedule, Cable interconnection (DCS end terminal details shall be provided to bidder 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.</p> <p>40. Number of pair to be selected for screen control cable (Size :0.5 mm²)</p> <p style="margin-left: 40px;">F-type: 2P/4P/8P G-type: 4P/8P Core Cable: 3CX2.5sqmm²</p>		

	1X800 MW NORTH CHENNAI FGD	
	SPECIFIC TECHNICAL REQUIREMENTS (C&I) GYPSUM DEWATERING EQUIPMENT	

Note:-

1. All equipment items shall be of latest design with proven on track record.
2. The above given scope is indicative & minimum. Any item/ equipment not indicated above however required for the completeness of the system is to be supplied by bidder without any technical, commercial and delivery implication to BHEL.
3. Documents of C&I System shall be submitted to end user/owner for approval during detail engineering. Changes, if any, shall be accommodated by the bidder without any price/time implication.



**C&I SPECIFICATION FOR
GYPSUM DEWATERING EQUIPMENT**

SECTION: C
SUB SECTION: C&I

LIST OF DOCUMENTS/DELIVERABLES



C&I SPECIFICATION FOR GYPSUM DEWATERING EQUIPMENT

SECTION: C
SUB SECTION: C&I

LIST OF DELIVERABLES OF PEM - C&I DEPARTMENT

Sl. No.	DRAWING NO.	DRAWING/DOCUMENT TITLE	CATEGORY
1	PE-V4-485-145-I901	CONTROL & OPERATIONAL WRITE-UP FOR THE SYSTEM WITH SET POINTS	A
2	PE-V4-485-145-I902	CONTROL SCHEME/LOGIC DIAGRAM (TO BE IMPLEMENTED IN DDCMIS)	A
3	PE-V4-485-145-I903	HMI PICTURES/PLANT SCHEMATICS	A
4	PE-V4-485-145-I904	INSTRUMENT SCHEDULE WITH SET POINTS	A
5	PE-V4-485-145-I905	I/O LIST (ANALOG & BINARY)	A
6	PE-V4-485-145-I906	DRIVE LIST/SOLENOID/ACTUATOR VALVE LIST WITH LOCA ¹ PE-V4-485-145-I905	A
7	PE-V4-485-145-I907	FIELD JB/LIE/LIR,DRIVES TERMINATIONS	A
8	PE-V4-485-145-I908	DATASHEETS FOR INSTRUMENTS, JBs, etc.	A
9	PE-V4-485-145-I909	QUALITY PLANS (INSTRUMENTS, VMS, etc.)	A
10	PE-V4-485-145-I910	INSTRUMENT HOOK-UP DRAWING	A
11	PE-V4-485-145-I911	THERMOWELL SIZING CALCULATION	A
12	PE-V4-485-145-I912	CABLE SCHEDULE & INTERCONNECTION	A
13	PE-V4-485-145-I913	ANNUNCIATION & SOE LIST	A

NOTES:

ANY OTHER DOCUMENT DECIDED DURING DETAILED ENGINEERING SHALL BE PROVIDED BY BIDDER WITHOUT ANY COMMERCIAL/TECHNICAL IMPLICATION.

CONTRACTOR TO SUBMIT REUSABLE DATABASE FORMATS IN BHEL/CUSTOMER APPROVED FORMATS LIKE MS EXCEL, MS ACCESS OF DOCUMENTS LIKE INSTRUMENT SCHEDULE, I/O LIST, DRIVE LIST, FIELD JB TERMINATIONS, CABLE SCHEDULE & INTERCONNECTION, etc.
SOFT COPY OF FORMATS SHALL BE PROVIDED TO SUCCESSFUL BIDDERS.



**C&I SPECIFICATION FOR
GYPSUM DEWATERING EQUIPMENT**

SECTION: C
SUB SECTION: C&I

FIELD & MESURING INSTRUMENTS

CUSTOMER SPECIFICATION

DESIGN REQUIREMENTS

1. All panels, cubicles and enclosures shall be furnished complete with integral piping, internal wiring, convenience outlets, internal lighting, grounding, ventilation, space heating, vibration isolating pads and other accessories.
2. Equipment inside the cabinets shall be so located that their terminals and adjustments are readily accessible for inspection and maintenance.
3. All the equipment fed from electrical system and installations shall meet the statutory requirements of relevant Indian Electricity Rules.
4. Conduits, junction boxes, and pull boxes shall be properly grounded.

4.2.0 Environmental Conditions

Instruments for location in outdoor/indoor/air-conditioned areas shall be designed to suit the environmental conditions indicated below and 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 covered under this specification.

1. All equipment/systems for air conditioned areas shall also be designed and constructed to operate indefinitely without loss of function, departure from specifications or damage during periods of air conditioning failure in summers such temperature may rise up to 55 deg. C even.
2. The period for which the equipment/system can function satisfactorily without A/C shall be mentioned by the bidder.
3. Outdoor Locations

Sl.No.	Design Temp.	Pressure	Relative humidity	Atmosphere
1.	Maximum 55 °C	Atmospheric	100%	Air (dirty)
2.	Minimum 4 °C	-do-	5%	Air (dirty)

- i. Indoor Locations (Excluding the heat self-generated by equipments)

Sl.No.	Design Temp.	Pressure	Relative humidity	Atmosphere
1.	Maximum 50 °C	Atmospheric	95%	Air
2.	Minimum 4 °C	-do-	5%	Air

- ii. Air-Conditioned

Sl.No.	Design Temp.	Pressure	Relative humidity	Particle size	Atmosphere
1.	Normal 24 °C ± 5°	Atmospheric	50% ± 10%	15 microns	Air
2.	* Maximum 50 °C	do	95%	* 50 microns	Air

* During air-conditioning failure for short duration's.

4.4.1 Instrument Accuracy

All instruments/systems furnished as per this specification shall meet the accuracy requirements indicated in these specifications. The minimum requirements to be met by all equipment/systems are indicated below:-

All instruments shall be constructed to perform normally and meet all guarantees when subjected to the service conditions listed in the applicable sections.

All thermocouples and extension lead wire shall have limits of error that comply with special limits of error contained in ANSI MC96.1-1982, Class-A accuracy.

Resistance temperature detector elements shall have a resistance characteristic which is linear with respect to temperature within plus or minus one-half of one per cent of the top range value, Class-A accuracy.

Transmitters for pressure shall transmit a signal which is linear with respect to the measured pressure accuracy shall be within plus or minus 0.065% of the measured range span.

Transmitters for level shall transmit a signal which is linear with respect to the measured level within plus or minus one-tenth of one percent of the metered level range span based on a specific gravity of 1.00.

Transmitter accuracy mentioned above shall be inclusive of the combined effects of hysteresis, repeatability and linearity etc. All transmitters shall have less than one-half of one percent shift in output with a 50° C change in ambient temperature.

Where temperature compensation networks are furnished, they shall produce corrections which are in accordance with theoretical requirements over the specified variations, over a flow range from 10 percent to 100 percent of maximum flow, subject to a plus or minus tolerance of one-half of one percent of the maximum flow.

Accuracy requirements of other instrument type are given in the appropriate specification paragraphs.

4.4.2 Instrument Scales

Instrument scales will be black graduations in white dials and where practicable with scale divisions based on multiples of 10. The smallest division shall preferably be a whole number approximately 1% of the scale range if not otherwise impracticable.

All Instrument scales and charts shall be calibrated and printed in Metric units and shall have linear graduation. The ranges shall be selected to have the normal reading at 75% of full scale.

All scales and charts shall be calibrated and printed in Metric Units as follows:-

- | | | | |
|----|------------------|---|---|
| 1. | Temperature | : | Degree centigrade (deg. C) |
| 2. | Pressure | : | Kilograms per square centimeter (kg/cm ²) |
| 3. | Draught | : | Millimeters of water column (mm wcl.) |
| 4. | Vacuum | : | Millimeters of mercury column (mm Hg)
or water column (mm wcl) |
| 5. | Flow (All gases) | : | Tonnes/hour. |
-

6.	Flow (Steam)	:	Tonnes/ hour
7.	Flow (liquid)	:	Tonnes/ hour
8.	Flow base	:	Based – 760 mm Hg, 15 deg.C
9.	Density	:	Grams per cubic centimeter
10	Speed	:	RPM
11.	Frequency	:	Hz
12.	Differential Pressure	:	kg/cm ²
13.	Level	:	mm
14.	Conductivity	:	micro S/cm
15.	Analytical parameter	:	ppm or ppb as specified in respective case.

Pressure instrument shall have the unit suffixed with 'a' or 'g' to indicate absolute or gauge pressure.

Scales and charts of all instruments shall have linear graduations and the Bidder shall offer devices for square root extraction or other functional operations required for this purpose. Local indicator scales may be non-linear if approved by the Owner.

All Instruments and Control devices provided on panels shall be of miniaturized design, suitable for modular flush mounting on panels with front draw out facility and flexible plug-in connection at rear.

4.4.3 Instrument Ranges

Instrument ranges will be selected to have the normal reading preferably at 60- 75% of full scale. Deviation indicators shall have the null position at mid-scale.

4.5.0 Choice of Hardware

4.5.1 General

The primary objective for the design of Instrumentation and Control systems shall be to assist in the attainment of maximum unit availability.

Instrument sensing, transmission, measuring system shall be of latest microprocessor based/solid state electronic type with signal transmission in current mode with 4-20 mA level except for local instruments.

All Instruments and Control devices located on control panels shall be of miniaturized design, suitable for modular flush mounting on control panels with front draw out facility and flexible plug-in connections at the rear.

The interrogation voltage level for plant annunciation, interlock and protection systems shall be adequate to ensure high signal to noise ratio, but should not exceed 24V DC. The logic system shall be adequately protected from signal and power line borne noise and surge voltages and shall satisfy stipulations in specification.

All instrument contacts unless otherwise specified shall be rated for interrupting 5 amp at 240V AC, 50 Hz and 0.5 amp at 220V DC. Potential free contacts at output of interlock and protection system for interlocking with electrical switchgear & motor control centers shall be capable of interrupting at least 10 Amps at 240V, 50Hz and 0.5 amp at 220V DC.

4.5.2 Proven Performance

Instruments and hardware furnished as per this specification shall be from the latest established range of a qualified manufacturer whose design, performance and high availability have been demonstrated by a considerable record of successful operation in coal fired utility stations.

4.6.0 Operability & Maintainability

4.6.1 The design of the control systems and related equipment shall adhere to the principle of "fail safe" operation at all system level. "Fail Safe Operation" signifies that the loss of signal, loss of power or failure of any component will not cause a hazardous condition and at the same time prevent occurrence of false trips.

4.6.2 The types of failure which shall be taken into account for ensuring operability of the plant shall include but not limited to:-

1. Failures of sensors or transmitters producing high or low signal
2. Failure of controller & other modules during automatic operation.
3. Loss of motive power to final control element
4. Loss of control power.
5. Loss of Instrument Air.

4.6.3 The Bidder shall ensure proper operability of all Instrument and Control modules and also take into account protections to minimize accidental mal-operations, in the operator interfaces and configuration of panel boards offered.

4.6.4 The choice of hardware shall also take into account, sound maintainability principles and techniques. The same shall include but shall not be limited to:-

1. Standardization of parts
2. Minimum use of special tools
3. Modular replacement
4. Grouping of functions
5. Separate adjustability/ Interchange-ability
6. Malfunction identification facility
7. Easy removal, replacement and repair
8. Easy assembly and disassembly
9. Fool proof design providing proper identification and other features to preclude improper mounting and installation.

4.6.5 Equipment devices which require maintenance shall be suitably located to ensure easy accessibility. Bidder shall supply all necessary furniture including ergonomically designed chairs & desks for use at the local control room and CCR desks for various operating and engineering programming stations, printers etc

4.6.6 All necessary furniture such as tables, desks, chairs etc shall also be furnished to set up and same shall be completely erected and commissioned by the bidder.

4.7.0 Established Reliability

4.7.1 All components and systems offered by the Bidder shall be of established reliability. The minimum target reliability of each component shall be established by the Bidder,

considering its failure rate & meantime between failures (MTBF) & meantime to repair (MTTR), such that the availability of the complete system is assured for 99.7%.

4.7.2 Further the Bidder shall ensure that all equipment/parts of his system that are not listed under recommended spares shall have the normal life expectancy exceeding the expected plant life.

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

4.7.4 Continuous self-checking features shall be incorporated in system design with automatic transfer to healthy/redundant circuits to enhance the reliability of the complete system. In general, failure of equipment used for alarm purpose will cause switching to the alarm state.

4.8.0 Proveness Criteria

Proveness of Supplier: The various C&I equipment shall be from established sources i.e. The supplier for any particular type of equipment/system should have equipment /system manufactured by him and under successful operation in a Power Plant for not less than 2 years.

Proveness of offered system: Equipment, system, instrument being offered by the bidder comprising of FGD instrumentation, PLC based control system, and their MMI system and other associated systems shall be as elaborated in Technical Specifications.

4.9.0 Standardization and Uniformity of Hardware and Software

To ensure smooth and optimal maintenance easy interchangeability and efficient spare parts management of various C&I instruments/equipment, uniformity shall be maintained in all 4-20mA electronic transmitters/ transducers, control hardware, control valves, actuators and other instruments/ local devices etc. being furnished by the Bidder .The Bidder shall ensure that they are of the same make, series and family of hardware.

4.10.0 Redundancy Criteria for Sensors

4.10.1 Redundancy of components and systems shall be dictated by availability criteria described under PLC to ensure the system availability target as well as safety considerations in critical applications are fully met.

4.10.2 Triple redundancy or double redundancy for sensors and transmitters will be used for critical control / protection application & other control/interlock applications. Where correction/ compensation for the measured signal are involved, the computed signal shall be the one transferred for control purposes. The measured value indicated shall be the duly corrected/ compensated signal.

4.10.3 It is mandatory to use sensors with 2 out of 3 logic for critical control & protection (Analog & Binary) application/service and sensors with 1 out of 2 logic for all other control & interlock (Analog & Binary) application/service as explained below. Sensor utilization shall be decided during detail engineering.

4.11.0 Triple measurement scheme

4.11.1 Triple measurement scheme for analog inputs employing three independent transmitters connected to separate tapping points shall be employed for the most critical

measurements. For protection of all the HT drives, 2 out of 3 logics shall be provided by the bidder accordingly.

- 4.11.2 For lube oil protection of all the HT drives, **2 out of 3 logics and necessary pressure transmitters for lube oil pressure** shall be provided by bidder accordingly.
- 4.11.3 The three signals shall be auctioneered to determine the median/average value, which will be used for control purpose. In case one transmitter fails or shows excessive deviation with respect to others, it will be removed from computation of median/average value & the average of the other two redundant transmitter outputs shall be used for controls.
- 4.11.4 The output of the other two redundant transmitters shall be continuously monitored for excessive deviation. In case the deviation is within limits, the mean value shall be used for the control loop. If the deviation becomes high (with both transmitters remaining healthy), the loop will be automatically transferred to manual.
- 4.11.5 The control loop shall trip to manual when any two of the three transmitter signals fail. The operator shall be able to select any of the transmitters or the median/average value from OWS. The outputs of the transmitters shall be continuously monitored for excessive deviation which shall be displayed, logged & alarmed. In triple measurement scheme, the operator shall have the option to select any one of the three measurement transmitters for auto control besides median/average value, when three/two transmitters are available.

4.12.0 Dual measurement scheme

- 4.12.1 For binary and analog inputs required for other modulating control, protection and interlock purpose of other equipment etc., min. dual sensors shall be provided.
- 4.12.2 Dual measurement scheme for analog inputs employing two independent transmitters, connected to separate tapping points/ temperature element shall be employed for the remaining measurements used for analog control functions.
- 4.12.3 Dual sensors shall be provided for Instruments required for auto starting of HT & LT driven pumps and for control and interlock applications.
- 4.12.4 The output of the redundant transmitters shall be continuously monitored for excessive deviation. In case the deviation is within limits, the mean value shall be used for the control loop. If the deviation becomes high (with both transmitters remaining healthy), the loop will be automatically transferred to manual, however, if one transmitter fails and the other transmitter remains healthy, then the output of the healthy transmitter shall be used for control. If the other transmitter also fails, loop shall trip to manual. The operator shall be able to select any of the transmitters or the mean value from the OWS. The outputs of the transmitters shall be continuously monitored for excessive operation which shall be displayed and logged and alarmed.
- 4.12.5 All the instruments/ sensors/transmitters/switches meant for redundant applications shall have completely separate and independent impulse pipes/ root valves etc. No redundant instrument shall share a single process tapping.

5.0.0 CODES AND STANDARDS

5.1.0 All equipment, system and service covered under this specification shall comply with the requirements of the latest statutes regulations and safety codes as applicable in the locality where the equipment/systems will be installed. The Bidder shall fully acquaint himself with these requirements and shall ensure compliance with them.

5.2.0 The equipment, systems and services furnished as per this specification shall confirm to the codes and standards as mentioned elsewhere in further clauses. However in the event of any conflict between the requirements of two standards or between the requirements of any standard and this specification, the more stringent requirements shall apply unless confirmed otherwise by the Owner in writing. The decision of the Owner shall be final and binding in all such cases.

5.3.0 The Bidder's scope of supply shall include some items such as thermowells, and other in-line devices falling under the purview of Indian Boiler Regulation (IBR) Act. It shall be the responsibility of the Bidder to obtain the necessary approval of the concerned Inspecting Authority/Chief Inspector of Boilers for the design and design calculations and manufacturing.

5.4.0 The requirements of statutory authorities (e.g. MOEF, Inspectors of factories, IBR, TAC, BEE, CPCB/TNPCB etc) with regards to various plants areas like FGD plant, Fire Fighting system, Emission Measurement etc. shall be complied even if not actually spelt out.

5.5.0 Reference Codes and Standards

The design, manufacture, inspection, testing, site calibration and installation of all equipment and systems covered under this specification shall conform to the latest editions of codes and standards mentioned below and all other applicable ANSI, ASME, IEEE, NEC, NEMA, ISA, DIN, VDE, NFPA and Indian Standards and their equivalents. Bidder to note that in no case, OEM/manufacturers own standards shall be accepted.

5.5.1 Temperature Measurement

1. Performance Test Code for temperature measurement ASME PTC 19.3 (1974 – R 1998)
2. Temperature measurement – Thermocouples ANSI-MC 96.1 – 1982, IEC 584
3. Temperature measurement by electrical resistance thermometers – IS-2806.
4. Thermometer-element-platinum resistance-IS-2848, IEC 751
5. RTD Design Code – DIN EN 60751:1996, BS EN 60751: 2008
6. Thermowell Design Code – ASME PTC 19.3 TW – 2010

5.5.2 Pressure Measurement

1. Performance Test Code for pressure measurement – ASME PTC 19.2 (2010)
2. Bourdon tube pressure and vacuum gauges – IS 3624, IS 3602, ASME B 40.1

5.5.3 Electronic measuring Instruments & Control hardware

1. Automatic null balancing electrical measuring instruments - ANSI C 39.4 (Rev. 1973)
2. Safety requirements for electrical and electronic measuring and controlling instrumentation - ANSI C 39.5 – 1974.
3. Compatibility of analog signals for electronic industrial process instruments – ISA-S 50.1:ANSI MC 12.1 – 1975.
4. Dynamic response testing of process control instrumentation – ANSI MC 4.1 (1975): ISA-S26 (1968).
5. Surge withstand capability (SWC) tests – ANSI C 37.90A (1974) IEEE Std. 472 (1974). IEC – 254.1.
6. Printed circuit boards – IPC TM-650, IEC 326 C

7. General requirements and tests for printed wiring boards - IS 7405 (Part-I) – 1973
8. Edge socket connectors – IEC 130-11.
9. Requirements and methods of testing of wire wrap terminations DIN 41611 Part-2.
10. Dimensions of attachment plugs & receptacles ANSI C73-1973.
11. Direct acting Electrical Indicating Instruments: IS-1248-1968.

5.5.4 Instrument Switches and Contacts

1. Contact rating – AC services NEMA ICS Part-2 125, A600
2. Contact rating – DC services NEMA ICS Part-2-125, N600.

5.5.5 PLC & other Control System

1. Application of Safety Instrumented System – ANSI/ISA 84.01 1996
2. Functional Safety – Safety Instrumented System for Process Sector – IEC – 61151
3. IEEE Application Guide for Distributed Digital Control Monitoring for Power Plant – IEEE 1046
4. Fossil Fuel Power Plant Steam Turbine Bypass System – ANSI/ISA – 77.13.01
5. Human System Interface Design Review Guide lines – NUREG – 700
6. Annunciation Sequence and Specification – ANSI/ISA 18.1
7. “IEEE 1050, IEEE guide for Instrumentation & control system grounding in generating station”.

5.5.6 Control Valves

1. Control Valve sizing – Incompressible fluids – ISA S39.2 – 1972.
2. Control valve sizing – Compressible fluids – ISA S39.3 – 1973, ISA S39.4 – 1974.
3. Face to face dimensions of control valves – ANSI B16.10
4. ISA Hand book of control valves – ISBN B1047-087664-234-2.
5. Valves – flanged, threaded and welding end : ANSI B 16.34(2009)
6. Casting : ASTM A 216 / A 351 (2008)
7. Welded end connection : As per ASME boiler and pressure vessel code / ANSI.B 16.34(2009), B16.25 (2009), B 16.11(2009).
8. Defect removal: ANSI B 16.34 2009.
9. Cleaning: ASTM A 380 2006.
10. CV test: As per ISA procedure S 75.02 (2008).

5.5.7 Enclosures

1. Types of enclosures – NEMA Std. ICS-6-110.15 through 110.22 (Type 4 to 13).
2. Racks, panels, and associated equipment – EIA: RS-310-B (ANSI C83.9 – 1972)
3. Protection Class for Enclosure, Cabinets, Control Panels and Desks – IS-13947-1962.

5.5.8 Apparatus, enclosures and installation practices in hazardous areas

1. Classification of hazardous area – NFPA Art. 500, Vol.70-1984.
2. Electrical Instruments in hazardous dust locations – ISA-RP 12.11
3. Intrinsically safe apparatus – NFPA Art.493 Vol.4.1978
4. Purged and pressurized enclosure for electrical equipment in hazardous location – NFPA Art. 496 1982.

5.5.9 Sampling System

1. Stainless steel material of tubing and valves for sampling system – ASTM A269-82 Gr TP316.
2. Submerged helical coil heat exchangers for sample coolers ASTM D 11-98.
3. Standard methods of sampling system – ASTM D 1066-69.

- 5.5.10 **Annunciators**
1. Specifications and guides for the use of general purpose annunciators – ISA RP 19.1-1979.
 2. Surge withstand capability tests – ANSI C.37.90a – 1974 and IEEE std. 472-1974.
- 5.5.11 **Interlocks, Protections**
1. Relays and relay system associated with electric power apparatus - IEEE std.3.13.
 2. Surge withstands capability tests – ANSI C.37.90a – 1974 and IEEE Std. 472 -1974.
 3. General requirements & tests for switching devices for control and auxiliary circuits including contactor relays - IS-6875 (Part-I) 1973.
 4. Turbine water damage prevention – ASME – TDP-1980.
 5. Boiler safety interlocks – NFPA Section 85B, 85D, 85E, 85F, 85G.
- 5.5.12 **Process Connection and Piping:**
1. Codes for pressure piping power piping ANSI B31.1
 2. Seamless carbon steel pipe ASTM A-106.
 3. Forged and Rolled Alloy steel pipe flanges, forged fittings, valves and parts – ASTM A-182.
 4. Material for socket welded fittings – ASTM A-105.
 5. Seamless ferrite alloy steel pipe – ASTM A-335.
 6. Pipe fittings of wrought carbon steel and alloy steel – ASTM A-234.
 7. Composition bronze or metal castings – ASTM B-62.
 8. Seamless copper tube, bright annealed ASTM B-168.
 9. Seamless copper tube – ASTM B-75.
 10. Dimensions of fittings – ANSI B-16.11
 11. Valves flanged and butt welding ends – ANSI B16.34.
 12. Nomenclature for Instrument tube fittings ISA-RP-42.1 – 1982.
- 5.5.13 **Instrument Tubing**
1. Seamless carbon steel pipe – ASTM – A106.
 2. Material for socket weld fittings – ASTM – A105.
 3. Dimensions of fittings – ANSI B16.11
 4. Code for pressure piping, welding, hydrostatic testing - ANSI B31.1.
- 5.5.14 **Cables**
1. Thermocouple extension wires/cables – ANSI C 96.1 – 1982.
 2. Colour coding of single or multi-pair cables – VDE 0815
 3. Guide for design and installation of cable systems in power generating stations (insulation, jacket materials) - IEEE Std. 422 – 1977.
 4. Requirements of vertical tray flame test – IEEE 383 – 1974.
 5. Standard specification for tinned soft or annealed copper wire for electrical purpose – ASTM B-33 – 81.
 6. Oxygen index and temperature index test – ASTM D-2863.
 7. Smoke generation test – ASTM D-2843 and ASTM E-662.
 8. Acid gas generation test – IEC-754-1.
 9. Swedish chimney test – SEN – 4241475 (F3)
 10. Instrumentation cables and internal wiring IS-1554 (Part-I, 1976) and IS-5831(1984).
 11. Standard for Control, Thermocouple Extension and Instrumentation cable –NEMA WC57-2004 ICEA S-73-532, Rev. 2, 2004)
 12. PVC insulated (heavy duty) Electric cables for working voltages upto and including 1100V- IS:1554 (Part-I)
 13. Conductors for insulated electric cables and flexible cords. – IS:8130
 14. PVC insulation and sheath of electric cables – IS:5831
 15. Mild steel wires, strips and tapes top armoring cables – IS:3975
 16. Water Immersion Test – VDE 0815
 17. Drums for electric cables – IS : 1048
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- 5.5.15 **Cable Trays, Conduits**
1. Guide for the design and installation of cable systems in power generating station (cable trays, support systems, conduits) – IEEE Std. 422, NEMA VE-1, NFPA-70-1984.
 2. Guide for the design and installation of cable systems in power generating station (Cable trays, support systems, conduits) Test Standards, NEMA VE-1 – 1979.
 3. Galvanising of Carbon steel cable trays – ASTM A-386-78.
- 5.5.16 **Flow measurement**
1. ASME Performance Test Code PTC-19.5 (2004), ISA RP3.2
 2. BS 1042
 3. ISO 5167
- 5.5.17 **Surge Protection System**
1. Surge withstand capability tests – ANSI C37.90a-1974. IEEE Std. 472 – 1974
 2. IEC 61643-1:1998-02 and E DIN VDE 0675 part 6:1996-03/A2: 1996-10
 3. IEC 61643-21:2000-09 and E VDE 0845 part 3-1:1999-07
- 5.5.18 **Digital Video Recording & Management System (DVRMS)**
- i. ISO 9001 (2000)
 - ii. ISO/IEC15504 Level 3 or higher (SPICE 2.0 Software Process Improvement and Capability Determination)
 - iii. SEICMM Level 3 or higher (American Software Engineering Institute - Capability Maturity Model).
- 5.5.19 **General**
- i. ANSI/ISA-RP77.60.05-2001 (R2007) - Fossil Fuel Power Plant Human-Machine Interface: Task Analysis
 - ii. ANSI/ISA-RP77.60.02-2000 (R2005) - Fossil Fuel Power Plant Human-Machine Interface: Alarms
 - iii. ANSI/ISA-77.70-1994 (R2005) - Fossil Fuel Power Plant Instrument Piping Installation
 - iv. ANSI/ISA-TR77.60.04-1996 (R2004) - Fossil Fuel Power Plant Human-Machine Interface-Electronic Screen Displays.
ISA-99/IEC 62433-2-1- Industrial Communication Networks – Network and System Security – Establishing an industrial automation and control system security program
 - v. IEEE 1100-2005, IEEE recommended practice for Powering and Grounding Electronic Equipment.
 - vi. IEEE 1100-2005, IEEE recommended practice for Powering and Grounding Electronic Equipment
 - vii. Hydrogen Piping and Pipelines: piping in gaseous and liquid hydrogen service and pipelines in gaseous hydrogen service – ASME B31.12. Code of Practice for Installation and maintenance of Power cables – IS : 1255. IEEE 1185: IEEE Recommended Practice for Cable Installation in Generating Stations and Industrial Facility.
 - viii. NEMA VE 2 (2013) – Cable Tray Installation Guidelines.

Where:

- i) IEEE – Institute of Electrical and Electronics Engineers.
 - ii) ISA – Instrument, Systems and Automation Society.
 - iii) NEMA – National Electrical Manufacturers Association.
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- iv) ANSI – American National Standards Institute
 - v) NFPA – National Fire Protection Association.
 - vi) ASME – American Society of Mechanical Engineers.
 - vii) IS – Indian Standards.
 - viii) IEC – International Electro-technical Commission
 - ix) ASTM – American Society for Testing Materials.
 - x) EIA – Electronic Industries Association
 - xi) DIN – Deutsche Institute Normale.

10.0.0 FIELD AND MEASURING INSTRUMENTS

10.1.0 General Requirements

- 10.1.1 Instruments, control devices and other equipment accessories covered under this specification shall be furnished in accordance with I&C specification sheets and drawings enclosed herewith and the requirements of all applicable clauses of this specification.
- 10.1.2 The Instrumentation and Control equipment shall conform to all applicable codes and standards. All equipment and systems shall also fully comply with the design criteria stated.
- 10.1.3 The Instrumentation & Control equipment and accessories shall be from the latest proven design for which the performance and high availability have been demonstrated by a

considerable record of successful operation in power station service for similar applications. The bidder shall furnish sufficient evidence to fully satisfy the Owner in this regard.

- 10.1.4 The Bidder shall furnish all Instrumentation & Control equipment and accessories under this specification as per technical specifications, ranges, makes and model numbers approved by the Owner during detailed engineering.
- 10.1.5 All instruments, devices and accessories furnished by the Bidder as per this specification shall be designed and constructed to perform normally and meet all guarantee when subjected to the environmental and service conditions and other applicable specification documents.
- 10.1.6 The necessary root valves, impulse piping, drain cocks, gauge zeroing cocks, valve manifolds and all other accessories required for mounting/erection of all local field instruments shall be provided by Bidder as per approved hook up drawings.
- 10.1.7 In general front draw out type instruments with plug-in facility at the rear for connecting flexible cables for power supply and signal shall be provided. Separate plugs shall be provided for connecting power supply and signal wires.
- 10.1.8 The plug & sockets shall be polarized to prevent wrong connections and have facility for secure coupling in plug-in position to prevent loose connections.
- 10.1.9 Every instrument requiring power supply shall be provided with a pair of easily replaceable glass cartridge fuse of suitable rating. Every instrument shall be provided with a grounding terminal and shall be suitably connected to the panel grounding bus.
- 10.1.10 All field instruments shall be weatherproof, drip tight, dust tight and splash proof suitable for use under outdoor ambient conditions prevalent in the subject plant. All field-mounted instruments shall be mounted in suitable locations where maximum accessibility for maintenance is achieved. The enclosures of all electronic instruments shall conform to IP-65 unless otherwise specified (Explosion proof for NEC class 1, Division 1 area) and an anti-corrosive paint shall be applied to the field mounted enclosures / instruments. All the field instruments shall also be provided with SS tag nameplate and double compression type nickel-plated brass cable gland. Gaskets, fastener, counter and mating flange shall also be included wherever required with instruments.

10.2.0 Minimum Requirement of Field Instruments

- 10.2.1 Following minimum requirement of field instruments shall be fulfilled by Bidder (In addition, Redundancy criteria for instruments shall be as specified elsewhere in specification): -
- 1) Level Transmitter, Level switches for very high / high / normal / low / very low interlocks (type as per Owner approval).
 - 2) Tapping points/test points shall be provided.
 - 3) All Thermocouples & RTDs shall be Duplex.
 - 4) All Field Instruments used in acid or alkaline atmosphere shall be with standard anti-corrosion coating i.e. the combination of polyurethane and epoxy resin baked coating (ANSI/ISA-71.04).
 - 5) All primary instruments installed at "Minus level or Floor" shall be with protection class of IP 68.
 - 6) Transmitters (all type) as on required basis for monitoring interlocks & controls as per redundancy criteria.

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- 7) 6 no. duplex or 12 no. simplex embedded temperature detectors for various motor stator windings and duplex RTDs for motor/pump bearing temp.
 - 8) All field mounted push button, selector switch etc. shall be as per IEC or NEMA 4X protection.
 - 9) All limit switches shall be conforming to IEC-60947-5-1.
 - 10) DPG, DPT & DPS across the filters/strainers.

Temperature Transmitters shall not be used for CLCS, OLCS, interlock & protection services anywhere in the plant with RTD & Thermocouples. However RTD & Thermocouples are used for control, interlock & protection application, same shall be directly wired to PLC using instrumentation & Extension cables respectively

- 1) For all instruments envisaged for sea water applications, they shall be provided with wetted parts of Super duplex SS.
- 2) Primary Elements: Flow nozzles shall be made of stainless steel, with three sets of pressure taps installed in the pipe wall where required. Installation of flow nozzles and pressure taps shall be made in the pipe
- 3) Paddle type orifice plates shall be used for other flow measurements where flanged construction and higher pressure loss are acceptable. Orifice plates shall be made of stainless steel. Orifice flanges shall be of the raised face weld neck type with dual sets of taps.
- 4) Construction and installation of flow nozzles and orifices shall conform to the requirements of ASME Performance Test Code PTC-19.5, and discharge coefficients shall be predicted in accordance with data published in ASME Research Report on Fluid Meters.
- 5) Orifice plates shall be supplied with carrier rings as per process requirement.
- 6) Secondary Elements: Secondary elements for differential type flow sensors shall be strain gauge or capacitance type differential pressure transmitters. Square root extraction required for the DP transmitters shall be performed electronically in the transmitter itself.
- 7) Instrument and Service Air – Vortex/Swirl type flow meter
- 8) Any other flow element/meter required for system shall be finalized as per system requirement and as per approved drawings/documents.
- 9) Instrument should be in easy reach of maintenance person, there should be separate platform for unreachable instruments. Easy access should be provided to all the tapping points of instruments used for measurement & control.
- 10) At each inlet and outlet lines of gas to gas heat exchanger, the following instruments shall be provided as a minimum:
 - (a) Pressure indicator – 1 no and pressure transmitter – 2 nos
 - (b) Differential pressure transmitter across inlet and outlet lines
 - (c) Temperature transmitters – 2 nos
- 11) Redundant SO_x analyzers shall be provided at inlet (untreated flue gas) and outlet (treated flue gas) of Gas to Gas Heater (GGH). Temperature measurements for GGH shall be considered on all the sides.

- 12) pH analyzers (redundant) to be provided for each oxidation tank and waste water tank. Density analyzers (redundant) to be provided for oxidation tank and limestone slurry preparation tank. Density measurements in hydro cyclone feed lines, slurry feed lines etc shall also be provided.
 - 13) Online Moisture analysis instruments to be provided for dewatered gypsum. Dew point analyzer to be provided for instrument air service and auto drain trap to be considered for air receiver.
 - 14) Analyzer like- SO_x, NO_x, Opacity & Oxygen analyzers at the inlet and outlet duct of the FGD system. Humidity analyzer shall also be included in the outlet of FGD system. Based on Process requirement if any other analyser required, same shall be supplied without any additional cost.
 - 15) All instruments shall be provided with durable epoxy coating for housings and all exposed surfaces of the instruments.
 - 16) Canopy/Enclosure shall be provided for field instruments like transmitters, switches & flow meters, etc and any other equipment to protect from direct sun light, lightning & rain.
 - 17) Analyser and instrument which are used for protection shall be 2 out of 3 and interlock controls shall be 1 out of 2, for monitoring panel single shall be considered.
- 10.2.2 Above are the min. requirements, however actual quantities shall be as decided during detailed engineering based on redundancy criteria. Other pressure gauges for systems shall be decided during detailed engineering.
- 10.2.3 It is envisaged to use separate instrument / switches for initiation of interlock and trip circuits. The proposal shall include adequate number of pressure, differential pressure, level, flow and temperature switches to meet the systems functional requirements. Where blind type of pressure, differential pressure and flow switches are employed, the necessary provision shall be made for connection of test gauge. All switches shall be provided with Double action snap type (DPDT) contacts and shall be equipped with plug in type connections for terminating field wiring.
- 10.2.4 Switch actuation point shall be field adjustable with a calibration scale to indicate the set point. Switches shall have capacity of 5.0 amps at 240V AC or 0.5 amps at 220V DC. Level switches for general service shall be float type. Float material shall be stainless steel SS316.
- 10.2.5 Thermowells, sight-flow indicators, level gauges etc. shall be of a reputed make and type and shall be subject to the Owner's approval. The switches should be of type designed for alarm and interlock purposes. Thermometers and pressure gauges with contacts attached to perform these functions will not be acceptable.

Field instruments shall be supplied & offered as per data sheets specified below:

10.3.0 Transmitters, Switches, Gauges and Panel Mounted Instruments

10.3.1 Pressure, Differential Pressure, Level and Flow Transmitters (PT, DPT, LT & FT)

- a. Smart Transmitters of the electronic type shall be furnished.
- b. Transmitters shall be equipped with mounting brackets suitable for a mounting in transmitter enclosures.

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

Type/Construction : Sealed capacitance/ Inductance/ Silicon resonance type

Material

Body : SS316 T

Diaphragm : 316 SS

Measurement element : Teflon seal

Valves : Carbon steel for non-corrosive Applications
SS316 for corrosive applications, SS super duplex for sea water application.

Output signal : 4 to 20 m Amp. DC (Two wires)
HART Compatible

Local Indicator : LCD indicator (5 digit) with scale of Engg. Unit

Overall Accuracy : $\pm 0.065\%$ or better of FSR

Turn down ratio : 10:1 for vacuum / very low pressure application
30:1 for other applications

Stability : $\pm 0.15\%$ for 10 years.

Response time : 100 msec.

Power supply : 24V DC nominal

Drive capability : 500 Ohms minimum

Enclosure Class : IP-65 (Explosion proof as per NEC article 500 for hazardous area)

Span and Zero : Locally adjustable, non-interacting

Zero suppression / elevation: At least 100% of Span

Connection

Process : Half (1/2) inch NPT (F)
:

Electrical : Plug and socket, unused entry with blind plug.

Accessories : Span and zero adjustment facility

For Absolute Pressure Transmitters : Two (2) valve SS316 manifold

For Gauge & Vacuum pressure transmitter : Three (3) valve SS316 manifold

For DP, level & flow Transmitter	:	Five (5) valve SS316 manifold
For oil and corrosive liquids	:	Separator diaphragm seals
Diaphragm material	:	SS super duplex
Flush ring & drain	:	Provided for lime stone slurry based & sea water applications
For all transmitters	:	Mounting bracket
Mounting	:	Local (in LIE/LIR)

- d. In case it becomes necessary to use a DP transmitter for pressure measurement, then a 3-Valve manifold shall be used in place of 2-valve manifold. Manifold shall not be mounted on the transmitter; It shall be non-integral type. Pulsation dampeners shall be used where the process media is unstable for measurement such as the discharge of a pump. Overrange protection shall be used where necessary. The coil siphons & condensate pots shall be used for steam services. Transmitters shall be provided with suitable drain & vent points.
- e. As for the water flow/ steam flow measurements, necessary flow elements/transmitters are chosen in the process line and supplied such that their algebraic summation shall be mass balanced for calculating the system efficiency.
- f. Contacts less, electronic 2-wire position transmitters shall be provided for all inching type motorized valve and dampers.
- g. For acid and alkali applications, only non-contact type level transmitters like acoustic, ultrasonic, radar based shall be provided by bidders.
- h. Where the process fluids are corrosive, viscous, solid bearing or slurry type, diaphragm seals shall be provided. Parts below the diaphragm shall be removable for cleaning. The entire volume above the diaphragm shall be completely filled with an inert liquid suitable for the application. For hazardous area, explosions proof enclosure as described in NEC article 500 shall be provided.
- i. LVDT type is not acceptable.
- j. Transmitters & other HART based instruments shall be supplied along with 3 Nos. of universal type hand held/portable pressure calibrators. Temperature transmitters shall be supplied along with 3 Nos. of hand held/portable mV source generators.

10.3.2 **Pressure Switches (PS) & Differential Pressure Switches (DPS)**

Applicable Standards	:	IS3624 – 1966/ISA-RP-8.1 except as modified in spec.
Type/Construction	:	Bellows /Sealed Diaphragm for low pressure / vacuum and Piston Actuated preferable for high pressure. Indicators with contacts are not acceptable.

Materials-

Bellows	:	316 SS
Bourdon tube	:	316 SS
Movement	:	316 SS

Protective Diaphragm	:	Die-cast aluminum with stoved enamel black finish. Epoxy coating shall be provided for corrosive atmosphere.
Accuracy	:	± One (1) percent or better
Repeatability	:	± 0.5(half) percent or better
Setting & Differential	:	Adjustable
Over pressure range	:	Fifty(50) percent of full scale.
Contact	:	
Number	:	DPDT /2 SPDT
Type	:	Auto reset with internal Adjustable snap action micro switch
Rating	:	5 Amp, 240V AC / 0.5 Amp, 220V DC
Connection – instrument Electrical	:	Half (1/2) inch NPT male Process Suitable for Plug & socket connection. All the switches are internally connected and brought to the surface with amphenol male/female connection. Cabling need not terminated inside the switch. Cable ends are to be soldered in connector and to be inserted for easy maintenance.
Over range protection	:	Fifty (50) percent of full scale
Enclosure	:	IP 65
Accessories		
3 / 5 valve manifold	:	For all switches
Self-cleaning type Pulsation dampeners/Snubber (Material SS316)	:	Pump and compressor discharge lines
Syphon	:	For all steam lines
Diaphragm material	:	SS super duplex
Flush ring & drain	:	Provided for lime stone slurry based & sea water applications
Protective separating diaphragm Mounting	:	For Corrosive liquid lines. Local (in LIE/LIR)

10.3.3 **Pressure & Differential Pressure Gauges (PG & DPG)**

Applicable standard	:	IS: 3602-1966, IS/3624, ASME B 40.1
Sensing Element and Materials	:	Bourdon for high pressure, diaphragm/bellow for low pressure of all materials in SS 316

Case	:	SS 316/ Die-cast aluminum with stoved enamel black finish. Epoxy coating shall be provided for corrosive atmosphere.
Protective Diaphragm	:	Teflon
Dial size	:	150mm with shatter proof glass
Scale Details	:	Graduations in black lines on white dial, 270 Deg pointer deflection scale provided with glass cover. Smallest scale division shall be one (1) percent of full scale value or smaller. Pointer stop for all gauges.
Accuracy	:	± One (1) percent or better
Connection – Instrument Process	:	1/2 inch NPT Male Bottom
Mounting	:	Local : 1/2 inch NPT Male (Back entry) mounted on local gauge board.
Accessories		
3 way needle valve/manifolds	:	For all gauges
Self-cleaning type Pulsation dampener/snubber	:	Pump and compressor discharge lines
Syphon	:	For all steam lines
Protective separating	:	For fuel oil and corrosive liquid lines
Other particulars		
Zero & span adjustment Safety device	:	For all gauges
Housing	:	IP 65
Diaphragm material	:	SS super duplex
Flush ring & drain	:	Provided for lime stone slurry based & sea water applications
Ranges 5 to 20 Kg/cm ²	:	Rubber blow out disc with open front construction
Ranges above 20 Kg/cm ²	:	Neoprene safety diaphragm at the back with solid front construction
Over range protection	:	Fifty (50) percent of full scale : Movement mechanism shall be glycerin filled for oil services & vibration prone area. : : For corrosive liquid lines diaphragm type sensors required. Armored capillary of 10 mtrs for Corrosive liquid service

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

Identification : Identification engraved with service legend or laminated phenolic name plate.

10.3.4 **Resistance Temperature Sensors with thermowells**

Applicable Standard : ASME PTC 19.3 / DIN 43760 for RTD
-Latest Revision

Element : Platinum, R0=100 ohm 4 –wire Duplex

Sheath Material/ Insulation : 316SS metal sheathed /Compacted
Magnesium Oxide

Sheath OD : 8 MM

Terminals : Spring loaded

Calibration : As per DIN Standard – 43760, Class A

Head : Die Cast Aluminum (Screwed) with
galvanized chain

Response Time : < 20 Sec for measurement
< 10 Sec for Control

Accuracy : $\pm 0.35^{\circ}$ C or class A DIN 43760 whichever
is better.

Electrical connection : Plug in connector type

Enclosure : IP 65

Thermo well

Applicable Standard : ASME PTC 19.3 TW – 2010

Construction : Tapered drilled from Bar stock for SS316
material thermowell. (Straight for Air & Gas
systems)

Material : - 316 SS – water and steam services
SS Duplex for sea water based
application
- Inconel for air & flue gas services

Bidder shall provide calculation for thermo
well as per ASME – PTC-19.3.

Process Connection : i) M33 x 2
ii) Flanged for Air & Gas systems with
mating flanges

Immersion Length : Within ± 10 mm of center line of pipe

Extension neck length : Minimum 100 mm above Insulation of pipe
and Minimum 160 mm when there is no
insulation on pipe.

Chemical, Formulas

IBR Certification : For high pressure service, Steam Temp., Fuel oil temp. Measurement as per IBR rules and regulations

Note :

Extension/Compensating cable exposed to atmosphere in the conventional method melts away in the high temperature. Hence The terminals of temperature sensors shall not be at the high temperature zone. The temperature sensors wires are to be laid up to JB though SS tube of required diameter and the head shall be placed nearer to the JB.

10.3.5 Thermocouples with thermowells

Applicable standard : ASME PTC 19.3- Latest Revision

Element : Duplex

- Sheath : 8 MM OD
- Sheath Material : 316 SS
- Spring Loaded : Yes
- Nipple/Union : Yes
- Packed connector : Compacted magnesium Oxide ungrounded

- Type : i. Type K (Chromel – Alumel)
ii. Type R (Platinum Rhodium-Platinum)

- Gauge : 16 AWG wire of Chromel – Alumel (Type – K) or 24 AWG wire Pt-Rhodium Pt(Type R) depending on operating temperature range (Ungrounded type)

Head : IP 65 / Die Cast Aluminum

Electrical connection : Plug in connector type.

Thermowell

Applicable Standard : ASME PTC 19.3 TW (latest)

- Construction : Tapered Drilled from Bar stock for SS316 material thermowell. (Straight for Air & Gas systems)
- Material : - 316SS for water/steam services
- Inconel for air & flue gas Services
- SS Duplex for Sea water application

For furnace zone, impervious ceramic protecting tube of suitable material along with Inconel supporting tubes and adjustable flanges.

For Mill outlet temperature long life solid sintered tungsten carbide material of high abrasion resistance. Bidder shall provide calculation for thermowell as per ASME – PTC-19.3.

- Process Connection : (i) M 33 x 2
(ii) SS316 Flanged, for Air & Gas systems, with mating flanges.
- Extension : Threaded union 1/2" NPT (F) with two nipples of SS 316 having 1/2"NPT (M) threads at both ends

Accuracy

- (For Type K T/C) : ± 1.1 deg.C (for 0 to 277 deg.C)
 ± 0.4 percent (for 277 to 1280 deg.C)
Class-A

- For Type S & R T/C : ± 0.6 deg.C or + 0.1%
- For Type T T/C : ± 0.5 deg.C or + 0.4%

- Accessories : Bolts, nuts and gaskets for flanged connections.

- Response Time : < 20 Sec for measurement
< 10 Sec for Control

- Immersion length : Within ± 10 mm of center line of pipe

- Extension neck length : minimum 100 mm above insulation of Pipe and minimum 160 mm when there is no insulation on pipe.

- IBR Certification : For high pressure service, Steam Temp., Fuel oil temp. measurement as per IBR rules and regulations.

Note :

Extension/Compensating cable exposed to atmosphere in the conventional method melts away in the high temperature. Hence The terminals of temperature sensors shall not be at the high temperature zone. The temperature sensors wires are to be laid up to JB though SS tube of required diameter and the head shall be placed nearer to the JB.

10.3.6 **Temperature Switches (TS)**

Type/Construction

- Switch : Industrial type Mercury in steel with capillary and separable thermowell and contacts directly connected to Bourdon element/vapour pressure sensing, liquid filled bellows type preferred.
- Thermowell : Bar stock

Material

- Thermowell & Bulb : 316 SS for water application and SS Duplex Sea water based application
- Capillary : Armoured Stainless Steel
- Bourdon : 316 SS

- Bourdon Movement	:	SS 316
- Casing	:	Die-cast aluminum with stoved enamel black finish Epoxy coating shall be provided for corrosive atmosphere.
Setting and Differential	:	Adjustable
Accuracy	:	± One (1) percent of setting and differential
Repeatability	:	One half (1/2) percent of setting
Contacts		
- Number	:	DPDT/2 SPDT
- Type	:	Auto reset with internal Adjustable snap action micro switch
- Rating	:	5 Amp, 240V AC / 0.5 Amp, 220V DC
Connection		
Pipe	:	M33 x 2
Thermowell	:	To suit switch
Electrical	:	Suitable for Plug in type.
Enclosure protection	:	All the switches are internally connected and brought to the surface with Amphenol male/female connection. Cabling need not terminated inside the switch. Cable ends are to be soldered in connector and to be inserted for easy Maintenance.
Other Particulars	:	IP 65
- Capillary length	:	As per requirement
- Immersion Length	:	Within ± ten (10) mm of center line of pipe with adjustable nuts.
- Extension neck length	:	Minimum 50 mm above insulation of pipe / As per approved hookup drawings.
- Packing glands	:	Yes
IBR Certification	:	For high pressure service, Steam Temp, Fuel oil temp. measurement as per IBR rules and regulations
N.B	:	Switches designed for cross ambient operation shall be used in applications where the ambient temperature will

	- Pointer	:	Externally adjustable Contact type Temp. gauges are not acceptable for interlock & protection.
	IBR Certification	:	For high pressure service, Steam Temp., Fuel oil temp. measurement as per IBR rules and regulations
	Enclosure protection	:	IP 65
10.3.8	Test Thermowells (TT)		
	Applicable Standard	:	ASME PTC 19.3 TW (latest)
	Type/Construction	:	Machined from Bar Stock
	Material	:	316 SS SS Duplex for Sea water based application
	Connection		
	- Pipe	:	M33 x 2
	- Test Instrument	:	To suit test instruments
	Accessories	:	Plug with chain
	IBR Certification	:	For high pressure service, Steam Temp., Fuel oil temp. measurement as per IBR rules and regulations Bidder shall provide calculation for thermowell as per ASME – PTC-19.3 TW – 2010.

Test wells shall be provided as required to meet ASME test requirements.

10.3.9 **Temperature Transmitters (TT) ((pg:78 cl:10.3.1)**

	Type	:	SMART type configurable from control room through HART protocol (HMS System).
	Display type	:	Indicating type (5 digit LCD Display),
	Accuracy	:	±0.10%

10.3.10 **Ultrasonic Level Transmitter (for Water sump/Tank level measurement)**

	Type	:	Non-contact Microprocessor based 2 wire type, HART protocol compatible
	Principle of Operation	:	Detection of reflected ultrasonic pulse
	Measuring Ranges	:	Up to 30 meters (typical)
	Signal Processing	:	Microprocessor Controlled Signal Processing
	Operating Freq.	:	10 KHz to 50 KHz (typical)



Display	:	Head mounted Large alpha-numeric back lit LCD/LED
Calibration & Configuration	:	Accessible from front of panel
Diagnosis	:	On-line
Status	:	For power, Hi / Lo / V. Hi / V. Lo-level indication, fault etc.
Construction	:	Plug-on board
Power supply	:	24 V DC +/- 10% or 230 VAC 50 Hz
Signal Output	:	Galvanically isolated 4-20mA DC with HART protocol
Hysteresis	:	Fully adjustable preferred
False signal tolerance	:	Transmitter shall be capable of ignoring false echoes
Output contacts	:	2SPDT Potential free changeover contacts @ 8A 230V AC.
Accuracy & Repeatability	:	±0.25% of span or better
Temperature compensation	:	To be provided with transducer
Resolution	:	±0.1% of span
Operating temp.	:	Transmitter-50 deg C and Sensor –80 deg C
MOC Sensor	:	Body- PVDF and Face – Polyurethane or Corrosion resistant material to suit Individual application requirement
Humidity	:	1% to 95% non-condensing.
Enclosure	:	IP-65 Epoxy painted die cast Aluminum or SS316L housing.
Cable Connection	:	Plug and socket.
Mounting	:	2" – 4" NPT or flanged
Accessories	:	Cable gland, prefab cable, mounting accessories like EPDM seal, SS316 flanged etc.

Additional separate local display unit with large Alphanumeric back light LCD/LED & to be provided for the applications which will be decided during detailed engineering.

All weather canopy for protection from direct sunlight and direct rain.



All mounting hardware and accessories required for erection and commissioning mounting fittings material shall be SS 316.

10.3.11 **Guided Wave Radar/Radar Level Transmitter (for Water sump/Tank level measurement)**

Type	:	Guided wave Radar (Contact type)/Radar (Non-contact type).
Application	:	For Low pressure Vacuum vessels.
Environment Class	:	Highly abrasive with Gases and Fumes
Orientation	:	Vertical
Probe Type	:	Flexible Single lead with chuck
Probe Material	:	SS 316L
Connection Size & Type	:	2" Flanged ANSI 300 lb SS316L material
Connection material	:	SS 316L
Accuracy	:	±5 mm
Resolution	:	±1 mm
Type (Transmitter)	:	SMART, 2 Wire
Operating Principle	:	Time Domain Reflectometry
Signal Output	:	4-20mA DC with HART protocol and
Electrical Connection	:	1/2" NPT
Enclosure Class	:	IP 65
Electrical Power	:	11-42 V DC
Housing material	:	Die Cast Aluminum
Vent & Drain Plug material	:	SS
Side Flange Material	:	SS
Local Display	:	Provided (LCD Digital)
Units of Measurement	:	Length M

Silo level measurement shall be radar level transmitter only, any other level transmitter shall be subjected to owner approval.



10.3.12 3 D Type Acoustic Wave Level Transmitter

Type	:	Acoustic Wave Level Transmitter (3D type)
Temperature compensation	:	Required for high temp applications
Operating Principle	:	Non – Intrusive acoustic wave transmission & Reflection
Frequency Range	:	3 – 10 KHz
Accuracy	:	±0.25 % for even surface & ± 0.5 % for uneven surface.
Resolution	:	1 MM
Output	:	4-20mA DC with HART

Local Display Unit:

Type	:	Head mounted LCD Display with Engg. Units
Location	:	Suitable location at bunker / Silo operating floor area
Protection Class	:	IP 65

Material of construction:

Housing	:	Polypropylene
Flange	:	Polypropylene

Sizes:

Flange Size	:	2" ANSI 300 # RF SS
Electrical connection size	:	1/2" NPT (F)
Accessories	:	<ul style="list-style-type: none"> i. Double compression type Nickel Plated Cable glands ii. Suitable Mating Flange, necessary gaskets iii. Local display unit & Suitable mounting brackets, necessary mounting hardware for Local display unit iv. Complete software as required to have 3 D view on monitors

10.3.13 Electromagnetic Flow meter

Electromagnetic flow meters shall have separate transmitter having accuracy +0.2% with zero stability feature, suitable for process medium with >20 micro siemens/cm for demineralised water for water / chemicals. Conductivity, flanges material SS-316, electrode & measuring tube material SS-316, liner material Teflon and enclosure IP-66, local digital display.



10.3.14 Vortex flow meter

No Features Essential / Minimum Requirements

Sensor

- 1 Type Vortex
- 2 Output Signal Pulse
- 3 Material of Construction Body : AISI 316
- 4 Sensor Seal PTFE / higher based on temperature
- 5 Flow range As required
- 6 Linearity 0.25% or better.
- 7 Repeatability 0.02% or better.
- 8 Ambient temperature 50 deg C
- 9 Mounting On-Line mounting with flanges of stainless steel.
- 10 Enclosure IP 65
- 11 Accessories Nuts, bolts, gaskets etc.

Transmitter

- 1 Electronics Micro processor based
- 2 Power Supply 240V AC, 50Hz. UPS
- 3 Input Input from Sensor
- 4 Display 4 1/2 digit LCD
- 5 Output Isolated 4-20mA DC HART
- 6 Measuring Accuracy 0.5% of full scale range
- 7 Totalized Value Required
- 8 Housing IP-65 (Explosion proof for NEC Class-1, Division 1 area)
- 9 Nameplate Tag number, service engraved in stainless steel tag plate
- 10 Accessories Clamping strip, bracket, prefab cable etc. and Calibration or configurator kit.

Refer NCTPS C&I spec -pg:77/700

10.3.15 Level Switches (LS)

- Type/Construction :
- a) External float cage type with magnetic switch actuator for tanks and vessels.
 - b) Displacer –Top mounted for all clean water sumps.
 - c) Conductivity type for high Pressure and high temperature enclosed vessel like drain pot, HP heaters etc.

Materials

- Body :
- a) Cast Carbon Steel suitable for specified pressure and temperature ratings
 - b) For corrosive liquids suitable anti-corrosive coat/lining shall be provided.
- Float/Displacer : 316 SS
- Wire rope : 316 SS
- Differential & Setting : ± 12 mm minimum (Adjustable) Contacts
- Number : DPDT/2 SPDT

Accessories	:	As per process requirement.
Process connection	:	1/2" NPT.
Electrical connection	:	1/4" NPT.
Turn Down ratio	:	1:100.
Measuring range	:	Adjustable (as per process requirement).
Totaliser	:	Required.
Enclosure class	:	IP-65.

10.3.21 Positive Displacement Flow Transmitter

Positive displacement flow transmitters shall be offered. An electronic totalizer shall be provided for each flowmeter with IP 65 protection and the location of the totalizers shall be acceptable to the Owner. Air eliminators shall also be provided to ensure maximum accuracy.

10.3.22 Electromagnetic Flow Meter

Electromagnetic flow meters shall have separate transmitter having accuracy $\pm 0.2\%$ with zero stability feature, electrode material SS-316, liner material Teflon and enclosure IP65, local digital display, 4-20 mA output HART signal with zero and span field adjustable. Application – DM Water and for other application as decided by owner.

10.3.23 Flow Gauges (FG)

Type/Construction	:	a) On-line type rotameter for 50 NB & below lines. b) Bypass type rotameter for above 50 NB lines.
Material		
- For On-line type		
Metering tube	:	Borosilicate glass
Float	:	316 SS
Packing	:	Teflon
End fittings	:	304 SS
- For bypass type		
Metering Tube	:	Borosilicate glass
Float	:	316 SS
Packing	:	Teflon
End fittings	:	304 SS
Orifice Plate	:	316 SS

Carrier ring	:	304 SS
Flanges & Mating flanges	:	Same as pipe material, 200 lbs ANSI – RF.
Impulse pipe	:	Same as pipe material.
Fittings	:	2000 ANSI, SW ends to match with pipe material.
Dial size / Scale length	:	250mm.
Scale Details	:	Direct reading type engraved on detachable aluminium scale.
Accuracy	:	± Two (2) percent.
Reproducibility	:	Half (1/2) percent.
Connection	:	SCRD NPT
Enclosure class	:	IP-65.
Accessories	:	a) Isolating valves (for Bypass type only). b) Bolts, Nuts and Gaskets as required.
Tests	:	Shall be tested at two hundred (200) percent of the maximum process pressure.

10.3.24 **Sight Flow Glass Indicators**

Type/Construction	:	Rotary type/ Flapper type as per process requirement.
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Materials

Body	:	Carbon steel.
Glass	:	Toughened Borosilicate
Gaskets	:	Neoprene.
Bolts & Nuts	:	SS
Flappers / Rotating Wheel	:	316 SS
Flappers / Rotating Wheel holder	:	304 SS
Process Connection	:	SW
Enclosure class	:	IP-65.
Accessories	:	Bolts, Nuts, Cover plates and Gaskets as required.
Tests	:	Tested at two hundred (200) percent of the maximum process pressure.

10.3.25 Solid Flow Meter

Type	:	Online Impact type Microprocessor Based.
Measuring Principle	:	The system measurement is basically pertains to the measurement of horizontal deflection using LVDT, created by the impact of solid flow upon online sensing plate. The horizontal deflection being proportional to the impact forces, LVDT convert this horizontal movement into electrical signal. The inbuilt integrator convert this signal into time based flow rate indication & provide totalized flow also.
Sensing plate	:	316 SS
Sensing head	:	Sensing mechanism shall be mounted outside the process flow line.
Enclosure	:	316 SS
Enclosure protection	:	IP 65
Class		
Accuracy	:	+/-1%
Repeatability	:	+/- 0.2%
Drift	:	Both zero & span \pm 2% / month.
Output	:	4-20mA DC isolated, load 600 ohm (min)
Digital communication	:	yes, (HART) facility.
Power Supply	:	240 V AC, 50Hz.
Ambient condition	:	Temperature -60°C, RH-95%. Environment – Highly Dusty.
Accessories	:	Shall be complete with all the accessories including digital display for flow rate, integral vents, baffles for air separation, etc., whichever required for satisfactory operation.

Note:-

1. The above on line flow meter shall not create any obstruction on flow.
2. User's list shall be submitted to support on proven satisfactory performance for similar Process application.

10.3.26 Dew Point Meter

Type	:	2 Wire Loop Powered Dew point transmitter
Overall Range	:	-60°C to +20°C Dew point
Accuracy	:	\pm 2°C Dew point

Material	:	SS316 (wetted parts)
Features	:	<ul style="list-style-type: none"> i) Automatic calibration ii) Can be Configured for Linear 4-20mA signal in °C & °F Dew point, ppm(v), ppb(v), g/m3 iii) Temperature Compensation iv) Failure Diagnostics v) Long Term Stability vi) Fast Response vii) IP 65 / NEMA4X Protection viii) Supplied with Calibration Certificate Traceable to National & International Humidity Standards ix) Sensor protection with sintered filter x) Local LCD Display for Dew Point

10.3.27 Analyser Instruments:

Common requirements:

Output signals Analog		4-20 mA DC galvanically isolated. If analyser provides superimposed HART signal on 4-20 mA DC output, It shall have provision also to be connected to PC based station.
Binary		2 NO + 2 NC for high alarm
Zero & span Adjustment		To be provided with range selection facility.
Ambient temp.		50 °C
Indication		Digital Alphanumeric Display. Display of reading in engineering units shall be provided.
Enclosure		Type/Material Weather & Dust proof (IP 65) Die cast Aluminium/SS.
Type of Electronics		Microprocessor based with self-diagnostic.
Digital Signal transmission		HART / RS 485 Port Modbus Protocol / Ethernet TCP/IP protocol for communication with plant control system.
Calibration		Auto & Manual (from Remote)
Power Supply		To be arranged by Bidder subject to Owner's approval
Enclosure class		IP 65
Others		All interconnection tubing and cabling between probe and analyzer / analyzer panel and cabling from analyzer/ analyzer panel to local junction box are to be provided
		All the calibration gases required for one year continuous operation shall be provided. The



calibration gas container material shall not contaminate the calibration gas.

10.3.28 pH Analyser

Type :	Cell - flow through
Accuracy :	< $\pm 1\%$ of reading
Range :	0 - 14 pH freely programmable (For others)
No. of steams :	Single
Temp. compensation :	Automatic

10.3.29 Oxygen Analyzer

O₂ analyzers shall be direct insertion 'in-situ' type with accuracy of $\pm 1\%$ of reading or better with auto and manual calibration having zirconia probe as sensing element. Accessories like back purge system etc., shall be provided. Material for flue gas carrying parts shall be of SS 316. Protection tube shall be provided to prevent erosion of the probe. Maintenance requirement shall not be more than once a week. Local indicating meter for read out to be provided. Alarm on abnormalities and self-diagnosis features shall be provided.

1. Measurement Range	: 0 to 25% oxygen programmable up to min 0.5% of O ₂
2. Accuracy	: +/- 1 % of Full Scale
3. Linearity	: +/- 1% of F.S.
4. Repeatability	: $\leq 0.5\%$ of Span
5. Response time(up to 90% of full scale	: ≤ 5 secs
6. Zero Drift	: < 1% span week
7. Span Drift	: < 1 % measured value/week
8. Operating Temperature Range	: 0-450 deg.C
9. Filter	: Suitable filter to be provided
10. Temperature	: Automatic temperature control of heating circuit through thermostat.

I) Accessories

- i) Electronic unit housed in a rugged sheet steel enclosure (IP65) houses transmitting system, probe heater control circuit etc. Electronic unit shall be separate from the probe and not be head mounted.
- ii) Calibration gas cylinder & accessories, reference air set, rotameters
- iii) Shield (316 SS), special cables, electronic control panel and Provision of SS 316

stainless steel diffuser assembly for the protection of Zirconia cell.

- iv) Ownership certificate, pressure test certificate, explosion proof certificate for standard gas cylinders shall be given and these will be used for next filling up of standard gases.
- vi) Moisture separator unit along with AFR for reference air shall be installed for long life of Zirconia cell.
- vii) Any other accessories as required.

10.3.30 Junction Boxes

Bidder shall note that the Analog and digital signals shall be wired to different junction boxes.

- (i) No. of ways 12/24/36/48/64/72/96/128 with 20% spare terminals.
- (ii) Material 4mm thick fibre glass reinforced polyester.
- (iii) Type Screwed at all four corners for door. Door handle shall be self-locking with common key. Door gasket shall be of synthetic rubber.
- (iv) Mounting clamps and structures etc accessories Suitable for mounting on walls, columns,.

The brackets, bolts, nuts, screws, double compression glands and lugs required for erection shall be of brass, included in Bidders scope of supply. Race ways for routing of cables inside JBs shall be provided.
- (v) Type of TB Rail mounted maxi termi or cage-clamp type suitable for terminal conductor size upto 2.5 mm². A M6 earthing stud shall be blocks provided.
- (vi) Protection class IP:65 minimum and Explosion/Flame Proof as per area classification.

10.3.31 Interposing Relays (IPR)

Electromagnetic type IPRs with modular design, plug-in type connections, suitable for channel/DIN rail mounting in cabinets; coil rating 24V D.C; 2 set of change over contacts rated for 0.5A 220 V DC / 5A 240 V AC. Freewheeling diode across relay coil and self-reset type status LED indicator flag (electronic) shall be provided. Manual forcing/override facility is required. The test voltage for relay shall not be less than 4 KV with operating temperature from -20 deg. C to 60 deg. C. The relay shall have the necessary approvals like V0 inflammability class in accordance with UL94", IEC60664/ IEC60664A/DIN VDE 0110.



- 10.3.36 **Push Buttons (PB)/ ILPBs for On/Off, Open/Close**
- Type : Momentary / Miniaturised suitable for mosaic grid 24x48 Mm with 2 PB and 3 coloured LED.
- Contact Configuration : 2 NO + 2 NC
- Contact Material : Hard Silver Alloy
- Contact Rating : 500V / 10 A
- Insulation Voltage : 2 KV for 1 minute between terminals and earth
- Lamp Rating : a) Voltage : 240 V AC
b) Watt : 2 Watt (approx.)
- Colour : Red, Green, Amber, Yellow
- 10.3.37 **Push Button For Desk Release,**
- Push button for desk release : Momentary mosaic grid mounted
- Desk lamp test desk ack : 24x48 mm size, single PB 18x40 mm
- 10.3.38 **Push Button for Sequence Start/Release**
- Push Button for Sequence Start/Release : Momentary (Miniaturised) suitable for mosaic grid 24x48 mm 3 PB + 5 LED
- 10.3.39 **Push Button for Annunciation**
- Contacts
- Number & Type : As per requirement
- Breaking capacity : 0.5 Amp, 220V DC
10 Amp, 600V AC Different colours for Accept/Ack – Green, reset Grey, test – Yellow & Audio Ack – Black.
- 10.4.0 **Control Valves, Actuators & Accessories**
- 10.4.1 **General Requirements**
- The control valves and accessories equipment furnished by the Bidder shall be designed, constructed and tested in accordance with the latest applicable requirements of code for pressure piping ANSI B 31.1, the ASME Boiler & pressure vessel code, Indian Boiler Regulation (IBR), ISA, and other standards specified elsewhere as well as in accordance with all applicable requirements of the "Federal Occupational Safety and Health Standards, USA" or acceptable equal standards. All the Control Valves, their actuators and accessories to be furnished under this Subsection will be fully suitable and compatible with the modulating loops covered under the Specification. All the control valves and accessories offered by the Bidder shall be from reputed, experienced manufacturers of specified type and range of valves.
- 10.4.2 **Control Valve Sizing & Construction**
- The design of all valve bodies shall meet the specification requirements and shall conform to the requirements of ANSI (USA) for dimensions, material thickness and material specification for their respective pressure classes.
- Control valves for steam and water applications shall be designed to prevent cavitation, wire drawing, flashing on the downstream side of valve and downstream piping. Thus for cavitation/flashing service, only valve with anti-cavitation trim shall be provided. Detailed



calculations to establish whether cavitation will occur or not for any given application shall be furnished.

Control valves shall have leakage rate as per leakage Class-V.

The control valve induced noise shall be limited to 85 dBA at 1 meter from the valve surface under actual operating conditions. The noise abatement shall be achieved by valve body and trim design and not by use of silencers.

10.4.3 Valve Construction

All valves shall be of globe / Butterfly body design & straightaway pattern with single or double port, unless otherwise specified or recommended by the manufacturer to be of angle body type. Rotary valve may alternatively be offered when pressure and pressure drops permit.

Valves with high lift cage guided plugs & quick-change trims shall be supplied. Cast Iron valves are not acceptable.

Bonnet joints for all control valves shall be of the flanged and bolted type or other construction acceptable to the Owner. Bonnet joints of the internal threaded or union type will not be acceptable.

Plug shall be of one-piece construction cast, forged or machined from solid bar stock. Plug shall be screwed and pinned to valve stems or shall be integral with the valve stems.

All valves connected to vacuum on downstream side shall be provided with packing suitable for vacuum applications (e.g. double vee type chevron packing) Valve characteristic shall match with the process characteristics.

Extension bonnets shall be provided when the maximum temperature of flowing fluid is greater than 280 deg. C,

Flanged valves shall be rated at no less than ANSI press class of 300 lbs

10.4.4 Valve Materials

1) The exact body and trim materials shall be finalized during detailed engineering depending on the service applications.

Valve material shall be as specified in Supplier's approved Control Valve Specification sheets. The following table defines abbreviations used for valve materials:

S.No.	Abbreviations	Description
a)	BR	Bronze ASTM B 61
b)	CS	Carbon Steel Forged - ASTM A 105 Cast - ASTM A 216 Grade WCC
c)	1 - 1/4 CR	1-1/4 percent chromium alloy steel Forged - ASTM A182 Grade F11 Cast-ASTM A17 Grade WC6
d)	2 - 1/4 CR	2-1/4 percent chromium alloy Steel Forged - ASTM A 182 Grade F22 Cast - ASTM A 217Grade WC9
e)	5CR	Five percent chromium alloy steel Forged - ASTM A 182Grade F5 Cast - ASTM A 217 Grade C5.



S.No.	Abbreviations	Description
f)	SS	Stainless Steel AISI Type 316 ASTMA351 Grade CF8M

- 2) Body material shall be selected by the bidder to be compatible with the nature of the fluid, service conditions, and piping material to which it is welded and shall be subjected to Owner approval. In general, cast or forged carbon steel bodies shall be provided for non-corrosive process applications up to 275 Deg.C. Alloy Steel castings shall be provided when the media is non-corrosive and the temperature exceeds 275 Deg.C and is within 550 Deg.C. Stainless Steel of suitable grade shall be provided when media is corrosive and the temperature is below 300 Deg.C.

Sr. No.	Service	Body Material
1.	Non Corrosive, Non Flashing, and non cavitations service for process temp. up to 275 deg. C	Cast Carbon Steel ASTM A216 Gr. WCB/WCC
2.	Non Corrosive, Non Flashing, and non cavitations service for process temp. above 275 deg. C. and up to 550 deg. C.	Cast Alloy Steel ASTM A217 Gr. WC9
3.	Severe Flashing/ cavitations service	Cast Alloy Steel ASTM A217 Gr. WC9
4.	Low Flashing/ cavitations service below 275 deg. C.	Cast Alloy Steel ASTM A217 Gr. WC6
5.	DM Water Application	Cast type 316 Stainless Steel ASTM A351 Gr. CF8M

- 3) Unless otherwise specified, all control valves shall have stems, guide bushings, plugs, seat rings, stem lock pins, stuffing box parts, and other trim, all made of stainless steel. Valve guide posts and bushings shall be Stellite faced for valves where specified. Stellite faced guide posts and bushings shall be differential hardened. For applications involving high pressure drop as also for flashing and cavitation services, trim material shall be properly chosen to ensure required degree of hard facing (such as 17-4 PH SS) so as to avoid erosion.

Sr. No.	Service	Trim Material
1.	Non Corrosive, Non Flashing, and non cavitations service for process temp. up to 275 deg. C.	SS316 Stellite
2.	Non Corrosive, Non Flashing, and non cavitations service for process temp. above 275 deg. C. and up to 550 deg. C.	SS316 Stellite
3.	Severe Flashing/ cavitations service	440 SS
4.	Low Flashing/ cavitations service	17-4 PH SS
5.	DM Water Application	17-4 PH SS

- 4) Where stellite facing is not specified, hardened stainless steel shall be furnished for all surfaces subject to wear.
- 5) Manufacturer recommended materials for cage guided valves may be substituted for materials specified provided they satisfy the specified service conditions. Also where substitutions are made, the manufacturer shall guarantee performance of



recommended materials to be equal to or better than the specified materials for conditions specified.

Bidder may offer valve with body and trim material better than the specified material and in such case, bidder shall furnish the comparisons of properties including cavitations resistance, corrosion resistance, temp. resistance, erosion resistance, hardness etc. of the offered material vis a vis specified material for owner approval.

10.4.5 End Preparation

- 1) Valve body ends shall be butt-welded type.
- 2) Flanged ends shall be of a pressure class equal or greater in pressure-temperature rating to the body design pressure and temperature indicated on the control valve. Unless otherwise specified, steel flanges shall be raised face type. Flanged ends for valves shall be in accordance with ANSI B 16.5.
- 3) Welded end for control valves where specified shall be socket-weld per ANSI B 16.11 for control valves of sizes 50 mm (2") and below and Butt welded connections per ANSI B16.25 for control valves 65 mm (2-1/2") and above. The end preparation for butt welded control valves shall be matched to the corresponding details for the piping on which the valve is installed.
- 4) All end preparations shall be as per Owners requirements indicated during Contract stage.

10.4.6 Valve Actuators

All Control Valves shall be furnished with Pneumatic Actuators. The Bidder shall be responsible for proper selection and sizing of valve actuators in accordance with the pressure drop and maximum shut off pressure and leakage class requirements. The valve actuators shall be capable of operating at 60 deg.C continuously.

Valve actuators and stems shall be adequate to handle the unbalanced forces occurring under the specified flow conditions or the maximum differential pressure specified. An adequate allowance for stem force, at least 0.15 Kg/sq.cm. per linear millimeter of seating surface, shall be provided in the selection of the actuator to ensure tight seating unless otherwise specified.

The travel time of the pneumatic actuators shall not exceed 10 seconds.

10.4.7 Control Valve Accessory Devices

All pneumatically actuated control valve accessories such as air locks, hand Wheels/hand-jacks, limit switches, Microprocessor based Positioner, diffusers, external volume chambers, position transmitters (capacitance or resistance type only), reversible pilot for Positioner, tubing and air sets, solenoid valves and junction boxes etc shall be provided as per the requirements.

1) Specifications for Microprocessor Based Positioners:

1	Electrical	a) Input signal	4-20 mA
		b) Power Supply	Loop powered from the output card of Control system.
		c) Hart Protocol	Compatibility for remote calibration & diagnostics (Super-imposed Hart signal on input signal (4-20 mA))
		d) Valve position	Non-contact type position sensing with 4-20 mA output signal



2	Environment	a) Operating temp b) Humidity c) Protection Class	-30 to 80 Deg C 0-95 % IP-65 Minimum
3	Test reports / Certificates	Factory Valve Signature Tests reports (Pr vs valve travel and reports/ travel vs I/P signal) are to be provided. Test certificates as per manufacture standard / relevant standard are to be submitted	
4	Configuration / Calibration	Remote calibration, auto & manual calibration shall be possible. Universal HART calibrator to be provided.	
5	Operating	Operating Range	Full range & split range signal.
6	Modes	Valve Action	Direct & Reverse valve action(selectable)
		Flow characterization	Possible to fit valve characteristic curve – Linear & Equal Percentage.
7	Fail safe / Fail Freeze	Fail safe/Fail freeze feature is to be provided. (In case, the fail freeze feature is not intrinsic to the positioner, Bidder shall achieve the same externally through solenoid valve connected in the pneumatic circuit).	
8	Pneumatic	Air capacity	Sufficient to handle the valves selected/ boosters to be supplied if required.
		Air supply pressure	To suit air supply pressure/quality available.
		Process connection	1/4 inch NPT
9	Electrical cable entry	1/2-NPT, side or bottom entry to avoid water ingress.	
10	Performance	Characteristic Deviation	<=0.5 % Of Span
		Ambient Temp Effect	<=0.01 % / Deg C Or Better
11	EMC & CE Compliance	Required to International Standard like EN/IEC.	En50081-2& En50082 Or Equivalent
12	Accessories	In-built operator panel	Display with push buttons for configuration and display on the positioner itself (password protected/hardware lock).
		Press gauge block	For supply & output pressure.
		Mounting assembly	On as required basis.

2) Limit Switches:

Valves shall be provided with limit switches. Switches shall have not less than two normally open and two normally closed contacts in both open and close directions. Electrical rating of the limit switch contacts shall be 240V AC, 5 amp or 220V DC, 0.5 amp, limit switches should be micro switch type or owner approved equal. The enclosures of the limit switches shall be as per NEMA-4 Standard. Limit switches shall be constructed to withstand the temperatures encountered in the actual service. Explosion proof construction shall be furnished where required by applicable code or these specifications. Limit switches shall be factory mounted on the valves with check limit switch operation prior to shipment.

Limit/micro switches can be offered as an integral part of Smart valve Positioner.



3) Solenoid Valves:

- a) Solenoid valves shall be selected to incorporate body construction, trim materials and internal arrangements suitable to the application and shall be acceptable to the Owner. Solenoid enclosures shall be NEMA-4 / IP 65 unless otherwise specified. Solenoid coils shall be Class-H High temperature construction and shall be suitable for continuous duty.
- b) Each solenoid valve shall be furnished with form U internal valve arrangement, Class H high temperature coil, threaded conduit connection, and other electrical and mechanical requirements as specified. The complete data such as material of construction, coil ratings, connection sizes, body rating etc shall be furnished along with the proposal. These shall be subject to Owner approval during detailed engineering stage.
- c) Solenoid valves shall be provided with pneumatic operated control valves/dampers hooked up with process interlock requirements and where direct tripping is involved. The number of ways for solenoid valve shall be provided as indicated below, however the no. of ways for solenoid valve shall be based on client approval during detail engineering and same has to be supplied by bidder without any commercial or price implication.
 - Two (2) way solenoid valves shall be provided, where process line of less than 50mm with low pressure and temperature application.
 - Three (3) way solenoid valve shall be provided commonly, where the pressure is admitted or exhausted from a diaphragm valve or single acting cylinder, e.g, Pneumatic operated spray water block valve.
 - Four (4) way solenoid valve shall be provided for operating double acting cylinders, e.g, Pneumatically operated on-off type dampers.
 - All solenoid shall be with varies tor, LED indication, surge suppress diode and circuits and with plug in connector connection.

4) Air Filter Regulator (AFR)

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

Air filter regulators shall be provided as follows:

- (a) Air supply line to valve positioners / power cylinders
- (b) Air supply line to electric to pneumatic convertors.
- (c) Air supply line to pneumatic interlocked block valves.
- (d) For each instrument rack, field instruments enclosure for purging.

5) Power Cylinders (Pneumatic)

Mounting Type	:	<ol style="list-style-type: none"> a) Fixed position mounting (End mounting). b) Trunnion mounting
Control Signal	:	0.2 to 1 Kg/Sq. cm. from I/P converter for modulating purposes. 24V/48VDC operated solenoid valve operating on pneumatic line. The Pilot solenoid will have separate coils for open closing purpose.



Supply Air	:	0-7 Kg / Cm2.
Selection	:	Based upon thrust / torque, stroke length, angular movement, full-scale travel time, repeatability, space factor etc. Provision for air-to-open and air-to-close operation
Casing	:	IP-65.
Accessories (as required)	:	a) Air lock relay b) Hand wheel. c) Air filter regulator with gauge. d) Volume Booster. e) Limit Switches. f) Positioner with Input, Output and supply pressure gauges. g) Pilot Solenoid Valve (Double Coil type) h) Position Transmitter (4-20 mA DC linear output, LVDT or non-contact type)
Fail-safe operation	:	Stayput, 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 1% of full travel.

10.5.0 Flow Elements

The equipment furnished to this specification shall conform exactly to the requirements herein, unless modified by the respective datasheet of the equipment.

b) Orifice Plate

Features	Essential/Minimum Requirements
Type	Concentric as per ASME PTC-19.5 (Part-II), ISA RP-3.2, 1960 or BS-1042
Material	316 SS, for sea water based application SSduplex shall be used <ul style="list-style-type: none"> ▪ Thickness 3 mm for pipe dia. upto 250 mm ▪ 6 mm for main pipe dia above 250 mm ▪ 10 mm for main pipe dia. 500 & above.
Material of branch pipe	Same as main pipe
Root valve type	Globe
Root valve material	316 SS, for sea water application SS duplex
Root valve size	1 inch
Impulse pipe of same material up to root valve	Required



Features	Essential/Minimum Requirements
Tappings	Flanged weld neck. 3 pairs. of tapping.
Beta Ratio	0.34 to 0.7
Beta Ratio calculation to be submitted	Yes
Assembly drg. and flow Vs DP Curves	Yes
Accessories	Root valves, flanges, Vent/drain hole (As required)

Bidder shall submit certified flow calculation and differential pressure vs. flow curves for each element for Owner's approval. Sizing calculation, precise flow calculation for all the flow elements, fabrication and assembly drawings and installation drawings shall be submitted for Owner's approval. One Flow element of each type shall be calibrated in the test laboratory for validation of computed flow calculations.

c) Flow Nozzle

Features	Essential/Minimum Requirements
Type	Long radius, welded type as per ASME PTC-19.5 (Part-III) or BS-1042
Material	316 SS, for sea water application SS duplex
Thickness	Suitable for intended application
Material of branch pipe	Same as main pipe
Root valve type	Globe
Root valve material	316 SS, for sea water application SS duplex
Root valve size	1 inch
Impulse pipe of same material up to root valve	Required
Tapping	D and D/2 (3 Nos. of tappings)
Beta Ratio	Around 0.7
Beta Ratio calculation to be submitted	Yes
Assembly drg. and flow Vs DP Curves	Yes
Accessories	Root valves, vent and drain hole.

12.0.0 ERECTION HARDWARE

12.1.0 General Requirements

- 12.1.1 This section covers the material requirement for instrument connection to process, instrument process, piping, tubing, supports, transmitter racks and main accessories to be furnished under this specification and the requirements of installation and routing. Impulse lines, fittings and other accessories required for the erection of complete Instrumentation and Control System supplied under various packages of this specification shall be supplied on "as required" basis. Bidder shall offer all necessary items for this section based on his experience on similar plants, plant layout diagrams, installation drawings and other applicable sections of this specification. Based on the good engineering practices, Bidder shall furnish installation drawings during the engineering of the system for Owner's review and approval. The installation of the drawings shall be suitable for his installation of his range of instrumentation.
- 12.1.2 The Bidder shall furnish and test all required erection hardware, which is necessary for proper installation and interconnection of the equipment/systems furnished by the Bidder and their integration with main equipment/systems as per the enclosed installation drawings and other applicable clause. The Bidder shall furnish all hardware and accessories to ensure that the equipment/systems furnished form a complete and operational system meeting the intent and requirement of this specification.
- 12.1.3 All materials, furnished shall conform to the latest editions of America National Standard Code for Pressure piping, Power piping, ANSI B311.1, ANSI B16.11, ASME Boiler and Pressure Vessel Codes, IBR and other applicable ASME, ANSI and Indian Standards. Schedule numbers, sizes and dimensions of all carbon steel, stainless steel and alloy seamless steel pipe shall confirm to ANSI B.36.10 and of stainless steel pipe shall confirm to ANSI B 36.19 unless otherwise specified.
- 12.1.4 Instrument erection hardware which includes all junction boxes, cable trays, cable glands, lugs, cable ties, support, local panels, pneumatic and process hook up hardware, Impulse piping & fittings and other erection materials and accessories required for the system supplied.
- 12.1.5 All materials supplied under this section shall be suitable for intended service; process operating conditions and type of instruments used and shall fully conform to the requirements of this specification.
- 12.1.6 The Bidder is responsible for the performance of the equipment furnished on system basis any shortfall in erection material observed during erection stage shall be compensated by the Bidder at no extra cost.

12.2.0 Process Connections

The type of instrument source connection shall depend upon the process parameters and the tapping size. The source connection drawings shall be finalized during the engineering stage, Refer Hookup diagram.

12.3.0 Impulse Piping System

General

Impulse piping system consists of primary impulse pipes/tubes, valves, fittings, valve manifolds and other accessories between the source connection point (source shut-off valve onwards) and all instruments/devices. Impulse pipe span for supporting clamp shall be 1.5 mtr. This will also include all piping and valves etc. required for instrument drain and vent connections. The Bidder shall furnish and test all items required for completeness of this specification.

12.4.0 Air Supply Piping

The piping for air supply shall be as specified below (However Bidder shall supply the materials as required basis to complete the system in all respect)

1. Individual Supply Lines and Control Signal Lines:-

Air lines shall be ¼ inch size, connected by brass/SS316 flare less tubing fittings. Copper tubing shall be light drawn tamped tubing conforming to ATM B75 except copper tubing in tubing cables shall be annealed soft temper tubing conforming to ASTM B68 or B75. Fittings on the branch line to facilitate connections to the individual supply line shall be cast brass screwed type.

2. Flexible Hoses:-

Flexible hoses shall be ¼ inch rubber hose with Buna-N liner steel wire braid reinforcement and rubber outer covering complete with ¼ inch brass fittings and shall have swivel male pipe threads. Each hose shall be one meter in length.

3. Pipe Material Specification:-

The piping material shall be carbon steel hot-dipped galvanized inside and outside as per IS-1239 or the equivalent of these standard heavy qualities with screwed ends. The piping threads shall be as per ASA B.2.1

4. Isolating Valves:-

Gate valves as per ASTM B62 inside screw rising stem screwed female ends as per ASA B.2.1 valve bonnet shall be union type and trim shall be stainless steel body rating 150 pounds ASA. Valves sizes shall be ½ inch to 2 inch.

5. Fittings:-

Forged cast steel A234 Gr. WPM galvanized inside and outside; screwed as per ASA B2.1 dimensions as per ASA B16.11, rating 2000 pounds, elbows and soft seats. The size of the fittings shall be ½ inch through 2 inch.

6. Air Filter Regulator Set:-

An instrument Air Filter Regulator Set with mounting assemblies shall be provided for each pneumatic device requiring air supply. The filter shall be of size 5 microns and material sintered bronze. The air set shall have a 2 inch size pressure gauge and built in filter housing blow-down valve. Filter regulators shall be suitable for 10 Kg/Sq.cm. maximum inlet pressure. The connection size shall be ¼ inch NPT. A ½ inch instrument air supply isolating valve shall be provided for each pneumatic device requiring air supply.

12.5.0 Process Connections

Following type of source connections shall be provided by the Bidder on equipment/piping for instrumentation purpose.

1. Source valves for pressure and differential pressure measurements as per enclosed instruments source connection details.

2. Threaded/weld able stubs for thermowells of various sizes for temperature elements as per enclosed source connection details.

3. Source valves with socket welded connections for level services as per enclosed instrument source connection details.
4. For control actuators at the master operating spindles/levers of the final control elements.

However, if the source connection details, as illustrated, do not match with the connection ports of the instruments, the same may be altered in consultation with Owner.

12.6.0 Impulse Tubing

High pressure and high temperature services (Water)

Seamless Alloy Steel piping to ASTM A335 GR.P22 (schedule 160 for high pressure & high temperature)

Low pressure and Low temperature services(Water)

Seamless carbon steel piping to STM A106 Gr.B

Low pressure and low temperature services (Air)

ERW carbon steel piping to IS 1239: 1973 Heavy class System

Analysis system

Seamless stainless steel piping to ASTM A312 GR. TP-321

12.7.0 Fittings Double compression type

i) Material for socket weld fittings

ASTM A105 ASTM A182, Gr. F22 6000/3000 lbs

ii) Dimensions of fittings

ANSI B16.11

12.8.0 Valves

i) 3-way valves

SS body/Forged CS body stellated 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 stellated internals with NPT(F) SCRCD ends for 2500 lb/1500 lb/600 lb ASA ratings.

iii) 2-valve manifolds

FCS body, 316SS stellated internals, NPT(F) SCRCD ends.

iv) Isolation and drain valves

Globe valves with FAS

12.9.0 Condensation vessels

body/FCS body, 316SS stellated internals, SW ends for 2500 lb/1500 lb/600 lb ASA ratings.

12.10.0 Flexible conduits with fittings

Lead coated, paper insulated, heat resistant flexible metal conduits with necessary fittings.

12.11.0 Guideline for Installation and Routing Of Instrument Piping

12.11.1 General Requirements

The following general erection guidelines have been enumerated here to enable the Bidder to estimate the requirement of instrument piping in plant:-

1. All instrument piping shall be in accordance with good engineering practice. It shall be finalized during engineering stage. Instrument piping shall be complete with fittings, valves and other required accessories.
 2. Instrument piping shall not be routed:-
 - a) Across equipment removal areas
 - b) Below mono-rails and cranes
 - c) Above or below removable gratings
 - d) Above or below cable trays.
 3. Primary Impulse Piping System:
 - a) The primary impulse piping system shall include the instrument piping and all required accessories from process tap off point (root valves onwards) up to the respective instruments. From the same source, Tee off for instruments are not allowed. Separate tapping shall be provided for each instrument. The Bidder shall provide the necessary fittings and accessories along with impulse pipes for completeness and arrangements as per the finalized Instrument Installation Diagrams. Special accessories such as reservoirs and other devices shall be installed as required for flow primary element connection as required by the design of instruments, in accordance with the instructions of the instrument manufacturer.
 - b) The Bidder shall prepare impulse pipe routing drawings.
 - c) Impulse piping shall include a blow-down line and shut-off valve adequate for the duty requirements and for withstanding continuous design pressure and temperature of process medium. For process pressure above 40 Kg/Cm²g, double valves shall be used before connecting to the blow-down header (This arrangement shall be provided for installation for the new transmitter if the existing transmitter has the same arrangement.)
 - a) To assure a constant static head the connections from low pressure steam and low pressure liquid filled lines should preferably slope downward continuously towards the instrument as the instrument is mounted below the source point. If downward slope is not feasible or the instrument is mounted above the source point, the line should slope upward continuously and a "pigtail" installed at the instrument to assure a water seal for temperature protection. Upward sloping liquid lines should be used only if the process pressure is sufficient to assure a head of liquid at the instrument. Horizontal runs should have a slope of not less than 40 mm per meter and must be adequately supported to maintain a constant slope. Vacuum connections to the condenser should always slope upward to the instrument.
 4. Primary process piping for steam flow, liquid flow and manometric level measurement systems should preferably slope downward from the primary element connections to the instrument. Primary piping for flue gas and air flow measurement systems should preferably slope upward from the primary element connections to the instrument. If these requirements cannot be met, special venting or drain provisions will be required. Horizontal runs must have a slope of not less than 40 millimeters and must be adequately supported to maintain a constant slope.
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5. Primary process piping from the field which enters the instrument enclosure from the bottom shall extend into the enclosure approximately 150 millimeters and be equipped with a socket weld to flare less tubing coupling of stainless steel. This coupling shall be used to connect the field primary process line to the enclosure process line. The field primary process line shall be anchored to the enclosure angle with U-bolts. Holes for supporting U-bolts shall be field or drilled. All impulse piping shall be supported rigidly at an interval not exceeding 1.5 meters so as to prevent excessive sag in piping. Process piping shall not be used for supporting impulse piping.
6. Impulse lines subject to severe sonic pulsations shall be of sufficient length and of suitable configuration to scatter harmful sonic wave energy before it reach the instrument.
7. Impulse piping shall be installed to permit thermal expansion without placing excessive stress on the piping and without affecting the gradient of slope. Long continuous straight runs of piping shall always be avoided. If required, expansion loops shall be provided at least every 2.5 meters to break the continuity.
8. All welded and screwed fittings shall conform to ANSI B16.11. Threads of piping components shall be taper pipe thread in accordance with ANSI B2.1. All threads shall be clean machine cut with all burrs and chips removed. Lubricants shall be of dry filch type. Any one of the following compounds may be used as a pipe thread sealer. Bidder shall supply adequate amount of his preferred sealer for erection purpose. Teflon tape shall not be used as a pipe thread sealer.

9. Instrument Air Piping System:-

Instrument Air shall be made available by the bidder at 3.5 to 7.0 Kg/cm² pressure. The instrument air may be arranged as under:-

For the control valves and power cylinders in Owner's scope but controlled by bidder's control system, the instrument air requirement for E/P converter shall be tapped from the nearby instrument air header laid by bidder / already laid existing piping with accessories available near the control valves or damper.

Air supply piping shall be installed at site always with a slope of over 1/100 to prevent accumulation of condensed water within the pipe.

All joints in the instrument air sub-header shall be of screwed type.

10. Signal / Control Air Tubing System:-

Necessary tubes with fittings and accessories for output signal from pneumatic instruments mounted in the field and control signals to final control elements shall be covered under this tubing system.

3 Valve manifold shall be used, wherever Diff pressure transmitter/ switch have been used for pressure measurement.

5 Valve manifold shall be used for Diff. Pressure & Flow measurement Transmitters/Switches.

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|---|--|
| 11. Code for Racks and Associated Equipment | ANSI C83.9-1972 |
| 12. Code for pressure piping, welding and Hydrostatic testing | ANSI B-31.1 |
| 13. Flexible conduits with fittings | Lead coated, paper insulated, heat resistant flexible metallic conduits with necessary fittings. |

12.11.2 Transmitter & Switches Enclosures

In general, process parameter transmitters & switches installed at outdoor location and in areas where they are subjected to splashing oil, water, steam etc., shall be mounted in closed type transmitter rack. For other areas (indoor), open type racks may be used for installation of transmitters and process switches. However the actual requirement shall be finalized during detailed Engineering considering following:-

1. Transmitter/Switches enclosures shall be free standing, enclosed type offering protection against dust, moisture and vermin. Enclosures shall be suitable for outdoor installations, in thermal power plants.
2. The enclosures shall comprise of Galvanized Sheet mounting plate internally. Also external-mounting brackets in Polyamide or Stainless Steel shall be available and shall be weather proof. Panel thickness shall be 3 mm for instrument supporting faces and back and for remaining sides shall be 2 mm.
3. Instrument piping inside the enclosure shall conform to the specification and in line with typical installation drawings enclosed with the specification.
4. Blow down header shall be provided inside the enclosure as called for.
5. Bulk head connection shall be provided to receive and terminate the impulse pipes from root valves.
6. Instrument tubing, fittings and isolation, drain valves shall be to ANSI code for pressure piping. Piping/tubing shall be subject to hydrostatic tests at 1.5 times maximum system pressure.
7. 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.
8. 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 Six (6) transmitters are envisaged to be grouped in one enclosure.
9. The field devices like switch devices, limit switches, position transmitters, solenoid valves etc shall be provided with removable type insert & screw type connectors, or terminal heads suitable for easy maintenance and testing of these equipment items.
10. All spare contacts/terminals on relays, control switches, limit switches or similar devices, process switches, duplex RTDs & Duplex T/Cs shall be wired to accessible terminal blocks/JBs for Owner's future connections. All wiring leaving a junction box or enclosure shall leave from terminal blocks and not from other devices in the enclosure. Two (2) pair cables shall be provided for terminating the transmitter to local JB's.
11. Auxiliary equipment such as relays, terminal blocks etc shall be readily accessible and servicemen shall have direct access to the equipment without removal of barriers, cover plates or wiring.
12. All electrical cables shall be conservatively selected for the electrical and environmental conditions of the installation and shall be of the best construction for the service conditions encountered. Oil resistant and proper temperature applicable cable shall be used throughout.

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13. A minimum of twenty (20) percent spare terminals shall be provided. Only one wire per terminal shall be used on the outgoing side of these blocks (for cable panel). Any common connections required shall be provided on the panel side of the block. All incoming power terminals are to be clearly identified in a manner distinctly different from all other terminals and grouped in a logical pattern.
 14. Each wire is to be identified at both ends corresponding to wire number shown in wiring diagrams.
 15. All wire terminations at terminal, shall be made with compression type connections properly sized for the conductor and the terminal. The connector shall be constructed of fine grade high conductivity copper and shall be tin plated. No more than two wires shall be connected to a terminal. Vertical wiring on the panels between the terminal blocks and the devices shall be enclosed in non-metallic raceways or punched metal raceways with removable cover. Horizontal wiring between the raceways and the devices may run exposed. Wiring on the panels shall be formed neatly with wires neatly grouped in packs using non-metallic bends, and with group substantially supported along the panel.
 16. Wire stripping shall be done in such a manner that conductor will not be nicked or cut.
 17. The entire arrangement of wiring and arrangement of connections/ terminal blocks shall be acceptable of the Owner's Engineer.
 18. Switches for temperatures, flow, level, pressure etc. required for unit protection/interlock shall be triplicated.
 19. Each instrument shall be provided with nameplate and labels etc.

12.11.3 Local Instruments, Local Boards and Tapping Points

- i. All local gauges as well as sensors and switches for parameters like pressure, temperature, level, flow etc for safe and efficient operation of equipment under the scope of specification, shall be provided by bidder as approved by Owner. Such equipment shall be listed by the Bidder detailing the items with the respective functions in service. All field mounted instruments shall be mounted in such a way as not to be affected by vibration & environmental conditions. Racks to mount these instruments shall be furnished by bidder complete with requisite erection hardware, tubings and junction boxes with all terminals of the instruments duly wired complete with cable glands. Groupings of instruments, actual number of racks for instruments and its construction shall be to Owners approval.
- ii. Transmitters provided shall be mounted in transmitter enclosures to Owner's approval. The junction box for electrical connections shall be outside the transmitter enclosures.
- iii. All erection hardware required for complete installation/ implementation of entire instrumentation specified is included in bidders scope. Any change in size, type, and rating or in quantity deemed necessary during engineering shall be supplied within package price with no additional financial implication to Owner.
- iv. Bidder's scope includes providing counter flanges on pipe lines/ vessels to suit Owner arranged flanged devices. Counter flanges shall be complete with gaskets, nuts, bolts and other requisite accessories for proper installation.
- v. Separate and independent tapping on equipment/associated piping shall be provided to suit the philosophy of redundant primary sensors. Separate sensors for control and monitoring etc are as decided by Owner. This shall include application such as first stage pressure. Wherever the process value being measured needs to be

compensated for temp, pressure variations, the tapping points for such compensating elements shall be provided in requisite number along with the tapping for the process value.

- vi. Tapping points shall include probes, wherever applicable, for analytical measurements and sampling.
- vii. For direct temperature measurement of all working media, one stub with internal threading of approved pattern shall be provided along with suitable plug and washer. The Bidder will be intimated about thread standard to be adopted.
- viii. The following shall be provided on equipment by the Bidder. The standard which is to be adopted, will be intimated to the Bidder.
 1. Temperature test pockets with stub and thermowell
 2. Pressure test pockets

12.11.4 Size of tapping point stub, number and size of root valves for different types of measurements

Size of tapping point stub, number and size of root valves for different types of measurements are as follows:

Sl. No.	Quantity of root valves	Size of stub and root valve	Service Condition
Pressure and Differential Pressure Measurement			
(i)	2	25NB	> 40 bar(g) OR 425degC
(ii)	1	15NB	< 40 bar(g) AND 425degC
Level Measurement			
Level Gauge & Switch			
(i)	2	25NB	> 40 bar(g) OR 425degC
(ii)	1	25NB	< 40 bar(g) AND 425degC
Level transmitter (displacement type)			
(i)	2	40NB	>40 bar(g) OR 425degC
(ii)	1	40NB	<40 bar(g) AND 425degC
Stand pipe for level measuring instrument			
(i)	2	80 NB	>40 bar(g) OR 425degC
(ii)	1	80 NB	< 40 bar(g) AND 425degC
Flow Measurement			
(i)	2	25NB	> 40bar(g) OR 425degC
(ii)	1	25NB	< 40 bar(g) AND 425degC

Note:-

- 1). Rating of piping / fittings / valves etc. is subjected to the final design pressure & temperature during the detailed engineering, as per ANSI B 31.1.
- 2). In case temperature is more than 540 deg C, the material shall be P-91 only.
- 3). Material shall be compatible with that of the impulse pipe material and design parameter.
- 4). For DM Plant or DM water services, complete erection Hardware material shall be SS316 only.

15.0.0 PANEL AND DESKS

15.1.0 General Requirements

- 15.1.1 All PLC/control system's electronic modules, power supply components, other control devices (except field mounted sensors/transmitters) and required for completeness of the system shall be housed in cabinets furnished by the Bidder. All equipment and dedicated cabinets required for termination, marshalling and proper interface within Bidder's system and also with other systems shall also be provided by the Bidder.
- 15.1.2 The cabinet mounted equipment shall be fully assembled, installed in mounting racks, wired and fully tested as per specification requirements and Owner approved drawings in the manufacturing works of a qualified manufacturer prior to shipment to the project site.
- 15.1.3 The Bidder shall ensure that the cabinets are complete and ready for installation before dispatch from manufacturing works. The installation work at project site for these cabinets should only involve connections through multi pair cables from marshalling cabinets (wherever provided) to system cabinets.
- 15.1.4 The Control cabinets shall house all types of modules / hardware to achieve all functions of Control System including signal conditioning modules, controller modules, I/O modules, communication controller modules, interposing relays and all other requisite hardware for a complete system.

15.2.0 Relay Based Local Control Panel/Desk

- 15.2.1 Local control panel shall be of 2.5 mm steel construction, free standing type, totally enclosed dust and vermin proof with enclosure protection class of IP-65 as per IS: 13947 Exterior color shall be as per shade no. RAL 7032 and Interior color shall be Brilliant white. Panel shall be mounted on vibration dampers secured to steel frame on to the floor. Equipment and relays mounted on the panel shall be easily accessible. The panel shall be supplied completely wired upto terminal blocks for connecting external cables entering the panel from the bottom. Blank removable gland plate shall be provided with double compression type cable glands/conduits knockout along with the panel.
- 15.2.2 Terminal block shall be rated 1100 volts minimum and shall have strap screw less terminals suitable for connection with 2x2.5 sq mm copper conductors on each side. Terminal block shall be provided with white marking strips. Fuses shall not be mounted on terminal blocks. At least 20 percent spare unused terminals shall be provided on terminal block.
- 15.2.3 Relays, timers and other devices mounted on the panel shall have clearly visible identification marking. All fuses shall be HRC semiconductor type of AC supply. HRC link & fuse shall be of removable type having 45 kA rupturing capacity (min) for protection of various circuits.
- 15.2.4 The panel shall be provided with a 50x6 mm tinned copper earthing strip running throughout the length of the panel at the bottom. Panel shall be provided with space heaters with isolating DPN MCB, and thermostats, LED based illuminating lamps, complete with door switches; and 2 nos. 6 pin 5/15amps sockets with DPN MCB.
- 15.2.5 Panel shall have removable lifting eye bolts for safe lifting from top during handling. Control power supply shall be provided from dual redundant feeders with auto change over scheme, surge protection devices and Power/Volt/AM meter.
- 15.2.6 The panel shall be provided with push buttons, indicating lamps, annunciators, indicating instruments, interlock/ deinterlock switches etc., required for the complete system. Colored Mimic for respective plant lay out shall be provided.

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- 15.3.6 Care shall be taken to ensure ergonomically aspects so as to create ergonomically ideal work place considering physical aspects such as an average Indian person's size and reach, physiological aspects such as line of sight and field of vision and cognitive factors such as concentration and perceptivity. Extreme care shall be taken to design the desks with correct angles and dimensions.
- 15.4.0 **Termination/Marshalling Cabinets & Interposing Relay Panel**
- 15.4.1 Marshalling/Termination cabinets for the system shall be supplied for terminating all cables originating from the field, MCC/SWGR or any other source of signal and for distributing the signals to different functional panels and cubicles.
- 15.4.2 Incoming cables from the field, MCC/SWGR or any other source of signal shall be terminated in suitable terminal blocks in logical sequence.
- 15.4.3 Prefabricated cables with plug in connectors at both ends shall be used for extending the signals to the functional panels. Matching plug sockets shall be provided in the termination cabinets for terminating the plugs.
- 15.4.4 Interposing relay panels for the system shall be supplied for mounting interposing relays & terminating all cables originating from the DO cards and for distributing the signals to different MCC/SWGR panels and cubicles. IPR panels shall be placed in LCR.
- 15.4.5 The cabinet shall have internal illumination lighting fixtures.
- 15.4.6 Terminal blocks shall be located inside the cabinets on support wings fabricated of metal plates.
- 15.4.7 The plug socket shall be mounted on hinged plates to provide an access to the rear pins of the plugs.
- 15.4.8 General features of termination cabinets and accessories shall conform to the general design and construction specification of panels. Terminal blocks shall be Rail mounted Terminal blocks (Screw less cage clamp type) with markers.
- 15.5.0 **Constructional Features Of Panels, Consoles, Cubicles & Enclosures**
- 15.5.1 All panels, cubicles, consoles, SOV panels and enclosures furnished as per this specification shall be of free standing type and shall be constructed of specified gauge of steel plates. The panel sheet thickness shall be not less than 2 mm. vibration isolating
- 15.5.2 The panels, consoles/desks shall be reinforced as required to ensure true surfaces and adequate support for instruments mounted thereon. All instrument cutouts, mounting studs, and support brackets shall be accurately located. All welds on the exposed panel surfaces shall be ground smooth. Finished panel surfaces shall be free from waves, bellies, or other imperfections. Unless specified, otherwise, panel doors shall be 4 points hinged and shall have turned back edges and additional bracing where required to ensure rigidity. Door hinges shall be of the concealed type. Door latches shall be of the three-point type to ensure tight closing. Door locks shall be furnished which will allow actuation of all locks by a single master key. All panels shall have removable lifting fire s for safe lifting from top during storage and installation handling.
- 15.5.3 Cabinet doors shall be hinged and shall have turned back edges and additional bracing where required ensuring rigidity. Hinges shall be of concealed type. Door latches shall be of three-point type to assure tight closing. Detachable lifting eyes or angles shall be furnished at the top of each separately shipped section and all necessary provisions shall be made to facilitate handling without damage. Front and rear doors shall be provided with locking arrangements with a master key for all cabinets. If width of a cabinet is more than 800 mm, double doors shall be provided.
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- 15.5.4 All panels shall be mounted on vibration dampers, which are secured to channels mounted on the floor. The channels shall be field welded to steel plates set into the concrete flooring. The steel plates shall be located such as to approximate the outline of panel bases. The exact mounting details shall be as approved by the Owner during detailed engineering stage. All panels shall be provided with adequate ventilation and packaging density of components shall be restricted so as to limit the temperature rise above ambient to 10°C under the worst conditions. All panels shall have auto on/off switch for internal lighting. All the power supply circuit for control panels shall be provided with auto changeover circuitry.
- 15.5.5 In each panel /cabinet, a 24 VDC Voltmeter digital type shall be provided to check the field interrogation voltage.
- 15.5.6 Exhaust fans with louvers & filters shall be provided on upper side to remove hot air in all consoles and panels.
- 15.5.7 Fire/Smoke detectors shall be provided inside the Control room mounted system/control cabinets.
- 15.5.8 Feeder failure/ healthy indication shall be provided in each cabinet & remote indication shall be hooked up to PLC/annunciation & suitably grouped.
- 15.5.9 All the panels shall be equipped with Anti vibration pad of min. 15 mm size. Cable gland plate thickness shall be 3 mm.
- 15.5.10 Doors shall be provided with neoprene gasket only.
- 15.5.11 Surface Preparation and Painting

All panel exterior steel surfaces shall be ground smooth, and painted as specified below: Suitable filler shall be applied to all pits, blemishes and voids in the surfaces. The filler shall be sand blasted so that surfaces are level and flat, corners are smooth and even. Exposed raw metal edges shall be ground burr free. The entire panel surface shall be sand blasted to remove rust and scale and all other residue due to the fabrication operation. Oil grease and salts etc. shall be removed from the panels by one or more solvent cleaning methods. Alternatively 7 tank process shall be followed.

Two spray coats of inhibitive epoxy primer – surface shall be applied to all exterior and interior surfaces; each coat of primer surface shall be of dry film thickness of 1.5 mil. A minimum of two spray coats of final finish colour (Catalyzed epoxy finish) shall be applied to all surfaces of dry film thickness 2.0 mil. The finish colours for exterior and interior surfaces shall conform to the following shades:

Exterior – RAL7035

Interior – Brilliant white

The above color shade shall be applicable and uniformity shall be maintained for the complete plant.

Paint films, which show sags, checks, blisters teardrops, fat edges or other painting imperfections, shall not be acceptable and if any such defects appear, they shall be repaired by and at the expenses of the Bidder.

15.6.0 Panel Wiring

- a. Interconnecting wiring shall be provided between all electrical devices mounted in the panels, and between the devices and terminal blocks if the devices are to be connected to equipment outside the panels. The Bidder shall install jumpers between terminal blocks as indicated on the Owner's schematic diagrams. All alarm contacts

located within a panel shall be wired to terminal blocks. Thermocouple and other special circuits shall be field wires direct to instrument terminal blocks without the use of panel wiring.

- b. All Control and Instrument wiring used within the panels shall conform to NEC and NEMA standards and shall be factory installed and tested at the works of a qualified manufacturer. All interior wiring shall be installed neatly and carefully, and shall be terminated at suitable terminal blocks. Sufficient clearance shall be provided for all Control and Instrumentation leads, and all incoming and outgoing leads shall be connected to terminal blocks suitably located for connecting external circuits. The arrangements for circuits and terminal blocks shall agree with schematic diagrams furnished by the Owner. All panel wiring shall have appropriate ferruling for clear identification. Interior wiring shall be so arranged that the external connections can be made with only one wire per terminal point. Any common connections shall be made internal side of the terminal blocks. Common connections shall be limited to two wires per terminal. Instrumentation cable shield wires shall be connected to separate terminal at the terminal block.
 - c. Signal circuit shields shall be grounded at the power supply end only or as recommended by manufacturer.
 - d. All internal wiring (except low level instrument wiring) shall be National Electric Code Type SIS, Polymetric/Elastomeric insulated, 1.5mm² tinned copper stranded conductor, switchboard wire, or Owner approved equal.
 - e. Panel wiring shall have a flame resistant insulation with adequately sized copper conductor based on current carrying capacities as etc forth by the National Electric Code.
 - f. Wire sizes shall be as specified herein and suitable for intended applications.
 - g. Wiring to door mounted devices shall be provided with (49 strand minimum) adequate loop lengths of hinge wire so that multiple door openings will not cause fatigue braking of the conductor.
 - h. Wiring shall be arranged to enable instruments or devices to be removed and/or serviced without unduly disturbing the wiring. No wire shall be routed cross the face or rear of any device in a manner, which will impede the opening of covers or obstruct access to leads, terminals or devices.
 - i. Panel wires shall be identified with wire number and each termination by means of Action craft products split sleeve or Borden Chemical Co. indelible tubing markers or Owner approved equal. Corrections and modifications of all panel wiring shall be Bidder's sole responsibility. Any corrections/modifications required at site for successful commissioning shall be done by the Bidder without any additional costs. Terminal lugs furnished must be of the compression, insulated sleeve, half ring tongue type. Open- ended terminal lugs will not be accepted. Wires shall not be looped around the terminal screws or studs.
 - j. Wires shall not be tapped or spliced between terminal points.
 - k. Panels, cabinets, consoles/desks will be provided with removable, gasketed cable gland plates and cable glands, for all floor slots used for cable entrance. Split type grommets shall be used for prefab cables.
 - l. Internal wiring in factory prewired electronic systems cabinets may be installed according to the Bidder's standard as to wire size, insulation, and method of termination on internal equipment except that insulation for all wiring power supply wiring, and interconnecting cables between devices shall pass the following tests.
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- Flammability test IEEE 383/1974
 - When tested under UITPP test method or ASTM 2893/77 light transmittance of 80%
 - When tested under IEC 754-1 maximum acid gas generation shall be 2% by weight
 - Oxygen index not less than 30 as per ASTM D 2863.
- m. All terminations for intra panel wiring inter panel cabling and connecting the Bidders panels, PB stations, control stations etc. shall be with cage clamp Screw less connections. Soldered connections are not acceptable. All field side or external input connections shall also preferably of cage Clamp/ Screwed less connection. Conductor Clamping shall also confirm to Standard IEC – 60947-1 & IEC-60947-7-1. Identification of conductors may be done by insulation colour coding identified on drawings or by printed wiring lists. Terminal blocks for connection of external circuits in to factory prewired electronic system cabinets shall meet all the requirements as described elsewhere in the specification. For all multicore cables, the outer sheath shall satisfy the properties identified above. However, for panel wiring, the wiring insulation shall also satisfy the properties identified above. The internal wiring shall be done in coloured wiring.
- n. Following wire size shall be utilized for internal wiring:
- 1) Current (4-20m A) : 0.75 sq.mm
Low voltage signals
(AI/AO & DI Signals)
 - 2) DO signals, Ammeter/
Voltmeter circuit, control
Switches, indicator, recorder : 1.5 sq.mm
 - 3) Internal illumination : 2.5 sq.mm
 - 4) Size of Power supply cables shall be as below :-
 - i. 1 to 16 Amp -2.5 sq.mm
 - ii. 17 to 20 Amp - 4 sq.mm
 - iii. 21 to 32 Amp - 6 sq.mm
 - iv. 33 to 40 Amp -10 sq.mm
 - v. 41 to 60 Amp -16 sq.mm
 - vi. Power earth - 4 sq.mm

15.7.0 Instruments Mounting

Instruments and relays mounted on the panels shall be easily accessible for repair and replacement without disturbing other equipment their connected wiring. No special tools shall be needed for the purpose.

15.8.0 Panel Illumination

Panels shall be provided with LED based illuminating lamps with door switch and six (6) point 6/16A, 240V AC universal type power sockets with switch for maintenance purposes. These switches shall be with quick make and break mechanism.

15.9.0 Fuse Blocks

Where fuse blocks rated 30 amp. 250 Volts are required by the specifications or the manufacturer's design, they shall be modular type with Bakelite frame and reinforced retaining clips. Blocks shall be class H.2 pole, screw terminal fuse blocks. Blocks for other current and voltage ratings shall be similar in construction.

15.10.0 Fuses

All fuses shall be fast acting semiconductor types for AC supply .For all DC Powered devices, similarly the fuses shall be fast acting compatible to DCDB fuse provisions. All the power supplies shall be provided with the protection of Fast acting semi-conductor fuses & MCB. Make of Fuses shall be GE or Siemens only.

15.11.0 Moulded Case Circuit Breakers

Moulded case circuit breakers used in equipment covered under these specifications shall have not less than 5000 amp, Interrupting capacity at 220 Volts DC 10,000 Amp. Symmetrical interrupting capacity at 240 Volts AC. MCCB shall be provided at each main feeder line like ACDB & DCDB main feeders, PLC main feeder, control panels, UPS circuits etc.

15.12.0 Grounding

All panels and cabinets shall be provided with a continuous bare copper ground bus of minimum 6 mm x 25/50 mm cross section. The ground bus shall be bolted to the panel structure and effectively ground the entire structure. Each Ground bus shall have provision at each end for connection of ground leaks (6 mm x 50 mm GI Flats) by suitable bolting. All system cabinets shall be brought to a common system ground by the bidder. Electronic earthing resistance shall be less than 0.5 ohms.

Each circuit requiring grounding shall be individually and directly connected to the panel ground bus by ring tongue type compression lugs. For electronic system cabinets the system ground bus shall be insulated from the cabinet enclosure and shall be separately connected to the system ground. All system cabinets shall be brought to a common system ground by the bidder.

The Bidder shall furnish his recommendations regarding grounding requirements for all equipment/systems and shall specifically indicate the deviations if any from the above requirements as a part of his proposal.

15.13.0 Terminal Blocks

For all inputs to the system emanating from the field or other systems, the bidder shall furnish terminals suitable for correct size of field cables.

All outputs going to MCC/SWGR terminal blocks, shall be rated 1100 volts minimum and shall have strap screw less terminals suitable for connection of wires with ring tongue type lugs. Standard terminal blocks shall be screw less cage clamps type WAGO/Phoneix make. Terminal blocks shall be approximately sized for larger wire size of higher voltage insulated incoming conductors as necessary. All the TBs used shall be 6.6 polyimide to withstand corrosion and the metallic portion shall be coated against rust /corrosion. All metal parts should be non –ferrous in nature.

Terminal blocks shall be provided with white marking strips and re permitted by the safety codes and standards shall be without covers.

Fuses shall not be mounted on terminal blocks. Neither step type terminal blocks nor angle mounting of terminal blocks will be acceptable.

At least 20 per cent spare unused terminals shall be provided on each terminal block for circuit modifications and for termination of all conductors in a multi-conductor control cable with each panel, enclosure, cubicle, SOV Boxes etc.

15.14.0 Name Plates and Labels

Name plates of adequate size shall be provided for each panel on front and rear of the panel. Instruments/other accessories mounted inside the panels shall have identification marking clearly visible from inside.

Devices to be mounted on the panels shall also be labeled on the panels shall also be labeled on the outside of the panel. Name plates shall be of polyamide sheets with black letters on white background. Name plates shall be attached to the boards by means of stainless steel panhead screws. Fuses provided for protection of various boxes shall be accessible for replacement. Fuse boxes shall be provided with circuit label and fuse rated current and voltage.

15.15.0 Markings/Labels

All markers/labels shall be made of halogen & silicon free polyamide material with inflammability class V2 as per UL 94, ensuring scratch proof printing with the use of environment friendly solvent free ink & latest BLUEMARK UV technology so as to comply the WIPE RESISTANCE according to DIN EN 61010-1/VDE 0411-1.

15.16.0 Assembly and Inspection

As soon as the panel's fabrication is over, Owner shall inspect the panels and further work on the panels, namely assembly, wiring and assembly of components shall be carried out only after the inspection.

15.17.0 Flexible Hoses

Flexible hoses shall be ¼ inch SS flexible hose pipe and with Buna-N liner steel wire braid reinforcement complete with ¼ inch brass/SS316 fittings and shall have swivel male pipe threads. Each hose shall be done meter in length.



VFD

VARIABLE FREQUENCY DRIVES

Variable Frequency Drive (VFD)

1.00.00

GENERAL

The Design, manufacture, erection, testing and performance of items and services provided under this specification shall comply with the latest edition including all applicable official amendments and revisions as on date of award of the following standards. In case of conflict between this specification and code (IS Code, standards, etc.) referred herein, the former shall prevail. All work shall be carried out as per the following codes and standards.

2.00.00

CODES AND STANDARDS

HT breaker	IEC:60056
DC reactor	IEC 60289
Transformers	IS:2026, IEC: 60076 IEC 61378
Bushing	IS: 2099, IEC 60137
Adjustable Speed Electrical Power Drive Systems	IEC 61800
Semiconductor converters–General requirements	IEC 60146
IEEE Recommended practices and requirements for harmonic control in electrical power systems	IEEE 519
Degrees of protection provided by enclosures (IP Code)	IEC 60529
Electrostatic immunity test	IEC1000-4-2
Fast transient immunity test	IEC1000-4-4
Surge immunity test	IEC1000-4-5
High-voltage switchgear and controlgear; Pt.102: Alternating current disconnectors and earthing switches	IEC 62271-102
High-voltage switchgear and controlgear; Pt.200: AC metal-enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 KV	IS/IEC: 62271-200
AC electricity meters	IS: 722
Metal oxide surge arrester without gap for AC system	IEC: 60099-4
Terminal blocks for copper conductors	IEC: 60947-7-1
Dry transformer	IS: 11171
Motor	IEC 60034-18-41 &42, IEC60034 / NEMA 30 & 31,
Contactors/Switches/Fuses etc.	IEC:60947, IS: 13947
Harmonics & EM compatibility	IEEE:519/IEC: 61000
VFD	IEC:60034/ IEC: 61800

Equipment complying with other internationally accepted standards will also be considered if they ensure performance and constructional features equivalent or superior to standards listed above. In such a case, the Bidder shall clearly indicate

VARIABLE FREQUENCY DRIVES

the standard(s) adopted, furnish a copy in English of the latest revision amendments and revision in force as on date of opening of bid and shall clearly bring out the salient features for comparison.

3.00.00

OPERATING CONDITIONS

3.01.00

For the purpose of design of equipment/systems, an ambient temperature of 50 deg. Centigrade and also relative humidity of 95% at 40 deg. Celsius shall be considered.

3.02.00

All equipment shall be suitable for rated frequency of 50 Hz with a variation of +3% & -5%, and 10% combined variation of voltage and frequency unless specifically brought out in the specification.

3.03.00

The auxiliary AC voltage supply arrangement shall have 11/6.6/3.3kV and 415V systems (as applicable). It shall be designed to limit voltage variations as given below under worst operating condition:

- 1. 11kV/ 3.3 kV/ 6.6 KV : +/- 6%
- 2. 415V : +/- 10%

Note: The Voltage level mentioned above is the Nominal Voltage available at the input of the VFD System from the MCC/ Switchgear/transformer, based on the system requirement/Availability.

The voltage level for the VFD output to be fed to motor shall be as follows:-

- 1. Upto 400 kW : 415V/690V, Low Voltage, Three Phase AC
- 2. Above 400kW and upto 700 KW : 690V, Low Voltage, Three Phase AC
- 3. Above 700KW : Medium Voltage

From here onwards in the specifications all the VFD Systems consisting of either 415 V or 690 V may be termed as LV VFD while the higher rated VFD System shall be termed as MV VFD. If nothing is mentioned than the Clause is applicable for both the LV and the MV VFD until deliberated otherwise.

4.00.00

SYSTEM DESCRIPTION

Type of drive : 3-Phase Diode / Thyristor / Multi Stage IGBT / IGCT / SGCT/ IEGT

5.00.00

Type of Cooling of VFD : Naturally air cooled/forced air cooled/Liquid cooled

Converter Type : Full wave diode rectifier/active front end type

Inverter Type : Thyristor/IGBT/IGCT/SGCT/IEGT

GENERAL REQUIREMENTS

5.01.00

Medium Voltage VFD: The Variable frequency drive (VFD) system shall be of a modern proven design for similar applications in power plants/industry. The system

VARIABLE FREQUENCY DRIVES

	<p>shall be either Current Source Inverter (CSI) or Voltage Source Inverter (VSI) type with minimum eighteen (18) pulse design.</p>
5.02.00	<p>415 V/690 V LV VFD: The Variable frequency drive (VFD) system shall be of a modern proven design for similar applications in power plants/industry. The system shall be either Current Source Inverter (CSI) or Voltage Source Inverter (VSI) type with minimum Twelve (12) pulse design. For drives less than 100 KW Six (6) pulse can be offered meeting all other requirements.</p>
5.03.00	<p>The system shall be fully digital, PLC/Microprocessor based, energy efficient, and shall provide very high reliability, high power factor, low harmonic distortion and low vibration and wear and noise. It shall be easy to install in minimum time and expense and no special tools shall be required for routine maintenance.</p>
5.04.00	<p>The offered equipment shall be with state of art technology and proven field track record. No prototype equipment shall be offered.</p>
5.05.00	<p>The VFD manufacturer shall ensure the proper coordination of their VFD with the Driven Motor and the supply system. All the Motors which are to be driven by VFDs will be of Inverter duty type. Also these motors shall comply the requirements stipulated in IEC: 60034-18-41 and IEC: 60034-18-42 as applicable. The VFD operation shall have no inherent detrimental impact on the Motors/ cables & supply system.</p>
6.00.00	<p>TECHNICAL AND OPERATIONAL REQUIREMENTS</p>
6.01.00	<p>The system shall be designed to deliver the motor input current and torque for the complete speed torque characteristics of the driven equipment, with worst input supply voltage and frequency variation. The system shall be suitable for the load characteristics and the operational duty of the driven equipment.</p>
6.02.00	<p>The overload capacity of the controller shall be 150% of the rated current of the motor for one minute for constant torque applications and 110% of rated current for one minute for variable torque applications at rated voltage. If the motor load exceeds the limit, the drive shall automatically reduce the frequency and voltage to the motor to guard against overload.</p>
6.03.00	<p>The drive system shall be designed to operate in one or more of the following operating modes as to suit characteristics of the driven equipment or specified by the load:</p> <ol style="list-style-type: none"> a. Variable torque changing as a function of speed. b. Constant torque over a specific speed range. c. Constant power over a specific speed range. d. Any other as specified in data-sheet
6.04.00	<p>VFDs shall comply with the latest edition of IEEE 519 & IEC 61000 for both individual as well as total harmonic voltage and current distortion limits. The Voltage and Current limits shall be applicable at the Point of Common Coupling (PCC), which shall be the MCC/ Switchgear/ from which the VFD system is fed.</p>

VARIABLE FREQUENCY DRIVES

6.05.00	The above compliance shall be verified by the field measurements of harmonics at the PCC with and without VFDs operation.
6.06.00	VFD shall be capable of withstanding the thermal and dynamic stresses and the transient mechanical torque, resulting from short circuit. Any damage resulting from such a short circuit or internal fault shall be limited to the component concerned.
6.07.00	The system shall be suitable to maintain speed variation within range 10-110% or as per the requirement of driven equipment with speed set accuracy of +1% of rated maximum speed and steady state regulation of +0.5% of rated speed as per system requirement.
6.08.00	The VFD System shall maintain a power factor of 0.95 (minimum) (for LV VFD system) and 0.9 (minimum) (for MV VFD system) in the entire operating range.
6.09.00	Maximum allowable audible noise from the VFD system will be 85 dB (A) at a distance of one meter under rated loaded with all cooling fan operating conditions.
6.10.00	All the circuit components shall be suitably protected against over voltages, surges, lightning etc.
6.11.00	The panels shall be designed to provide easy access to hardware, to facilitate replacement of cards in case of any failure.
6.12.00	All the VFDs for particular application shall be of same design so as to ensure 100 % interchangeability of components.
6.13.00	For each programmed warning and fault protection function, the VFD shall display a message in complete English words or Standard English abbreviations. At least 30 time tagged fault messages shall be stored in the drive's fault history.
6.14.00	The VFD cubicles shall be placed in air conditioned environment. However if VFDs of less than 100 kW are designed to operate in non-air condition environment the same shall also be acceptable.
6.15.00	The 3-Phase Thyristor/IGCT/SGCT/ multistage IGBT/IEGT based VFD system shall have minimum number of components to ensure very high reliability. The input side converter shall have 3-Phase Diode/Thyristor bridge configuration modular type and inverter shall be of 3-Phase Thyristor/IGCT/SGCT/multi stage IGBT/IEGT type, using Pulse Width Modulation or better technique for generating near sine wave output to motor.
6.16.00	Fiber optic cable connection shall be provided preferably to ensure high network reliability.
7.00.00	VFD COMPATIBILITY WITH THE MOTOR
7.01.00	MV VFD output current waveform, as measured at the motor, shall be inherently sinusoidal at nominal loads, with a total harmonic current and voltage distortion within acceptable/standard limits. VFD with transformers on output side are not acceptable.

VARIABLE FREQUENCY DRIVES

7.02.00	The system design shall not have any inherent output harmonic resonance in the operating speed range.
7.03.00	VFD shall provide stable operation of motor from high-voltage dv/dt stress, regardless of cable length to motor. The vendor shall clearly state the limitations in the motor cable distance in his proposal. However, due to system requirements & constraints if the cable length becomes critical, filters/ chokes etc. shall be provided by the VFD manufacturers as an integral part of the VFD to mitigate the reflected wave effect of harmonics.
8.00.00	BYPASS ARRANGEMENT (OPTIONAL, IF SPECIFIED)
8.01.00	The VFD System shall have an optional feature to run the motor under bypass arrangement for operation of Motor with VFD bypassed. During starting (under rated conditions) the motor will be switched on in VFD Mode to limit the starting current and after gaining speed, the load would be switched over to bypass mode.
8.02.00	Comprehensive motor protection scheme for protection and control for operation VFD during bypass mode shall be finalized during detailed engineering.
9.00.00	STANDBY VFD ARRANGEMENT (OPTIONAL, IF SPECIFIED)
9.01.00	A Common standby arrangement with auto/manual switchover shall be provided in case of failure of any VFD in a group of drives. Complete protection, interlocks & control required shall be provided in the changeover module.
10.00.00	EFFICIENCY
10.01.00	Efficiency (Drive only) shall be minimum 98% for both MV VFD and LV VFD. Overall efficiency shall be minimum 96.5% for LV VFD and minimum 94 % for MV VFD at rated load and speed. Overall Efficiency evaluation shall include input transformer, harmonic filters and power factor correction (if applicable), VFD converters, cooling fans and output filter, as applicable in the system. Auxiliary controls, such as internal VFD control boards, cooling fans/pumps.
10.02.00	In absence of valid test report, a factory test shall be performed at the VFD manufacturer's facility verifying the efficiencies. Manufactures who are supplying Drive and transformer from different locations, efficiency test will be conducted separately for Drive and transformer.
11.00.00	COOLING SYSTEM
11.01.00	The VFD shall be designed to operate indoor under temperature range of 0 deg C to 50 deg C and relative humidity of 95 %(at 40 deg C).
11.02.00	VFD manufacturer to primarily offer Air cooled Design. However in case of large ratings, liquid cooled drives may be accepted subject to employer's approval. In case of liquid cooled system, there shall be no necessity of continuous water supply system (Closed Loop System).
11.03.00	In case of Air cooled design, the VFD Cooling system shall be such that it puts minimum heat load inside the room and preferably throw the hot air outside the room with ventilation ducts. The Cooling system shall be designed in such a way that the Air Conditioning & Ventilation Air requirements are kept to minimum. The VFD

VARIABLE FREQUENCY DRIVES

	Manufacturer shall furnish the data regarding heat load, air flow requirements during the detailed engineering.	
11.04.00	Air cooled VFDs shall be provided with cooling fans mounted integral to the VFD/ enclosure. The VFD shall include air-flow pressure switches and temperature detectors to monitor proper operation of the air cooling system. If the fan fails, the system must generate the alarm/trip for the fan failure.	
12.00.00	TRANSFORMER:	
12.01.00	Type: Outdoor Mineral oil filled ONAN type or Indoor natural air-cooled Dry type, Three phase unit, rectifier/converter duty type transformer.	
12.02.00	All other components, technical parameters shall be as per applicable IEC/IS.	
12.03.00	Enclosure for Dry Type Transformer (as applicable)	
	Enclosure shall be of a tested quality sheet steel of minimum thickness 2 mm & shall also accommodate cable terminations. The housing door shall be interlocked such that it should be possible to open the door only when transformer is off. The enclosure shall be provided with lifting lugs and other hardware for floor mounting.	
12.04.00	Core	Shall be High grade non-ageing cold rolled grain oriented silicon steel Laminations.
12.05.00	Winding conductor	Shall be electrolytic grade copper. Windings shall be of class F insulation.
12.06.00	Winding temperature Indicator (WTI)	Shall be Platinum resistance type temperature detector in each limb.
12.07.00	Thermistors	Shall be embedded in each limb with alarm and trip contacts for remote annunciation.
12.08.00	Temperature rise:	Winding temperature rise shall be as per applicable IEC.
13.00.00	POWER CONVERTER:	
13.01.00	The static power converter shall consist of a line side converter for operation as a rectifier and a load side power converter for operation as a fully controller inverter. Power converter shall be fast switching, most efficient and low loss type.	
13.02.00	The converter shall be coordinated with the transformers. The converter shall be able to withstand a three phase short circuit current until interrupted by normal breaker operation.	
13.03.00	Adequate short circuit and over voltage protection shall be provided for the converter and inverter system.	
13.04.00	All power converter devices shall include protective devices, snubber networks and dv/dt networks as required.	
13.05.00	The current rating of the converter's semi-conductor components shall not be less than 120% of the nominal current flowing through the elements at full load of the VFD	

VARIABLE FREQUENCY DRIVES

	through the whole speed range. If the parallel connection of semiconductor is applied, the above current rating shall not be less than 140% of the above values.
13.06.00	All power diodes shall be of silicon type with minimum VBO rating at 2.5 times the rated operating voltage.
13.07.00	The power converter circuit shall be designed so that motor can be powered at its full nameplate rating continuously without exceeding its rated temperature rise nor reducing its service factor due to harmonic currents generated by the inverter operation. The conversion devices and associated heat sinks shall be assembled such that individual devices can be replaced without requiring the use of any special precautions / tools.
13.08.00	The cooling system of the electronic components, if provided, shall be monitored and necessary alarms shall be provided to prevent any consequential damage to the power control devices.
14.00.00	OUTPUT FILTER (AS APPLICABLE):
14.01.00	Output/ dv/dt filter shall be provided, if required. It shall be an integral part of the VFD system and included within the VFD enclosure. It shall inherently protect motor from high voltage dv/dt stress.
15.00.00	DC LINK CAPACITOR (AS APPLICABLE):
15.01.00	Capacitor shall be of self-healing film or electrolytic type having high life time. The capacitor shall be an integral part of VFD system. DC link Capacitors shall have discharge resistors which shall be capable of reducing the residual charges to zero just after the capacitor is disconnected from the supply source. The capacitor shall be suitable for high ripple currents.
16.00.00	AC/DC Reactor (As applicable)
	<ol style="list-style-type: none"> 1) Type: Dry type, air cored, self cooled, indoor type. Suitable for withstanding earth fault continuously. 2) Insulation: Thermal Class 155(F), temperature rise is limited to thermal class 130 (B). 3) Noise level shall not exceed value specified in NEMA TR-1.
17.00.00	VFD PANEL REQUIREMENTS
17.01.00	Enclosure frames and load bearing members shall be fabricated using suitable mild steel structural sections or pressed and shaped cold-rolled sheet steel of thickness 2.0 mm. Frames shall be enclosed in cold-rolled sheet steel of thickness 1.6 mm. Doors and covers shall also be of cold rolled sheet steel of thickness 1.6 mm. Stiffeners shall be provided wherever necessary. The gland plate thickness shall be 3.0 mm for hot / cold-rolled sheet steel and 4.0 mm for non-magnetic material. In case dry type transformer is provided inside VFD panels, the enclosure and in its frame thickness shall be same as indicated in this para.
17.02.00	The cable entry shall be from the bottom of the panel and a removable bolted un-drilled gland plate.
17.03.00	All Panels shall be of dust-proof and vermin-proof construction and shall be provided with a degree of protection of IP: 3X or better for MV VFD and IP: 4X or better for LV VFD as per IS/IEC 60947

VARIABLE FREQUENCY DRIVES

17.04.00	Enclosures must be designed to avoid harmonic and inductive heating effects and to shield any outside equipment from interference, enclosing and shielding the complete to eliminate any radio frequency interference. The construction of the panel shall provide effective protection against electromagnetic emissions.
17.05.00	Each panel shall be provided with illuminating lamp, space heater with switch fuse and variable setting thermostat.
17.06.00	Proper ventilation using air filters and fans/pumps shall be provided in the panels to ensure that maximum temperature inside the cubicle is within permissible limits for reliable and continuous operation of the system.
18.00.00	<p>PAINTING</p> <p>Paint shade shall be as follows</p> <ul style="list-style-type: none"> a) VFD transformer : RAL 5012 (Blue), legend in black letter reactor enclosure b) Motors : RAL 5012 (Blue) c) VFD Panels : Front and rear panels in Grey (RAL9002). End panel sides in blue (RAL 5012)
19.00.00	HT SWITCHGEAR
19.01.00	The technical requirements of HT switchgear shall be as per chapter of HT switchgear in Part-B of Technical specifications.
20.00.00	MOTORS
20.01.00	VFD shall be used to drive three (3) phase squirrel cage inverter duty Induction motor with VPI insulation (Resin poor) suitable for VFD application. These motors shall be provided with insulated bearing on at least one side.
20.02.00	Motors shall also meet the requirements mentioned in subsection for motors and relevant IS/IEC.
20.03.00	Motor shall be suitable for operation with a solid state power supply consisting of an adjustable frequency inverter for speed control & shall be suitable for the current waveforms produced by the power supply including the harmonics generated by the drive.
20.04.00	Motor insulation shall be designed to accept the applied voltage waveform, within the Vpeak and dv/dt limits as per IEC-61800.
20.05.00	Drive manufacturer shall coordinate with the motor manufacturer for proper selection of the motor for the given load application and the output characteristics of the drive.
20.06.00	Other requirements of motor shall be as stipulated in technical chapter of Motors in Part-B of technical specifications.
21.00.00	LT & HT CABLES
21.01.00	Contractor's scope shall also include LT and HT cables suitable for VFD system and Motors.
22.00.00	CONTROL AND PERFORMANCE REQUIREMENTS

VARIABLE FREQUENCY DRIVES

22.01.00	The VFD to provide an automatic current limiting feature to control motor currents during startup and provide a "soft start" torque profile for the motor load combination. Current and torque limit adjustments shall be provided to limit the maximum VFD output current and the maximum torque produced by the motor.
22.02.00	It shall be possible to vary the speed of the drive and control it in either Local or Remote mode. Local / Remote selection shall be done from VFD panel unless otherwise specified.
22.03.00	<p>Provision shall be kept for exchange of information between different VFD control system parameters thru PLC/DDCMIS.</p> <p>Man machine interface for (MV) VFD shall have one flat TFT monitor with keyboard (password protected) in the VFD room and a color laser printer for system alarm and monitoring located in control room.</p> <p>Parameter Monitoring:</p> <ul style="list-style-type: none"> - Input and output voltage of Drive - Input and output current of Drive - Motor speed - Input and output power frequency of Drive - Torque - Input and Output power of Drive system (covering transformer if applicable) - Output kWhr of Drive - Transformer (if applicable) temperature for alarm & trip. - Ambient temperature - Run/stop and local/remote status displayed
22.04.00	Drive shall be equipped with a front mounted operator console panel consisting of a backlit alphanumeric display and a keypad with keys for parameterization and adjusting parameter. Control panel shall be operable with password for changing the protection setting, safety interlock etc.
22.05.00	Operator console/Main Control Card shall have facility / port to connect external hardware such as Lap-Top etc. Console shall have facility for upload and download of all parameter settings from one drive to another drive for start up and operation.
22.06.00	User-friendly licensed software for operation and fault diagnostic shall be loaded in the drive system panel before commissioning.
23.00.00	PROTECTION FEATURES
23.01.00	<p>The system offered shall incorporate adequate protection features as per IEC 61800-4: 2002 Table-8, properly coordinated for the drive control and for motor including following:</p> <ul style="list-style-type: none"> i) Converter transformer: short circuit, over current, earth fault & winding temperature high protection. ii) Incoming and outgoing line surge protection. iii) Under / over voltage protection iv) Phase loss, phase reversal, overload, negative phase sequence, locked rotor protection.

VARIABLE FREQUENCY DRIVES

	<ul style="list-style-type: none"> v) Instantaneous Over current & Earth fault protection vi) Converter/Inverter module failure indication. vii) Over frequency/speed protection. viii) Ventilation failure indication & alarm. ix) Over temperature of VFD x) Bearing temperature protection. xi) System earth fault protection. xii) Speed reference loss protection.
23.02.00	Under VFD Bypass Mode (if applicable) all the electrical protections related to the Motor shall remain applicable.
24.00.00	CONTROL FEATURES
24.01.00	<p>Following controls shall be provided as a part of the Operator Control Panel or through separate switches on the front panel door.</p> <ul style="list-style-type: none"> i) Start / stop (in local/remote mode) ii) Speed control (Raise / lower) iii) Acknowledge/Accept/ Test Push Button for annunciation iv) Auto / Manual / Test Mode select v) Emergency stop vi) Trip-Remote Breaker
25.00.00	DIAGNOSTIC FEATURES
25.01.00	The VFD shall include a microprocessor/PLC based digital diagnostic system which monitors its own control functions and displays faults and operating conditions.
25.02.00	Fault diagnostic shall be built into the system to supervise the operation and failure of the system. The information regarding failure of any of the system including shut down of the system shall be available. It shall be possible to retrieve the record of events prior to tripping of the system or de-energization. Auxiliary supply to the system components or to the electronics (firmware) for the diagnostics / display shall be taken care of by the manufacturer for this purpose.
26.00.00	SERVICEABILITY / MAINTAINABILITY
26.01.00	Power Component Accessibility: All power components in the converter sections shall be designed for rack-out accessibility for ease of maintenance and to minimize repair downtime.

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VARIABLE FREQUENCY DRIVES

- i. As per requirements mentioned in subsection for Transformer chapter in technical specifications.



**C&I SPECIFICATION FOR
GYPSUM DEWATERING SYSTEM**

SECTION: C
SUB SECTION: C&I

**TYPE TEST REQUIREMENT
FOR C&I SYSTEMS**

16.3.6 Type Test Requirement For C&I Systems

SI No	Item	Test requirement	Standard	Test to be specifically conducted	Owner's approval req. On test certificate	Remarks
Col1	Col2	Col3	Col4	Col5	Col6	Col7
1	Elect. Metering instruments	As per standard (col 4)	IS-1248	No	Yes	
2	Electronic transmitter	As per standard (col 4)	BS-6447/ IEC60770	No	Yes	
3	Instrumentation Cables Twisted & Shielded	No	Yes			
4	Pressure gauge	Degree of protection test	IS-2147	No	No	
		Temp interference test	IS -3624	No	No	
5	Temperature gauge	Degree of protection test	IS-2147	No	No	



SI No	Item	Test requirement	Standard	Test to be specifically conducted	Owner's approval req. On test certificate	Remarks
6	Degree of protection test	Degree of protection test	IS-2147	No	No	
		As per standard (col 4)	BS 6134	No	No	
7	Level switch	Degree of protection test	IS-2147	No	No	
8	Control valves	CV Test	ISA 75.02	No	Yes	
9	Flow Nozzles & Orifice plate	Calibration	ASME PTC, BS 1042	No	Yes	
10	PLCs	All tests as per IEC-1131	IEC-601131	No	Yes	
11	Junction Box	Degree of Protection test	IS-13947	No	Yes	
12	Battery charger (Not required for inbuilt chargers)	Degree of Protection test		No	No	
		Short circuit current capability	IEC-60146-2	No	Yes	
		Temp rise test without redundant fans	Approved procedure, IEC 60146-2	No	Yes	
		SWC test	Approved procedure	No	Yes	
		Burn-in-test	Approved procedure	No	Yes	
		Efficiency	IEC-60146-2	No	Yes	
		Audible Noise test	IEC-60146-2	No	Yes	
		Fuse Clearing capability	Approved Procedure	No	Yes	
		Relative harmonic content	Approved Procedure	No	Yes	
		ESD immunity test	IEC-61000-2-9(1)	No	Yes	
		Radio interference	IEC-60146-2	No	Yes	
		Over load test on Inverter & charger	Approved procedure	No	Yes	
		Restart test	IEC 60146-2	No	Yes	
		Output voltage Harmonic content	Approved procedure	No	Yes	



SI No	Item	Test requirement	Standard	Test to be specifically conducted	Owner's approval req. On test certificate	Remarks
		Insulation test	IEC 60146	No	Yes	
		Load tests	Approved procedure	No	Yes	
		Preliminary light load test	IEC-60146	No	Yes	
		Current division / Voltage division	IEC-60146-2	No	Yes	
13	Battery	As per standard (Col.4)	IEC-623 / IS 10918 for Ni-Cd, IS-1652 for Plante Lead Acid	No	Yes	
14	Voltage	Over Load test	Approved procedure	No	Yes	



2.10.4 VFD Panel

Attributes Characteristics														
	Electrical Properties	Mechanical Properties	Chemical properties	Dimension/ Finish	Type/ Rating/ Functional Check	HV/ IR	Routine Test as per relevant Standard	Constructional Features	IS : 6005, Seven tank process	Paint finish/ Shade/ Thickness	Mounting/ BOM/ Make, Completeness	Interlock functional & operation testing/ Simulation check	Degree of Protection Test	Final testing as per relevant standard
Item/ Components/ Sub-system/ Assembly														
Sheet Steel (IS-513)		Y	Y	Y										
Aluminum / Copper Busbar (IS-5082/IS-613/IS-1987)	Y	Y	Y	Y										
Support Insulator (BS-2782/IEC-660/IS-10912)	Y	Y	Y	Y										
Control / Selector Switch (IS6875)					Y	Y	Y							
Contactors/ MCB (IS-13947)					Y	Y	Y							
O/L Protection relays (IS-3231)					Y		Y							
C.T /V.T/ Indicating Meter (IS2705/3156/1248)					Y	Y	Y							
Fuse/ Fuse carrier (IS-13703)					Y	Y	Y							
Terminals/lugs/PVC wires (IS13947//IS-694)	Y			Y	Y	Y	Y							
Timers (IS-3231)					Y	Y	Y							
Push Button/ Lamp/ (IS-6875)					Y	Y	Y							
Control Transformer (IS12021)					Y	Y	Y							
Mimic, Annunciator					Y		Y							
GASKET (IS-11149)		Y	Y	Y	Y		Y							
Fabrication								Y						
Pretreatment & Painting									Y	Y				
VFD panel										Y	Y	Y	Y	Y

NOTE:

1. This is an indicative list of Test/ Checks. The manufacturer to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents.
2. All major Bought-out items will be subject to Purchaser's approval.

	FGD FOR NORTH CHENNAI TPP STAGE-III (1 X 800 MW)	
	TECHNICAL SPECIFICATION (C&I) FOR GYPSUM DEWATERING EQUIPMENT	

ELECTRICAL ACTUATORS



SECTION-3.2 : 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

Electric actuators shall be provided where specified/required. It shall be equipped with 3 phase, 415V, 50Hz induction motor, rated for intermittent duty S4-25%.

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.

The operating speed shall be such as to give valve closing and opening at approximately 4 to 5 mm per sec. The actuator shall be sized to guarantee valve closure at the specified differential pressure.

Motor shall be surface cooled designed for enclosure protection class of IP 68. Motor shall be suitable for starting direct on line.

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

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

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)

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.

Actuators shall be of totally enclosed weather proof and dust proof construction with NEMA-6/IP 68 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.



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.

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.

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.

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.

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

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.

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.

Actuators shall be supplied with integral starter which shall have sophisticated electronic controls with field programming feature.

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.

The Remote command signal (OPEN-STOP-CLOSE) from DCS/PLC/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

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

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)

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.

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

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


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, thermos switch trip and thermal overload relay trip
- Actuator in inching mode
- Actuator power switched off/ single phase

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 IS:325, IS:4722, IS:9283 and other applicable standards.


Tests shall be performed in presence of Owner's representatives. Successful Bidder shall give atleast fifteen (15) days advance notice for witnessing the tests. Copies of certified reports of all tests carried out at the works shall be furnished. The equipment shall be dispatched from works, only after receipt of Owner's written approval of the test reports.

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GENERAL *	* PROJECT		
	OFFER REFERENCE		
	* TAG NO. SERVICE		
	* DUTY	<input type="checkbox"/> ON / OFF ** <input type="checkbox"/> INCHING	
	* LINE SIZE (inlet/outlet): MATERIAL		
	* VALVE TYPE	<input type="checkbox"/> GLOBE <input type="checkbox"/> GATE <input type="checkbox"/> REG. GLOBE <input type="checkbox"/> BUTTERFLY	
	* OPENING / CLOSING TIME		
	* WORKING PRESSURE		
	AMBIENT CONDITION	SHALL BE SUITABLE FOR CONTINUOUS OPERATION UNDER AN AMBIENT TEMP. OF 0-55 DEG C AND RELATIVE HUMIDITY OF 0-95%	
	VALVE SEAT TEST PRESS	BIDDER TO SPECIFY	
	REQUIRED VALVE TORQUE	BIDDER TO SPECIFY	
	ACTUATOR RATED TORQUE	BIDDER TO SPECIFY	
CONSTRUCTION AND SIZING	CONSTRUCTION	TOTALLY ENCLOSED, WEATHER PROOF, IP:68	
	MECHANICAL POSITION INDICATOR	TO BE PROVIDED FOR 0-100% TRAVEL	
	BEARINGS	DOUBLE SHIELDED, GREASE LUBRICATED ANTI-FRICTION.	
	GEAR TRAIN FOR LIMIT SWITCH/TORQUE SWITCH OPERATION	METAL (NOT FIBRE GEARS). SELF-LOCKING TO PREVENT DRIFT UNDER TORQUE SWITCH SPRING PRESSURE WHEN MOTOR IS DE-ENERGIZED.	
	SIZING	OPEN/CLOSE AT RATED SPEED AGAINST DESIGNED DIFFERENTIAL PRESSURE AT 85% OF RATED VOLTAGE. FOR ISOLATING SERVICE THREE SUCCESSIVE OPEN-CLOSE OPERATIONS OR 15 MINS. WHICHEVER IS HIGHER. FOR INCHING SERVICE - 150 STARTS/HR MINIMUM & FOR REGULATING SERVICE - 600 STARTS/HR MINIMUM.	
HANDWHEEL as per standard EN 12570:2000	* REQUIRED	<input checked="" type="checkbox"/> YES <input type="checkbox"/> NO	
	* ORIENTATION	<input type="checkbox"/> TOP MOUNTED <input type="checkbox"/> SIDE MOUNTED	
	*TO DISENGAGE AUTOMATICALLY DURING MOTOR OPERATION.		
ELECTRIC ACTUATOR	ACTUATOR MAKE/MODEL	BIDDER TO SPECIFY	
	MOTOR MAKE / MODEL / TYPE / RATING (KW) (REFER NOTE NO. 6 & 7)	BIDDER TO SPECIFY	
	@ MOTOR TYPE	SQUIRREL CAGE INDUCTION MOTOR, STARTING CURRENT LIMITED TO SIX TIMES THE RATED CURRENT-INCLUSIVE OF I.S. TOLERANCE	
	ACTUATOR APPLICABLE WIRING DIAGRAM	<input checked="" type="checkbox"/> ENCLOSED (BIDDER TO CONFIRM) A: <input type="checkbox"/> DRG. NO. 3-V-MISC-24227 R00 B: <input type="checkbox"/> DRG. NO. 3-V-MISC-24550 R00 C: <input type="checkbox"/> DRG. NO. 3-V-MISC-24283 R00 D: <input type="checkbox"/> DRG. NO. 4-V-MISC-90271 R11 E: <input type="checkbox"/> For Thyristor based Integral starter, Bidder/Vendor to furnish wiring diagram	
	COLOUR SHADE	<input type="checkbox"/> BLUE (RAL 5012) <input type="checkbox"/>	
	PAINT TYPE (## Refer Notes)	<input type="checkbox"/> ENAMEL <input type="checkbox"/> EPOXY CONFIRMING TO CORROSION CATEGORY C5-I	
	SHAFT RPM	BIDDER TO SPECIFY	
	OLR SET VALUE	BIDDER TO SPECIFY	
	@ STARTING / FULL LOAD CURRENT	BIDDER TO SPECIFY	
	NO. OF REV FOR FULL TRAVEL	BIDDER TO SPECIFY	
	@ PWR SUPP TO MTR / STARTER	415V, 3PH, AC	

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	@ CONTROL VOLTAGE REQUIREMENT	TO BE DERIVED FROM THE POWER SUPPLY TO THE STARTER <input type="checkbox"/> 230 V <input type="checkbox"/> 110 V	
	@ ENCLOSURE CLASS OF MOTOR	<input type="checkbox"/> IP 67 <input type="checkbox"/> IP 68 <input type="checkbox"/> FLAME PROOF	
	@ INSULATION CLASS	CLASS-F TEMP. RISE LIMITED TO CLASS-B	
	@ WINDING TEMP PROTECTION	<input checked="" type="checkbox"/> THERMOSTAT (3 Nos.,1 IN EACH PHASE) <input type="checkbox"/> -----	
	SINGLE PHASE / WRONG PHASE SEQUENCE PROTECTION	REQUIRED (THERMISTOR PTC)	
INTEGRAL STARTER	INTEGRAL STARTER	<input type="checkbox"/> REQUIRED <input type="checkbox"/> NOT REQUIRED	
	TYPE OF SWITCHING DEVICE	<input type="checkbox"/> CONTACTORS <input type="checkbox"/> THYRISTORS	
	TYPE	<input type="checkbox"/> CONVENTIONAL <input type="checkbox"/> SMART (NON-INTRUSIVE)	
	IF SMART (REFER BELOW POINT a – h)		
	a) SERIAL LINK INTERFACE	<input type="checkbox"/> INTEGRAL <input type="checkbox"/> FIELD MOUNTED	
	b) SERIAL LINK PROTOCOL	<input type="checkbox"/> FOUNDATION FIELD-BUS <input type="checkbox"/> PROFI-BUS <input type="checkbox"/> DEVICE NET <input type="checkbox"/>	
	c) SERIAL LINK MEDIA	<input type="checkbox"/> TWISTED PAIR Cu-CBL <input type="checkbox"/> CO-AXIAL Cu-CBL <input type="checkbox"/> OFC	
	d) HAND HELD PROGRAMMER	<input type="checkbox"/> REQUIRED <input type="checkbox"/> NOT REQUIRED	
	e) TYPE OF HAND HELD PROGRAMMER	<input type="checkbox"/> BLUETOOTH <input type="checkbox"/> INFRARED <input type="checkbox"/>	
	f) MASTER STATION	<input type="checkbox"/> REQUIRED <input type="checkbox"/> NOT REQUIRED	
	g) MASTER STN INTRFACE WITH DCS	<input type="checkbox"/> MODBUS <input type="checkbox"/> TCP/IP	
	h) DETAILS OF SPECIAL CABLE	<input type="checkbox"/> ENCLOSED <input type="checkbox"/> NOT REQUIRED	
	STEP DOWN CONT. TRANSFORMER	<input type="checkbox"/> REQUIRED	
	OPEN / CLOSE PB	<input type="checkbox"/> REQUIRED <input type="checkbox"/> NOT REQUIRED	
	STOP PB	<input type="checkbox"/> REQUIRED <input type="checkbox"/> NOT REQUIRED	
	INDICATING LAMPS	<input type="checkbox"/> REQUIRED <input type="checkbox"/> NOT REQUIRED	
	LOCAL REMOTE S/S	<input type="checkbox"/> REQUIRED <input type="checkbox"/> NOT REQUIRED	
	STATUS CONTACTS FOR MONITORING	<input type="checkbox"/> REQUIRED <input type="checkbox"/> NOT REQUIRED	
	INTEGRAL STARTER DISTURBED SIGNAL(Refer Note 14)	REQUIRED (O/L RELAY OPERATED, CONT./POWER SUPPLY FAILED, S/S IN LOCAL, TORQUE SWITCH OPTD. MID WAY,)	
	ACTION ON LOSS OF EXTERNAL ELECTRIC POWER	<input type="checkbox"/> STAYPUT <input type="checkbox"/> FAIL SAFE	
INTERPOSING RELAY/OPTO COUPLER (Applicable for integral Starter) DATASHEET & WIRING DIAGRAM OF ISOLATION DEVICE TO BE PROVIDED	TYPE OF ISOLATING DEVICE	<input type="checkbox"/> INTERPOSING RELAY <input type="checkbox"/> OPTO COUPLER TO BE DECIDED DURING DETAILED ENGINEERING	
	QUANTITY	<input type="checkbox"/> 2 NOs. <input type="checkbox"/> 3 NOs.	
	DRIVING VOLTAGE	<input checked="" type="checkbox"/> 20.5 – 24V DC <input type="checkbox"/> _____ V DC	
	DRIVING CURRENT	<input checked="" type="checkbox"/> 125mA MAX <input type="checkbox"/> _____ mA MAX	
	LOAD RESISTANCE	<input checked="" type="checkbox"/> > 192 ohms - <25 k ohms <input type="checkbox"/> > _____ ohms - < _____ ohms	
TORQUE SWITCH (Not Applicable for Smart Actuator) (\$\$ Refer Notes)	MFR & MODEL NO.	BIDDER TO SPECIFY	
	OPEN / CLOSE	<input checked="" type="checkbox"/> 1 No. <input type="checkbox"/> 2Nos. / <input checked="" type="checkbox"/> 1 No. <input type="checkbox"/> 2Nos	
	CONTACT TYPE	2 NO + 2 NC	
	RATING	5A 240V AC AND 0.5A 220V DC	
	CALIBRATED KNOBS(OPEN&CLOSE TS)	REQUIRED FOR SETTING DESIRED TORQUE	
	ACCURACY	+3% OF SET VALUE	

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LIMIT SWITCH (Not Applicable for Smart Actuator) (\$\$ Refer Notes)	MFR & MODEL NO.	BIDDER TO SPECIFY		
	OPEN : INT : CLOSE	<input type="checkbox"/> 1 No <input checked="" type="checkbox"/> 2 Nos.	2 Nos. (ADJ.)	<input type="checkbox"/> 1 No. <input checked="" type="checkbox"/> 2Nos.
	CONTACT TYPE	2 NO + 2 NC		
	RATING (AC / DC)	5A 240V AC AND 0.5A 220V DC		
	ACCURACY	2% OF SET VALUE		

POSITION TRANSMITTER	POSITION TRANSMITTER (For inching duty & other specific applications)	<input type="checkbox"/> REQUIRED <input type="checkbox"/> NOT REQUIRED
	MFR & MODEL NO.	BIDDER TO SPECIFY
	TYPE	<input type="checkbox"/> ELECTRONIC (2 WIRE) R/I CONVERTER <input type="checkbox"/> ELECTRONIC (2 WIRE) CONTACTLESS
	SUPPLY	<input checked="" type="checkbox"/> 24V DC <input type="checkbox"/>
	OUTPUT	<input checked="" type="checkbox"/> 4-20mA
	ACCURACY	± 1% FS
SPACE HEATER	@SPACE HEATER	REQUIRED
	@ POWER SUPPLY (NON INTEGRAL)	230V AC,1 PH.,50 Hz
	@ POWER SUPPLY (INTEGRAL)	BIDDER TO SPECIFY
	@ RATING	
TERMINAL BOX	ACTUATOR/MOTOR TERMINAL BOX	REQUIRED
	ENCL CLASS ACTUATOR/MOTOR T.B.	@ <input type="checkbox"/> IP 68 @ <input type="checkbox"/>
	@ EARTHING TERMINAL	REQUIRED
	PLUG & SOCKET	<input type="checkbox"/> REQUIRED <input type="checkbox"/> NOT REQUIRED
	NO. OF PINS REQUIRED(TO BE CHECKED AS PER SIGNALS IN DRIVE CONTROL PHILOSOPHY)	
	NOS. OF PLUG & SOCKET	<input type="checkbox"/> 1 Nos. for ON/OFF <input type="checkbox"/> 2 NOS.(for inching duty) <input type="checkbox"/> OTHER (TO BE SPECIFIED INLINE WITH DRIVE CONTROL PHILOSOPHY)
CABLE GLANDS	@ POWER CABLE GLAND	SIZE:-----
	@ SPACE HEATER CABLE GLAND	SIZE:-----
	CONTROL CABLE GLANDS-1	QUANTITY & SIZE :-----
	CONTROL CABLE GLANDS-2	QUANTITY & SIZE :-----
WEIGHT	TOTAL WEIGHT (ACTUATOR + ACCESSORIES)	BIDDER TO SPECIFY _____ Kg.

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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, IS-4722, IEC 60947-5-1 AND EN 15714-3 :2010 OR LATEST VERSION.
 - 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 BE SUITABLE FOR DIRECT ON LINE STARTING.
 - 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%. **(FOR NTPC PROJECTS)**

THE MOTOR SHALL BE CAPABLE OF STARTING AT 85 PERCENT OF RATED VOLTAGE RUNNING AT 80 PERCENT OF RATED VOLTAGE AT RATED TORQUE AND 85 PERCENT RATED VOLTAGE AT 33 PERCENT EXCESS RATED TORQUE FOR A PERIOD OF 5 MINUTES EACH. **(FOR NON NTPC PROJECTS)**
 - IN ADDITION TO ABOVE REQUIREMENTS FOR LIMIT/TORQUE SWITCH, **MECHANICAL END STOP** WITH ACCURACY OF 2% SHALL BE SUPPLIED.
 - IT SHOULD BE POSSIBLE TO OPERATE THE ACTUATOR LOCALLY. LOCKABLE LOCAL/REMOTE SELECTION SHALL BE PROVIDED ON THE ACTUATOR.
 - LOCAL POSITION INDICATOR SHALL BE PROVIDED FOR 0 TO 100 % TRAVEL.
 - CONTROL WIRING SHALL BE SUITABLE VOLTAGE GRADE COPPER WIRE 1.5 SQ. MM.
 - ENDURANCE: RATED TORQUE RANGE SHOULD BE BASED ON ISO 5211, ISO5210.
 - TAG PLATE SHALL BE CONFIRMING TO STANDARD BS-15714.
 - INTEGRAL STARTER/ACTUATOR DISTURBED SIGNAL SHALL BE CHECKED AND INCLUDE AS PER DRIVE CONTROL PHILOSOPHY.
 - ** VALVES WITH 10 DEGREE/20DEGREE FEEDBACK REQUIREMENT FOR APPLICATIONS SUCH AS CW/ACW/PLANT WATER SYSTEM ETC SHALL BE CONSIDERED AS INCHING DUTY VALVES. ACCORDINGLY, POSITION FEED BACK TRANSMITTER, PLUG & SOCKET REQUIREMENT SHALL BE CONSIDERED.**
- \$\$ TORQUE SWITCH & LIMIT SWITCH SHALL ACT INDEPENDENT OF EACH OTHER. TANDEM OPERATION IS NOT ACCEPTABLE.**
- ## EPOXY PAINT IS RECOMMENDED FOR COASTAL AREAS.**

NAME SIGNATURE DATE	PREPARED BY	CHECKED BY	APPROVED BY	VENDOR COMPANY SEAL
	MADHAV GUPTA	VIPUL KUMAR VERMA	SHIVRAJ SINGH BANSALA	NAME
				SIGNATURE
	15.05.2019	15.05.2019	15.05.2019	DATE

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

@ BE FILLED BY ES



**C&I SPECIFICATION FOR
GYPSUM DEWATERING EQUIPMENT**

SECTION: C
SUB SECTION: C&I

MANDATORY SPARES

983291/2022/PS-PEM-MAX

MANDATORY SPARES - CONTROL AND INSTRUMENTATION

1.00.00	DESCRIPTION	QUANTITY
1.01.00	MEASURING INSTRUMENTS	
1.01.01	1.1 All type of Transmitters including sensors.	10% or 1 no. of each type and model whichever is more.
1.01.02	1. Temperature elements	
	1.1 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
	1.2 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
	1.3 Cold junction compensation boxes of each model (if applicable)	10% or 2 nos. whichever is more
	1.4 Thermostatic units for each model of CJC box (if applicable)	10% or 2 nos. whichever is more
	1.5 Temperature transmitters	10% of each type and length
1.01.03	1.1 Limit switches for isolation valves	2 nos. of each type
	1.2 Local Indicators like temperature gauges, pressure gauges, differential pressure gauges, flow gauges, flow meters etc.,	5% or 1 no. of each make, model and type whichever is more (to be divided to various ranges in proportion to main of all make, model, type population)
	1.3 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
1.01.04	Any other instrument (Flow transmitter, Density meter) (as applicable)	10% or 1 no. of each type and model whichever is more
1.02.00	CEMS (SOx, NOx, CO, CO2, Mercury, Stack opacity, flue gas flow):-	
(a)	Analyzer for SOx, NOx, CO2, CO.	1 no complete instrument of each type and model.
(b)	Flue gas flow measurement	1 no. complete instrument along with sender/receiver unit
(c)	Stack Opacity measurement	1 no. complete instrument along with sender/receiver unit
(d)	Electronic card assembly/ PCBs, moisture/condensate monitor, power supply modules	10% of each type, model and rating
(e)	Set of gaskets/O-rings/ seals	200% of each type, model, rating and size
(f)	Temp. Sensor	20% of each type and model
(g)	Heater assembly, Cooler assembly	20% of each type and model
(h)	Complete Probe with shield assembly (Not applicable for In situ- path)	1 no. of each type and model
(i)	Solenoids	2 nos. of each type, model and rating

983291/2022/PS-PEM-MAX

MANDATORY SPARES - CONTROL AND INSTRUMENTATION

1.00.00	DESCRIPTION	QUANTITY
U)	Filters, light source, sensor, detector, etc.	200% of each type, model and rating
(k)	Calibration gases, Calibration cell and other consumables for calibration: - of all types and ranges.	One year supply
(l)	Heavy duty blower assembly	1 no. of each type, size and rating.
(m)	Rotameter/Air flow meter	2 nos. of each type, model and rating
1.03.00 A	Analyzers (SO ₂ , pH) for FGD system	10% or 2 Nos of each type complete with accessories
1.04.00	PROCESS CONNECTION PIPING (For Impulse Piping / Tubing and Air Supply Piping as Applicable)	
	1. Valves of all types and models	10% or 1 no. of each type, class, size and model whichever is more.
	2. 2 way, 3way, 5way valve manifolds	10% or 1 no. of each type, class, size and model whichever is more.
	3. Fittings	10% or 1 packet of each type, class, size and model whichever is more.
	4. Purge meters	5% of each model or 1 no. whichever is more.
	5. Filter regulators	20% of each model or 2 nos. whichever is more.

983291/2022/PS-PEM-MAX

MANDATORY SPARES - CONTROL AND INSTRUMENTATION

1.00.00	DESCRIPTION	QUANTITY
	7. Relays	10% of each type and rating
	8. Batteries used for battery backup of RAMs.	10% of each type and model
	9. Fuses	200%
1.08.00	OTHER RELATED CONTROL AND INSTRUMENTATION SYSTEMS / EQUIPMENTS	
	1. Lime Feeders	
	1.1 Motion monitor	10% or 2 nos. whichever is more.
	1.2 Speed pick-up	10% or 2 nos. whichever is more.
	1.3 Torque switch (if applicable)	10% or 2 nos. whichever is more.
	1.4 Load Cell	10% or 2 nos. whichever is more.
	1.5 Electronic cards & Power Supply cards	10% or 2 nos. whichever is more.
	1.6 Clutch (if applicable)	10% or 2 nos. whichever is more.
	1.7 Local indication lamps	200%
	1.8 Panel meters	10% or 2 nos. whichever is more.
	1.9 Limit switch assembly for lime-on- belt, no lime flow, shear pin failure, etc.	10% or 2 nos., whichever is more.
1.09.00	CONTROL VALVES, ACTUATORS & ACCESSORIES (Following items shall be provided under this clause for all modulating control valves being supplied under this package)	
	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.	100%
	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) & accessories (link assembly)	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. Air lock relays	10% or 2 nos. of each type whichever is more

983291/2022/PS-PEM-MAX

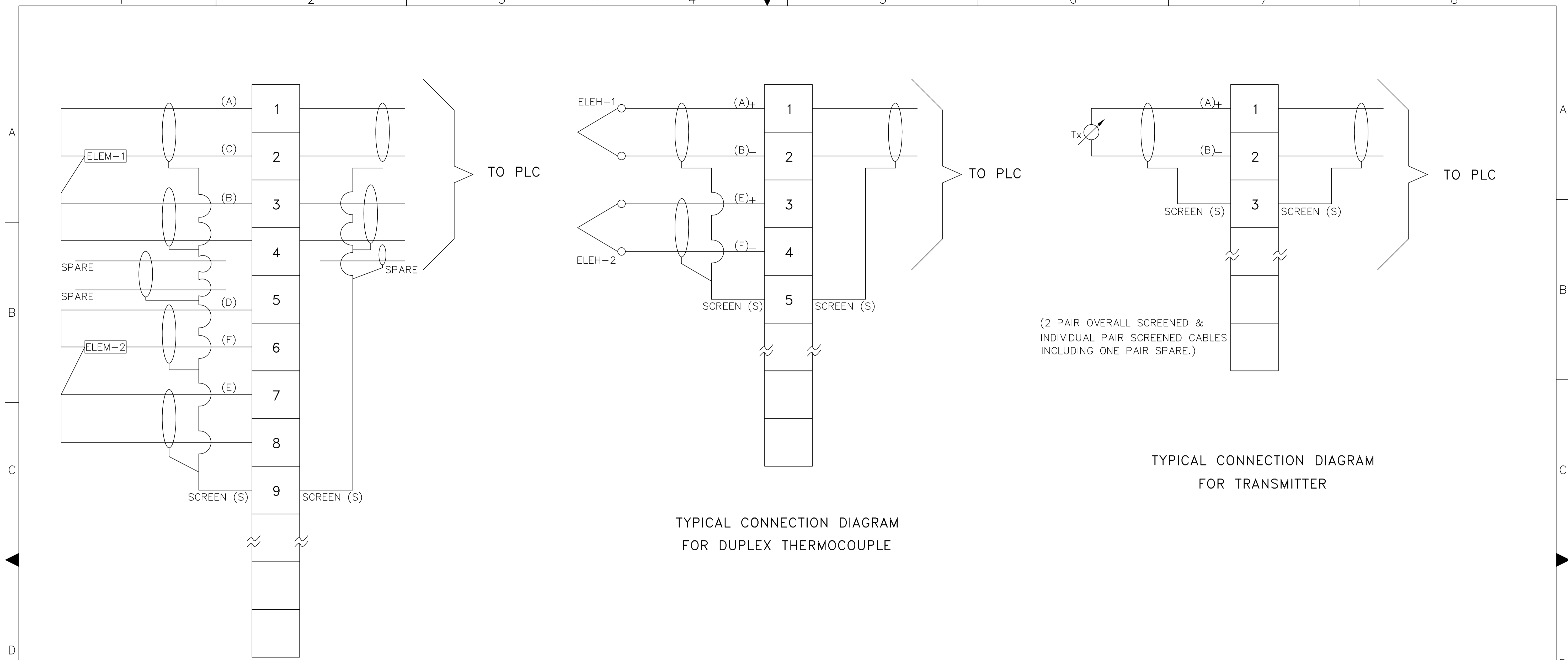
MANDATORY SPARES - CONTROL AND INSTRUMENTATION

1.00.00	DESCRIPTION	QUANTITY
1.10.00	PNEUMATICS ISOLATION / BLOCK VALVES, ACTUATORS & ACCESSORIES (For all ON/OFF valves supplied under this package)	
	1. Pneumatic actuator assembly	10% or 1 no. of each type, model and rating, whichever is more.
	2. Diaphragms, O' rings, seals etc. of all types make etc.	100%
	3. Limit switches (complete unit)& accessories (link assembly)	10% or 2 Nos., whichever is more
	4. Pneumatic air-filter/Regulator of each type, make rating etc.	10% or 2 Nos., whichever is more
	TOTAL	



NOTE:

1. Wherever set is mentioned, one set of the spares of that item shall be for complete replacement of that particular item for one equipment.
2. Any fraction of an item shall mean the next higher integer.
3. Wherever quantity has been specified as percentage (%), the quantity of mandatory spares to be provided by contractor shall be the specified percentage (%) of the total population of the plant. In case the quantity so calculated happens to be fraction, the same shall be rounded off to next higher whole number.
4. Wherever the quantities have been indicated for each type, size, thickness, material, radius, range etc., these shall cover all the items supplied and installed and the breakup for these shall be furnished in the bid.
5. 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 in the above list.



TYPICAL CONNECTION DIAGRAM FOR DUPLEX RTD

TYPICAL CONNECTION DIAGRAM FOR DUPLEX THERMOCOUPLE

TYPICAL CONNECTION DIAGRAM FOR TRANSMITTER

FOR TENDER PURPOSE ONLY

NOTES

1. SPLITTING OF CABLE MAY OCCUR WHEN TERMINALS REQUIRED FOR AN ELEMENT ARE LOCATED ON SEPARATE STRIPS. HENCE, NO.OF TBS ON A TERMINAL STRIP SHALL BE ADJUSTED TO PREVENT SPLITTING. 20% SPARE TB SHALL BE PROVIDED.
2. SCREENS SHALL BE EARTHED AT DDCMIS/PLC END ONLY. NO EARTHING OF SCREEN TO BE DONE AT JB/INSTRUMENT END.
3. OVERALL SCREEN OF OUTGOING AND ASSOCIATED INCOMING CABLE TO BE CONNECTED TOGETHER ON A SPARE TERMINAL AND THEN CONNECTED TO EARTH AT DDCMIS/PLC END.
4. FOR SWITCH, BOTH CONTACTS SHALL BE WIRED TO JB'S WITH 2PAIR OVERALL SCREENED & INDIVIDUAL SCREENED PAIR CABLES.

REV.	DATE	DESCRIPTION	DRN.	STR.	MECH.	ELEC.	INST.
OC	21.01.19	BASED ON COMMENTS	RV				KA
OB	20.12.18	BASED ON COMMENTS	RV				KA
OA	12.05.17	TENDER PURPOSE	KK				KA
			APPROVED BY				

PROJECT : **1 x 800MW NORTH CHENNAI TPP STAGE -III FGD PACKAGE**

OWNER : **TAMILNADU GENERATION & DISTRIBUTION CORPORATION LIMITED**
CHENNAI-600 002, TAMILNADU, INDIA


OWNER'S ENGINEER **FICHTNER India** Private Limited
Chennai

	SIGNATURE	DATE
DRAWN	RV	21.01.19
DESIGNED	KRK	21.01.19
CHECKED	KRK	21.01.19
DEPT.HEAD	KA	21.01.19
PROJ.MGR.	SSR	21.01.19

TYPICAL WIRING ARRANGEMENT IN JUNCTION BOX

RELEASED FOR	PRELIMINARY		DEPT. C&I	JOB NO. 1116127	SCALE: NTS	REV.
	TENDER	✓				
	ENGINEERING					
	CONSTRUCTION					
			DWG.NO. ANNEXURE-2			OC
						SHEET: 01 OF 01

TYPICAL INSTRUMENT HOOK UP DIAGRAM

OC	21.01.19	BASED ON COMMENTS	RV		KA
OB	20.12.18	BASED ON COMMENTS	RV		KA
OA	12.05.17	TENDER PURPOSE	KK		KA
REV.	DATE	DESCRIPTION	DRN.	STR.	MECH. ELEC. INST. APPROVED BY
PROJECT : 1 x 800MW NORTH CHENNAI TPP STAGE -III FGD PACKAGE					
OWNER :  TAMILNADU GENERATION & DISTRIBUTION CORPORATION LIMITED CHENNAI-600 002, TAMILNADU, INDIA					
OWNER'S ENGINEER FICHTNER INDIA FICHTNER Consulting Engineers (India) Private Limited Chennai					
	SIGNATURE	DATE	HOOK UP DIAGRAM		
DRAWN	RV	21.01.19			
DESIGNED	KRK	21.01.19			
CHECKED	KRK	21.01.19			
DEPT.HEAD	KA	21.01.19			
PROJ.MGR.	SSR	21.01.19			
RELEASED FOR	PRELIMINARY		DEPT. C&I	JOB NO. 1116127	SCALE: NTS
	TENDER	✓	DWG.NO. ANNEXURE-7		REV. OC
	ENGINEERING		SHEET: 01 OF 17		
	CONSTRUCTION				

S.NO.	DESCRIPTION	SH.NO.	REV.
1.	COVER SHEET	01	0C
2.	INDEX SHEET	02	0C
3.	INST. DRAWING FOR PRESSURE & DIFFERENTIAL PRESSURE TRANSMITTER/SWITCH (STEAM & LIQUID SERVICE) – 1	03	0C
4.	INST. DRAWING FOR PRESSURE & DIFFERENTIAL PRESSURE TRANSMITTERS (AIR SERVICE)	04	0C
5.	INST. DRAWING FOR PRESSURE & DIFFERENTIAL PRESSURE TRANSMITTERS/SWITCH (OIL SERVICE)	05	0C
6.	INST. DRAWING FOR PRESSURE TRANSMITTER – DIAPHRAGM SEAL TYPE	06	0C
7.	INST. DRAWING FOR LOCAL PRESSURE GAUGE	07	0C
8.	INST. DRAWING FOR LOCAL PRESSURE GAUGE – DIAPHRAGM SEAL TYPE	08	0C
9.	INST. DRAWING FOR LOCAL PRESSURE & DIFFERENTIAL PRESSURE GAUGE/SWITCH	09	0C
10.	INST. DRAWING FOR TEMP. STUB-1	10	0C
11.	INST. DRAWING FOR TEMP. STUB-2	11	0C
12.	INST. DRAWING FOR ULTRASONIC LEVEL TRANSMITTER	12	0C
13.	INST. DRAWING FOR LEVEL SWITCHES	13	0C
14.	INST. DRAWING FOR LEVEL SWITCH WITH FLANGED CONNECTION	14	0C
15.	INST. DRAWING FOR FLOW MEASUREMENT	15	0C
16.	INST. DRAWING FOR ELECTRO MAGNETIC FLOW METER	16	0C
17.	INST. DRAWING FOR U-TUBE	17	0C

NOTES:

1. FOR PROCESS PRESSURE UPTO 40Kg/sqcm, 1/2" PIPE WITH 1 ROOT VALVE SHALL BE PROVIDED.
2. FOR PROCESS PRESSURE MORE THAN 40Kg/sqcm, 1" PIPE WITH 2 ROOT VALVE SHALL BE PROVIDED.

REV.	DATE	DESCRIPTION	DRN.	STR.	MECH.	ELEC.	INST.
OC	21.01.19	BASED ON COMMENTS	RV				KA
OB	20.12.18	BASED ON COMMENTS	RV				KA
OA	12.05.17	TENDER PURPOSE	KK				KA

PROJECT : **1 x 800MW NORTH CHENNAI TPP STAGE -III FGD PACKAGE**

OWNER :  **TAMILNADU GENERATION & DISTRIBUTION CORPORATION LIMITED**
CHENNAI-600 002, TAMILNADU, INDIA

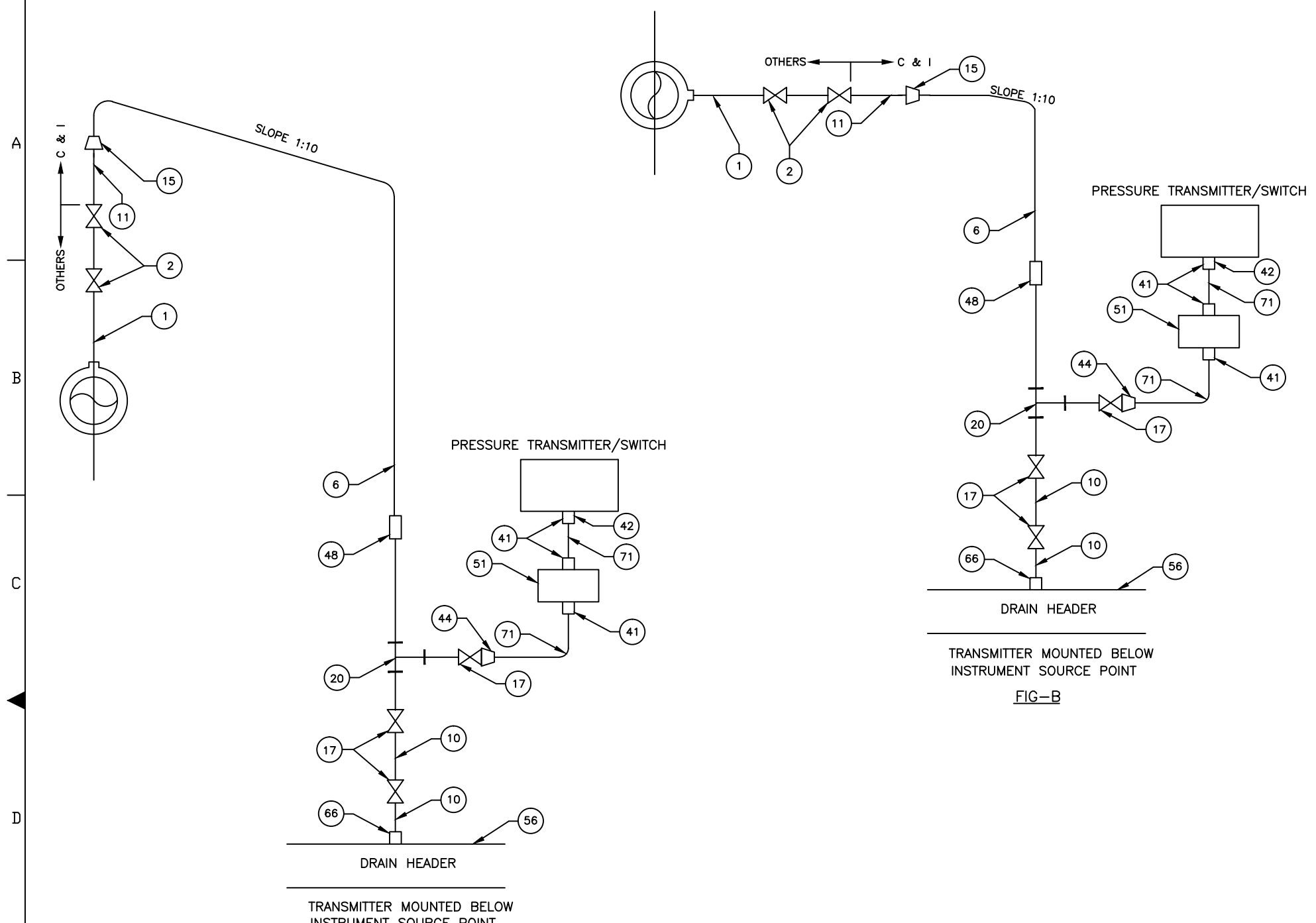
OWNER'S ENGINEER **FICHTNER INDIA** **FICHTNER Consulting Engineers (India) Private Limited**
Chennai

	SIGNATURE	DATE
DRAWN	RV	21.01.19
DESIGNED	KRK	21.01.19
CHECKED	KRK	21.01.19
DEPT.HEAD	KA	21.01.19
PROJ.MGR.	SSR	21.01.19

INDEX SHEET

RELEASED FOR	PRELIMINARY	DEPT. C&I	JOB NO. 1116127	SCALE: NTS	REV.
	TENDER				
	ENGINEERING				
	CONSTRUCTION				

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- NOTES:-**
- FOR HIGH TEMP. SERVICE (MORE THAN 80°C) A 'U'-TUBE / SYPHON (REF. SHEET NO. 15) SHALL BE PROVIDED BETWEEN THE MANIFOLD AND THE TRANSMITTER/SWITCH.
 - FOR PRESSURE LESS THAN 40KG, ROOT VLV. OF SIZE 1/2"SW, NIPPLE PIECE(11), 1 TO 1/2"SW REDUCER(15) & ISOLATION VALVE(17) ARE NOT REQUIRED.
 - FOR SWITCHES PROCESS CONNECTION SHALL BE NPT(M) & HENCE SL.NO:41 SHALL BE REPLACED BY SL.NO:42.
 - FOR SEA WATER & SLURRY APPLICATION SS SUPER DUPLEX SHALL BE CONSIDERED.
 - FOR LIME STONE SLURRY BASED & SEA WATER APPLICATIONS FLUSH RING & DRAINS SHALL BE PROVIDED.

71	1/2"OD IMPULSE TUBE, SS-316/SS SUPER DUPLEX	AS REQD.
66	1/2" GI SOCKET	1 1
56	2"NB GI DRAIN HEADER	AS REQD.
51	3 VALVE MANIFOLDS, SS-316	1 1
48	1/2"SW,CS/AS BULK HEAD PIPE UNION	1 1
44	1/2"SW X 1/2"OD COMPRESSION TUBE FITTING, SS-316/SS SUPER DUPLEX	1 1
42	1/2"NPT(F) X 1/2"OD TUBE COMPRESSION FITTING, SS-316/SS SUPER DUPLEX	1 1
41	1/2"NPT(M) X 1/2"OD TUBE COMPRESSION FITTING, SS-316/SS SUPER DUPLEX	3 3
20	1/2"SW EQUAL TEE,CS	1 1
17	1/2" SW,CS GLOBE VALVE / NEEDLE VALVE	3 3
15	1" TO 1/2" SW REDUCER	1 1
11	1" NPS SCH-80 CS/AS NIPPLE/SS SUPER DUPLEX	1 1
10	1/2" NPS, SCH 80/160, CS/AS NIPPLE/SS SUPER DUPLEX	2 2
6	1/2" NPS. SCH-80/160 CS/ AS PIPE/SS SUPER DUPLEX	AS REQD.
2	1" ROOT VALVE	2 2
1	1" CARBON/ALLOY STEEL NIPPLE OF MTL. SAME AS THAT OF MAIN PIPE(AS PER PROCESS REQD.)	AS REQD.
TAG NO.	DESCRIPTION	A B QTY.

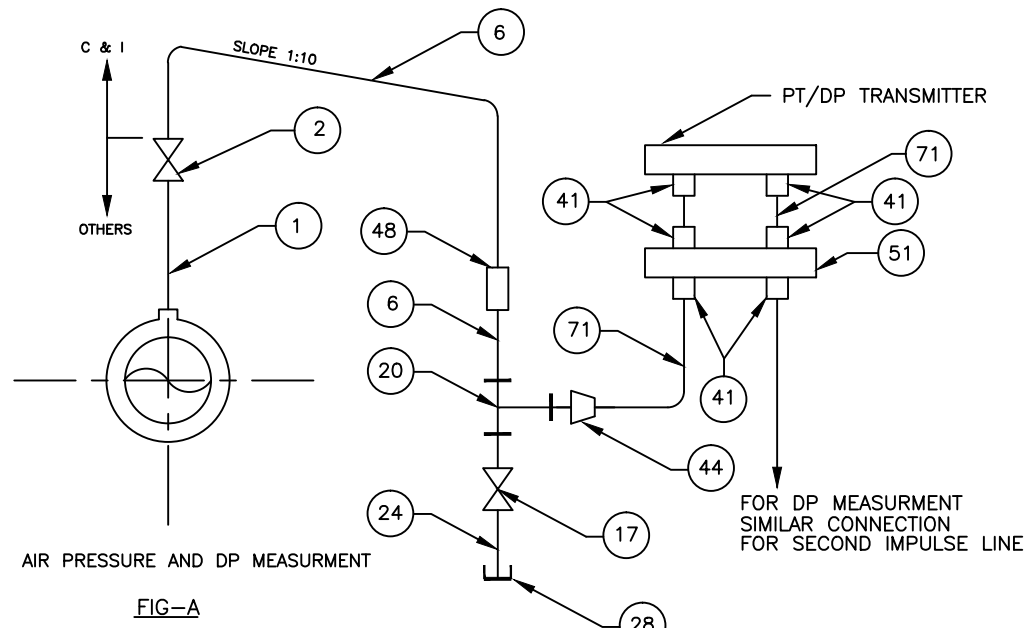
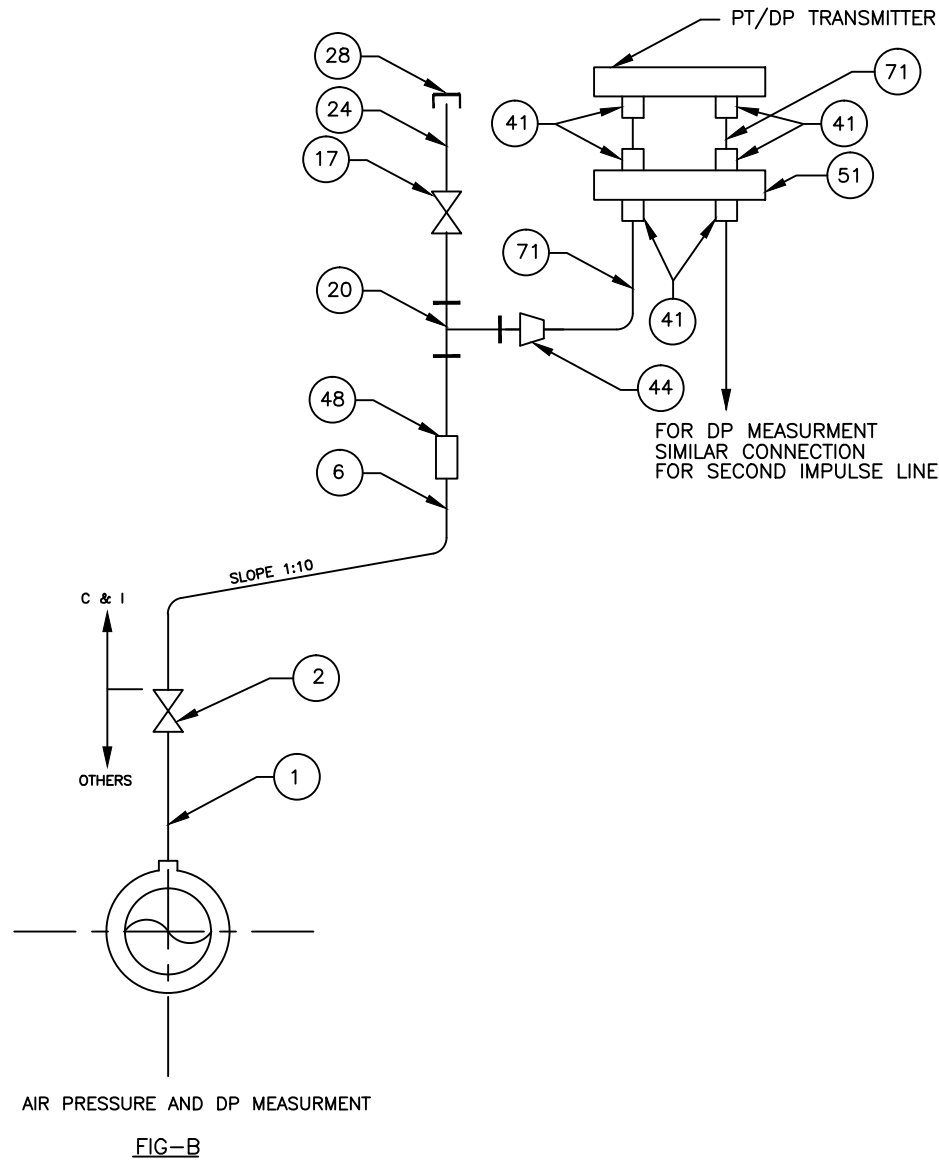
OC	21.01.19	BASED ON COMMENTS	RV		KA
OB	20.12.18	BASED ON COMMENTS	RV		KA
OA	12.05.17	TENDER PURPOSE	KK		KA
REV.	DATE	DESCRIPTION	DRN.	STR.	MECH. ELEC. INST.
			APPROVED BY		
PROJECT : 1 x 800MW NORTH CHENNAI TPP STAGE -III FGD PACKAGE					
OWNER : TAMILNADU GENERATION & DISTRIBUTION CORPORATION LIMITED CHENNAI-600 002, TAMILNADU, INDIA					
OWNER'S ENGINEER FICHTNER INDIA			FICHTNER Consulting Engineers (India) Private Limited Chennai		
	SIGNATURE	DATE			
DRAWN	RV	21.01.19	INST. DRAWING FOR PRESSURE & DIFFERENTIAL PRESSURE TRANSMITTER /SWITCH(STEAM & LIQUID SERVICE) - 1		
DESIGNED	KRK	21.01.19			
CHECKED	KRK	21.01.19			
DEPT. HEAD	KA	21.01.19			
PROJ. MGR.	SSR	21.01.19			
RELEASED FOR	PRELIMINARY		DEPT. C&I	JOB NO. 1116127	SCALE: NTS
	TENDER	✓			
	ENGINEERING				
	CONSTRUCTION				
			DWG.NO. ANNEXURE-7	Page 269 of 448	OC
SHEET: 03 OF 17					

NOTES:-

1. QUANTITY IN COLUMN A & B TO BE DOUBLED FOR DP TAPPING EXCEPT ITEM NO. 51
2. FOR INSTRUMENT AIR SERVICE, SL.NO 1 & 2 PIPE, ROOT VALVE SHALL BE SCREWED END AND ADDITIONAL CONNECTOR 1/2" SW X NPT(M) SHALL BE PROVIDED.

A
B
C
D
E
F

A
B
C
D
E
F



71	1/2"OD IMPULSE TUBE,SS-316	AS REQD.
51	3/5 VALVE MANIFOLDS, SS-316	1 1
48	1/2" SW, CS/AS BULK HEAD PIPE UNION	1 1
44	1/2" SW X 1/2"OD TUBE FITTING, SS-316	1 1
41	1/2" NPT(M) X 1/2"OD TUBE COMPRESSION FITTING ,SS-316	6 6
28	1/2" NPT(F) CS CAP	1 1
24	1/2" NPS, SCH-80 X 1/2"NPS(M)CS NIPPLE	1 1
20	1/2" SW, EQUAL TEE, CS	1 1
17	1/2" SW, CS GLOBE VALVE	1 1
6	1/2" NPS. SCH-80 CARBON STEEL PIPE	AS REQD.
2	1/2" ROOT VALVE - SW GLOBE VALVE	1 1
1	1/2" CARBON STEEL NIPPLE OF MTL. SAME AS THAT OF MAIN PIPE(AS PER PROCESS REQD.)	AS REQD.
TAG NO.	DESCRIPTION	A B
		QTY.
BILL OF MATERIAL		

OC	21.01.19	BASED ON COMMENTS	RV		KA
OB	20.12.18	BASED ON COMMENTS	RV		KA
OA	12.05.17	TENDER PURPOSE	KK		KA
REV.	DATE	DESCRIPTION	DRN.	STR.	MECH. ELEC. INST.
			APPROVED BY		

PROJECT : **1 x 800MW NORTH CHENNAI TPP STAGE -III FGD PACKAGE**

OWNER : **TAMILNADU GENERATION & DISTRIBUTION CORPORATION LIMITED**
CHENNAI-600 002, TAMILNADU, INDIA

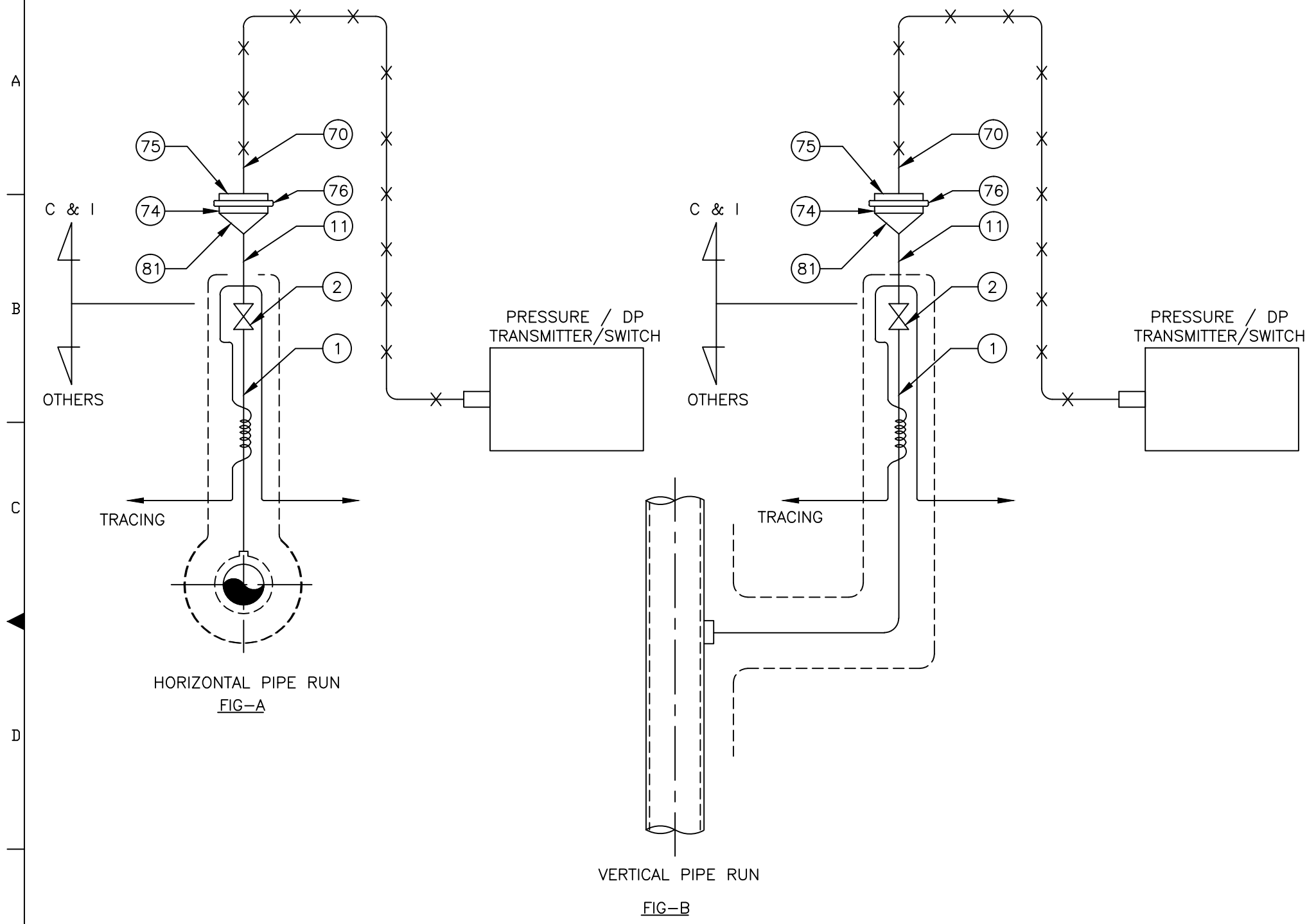
OWNER'S ENGINEER **FICHTNER Consulting Engineers (India) Private Limited**
Chennai

	SIGNATURE	DATE	INST. DRAWING FOR PRESSURE & DIFFERENTIAL PRESSURE TRANSMITTER (AIR SERVICE)
DRAWN	RV	21.01.19	
DESIGNED	KRK	21.01.19	
CHECKED	KRK	21.01.19	
DEPT.HEAD	KA	21.01.19	
PROJ.MGR.	SSR	21.01.19	

RELEASED FOR	PRELIMINARY	DEPT. C&I	JOB NO. 1116127	SCALE: NTS	REV.
	TENDER				
	ENGINEERING				
	CONSTRUCTION				
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NOTES:-

1. QTY IN COLUMNS A & B TO BE DOUBLED FOR DP MEASUREMENT.
2. HFO SERVICE SHALL BE PROVIDED WITH ELECTRICAL HEAT TRACING.



81	1"x2" C.S. EXPANDER, SW	1	1
76	SEAL DIAPHARAGM	1	1
75	2" 300 LBS. ANSI.FLANGE SUPPLIED ALONGWITH INSTRUMENT, BOLT HOLES- 8-190	-	-
74	2" 300 LBS. ANSI.FLANGE BOLT HOLES 8-190	1	1
70	INSTRUMENT CAPALLARY TUBE, SS-316	AS REQD.	
11	1" NPS SCH-80/160 CS/AS NIPPLE	1	1
2	1/2"/3/4"/1" ROOT VALVE	1	1
1	1/2"/3/4"/1" CARBON/ALLOY STEEL NIPPLE OF MTL SAME AS THAT OF MAIN PIPE(AS PER PROCESS REQD.)	1	1

TAG NO.	DESCRIPTION	A	B
		QTY.	
BILL OF MATERIAL			

OC	21.01.19	BASED ON COMMENTS	RV		KA
OB	20.12.18	BASED ON COMMENTS	RV		KA
OA	12.05.17	TENDER PURPOSE	KK		KA
REV.	DATE	DESCRIPTION	DRN.	STR.	MECH. ELEC. INST.
			APPROVED BY		

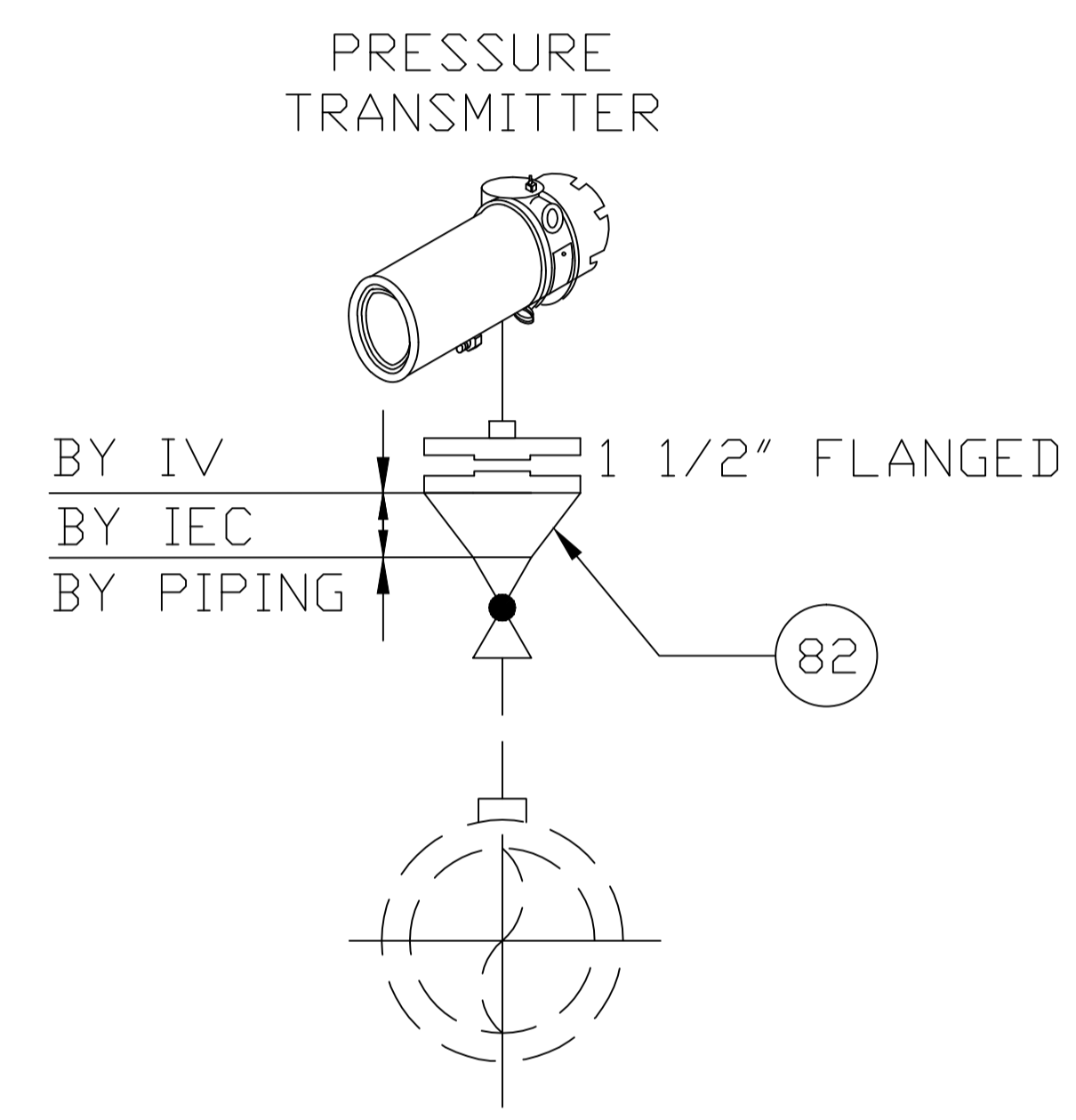
PROJECT : **1 x 800MW NORTH CHENNAI TPP STAGE -III FGD PACKAGE**

OWNER : **TAMILNADU GENERATION & DISTRIBUTION CORPORATION LIMITED**
CHENNAI-600 002, TAMILNADU, INDIA

OWNER'S ENGINEER : **FICHTNER Consulting Engineers (India) Private Limited**
Chennai

	SIGNATURE	DATE	INST. DRAWING FOR PRESSURE & DIFFERENTIAL PRESSURE TRANSMITTERS /SWITCH(OIL SERVICE)
DRAWN	RV	21.01.19	
DESIGNED	KRK	21.01.19	
CHECKED	KRK	21.01.19	
DEPT.HEAD	KA	21.01.19	
PROJ.MGR.	SSR	21.01.19	

RELEASED FOR	PRELIMINARY	DEPT. C&I	JOB NO. 1116127	SCALE: NTS	REV.
	ENGINEERING	DWG.NO. ANNEXURE-7		Page 271 of 448	OC
	CONSTRUCTION			SHEET: 05 OF 17	



82	1"x1 1/2" CS EXPANDER, SW, SS316	1
TAG NO.	DESCRIPTION	QTY.
	BILL OF MATERIAL	

OC	21.01.19	BASED ON COMMENTS	RV		KA
OB	20.12.18	BASED ON COMMENTS	RV		KA
OA	12.05.17	TENDER PURPOSE	KK		KA
REV.	DATE	DESCRIPTION	DRN.	STR.	MECH. ELEC. INST. APPROVED BY

PROJECT : **1 x 800MW NORTH CHENNAI TPP STAGE -III FGD PACKAGE**

OWNER : **TAMILNADU GENERATION & DISTRIBUTION CORPORATION LIMITED**
CHENNAI-600 002, TAMILNADU, INDIA

OWNER'S ENGINEER **FICHTNER Consulting Engineers (India) Private Limited**
Chennai

	SIGNATURE	DATE
DRAWN	RV	21.01.19
DESIGNED	KRK	21.01.19
CHECKED	KRK	21.01.19
DEPT. HEAD	KA	21.01.19
PROJ. MGR.	SSR	21.01.19

INST. DRAWING FOR
PRESSURE TRANSMITTERS
DIAPHRAGM SEAL TYPE

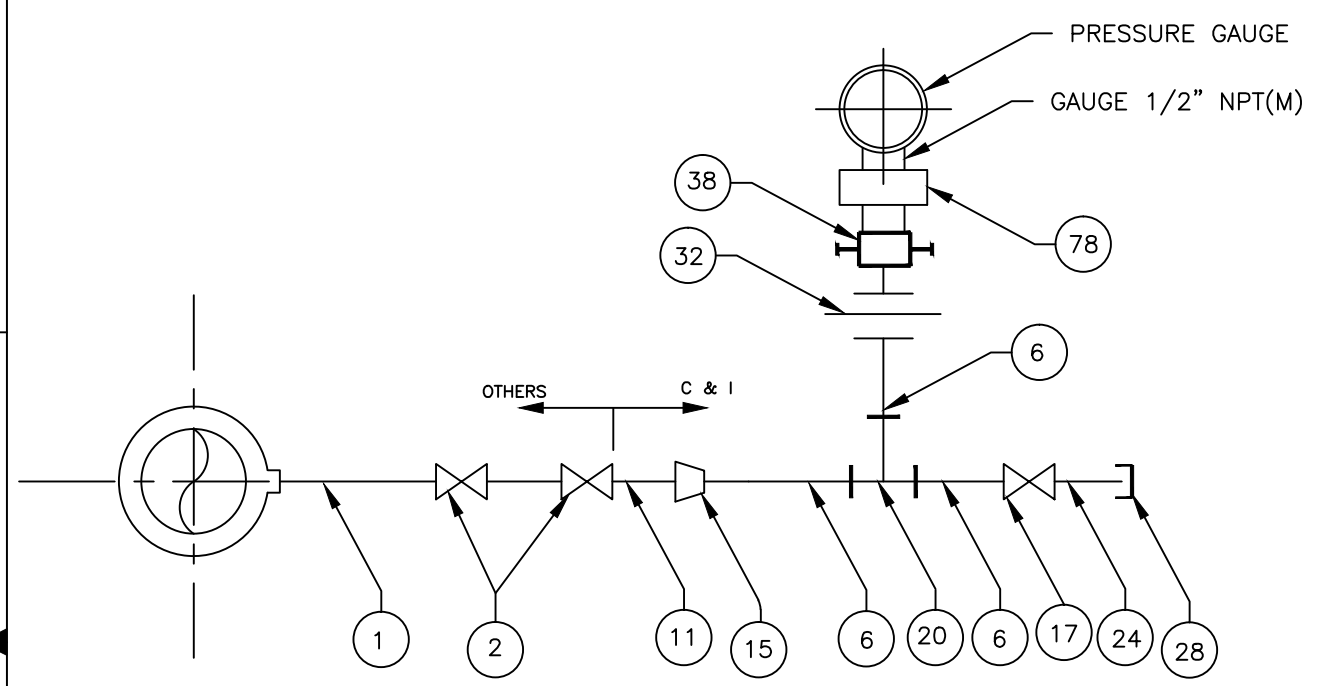
RELEASED FOR	PRELIMINARY		DEPT. C&I	JOB NO. 1116127	SCALE: NTS	REV.
	TENDER	✓				
	ENGINEERING					
	CONSTRUCTION					
			DWG.NO. ANNEXURE-7	SHEET: 06 OF 17		OC

NOTE:-

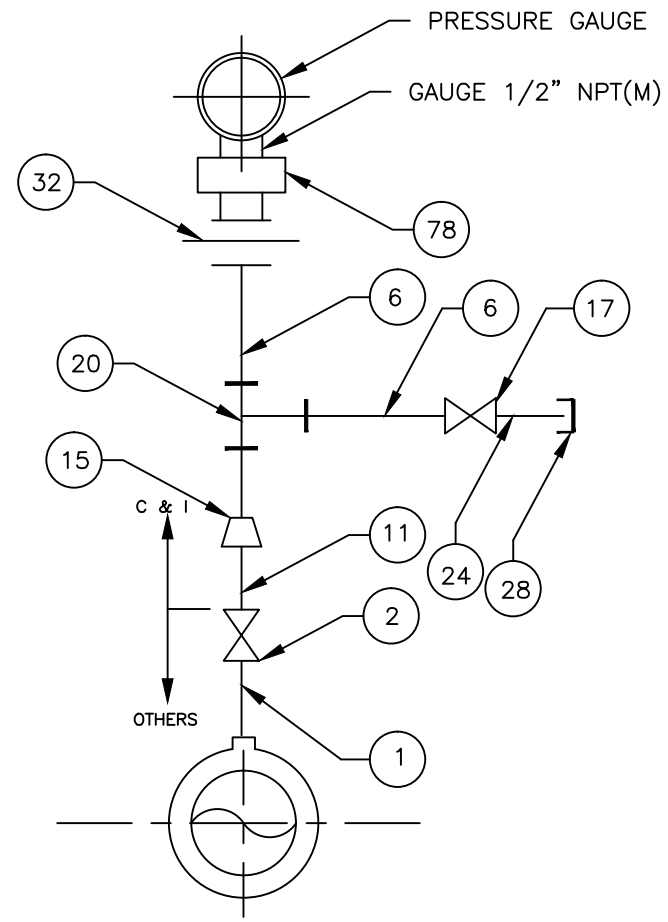
1. FOR PRESSURE LESS THAN 40KG, ROOT VLV. OF SIZE 1/2"SW, NIPPLE PIECE(11) & 1 TO 1/2"SW REDUCER(15) ARE NOT REQUIRED.
2. BIDDER HAS TO PROVIDE SNUBBER AS REQUIRED.
3. FOR SEA WATER & SLURRY APPLICATION SS SUPER DUPLEX SHALL BE CONSIDERED.
4. FOR LIME STONE SLURRY BASED & SEA WATER APPLICATIONS FLUSH RING & DRAINS SHALL BE PROVIDED.

A
B
C
D
E
F

A
B
C
D
E
F



STEAM/LIQUID SERVICE
FIG-A



AIR SERVICE
FIG-B

TAG NO.	DESCRIPTION	A	B	TAG NO.	DESCRIPTION	A	B
20	1/2"SW EQUAL TEE, CS/AS	1	1	78	1/2"NPT(F)X1/2"NPT(M) SNUBBER/PULSATION DAMPER AS APPLICABLE	1	1
17	1/2" SW CS/AS GLOBE VALVE	1	1	59	1/2"SW, STRAIGHT PIPE CONNECTOR, CS/AS	AS REQD.	
15	1" TO 1/2" SOCKET WELDED REDUCER	1	1	38	3 WAY GAUGE VALVE 1/2" NB SW	1	-
11	1" NPS SCH-80/160 CS/AS NIPPLE/SS SUPER DUPLEX	1	1	37	6" COILED SYPHON SCH 80/160 1/2"NB CS/SS	AS REQD.	
6	1/2" NPS. SCH-80/160 CS/ AS PIPE/SS SUPER DUPLEX	AS REQD.		32	1/2"NPS,3PIECE PIPE UNION WITH 1/2"NPT(F) SCREWED	1	1
2	1/2"/3/4"/1" ROOT VALVE-SW GLOBE VALVE	2	1	28	1/2"NPT (F) CS CAP	1	1
1	1/2"/3/4"/1" CARBON/ALLOY STEEL NIPPLE OF MTL. SAME AS THAT OF MAIN PIPE(AS PER PROCESS REQD.)	AS REQD.		24	1/2"NPS,SCH-80/160X1/2"NPT(M)CS/AS NIPPLE	1	1
		A	B			A	B
		QTY.				QTY.	

REV.	DATE	DESCRIPTION	DRN.	STR.	MECH.	ELEC.	INST.
OC	21.01.19	BASED ON COMMENTS		RV			KA
OB	20.12.18	BASED ON COMMENTS		RV			KA
OA	12.05.17	TENDER PURPOSE		KK			KA

PROJECT : **1 x 800MW NORTH CHENNAI TPP STAGE -III FGD PACKAGE**

OWNER : **TAMILNADU GENERATION & DISTRIBUTION CORPORATION LIMITED**
CHENNAI-600 002, TAMILNADU, INDIA

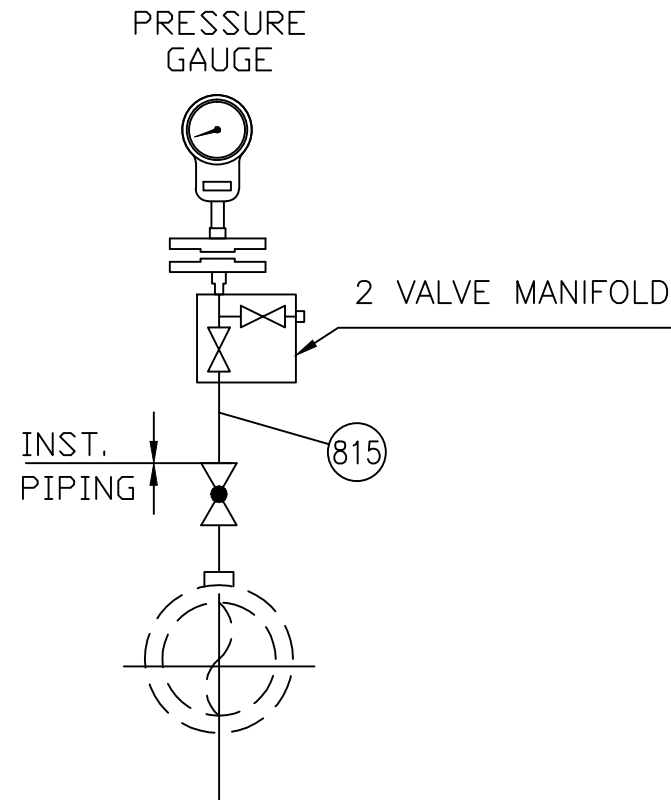
OWNER'S ENGINEER : **FICHTNER INDIA**
FICHTNER Consulting Engineers (India) Private Limited
Chennai

	SIGNATURE	DATE
DRAWN	RV	21.01.19
DESIGNED	KRK	21.01.19
CHECKED	KRK	21.01.19
DEPT. HEAD	KA	21.01.19
PROJ. MGR.	SSR	21.01.19

INST. DRAWING FOR
LOCAL PRESSURE GAUGE

RELEASED FOR	DEPT. C&I	JOB NO. 1116127	SCALE: NTS	REV.
PRELIMINARY				
TENDER				
ENGINEERING				
CONSTRUCTION				

PRESSURE GAUGE
WITH DIAPHRAGM
SEAL



NOTE:-

1. 2 VALVE INTEGRAL MANIFOLD SHALL BE THE PART OF INSTRUMENT VENDOR SCOPE.
2. SNUBBER SHALL BE PROVIDED FOR PUMP DISCHARGE APPLICATION.
3. DIAPHRAGM SEAL SHALL BE PROVIDED FOR CHEMICAL/OILY WATER APPLICATION.

REV.	DATE	DESCRIPTION	DRN.	STR.	MECH.	ELEC.	INST.	APPROVED BY
OC	21.01.19	BASED ON COMMENTS	RV					KA
OB	20.12.18	BASED ON COMMENTS	RV					KA
OA	12.05.17	TENDER PURPOSE	KK					KA

PROJECT : **1 x 800MW NORTH CHENNAI TPP STAGE -III
FGD PACKAGE**

OWNER :  **TAMILNADU GENERATION & DISTRIBUTION CORPORATION LIMITED**
CHENNAI-600 002, TAMILNADU, INDIA

OWNER'S ENGINEER **FICHTNER INDIA** **FICHTNER Consulting Engineers (India) Private Limited**
Chennai

	SIGNATURE	DATE
DRAWN	RV	21.01.19
DESIGNED	KRK	21.01.19
CHECKED	KRK	21.01.19
DEPT. HEAD	KA	21.01.19
PROJ. MGR.	SSR	21.01.19

INST. DRAWING FOR
LOCAL PRESSURE GAUGE
DIAPHRAGM SEAL TYPE

RELEASED FOR	PRELIMINARY		DEPT. C&I	JOB NO. 1116127	SCALE: NTS	REV.
	TENDER	✓				
	ENGINEERING					
	CONSTRUCTION					

DWG.NO. ANNEXURE-7 Page 274 of 448 SHEET: 08 OF 17

TAG NO.	DESCRIPTION	QTY.
1	NIPPLE (100mm), 1/2" NPTM X SW, SCH 80, SS316	1
BILL OF MATERIAL		

- NOTE:-**
- FOR PRESSURE LESS THAN 40KG, ROOT VL.V. OF SIZE 1/2"SW, NIPPLE PIECE(11) & 1 TO 1/2"SW REDUCER(15) ARE NOT REQUIRED.
 - FOR SEA WATER & SLURRY APPLICATION SS SUPER DUPLEX SHALL BE CONSIDERED.
 - FOR LIME STONE SLURRY BASED & SEA WATER APPLICATIONS FLUSH RING & DRAINS SHALL BE PROVIDED.

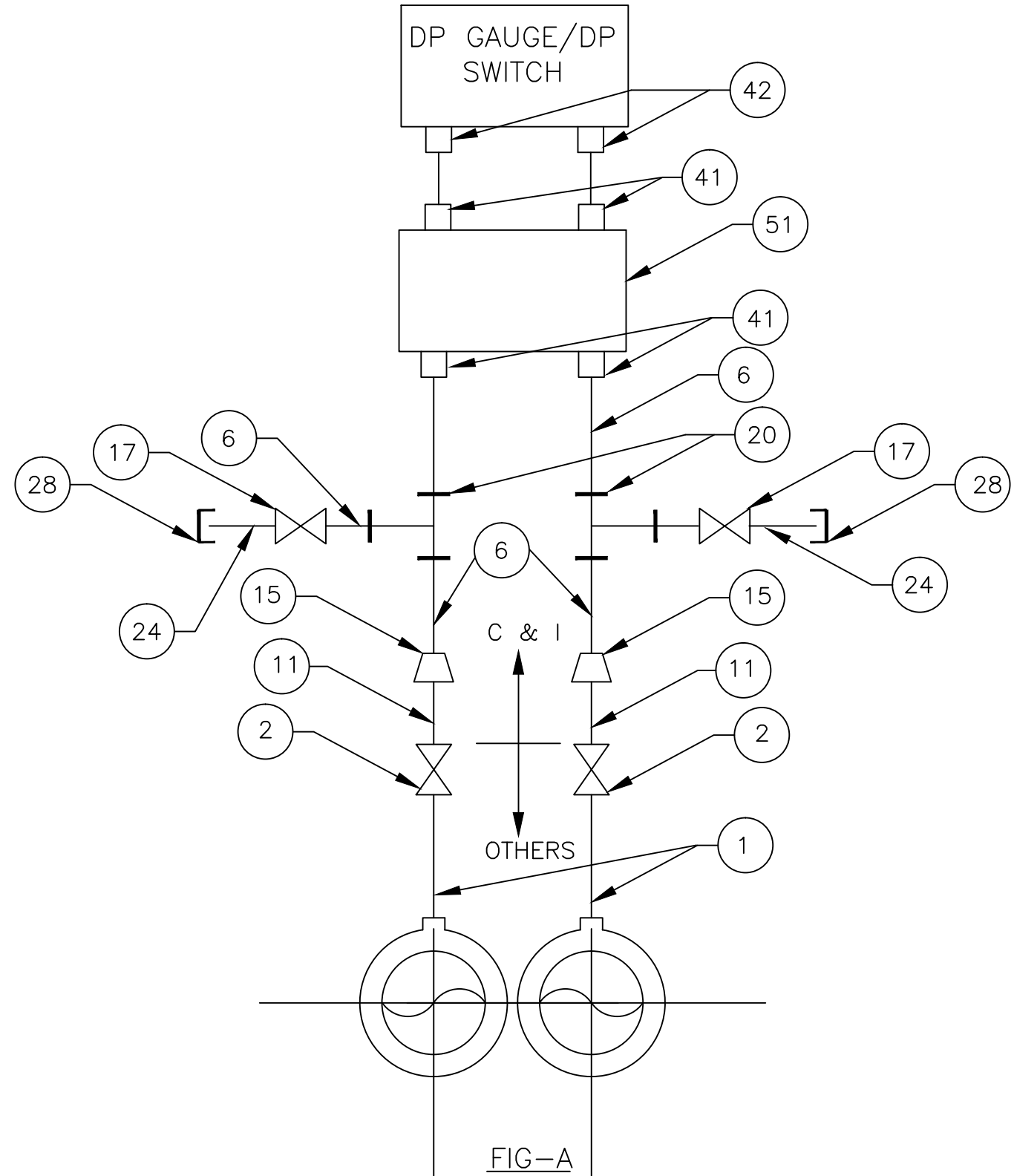


FIG-A

TAG NO.	DESCRIPTION	QTY.
51	3/5 VALVE MANIFOLDS, SS-316	1
42	1/2" NPT(F) X 1/2" OD TUBE COMPRESSION FITTING,SS-316/SS SUPER DUPLEX	2
41	1/2" NPT(M) X 1/2" OD TUBE COMPRESSION FITTING,SS-316/SS SUPER DUPLEX	4
28	1/2" NPT(F) CS. CAP	2
24	1/2" NPS,SCH 80/160 X 1/2" NPT(M) CS/AS NIPPLE/SS SUPER DUPLEX	2
20	1/2"SW EQUAL TEE CS/AS	2
17	1/2" SW,CS/AS, GLOBE VALVE	2
15	1" TO 1/2" SOCKET WELD REDUCER	2
11	1"NPS SCH 80/160 CS/AS NIPPLE/SS SUPER DUPLEX	2
6	1/2"NPS,SCH 80/160 CARBON/ALLOY STEEL PIPE/SS SUPER DUPLEX	AS REQD.
2	1/2"3/4"/1" ROOT VALVE - SW GLOBE VALVE	2
1	1/2"3/4"/1" CARBON/ALLOY STEEL NIPPLE OF MTL SAME AS THAT OF MAIN PIPE (AS PER PROCESS REQD.)	AS REQD.
		A
		QTY.

REV.	DATE	DESCRIPTION	DRN.	STR.	MECH.	ELEC.	INST.
OC	21.01.19	BASED ON COMMENTS	RV				KA
OB	20.12.18	BASED ON COMMENTS	RV				KA
OA	12.05.17	TENDER PURPOSE	KK				KA
			APPROVED BY				

PROJECT : **1 x 800MW NORTH CHENNAI TPP STAGE -III FGD PACKAGE**

OWNER : **TAMILNADU GENERATION & DISTRIBUTION CORPORATION LIMITED**
CHENNAI-600 002, TAMILNADU, INDIA

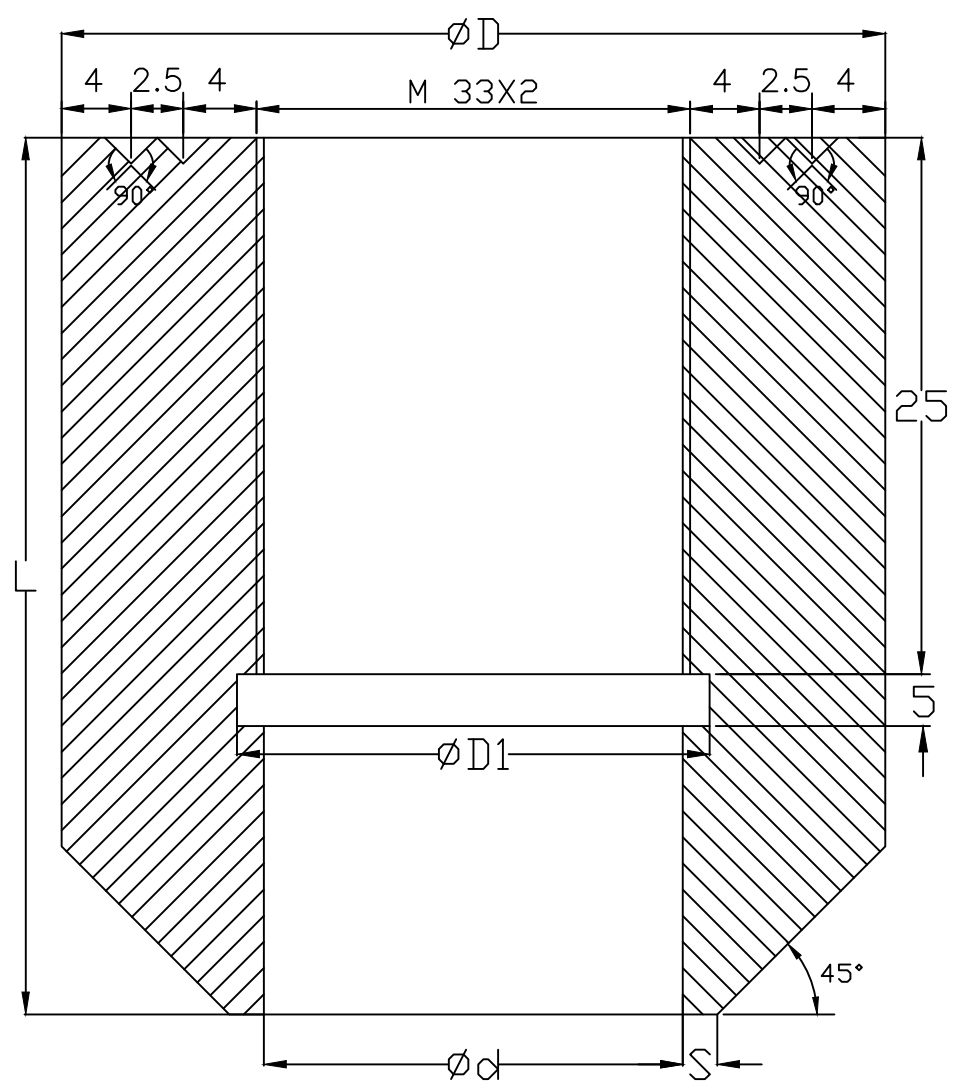
OWNER'S ENGINEER: **FICHTNER Consulting Engineers (India) Private Limited**
Chennai

	SIGNATURE	DATE
DRAWN	RV	21.01.19
DESIGNED	KRK	21.01.19
CHECKED	KRK	21.01.19
DEPT. HEAD	KA	21.01.19
PROJ. MGR.	SSR	21.01.19

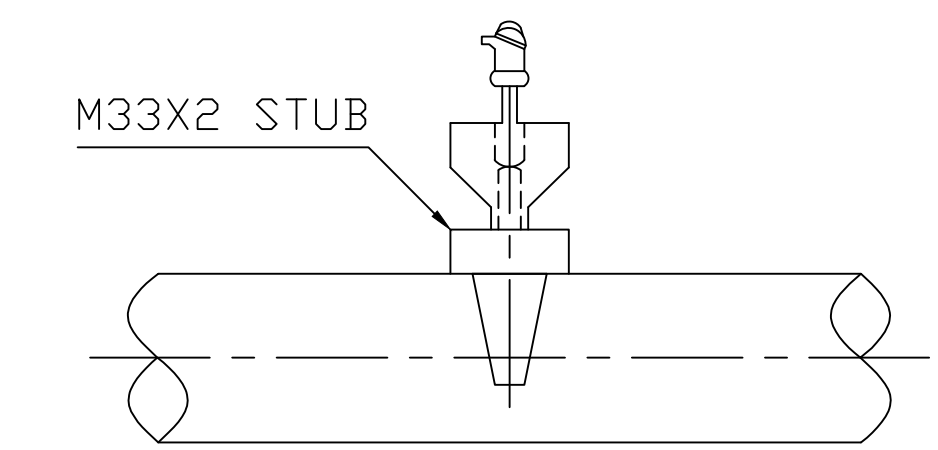
INST. DRAWING FOR LOCAL PRESSURE & DIFFERENTIAL PRESSURE GAUGE/SWITCH

RELEASED FOR	DEPT. C&I	JOB NO. 1116127	SCALE: NTS	REV.
PRELIMINARY				
TENDER				
ENGINEERING				
CONSTRUCTION				

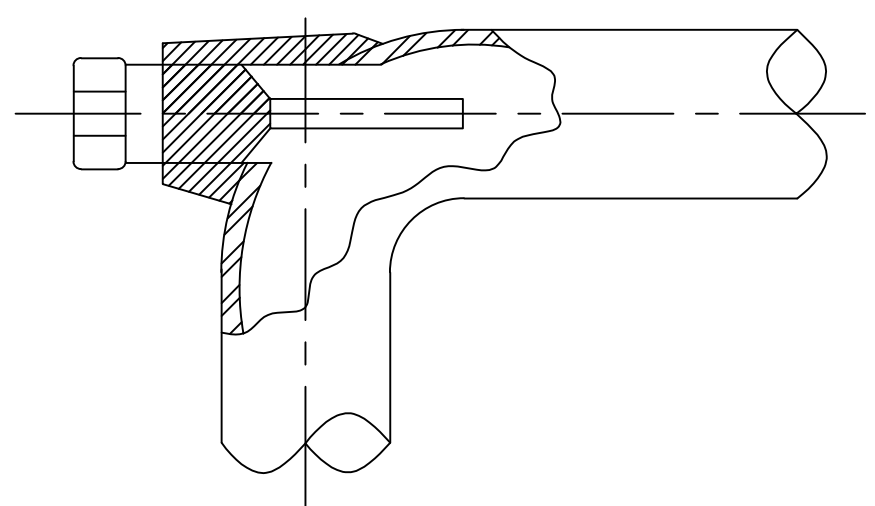
- NOTES:-**
1. MATERIAL OF THE BOSS SHALL BE THE SAME AS THE PIPE INTO WHICH IT IS WELDED.
 2. STRAIGHT IMMERSION STUBS SHALL BE USED FOR PIPE OD'S 168.3mm AND ABOVE. THE STUB HEIGHT FOR PIPE OD,168.3mm TO <219.1mm SHALL BE 65mm.
 3. SLANT IMMERSION STUBS SHALL BE USED FOR PIPE OD'S 88.9mm TO 159mm.
 4. FOR MAIN PIPE OD'S 88.9mm & BELOW SUITABLE EXPANDER SHALL BE USED.



TEMPERATURE STUB FOR STRAIGHT IMMERSION



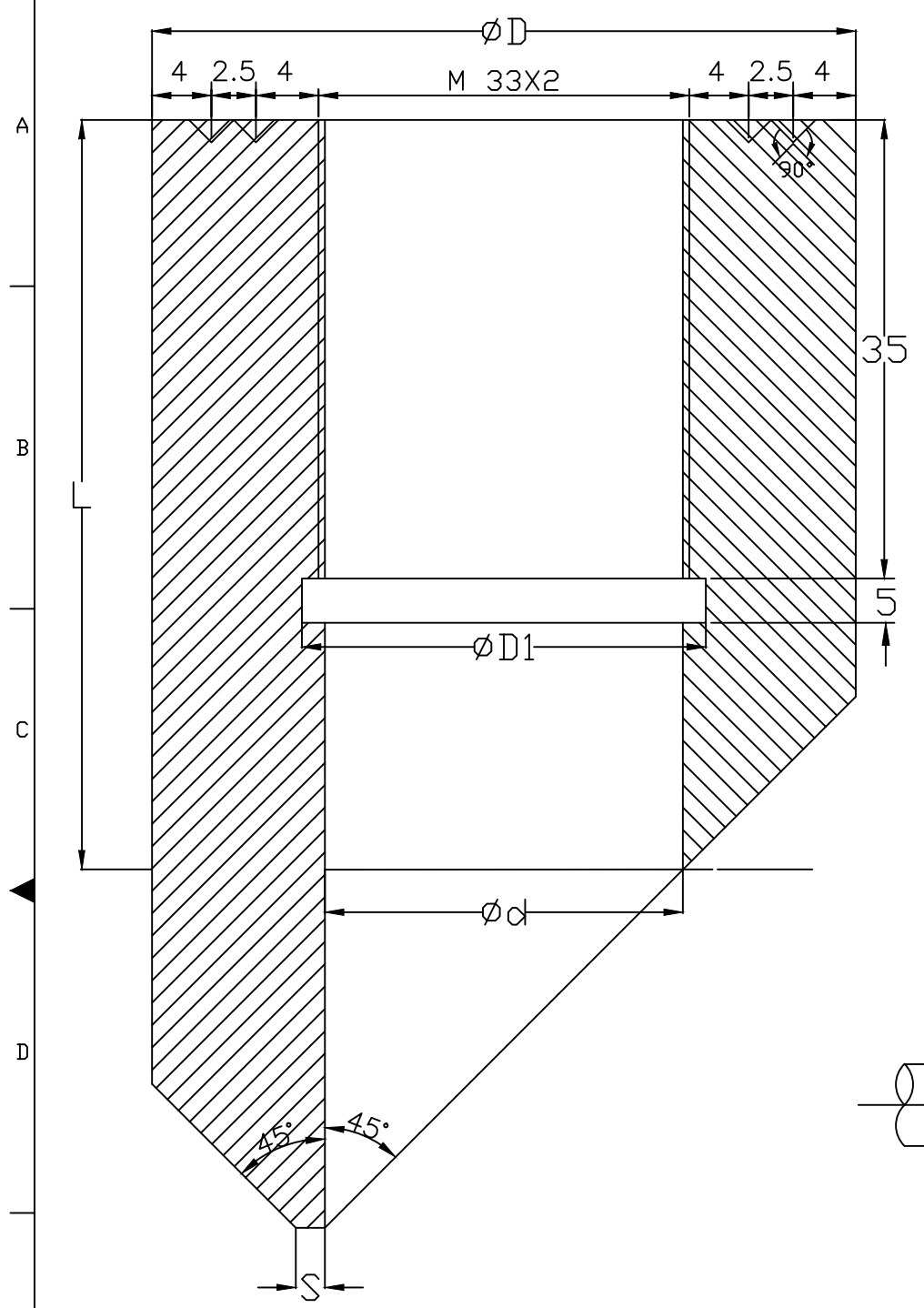
INSTALLATION TYPE-1
(FOR MAIN PIPE OD 168.3MM & ABOVE)



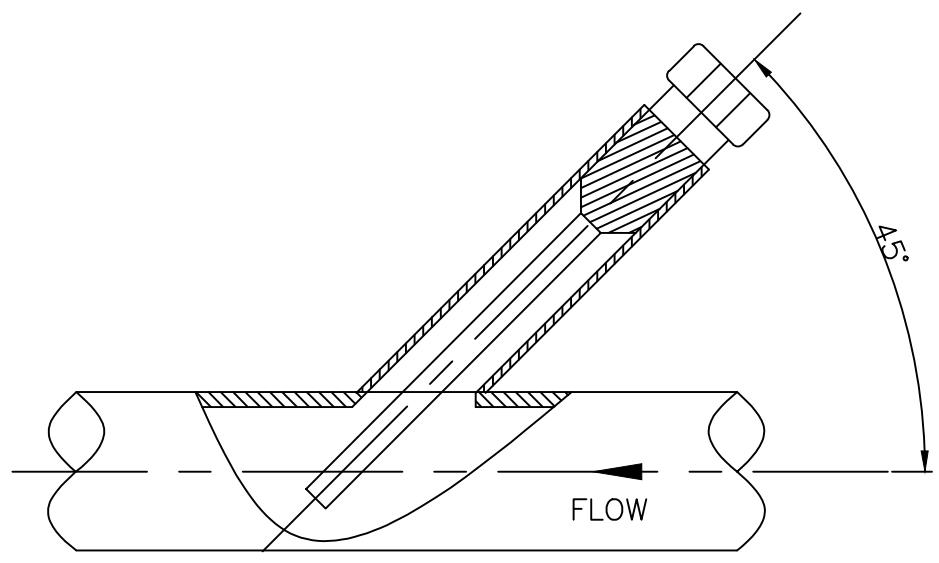
INSTALLATION TYPE-2
(FOR MAIN PIPE OD 88.9MM & BELOW)

FOR PIPE OD BELOW 219.1mm	29	55	33.5	1.5	65
FOR PIPE OD 219.1mm & ABOVE	29	55	33.5	1.5	45
MAIN PIPE SIZES	d	D	D1	S	L

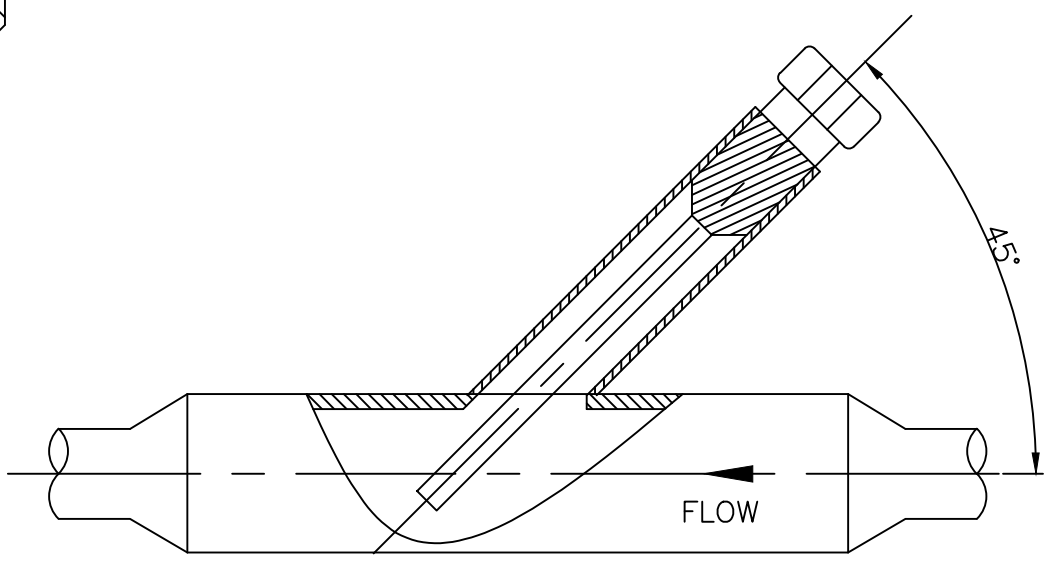
OC	21.01.19	BASED ON COMMENTS	RV		KA
OB	20.12.18	BASED ON COMMENTS	RV		KA
OA	12.05.17	TENDER PURPOSE	KK		KA
REV.	DATE	DESCRIPTION	DRN.	STR.	MECH. ELEC. INST. APPROVED BY
PROJECT : 1 x 800MW NORTH CHENNAI TPP STAGE -III FGD PACKAGE					
OWNER : TAMILNADU GENERATION & DISTRIBUTION CORPORATION LIMITED CHENNAI-600 002, TAMILNADU, INDIA					
OWNER'S ENGINEER FICHTNER INDIA FICHTNER Consulting Engineers (India) Private Limited Chennai					
	SIGNATURE	DATE	INST. DRAWING FOR TEMP. STUB-1		
DRAWN	RV	21.01.19			
DESIGNED	KRK	21.01.19			
CHECKED	KRK	21.01.19			
DEPT. HEAD	KA	21.01.19			
PROJ. MGR.	SSR	21.01.19			
RELEASED FOR	PRELIMINARY		DEPT. C&I	JOB NO. 1116127	SCALE: NTS
	TENDER	✓	DWG.NO. ANNEXURE-7		Page 276 of 448
	ENGINEERING				SHEET: 10 OF 17
	CONSTRUCTION				OC



TEMPERATURE STUB FOR STRAIGHT IMMERSION



INSTALLATION TYPE-3
(FOR MAIN PIPE OD 88.9mm & 159mm)



INSTALLATION TYPE-4
(FOR MAIN PIPE OD 88.9mm & BELOW)

NOTES:-

1. MATERIAL OF THE BOSS SHALL BE THE SAME AS THE PIPE INTO WHICH IT IS WELDED.
2. STRAIGHT IMMERSION STUBS SHALL BE USED FOR PIPE OD'S 168.3mm AND ABOVE. THE STUB HEIGHT FOR PIPE OD, 168.3mm TO <219.1mm SHALL BE 65mm.
3. SLANT IMMERSION STUBS SHALL BE USED FOR PIPE OD'S 88.9mm TO 159mm.
4. FOR MAIN PIPE OD'S 88.9mm & BELOW SUITABLE EXPANDER SHALL BE USED.

FOR PIPE OD BELOW 219.1mm	29	55	33.5	1.5	65
FOR PIPE OD 219.1mm & ABOVE	29	55	33.5	1.5	45
MAIN PIPE SIZES	d	D	D1	S	L

REV.	DATE	DESCRIPTION	DRN.	STR.	MECH.	ELEC.	INST.	APPROVED BY
OC	21.01.19	BASED ON COMMENTS	RV					KA
OB	20.12.18	BASED ON COMMENTS	RV					KA
OA	12.05.17	TENDER PURPOSE	KK					KA

PROJECT : **1 x 800MW NORTH CHENNAI TPP STAGE -III FGD PACKAGE**

OWNER : **TAMILNADU GENERATION & DISTRIBUTION CORPORATION LIMITED**
CHENNAI-600 002, TAMILNADU, INDIA

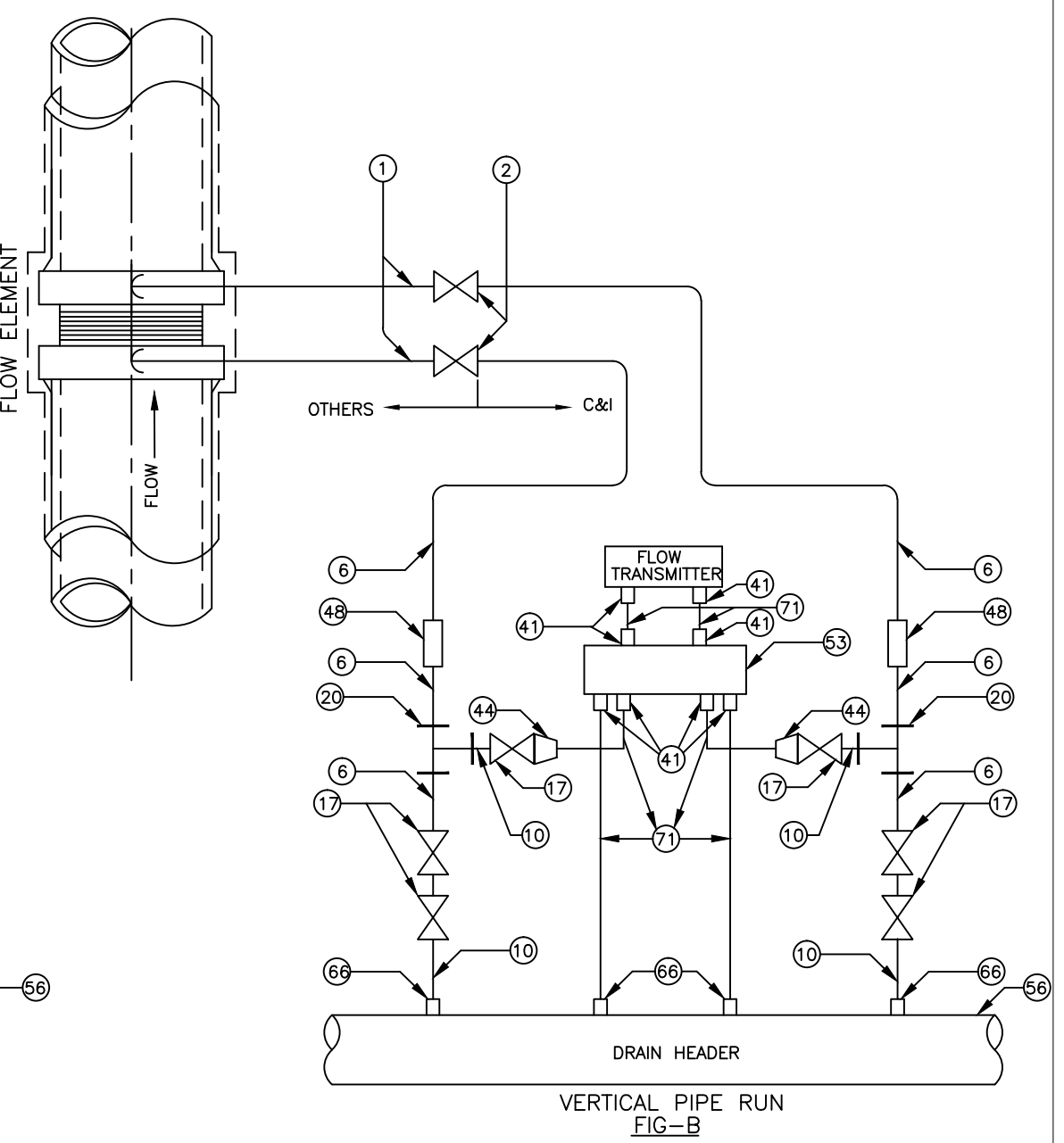
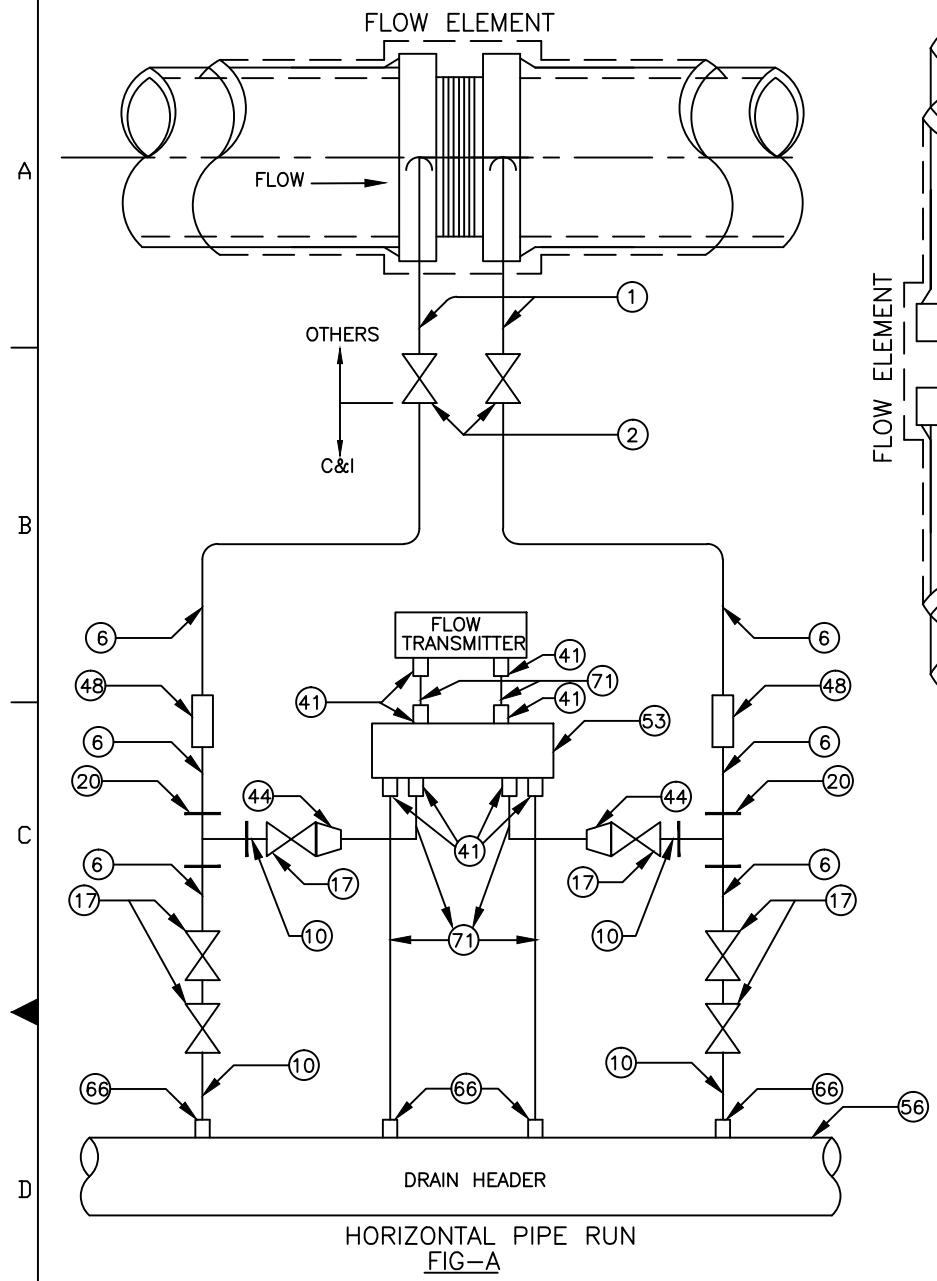
OWNER'S ENGINEER: **FICHTNER INDIA**
FICHTNER Consulting Engineers (India) Private Limited
Chennai

	SIGNATURE	DATE			
DRAWN	RV	21.01.19	INST. DRAWING FOR TEMP. STUB-2		
DESIGNED	KRK	21.01.19			
CHECKED	KRK	21.01.19			
DEPT. HEAD	KA	21.01.19			
PROJ. MGR.	SSR	21.01.19			

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	TENDER				
	ENGINEERING				
	CONSTRUCTION				
DWG. NO. ANNEXURE-7		Page 277 of 448		SHEET: 11 OF 17	

NOTE:-

1. FOR SEA WATER APPLICATION MATERIAL FROM THE FLANGE SHALL BE SS SUPER DUPLEX.



TAG NO.	DESCRIPTION	A	B	TAG NO.	DESCRIPTION	A	B
20	1/2" SOCKET WELDED EQUAL TEE CS/AS	2	2	71	1/2"OD IMPULSE TUBE, SS-316	AS REQD.	
17	1/2" SOCKET WELDED CS GLOBE VALVE	6	6	66	1/2" GI SOCKET / FUNNEL	4	4
10	1/2" NPS SCH 80/160,CS/AS NIPPLE	4	4	56	2"NB GI DRAIN HEADER	AS REQD.	
6	1/2" NPS SCH 80/160 CS/AS PIPE	AS REQD.		53	5-VALVE MANIFOLD, SS-316	1	1
2	1/2" SOCKET WELDED GLOBE VALVE	2	2	48	1/2" SW, CS/AS BULK HEAD PIPE UNION	2	2
1	1/2" NPS SCH 80 NIPPLES OF MATERIAL SAME AS MAIN PIPE WITH NECESSARY ATTACH TO FLANGES	AS REQD.		44	1/2"SWX1/2"OD COMPRESSION TUBE FITTING,SS-316	2	2
				41	1/2"NPT(M)X1/2"OD TUBE COMPRESSION FITTING,SS-316	8	8

REV.	DATE	DESCRIPTION	DRN.	STR.	MECH.	ELEC.	INST.
OC	21.01.19	BASED ON COMMENTS		RV			KA
OB	20.12.18	BASED ON COMMENTS		RV			KA
OA	12.05.17	TENDER PURPOSE		KK			KA

PROJECT : **1 x 800MW NORTH CHENNAI TPP STAGE -III FGD PACKAGE**

OWNER : **TAMILNADU GENERATION & DISTRIBUTION CORPORATION LIMITED**
CHENNAI-600 002, TAMILNADU, INDIA

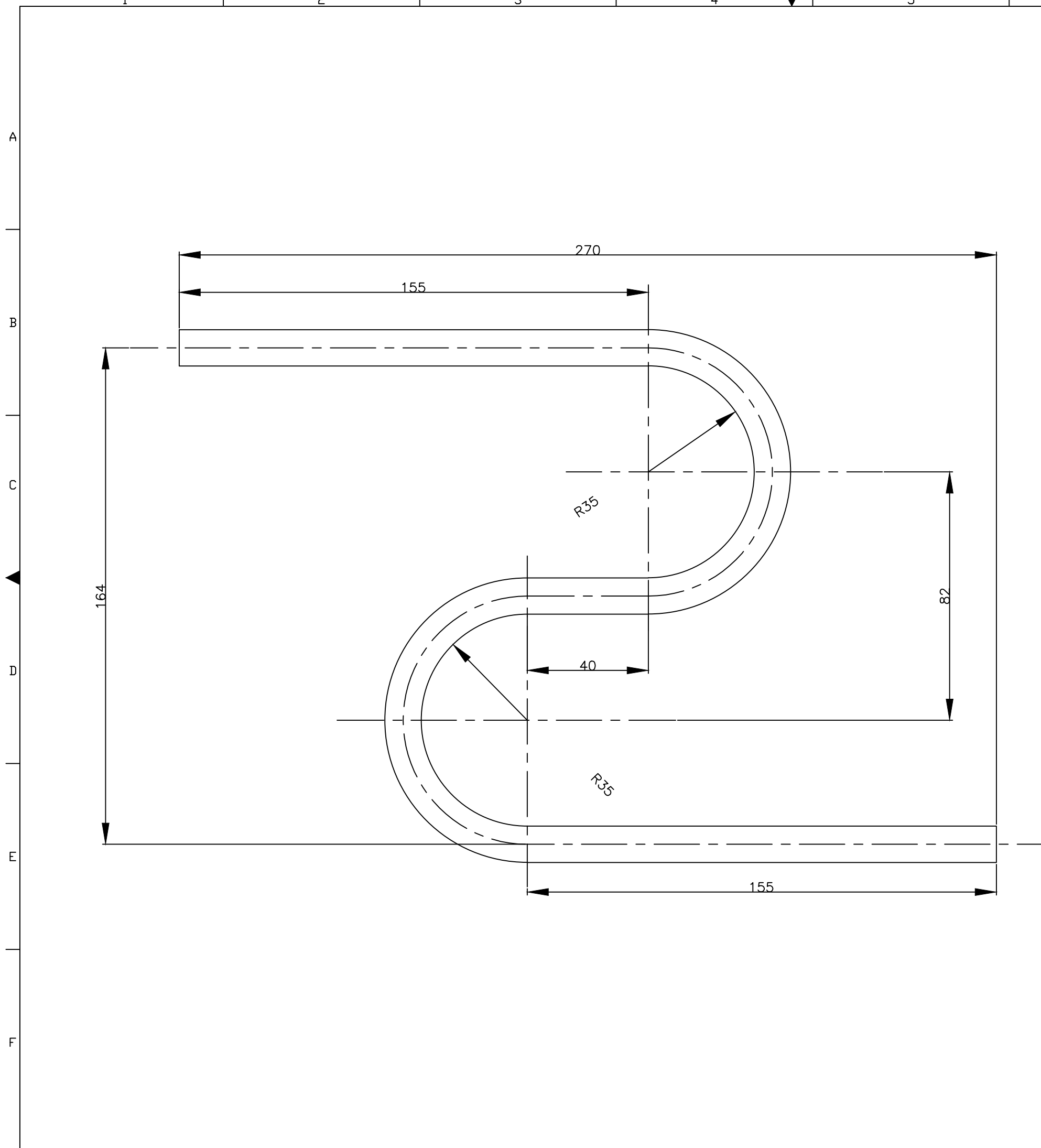
OWNER'S ENGINEER : **FICHTNER Consulting Engineers (India) Private Limited**
Chennai

	SIGNATURE	DATE
DRAWN	RV	21.01.19
DESIGNED	KRK	21.01.19
CHECKED	KRK	21.01.19
DEPT. HEAD	KA	21.01.19
PROJ. MGR.	SSR	21.01.19

INST. DRAWING FOR FLOW MEASUREMENT

RELEASED FOR	DEPT. C&I	JOB NO. 1116127	SCALE: NTS	REV.
PRELIMINARY				
TENDER				
ENGINEERING				
CONSTRUCTION				

DWG.NO. ANNEXURE-7 Page 278 of 448 SHEET: 15 OF 17



OC	21.01.19	BASED ON COMMENTS	RV				KA
OB	20.12.18	BASED ON COMMENTS	RV				KA
OA	12.05.17	TENDER PURPOSE	KK				KA
REV.	DATE	DESCRIPTION	DRN.	STR.	MECH.	ELEC.	INST.
			APPROVED BY				

PROJECT : **1 x 800MW NORTH CHENNAI TPP STAGE -III
FGD PACKAGE**

OWNER :  **TAMILNADU GENERATION & DISTRIBUTION CORPORATION LIMITED**
CHENNAI-600 002, TAMILNADU, INDIA

OWNER'S ENGINEER **FICHTNER INDIA** **FICHTNER Consulting Engineers (India) Private Limited**
Chennai

	SIGNATURE	DATE
DRAWN	RV	21.01.19
DESIGNED	KRK	21.01.19
CHECKED	KRK	21.01.19
DEPT. HEAD	KA	21.01.19
PROJ. MGR.	SSR	21.01.19

INST. DRAWING FOR U-TUBE

RELEASED FOR	PRELIMINARY		DEPT. C&I	JOB NO. 1116127	SCALE: NTS	REV.
	TENDER	✓	DWG.NO. ANNEXURE-7		Page 279 of 448	OC
	ENGINEERING				SHEET: 17 OF 17	
	CONSTRUCTION					

983291/2022/PS-PEM-MAX

Checklist for Serial Communication between maxDNA Systems and Foreign Device :BHEL

A Device Specific :

SN	Parameters	Options available	Remarks if any
1	Modle No.& Make of Device		
2	Communications Link Options	<input type="checkbox"/> Multidrop <input type="checkbox"/> Peer to Peer <input type="checkbox"/> N/w topology attached	
3	Protocol Mode (Device is a)	<input type="checkbox"/> Master <input type="checkbox"/> Slave <input type="checkbox"/> Master/Slave	
4	Protocol	<input type="checkbox"/> RTU <input type="checkbox"/> ASCII <input type="checkbox"/> Other -----	
5	Master	<input type="checkbox"/> System maxDNA <input type="checkbox"/> Other -----	
6	Redundancy Requirements	Yes / No	
7	Dist.bet.maxDNA System & Device*	<input type="checkbox"/> ----- Feet <input type="checkbox"/> ----- Meters	

B Electrical Specific :

1	Interface Type	<input type="checkbox"/> RS232 <input type="checkbox"/> RS422 <input type="checkbox"/> RS485	
2	Wiring at Device end	<input type="checkbox"/> 2 Wire <input type="checkbox"/> 4 Wire	
3	Transmission Channel	<input type="checkbox"/> Half Duplex <input type="checkbox"/> Full Duplex	
4	Baud Rates (bps)	<input type="checkbox"/> 1200 <input type="checkbox"/> 2400 <input type="checkbox"/> 4800 <input type="checkbox"/> 9600 <input type="checkbox"/> 19200	
5	Databits	<input type="checkbox"/> 8 <input type="checkbox"/> 7	
6	Stopbits	<input type="checkbox"/> 1 <input type="checkbox"/> 2	
7	Parity	<input type="checkbox"/> None <input type="checkbox"/> Odd <input type="checkbox"/> Even	
8	H/w & Software Handshake	<input type="checkbox"/> Yes <input type="checkbox"/> No	
9	Response Timeout time (Sec)	<input type="checkbox"/> ----- <input type="checkbox"/> Configurable timeout	
10	Data Formats Supported	<input type="checkbox"/> Boolean <input type="checkbox"/> Real <input type="checkbox"/> Char <input type="checkbox"/> Sn.Int <input type="checkbox"/> UnSn.Int	
11	Transmission mode	<input type="checkbox"/> Asynchronous <input type="checkbox"/> Synchronous	

C Application Specific : *

1	Primary Function*	<input type="checkbox"/> Data Acquisition <input type="checkbox"/> Data Acquisition & Control	
		<input type="checkbox"/> Download parameter sets	
2	Analog Points to read	-----Nos. <input type="checkbox"/> Details attached <input type="checkbox"/> Details not attached	
3	Analog Points to write	-----Nos. <input type="checkbox"/> Details attached <input type="checkbox"/> Details not attached	
4	Digital Points to read	-----Nos. <input type="checkbox"/> Details attached <input type="checkbox"/> Details not attached	
5	Digital Points to write	-----Nos. <input type="checkbox"/> Details attached <input type="checkbox"/> Details not attached	
6	Memory / Flag Points to read	-----Nos. <input type="checkbox"/> Details attached <input type="checkbox"/> Details not attached	
7	Memory / Flag Points to write	-----Nos. <input type="checkbox"/> Details attached <input type="checkbox"/> Details not attached	

D Hardware Specific :

1	Cable type	<input type="checkbox"/> Boolean cable <input type="checkbox"/> Twisted pair cable	
2	Cable Details Enclosed	<input type="checkbox"/> Yes <input type="checkbox"/> No	
3	Any specific Converter required	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Details enclosed	

E Device Documents :

1	Manufacturer's Documents*	<input type="checkbox"/> Tech., Spec. <input type="checkbox"/> Operating Manual	

***Notes:**

A6 To identify converter requirement and cable length.

C The sr.no.1 to 7 are reqd.to be furnished for interface impl. :such as Tagname,Description,point type, modbus(Register) address,EU,range & device (dlave) address

C1 What is the primary purpose of the communications link?

E1 Reqd. Contents : This document must provide an overview of the device including its intended use(a general technical,communication & electrical details)

	FGD FOR NORTH CHENNAI TPP STAGE-III (1 X 800 MW)	
	TECHNICAL SPECIFICATION (C&I) FOR COMPRESSED AIR SYSTEM	

**INSTRUMENTATION CABLE, CABLE
INTERCONNECTION AND TERMINATION
PHILOSOPHY**



13.3.8 Instrumentation cable interconnection and termination philosophy

The cable interconnection philosophy to be adopted shall be such that extensive grouping of signals by large scale use of field mounted Group JBs at strategic locations (where large concentration of signals are available, e.g. switchgear) is done and consequently cable with higher number of pairs are extensively used. The details of termination to be followed are mentioned below.

Application		Type of termination		Type of cable
FROM (A)	TO (B)	END A	END B	
Valves/ Dampers drives (Integral Junction box)			Post Mounted Maxi termi/ cage clamp type	N
Transmitters			Maxitermi/ cage clamp (rail mounted) type	M
MCC/SWGR			Post mounted Maxi termi/ cage clamp type	N
Local Junction box, MCC / SWGR			Maxitermi/ cage clamp (rail mounted) type	N
Field mounted Instrument / Switches			Maxitermi/ cage clamp (rail mounted) type	N
Inter marshalling termination cabinet			Post mounted Maxitermi / cage clamp type	M & N
Marshalling termination in cabinet			Plug-in connector / Cage clamp type (rail mounted)	M & N
Motor current transducer in MCC			Plug in connector/ Cage clamp type (rail mounted)	M
PLC cabinets			Plug in connector	Mfr's std. However, connection between PLC and the remote I/Os shall be through fibre optic cable by Bidder if length is >300 M & coaxial cable if length <300 M
Detectors / Any loop device	Detector / Isolator / Interface Unit	-	-	Shielded twisted, fire survival mica glass tape cable confirming to IEC 331 & BS6387



Application		Type of termination		Type of cable
FROM (A)	TO (B)	END A	END B	
				(which shall with stand 950 °C for 3 hrs).
JB	Fire Alarm Panel			Shielded twisted, Fire survival mica glass tape cable confirming to IEC 331 & BS6387 (which shall with stand 950 °C for 3 hrs).

13.3.9 Cable installation and Routing

All cables assigned to a particular duct/conduit shall be grouped and pulled in simultaneously using cable grips and suitable lubricants. Cables removed from one duct/conduit shall not be reused without approval of Owner.

Cables shall be segregated as per IEEE Std.-422. In vertically stacked trays, the higher voltage cable shall be in higher position and instrumentation cable shall be in bottom tier of the tray stack. The distance between instrumentation cables and those of other system shall be as follows:

From 11 kV/6.6 kV/3.3 kV tray system

From 415V tray system

From control cable tray system

Cables shall terminate in the enclosure through cable glands. All cable glands shall be properly gasketed. Fire proof sealing to prevent dust entry and propagation of fire shall be provided for all floor slots used for cable entrance.

All cables shall be identified by tag. Nos. provided in Owner's approved format at both the ends as well as at an interval of 5 meters.

Line voltage drop due to high resistance splices, terminal contacts, insulation resistance at terminal block, very long transmission line etc. shall be reduced as far as practicable.

The cables emanating from redundant equipment / devices shall be routed through different routes.

13.3.10 Cable laying and Accessories

A) Cable laying

Cables shall be laid strictly in line with cable schedule.

B) Identification tags for cables:

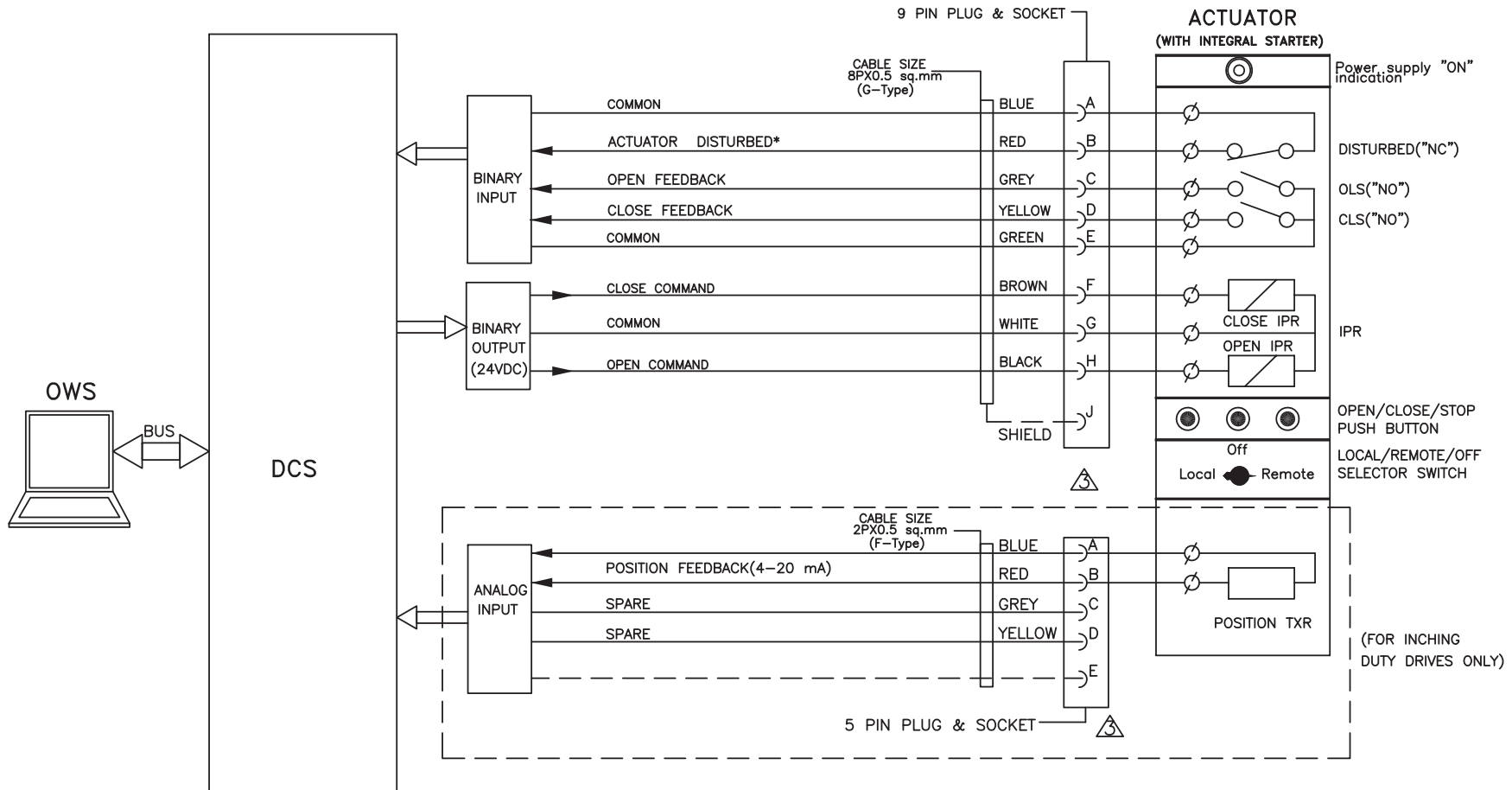
Indelible tags to be provided at all terminations, on both sides of wall or floor crossing, on each conduit/duct/pipe entry/exit, and at every 20 m in cable trench/tray.

	FGD FOR NORTH CHENNAI TPP STAGE-III (1 X 800 MW)	
	TECHNICAL SPECIFICATION (C&I) FOR GYPSUM DEWATERING EQUIPMENT	

**SIGNAL INTERFACE
BETWEEN
DRIVES AND DCS**

PRODUCED BY AN AUTODESK EDUCATIONAL PRODUCT

DCS INTERFACE FOR BIDIRECTIONAL DRIVE(WITH INTEGRAL STARTER)



NOTE:





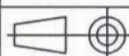
- * DISTURBED= LOSS OF POWER SUPPLY (1 PHASE/3 PHASE)/ LOSS OF CONTROL SUPPLY/ MOTOR THERMOSTAT TRIP/THERMAL OVER LOAD/TORQUE OPEN/CLOSE CUTOFF LOCAL/OFF/REMOTE SEL. SWITCH IN LOCAL OR OFF MODE/STOP PB OPTD.
- POSITION FEEDBACK OF BIDIRECTIONAL INCHING DUTY DRIVES IN VICINITY MAY BE GROUPED TOGETHER IN THE FIELD DURING CABLE ENGG. USING JUNCTION BOXES & SINGLE TRUNK CABLE OF HIGHER SIZE MAY BE USED TO CONNECT.

	PROJECT: 1X800 MW TANGEDCO NORTH CHENNAI TPP STAGE III-BTG		DRG.NO. :PE-DM-423-145-1002
	TITLE DDCMIS INTERFACE FOR BIDIRECTIONAL DRIVE		DATE 31.10.2017
			REV.NO. 06
			SHT 7 OF 11

PRODUCED BY AN AUTODESK EDUCATIONAL PRODUCT

PRODUCED BY AN AUTODESK EDUCATIONAL PRODUCT

STANDARD CHECKLIST FOR C&I INSTRUMENTS FOR MAUX PACKAGES

PROJECT		REVIEWED BY				
	BHARAT HEAVY ELECTRICALS LTD. POWER SECTOR PROJECTS ENGINEERING MANAGEMENT NOIDA	DEPT CODE	NAME	SIGN	DATE	
		I	DESN	RK		18/03/14
			CHD	MK		18/03/14
			APPD	BS		18/03/14
TITLE STANDARD CHECKLIST FOR C&I INSTRUMENTS FOR MAUX PACKAGES						
		DEPT.	SCALE	DRAWING NO.		
		SIGN		PED-CL-999-145-1104		
		DATE		SHEET 1	OF 16	
				REV.	00	



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

CHECK LIST FOR FLOW SWITCH

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECK FOR	100%	APPROVED SPEC./ DATA SHEETS	P	W	V	
	TYPE						
	RANGE						
	MODEL / TAG No.						
	END CONNECTION						
	DIMENSIONS						
	SIZE						
2	ACCURACY & REPEATABILITY (WET CALIBRATION)	100%		P	W	V	
3	HV / IR	100%		P	W	V	
4	CONTACT RATING / No. OF CONTACTS	RANDOM	P	W	V		
5	MATERIAL TC FOR BODY, WET PARTS, SENSING ELEMENT	ONE / LOT	P	W	V		
6	ACCESSORIES AS APPLICABLE	100%	P	W	V		
7	DEGREE OF PROTECTION	ONE / LOT	P	W	V		
8	OVER PRESSURE TEST	100%	P	W	V		

Legend :

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

Note :

- Quantum of check shall be as below :
100 % - By Manufacturer
- Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
- Manufacturer to carry out routine test for 100%
- Contractor to provide compliance certificate for tests/checks verified by contractor and submit the same alongwith test certificates to be verified by BHEL.



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

CHECK LIST FOR TEMPERATURE SWITCH

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

Legend :

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

Note :

- Quantum of check shall be as below :
100 % - By Manufacturer
- Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
- Contractor to provide compliance certificate for tests/checks verified by contractor and submit the same alongwith test certificates to be verified by BHEL.
- Manufacturer to carry out routine test for 100%



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

CHECK LIST FOR PRESSURE SWITCH

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks	
				M	C	B		
1	CHECK FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS	P	V	V		
	1.1 MODEL NO/TAG NO							
	1.2 RANGE							
	1.3 END CONN							
	1.4 NO. OF CONTACT							
2	CALIBRATION				P	V	V	
	2.1 REPEATABILITY							
	2.2 SET POINT ADJUSTMENT							
	2.3 DIFFERENTIAL							
3	OVER PR & LEAK TEST				P	V	V	
4	ELECT. INSULATION/HV TEST	ONE		P	V	V		
5	REVIEW OF TC FOR MATERIALS OF	FOR LOT		V	V	V		
	5.1 SENSOR							
	5.2 MOVEMENT							
	5.3 PROCESS CONNECTION							
	5.4 HOUSING							
6	REVIEW OF TC FOR DEGREE OF PROTECTION	TYPE TEST		V	V	V		
7	REVIEW OF TC OF MICROSWITCH	FOR LOT		V	V	V		

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Note :

- Quantum of check shall be as below :
100 % - By Manufacturer
- Manufacturer to carry out ROUTINE TEST on 100 %.
- Contractor to provide compliance certificate for tests/checks verified by contractor and the same alongwith test certificates to be verified by BHEL



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

CHECK LIST FOR ANALYTICAL INSTRUMENTS

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

Legend :

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P = Perform, W = Witness, V = Verification

Note :

- Quantum of check shall be as below :
100 % - By Manufacturer
- Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
- Contractor to provide compliance certificate for tests/checks verified by contractor and submit the same alongwith test certificates to be verified by BHEL.



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

CHECK LIST FOR ANNUNCIATORS

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECK FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS	P	W	V	
	TYPE/ MODEL						
	DIMENSIONS OF HARDWARE						
	MODULARITY						
	SEQUENCE						
	FACIA DETAILS						
2	FUNCTIONAL TEST	100%		P	W	V	
3	IMMUNE TO STEP VARIATIONS IN THE POWER SUPPLY	SEE NOTE-1 BELOW		P	W	V	
4	DEGREE OF PROTECTION FOR ENCLOSURE	TYPE TEST		P	W	V	
5	I/R CHECK	SEE NOTE-1 BELOW		P	W	V	
6	RESPONSE			P	W	V	

Legend :

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

Note :

- Quantum of check shall be as below :
100 % - By Manufacturer
- Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
- Manufacturer to carry out ROUTINE TEST on 100 %.
- Contractor to provide compliance certificate for tests/checks verified by contractor and submit the same alongwith test certificates to be verified by BHEL.



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

CHECK LIST FOR TRANSMITTER

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECKS FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS	P	W	V	
	VISUAL.						
	MODEL/TAG No						
2	PROCESS CONNECTION			P	W	V	
3	ACCURACY			P	W	V	
4	REPEATABILITY			P	W	V	
5	HYSTERESIS	P		W	V		
6	EFFECT OF TEMP VARIATION ON ACCURACY	P		W	V		
7	SPAN / ZERO ADJUSTMENT	ONE / TYPE		P	W	V	
8	EFFECT OF SUPPLY VOLTAGE VARIATION			P	W	V	
9	EFFECT OF LOADING (500 OHM METERS)			P	W	V	
10	HIGH PRESSURE TEST	SEE NOTE-1 BELOW		P	W	V	
11	BURN-IN TEST	ONE / TYPE		P	W	V	
12	DEGREE OF PROTECTION		P	W	V		
13	ACCESSORIES AS APPLICABLE	SEE NOTE-1 BELOW	V	V	V		

Legend :

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Note :

- Quantum of check shall be as below :
100 % - By Manufacturer
- Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
- When material correlation are not available manufacturer's compliance to be provided.
- Contractor to provide compliance certificate for tests/checks verified by contractor and submit the same alongwith test certificates to be verified by BHEL.



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

CHECK LIST FOR TEMPERATURE ELEMENT

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

Legend :

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P = Perform, W = Witness, V = Verification

Note :

- Quantum of check shall be as below :
100 % - By Manufacturer
- Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
- Contractor to provide compliance certificate for tests/checks verified by contractor and submit the same alongwith test certificates to be verified by BHEL.
- IBR certificate to be provided, if applicable



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

CHECK LIST FOR MAGNETIC TYPE FLOW METER

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks		
				M	C	B			
1	CHECK FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS	P	W	V			
	MODEL								
	TAG No								
	VISUAL								
2	DIMENSIONS,				P	W		V	
3	PROCESS CONNECTION				P	W		V	
4	RANGE / SCALE				P	W		V	
5	ACCURACY				P	W		V	
6	MATERIAL TC FOR METERING TUBE, ORIFICE PLATE, FLANGES AND FASTNER				P	V		V	
7	CALIBRATION REPORT			ONE / SIZE		P		V	V
8	ACCESSORIES AS APPLICABLE	SEE NOTE-1 BELOW		V	V	V			
9	TC FOR DEGREE OF PROTECTION	TYPE TEST		V	V	V			

Legend :

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

Note :

- Quantum of check shall be as below :
100 % - By Manufacturer
- Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
- Manufacturer to carry out ROUTINE TEST on 100 %.
- Contractor to provide compliance certificate for tests/checks verified by contractor and the same alongwith test certificates to be verified by BHEL



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

CHECK LIST FOR SOLENOID VALVES

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks			
				M	C	B				
1	CHECK FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS	P	W	V				
	TYPE									
	MAKE									
	MODEL No.									
2	MATERIAL (BODY. PLUNGER/TRIM)					P		W	V	
3	PORT SIZE					P		W	V	
4	CABLE CONNECTION SIZE					P		W	V	
5	ENCLOSURE CLASS					P		W	V	TYPE TEST CERTIFICATE TO BE FURNISHED BY VENDOR
6	No. OF COILS & INSULATION CLASS					P		W	V	TEST CERTIFICATE TO BE FURNISHED FOR INSULATION CLASS BY VENDOR
7	POWER SUPPLY CHECK			P	W	V				
8	IR / HV TEST			P	W	V				
9	FUCTIONAL TEST			P	W	V				

Legend :

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P = Perform, W = Witness, V = Verification

Note :

- Quantum of check shall be as below :
100 % - By Manufacturer
- Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
- Contractor to provide compliance certificate for tests/checks verifid by contractor and submit the same alongwith test certificates to be verified by BHEL.



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

CHECK LIST FOR TEMPERATURE GAUGE

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECK FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS	P	W	V	
	DIAL SIZE						
	MODEL NO./TAG NO./TYPE						
	RANGE/SCALE						
	END CONNECTION						
2	CALIBRATION	1 OF TYPE	APPROVED SPEC./ DATA SHEETS	P	W	V	
	ACCURACY						
	REPEATABILITY						
	HYSTERESIS						
3	OVER TEMP. TEST	FOR LOT	APPROVED SPEC./ DATA SHEETS	P	W	V	
4	AMBIENT TEMP. COMPENSATION CHECK			P	V	V	
5	REVIEW OF TC FOR MATERIALS OF			TYPE TEST	AS PER APPD DWG	V	
	SENSOR						
	MOVEMENT						
	PROCESS CONNECTION						
	THERMOWELL						
6	REVIEW OF TC FOR DEGREE OF PROTECTION	SEE NOTE-1 BELOW	AS PER APPD DWG	V	V	V	
7	THERMOWELL	SEE NOTE-1 BELOW	AS PER APPD DWG		V	V	
	MATERIAL TC & DIMN. CHECK						
	HYD. TEST						
	OVER RANGE TEST						

Legend :

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Note :

- Quantum of check shall be as below :
100 % - By Manufacturer
- Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
- Manufacturer to carry out ROUTINE TEST on 100 %.
- IBR certificate to be provided if called for in specn.
- Contractor to provide compliance certificate for tests/checks verified by contractor and submit the same alongwith test certificates to be verified by BHEL.



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

CHECK LIST FOR PRESSURE & DP GAUGE

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks	
				M	C	B		
1	CHECK FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS	P	W	V		
	SENSOR TYPE							
	DIAL SIZE							
	MODEL NO/TAG NO							
	RANGE/SCALE							
	SWITCH CONTACT RATING & NOS.							
	END CONNECTION							
2	CALIBRATION	ONE	APPROVED SPEC./ DATA SHEETS	P	W	V		
	ACCURACY							
	REPEATABILITY							
	SET POINT ADJUSTMENT							
3	OVER PRESSURE & LEAK TEST			P	W	V		
4	OPERATION OF PRESSURE. RELIEF DEVICE	ONE			P	W	V	
5	REVIEW OF TC FOR	FOR LOT	APPROVED SPEC./ DATA SHEETS	V	V	V		
	MATERIALS OF SENSOR							
	MOVEMENT							
	PROCESS CONNECTION							
6	REVIEW OF TC FOR DEGREE OF PROTECTION	TYPE TEST			V	V	V	
7	ACCESSORIES AS APPLICABLE	SEE NOTE-1 BELOW			V	V	V	

Legend :

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Note :

- Quantum of check shall be as below :
100 % - By Manufacturer
- Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
- Manufacturer to carry out ROUTINE TEST on 100 %.
- When material correlation is not available, MFR's compliance to be provided
- Contractor to provide compliance certificate for tests/checks verified by contractor and submit the same alongwith test certificates to be verified by BHEL.



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

CHECK LIST FOR SIGHT FLOW INDICATOR

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks		
				M	C	B			
1	CHECK FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS	P	W	V			
	MODEL								
	TAG No.								
	VISUAL								
2	DIMENSIONS,				P	W		V	
3	PROCESS CONNECTION				P	W		V	
4	RANGE / SCALE				P	W		V	
5	ACCURACY				P	W		V	
6	MATERIAL TC FOR METERING TUBE, ORIFICE PLATE, FLANGES AND FASTNER				P	V		V	
7	CALIBRATION REPORT	ONE / SIZE		P	V	V			
8	ACCESSORIES AS APPLICABLE	SEE NOTE-1 BELOW		V	V	V			
9	TC FOR DEGREE OF PROTECTION	TYPE TEST		V	V	V			


Legend :

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P = Perform, W = Witness, V = Verification

Note :

- Quantum of check shall be as below :
100 % - By Manufacturer
- Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
- Manufacturer to carry out ROUTINE TEST on 100 %.
- Contractor to provide compliance certificate for tests/checks verified by contractor and the same alongwith test certificates to be verified by BHEL

KKS PHILOSOPHY

	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
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 --- <i>Equipment Code – AA</i>	
	<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 (Open / Close duty (Valves, NRVs, Gate)	- 2 01 to 99
Hydraulic	- 3 01 to 99

		DOCUMENT TITLE	
		KKS NUMBERING PHILOSOPHY	
	NRV (Without actuation)	-	4 01 to 99
	Manual	-	5 01 to 99
	Manual	-	6 01 to 99
	Relief & Safety Valves	-	7 01 to 99
	Reserve	-	8 01 to 99
	Reserve	-	9 01 to 99
ii) Field Instruments			
	Field Transmitters & Analog Signals	-	0 01 to 99
	Field Switches & Binary Signals	-	1 00 to 99
	PG Test Point	-	4 00 to 99
	Gauges	-	5 00 to 99
	Automatic Turbine Tester (ATT)-HWR	-	2 00 to 99
(Reserved for protection Signals used by Hardwar)			
Example of Numerical Key Usage:			
<p>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.</p>			



**C&I SPECIFICATION FOR
GYPSUM DEWATERING SYSTEM**

SECTION: C
SUB SECTION: C&I

MANDATORY SPARES

SUB-VENDOR LIST FOR C&I ITEMS

SI No	Package Code	Package Name	Supplier Name	Supplier Communication Address	Supplier Works Address	Tech Limit	Fin Limit
10	145-04000-A	CONTROL VALVE	BOMAFA SPECIAL VALVE SOLUTIONS PVT LTD	Mr. K.M. Anklesaria/ R. M. Anklesaria Plot No: 285/2, Panchratna Estate, Near Ramol Bridge, Vatva Ahmedabad Phone- 079-40083825 Pincode : 382445 Email : info@bomafa- india.com	Works-1->Mr. K.M. Anklesaria/ Mr. R.M. Anklesaria Dir Plot No: 285/2, Panchratna Estate, Near Ramol Bridge, Vatva, - Ahmedabad-GUJARAT INDIA Phone- 079-40083825 FAX : Pincode : 382445 Email : info@bomafa-india.com		
11	145-04000-A	CONTROL VALVE	DRESSER VALVE INDIA PVT. LTD	Mr. Raj Raman/Mr. Rajkumar Moria S.F. No: 608,Chettipalayam Road, Echanari Post, Coimbatore Phone- +91-98451 19085 Pincode : 641021 Email : Anoop.Ramachandran@ge.com	Works-1->Mr. Anoop Ramchandran S.F. No: 608,Chettipalayam Road, Echanari Post, -Coimbatore-TAMIL NADU INDIA Phone- +919500978296 FAX : +91 4223011200 Pincode : 641021 Email : Anoop.Ramachandran@ge.com		
12	145-04000-A	CONTROL VALVE	Severn Glocon India Pvt. Ltd.	F96 & F97, Sipcot Industrial Park, Irungattukottai, Chennai, Phone- 044-47104200, Pincode : 602117, Email : info@severnalocon.co.in.	Works-1->Mr. K.Kaushik, F96 & F97, Sipcot Industrial Park,Irungattukottai, -Chennai-TAMIL NADU India Phone- 044-47104200, FAX : 044-47100073, Pincode : 602117, Email : info@severnalocon.co.in		
13	145-04000-A	CONTROL VALVE	EMERSON PROCESS MANAGEMENT CHENNAI LIMITED	147, KARAPAKKAM VILLAGE, CHENNAI Phone- 23722184, 23716242 Pincode : 600096 Email : jatinder.singh@emerson.com	Works-1->Mr. Rangarajan (Head - Lean and Manufact 147,Karapakkam Village, -Chennai-TAMIL NADU India Phone- 0444903 4395 FAX : Pincode : 600097 Email : Rangaraian.M@emerson.com		
14	145-04000-A	CONTROL VALVE	WALDEMAR PRUSS ARMATURENFABRIK GMBH	Mr. Winfried Dremhel Schulenburglandstrasse 261, Hannover Phone- +49-511279260 Pincode : 30419 Email : dremhel@pruss.de; voegel@pruss.de	Works-1->Mr. Winfried Dremhel CEO Schulenburglandstrasse 261, -Hannover- GERMANY Phone- +49-511279260 FAX : Pincode : 30419 Email : dremhel@pruss.de		
15	145-06000-A	PRESSURE SWITCH/DIFF. PRESSURE SWITCH	SWITZER PROCESS INSTRUMENTS PVT. LTD.	Mr. V S Jayaprakash, 128, SIDCO North Phase, Ambattur Estates CHENNAI Phone- 044-26252017/2018 Pincode : 600050 Email : sales@switzernprocess.co.in	Works-1->C S Shankar 127, Sidco North Phase, Ambattur Estates, -CHENNAI-TAMIL NADU INDIA Phone- 8754491904 FAX : 044-26248849 Pincode : 600050 Email : cservice@switzerinstrument.com		
16	145-06000-A	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			
17	145-06000-A	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			
18	145-06000-A	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			
19	145-06000-A	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	Works-1->Mr. Hitesh Parmar/Mr. Hitesh Parmar Plot No.2306, Phase II, GIDC Chhatral, -Kalol-GUJARAT INDIA Phone- 9327359227 FAX : 02764-233440 Pincode : 382729 Email : hitesh.parmar@ashcroftindia.com		

SUB-VENDOR LIST FOR C&I ITEMS

SI No	Package Code	Package Name	Supplier Name	Supplier Communication Address	Supplier Works Address	Tech Limit	Fin Limit
20	145-06000-A	PRESSURE SWITCH/DIFF. PRESSURE SWITCH	INDFOS INDUSTRIES LIMITED	B-20-21, INDUSTRIAL AREA, MEERUT ROAD, GHAZIABAD Phone- 0120-2712016 Pincode : Email : mkt@indfos.com			
21	145-06000-A	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			
22	145-06000-A	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	Works-1->LARRY DEGARMO/ ROY STUMBOUGH 14685 W. 105TH STREET, LENEXA -KANSAS- USA Phone- 913-888-0767 FAX : 913-888-0767 Pincode : 66215 Email : rstumbough@sorinc.com		
23	145-06000-A	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,			
24	145-08000-A	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	Works-1->NA NA -- Phone- FAX : Pincode : Email :		OVERALL PENDING ORDER VALUE (EXCLUDING VALUE OF ORDERS ALREADY EXECUTED) FOR ALL PACKAGES FOR WHICH VENDOR IS REGISTERED SHALL NOT EXCEED RS. 1.0 CRORE
25	145-08000-A	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	Works-1->Mr. Gautam Mukherjee Kusumba,Sonarapur Station Road,P.O. -Narendrapur, -Kolkata-WEST BENGAL INDIA Phone- 9836878855 FAX : 033-24342748 Pincode : 700103 Email : gkm_ani@hotmail.com		
26	145-08000-A	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	Works-1->Mr. Partha Bose 44, Saheed Hemanta Kumar Bose,Sarani, -Kolkata-WEST BENGAL India Phone- +91 33 2548 7220 FAX : +91 33 2548 0429, Pincode : 700074 Email : parthabosebpi@gmail.com bosepanda@vsnl.net		

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SI No	Package Code	Package Name	Supplier Name	Supplier Communication Address	Supplier Works Address	Tech Limit	Fin Limit
27	145-08000-A	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@nrecisionmass.com	Works-1->Mr. Hitesh Parmar/Mr. Hitesh Parmar Plot No.2306, Phase II, GIDC Chhatral, -Kalol-GUJARAT INDIA Phone- 9327359227 FAX : 02764-233440 Pincode : 382729 Email : hitesh.parmar@ashcroftindia.com		
28	145-08000-A	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	Works-1->Shikha Hazra/ Shyamal Hazra 32, Industrial Suburb,Yeshwanthpur -BANGALORE-KARNATAKA INDIA Phone- 080-23370300 FAX : 080-23379890 Pincode : 560022 Email : shikhahazra@hgurusouth.com		
29	145-08000-A	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	Works-1->Mr. Shyam Warilani/Mr. V Suresh Babu Plot No 34 À GIDC À Phase 1, -VAPI-GUJARAT INDIA Phone- +91 11 4161 7111 FAX : 022 2687 3613 Pincode : 396 195 Email : pbajaj@baumer.com		
30	145-08000-A	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	Works-1->MR G.SRINIVASAN/MR ANUJ MALPANI PLOT NO:A-19/2 & T-4/2,I.DA. NACHARAM , -HYDERABAD- TELANGANA INDIA Phone- 09866550762 FAX : 040 27152193 Pincode : 560076 Email : gshrinivasan@forbesmarshall.com		
31	145-08000-A	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	Works-1->Gauge Bourdon India Pvt. Ltd., Plot No-4, 5, 6,Jawahar Co-operative Industrial Estate, -Kalamboli Taluka Panvel-MAHARASHTRA India Phone- 022-27421095, FAX : 022-27421901, Pincode : 410209, Email : info@general- gauges.com		
32	145-08000-A	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	Works-1-> Others 26/2, G Type, Global Ind. Park Near Nahuli Railway Crossing, -Vapi-GUJARAT INDIA Phone- 9920576002 FAX : Pincode : 396105 Email : sales@nesstech.co.in, bkapadia@nesstech.co.in		
33	145-08000-A	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 : sdbnl@vsnl.com	Works-1->Scientific Center, Others By-Pass Junction,Near Kalsekar College kausa, mumbra,Thane -Mumbai- MAHARASHTRA INDIA Phone- 022-25491409,9892230623 FAX : Pincode : 400612 Email : sdbpl@vsnl.com		
34	145-14000-A	TRANSMITTERS	YOKOGAWA INDIA LIMITED,	PLOT NO.96, ELECTRONICS CITY COMPLEX, HOSUR ROAD, BANGALORE, Phone- 080-41586000, Pincode : Email : udav.shankar@in.yokogawa.com	Works-1-> PLOT NO.96, ELECTRONICS CITY COMPLEX, HOSUR ROAD, -BANGALORE-KARNATAKA INDIA Phone- 080- 41586000, FAX : 080-28521442, Pincode : Email : udav.shankar@in.yokogawa.com		
35	145-14000-A	TRANSMITTERS	ABB INDIA LIMITED	MR. RAJIV GOVIL 14, MATHURA ROAD, FARIDABAD Phone- 09971085678 Pincode : 121003 Email : vipin.swami@in.abb.com		PRESSURE TRANSMITTER, DP TRANSMITTER and TEMP TRANSMITTER	

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SI No	Package Code	Package Name	Supplier Name	Supplier Communication Address	Supplier Works Address	Tech Limit	Fin Limit
36	145-14000-A	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	Works-1->Mr. BHAGWAN SINGH/ Mr. NANDAN SINGH F-61, OKHLA INDL.AREA,PHASE-I -NEW DELHI-DELHI INDIA Phone- 011-47627200 Extn. 3 FAX : 011- 26819440 Pincode : 110 020 Email : production@vautomat.com	a)DISPLACEMENT TYPE TRANSMITTERS. b)PRESSURE AND DP TRANSMITTERS	
37	145-14000-A	TRANSMITTERS	Pune Techtrol Pvt. Ltd.	N.P.Khatan/Sudhakar Badiger S-18, MIDC Bhosari, Pune Phone- 9850560042 Pincode : 411 026 Email : ho@punetechtrol.com		Only for capacitance Type Level Transmitter	
38	145-14000-A	TRANSMITTERS	TOSHNIWAL INDUSTRIES PVT. LTD.,	Industrial Estate, Makhupura, Ajmer, Phone- 9352009000, Pincode : 305002, Email : info@tipl.com,	Works-1-> Khasra No.: 218-230& 235, Industrial Estate,Makhupura, -Ajmer-RAJASTHAN India Phone- 9887865856, FAX : 0145-2695174, Pincode : 305002, Email : raieev.quota@tipl.com		
39	145-14000-A	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	Works-1->MR. MOHAN PADWAL 691/A/2,BIBWEWADI INDL ESTATE -PUNE-MAHARASHTRA INDIA Phone- 918600042374 FAX : 912024215670 Pincode : 411037 Email : wm@sbem.co.in	FOR CAPACITANCE TYPE.	
40	145-14000-A	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	Works-1-> M-171 to 173, MIDC, Waluj, -Aurangabad- MAHARASHTRA India Phone- 9881000474, FAX : 0240-2555179, Pincode : 431136, Email : Narendra.Kulkarni@wetzler.endress.com	"Except Displacement Type Level Transmitters"	
41	145-14000-A	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	Works-1->Matt Moren/Gina Cruz 16650 Schoenborn St., North Hills -CALIFORNIA- USA Phone- +1 818 894 7111, ext FAX : +1 818 830 5588 Pincode : 91343 Email : gcruz@miinet.com		
42	145-14000-A	TRANSMITTERS	PANAM ENGINEERS	Mr. Santosh Shukla 203, Jaisingh Business,Parsiwada, Sahar road,Andheri(East), Mumbai, Phone- 9892179529, Pincode : 400099, Email : santosh@panamengineers.com	Works-1->Mr. Santosh Shukla Others R-628,TTC Industrial Area, MIDC Rabale, -Navi Mumbai-MAHARASHTRA India Phone- 9821350761, FAX : 022-27695559, Pincode : 400701, Email : sales@panamengineers.com	For Pressure and Diff. Pressure transmitter	
43	145-14000-A	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	Works-1->Mr.Kedar Tillu 53, 54, 56 & 57,Hadapsar Industrial Estate -PUNE-MAHARASHTRA INDIA Phone- 9665034625 FAX : 020 66039905 Pincode : 411013 Email : kedar.tillu@honeywell.com		
44	145-14000-A	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	Works-1->Kalpesh Chandan/Hrishikesh Aghor Plot No. A 145/4 TTC IND AREA,MIDC, PAWANE, -NAVI MUMBAI- MAHARASHTRA INDIA Phone- 9619688001 FAX : 022-66736000 Pincode : 400 705 Email : Kalpesh.chandan@emerson.com		

SUB-VENDOR LIST FOR C&I ITEMS

SI No	Package Code	Package Name	Supplier Name	Supplier Communication Address	Supplier Works Address	Tech Limit	Fin Limit
45	145-14000-A	TRANSMITTERS	SMART INSTRUMENTS LTD, BRAZIL	Agents: Digital Electronic Ltd. 74/11 'C' Cross Road MIDC Andheri (East) MUMBAI Phone- 28208477 Pincode : 400093 Email : corp@delbby.rpgms.ems.vsnl.net.in		LD-301 & T-301 TRANSMITTER FROM M/S SMART EQUIPMENTS BRAZIL.	
46	145-14000-A	TRANSMITTERS	SIEMENS LIMITED	Dr. Armin Bruck/Sandeep Mathur 130, Pandurang Budhkar Marg Worli Mumbai Phone- 0124 383 7377 Pincode : 400018 Email : ankit.varshnev@siemens.com	Works-1->Ankit Varshney Kalwa Works, Thane-Belapur Road, Thane, -MUMBAI-MAHARASHTRA INDIA Phone- FAX : Pincode : 400708 Email :		
47	145-14000-A	TRANSMITTERS	NIVO CONTROLS PVT. LTD.	Mr. Praveen Toshniwal 104-115, Electronic Complex, Indore Phone- 0731-4081305 Pincode : 452010 Email : sales@nivocontrols.com	Works-1->Mr. Praveen Toshniwal 104-115, Electronic Complex, -Indore-MADHYA PRADESH India Phone- 0731-4081305 FAX : 0731-255075 Pincode : 452010 Email : sales@nivocontrols.com	For Capacitance type only	
48	145-21000-A	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			
49	145-25000-A	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			
50	145-25000-A	JUNCTION BOX	SUCHITRA INDUSTRIES	NO-2,OPP-27 AECS LAYOUT 2ND STG REJAMAHALVILAS EXTN 2ND STG BANGALORE Phone- Pincode : Email : suchitra_industriesblr@gmail.com	Works-1->B. Srinivas Suchitra Industries, Opp No 53, Muneshwara Black Devinagar, Lottagal hal -BANGALORE-KARNATAKA INDIA Phone- 080-23511247 FAX : Pincode : 560094 Email : suchitra_industries@yahoo.com		
51	145-25000-A	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, pulin@sumip.com	Works-1->Mr.Pulin Shah/ Mr. Kaloesh Parmar 39 A/3 ,Panchratna Industrial Est,Sarkhej-Bavla Road, Changodhar - Ahmedabad-GUJARAT INDIA Phone- 98250 80339 1 FAX : 079-26932424 Pincode : 382213 Email : sales@sumip.com		
52	145-25000-A	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	Works-1->Mr. Dineshbhai Zaveri CEO C-1/ 27&37, GIDC, Kabilpore, -Navsari-GUJARAT INDIA Phone- 02637-265140,265003 FAX : 02637-265308 Pincode : 396424 Email : flexpro@flexproltd.com	Metal type junction box only	
53	145-25000-A	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	Works-1->JIGNESH MAHENDRA AJMERA DENA BANK BLDG., SHREE NAGESHINDL. ESTATE,STATION ROAD, - MUMBAI-MAHARASHTRA INDIA Phone- 022 67973578 FAX : Pincode : 400 088 Email : ajmera@ajmera.net		

SUB-VENDOR LIST FOR C&I ITEMS

SI No	Package Code	Package Name	Supplier Name	Supplier Communication Address	Supplier Works Address	Tech Limit	Fin Limit
54	145-32000-A	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	Works-1->S.R.SINGH/ NAVEEN SINGH B - 2, SECTOR - 6, - NOIDA-UTTAR PRADESH INDIA Phone- 0120-4352940 FAX : 0120-4352940 Pincode : 201301 Email : naveensingh@vsnl.com		Over all financial limit for ordering as Rs.30 lacs (Rs.Thirty Lacs). The registration category & the financial limit may be reviewed after survey in March 2009 and approval thereof. Registered w.e.f. 22.01.2009.
55	145-32000-A	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	Works-1->Mr. Tansen Choudhari/Mr. Mahesh Darekar Shed No.8, Lonavla Indl.Co-op.Estate Ltd,Nagargaon, - Lonavla-MAHARASHTRA INDIA Phone- 9823951347 FAX : (02114) 271132 Pincode : 410 401 Email : factory@hyd-air.com		
56	145-32000-A	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	Works-1->ALEX BAPTIST/ K. SRINIVAS 7. SIDHAPURA INDUSTRIAL ESTATE,SV ROAD, GOREGAON(WEST) - MUMBAI-MAHARASHTRA INDIA Phone- 022-42631700 FAX : 022-40035259 Pincode : 400 062 Email : srinivas@precision-engg.com		
57	145-32000-A	INSTRUMENTS TUBE FITTINGS	AURA INCORPORATED	NIRAJ SHARAN/SUJIT KUMAR W-167A, GREATER KAILASH-II NEW DELHI Phone- 9810182430 Pincode : 110048 Email : niraj@aurainc.com			
58	145-38000-A	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	Works-1->S.R.SINGH/ NAVEEN SINGH B - 2, SECTOR - 6, - NOIDA-UTTAR PRADESH INDIA Phone- 0120-4352940 FAX : 0120-4352940 Pincode : 201301 Email : naveensingh@vsnl.com		Over all financial limit for ordering as Rs.30 lacs (Rs.Thirty Lacs).
59	145-38000-A	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	Works-1->Mr. Tansen Choudhari/Mr. Mahesh Darekar Shed No.8, Lonavla Indl.Co-op.Estate Ltd,Nagargaon, - Lonavla-MAHARASHTRA INDIA Phone- 9823951347 FAX : (02114) 271132 Pincode : 410 401 Email : factory@hyd-air.com		
60	145-38000-A	INSTRUMENTS PIPE FITTINGS	AURA INCORPORATED	NIRAJ SHARAN/SUJIT KUMAR W-167A, GREATER KAILASH-II NEW DELHI Phone- 9810182430 Pincode : 110048 Email : niraj@aurainc.com			
61	145-38000-A	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	Works-1->ALEX BAPTIST/ K. SRINIVAS 7. SIDHAPURA INDUSTRIAL ESTATE,SV ROAD, GOREGAON(WEST) - MUMBAI-MAHARASHTRA INDIA Phone- 022-42631700 FAX : 022-40035259 Pincode : 400 062 Email : srinivas@precision-engg.com		
62	145-45000-A	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	Works-1->S. Harichandran/ P.S. Pandi B-11, Mugappair Industrial Estate, -CHENNAI-TAMIL NADU INDIA Phone- 044-25252537 FAX : 044-26252538 Pincode : 600037 Email : sales@hpvalvesindia.com		

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SI No	Package Code	Package Name	Supplier Name	Supplier Communication Address	Supplier Works Address	Tech Limit	Fin Limit
63	145-45000-A	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	Works-1->Shahanawaz Khan Vishweshwar Ind. Premises Co-op Soc. Ltd,F-18/19, Pradhikaran,Bhosadi MIDC -PUNE- MAHARASHTRA INDIA Phone- 020-30694134 FAX : 022- 23013010 Pincode : 411026 Email : shahanawaz.khan@perfectinstrumentation.com		
64	145-45000-A	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			
65	145-45000-A	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	Works-1->ALEX BAPTIST/ K. SRINIVAS 7. SIDHAPURA INDUSTRIAL ESTATE,SV ROAD, GOREGAON(WEST) - MUMBAI-MAHARASHTRA INDIA Phone- 022-42631700 FAX : 022-40035259 Pincode : 400 062 Email : srinivas@precision-engg.com		
66	145-45000-A	INSTRUMENT FITTINGS	AURA INCORPORATED	NIRAJ SHARAN/SUJIT KUMAR W- 167A, GREATER KAILASH-II NEW DELHI Phone- 9810182430 Pincode : 110048 Email : niraj@aurainc.com			
67	145-45000-A	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	Works-1->Miss Sonal Pithadia/Miss Pavan Chavda Survey No. 23/1, Part 2, Ahmedabad-Mehsana Highway, Laxmipura - Nandasan-GUJARAT INDIA Phone- 8460848087 FAX : 2764- 267036/37 Pincode : 382705 Email : domestic@com- fit.com		
68	145-45000-A	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	Works-1->Mr. Abbas Bhola Unit No. 16, Supreme Industrial Estate,Kaman Bhiwandi Road,Devdal, -Vasai East- MAHARASHTRA India Phone- 9920044113 FAX : 07303178243 Pincode : 401208 Email : ab@fluidfitengg.com		
69	145-45000-A	INSTRUMENT FITTINGS	VIKAS INDUSTRIAL PRODUCTS	S.R.SINGH/NAVEEN SINGH B - 2, SECTOR - 6, NOIDA Phone- +91- 9810122070 Pincode : 201301 Email : naveensingh@vsnl.com	Works-1->S.R.SINGH/ NAVEEN SINGH B - 2, SECTOR - 6, - NOIDA-UTTAR PRADESH INDIA Phone- 0120-4352940 FAX : 0120-4352940 Pincode : 201301 Email : naveensingh@vsnl.com		Over all financial limit for ordering as Rs.30 lacs (Rs.Thirty Lacs).
70	145-45000-A	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	Works-1->Mr. Tansen Choudhari/Mr. Mahesh Darekar Shed No.8, Lonavla Indl.Co-op.Estate Ltd,Nagargaon, - Lonavla-MAHARASHTRA INDIA Phone- 9823951347 FAX : (02114) 271132 Pincode : 410 401 Email : factory@hyd- air.com		

SUB-VENDOR LIST FOR C&I ITEMS

SI No	Package Code	Package Name	Supplier Name	Supplier Communication Address	Supplier Works Address	Tech Limit	Fin Limit
71	145-45000-A	INSTRUMENT FITTINGS	PANAM ENGINEERS	Mr. Santosh Shukla 203, Jaisingh Business, Parsiwada, Sahar road, Andheri(East), Mumbai, Phone- 9892179529, Pincode : 400099, Email : santosh@panamengineers.com	Works-1->Mr. Santosh Shukla Others R-628, TTC Industrial Area, MIDC Rabale, -Navi Mumbai-MAHARASHTRA India Phone- 9821350761, FAX : 022-27695559, Pincode : 400701, Email : sales@panamengineers.com		

Notes :-

- i) The above sub-vendor list is tentative & for reference only. However Sub-Vendor List is subject to BHEL/ end user approval without any commercial/ delivery implication.
- ii) New Sub-Vendor if proposed by Vendor during contract stage shall be subject to BHEL/ end user approval without any commercial/ delivery implication.


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TECHNICAL SPECIFICATION

ANNEXURE-I	LIST OF MAKES OF SUB-VENDOR ITEMS
ANNEXURE-II	MANDATORY SPARE LIST
ANNEXURE-III	INSPECTION AND TESTING, QUALITY PLAN
ANNEXURE-IV	INPUT DRAWINGS (P&IDs / MECHANICAL LAYOUT DRAWINGS SHOWING LOCATION OF EQUIPMENT/ PLOT PLAN)
ANNEXURE-V	MASTER DRAWING LIST WITH SCHEDULE OF SUBMISSION
ANNEXURE-VI	PACKING PROCEDURE
ANNEXURE-VII	SEA-WORTHY PACKING PROCEDURE
ANNEXURE-VIII	PIPE & VALVE MATERIAL SPECIFICATION

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ANNEXURE-I

1. REFER ELECTRICAL AND C&I SPECIFICATION FOR APPLICABLE SUB-VENDOR LIST FOR THE RELEVANT ITEMS, FOR REFERENCE.
2. THE LIST OF ALL BOUGHT OUT ITEMS WITH MAKES AND COUNTRY OF ORIGIN AND CONTACT DETAILS OF THE MANUFACTURERS TO BE MENTIONED ALONG WITH OFFER TO BE SUBMITTED IN THE FORMAT ATTACHED IN SECTION III AS AN INFORMATION TO BHEL.
3. ACCEPTANCE OF MAKES SHALL BE SUBJECT TO BHEL/ CUSTOMER ACCEPTANCE DURING THE DETAILED ENGINEERING WITHOUT COST AND DELIVERY IMPLICATION TO BHEL.


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ANNEXURE-II


MANDATORY SPARES LIST

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Sl. No.	DESCRIPTION	Qty
I.	MECHANICAL	
1	Hydro-cyclones (Gypsum Primary Dewatering, Secondary Waste Water and any other Hydrocyclone)	
a.	Hydro-cyclone Isolation Valve	10% of each type OR 1 no. whichever is higher
b.	Hydro-Cyclone	10% of each type OR 1 no. whichever is higher
c.	Hydro-Cyclone rubber lining - feed chamber & overflow chamber	10% of each type OR 1 no. whichever is higher
d.	Vortex finder & Apex inserts	10% of each type OR 1 no. whichever is higher
2	Vacuum Belt Filter	
a.	Filter Cloth	4 sets
b.	Belt	1 sets
c.	Vacuum Box Seals	2 sets
d.	Drive Motor	1 no.
3	Vacuum Pumps	
a.	Pump Impeller Assembly	1 no.
b.	Pump Bearing	1 set
c.	Seals	1 set
d.	Motor	1 no.
e.	V Belt	1 no.
4	Vacuum Breaker Valves	
a.	Valve Assembly	1 no.
b.	Actuator	1 no.
5	Slurry Valves	4 nos. of each type and size
6	Slurry Line Bends	4 nos. of each type and size
7	Horizontal Centrifugal Pumps	
a.	Complete Impeller Assembly	1 no. of each type
b.	Casing Liners	1 set* of each type

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c.	Bearing	2 set*
d.	Motor	1 no. of each type
e.	Pump discharge valve assembly	1 nos. of each type
f.	V Belt	2 sets
II. MEASURING INSTRUMENTS		
SI. NO.	PARTICULARS	QUANTITY
1.01.00	MEASURING INSTRUMENTS	
1.01.01	(i) All type of Transmitters including sensors.	10% or 1 no. of each type and model, whichever is more.
1.01.02	1. Temperature elements	
	(i) RTD's* of each type and length(with head assembly, terminal block & nipple)	10% or 2 no. of each type & length, whichever is more.
	(ii) Thermocouples of each type like K-type, R-type, metal etc. * (with head assembly, terminal block & nipple)	10% or 2 no. of each type & length, whichever is more.
	(iii) Cold junction compensation boxes of each model (if applicable)	10% or 2 no. of each type & length, whichever is more.
	(iv) Thermostatic units for each model of CJC box (if applicable)	10% or 2 no. of each type & length, whichever is more.
	(v) Temperature transmitters	10% or 2 no. of each type & length, whichever is more.
1.01.03	(i) Limit switches (for isolation valves)	2 nos. of each type
	(ii) Local Indicators like temperature gauges, pressure gauges, differential pressure gauges, flow gauges, flow meters etc.,	5% or 1 no. of each make, model and type whichever is more (to be divided to various ranges in proportion to main of all make, model, type population)
	(iii) 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
1.01.04	Any other instrument (Flow transmitter, Density meter) (as applicable)	10% or 1 no. of each type and model whichever is more

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1.02.00	PROCESS CONNECTION PIPING (For Impulse Piping / Tubing and Air Supply Piping as Applicable)	
1.02.01	Valves of all types and models	10% or 1 no. of each type, class, size and model whichever is more.
1.02.02	2 way, 3way, 5way valve manifolds	10% or 1 no. of each type, class, size and model whichever is more.
1.02.03	Fittings	10% or 1 packet of each type, class, size and model whichever is more.
1.02.04	Purge meters	5% of each model or 1 no. whichever is more.
1.02.05	Filter regulators	20% of each model or 2 nos. whichever is more.
1.03.00	CONTROL VALVES, ACTUATORS & ACCESSORIES (Following items shall be provided under this clause for all modulating control valves being supplied under this package)	
1.03.01	Pneumatic and electro-hydraulic actuator assembly	10% or 1 no. of each type, model and rating, whichever is more.
1.03.02	Valve trim (including cage, plug, stem, seat rings, guide bushings etc.)	1 set for each type of control valve.
1.03.03	Diaphragms, O' rings, seals etc. of all types make etc.	100%
1.03.04	Pressure Gauges of all types, make, rating etc.	10% or 2 nos. of each type whichever is more
1.03.05	Solenoid valves (if applicable)	10% or 2 nos. of each type whichever is more
1.03.06	Positioner units (complete unit)& accessories (link assembly)	10% or 1 no. of each type whichever is more
1.03.07	Pneumatic air-filter/Regulator of each type, make rating etc.	10% or 2 Nos., whichever is more
1.03.08	Air lock relays	10% or 2 nos. of each type whichever is more
1.04.00	PNEUMATICS ISOLATION / BLOCK VALVES, ACTUATORS & ACCESSORIES (For all ON/OFF valves supplied under this package)	

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1.04.01	Pneumatic actuator assembly	10% or 1 no. of each type, model and rating, whichever is more.
1.04.02	Diaphragms, O' rings, seals etc. of all types make etc.	100%
1.04.03	Limit switches (complete unit) & accessories (link assembly)	10% or 2 Nos., whichever is more
1.04.04	Pneumatic air-filter/Regulator of each type, make rating etc.	10% or 2 Nos., whichever is more
NOTE:		
1	Wherever set is mentioned, one set of the spares of that item shall be for complete replacement of that particular item for one equipment.	
2	Any fraction of a item shall mean the next higher integer.	
3	Wherever quantity has been specified as percentage (%), the quantity of mandatory spares to be provided by contractor shall be the specified percentage (%) of the total population of the plant. In case, the quantity so calculated happens to be fraction, the same shall be rounded off to next higher whole number.	
4	Wherever the quantities have been indicated for each type, size, thickness, material, radius, range, etc., these shall cover all the items supplied and installed and the breakup for these shall be furnished in the bid.	
5	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 in the above list.	
6	(*) Unless otherwise stated, a set shall mean complete replacement for one equipment.	
7	Mandatory spares listed above is bare minimum requirement. In case any additional mandatory spares requirement is covered elsewhere in the tender specification apart from specified above, same shall be deemed to have been covered in bidders scope of supply-	

Note(s):


1. One set means 100% complete replacement of the particular component/equipment, as mentioned i.e., Set for the particular equipment, would include all components required to replace the item. For example, a set of bearing shall include all hardware normally required while replacing the bearings.
2. It is further, intended that the assembly / sub-assembly which have different orientation (like left hand or right hand, top or bottom), different direction of rotation or mirror image positioning or any other reasons which result in maintaining two different sets of the spares to be used for the subject assembly / sub-assembly, these shall be considered as different types of assembly/sub-assembly.
3. Wherever the quantities have been indicated for each type, size, thickness, material, radius, range etc. these shall cover all the items supplied and installed.

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4. 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 in the above list.
5. Any item which is quoted as “not applicable” in the above list and is found to be “applicable” at a later date shall be supplied by the Bidder without any commercial implications. The Bidder shall note that if there is any change/ variation in equipment/ system during detail engineering which causes any change/ variation in the essential spares quantity, the same shall be supplied without any commercial implications. The price indicated for the mandatory spares shall be considered for the purpose of evaluation.
6. All the spares shall be manufactured along with the main equipment components as a continuous operation as per same specification and quality plan. Mandatory spares shall not be dispatched before dispatch of corresponding main equipment. The spares shall be treated and packed for a long storage under the climatic condition prevailing at site.
7. The bidder shall indicate the service expectancy period for the mandatory spare parts under normal operating conditions before replacement is necessary.
8. All spares supplied under this contract shall be strictly interchangeable with parts for which they are intended for replacements. These spares should include all mounted accessories like components, boards, add on items, fitting, connectors etc. and be complete in all respects so that the replacement of the main items by these spares does not require any additional item. The vendors must conform the pair to pair compatibility of each electrical spares modules with the modules should be supplied in the original package. All electronic modules should be pre-set and/or pre-programmed for ready use at site. Alternatively, suitable instruction sheet indicating the details of required PCB jumper position, BCD which is setting, EPROM/PROM listing etc. should be packed along with each module. Also a caution mark sign should be put on all such module which needs pre-setting/pre-programming before putting them in to service. The spare shall be treated and properly packed for long term storage.
9. Each spare shall be clearly marked and labelled on the outside of the packing with its description. When more than one spare part is packed in single case, a general description of the contents shall be shown on the outside of such case and a detailed list enclosed. All cases, containers and other packages must be suitably marked and numbered for the purpose of identification. All cases, containers or other packages are to be opened for such examination as may be considered necessary by the Employer.
10. 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.
11. The Contractor will provide Employer with cross-sectional drawings, catalogues, assembly drawings and other relevant documents so as to enable the Employer to identify and finalize order for recommended spares.
12. The bidder shall guarantee the long term availability of spares to the Employer for the full life of the equipment covered under the Contract. The bidder shall guarantee that before going out of production of spare parts of the equipment covered under the Contract, he shall give

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the Employer at least 2 years advance notice so that the latter may order his bulk requirement of spares, if he so desires. Further, in case of discontinuance of manufacture of any spares by the bidder and/or his Sub-vendors, bidder will provide the Employer, two years in advance, with full manufacturing drawings, material specifications and technical information including information on alternative equivalent makes required by the Employer for the purpose of manufacture/procurement of such items.

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ANNEXURE- III

1.01.00 INSPECTION AND TESTS DURING MANUFACTURE

- 1.01.01 The method and techniques to be used by the Bidder for the control of quality during manufacture of all plant and equipment shall be agreed with the Owner.
- 1.01.02 The Owner's general requirements with respect to quality control and the required shop tests are set out elsewhere in this specification.
- 1.01.03 Before any item of plant or equipment leaves its place of manufacture, the Owner shall be given the option of witnessing inspections and tests for compliance with the specification and related standards.
- 1.01.04 Advance notice shall be given to the Owner as agreed in the Contract, prior to the stage of manufacture being reached, and the piece of plant must be held at this stage until the Owner has inspected the piece, or has advised in writing that inspection is waived. If having consulted the Owner and given reasonable notice in writing of the date on which the piece of plant will be available for inspection, the Owner does not attend, the Bidder may proceed with manufacturing having forwarded to the Owner duly certified copies of his own inspection and test results.
- The owner's representative shall have at all reasonable times access to bidder's or his sub-vendor's premises and shall have power to inspect/ examine materials and workmanship or equipment under manufacture.
- The Bidder shall forthwith forward to the engineer duly certified copies of the Test Certificates in six copies (one to the Purchaser and five to the Consulting Engineer) for approval. Further nine (9) copies of Shop Test Certificates shall be bound with Instruction Manuals referred to elsewhere in the specification.
- For electrical equipment, routine tests as per relevant IS/International standard as detailed in the specification are to be carried out on all equipments. Type tests are also to be carried out on selected equipment as detailed in the specifications of the electrical equipment concerned.
- 1.01.05 Under no circumstances, any repair or welding of castings be carried out without the consent of the Engineer. Proof of the effectiveness of each repair by radiographic and/or other non-destructive testing technique, shall be provided to the Engineer.
- 1.01.06 All the individual and assembled rotating parts shall be statically and dynamically balanced at the works. Where accurate alignment is necessary for component parts of machinery normally assembled on site, the Bidder shall allow for trial assembly prior to dispatch from place of manufacture.
- 1.01.07 All materials used for the manufacture of equipment covered under this specification shall be of tested quality. Relevant test certificates shall be made available to the Purchaser. The certificates shall include tests for mechanical properties and chemical analysis of representative

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material. Equipment or parts coming under any statutory Regulations shall be certified by a Competent Authority under the regulations in the specified format.

1.01.08 All pressure parts connected to pumping main shall be subjected to hydraulic testing at a pressure of 150% of shut-off head for a period not less than 30 minutes. Other parts shall be tested for one and half times the maximum operating pressure, for a period not less than 30 minutes.

1.01.09 All necessary non-destructive examinations shall be performed to meet the applicable code requirements.

1.01.10 All welding procedures adopted for performing welding work shall be qualified in accordance with the requirements of Section-IX of ASME code or IBR, as applicable. All welded joints for pressure parts shall be tested by liquid penetrant examination according to the method outlined in ASME Boiler and Pressure Vessel code. Radiography, magnetic particle examination magnaflux and ultrasonic testing shall be employed wherever necessary/ recommended by the applicable code. At least 10% of all major butt welding joints shall be radiographed unless otherwise stipulated.


Bidder's scope shall include to preparation of all necessary documents, co-ordination and follow up for above approval related to bidder's works. Owner shall only forward assistance/ endorsement of documents /design /drawings /reports/records to be submitted for approval as stipulated/ required by Statutory Authorities till registration of the unit and clearance for commercial operation.

1.02.00 PERFORMANCE TESTS AT SITE


1.02.01 The full requirements for testing the equipment/ system shall be agreed between the Owner and the Bidder prior to Award of Contract. The completely erected System shall be tested by the Bidder on site under normal operating conditions. The Bidder shall also ensure the correct performance of the System under abnormal conditions, i.e. the correct working of the various emergency and safety devices, interlocks, etc.

1.02.02 The Bidder shall provide complete details of his normal procedures for testing, for the quality of erection and for the performance of the erected plant. These tests shall include site pressure test on all erected pipe work to demonstrate the quality of the piping and the adequacy of joints made at site.


1.02.03 The Bidder shall furnish the quality procedures to be adopted for assuring quality from the receipt of material at site, during storage, erection, pre-commissioning to tests on completion and commissioning of the complete system/equipment.

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1.03.00	SPECIFIC INSPECTION REQUIREMENT FOR COMPONENTS/EQUIPMENTS
1.	Hydro-cyclones
a.	Visual
b.	Dimensional etc.
2.	Pumps :
c.	All pressure parts shall be hydraulically tested at 150% of the shut-off head or 200% of rated head, whichever is higher for 30 minutes. No leakage is allowed.
d.	Impeller and rotor shall be first statically balanced and then dynamically balanced according to ISO 1940 (in the case of impellers this shall be done before and after mounting of the service rotor shaft).
e.	Vibration levels measured on the non-rotating parts shall not exceed the zone limit "B" as defined in ISO 10816 at steady conditions and shall not exceed the zone limit "C" as defined in ISO 10816 at transient conditions.
f.	List of Non-Destructive test over and above the material test are as follows: Casing: Material test, Magnetic particle (MPI), DP and Hydro test, as applicable Impeller- DPT and MPI as applicable Shaft- Ultrasonic (UT), DPT and MPI Sleeve- DP and Hardness test/ Manufacturer's recommendation Mechanical Seal- Manufacturer's recommendation. Base Plate- Stress relieving of weld. Replaceable Rubber liner- Shore Hardness, Class and Type certificate
g.	Vibration test and Noise level test shall be witnessed at shop. (as already stated above.)
h.	Mechanical running and the performance test shall be conducted for Pump at the Bidder's works before dispatch or where the test facilities are available. All pumps to be performance tested as per Hydraulic Institute Standard/Indian Standard. Performance test to include check for noise, vibration level and temperature rise.
i.	The Bidder shall conduct performance test for the remaining pump and submit the reports.
3.	Vacuum Belt Filters:
a.	Impeller, casing and shaft of vacuum pumps shall be tested for chemical and mechanical properties as per relevant standard. All plates above 40 mm shall be 100% Ultrasonically tested.
b.	UT on shaft (if greater or equal to 40mm) and impeller shall be carried out.
c.	All vacuum pumps shall be tested at shop for capacity, power, pressure, efficiency, noise and vibration etc.
d.	Filter cloths and belts shall be tested for physical properties as per relevant Standard.

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4.	General Inspection Requirements to be considered are as below:			
1.	Sl.No.	Item	Inspection & Test Item	Remarks
	1.	Hydro-cyclones	Material certificate check	
			Dimensional Inspection	
	2.	Pumps	Material certificate check	Shaft & impeller only
			Dimensional inspection	
			Non-destructive testing	DPT on shaft & impeller
			Hydrostatic test	
			Balancing Test	Static & dynamic
			Performance test	Incl. Noise & Vibration
	3.	Motors	Material certificate check	
			Non Destructive Testing	
			Dimensional inspection	
			Balancing Test	Static & dynamic
			Function test	
	4.	Vacuum Belt filter (with Accessories)	Material certificate check	
			Dimensional inspection	
			Function test	Short time no load test
	5.	Vacuum Receiver	Material certificate check	
			Dimensional inspection	
			Hydrostatic Test	
	6.	Belt Filter Vent Fan	Material certificate check	
			Dimensional inspection	
			Performance Test	
	7.	Conveyor & Silo Extraction Device	Material certificate check	
			Dimensional inspection	
			Function Test	Short time no load test
	8.	Rubber lining Pipe	Dimensional inspection	
			Visual Inspection	
			Spark Test	
	9.	Flow Nozzles	Material certificate check	
			Dimensional Inspection	

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	10.	Control Panel	Insulation Resistance Test	
			Dielectric Strength Test	
			Function Test	
			Dimensional Inspection	
	11.	Control valve & valves	Material certificate check	
			Hydrostatic test	
			Seat leak test	
			Function test	
			Dimensional Inspection	
	12.	RTD	Material certificate check	
			Performance test	
			Hydrostatic test	
	13.	Shut off valve	Material certificate check	
			Hydrostatic test	
			Seat Leak test	
			Function Test	
			Dimensional Inspection	
	14.	Flow meter	Material certificate check	
			Calibration Test	
			Dimensional Inspection	
Hydrostatic test				
15.	Butterfly Valve	Material Certificate check		
		Non-destructive testing		
		Hydrostatic test		
		Operation test	Motorized valve only	
2.	Valves and Specialties shall be tested as per relevant standards / codes. Seat Leakage and hydraulic test to be carried out as per relevant standards /codes.			
3.	Pipes and fittings shall be tested as per relevant standards/ codes.			
4.	MQP (Manufacturing Quality Plan) shall be submitted by the bidder along with the technical offer. Above mentioned item-wise inspection requirement is tentative only and shall be mutually discussed and finalized during detailed engineering.			

	North Chennai TPP Stage-III - 1x800 MW	SPECIFICATION No: PE-TS-485-571-A901	
	GYPSUM DEWATERING EQUIPMENT TECHNICAL SPECIFICATION INSPECTION AND TESTING	SECTION : I	
		SUB-SECTION : D	
		REV. 00	
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5.	Bidder shall furnish written copies of shop production, fabrication and quality test procedures and drawings to be used for review by BHEL / BHEL's Customer prior to manufacture. Inspection of above mentioned tests by BHEL/ BHEL's Customer representative at bidder's works is envisaged.
6.	The Bidder shall furnish performance test procedure along with standard. The test procedure will be reviewed and approved by the BHEL / BHEL's Customer.
7.	A dynamic balancing certificates stating that the rotating assembly has been balanced dynamically shall be sent to BHEL/ BHEL's Customer within one (1) week of the successful completion of balancing.
8.	Vibration levels shall be measured during shop running/performance tests.
9.	For surfaces with rubber lining, Welding shall be visually inspected to verify the absence of rough area and unacceptable transition between surfaces which prevent the adequate adherence of rubber. The acceptance criteria shall be as per latest standard.
10.	For surfaces with rubber lining, degree of cleaning shall be visually checked before the application of the coating. There must be no area with oxidation, dirt or partially or generalized corrosion defects.
11.	Test certificates shall be issued for each lot of raw material used in the coating, corresponding to specific weight and traction resistance.
12.	For surfaces with rubber lining, adherence test shall be conducted on production samples. Adherence test shall be conducted on the actual surface through hammering. In order to verify the absence of air pockets (or) surface without adherence.
13.	For surfaces with rubber lining, Coating thickness shall be checked at 100%. A High voltage porosity test will be conducted on 100 % of the coated surface.
14.	Equipment shall not be released for shipment, until shop tests data and performance tests curves have been approved by Owner.
15.	Bidder should furnish performance guarantee as per applicable standard guarantee for the design, manufacture, material and safe operation of the equipment's.
16.	BHEL/BHEL's Customer of their authorized third party inspection agency representative shall witness the test at Bidder's works and a notice of minimum three (3) weeks shall be given for attending the inspection. The charges for Inspection agency (TPIA) in India will be in BHEL scope. However, the charges for inspection outside India will be in bidder's scope.
17.	Bidder to arrange all calibrated gauges, Instruments during inspection at works and also during performance test at site. All inspection, measuring and test equipment(s) used by Bidder shall be calibrated (<i>at accredited laboratory, as applicable</i>) periodically depending on its use and criticality of the test/measurement to be done. The Bidder shall maintain all the relevant records of periodic calibration and instrument identification, and shall produce the same for inspection by the Owner. Wherever asked specifically, the Bidder shall re-calibrate the measuring/test equipment in the presence of Project Manager/Inspector.
18.	Mechanical running test shall be carried out for Vacuum Belt Filter, Vacuum Pump & Belt Filter Wash Pump. Bidder to arrange suitable Motor for the shop test and inspection.
19.	In case, order is placed on a foreign vendor (i.e. supplies from outside India), vendor will tie-up with BHEL approved inspection agency on their own cost and carry out inspection as per the Quality Plan approved by BHEL/ BHEL's Customer. Vendor shall furnish BHEL the inspection reports and other documents required as per approved Quality plan duly signed by the Inspection Agency after their witness for review and acceptance.



ANNEX – 1.7

QUALITY ASSURANCE PLAN

The testing and inspection requirements of major equipment of FGD system to be followed by the bidder over and above the respective code/ standard requirements are given hereunder

1.0.0 MECHANICAL SYSTEMS~~1.1.0 FLUE GAS SYSTEM~~~~1.1.1 Booster fans~~

- ~~i) Rotor components shall be subjected to ultrasonic test at mill and magnetic particle examination/dye penetration examination after rough machining.~~
- ~~ii) Butt welds in rotor components shall be subjected to 100% UT and all welds shall be subjected to MPE or DPT after stress relieving.~~
- ~~iii) All rotating components of fans shall be dynamically balanced to quality grade 2.5 of ISO 1940.~~
- ~~iv) Test for natural frequency of all fan components, including fan blades shall be carried out for the fans.~~
- ~~v) Full range performance test shall be carried out on one fan as per BS 848, Part-1.~~
- ~~v) Hydraulic coupling of booster fan shall be checked for string test i.e., operational check of one fan assembly using hydraulic coupling to check temperature rise, smooth operation, vibration and noise level. Dry run test shall preferably be carried out during string test.~~

~~1.1.2 Type Test~~

~~Full scale type tests using actual equipment shall be conducted by the Contractor for the equipment mentioned in the subsequent clauses below:~~

~~Full range and full scale performance testing shall be conducted at shop on one number each of the following Fans as per BS 848, Part-1:~~

~~(a) Booster Fan~~

~~The performance testing at shop shall be conducted using actual fans. Leak tightness testing of dampers for each type and size of damper at shop to demonstrate the guaranteed gas tightness efficiency (on flow). The minimum guaranteed gas tightness efficiency of dampers shall not be less than that indicated in clause no. 3.03.08 of this Sub-Section.~~

~~The Bidder shall indicate the charges for each of these type tests separately in the relevant price schedule of Bid Proposal Sheet (BPS) and the same shall be considered for the evaluation of the Bids. The type test charges shall be paid only for the test(s) actually conducted successfully under this contract and upon certification by the Employer's Engineer.~~



- v) ~~For other items like drive system, motor, pulley, belt etc. relevant portion of specification shall be applicable.~~
- vi) ~~No load trial run test shall be carried out at shop on completely assembled Bucket Elevator to check for trouble free operation, temperature rise, Noise & vibration. The procedure for the No load trial run shall be submitted for approval.~~

1.7.0 SILOS/ BUNKERS

- i) ~~All material shall be tested for Chemical & Mechanical properties as per relevant standard. MPI/DP test on welding shall be carried out. Fit up assembly checks shall be carried out at shop for all despatchable segments.~~
- ii) ~~Bag Filters: Bag Leakage test shall be carried out for pressure parts. Pulsing and sequential test on bag filter shall be done.~~

1.8.0 BALL MILLS

- i) ~~Raw material for shaft, coupling, gears and pinions, top and bottom races and other rotating components shall be subjected to UT. MPI/LPI shall be carried out to check surface soundness.~~
- ii) ~~Wear resistant parts shall be UT/RT tested to check soundness after suitable heat treatment. Check for chemical composition, hardness and microstructure shall be carried out.~~
- iii) ~~Butt welds in the tube/separator/body casing of the mill shall be tested by RT and MPI. All other welds in main tube/separator shall be tested by MPI/LPI for acceptance. The tube shall be statically balanced.~~
- iv) ~~All gearboxes shall be run tested for adequate duration to check rise in oil temperature, noise level and vibration. Check for leak tightness of gear case also shall be performed.~~

1.8.1 Gravimetric Feeders

- i) ~~Any welds in the casing/pulley fabrication shall be checked with MPI.~~
- ii) ~~Routine tests shall be done as per relevant Indian Standards or equivalent International Standards.~~
- iii) ~~All major items like plates for casing, head pulley, tail pulley, pulley shaft and major castings shall be procured with respective material test certificates.~~
- iv) ~~Calibration check shall be carried out on all feeders.~~

1.8.2 Lubricating oil systems

~~Complete lub-oil system shall be checked suitably as per standard practice.~~

1.9.0 VACUUM BELT FILTER SYSTEM

- i) ~~Impeller, casing and shaft of vacuum pumps shall be tested for chemical and mechanical properties as per relevant standard. All plates above 40mm shall be 100% Ultrasonically tested.~~



- ii) UT on shaft (if greater or equal to 40mm) and impeller shall be carried out.
- iii) All vacuum pumps shall be tested at shop for capacity, power, pressure, efficiency, noise and vibration etc.
- iv) Filter cloths and belts shall be tested for physical properties as per relevant standard
- vi) Hydro cyclones shall be checked by visual, dimensional etc.

1.10.0 MONORAIL AND HOISTS

1.10.1 Hooks

- i) All tests including proof load test as per relevant IS shall be carried out.
- ii) MPE or DPT shall be done after proof load test.

1.10.2 Steels castings

Steel castings shall be subjected to DPT on machined surface.

1.10.3 Forgings

- i) All forgings (wheel, gears, pinions, axles, hooks and hook trunion) greater than or equal to 50mm diameter or thickness shall be subjected to ultrasonic testing.
- ii) DPT or MPE shall be done after hard facing and machining.

1.10.4 Wire rope

Wire rope shall be tested as per relevant standard.


1.10.5 Electric hoists

All electric hoists shall be tested as per IS-3938 and chain pulley blocks shall be tested as per IS-3832.

1.11.0 VENTILATION SYSTEM

- i) Fans
 - a) ~~20% DPT of welding on fan hub, blades, casing and impeller as applicable shall be carried out.~~
 - b) ~~DPT of fan shafts shall be carried out after machining.~~
 - c) ~~UT of fan shafts (diameter greater than or equal to 50mm) shall be carried out.~~
 - d) ~~Rotating components of all fans shall be statically and dynamically balanced to ISO-1940 Gr. 6.3.~~
 - e) ~~All centrifugal fans shall be subjected to run test for 4 hour or till temperature stabilization is reached. Vibration, noise level, temperature rise and current drawn shall be measured during the run test.~~

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	MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS			MANUFACTURING QUALITY PLAN (FOR REFERENCE)				SPEC. NO : PE-TS-485-571-A901			DATE:		
				CUSTOMER : M/s TANGEDCO				QP NO.: PE-V0-485-571-A101			DATE: AUG, 2022		
				PROJECT: 1x800 MW 1X800 MW North Chennai TPP Stage-III - FGD				PO NO.:			DATE:		
				ITEM: GYPSUM DEWATERING EQUIPMENT		SYSTEM: FGD		SECTION:			SHEET 1 of 9		


SL NO.	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY	REMARKS
1	2	3	4	5	6	7	8	9	*	**
					M C/ N				D	M C N

1.0 RAW MATERIAL (*Material shall be as per Drawing)

1.1	Vacuum pump	Physical & Chemical for impeller, casing, shaft.	MA	Physical	100%	100%	Approved Drawing/Data sheet	Approved Drawing/Data sheet	TC	√	P	V	V	NOTE-5
		NDT of Impeller, casing, shaft, sleeve	MA	DPT	100%	100%	Approved Drawing/Data sheet	Approved Drawing/Data sheet	IR	√	P	V	V	NOTE-5
		Balancing of Rotating Parts	MA	Static & Dynamic Balancing	100%	100%	ISO 1940 Gr.6.3	ISO 1940 Gr.6.3	IR	√	P	V	V	NOTE-5
		NDT of Impeller & Shaft	MA	UT	100%	100%	ASTM A 388/ASME Sec.V	ASTM A 388/ASME Sec.V	IR	√	P	V	V	UT of shaft ≥φ 40mm NOTE-5
1.2	Speed reducer	Visual, dimensional, Run test including oil leakage, Temp.	MA	Visual	100%	100%	Approved Drawing/ Data sheet	Approved Drawing/ Data sheet	IR	√	P	V	V	


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		ITEM: GYPSUM DEWATERING EQUIPMENT			SYSTEM: FGD		SECTION:			SHEET 2 of 9				
SL NO.	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY	REMARKS			
1	2	3	4	5	6		7	8	9	*	**			
					M	C/ N				D	M	C	N	
		rise, Noise level and vibration												
1.3	AC Drive	Type, Make, Rating, Routine test.	MA	Visual	100%	100%	Approved Drawing/Data sheet	Approved Drawing/Data sheet	TC	√	P	V	V	Refer Electrical QP for details. NOTE-5
1.4	Belt	Visual & review of test certificate (Tensile, Elongation, Thickness)	MA	Visual	100%	100%	Approved Drawing/Data sheet	Approved Drawing/Data sheet	TC	√	P	V	V	
1.5	Filter Cloth	Physical Properties (Tensile, Elongation, Thickness, air permeability test, etc.)	MA	Physical	100%	100%	Approved Drawing/Data sheet	Approved Drawing/Data sheet	TC	√	P	V	V	
1.6	Water Pump/ Slurry Pump	Chem. & Mech. Properties of Impeller, Casting,	MA	Chemical Mechanical	100%	100%	Approved Drawing/Data sheet/Relevan	Approved Drawing/Data sheet/Relevan	TC	√	P	V	V	UT of shaft $\geq \phi$ 40mm *Lining if applicable

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					ITEM: GYPSUM DEWATERING EQUIPMENT		SYSTEM: FGD		SECTION:			SHEET 3 of 9		
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1	2	3	4	5	6		7	8	9	*	**			
					M	C/ N				D	M	C	N	
		Shaft, Lining*					t Standard	t Standard						
		Balancing of Rotating Parts	MA	Static & Dynamic Balancing	100%	100%	ISO 1940 Gr.6.3	ISO 1940 Gr.6.3	IR	√	P	V	V	
		Hydro test of casing	MA	Static pressure testing	100%	100%	Approved Drawing/Data sheet	Approved Drawing/Data sheet	IR	√	P	V	V	Hydrostatic testing of casings for 30min.at 1.5 times of shut-off head or 2 times pump rated head which ever higher.
		NDT of Impeller, casing, shaft, sleeve	MA	DPT	100%	100%	Approved Drawing/Data sheet	Approved Drawing/Data sheet	IR	√	P	V	V	
		NDT of Impeller & Shaft	MA	UT	100%	100%	ASTM A 388/ASME sec.V	ASTM A 388/ASME sec.V	IR	√	P	V	V	UT of shaft ≥φ 40mm

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1		2	3	4	5	6	7	8	9	*	**	
						M C/ N				D	M C N	
1.7		Hydro cyclone	Visual & Dimension	MA	Visual & Measurement	100% 100%	Approved Drawing/Data sheet	Approved Drawing/Data sheet	IR	√	P W V	NOTE-5
1.8		Valves (Control valve & Butterfly Valve etc*)	Material certificate Hydrostatic test Seat leak test Function test DimensionS	MA	Visual	100% 100%	Approved Drawing/Data sheet	Approved Drawing/Data sheet	IR	√	P V V	*As applicable NOTE-5
1.9(a)		Rubber Composition	Material content	MA	Chemical	1/Batch 1/Batch	Approved Drawing/Data sheet	Approved Drawing/Data sheet	COC	√	P V V	
1.9(b)		Rubber lining	Spark test at accessible area	MA	Inspection check	100% 100%	Approved Drawing/Data sheet	Approved Drawing/Data sheet	IR	√	P W V	Spark test 10-12.5KV min.
1.10		LT Motor	Make, Rating, Type, Routine Test, Paint	MA	Visual	100% 100%	Approved Drawing/Data sheet	Approved Drawing/Data sheet	IR	√	P V V	For Motor up to 30KW COC Will be submitted. NOTE-5


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1		2	3	4	5	6		7	8	9	*	**			
						M	C/ N				D	M	C	N	
1.11		Junction Box	Type Test-Enclosure Protection Test	MA	Visual	One of Design	One of Design	IS:60529	IS:60529	IR	√	P	V	V	NOTE-5
1.12		Instruments (Transmitters, Switches, Gauges, RTD etc.)	COC/Functional Check	MA	Visual	100%	100%	Approved Drawing/Data sheet	Approved Drawing/Data sheet	TC	√	P	V	V	
2.0		FINAL INSPECTION (Vacuum belt filter assembly)													
2.1		Vacuum belt filter assembly	Dimensional	MA	Dimensional	100%	100%	Approved Drawing	Approved Drawing	IR	√	P	W	W	
			Run test(for 30 minutes)	MA	Visual, Measurement	100%	100%	Approved Drawing	Approved Drawing	IR	√	P	W	W	
2.2		All components required paints.	Paint Finish, Paint Thickness, High voltage porosity test	MA	Measurement	100%	100%	Approved Drawing/Data sheet	Approved Drawing/Data sheet	IR	√	P	W	V	


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		ITEM: GYPSUM DEWATERING EQUIPMENT				SYSTEM: FGD				PO NO.:			DATE:	
		SECTION:				SHEET 6 of 9								
SL NO.	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY	REMARKS			
1	2	3	4	5	6		7	8	9	*	**			
					M	C/ N				D	M	C	N	
2.3	Vacuum pump/ Water Pump/ Slurry Pump	Capacity, power, pressure, efficiency, noise, vibration, temperature rise	MA	Measurement	100%	100%	Approved Drawing/Data sheet	Approved Drawing/Data sheet	IR	√	P	W	V	NOTE-5
3	VACCUM TANK (RAW MTRIAL INSPECTION)													
3.1	Plates for shell and dished ends & structural	Chemical & Physical	MA	Chemical & Physical	1 /Heat	1 /Heat	Approved Data Sheet /Drawing	Approved Data Sheet /Drawing	TC	√	P	V	V	
4.0	IN PROCESS CONTROLS													
4.1	Welding (As applicable)	WPS,PQR,WPO	CR	Visual	100%	100%	ASME Sec, IX/Relevant Standard	ASME Sec, IX/Relevant Standard	Report	√	P	V	V	


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SL NO.	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY	REMARKS			
1	2	3	4	5	6		7	8	9	*	**			
					M	C/ N				D	M	C	N	
4.2	Stress Relieving	Physical	MA	Physical	100%	100%	Relevant Standard/Manufacturer standard	Relevant Standard/Manufacturer standard	HT chart	√	P	V	V	As applicable
4.3	All Weld	Weld Quality	MA	DPT	10%	10%	Relevant Standard /ASME Sec – VIII Div.1	Relevant Standard /ASME Sec – VIII Div.1	IR	√	P	W	V	
4.4	Weld quality of circumferential & longitudinal seams	Weld Defect	CR	RT- Review of documents	10%	10%	Relevant Standard /ASME Sec – VIII Div.1	Relevant Standard /ASME Sec – VIII Div.1	IR	√	P	V	V	
5.0	FINAL INSPECTION (Complete Equipment)													
5.1	Complete Equipment	Dimensional	MA	Dimension	100%	100%			Approved Drawing	√	P	W	V	NOTE-5
		Nozzle Orientation	CR	Dimension	100%	100%	Approved Drawing	Approved Drawing	IR	√	P	W	V	NOTE-5


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SL NO.	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY			REMARKS	
1	2	3	4	5	6		7	8	9	*	**			
					M	C/ N				D	M	C	N	
		Hydro Test	CR	Hydro Test	100%	100%	2X working PR or 1.5x design PR Whichever is higher for 30 minutes	2X working PR or 1.5x design PR Whichever is higher for 30 minutes	IR	√	P	W	V	NOTE-5
		Pneumatic Test of RF pads for soundness /leakages	CR	Pneumatic Test	100%	100%	ASME SEC – VIII /appd. Drg/appd. Datasheet	ASME SEC – VIII /appd. Drg/appd. Datasheet	IR	√	P	W	V	*as applicable NOTE-5
5.2(a)	Rubber Lining of tank	Spark test	MA	Electrical	100%	100%	Technical Spec/ Relevant standard	Technical Spec/ Relevant standard	IR	√	P	V	V	Spark test 10-12.5KV min.
5.2(b)	Rubber Lining of tank	Hardness testing	MA	Physical	100%	100%	Technical Spec/ Relevant standard	Technical Spec/ Relevant standard	IR	√	P	W	V	Shore hardness value shall be within 60. NOTE-5
5.3	Junction Box	Insulation Resistance Test High Voltage Test	MA	Electrical	100 %	10%	Approved Drawing	Approved Drawing	IR	√	P	W	V	NOTE-5

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983291/2022/PS-PEM-MAX

		MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS			MANUFACTURING QUALITY PLAN (FOR REFERENCE)				SPEC. NO : PE-TS-485-571-A901			DATE:		
		CUSTOMER : M/s TANGEDCO				PROJECT: 1x800 MW 1X800 MW North Chennai TPP Stage-III - FGD				QP NO.: PE-V0-485-571-A101			DATE: AUG, 2022	
		ITEM: GYPSUM DEWATERING EQUIPMENT				SYSTEM: FGD				SECTION:			SHEET 9 of 9	
		SL NO.		COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY	
1	2	3	4	5	6		7	8	9	*	**			
					M	C/ N				D	M	C	N	
5.4	Painting & Marking	Paint Finish, Thickness, HV porosity test	MA	Visual	100%	100%	Appd. Drg /Data Sheet	Appd. Drg /Data Sheet	IR	√	P	V	V	NOTE-5
5.5	Packing	Proper Packing	MA	Visual	100%	100%	Technical Spec	Technical Spec	Packing List	√	P	V	V	NOTE-2,5
5.6	Quality Dossier	Document	MA	Visual	100%	100%	Compilation of documents	Compilation of documents	Quality Dossier	√	P	V	V	

LEGENDS:

*RECORDS, IDENTIFIED WITH "TICK"(√) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION,
 ** M: SUPPLIER/ MANUFACTURER/ SUB-SUPPLIER, C: MAIN SUPPLIER/ BHEL/ THIRD PARTY INSPECTION AGENCY, N: CUSTOMER,
 P: PERFORM, W: WITNESS, V: VERIFICATION, AS APPROPRIATE
 MA: MAJOR, MI: MINOR, CR: CRITICAL
 IR: INTERNAL REPORT D: DOCUMENTATION
 RT: RADIOGRAPHY TEST UT: ULTRASONIC TEST DPT: DIE PENETRANT TEST

NOTE:

1. ORIGINAL TCS/ PHOTOCOPIES CERTIFIED IN ORIGINAL BY MILL SHALL BE FURNISHED FOR REVIEW.
2. PACKING PHOTO GRAPH IS TO BE SUBMITTED TO BHEL BEFORE DISPATCH.
3. BHEL RESERVES THE RIGHT FOR CONDUCTING REPEAT TEST, IF REQUIRED.
4. DURING TESTING ONLY CALIBRATED MEASURING AND TESTING INSTRUMENT IS TO BE USED AND. CALIBRATION CERTIFICATES ARE NEEDED TO BE FURNISHED DURING INSPECTION.
5. THESE TESTS/CHECKS ARE INDICATIVE ONLY. FURTHER TESTS MAY BE ADDED BASED ON END CUSTOMER REQUIREMENT AND WILL BE FINALISED DURING DETAILED ENGINEERING

BHEL						BIDDER/ SUPPLIER		FOR CUSTOMER REVIEW & APPROVAL			
ENGINEERING			QUALITY			Sign & Date		Doc No:			
Sign & Date		Name	Checked by:	Sign & Date	Name	Seal		Sign & Date	Name	Seal	
Prepared by:								Reviewed by:			
Reviewed by:								Approved by:			