TECHNICAL SPECIFICATION

FOR

GEAR PUMP WITH DRIVES

PROJECT	**5X800 MW YADADRI THERMAL POWER STATION PROJECT, NALGONDA, TELANGANA**
CUSTOMER	**TELANGANA STATE POWER GENERATION CORPORATION LTD. (TSGENCO)**
CONSULTANT	**TATA CONSULTING ENGINEERS LTD.**

INDEX

	Annexure 5- A: Technical Specification For Fire Protection System Annexure 5- B: Technical Specification For A.C. & D.C. Motors Annexure 5- C: General Electrical Specification Annexure 5- D: C&I Specification Annexure 5- E: Misc Specification
	Annexure 6 - Equipment qualification criteria (EQC)
	Annexure 7 - QAP Guide Line & Formats
	Annexure 8- Sub-vendor List
	Annexure 9 - Master DOC List Format
	Annexure 10- Deviation Format
	Annexure 11- Pre-bid clarification format

DOCUMENTS TO BE SUBMITTED WITH THE BID:

The bidder must submit the following documents along with their bid to enable BHEL to evaluate their offer.

i. Duly filled in Gear Pump-Motor-Diesel Engine datasheet **(Annexure-2)**

ii. Tentative GA Drawings for Gear Pump & Drive assembly

iii. Performance curves for Pump

iv. Un-priced copy of price in attached BHEL price bid formats **(Annexure-3)** indicating quoted/ not quoted against each row & column.

v. Checklist as per **(Annexure-4)**

vi. Equipment qualification criteria / PTR / Reference Lists as per **(Annexure-6)**

vii. Bidder shall submit ***NO DEVIATION certificate*** along with their offer. Any specific deviations, which are impractical, shall be raised in form of pre-bid queries as per Annexure-11 before submission of Techno Commercial offer.

In case the above-mentioned documents are not submitted with the offer, the offer of the bidder may be liable for technical rejection.

1. INTENT OF SPECIFICATION

This specification specifies the requirement of Design, Engineering, Manufacturing, Assembling, Inspection, Testing at manufacturer's works and Delivery of properly packed and painted **Gear Pumps** including drive assembly with all accessories as specified in the scope of work and as required for the safe and trouble-free operation of equipment to be installed at site.

2. SPECIAL NOTES TO BIDDERS

2.1 This specification shall be read in conjunction with its enclosures. In case of any discrepancy arising between this specification & its enclosures, the most stringent of all shall be followed and shall over-ride others. Further, if a requirement in this specification or its enclosures, calls for decision of owner/BHEL, it shall be bidder's sole responsibility to clearly bring out the same distinctively in his technical tender offer, so as to enable owner/BHEL to furnish their decision. If such a requirement is not duly addressed by bidder during tender stage and same comes out during order execution stage, it shall be binding on the bidder to comply with the decision furnished by owner/BHEL then, without any cost, delivery, or any other commercial implications.

2.2 Any additional equipment, material, etc., which are not specifically mentioned here, but are required to make the supplied equipment complete in all respects, in accordance with the intent of this technical specification, contractual agreement, statutory requirements, relevant/applicable codes/standards, good engineering practices, and for safe and trouble-free operation, shall be deemed to be covered under the scope of this specification.

2.3 The Bidder shall accept full responsibility for the completeness and for the faultless working of all the equipment. These shall be executed on the basis of proven design principle and in accordance with the latest state of the art in such a manner that the purpose to be served by the Pump unit is fulfilled in every respect and a maximum of operational dependability and efficiency are assured. Standardization of equipment, materials etc. shall be employed in the design. Care shall be taken to ensure safe operation as well as simplicity of assembling and dismantling of all parts of the plant.

2.4 Bidder shall quote strictly as per the scope of supply and requirements of this specification.

2.5 Bidder offer shall be strictly as per these specification requirements. Unsolicited or Alternate offers from the bidders will not be entertained.

2.6 In case bidder feels that it is necessary to exclude some components of scope of supply or some of the features of specification requirements due to any technical constraints, bidder shall bring the same to the notice of purchaser during pre-bid stage through pre-bid queries and take their prior approval before submission of their bid.

2.7 Incase Bidder is unable to offer any specific requirement of specification, Bidder shall bring out the same in their regret letter. Otherwise, it will be considered that non-participation by the bidder is attributable to reasons other than any specification requirements.

3. PROJECT INFORMATION

4.

Sl. No.	Owner	Telangana State Power Generation Corporation Ltd. (TSGENCO)
1.	Project	5X800 MW Yadadri Thermal Power Station Project, Nalgonda, Telangana
2.	Owner's consultant	Tata Consulting Engineers Ltd.
3.	Airport	Vijayawada Airport- 140 km
4.	Nearest Railway Station	Guntur Jn Rail Way Station- 109 km
5.	Maximum outside Ambient Air Temperature (deg. C)	50
6.	Minimum outside Ambient Air Temperature (deg. C)	10
7.	Elevation	235 m
8.	Relative humidity	65 %
9.	Design Ambient for Electrical equipment / system (deg. C)	50

Note: Any other data required for designing the equipment, bidder may ask prior to the submission of bid.

5. APPLICATION OF SYSTEM

Gear type Pumps are envisaged for supplying Foam to Foam system from the Foam storage tank for fire protection. Refer to below clause for the details of the Foam liquid properties.

6. DESIGN PARAMETERS/TECHNICAL DETAILS/REQUIREMENTS:

6.1. Design Parameters and Technical Details / Requirements of Gear Pump :

Sl. No.	**Description**	**Gear Pump**
1.	Number of Pumps & Drive	**2 Nos.** **[1 No. Motor Driven + 1 No. Diesel Engine Driven]**
2.	Drive (Pump Supplier's Scope)	1 No. Motor + 1 No. Diesel Engine
3.	Application	To transfer Foam concentrate ~~Foam~~ in Firefighting System
4.	Pump Type	Gear Pump

5.	Pump Design Standard	Generally as per API 676
6.	Motor Standard	Refer Annexure-5
7.	Diesel Engine Standard	As per TAC recommendations
8.	Design Pump Capacity	17.1 m^3/hr
9.	Discharge Pressure	12.1 kg/cm^2(g)
10.	Fluid Handled / Viscosity/ Temperature etc.	1. Foam Type : 3% Aqueous Film Forming Foam concentrate (AFFF) 2. Appearance : Amber color Liquid 3. PH @ 20 °C : 7.0 – 8.0 4. Sp. Gravity @ 20 °C: 1.00 to 1.04 5. Viscosity @ 20 °C : Less than 10 cst 6. Storage : Storage temperature should be lower than 49° C. Containers shall not directly exposed to sunlight & heat for longer period 7. SPEREADING CO-EFFICIENT : +3 Minimum 8. SLUDGE CONTENTS (%, V/V) , MAX: Nil
11.	Available Pressure at Center line of Suction nozzle of Pump	8 mlc
12.	NPSHA at pump suction flange	8 mlc
13.	Margin between NPSHA & NPSHR	Sufficient for trouble free operation of pump
14.	Power Supply to Motor Controller	3 phase, 415V (+/- 10%), 50 Hz (+3/-5%), (+/-)10% combined variation of voltage and frequency
15.	Material of construction for Pump	Casing (Pump body) : CF8M Rotor Gear : SS 316 Rotor Shaft : SS 431 End cover : SS 316 Sealing : Mechanical Seal Gland : SS 316 Bearing Cover : SS316 Base plate : MS Fabricated Integral relief valve : SS 316/CF8M Fasteners: SS-316 Companion Flange : SS316 Expander and reducer : SS 316 Foundation bolt : MS

		Coupling : SS 316 Coupling Guard : Aluminum (Vendor to ensure that all the selected materials is suitable for the application)
16.	Area classification	Non-hazardous area

7. SCOPE OF SUPPLY :

Scope of supply shall be as per as per follows:

Please refer to the enclosed P&ID for Gear Pumps (Annexure-1) for general clarity on scope of supply of Gear System. The system shall be provided as per Annexure-1 taking into all requirements including for testing, painting, documentation, sub vendor list, equipment specifications etc., specified in this specification and enclosures.

Scope & Quantity of items Pumps package:

2 Nos. of Gear Pumps [1 No Motor Driven +1 No Engine Driven].
1 No. Motor
1 No. Diesel Engine
1 No. Diesel Engine Control Panel with Battery chargers (as mentioned in below clauses)
Batteries with accessories (as mentioned in below clauses)
Fuel Tank with accessories (as mentioned in below clauses)
Diesel Engine Exhaust piping & fittings (as mentioned in below clauses)
Other items (as mentioned in below clauses)

All the items such as Pump, Motor, Diesel Engine, Relief Valve etc. need **NOT** be "FM / UL Listed".

The scope of supply for each Pump & Motor/ Diesel Engine drive assembly is as described below.

7.1. Pump

Gear Pump complete with all accessories as per specification.

The design and material of construction for Gear concentrate pumps shall be as per above clause.

Scope of supply shall be as per Annexure-1 & subsequent clauses of this specification. Pump shall be equipped with integral Relief valve.

7.2. Drives for pumps [Motor / Diesel Engine]

7.2.1. Motor

Supply of Electric motor of required rating is in bidder's scope of supply.

Drive Unit Power rating for the fire water pumps shall be selected such that it is equal to **higher** of the below two conditions:

i. 115 % of the duty point power requirement
ii. Motor Input power required at 110% Relief Valve set Pressure or at any condition of operation of pump.

Electric motors designed standard shall be as per clause no. 6.1 above.
Voltage levels for Motors : 415 V

7.2.2. Diesel Engine

Design of Diesel Engines shall be as per TAC recommendations and enclosed annexures. The scope of supply shall be as per TAC recommendations, Annexure-1 & subsequent clause of this specification. Engine cooling type shall be Radiator cooled.

Performance requirement, Design and construction of the diesel engine shall be guided by the TAC recommendations and as per enclosed annexures.

a) The continuous engine brake horse power rating (after accounting for all auxiliary power consumption) at the site conditions shall be at least 20% greater than the brake horse power required to drive the pump at its duty point at rated R.P.M. and in no case less than the brake horse power required to drive the pump @ 110% Relief valve pressure or at any condition of operation of pump.

b) Deaerating Factors considered by the manufacturer to arrive at the shaft power of the diesel engine at site, shall not be less than the following:

- 3% for each 305 meter elevation above MSL
- 1% for each 5.6° C rise in air temperature above 15.6° C

c) The base power rating of the diesel engine shall be referred to any accepted datum like BS/SAE Standard condition or equivalent. In any case, horsepower rating shall not be higher than the limit set by Tariff Advisory Committee.

Instrumentation & Control

The diesel engine shall be provided with all the necessary and adequate instrumentation. These shall include but not limited to the following:

a. Temperature indicator (contact type) in cooling water inlet and outlet.
b. Temperature indicator in lubricating oil outlet from the oil cooler.
c. Pressure gauges (contact type) for lubricating oil system.
d. Differential pressure gauges (contact type) across strainers/ filters.

e. Speed indicator.
f. Running hour meter.
g. Dip stick type lubricating oil sump level indicator.
h. Gauge glass type Fuel Oil Tank level indicator.
i. Voltmeter & Ammeter in dynamo type battery charging circuit.

7.2.2.1. Diesel Engine Control Panel:

PLC based Diesel Engine Control panel meeting to the requirements of TAC for each engine shall be included in bidder scope of supply. Panel shall be operated on DC Supply, suitably converted by dedicated rectifier bank, redundant transformers from mains A.C supply (240 V). Further, Battery backup shall also be provided along with auto-change over from normal to Battery supply in case of non-availability of Mains supply. 6 Nos [1 first time and 5 Repeat starts] of Kick Starts of Diesel Engine shall be envisaged in the panel.

The Control panel shall be Stand mounted. Bidder to provide suitable stand and all fixing accessories for mounting control panel.

Bidder to submit Soft copy and hard copy of logics executed in PLC for uploading the same by end customer later.

Starting power shall be supplied from two (2) sets of storage batteries. One (1) set of battery is for automatic starting of the engine and the other provided for manual starting. A selector switch shall be provided at the automatic starting control panel to select any of the two (2) sets of battery for manual/auto starting of the engine.

The automatic starting arrangement shall include, as a safeguard, a "Repeat Start" feature so that if the pinion of the starting motor does not engage the flywheel at the first attempt, it is automatically retracted and after a short pause again will advance towards the flywheel.

This repeat start cycle will continue until five (5) kicks after which there will be suitable annunciation.

Arrangement for both trickle and booster charge of the batteries shall be provided. When the engine starts running, provision should be kept to ensure that the charger is automatically disconnected and the battery is charged by engine dynamo.

Each diesel engine shall be provided with two (2) battery charger units of air cooled design. Each charger unit shall be capable of charging one (1) set of battery at a time. Provision shall, however, be kept so that any of the charger units of a particular engine can be utilized for charging any one of the two (2) batteries of that engine.
All cabling [control/signal/power], gland, lugs, from engine to control panel, panel to battery and engine to battery selector switch shall be in bidder scope of supply. Control panel, battery charger and battery selector switch is located within 5 m radius of pump skid. Pls refer annxure-1 for layouts for calculation of cable BOQ. Final Pump house layout shall be provided during detail engineering stage. Accordingly, bidder to consider suitable margin on required cabling based on their experience. Bidder to furnish cable BOQ, electrical load list, cable schedule and cable interconnection diagram.

Technical details of local control panel are indicated in **Annexure-5.**

Software:

Bidder to submit Soft copy and hard copy of logics executed in Controllers for uploading the same by end customer later.

7.2.2.2. Terminal point for power supply

BHEL shall provide 1 No. of feeder [415 V, (+/-) 10%, 3 phase, 50 Hz] for each Controller for Motor driven Gear Pump. Further distribution shall be in bidder scope of supply. Required cable glands, lugs shall be in bidder scope of supply.

BHEL shall provide 1 no of feeder [240 V, (+/-) 10%, 3 phase 50 Hz] for each Diesel Engine Control Panel. Further distribution shall be in bidder scope of supply.
Required cable (Length : 15m, with cable glands, lugs) between Diesel Engine, DECP, battery, Battery selector switch, shall be in bidder scope of supply.

7.2.2.3. Diesel Engine Fuel Tank

Fuel oil tank having storage capacity sufficient to run the engine at full load for at least 6 hrs. Level transmitter, level gauge and required inlet/outlet/recirculation piping [5 m length minimum each] & valves [from tank to engine and engine to tank] for engine (as per Annexure-1) shall be included in bidder scope. Valve in the fuel feed pipe between the fuel tank and the engine shall be placed adjacent to the tank and it shall be locked in the open position. Pipe joints shall not be soldered and plastic tubing shall not be used.

Tanks shall be securely mounted on noncombustible supports. Accordingly, bidder to supply Fuel Tank mounting structure, all fixing accessories. Bidder to ensure sufficient leg height for flow of fuel from tank to Engine up to minimum level of fuel and ensuring engine manufacturer's fuel pump static head pressure limits not be exceeded when the level of fuel in the tank is at a maximum.

For details [such as pipe size, fill-drain-vent connections etc.]. Please refer Annexure-1.

7.2.2.4. Diesel Engine Exhaust System

The exhaust system shall be gas tight throughout the operating range of exhaust temperatures and pressures. It shall be designed with an outlet connection to readily duct exhaust gases outside the engine room and away from air-intake systems. The system shall be sized in accordance with the manufacturer's recommendations, and arranged to preclude the entry of water into the pump room. The exhaust manifold and turbocharger housing (when provided by the drive manufacturer) shall be suitably guarded, insulated, or cooled to prevent fire hazards and injury to operators. Each diesel engine foam pump driver in a multiple engine room shall have an independent exhaust system.

Bidder to consider suitable length of exhaust piping with silencer, SS metal expansion below & insulation with required number of bends. However, As a minimum bidder to consider 15 m of exhaust piping with silencer, SS metal expansion below & insulation with 6 Nos. of bends. The exhaust piping shall consist of bends, hood, bird screen etc. [For Additional Details please refer Annexure-1, preliminary layout]. Final layout shall be furnished during detailed engineering stage.

7.2.2.5. Starting & Charging System :

Starting system:

i. Two (2) sets (1 working & 1 standby, 100% capacity) of 24 or 12 Volt (as applicable) Automotive type battery with charger for each diesel engine driven foam pumps shall be provided primarily for starting the engine and control power supply to local control panel.

ii. Each engine shall be provided with 2 Nos. Lead-acid plante battery units as per IS. Battery shall be sized to Cater for the following without any charging in-between

a. Crank the engine twelve times (12) consecutive starts [each for a duration of 10 sec.] without recharging with a cold engine under full compression, [please avoid repetition of clauses]
b. Control panel stand by load requirements for 72 hours.

iii. Storage batteries shall be rack supported above the floor, secured against displacement, and located where they will not be subject to excessive temperature, vibration, mechanical injury, or flooding with water. Accordingly, bidder to provide suitable stand/structure for mounting the battery.

Charging system:

i. Each diesel engine shall be provided with two (2) battery charger units of air cooled design. Each charger unit shall be capable of charging one (1) set of battery at a time. Provision shall, however, be kept so that any of the charger units of a particular engine can be utilised for charging any one of the two (2) batteries of that engine. [please avoid repetition of clause]

ii. Arrangement for both trickle and booster charger of the batteries shall be provided. When the engine starts running, provision should be kept to ensure that the charger is automatically disconnected and the battery is charged by engine dynamo. [please avoid repetition of clause]

All other details shall be as per TAC guidelines.

7.3. Coupling between Pump and Drives [motor/engine]

Flexible Coupling as per OEM recommendation.

The coupling shall be selected to ensure that it is capable of transmitting the horsepower of the driver and does not exceed the manufacturer's maximum recommended horsepower and operating speed.

7.4. Mechanical Seal

Sealing arrangement shall be Mechanical seal as per OEM Standard.

7.5. Baseplate

The baseplate with fixing bolts shall be suitably designed to support the pump and driver without excessive vibration or visible distortion at all variations of load.

7.6. Interconnecting Piping & Instrumentation

Interconnecting piping and instrumentation shall be as per P&ID [Annexure-1] & relevant standards as mentioned in this specification.

The terminal point connection of Suction & Discharge nozzles of offered pumps shall be as per ASME standard sizes, (and if required, suitable eccentric type Reducer / Expanders shall be provided by bidder) to meet BHEL pipe size (as per Annexure-01).

Also, Flanges & Counter flanges (ASME standard sizes) with necessary fasteners & gaskets at Pump suction & discharge nozzles shall be as per Annexure-1. All counter flanges shall be of weld neck type.

The material of the piping / Pipe fittings shall be as below.

Pipes: Stainless steel to ASTM A-312 TP-304, Sch.-10.

Flanges: Plate fabricated to ASTM A-240 TP-304

Fittings: SS forged to ASTM-A-182 F-304 for sizes 15NB to 40NB, and S.S. seamless to ASTM-A- 403 WP-304, Schedule-40 for sizes 50NB & above.

Gasket: CAF as per IS:2712 Gr.W3.

The fittings shall be galvanized as per IS:4736 for galvanized pipe application

7.7. Necessary Foundation Bolts, Nuts, Shims/Grouting Pads Etc.

7.8. First Fill of Lubricant & Consumables

Excluded from bidder scope of supply. However, bidder to furnish detailed requirements of first fill of lubricants and consumables.

7.9. Complete Unit Test:

1) Motor driven Gear Pump:

Pump shall be tested with Job motor, Job coupling, and Job base plate etc.

2) Engine driven Gear Pump:

Pump shall be tested with done with Job engine, Job coupling, and Job base plate etc. Power Vs Flow need not to be drawn considering the limitation of estimating the power absorbed.

7.10. All other items necessary for safe and smooth running of Pump, Motor and Engine & accessories required to make the supplied equipment complete in all respects.

7.11. Commissioning Spares

i. One set of commissioning spares for Pump with drive motor shall be quoted as per manufacturer's recommendation. Commissioning spares shall contain minimum 1 Set of O-rings & gaskets for each Pump & 1 Set of Commissioning Spares for Motor etc. as per Manufacturer's recommendation.

ii. One set of commissioning spares for Pump with Diesel Engine shall be quoted as per manufacturer's recommendation. Commissioning spares shall contain Minimum 1 Set of O-rings & gaskets for each Pump & 1 Set of Commissioning Spares for Engine, Control Panel and Battery etc. as per Manufacturer's recommendation.

1 set stands for requirement for one no. of skid. Bidder to furnish the list along with the offer. Bidder shall include all the required commissioning spares in their scope of supply and ensure that the erection and commissioning of the plant is not delayed for want of Commissioning spares.

Prices for the commissioning spares shall be part of main scope of supply. No separate price shall be offered for the same.

Any leftover (unused) spares after commissioning, out of those included by vendor, shall be handed over to the owner.

Note: Any commissioning spare consumed over and above the recommended commissioning Spares, during commissioning shall be supplied free of cost by the equipment vendor without causing delay to project schedule.

7.12. Engine Revalidation spares:

Revalidation spares are those spares, which are required at the time of commissioning of Engine, in case the scheduled commissioning of engine is delayed beyond the permissible duration as recommended OEM.

Bidder to quote revalidation spares required for Engine as per OEM practice under main prices as indicated in price bid format.

Bidder shall furnish list of revalidation spares along with their offer.

Note:

1. Revalidation spares consumed over and above the recommended revalidation spares, during commissioning of engine shall be supplied free of cost by the equipment vendor.
2. Bidder to furnish list of revalidation spares with offer.
3. Price of revalidation spare shall be considered for L1 bidder evaluation and LOI shall be placed by BHEL-PE&SD. Accordingly, as per requirement at site, PO shall be placed by BHEL-Power sector region.

7.13. Mandatory Spares:

7.13.1. Pump

Nil

7.13.2. Motor

Up to 30 kW Rating

Description	Quantity
a) Driving End & Non-Driving End Bearing	6 Sets for each type and rating of Motor
b) Cooling Fan	4 Nos for each type and rating of Motor
c) Motor Terminal Block	10 Nos for each type and rating of Motor
d) Complete Set of Coupling	2 Sets for each Application

7.13.3. Engine

Description	Quantity
a) Element for lub oil Filter	4 Nos.
b) Element for Fuel Filter	4 Nos.
c) Outer Element for Air cleaner	4 Nos.
d) Inner Element for Air cleaner	4 Nos.
e) Turbo-charger	2 Nos.
f) Engine - starter Motor	2 Nos.
g) Injector	4 Nos.
h) Piston rings & liner set	4 Sets

7.13.4. For Panel

Description	Quantity
a) Push Button-Complete assembly	10 Nos per each color
b) Push Button-Contact Element (1NO + 1NC) Block	40 Nos
c) Selector Switch [each type and rating]	20 Nos
d) Voltmeter [each type & Rating]	Total Installed qty x 10 % x (2/5) or minimum 2 nos
e) Ammeter [each type & Rating]	Total Installed qty x 10 % x (2/5) or minimum 2 nos
f) Frequency Meter [each type & Rating]	Total Installed qty x 10 % x (2/5) or minimum 2 nos
g) Indicating Lamps complete assembly	20 Nos per each color and type

7.13.5. For Instrumentation

Description	Quantity
a) Transmitters/ Gauges/Switches etc. along with relevant accessories	Total Installed qty x 10 % x (2/5) or minimum 2 nos) for each type along with accessories.
b) Temperature Element (RTD/Thermo-couple) with thermowell	Total Installed qty x 10 % x (2/5) or minimum 5 nos
c) Cables (Control & Instrumentation)	Total Installed qty x 10 % x (2/5)

Special notes for Mandatory spares:

i. The word "set" means the quantity required for full replacement of that part in one machine.
ii. The word "TYPE" means the Make, Model no., Type, Range, Size/ Length, Rating, Material as applicable.
iii. Wherever % age is identified, bidder shall supply next rounded figure on higher side.
iv. Part Description is the commonly used name of the part and may vary from manufacturer to manufacturer.
v. Mandatory spares as indicated above do not cover commissioning spares.
vi. Mandatory spares as indicated above do not cover two year O&M spares.
vii. All Mandatory spares should be supplied separately with green color painted box.
viii. Loose items sent by Vendor to sites shall be quantified/numbered/tagged and not merely mentioned as ONE lot of loose items.
ix. A packing list covering items having shelf life are to be intimated to site. In addition, shelf life items shall be packed separately in black color painted box for easy identification at site.
x. Spare rotors shall be boxed in a metal containers for vertical storage with nitrogen purging. Storage container shall be property of the owner.

7.14. Auxiliaries Equipment /Spares

Bidder to include all auxiliary equipment, if applicable, in their scope in addition to above mandatory spares. The list of the same shall be submitted with the offer, indicating the purpose and function of the same.

7.15. Special Tools And Tackles

2 Sets of Special tools and tackles for Pump & Drive assembly. [ie., 1 set for Pumps with Motor assembly & 1 set for Pumps with Diesel Engine assembly]

One set (1 Set) of Special tools and tackles comprises of special tools, wrenches etc. with necessary tools boxes as required for operation and maintenance (disassemble, assemble, or maintaining the unit) of the Pump and Drive [Motor/Engine] assembly shall be quoted as per manufacturer's recommendation.

1 set stands for requirement for one no. of skid. Bidder to furnish the list along with the offer. Prices for Special tools and tackles shall be part of main scope of supply. No separate price shall be offered for the same.

7.16. Supervision of Erection & Commissioning:

Supervision of erection, commissioning of the supplied system shall be included in bidder's scope of service.

Bidder to note that the supervision charges for erection & commissioning shall consists of the following:

- Per day supervision charges of an Engineer including all other expenses like boarding, lodging, local travel, insurance etc.
- Travel expenses (inclusive of any clearance charges like Visa fee etc, insurance) from / to vendor works to site.

Per diem charges shall be applicable from the day bidder's representative reports to site, up to the day certified by BHEL's site.

For the purpose of tender following to be considered: [For more details, please refer to price bid format]

Gear Pump with Drives:

Five Man-days for Pump/Motor /Diesel Engine and One Visit

Notes:

1. However, either or both of the number of man days and number of visits may change on either side based on the actual site requirement.
2. All payments towards supervision of E&C shall be made only after BHEL-site certification.
3. Bidder to mobilize concerned competent person for supervision of Erection & commissioning activities within a period of 7 days of receipt of intimation in this regard by BHEL.
4. Bidder to quote supervision of erection and commissioning activities strictly as per BHEL's price format.

7.17. Conflicts in Specification Requirement:

In case of any conflict between this specification and Annexures stringent of the requirement will govern. [avoid repetition of clause]

8. OPTIONAL PRICES

Bidder to furnish the following as optional prices. Please refer to attached Price Bid Format for more details.:

Bidder to furnish optional prices for 2 year recommended spares as per equipment manufacturer's recommendations. [The Bidder shall quote separately with optional price for the recommended list of spare parts for operation, with recommended quantities for the

equipment covered under this specification. Bidder shall furnish such a list along with offer. The list of spares shall be as per Bidder's experience.

9. EQUIPMENT QUALIFICATION CRITERIA (EQC) / PRE-QUALIFICATION CRITERIA (PQC):

For details, please refer Annexure-06.

10. QUALITY PLAN & INSPECTION AGENCY & TESTING

For details, please refer Annexure-5&7.

10.1. Quality Plan

Quality plan will be reviewed during detailed engineering stage with respect to Inspection, standard Engineering practices & Specification Requirements and various tests and stages of inspection and appropriate agencies for Inspection will be Intimated. Bidder to abide by the same.
For guidelines & format: Refer **Annexure-7**, ITPs for Pump, Motor, Engine, etc. In addition, Annexure-7 & enclosed datasheets, specifications and applicable Standard shall be referred.

10.2. Inspection Agency

BHEL/ Customer / Consultant / Third Party appointed by BHEL/Third party appointed by Customer for inspection offered inside India.

In case, if any of the items are imported / sourced from outside India by bidder, it is in bidder's scope to appoint TPI agency (as recommended by BHEL) on behalf of BHEL for inspection of those items. Bidder shall contact BHEL, during bid stage itself, for the list of recommended TPI agencies for such imported items.

The various review/witness/observation stages by individual agencies (or) Group of Agencies as above will be in line with approved quality plan.

Please refer Annexure: 7, ITPs for Pump, Motor, Engine etc. In addition, annexure-7 & enclosed datasheets, specifications and applicable standards shall be referred.

10.3. Testing

The design and Testing Standards, Performance tolerances of the Pumps, Motor, Diesel Engines shall be as per Manufacturing standard.

However, Performance tolerance shall be as mentioned below:

i. Rated head at rated flow: Zero negative tolerance

ii. Shut-off head: Zero negative tolerance. Maximum 5% Positive tolerance permitted.

iii. Permissible tolerance in efficiency at rated capacity: No negative tolerance

iv. Rated BKW: Zero positive tolerance. Positive tolerance is permitted from rated point till motor rating meets end of the curve condition.

11. PAINTING:

Painting for Pump, Motor, Engine and all other accessories shall be as per annexure -5.

Final shade for Pump, Motor and Engine shall be informed during detail engineering stage.

12. PACKING AND FORWARDING

Bidder to note that Packing and Forwarding shall be suitable for as per manufacturing standard meeting the requirement (Sea Worthy Packing) is acceptable. Packing shall be suitable for outdoor storage: More than 12 months. For details Pl. refer Annexure -05

13. SUB VENDORS

Bidder shall follow sub vendors list enclosed as Annexure-8. In case of any specific practical difficulty, bidder is requested to bring out the same with proper reason for not following vendor list. For other items for which sub vendors are not specified, bidder can follow their standard vendors. However, they have to ensure the Proven Track record of the sub vendors and Bidder to take prior approval of BHEL for the same.

14. DOCUMENTATIONS

Please refer to enclosed Master Documentation List [MDL] for the list of DOCUMENTS / DRAWINGS to be submitted by the bidder as part of documentation. Bidder shall ensure submission of all documentation as per the MDL, Annexure: 9.

Bidder to note that the dates of submission of all the documents shall be finalized based on PO date. It shall be solely bidder's responsibility to get approval on the entire document from purchaser to meet project schedule.

DEFINITION OF VENDOR DOCUMENT REVIEW STATUS ASSIGNED BY BHEL

The guidelines listed below are followed in assigning the document status code to the vendor documents: Final submittal of vendor documents will not be required as long as the document status code is 1 or 4 and the "AS-BUILT" condition of the component agrees with the current document.

Permission to proceed does not constitute acceptance or approval of design details, calculations, analyses, test methods, or materials developed or selected by the vendor and does not relieve the vendor from full compliance with contractual obligations.
Code-1: Work may proceed

The document conforms to procurement document requirements. The document requires no changes or additions. Matters remaining to be resolved do not require document change and will be handled by correspondence. Where it is known that the design information on a vendor

document is not complete and re-submittals will be required, e.g., due to "hold" areas, the document is assigned another status code.

Code-2: Revise and resubmit

Work may proceed subject to resolution of indicated comments. The document is in basic conformance with procurement document requirements. Minor deviations from procurement document requirements have been noted or other minor technical or physical changes in the equipment are required. The vendor shall resolve comments and resubmit documents prior to shipment of commodity.

Code-3: Rejected. Revise and resubmit

The document:

- Does not conform to the procurement requirements,
- Is of a design that is technically unacceptable without significant changes,
- Does not meet project requirements, i.e., orientation of equipment, nozzles, conduit connections, etc.,
- Does not conform to project criteria or with proposal documents or data, or
- Does not meet minimum submittal requirements.

This submittal rejection does not relieve vendor of any schedule commitments.

Code-4: Review not required

The document is not subject to BHEL review. Typical uses for this status are in the review of items that are vendor standard products, small internal parts of major equipment, or vendor standardized data.

DRAWINGS REVIEW & APPROVALS:
Each drawing submitted by the bidder shall be with a title bock furnished by BHEL during detailed engg stage.

All drawings / documents shall be thoroughly checked, duly signed, and stamped by the vendor including drawing /documents of sub-vendor, before submission to BHEL. Documents, which are unchecked, unsigned, and without revisions marked clearly, shall be returned without review. Any delay on account of this shall be to the vendor's account. After first review of documents, vendor to submit all the further revisions of documents along with comment resolution sheet. Successive documents submitted without comment resolution sheet shall be returned without review.

The approval and /or review by BHEL /End customer shall not be construed by the bidder as limiting any of his responsibilities and liabilities for mistakes and deviations from the requirements, specified under these specifications and drawings.

Documents once reviewed in Code-1 shall not be submitted (incorporating some changes) again for review, however if some change is really necessary, the same shall be brought to the

notice of BHEL separately through design change note for review / information. Finally, As –built drawings, duly updated, shall be submitted.

During detailed engg stage, BHEL shall furnish detailed format for datasheet of Pump, Motor, Engine and check list reg minimum contents in GA drawing. Bidder to submit duly filled in respective datasheets for Pump, Motor, Engine and submit GAD [duly incorporating all requirements as per the check list] along with signed checklist. GAD shall not be reviewed without duly filled in checklist signed by the bidder.

NO. OF COPIES OF EACH DOCUMENT TO BE FURNISHED:
All the documents shall be submitted as given below:

SL NO.	DESCRIPTION	NO. OF COPIES / PIECES TO BE SUBMITTED	WHEN TO SUBMIT
1)	Initial drawings/documents under approval and information	Soft copy only	Within 2 weeks of placement of order
2)	BHEL shall furnish their observation on submitted documents	Soft copy only	Within 2 weeks of document submission
3)	*Revised drawings/documents along with compliance sheet incorporating all BHEL comments. **Vendor to incorporate all BHEL comments so that further revisions can be minimized.*	Soft copy only	Within 1 weeks of receipt of commented Drawings from BHEL
4)	BHEL shall furnish their observation on submitted documents	Soft copy only	Within 2 weeks of document submission
5)	Final Drawings/documents	12	Within 2 months of placement of order.
6)	Erection Documentation	5	1 month before dispatch of equipment. The list of documents identified under master document list for erection to be furnished in 5 no's of folders

7)	Draft O & M Manuals for BHEL review. Note: *Bidder to furnish final hard copy of O&M only after getting concurrence on soft copy.*	Soft copy	At least 2 months before the delivery date of equipment
8)	Revised O & M Manuals with Test Certificates to be submitted to BHEL (Hyderabad)	12	Within one month before the delivery date of equipment
9)	Final O&M manuals in a CD	4	Within one month after dispatch of equipment after BHEL concurrence on soft copy.

Notes:

The O&M manuals shall contain the following as minimum:

a) The identification details of the equipment like BHEL P.O. No., Vendor's Job Identification No., full contact address with telephone, fax, & e-mail details.
b) Brief description of the system.
c) All approved documents [Drawings, documents & test procedures as per MDL]
d) Bill of material, BBU, LO schedule, sub vendor list, Mandatory & commissioning spares list etc.
e) Operation, Instruction & maintenance manuals of all equipments / items fo the complete package
f) System unloading, storage erection, start up, commissioning, shut down requirements.
g) Operational & environmental safety instructions.
h) Test reports and certificates.
i) Catalogues of the equipment & instrumentation.

15. PRICE BID FORMAT

Bidder to indicate his offer as per Price Bid format enclosed as Annexure-3A, 3B, 3C & 3D.

All the items included in the price bid format shall be quoted as per tender specification and pre-bid clarifications as per annexure-11, if any. Responsibility of ensuring correctness & completeness of scope of supply as per specification requirement solely lies with bidder.

The equipment supplied shall be complete in all respects. The bidder shall not be eligible for any extra payment in respect of such mountings, fittings, fixtures and accessories if required for the safe and reliable operation of the equipment. Any additional equipment, material, etc., which are not specifically mentioned here, but are required to make the supplied equipment complete in all respect, in accordance with the intent of this technical specification, contractual agreement, statutory requirements, relevant/applicable codes/standards, good engineering practices, and for safe and trouble-free operation, shall be deemed to be in bidder scope Only.

Main offer consists of those items, which will be part of main order after successful bidder is identified. Optional Items consists of those items, which need to be quoted by bidder but may or may not be ordered by BHEL. Bidders are instructed to provide the pricing details listed under Main offer and Optional items as per the prescribed format. Prices quoted by the bidder shall remain firm till the successful handing over of the entire package to end customer. Any request for upward revision of price during any intermediate stage before handing over the plant to end customer will be summarily rejected by BHEL.

The Priced Bid shall be submitted in Original (without any copy) duly signed and stamped on each page in a separate sealed envelope super scribing "Price Bid –Do not Open" This shall not contain any condition whatsoever failing which the Bids shall be liable to be rejected. In case of any correction, the bidder shall put its signature and its stamp. Eraser fluid will not be allowed for making any correction.

Bidder shall confirm to the un-priced bid as part of their offer.

16. PRE-BID CLARIFICATIONS

Bidders shall comply with various requirements of this specification. It may please be noted that the requirements specified here in this specification are the standard practices being followed by the bidders. However, same things are presented in a structured form so that it can be ensured that the requirements of ultimate customer are complied with.

Bidders can bring out only those deviations which are impractical to meet, for our review in pre bid clarification only.

Bidders may also please note that the data sheets for valves, instruments etc., submitted along with the offer will be considered as indicative only, as the requirements specified in the specification are standard in nature. These will not be reviewed by BHEL before award of contract. Same will be reviewed during order execution stage in line with the requirements of specification and agreed deviations.

All pre-bid clarifications & deviations shall be clear bring as per Annexure 11 only.

In case bidder doesn't bring any clarification/deviation in prebid stage, the same shall be brought in their offer with following conditions:

a) Any deviations to Customer specifications, same are acceptable provided these deviations are also regularly accepted by Customer for their direct orders on bidders. In such cases, proof of the same shall be furnished along with the offer.

b) Bidders may please note that unless the deviations are specifically brought out under deviations clause, it will be considered that no deviations are taken, even if they are mentioned elsewhere directly/indirectly in the offer.

c) Price implication due to non-acceptance [by BHEL/Customer] of the deviations considered by bidder will not be permitted.

d) Deviations [if any] shall be clear bring as per Annexure 10 only.

17. VARIANT TABLE:

Variant	Item	Material Code
01	Gear Pump Motor Driven with CS and ST	PY9751765013
02	Gear Pump engine driven with CM and ST	PY9751765021
03	Gear Pump mandatory spare	PY9851765031
04	Supervision of E& C of Gear Pump assembly	PY9751765048
05	Revalidation spare for engine	PY9751765056

RECORD OF REVISIONS				
Rev. No.	**Date**	**Revision Details**	**Revised By**	**Approved By**
00	10.09.2021	First Issue	----------	Surya Satya Nagesh M

BHARAT HEAVY ELECTRICALS LIMITED
PROJECT ENGINEERING & SYSTEMS DIVISION
RAMACHANDRAPURAM: HYDERABAD - 502 032

Std. / Doc. Number	
Annexure-1	
Rev. No.	00

Annexure-1

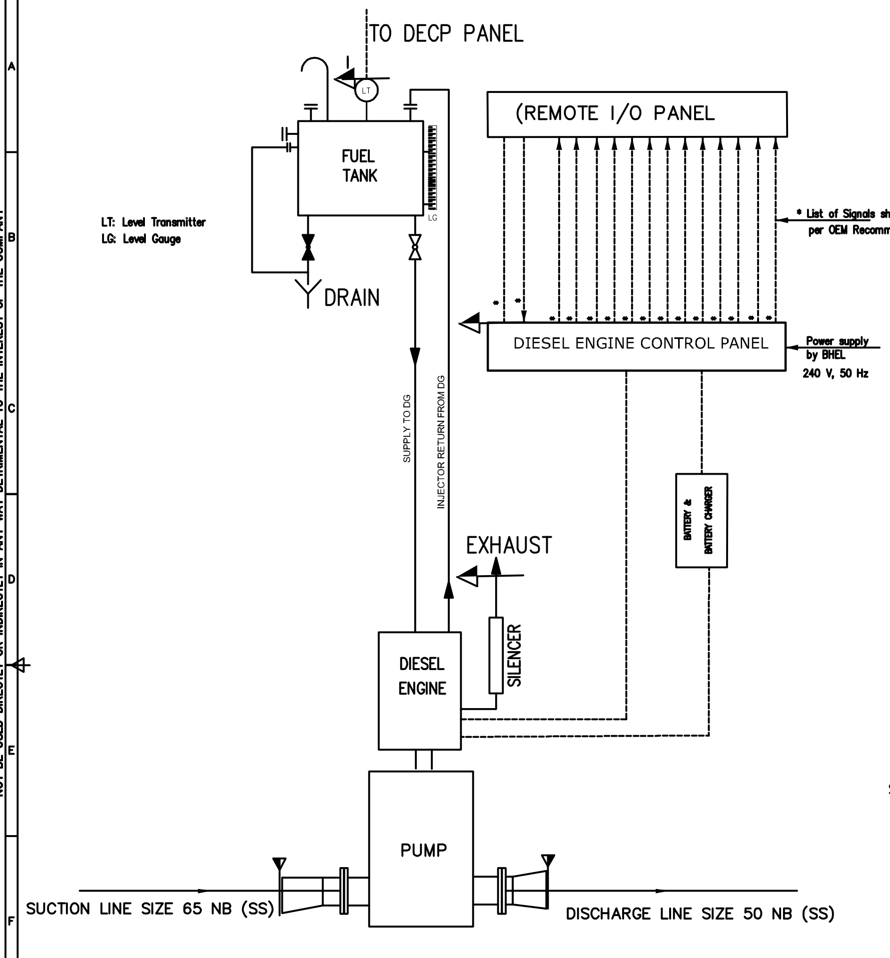
1.P&ID for Pump & Drive assembly
2.Layout
3. Exhaust Piping layout

Revisions: Refer to record of revisions	**Prepared by :**	**Checked by :**	**Approved by :**	**Date :**
	RATISH KUMAR	GIRISH PALO	SURYA SATYA NAGESH M	

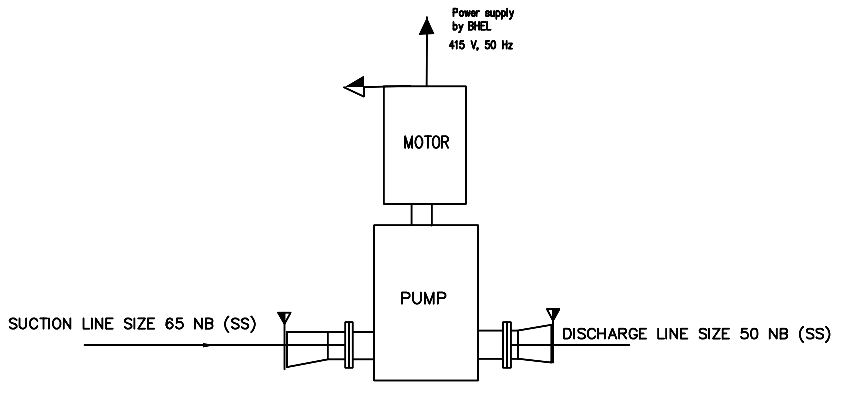
FIRST ANGLE PROJECTION

(ALL DIMENSIONS ARE IN mm)

ANNEXURE–1



TYP. FOR ENGINE DRIVEN FOAM PUMP



TYP. FOR MOTOR DRIVEN FOAM PUMP

Notes:

1. For scope of supply specification shall be referred.
2. This is typical schematic of Foam Pump set.
3. Pump Nozzle and BHEL Pipe size meeting Standard reducer/expander.
4. Following standards shall be applicable:
   a) Pipe: Stainless steel to ASTM A–312, TP–304, Sch.–10
   b) Pipe Fitting: SS forged to ASTM–A–182, F–304 for sizes 15NB to 40NB and S.S. seamless to ASTM–A– 403, WP–304, Schedule–40 for sizes 50NB & above.
   c) Flanges/Companion Flanges: Plate fabricated to ASTM A–240, TP–304
   d) Gasket: CAF as per IS:2712, Gr.W3.
5. Layout shall be refereed for deciding BOQ for fuel piping, Exhaust piping, cabling etc. which are in bidder scope of supply.

BHEL SCOPE | VENDOR SCOPE

CUSTOMER: UTTAR PRADESH RAJYA VIDYUT UTPADAN NIGAM LTD

PROJECT: 1X660 MW PANKI THERMAL POWER STATION, PANKI, UTTAR PRADESH

BHARAT HEAVY ELECTRICALS LTD.
HYDERABAD

	NAME	SIGN.	DATE	NO.OF VAR.
DRN.	Ratish	–SD–	11.09.21	N.A.
CHD.	BNS	–SD–	11.09.21	
APPD.	MSSN	–SD–	11.09.21	

DEPT. PE&SD / CODE 450	UNTOL. DIMS. GR.	SCALE	WEIGHT (KG)	REF. TO ASSY. DRG.	ITEM NO.	NO.OF ITEMS
	C/M/F	N.T.S	N.A.	N.A.	N.A.	N.A.

TITLE: SCHEME FOR FOAM PUMPS

CARD CODE: NA

DRG. NO. PESD/YADADRI/FOAM/001 — REV. 00

CUST. DRG. NO. __________

SHT. No 01 | NO. OF SHT. 01

Annexure-2

Pump-Motor-Engine datasheet

ANNEXURE-2 : DATA SHEET FOR GEAR PUMP -MOTOR-DIESEL ENGINE			
Sl.no.	**Description**	**BHEL Requirement**	**Bidder's Details**
GENERAL DATA			
1	Service	For supplying the foam to the foam system from the foam tank	
2	Number of Pumps	2 Nos [1 Motor driven +1 Diesel Engine driven]	
3	Location	Indoor	
4	Duty	Motor driven - Continuous Engine driven - Intermittent	
5	Drives	Motor & Diesel Engine	
6	Pumping fluid /Viscosity/Sp Gr	Foam Type : 3% Aqueous Film Forming Foam concentrate (AFFF) Appearance : Amber color Liquid PH @ 20 °C : 7.0 – 8.0 Sp. Gravity @ 20 °C: 1.00 to 1.04 Viscosity @ 20 °C : Less than 10 cst Storage : Storage temperature should be lower than 49° C. Containers shall not directly exposed to sunlight & heat for longer period SPEREADING CO-EFFICIENT : +3 Minimum SLUDGE CONTENTS (%, V/V) , MAX: Nil	
7	Fluid temp Deg C	Ambient	
PUMP PERFORMANCE & OTHER DETAILS			
8	Pump Type	Gear Pump	
9	Design Standard of pump	Generally as per API 676	
10	Rated Flow (m^3/hr)	17.1	
11	Rated Differential Head in Kg/cm^2(g)	12.1	
12	Temperature of pumping fluid	Ambient	
13	Pump Model No.	Pump model shall be interchangeable for both Motor & Engine driven pump. Bidder to indicate pump model	
14	Pump end connection	Side Suction Side Discharge	
15	Rated Speed of Pump (rpm)	Bidder To Furnish	
16	Rated speed of Motor (rpm)	Bidder To Furnish	
17	Rated speed of Engine (rpm)	Bidder To Furnish	
18	Pump Efficiency in %	Bidder To Furnish	
19	Available Pressure at centre line of Suction nozzle of Pump mlc	8	
20	NPSH(A) at pump suction nozzle (mlc)	8	
21	NPSH(R) (mlc)	Bidder to furnish.	
22	NPSH(A) - NPSH(R)	Sufficient for trouble free operation of pump.	
23	Material of Construction:	Casing (Pump body) : CF8M Rotor Gear : SS 316 Rotor Shaft : SS 431 End cover : SS 316 Sealing : Mechanical Seal Gland : SS 316 Bearing Cover : SS316 Base plate : MS Fabricated Integral relief valve : SS 316/CF8M Fasteners: SS-316 Companion Flange : SS316 Expander and reducer : SS 316 Foundation bolt : MS Coupling : SS 316 Coupling Guard : Aluminum (Vendor to ensure that all the selected materials is suitable for the application)	
24	Type of main bearings for pump	Bidder To Furnish	
25	Main bearings lubrication	Bidder To Furnish	
26	Direction of rotation of Pump	Bidder To Furnish	
27	Direction of rotation of Motor	Bidder To Furnish	
28	Direction of rotation of Engine	Bidder To Furnish	
COUPLING			
29	Coupling standard	Bidder to furnish.	
30	Type of coupling	Flexible Coupling	
31	Non sparking type couplign guard	Yes	
31	Service factor for the coupling	1.5	
PERFORMANCE TEST STANDARD FOR PUMPS			
33	Performance test standard	As per Manufacturing Standard duly taking care of TAC requirement	

34	Maximum Allowed Working Pressure (MAWP) in Kg/cm^2 (g)	Bidder To Furnish	
35	Hydraulic test pressure of casing Kg/cm^2(g)	Bidder To Furnish	
36	Noise level for Pump and motor assembly	85 DBA at 1 m distance, in any direction	
37	Noise level for Pump and engine assembly	105 DBA at 1 m distance, in any direction	
38	Vibration for Pump	As ISO 10816	
PUMP TERMINAL POINT DETAILS			
39	Pump Suction nozzle - Size - Rating - Standard - Facing - Location	Bidder To Indicate	
40	Pump Discharge nozzle - Size - Rating - Standard - Facing - Location	Bidder To Indicate	
41	Expander meeting BHEL suction pipe size as per Annexure-1	Bidder to provide	
42	Expander meeting BHEL disharge pipe size as per Annexure-1	Bidder to provide	
MOTOR DETAILS FOR MOTOR DRIVEN PUMPS [For More Details Please refer enclosed annexures]			
43	Drive/Installation	Motor/Horizontal	
44	BKW at the rated point	Bidder To Indicate	
45	BKW at 110% of RV Pressure	Bidder To Indicate	
46	Selected drive rating in kW: Continuous drive motor rating (at 50 degree C ambient) shall be Drive Unit Power rating for the foam Pump shall be selected such that it is equal to higher of the following conditions i. 115 % of the duty point power requirement ii. Motor input power required at 150% of the duty point capacity of pump iii. Motor Input power required at 110% Relief Valve set Pressure or at any condition of operation of pump.	Bidder to mention motor kW rating for the motor duly taking care of requirements.	
47	Design Standard of Motor	AS Per Annexure-5 of Tender Specification.	
48	Manufacturer	As per attached subvendor list	
49	Ambient Temperature	50 Deg C All motors shall be designed to operate in humid atmosphere with a maximum ambient temperature of 50 Deg C.	
50	Area classification for motor	Safe Area	
51	Rated Voltage & Frequency	415 V & 50 Hz	
52	Permissible variations in Voltage/Frequency/Combined	Voltage: (+/-)10% Frequency: +3/-5% Combined: (+/-)10% combined variation of voltage and	
53	No of poles / synchronous speed	Bidder To Furnish	
54	Energy efficient class	IE3	
55	Starting Current as % of FLC	AS Per Annexure-5 of Tender Specification.	
56	Method of Starting	DOL	
57	Method of cooling	Bidder To Furnish	
58	Winding and Insulation	All insulated winding shall be of copper. All motors shall have class F insulation but limited to class B temperature rise. Windings shall be impregnated to make them non-hygroscopic and oil resistant.	

59	Temp. rise	All motors shall have class F insulation but limited to class B temperature rise	
60	Degree of protection/Canopy Required	IP 55/Yes	
61	TB Short time-Current & Short time-Time	50 kA , 0.25 Sec	
62	Cable, Cable glands & Lugs	Suitable cable lugs and double compression brass glands to match with BHEL supplied cable.	
63	No. of Starts	Motors shall be capable of three equally spread starts per hour under normal condition or two starts in quick succession from cold	
64	Bearing RTDs, Winding RTDs & TGs	Not Applicable	
65	Noise	85 DBA at 1.0 m distance from motor body, in any direction	
66	Vibration	Maximum double amplitude vibrations upto 1500 rpm shall be 40 microns and 15 microns upto 3000 rpm	
DIESEL ENGINE DETAILS FOR ENGINE DRIVEN PUMPS			
67	Drive	Diesel Engine	
68	Type	The engine shall be naturally aspirated, super charged or turbo-charged as recommended by the manufacturer. Compression ignition, mechanical (air less) direct injection, multicylinder and four stroke cycle and cold starting type. (Ref. Fire Protection Manual by TAC).	
69	Location	Indoor	
70	BKW at the rated point	Bidder To Indicate	
71	BKW at the 150 of Rated point Flow		
72	BKW at 110% of RV Pressure	Bidder To Indicate	
73	Selected drive rating: i. The continuous engine brake horse power rating (after accounting for all auxiliary power consumption) at the site conditions shall be at least 20% greater than the brake horse power required to drive the pump at its duty point at rated R.P.M. and in no case less than the brake horse power required to drive the pump at 110 % of RV pressure or at any condition of operation of pump. ii. Deaerating Factors considered by the manufacturer to arrive at the shaft power of the diesel engine at site, shall not be less than the following: a. 3% for each 305 meter elevation above MSL b. 1% for each 5.6° C rise in air temperature above 15.6° C iii. The base power rating of the diesel engine shall be referred to any accepted datum like BS/SAE Standard condition or equivalent. In any case, horsepower rating shall not be higher than the limit set by Tariff Advisory Committee.	Bidder to mention engine HP rating for the motor duly taking care of the requirements.	
74	Drive Standard	Performance requirement of the diesel engine shall be guided by TAC/LPA recommendations. IS -10000, BS- 5514, ISO-3046, ISO-8528 and as per standard practice of diesel engine manufacturer's association of USA. Selection, Design and construction of the diesel engine shall be guided by the TAC recommendations.	
75	Name of Manufacturer	Bidder to furnish.	
76	Model No	Bidder to furnish.	
77	Duty	Intermittent. However, same shall be capable of operating continuously on full load at the site elevation for a period of 1 hours.	
78	Speed	Bidder to Furnish	
79	Type of cooling	Bidder to Furnish	
80	Noise	105 DBA at 1 m distance, in any direction	
81	Vibration	As per IS standard	
	Note: Individual datasheets for Pump, Motor & Diesel shall be furnished during detailed engg stage. It is mandatory for the equipment supplier to furnish in format [to be submitted during detailed engg stage] in case of placement of order.		

Special notes:
1. As per specification, Electronics governor to be envisaged.

2. As per specification "lubricating oil sump shall be equipped with adequate heaters having thermostat control to maintain the lubricating oil at recommended temperature for maintaining oil at low viscosity".

3. 1 No. of suitable 1 phase 230 Volt fuel pump (portable) with ex-proof motor to be supplied to fill up diesel oil from Diesel Drum received from supplier of Diesel. Additionally, 1 No. of hand operated pump shall be supplied to fill up diesel oil from diesel drum received from supplier of diesel.

Annexure-3

Pump-Price bid format

Annexure-3A

BHARAT HEAVY ELECTRICALS LIMITED
PROJECT ENGINEERING & SYSTEMS DIVISION
RAMACHANDRAPURAM: HYDERABAD - 502 032

PRICE FORMAT (R00) FOR HYDRANT AND SPRAY PUMP WITH DRIVES (MOTOR & DIESEL ENGINE)
PROJECT: 5X800 MW YADADRI THERMAL POWER STATION PROJECT, NALGONDA, TELANGANA
CUSTOMER: TELANGANA STATE POWER GENERATION CORPORATION LTD. (TSGENCO)
CONSULTANT : TATA CONSULTING ENGINEERS LTD.

SL NO	ITEM DESCRIPTION	QTY	UNIT	Weightage w.r.t Overall Price (In %)	Bidder confirmation (Quoted/ Not Quoted)	HSN/SAC Code	GST (%))
	Bidder's Name : <Bidder to indicate> Bidder's Offer No. & Dt. : <Bidder to indicate> Bidder's Ref No. & Dt. :<Bidder to indicate> BHEL Enq. No. & date :<Bidder to indicate>						
1	**MAIN OFFER**						
A	**MATERIAL SUPPLY: FOAM PUMP WITH MOTOR [Material code:PY9751765013]**			31.79			
A.1	Foam Pump with Drive Motor along with all accessories including commissioning spares, special tools & tackles as per specification**.**	1	Sets				
B	**MATERIAL SUPPLY: FOAM PUMP WITH ENGINE [Material code:PY9751765021]**			50.97			
B.1	Foam Pump with Diesel engine, Control Panel, Fuel tank, Battery, Charger etc along with all accessories including commissioning spares, special tools & tackles as per specification.	1	Sets				
C	**MATERIAL SUPPLY: Mandatory spares [Material code: PY9751765048] Refer Note-14**			12.29			
C.1	**Mandatory spares for Motor [Motor rating is upto 30 kW]**						
i)	Driving End & Non-Driving End Bearing	6 Sets for each type and rating of Motor					
ii)	Cooling Fan	4 Nos for each type and rating of Motor					
iii)	Motor Terminal Block	10 Nos for each type and rating of Motor					
iv)	Complete Set of Coupling	2 Sets for each Application					
C.2	**Mandatory spares for Engine**						
i)	Element for lub oil Filter	4	Nos				
ii)	Element for Fuel Filter	4	Nos				
iii)	Outer Element for Air cleaner	4	Nos				
iv)	Inner Element for Air cleaner	4	Nos				
v)	Turbo-charger	2	No				
vi)	Engine - starter Motor	2	No				
vii)	Injector	4	Nos				
viii)	Piston rings & liner set	4	Set				
C.3	**Mandatory spares for Panel**						
i)	Push Button-Complete assembly	10 Nos per each color					
ii)	Push Button-Contact Element (1NO + 1NC) Block	40 Nos					
iii)	Selector Switch [each type and rating]	20 Nos					
iv)	Voltmeter [each type & Rating]	Total Installed qty x 10 % x (2/5) or minimum 2 nos					
v)	Ammeter [each type & Rating]	Total Installed qty x 10 % x (2/5) or minimum 2 nos					
vi)	Frequency Meter [each type & Rating]	Total Installed qty x 10 % x (2/5) or minimum 2 nos					
vii)	Indicating Lamps complete assembly	20 Nos per each color and type					
C.4	**For Instrumentation**						
i)	Transmitters/ Gauges/Switches etc. along with relevant accessories	Total Installed qty x 10 % x (2/5) or minimum 2 nos) for each type along with accessories.					
ii)	Temperature Element (RTD/Thermo-couple) with thermowell	Total Installed qty x 10 % x (2/5) or minimum 5 nos					
iii)	Cables (Control & Instrumentation)	Total Installed qty x 10 % x (2/5)					
D	**Supervison charges for erection & commissioning at site [Material code:PY9851765031]**			**3.62**			
	Supervison charges for erection & commissioning shall include the following: 1. Per diem charge of for supervision of erection & commissioning of **Pump/Motor & Controller/Diesel Engine & Controller** etc. 2. Charges for 1 visit Note: The above shall also include all other expenses like boarding, lodging, local travel, insurance, travel expenses (inclusive of all other charges like visa fee (if applicable), insurance etc) from / to vendor works to site for Engineer. [Refer Note 11]	5 Day and 1 Visit					
E	**REVALIDATION SPARE FOR ENGINE [Material Code: PY9751765056]**			**1.33**			
	Bidder to quote revalidation spares required for Engine as per OEM practice. Note: 1. Revalidation spares are those spares which are required at the time of commissioning of Engine, if engine is commissioned after the time recommended by vendor. 2. Revalidation spare consumed over and above the recommended revalidation spares, during commissioning of engine shall be supplied free of cost by the equipment vendor. 3. Bidder to furnish list of revalidation spare with offer. 4. PO for revalidation spare is placed as per requriment. However, price of revalidation spare is considered for L1 bidder evaluation.	1 Set					
	Grand total price for sl no A, B, C and D **(Inclusive of Packing & Forwarding, Freight and Insurance)**			100			
Packing & Forwarding, Frieght, Insurance and GST :							
(A) For Supply:							
(i) Packing & Forwarding :	In bidder scope			Included in basic price			
(ii) Frieght:	In bidder scope			Included in basic price			
(iii) Insurance:	In BHEL scope						
(iv) GST	Extra at actuals			Extra at actuals			
(v) Any other:	shall be included in baisc price of pumps			Included in basic price			
(B) For supervision of E&C:							
(i) GST:	Extra at actuals			Extra at actuals			
(ii) Any other:	Included in basic price			Included in basic price			

SL NO	ITEM DESCRIPTION	QTY	UNIT	Weightage w.r.t Overall Price (In %)	Bidder confirmation (Quoted/ Not Quoted)	HSN/SAC Code	GST (%))
	Bidder's Name : <Bidder to indicate> Bidder's Offer No. & Dt. : <Bidder to indicate> Bidder's Ref No. & Dt. :<Bidder to indicate> BHEL Enq. No. & date :<Bidder to indicate>						

Notes:

1) Bidders should quote the Total Bid Value in both in figures & words in the specified place.

2) Bidders should mention the applicable HSN/SAC code along with GST% against respective line items.

3) Bidders shall not fill/edit/modify anything else in the Price Bid Format.

4) The rates of line items mentioned in the Price Format shall be derived by BHEL by multiplying the Total Bid Value quoted by the Bidder with the Weightage Factor assigned against respective line items. The rate of each item shall be rounded off to the next 1 (one) paisa.

5) The Total Bid Value quoted by the Bidder shall represent the total landed cost for this enquiry and shall include Packing & Forwarding Charges, Freight & Insurance Charges, and all applicable taxes and duties, other than GST. GST shall be paid extra by BHEL at applicable rates.

6) Evaluation shall be done on the basis of total bid value i.e. the total landed cost to BHEL for this enquiry. Loading (if applicable) shall be added to the Total Bid Value for evaluation purpose.

7) The bidders will also provide un-priced price format strictly in the BHEL price format given above, in the techno commercial part of their offers. Bid will be rejected if any other price format is used. Both priced and un-priced price formats to be provided by the bidders shall be signed and stamped copies.

8) Bidder to quote strictly as per BHEL's NIT requirements.

9) Bidder to note that this is a LUMP SUM Turn-Key Order. However
(a) Changes to the tender specification during execution of the project for successful operation of the system need to be carried out by bidder and commercial implications if any will be settled suitably.
(b) Unit rates quoted by bidder shall be applicable for any changes in BOQ during detailed engineering stage.

10) **Main offer (Annexure-3A)** consists of those items which will be part of main order after successful bidder is identified. **Optional Items (Annexure-3A-I)** consists of those items which need to be quoted by bidder but may or may not be ordered by BHEL. Bidders are instructed to provide the pricing details listed under **Main offe**r and **Optional items** as per the prescribed format.

11) Prices quoted by bidders for items under main offer : Sl. No.I(A+B+C+D+E) will be considered for evaluation of lowest bidder.
For the purpose of tender (L1 bidder evaluation) following shall be noted:

Referring to Sl no D- Supervision charges for Pump/Motor & Controller/Diesel Engine & Controller , For the purpose of Quotation, total no of 5 man days for Pump/Motor & Controller/Diesel Engine & Controller will be covered in 1 visit have been considered and payment against Sl.No D above shall be made as per the actual number of visits and man days required for the supervision of the complete E&C activities as per these diem rates. Purchase Order for supply of main items, (A to C) shall be placed by BHEL- PE&SD Hyderabad. For Supervisionof E&C (Sl. No. I.D) and Revalidation Spare for Engine (Sl. No. I.E), LOI shall be placed by PE&SD and PO By BHEL-Power sector region.

However, BHEL reserves the right
(a) To include any of the optional items in scope of supply (as per customer contract requirements) and accordingly consider the same in evaluation. Any such scope increase and change in evalution will be intimated to vendor during technical evaluation(before price bid opening).
(b) To place PO for any of the Optional items with in the contract period.
Hence bidders need to mandatorily quote reasonable prices for all optional items considering such requirement and keep the validity of the prices till the end of contract period.

12.a) For all items including Optional items, prices to be furnished in this prescribed price bid format only for each individual item. The price to be quoted against sl no A, B & C shall be Weightage w.r.t Overall Priceas mentioned above. No combined prices, common prices or any other format will be accepted and such bids may be liable for rejection.
12 b) Bidder must not change the indicated item description, quantity & units in the price bid format. Bidder should only fill the unit rates & total price.
12 c) Bidder to quote for all the items as per price bid format. Incomplete/partial offer may be liable for rejection.

13 a.) Commissioning spares are those spares which are required at the time of commissioning and shall be recommended (as per bidders experience) and quoted by bidder. However commissioning spares indicated in the price bid format shall be quoted as minimum.
13.b) Commissioning spare consumed over and above the recommended commisioning spares, during commissioning shall be supplied free of cost by the equipment vendor.

14)With respect to Mandatory Spares;
A) If any of above items indicated by the specified name are not applicable, bidder to offer alternative item serving the same function as per equipment's design and indicate below the item being replaced.
B) If bidder is not able to meet the above note, then bidder may mention "Not Applicable". However, if found applicable during detailed engg. stage or alternative item as per equipment design can serve the same function, bidder to supply the specified quantity with out any delivery and commercial implications to BHEL.

15) Reference document: **PY51765, R00 & annexures**.

16) Unpriced price bid format indicating as quoted against each applicable item shall be submitted duly signed & stamped along with technical offer by bidder as a token of concurrence that prices are submitted in this format only. The offer shall be liable for rejection in case if un-priced price bid format is not submitted or any modification is carried out in price bid format.

17) **In case the systems are being supplied from outside India,** reputed Third Party Inspection as mentioned in BHEL Tender Specification has to be considered and the charges should be included in the Main offer. For those bidders who are supplying from India, such third party inspection charges need not be considered and same will be arranged by BHEL/BHEL nominated inspection agency.

Annexure-3A-I

BHARAT HEAVY ELECTRICALS LIMITED
PROJECT ENGINEERING & SYSTEMS DIVISION
RAMACHANDRAPURAM: HYDERABAD - 502 032

PRICE FORMAT (R00) FOR HYDRANT AND SPRAY PUMP WITH DRIVES (MOTOR & DIESEL ENGINE)
PROJECT: 5X800 MW YADADRI THERMAL POWER STATION PROJECT, NALGONDA, TELANGANA
CUSTOMER: TELANGANA STATE POWER GENERATION CORPORATION LTD. (TSGENCO)
CONSULTANT : TATA CONSULTING ENGINEERS LTD.

SL NO	ITEM DESCRIPTION	QTY	UNIT	Bidder confirmation (Quoted/ Not Quoted)	HSN/SAC Code	GST (%)
	Bidder's Name : <Bidder to indicate> Bidder's Offer No. & Dt. : <Bidder to indicate> Bidder's Ref No. & Dt. :<Bidder to indicate> BHEL Enq. No. & date :<Bidder to indicate>					
II	**Optional Items**	--	--			
A	**2 Years Recommended Spares**					
	Recommended spares list for two years normal operation along with unit price breakup for Pump, Drives & other accessories. **(List with price break up to be enclosed)** (1 set stands for quantity required for the replacement of one pump, drive (or) accessories)	1	Set			

Annexure-4

Pump-Check list

ANNEXURE- 4 to BHEL TENDER SPECIFICATION

CHECKLIST FOR OFFER FOR FOAM PUMP WITH DRIVES (MOTOR/DIESEL ENGINE)

S.No.	Description	Bidder's Reply
1.	Bidder to confirm that the following documents are submitted along with their offer to enable BHEL to evaluate the offer. a) Duly filled in Pump-Motor-Diesel Engine datasheet (Annexure-2) b) Tentative GAD for Pump with Motor & Engine c) Performance curves for pump d) Un-priced copy of price in attached BHEL price bid formats (Annexure-3) indicating quoted/ not quoted against each row & column. e) Equipment qualification criteria / PTR / Reference Lists (Annexure-6) f) Checklist as per Annexure-4 g) No Deviation Certificate as per (Annexure-10) **Datasheets in formats other than Annexure-2 shall not be reviewed.**	
2.	All-important documents such as duly signed in unpriced price bid, reference list, pump performance curve, Pump & drive assembly GA drawings, CS drawings must necessarily to be furnished by bidder along with their offer for evaluation. **Bidder to once again check their offer before submission and confirm.**	
3.	Scope of supply as per Tender Specification. Bidder to Confirm. **Further any document indicating scope of supply submitted by bidders shall not be reviewed.**	
4.	Bidder to confirm that Performance requirement, Design and construction of the offered Pump model shall be as per Manufacturing Standard duly taking care of TAC requirement and Tender specification requirement.	
5.	Bidder to confirm that Performance requirement, Design and construction of the offered Diesel Engine shall be as per As Per TAC and Tender Specification.	
6.	Bidder to confirm that Performance requirement, Design and construction of the offered Motor shall be tender specification and meeting the TAC requirement.	
7.	Bidder to confirm that Motors, Engine, Panel make shall be as per approved vendor list.	
8.	Bidder to submit Soft copy and hard copy of logics executed in the control panel. The same is required by customer during operations for uploading the program.	
9.	Bidder to confirm that the Motor Rating Selected is as per requirement mentioned in BHEL Tender Specification.	
10.	Bidder to confirm that the Engine Rating Selected is as per requirement mentioned in BHEL Tender Specification.	

11.	Refer Annexure-2 of Tender Specification: Datasheet of Foam Pump-Motor & Engine Datasheet. Duly filled Annexure-2 is enclosed with bidder's offer as indicated Tender Specification, Bidder to Confirm.	
12.	Bidder to confirm that suitable supporting structure for Fuel tank along with necessary fixing arrangement included in their scope.	
13.	Bidder to confirm that suitable supporting structure for Battery along with necessary fixing arrangement included in their scope.	
14.	Bidder to confirm that suitable supporting structure for diesel engine control panel along with necessary fixing arrangement included in their scope.	
15.	Suitable power, control and signal cable with glands & lugs for cable between Control panel, Battery, Battery selector switch and Diesel Engine shall be included in bidder scope of supply. Deviation in this is not acceptable. Bidder to Confirm.	
16.	Bidder to provide suitable Power cable gland and lugs for motor. Cable details shall be furnished during detail engineering stage. Bidder to confirm.	
17.	Bidder to provide suitable canopy for motor. Bidder to confirm.	
18.	Minimum instrumentations indicated in Tender Specification, bidder to include it in their scope of supply. Deviation in this is not acceptable. Bidder to Confirm.	
19.	Bidder to consider Exhaust Piping, Silencer, Insulation, Bends, Fittings etc. as per BHEL tender specification. However, as a minimum Bidder to consider 15 m of exhaust piping with silencer & insulation with 6 Nos. of bends in bidder's scope of supply. The exhaust piping shall consist of bends, hood, bird screen etc. Deviation in this is not acceptable. **Bidder to Confirm.**	
20.	Each engine shall be provided with Two (2) sets (1 working & 1 standby, 100% capacity) battery units as per IS. Battery shall be sized as per BHEL tender specification. Bidder to Confirm.	
21.	Each engine shall be provided with 2 sets of battery charger units as per specification. Bidder to Confirm.	
22.	Suitable reducers/expanders & counter flanges along with gaskets & stud nuts at all the terminal points are considered by bidder. Deviation in this is not acceptable. Bidder to Confirm.	
23.	Bidder to furnish list of commissioning spares as per OEM recommendation. Any commissioning spare required over and above the recommended commissioning spares during commissioning shall be supplied free of cost by the equipment vendor. Deviation in this is not acceptable. Bidder to Confirm.	
24.	Bidder to furnish list of special tools & tackles. All the special tools and tackles indicated in tender specification are included in bidder's scope of supply. Deviation in this is not acceptable. Bidder to Confirm.	
25.	Bidder to furnish list of 2 year recommended spares as per OEM recommendation. Bidder to quote for the same in the price bid as optional price. Bidder to Confirm.	
26.	Painting schedule shall be as per Annexure-5 of Tender Specification, Bidder to Confirm.	

27.	**Inspection, Testing requirements for Pump & Drive assembly:** Inspection, testing requirements shall be as per BHEL QAP & specification requirement only. Bidder to note that QAP shall be as per Annexure-7 & the same shall be discussed during detail engg. However, in case of practical difficulties in meeting the quality requirement, same shall be mutually discussed & agreed during detail engg. Stage. Bidder to note & confirm.	
28.	Make of all the items shall be as per Annexure-8 (Sub-Vendor List). Bidder to confirm.	
29.	Bidder to confirm compliance with Annexure-9, Master Document List enclosed with Tender Specification, wrt list of documents, schedule of submission.	
30.	Bidders to comment on the instrumentation requirement as per P&ID (Annexure -1) based on their experience. If any other instruments are required as per good engg practice, bidder to highlight & Consider the same.	
31.	Any specific deviations, which are impractical, shall be raised in form of pre-bid queries as per Annexure-11 before submission of Techno Commercial offer. Any deviation/ queries raised during technical bid submission shall not be entertained. Bidder to Confirm.	
32.	Bidder to quote as per Annexure-3, Price Bid Format only. Price quoted as per the price bid format, clearly indicating all the applicable items are quoted, and not applicable items are clearly highlighted. Un priced copy of the same is enclosed with bidder's offer. Bidder to check and confirm.	
33.	Bidder to quote individual price for each item mentioned in the seal priced bid. Bidder to check and confirm.	
34.	Bidder to confirm that the bidder has quoted prices for respective items as percentage of total price mentioned in price bid format.	

SIGNATURE:

NAME:

DESIGNATION:

COMPANY:

DATE:

Annexure-5

Annexure 5- A: Technical Specification For Fire Protection System
Annexure 5- B: Technical Specification For A.C. & D.C. Motors
Annexure 5- C: General Electrical Specification
Annexure 5- D: C&I Specification
Annexure 5- E: Misc Specification

Annexure 5- A: Technical Specification For Fire Protection System

VOLUME-IIIE

SECTION-II

TECHNICAL SPECIFICATION FOR FIRE PROTECTION SYSTEM

CONTENT

ATTACHMENT

VOLUME: IIIE

SECTION-II

TECHNICAL SPECIFICATIONS FOR FIRE DETECTION, ALARM AND PROTECTION SYSTEM

1.00.00 GENERAL INFORMATION

This section covers the requirements envisaged for Fire Detection and Protection System including Alarm and Communication which will be used to control any outbreak of fire in the proposed1 x 800 MW Sri Kothagudem Thermal Power Station (KTPS), Stage-VII, Unit-12 for Telangana State Power Generation Corporation Limited (TSGENCO) at Kothagudem, Telangana to reduce consequential damages by containing and extinguishing the same. This section of the Specification shall have two parts – Fire Extinguishing System and Fire Detection & Alarm System. Bidder's scope of work covers supply, erection, commissioning and testing of the entire fire detection, alarm and protection system including supply of all fire extinguishing equipment and systems, fire detectors, manual call points, linear heat sensing cables, all local, remote Fire detection alarm cum MIMIC panels , repeater fire alarm panels, PCs and peripherals, hardware and licensed versions of software as detailed hereunder, meeting all code requirements to make the system complete.

2.00.00 CODES AND STANDARDS

The system shall be designed keeping in view the recommendations of Tariff Advisory Committee (TAC) of Insurance Companies of India/LPA India/NFPA USA. Any other International Standard having equivalent stringent codes may also be considered. However, the system shall be approved by statutory authorities.

3.00.00 SYSTEM DESCRIPTION

For protection against fire, all yard equipment will be protected by a combination of hydrant system, automatic sprinkler spray system (emulsifier system), fixed foam system for oil handling areas, automatic high velocity and medium velocity sprinkler spray system, auto-modular clean agent system for control rooms apart from portable and mobile fire extinguishers located at strategic areas of plant buildings and adequate Passive Fire Protection measures.

Fire extinguishing system is broadly divided into following sub-systems:

- Cable vault and cable galleries of main plant, switchyard control room, and ESP control room. Detection system shall consist of smoke detectors, LHS cables.

- Fuel oil storage and day tank area, DG set diesel tanks.

3.01.04 **Fixed Foam Protection System**

Water based automatic activated low expansion foam protection system shall be provided for HFO & LDO/ HSD storage and day tanks.

Foam protection systems are based on the principle of blanketing the burning surface of oil stored inside the tanks by pouring foam mixed with water, enabling to cut-off the oxygen to the burning fuel thus achieving immediate Extinguishments of fire.

Foam concentrate will be pumped from the foam concentrate storage tank by two (1W + 1S) foam pumps to foam proportioner skids one provided for each fuel oil (FO) tank. Pressurized water connection is provided to the eductor of each foam proportioner skid. In the event of fire, the foam system for respective tank shall be automatically activated on detection of fire by ROR/Probe type heat detectors provided inside the FO tanks. Water will start flowing through the eductor where foam concentrate is induced and mixed with the flowing water in definite proportion.

This foam water mixture flows to tank, where the foam solution expands by sucking air from the atmosphere and foam thus formed fills the oil surface inside tank by suitably designed deflectors.

3.01.05 **Inert gas flooding system / Auto modular clean agent system**

One centralized total flooding type clean inert gas extinguishing system shall be provided for the following areas as a protection for fire damage.

- Control room, Control equipment room, computer room and other electrical and electronic equipment rooms.

The inert gas flooding system for the above areas shall consist of battery of inert gas storage cylinders of adequate capacity, which shall be located suitably at a centralized location. Discharge nozzles shall be provided on the gas distribution pipe network suitably located on the areas to be protected.

In the event of fire, the fire detectors initiate an alarm in the local panel, and main fire alarm panel. Simultaneously, the detection signal opens the valves automatically and the protected area is filled up by rapid injection of required quantity of inert gas through the pipe network and discharge nozzles to create a homogenous air/inert gas atmosphere within.

The pipe network shall be connected to a gas manifold, through a manually operated valve. The manifold shall be connected to a group of inert gas cylinders

7.01.01 **Performance Requirement**

a) Performance requirement for the pumps shall be guided by the `Data Sheet' enclosed in this section and TAC/LPA recommendation.

b) Pumps shall be capable of furnishing not less than 150 % of rated capacity at a head of not less than 65 % of the rated head. The shut-off head shall not exceed 120 % of rated head in the case of horizontal pumps and 140 % in the case of vertical turbine type pumps.

c) Pump-Motor sets shall be capable of continuously delivering the rated output for the voltage variation of (±) 10% and frequency variation of (±) 5% occurring separately or combined voltage and frequency variation of (±) 10% (absolute sum).

7.01.02 **Constructional Features**

a) The design and Testing Standards of the Pumps shall conform to the standards as indicated in the TAC/LPA recommendation.

b) The pumps shall comply with the regulations of Tariff Advisory Committee (TAC)/LPA and National Fire Protection Association (NFPA), USA as applicable.

c) Drive Unit Power rating for the fire water pumps shall be selected such that it is equal to higher of the two conditions:

i) 110% of the duty point power requirement.

ii) Motor input power required at 150% of the duty point capacity of pump

7.02.00 **Diesel Engine**

7.02.01 Performance requirement of the diesel engine shall be guided by TAC/LPA recommendations.

7.02.02 The engine shall be capable of operating continuously on full load at the site conditions for a period of at least six (6) hours.

7.02.03 The engine shall be naturally aspirated, super charged or turbo-charged as recommended by the manufacturer. (Ref. Fire Protection Manual by TAC/LPA).

7.02.04 The continuous engine brake horse power rating (after accounting for all auxiliary power consumption) at the site conditions shall be at least 20% greater than the brake horse power required to drive the pump at it's duty point at rated R.P.M. and in no case less than the brake horse power required to drive the pump at 150% of rated discharge or at any condition of operation of pump. Deaerating Factors considered by the manufacturer to arrive at the shaft power of the diesel engine at site, shall not be less than the following for

normally aspirated engines only:

a) 3% for each 305 metre elevation above MSL (Ref. NFPA, Volume-2, 1978).

b) 1% for each 5.6° C rise in air temperature above 15.6° C (Ref. NFPA, Volume-2, 1978).

The base power rating of the diesel engine shall be referred to any accepted datum like BS/SAE Standard condition or equivalent. In any case, horsepower rating shall not be higher than the limit set by Tariff Advisory Committee.

7.02.05 Design and construction of the diesel engine shall be guided by the TAC/LPA recommendations.

7.02.06 **Starting**

a) The engine shall be capable of both automatic and manual start.

b) Automatic cranking shall be effected by a battery driven D.C. motor having high starting torque to overcome full engine compression. Starting power shall be supplied from two (2) sets of storage batteries. One (1) set of battery is for automatic starting of the engine and the other provided for manual starting. A selector switch shall be provided at the automatic starting control panel to select any of the two (2) sets of battery for manual/auto starting of the engine.

The automatic starting arrangement shall include, as a safeguard, a "Repeat Start" feature so that if the pinion of the starting motor does not engage the flywheel at the first attempt, it is automatically retracted and after a short pause again will advance towards the flywheel.

This repeat start cycle will continue until five (5) kicks after which there will be suitable annunciation. The battery capacity shall be adequate for ten (10) consecutive starts without recharging with a cold engine under full compression.

c) Arrangement for both trickle and booster charge of the batteries shall be provided. When the engine starts running, provision should be kept to ensure that the charger is automatically disconnected and the battery is charged by engine dynamo.

Each diesel engine shall be provided with two (2) battery charger units of air cooled design. Each charger unit shall be capable of charging one (1) set of battery at a time. Provision shall, however, be kept so that any of the charger units of a particular engine can be utilised for charging any one of the two (2) batteries of that engine.

7.02.07 **Governing System**

a) The engine shall be fitted with a speed control device that will control the speed under all conditions of load.

b) The governor shall offer following features:

i) Engine should be provided with an adjustable governor capable of regulating engine speed within 10% of it's rated speed under any condition of load up to the full load rating. The governor shall be set to maintain rated pump speed at maximum pump load. (Refer Fire Protection Manual by TAC/LPA).

ii) Engine shall be provided with an over speed shut-down device. It shall be arranged to shut-down the engine at a speed approximately 20% above rated speed and for manual reset, such that the automatic engine controller will continue to show an over speed signal until the device is manually reset to normal operating position. (Refer NFPA).

c) The governor shall be suitable for operation without external power supply.

7.02.08 **Fuel System**

a) The diesel engine will run on High Speed diesel oil, analysis of which has been indicated elsewhere in specification.

b) Each engine shall be provided with fuel oil tank having storage capacity sufficient to run the engine at full load for at least six (6) hours.

c) For each compression ignition engine driven pump set, there shall be individual fuel tank and fuel feed pipes.

d) A suitable 1 phase 240 Volt fuel pump (portable) to be provided to fill up diesel oil from Diesel Drum received from supplier of Diesel. This pump should also have facility to be operated by hand, in case electricity fails.

7.02.09 **Lubricating Oil System**

Automatic pressure lubrication shall be provided by a crankshaft driven oil pump, taking suction from a sump and deliver pressurized oil through cooler and fine mesh filters to a main supply header fitted in the bed plate casing. High pressure oil shall be supplied to main and big end bearings, cam-shaft bearings, cam-shaft chain and gear drives, governor, auxiliary drive gears etc. Valve gear shall be lubricated at reduced pressure through a reducing valve and the cams by an oil bath. The above lubricating oil sump shall be equipped with adequate heaters having thermostat control to maintain the lubricating oil at recommended temperature for maintaining oil at low viscosity.

7.02.10 **Cooling Water System**

The cooling water system shall conform to any one of the systems specified in Fire Protection Manual of the Regional committee of the Tariff Advisory Committee / LPA / NFPA. The Contractor shall clearly indicate in his offer the type of cooling system adopted. In case fire water is used as a cooling media by tapping of the water from the fire water pump discharge (before the pump discharge valve), the capacity of the fire pump shall be increased, so that the net capacity meets the specification requirement.

7.02.11 **Instrumentation & Control**

The diesel engine shall be provided with adequate instrumentation. These shall include but not limited to the following:

a) Temperature indicator (contact type) in cooling water inlet and outlet.

b) Temperature indicator in lubricating oil outlet from the oil cooler.

c) Pressure gauges (contact type) for lubricating oil system.

d) Differential pressure gauges (contact type) across strainers/ filters.

e) Speed indicator.

f) Running hour meter.

g) Dip stick type lubricating oil sump level indicator.

h) Gauge glass type Fuel Oil Tank level indicator.

i) Voltmeter & Ammeter in dynamo type battery charging circuit.

7.03.00 **Air Compressors**

7.03.01 Air Compressors shall be designed for intermittent operation with high efficiency to satisfy the requirement as specified in the data sheets.

7.03.02 Compressor shall be mounted on an air receiver of suitable size so that delivery air pressure is kept within (±) 5% of rated pressure without excessive start-stop operations in the working cycle.

7.03.04 **Instrumentation and Miscellaneous Accessories**

The package air compressor and drive shall be supplied complete with the following instrumentation and accessories as minimum.

a) Discharge air pressure gauge.

b) Pressure switch to control actuation of compressor drive motor.

c) Starter for drive motor.

d) Pressure relief valve.

7.07.04 Clear inscription reading (in English) "FIRE ALARM - IN CASE OF FIRE BREAK GLASS" shall be provided for each manual call point unit, either on the MS enclosure or on a separate metal plate mounted behind the glass cover. The metal plate for inscription shall not tarnish under the atmospheric conditions.

7.07.05 Each manual call point unit shall be provided with the following accessories:

i) An iron hammer of sufficient weight, which could be used to break the glass cover. The iron hammer shall be suspended on a hook fixed to the external MS enclosure by means of a non-corrodible iron chain of sufficient length and play to facilitate easy breaking of the glass cover.

ii) Two numbers diametrically opposite earthing studs located on the outside surface of the external MS enclosure.

iii) An identification number (on a number plate) which will be invariably same as the number given to the fire alarm, indicating point on the Zonal and Main Fire Alarm panel. The identification number shall match with the address of the intelligent addressable Manual call point for easy identifying the Call Point unit.

iv) A dust sealing gland or equivalent on the external MS enclosure for outgoing cable from the unit.

v) A compression type cable terminating brass gland of reputed make for out going cable from the internal MS enclosure.

vi) In addition to this a red lamp Response Indicator shall be provided which will light up on actuation of manual call point to locate the manual call point station, which is operated.

7.08.00 **Control and Instrumentation**

For features and requirements of the control and instrumentation items including field instrument, Panels and Panel mounted instruments, relays, annunciators, selector switches, PLCs and other hardware and peripherals under scope of supply for the Fire Detection and Protection system. Bidder shall also refer the relevant clauses of the Volume VI of this Specification.

Specifications and data sheets for Detectors are furnished at the end of present Specification volume.

7.09.00 **Battery and Battery Charger**

7.09.01 **Battery**

a) Battery to be located in Plant Service Water Pump House shall be suitable to meet starting requirements of Diesel Engine driven pumps. Besides these all controls, indications, annunciations etc. (including multiplication of process interlock relays and auxiliary relays) shall have power supply from 24 V (2 X 12 V) Battery and Battery Charger

unit.

b) All controls, interlocks, indications, annunciation system etc. for each of the Fire detection alarm cum MIMIC panels (located in Central Control room) and the Repeater Panel (located in Fire Station), shall have power supply from 24 V (2 X 12V) Battery and Battery Charging Units. The Battery of each of the above Panels shall be located in the bottom portion of the same Panel. The PC with Printer in the central control room shall be powered up by the respective UPS Power of the Plant Instrumentation and Control System.

c) Diesel Engine Driven Fire Water Pump

The Battery shall have the capacity to start the Diesel engine at least for eleven starts. Further Battery shall have capacity to meet auxiliaries & other loads of Local Control Panel (if any) for a minimum period of 10 hours. Minimum Ampere-hour capacity of the Battery shall be selected accordingly.

d) The Battery driven Power supply shall be available to main and repeater fire alarm panel shall be designed to provide supply for a minimum period of 10 hours. Minimum ampere hour capacity of the Battery shall be selected accordingly.

e) Bidder shall compute the ampere hour capacity at suitable discharge rate based on above duty and furnish the calculation along with the Bid which shall consider the duty cycle and 25% & 15% compensation for ageing & unforeseen future growth respectively of each battery unit. The maximum and minimum ambient shall be 42°C and 11.7°C respectively.

The minimum voltage at the end of the load cycle shall not be less than 1.8 volts per cell.

7.09.02 **Battery Charger**

For design and construction of Battery Charger refer Volume V.

7.09.03 **Layout of Battery & Battery Charger**

a) The battery and charger of the respective panels shall be an integral part of each of the main fire panel / local fire panel / repeater panel.

b) Bidder shall indicate his own layout of 24 volt Battery and Charger to suit the space available.

7.09.04 Fittings & Accessories

Battery

Each battery shall be furnished with necessary accessories required.

8.00.00 **INSPECTION AND TESTING**

8.01.00 **Pipes/Fittings**

8.01.01 Hydraulic test or Eddy Current test shall be carried out at manufacturer works on pipes as per IS: 1239 Part 1/ IS: 3589. Fittings (bends, elbow, etc.) shall be as per IS 1239 Part 2 or equivalent specification.

8.01.02 Butt welds joints on buried as well as on above ground pipes shall be subjected to radiographic inspection as per TAC/LPA's manual.

8.02.00 **Water and Air Line Valves**

8.02.01 All valves shall be tested as per relevant design code of valve.

8.02.02 Valve trim material shall be subjected to NDT if diameter is equal to or grater than 50 mm.

8.02.03 Air tests shall be conducted as per applicable codes to detect seat leakages.

8.02.04 As cast heat marks shall be provided on castings and must be co-related with test certificates.

8.03.00 **Hydrant Valves and Stand Post Assembly**

8.03.01 The stand post assembly along with the hydrant valve (valve being open and outlet closed) shall be pressure tested to detect any leakage.

8.03.02 Flow test shall be conducted on the hydrant valves. The flow through the valve shall not be less than 900 liters/min. Vender may submit type test report of similar size of valves duly certified by reputed TPIA (eg Lloyds, BV etc) or by ISI

8.03.03 Leak tightness test of the valve seat shall be conducted.

8.04.00 **Indoor Hydrant Valves (Internal landing valves)**

Each internal landing valve shall be tested for pressure, flow and leak tightness as in clause no. 8.03.00 above.

8.05.00 **Hydrant Valves for First Aid Fire Protection System**

Each hydrant valve for first aid fire protection system shall be tested for pressure, flow and leak tightness as in clause no. 8.03.00 above.

8.06.00 **Fire Water Monitors**

Tests shall be done on Fire Water Monitor as per Code and Data Sheet.

8.07.00 **Hoses, Nozzles, Branch Pipes and Hose Boxes**

8.07.01 Rubber lined impregnated woven jacketed hoses shall be tested as per IS-636, Type-II and first aid fire protection hose shall be tested as per IS-444.

In both cases, following tests shall be included.

a) Percolation test b) Pressure test c) Burst test

The branch pipe, coupling and nozzles shall be subject to a hydrostatic test pressure to detect any leakage.

8.08.00 **Strainers**

Pressure drop test shall be carried out for basket strainers as well as Y-type line strainers.

8.09.00 **Battery and Battery Charger**

All equipment and components thereof shall be subject to shop tests as per relevant IS/IEC standards. The tests shall also include dielectric tests on Battery Charger.

8.10.00 **Fire detection alarm cum MIMIC panels and Repeater panels**

8.10.01 All equipment shall be completely assembled, wired, adjusted and tested at the factory as per the relevant standards.

8.10.02 Routine Tests

The tests for the panels shall include but not necessarily limited to the following :

a) Operation under simulated service condition to ensure accuracy of wiring, correctness of control schemes/annunciation system and proper functioning of the equipment/devices and continuity test of printed circuit cards.

b) All wiring and current carrying part shall be given appropriate High Voltage Test.

c) Routine test shall be carried out on all equipment such as contactors, relays, switch, fuse, instrument transformers, meters etc.

d) Power frequency withstand test shall be performed on control/ secondary wiring.

8.10.03 Type Test

Type test on typical section of a panel consisting of Transformer Panel, Power pack module unit, Control and operation unit, Annunciation unit etc. shall be performed as per relevant IEC/Fire codes.

8.10.04 Auxiliary Equipment

All component parts and auxiliary equipment such as space heater, insulator etc. shall be routine tested as per relevant IS/IEC.

8.11.00 **Type Tests on Fire Proof Sealing System and Fire Stop System**

The type tests for fireproof sealing system for floor/wall opening/fire stop system for bottom of Electrical Switchgear MCCs/Panel are as under:

a) Fire rating test

b) Hose stream test

c) Accelerated ageing test

d) Fire rating test on the penetration seal system built of accelerated aged components followed by Hose Stream Test.

e) Temperature rise test for cable in the fire stop.

f) Water absorption test followed by fire rating test.

g) Flame resistance test for fire protection coating material.

h) Anti-rodent Test.

The detailed test procedures for each of these tests are to be submitted by the bidder and is subject to approval by Owner/ Consultant.

9.00.00 **DRAWING, DATA AND MANUALS TO BE SUBMITTED BY BIDDER**

9.01.00 **Drawings to be Submitted by the Bidder**

9.01.01 Flow diagram showing the complete fire protection scheme with associated controls for the following :

i) Hydrant System both Indoor and Outdoor.

ii) Automatic type High Velocity Water Spray System with quartzoid bulb detection system in pressurized water loop.

iii) Automatic type Medium Velocity water spray system with digital type heat sensing cable as detector.

iv) Multicriteria smoke detection system arranged in cross-zoning principle.

v) Heat Detection System (IC type).

vi) Diagram showing the lubricant system etc.

9.01.02 Schematic and wiring diagram for Battery Charger.

9.01.03 Layout arrangement of battery with catalogues.

9.01.04 Mounting arrangement of battery charger.

ANNEXURE-II

DATA SHEET
FOR
DIESEL ENGINE

1.00.00	**GENERAL INFORMATION**		
1.01.00	Service	:	Plant Service Water Pump House
1.02.00	Designation	:	Internal combustion Diesel Engine.
1.03.00	Type	:	Compression ignition, mechanical (air less) direct injection, multi cylinder and four stroke cycle and cold starting type.
1.04.00	No. of engine required	:	Three (3)
1.05.00	Duty	:	Intermittent
1.06.00	Location	:	Indoor
2.00.00	**ENGINE PARAMETERS**		
2.01.00	Nominal output of engine at site operating under ambient conditions	:	Bidder to indicate during detailed engineering.
2.02.00	Speed of the engine	:	Not more than 2300 rpm.

ANNEXURE-V

DATA SHEET
FOR
PIPING, FITTINGS, VALVES AND SPECIALTIES

A. PIPING AND FITTINGS

1.00.00	Type	Buried pipes	Overground pipes normally full of water	Overground pipes normally empty but periodically charge with water & foam system applications	Overground compressd air pipes
		(i)	(ii)	(iii)	(iv)
2.00.00	Material	M. S. ERW pipes as per IS-1239, Part – 1 heavy grade (for pipes of sizes 150 mm NB or below) and IS-3589 Gr.410 ERW (For sizes 200 mm NB and above) or equivalent and galvanized as per IS 4736 for pipes normally empty and periodically charged with water and foam system application.			
3.00.00	Piping Thickness	Pipes for sizes 200 NB & above shall conform to IS: 3589 Grade 410. The final thickness shall not be less than that specified as per IS: 3589 as indicated below.			

Nominal Pipe Size (mm)	Outside Diameter (mm)	Wall Thickness (mm)
200 NB	219.1	6.3
250 NB	273	6.3
300 NB	323.9	7.1
350 NB	355.6	8.0
400 NB	406.4	8.0
450 NB	457	8.0
500 NB	508	8.0
600 NB	610	8.0

Note : a) To prevent soil corrosion buried pipes shall be properly lagged with two coat and corrosion protective tapes of minimum thickness of 4 mm (in two layers) of coal tar type as per AWWA C 203 / IS :15337.

b) Over-ground pipes normally empty but periodically charged with water, foam system applications & compressed air shall be galvanized as per IS : 4736.These pipes shall be provided with one coat of primer and three coats of chlorinated rubber paint.

3.00.00	Size	As per final design and engineering by Bidder and approved by Owner. However Bidder shall consider velocity of fluid in the pipeline & other criteria as indicated elsewhere for selection of pipe size.			
4.00.00	Construction	←---------- ERW ----------→			
		(i)	(ii)	(iii)	(iv)
5.00.00	Joints	Butt-welded for size 65 mm NB & higher as per ANSI B 16.9 and socket welded for sizes up to 50 m NB as per ANSI B16.11		Screwed flange as required for dismantling purposes for sizes 65 mm NB & above as per ANSI B 16.5 and screwed socket for sizes 50 mm NB & below. Welding on GI Pipes/fittings would be permitted provided the same is carried out by means of special electrodes suitable for the above application and the same shall be approved by the employer. After welding, welded portions shall be applied with three coats of zinc silicate treatment/rich paint over one coat of suitable primer. Further the contractor shall provide proper zinc paint at the point of welding.	
6.00.00	Fittings				
	Ratings/Wall thickness	Minimum thickness to match with that of pipe for pipe size 65 mm NB and above. For pipe size above 150 mm NB, minimum thickness shall be 6 mm. For pipe size 50 mm NB & below rating shall be 3000 lbs or wall thickness matching with that of corresponding pipe.			
	Material	The material shall conform to ASTM A234 Gr. WPB or ASTM A 105 or equivalent.			

Note :

1) All fittings and flanges for galvanized pipes shall be galvanized.

2) Unless otherwise specified, all elbows/bends shall be long radius type.

3) The fittings shall be galvanized as per IS: 4736 for galvanized pipe application. In case of branching connections from GI mains for spray piping network socket may be welded for more than two pipe reductions instead of standard tees.

4) Fabricated fittings shall not be acceptable up to pipe size of 300 NB. For sizes 350 NB & above, fittings may be fabricated as per BS: 2633/BS: 534.

5) Working and test pressure of piping & fittings shall be as per IS or relevant international standards.

B. VALVES

I. Gate, Globe & Check Valve

1. Basic Design Code

a)	Gate Valve	:	i)	IS-14846 for sizes 65 mm NB to 300 mm NB
			ii)	IS-2906 for sizes 350mm NB and above
b)	Globe Valve	:	BS EN-13789	
c)	Check Valve	:	BS-1868	

2. Construction : Cast body and bonnet/cover.

3. Material of Construction for Gate and Globe Valve

a)	Body and bonnet Material for Gate and Globe valve cover IS-210 Gr. FG 260.		
b)	Trim/disc.	:	IS-210 Gr. FG 260.
c)	Stem	:	Stainless steel to AISI-410 13% Cr. St.

4. Material of Construction of Check Valve shall be as given below:

a)	Body, Bonnet & Cover	:	ASTM-A-216 Gr. WCB
b)	Trim/Disc	:	13% Cr. Steel as per ASTM-A-182 Gr. F6 Heat treated and Hardened, min. Hardness-250 HB.
c)	Back seat & Hinge Pin	:	13% Cr. Steel as per ASTM-A-182 Gr. F6.

Note: Gate, globe and check valve of size 50 mm NB & below shall be of forged CS body as per API 602(Gate valve), BS 1868(Check valve) and BS 1873(Globe valve). These valves shall have socket welded ends. Valves will be provided with locking arrangements.

II. Deluge Valve

4. **Other Requirements for System Installation**

A. Oil drain and nitrogen openings with gate valve on transformer tank, flanges with dummy piece in conservator pipe and fire detector brackets on transformer top cover.

B. Spare potential free contacts for system activating signals i.e. Differential relay, Buchholz relay, PRV/ RPRR, Transformer isolation.

C. Pipe connections between transformer to fire extinguishing cubicle and fire extinguishing cubicle to oil pit.

D. Cabling on transformer top cover. All fire detector to be connected in parallel and inter cabling between signal box to control box and control box to FEC.

E. Plinth for FEC, Oil pit with capacity as 10% of total oil quantity of transformer.

5. **Technical Details**

Fire Extinction Period
On Commencement of Nitrogen injection: Maximum 30 seconds
On system activation up to post cooling: Maximum 3 minutes

Fire Detectors heat sensing temperature: 141 ° C

Heat Sensing Area: 800 mm radius

Pre-stressed non-return valve setting for operation: Minimum 60 litre per minute.

6. **Power Source**

Control Box: 220V DC

Fire Extinguishing cubicle: 240V AC, 40W

7. **Cabling**

Fire survival cables 4 C x 1.5 mm ² for connection of fire detectors in parallel.

Fire survival cable 12 C x 1.5 mm ² for connection between transformer signal box/ marshalling box to control box and control box to FEC.

Fire survival cable 4 C x 1.5 mm ² for connection between control box to DC supply source and FEC to AC supply source, signal box/ marshalling box to pre-stressed non-return valve connection on transformer.

Annexure 5- B: Technical Specification For A.C. & D.C. Motors

VOLUME: V-A

SECTION-II

TECHNICAL SPECIFICATION FOR A.C. & D.C. MOTORS

CONTENT

VOLUME: V-A

SECTION-II

TECHNICAL SPECIFICATION FOR A.C. & D.C. MOTORS

1.00.00 SCOPE

1.01.00 This section covers the general requirements of the drive motors for power station auxiliary equipment.

1.02.00 Motors shall be furnished in accordance with both this general specification and the accompanying driven equipment specification.

1.03.00 In case of any discrepancy, the driven equipment specification shall govern.

2.00.00 CODES & STANDARDS

2.01.00 All motors shall conform to the latest applicable IS, IEC and CBIP Standards/ Publications except when otherwise stated herein or in the driven equipment specification.

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

i) IS-325

ii) IS-12615

iii) IEC-60034

3.00.00 SERVICE CONDITIONS

3.01.00 The motors will be installed in hot, humid and tropical atmosphere highly polluted at places with coal dust and/or fly ash.

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

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

4.00.00 TYPE AND RATING

4.01.00 A.C. Motors

4.01.01 Motors shall be general purpose, constant speed, squirrel cage, three/single phase, induction type.

4.01.02 All motors shall be rated for continuous duty. They shall also be suitable for long period of inactivity.

4.01.03 LT motor & HT motor name-plate rating at 50°C shall have at least 15% margin and 10% margin respectively over the input power requirement of the driven equipment at rated duty point unless stated otherwise in driven equipment specification.

4.01.04 The motor characteristics shall match the requirements of the driven equipment so that adequate starting, accelerating, pull up, break down and full load torques are available for the intended service.

4.01.05 Motors efficiency class shall be IE1, IE2 as per latest version of IEC-60034.

4.02.00 **D.C. Motors**

4.02.01 D.C. motor provided for emergency service shall be shunt/compound wound type.

4.02.02 Motor shall be sized for operation with fixed resistance starter for maximum reliability.

Starter panel complete with all accessories shall be included in the scope of supply.

5.00.00 **PERFORMANCE**

5.01.00 **Running Requirements**

5.01.01 Motor shall run continuously at rated output over the entire range of voltage and frequency variations as given in the annexure.

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

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

5.02.00 **Starting Requirements**

Motor shall be designed for direct online starting at full voltage. Breakaway starting current as percentage of full load current for various motor rating shall not exceed the given below-

Motors up to 1500kW	-	600% subject to IS tolerance of plus 20%.
Motors above 1500kW	-	450% not subject to any positive tolerance.

5.02.01 The motor shall be capable of withstanding the stresses imposed if started at 110% rated voltage.

5.02.02 Motor shall start with rated load and accelerate to full speed with 80% rated voltage at motor terminals except mill motor. Mill motor shall start with rated load and accelerate to full speed at 85% of the rated voltage at the motor terminals.

5.02.03 a) Two hot starts in succession with motor initially at normal running temperature.

b) Pump motor subject to reverse rotation shall be designed to withstand the stresses encountered when starting with shaft rotating at 125% rated speed in reverse direction.

5.02.04 The motors shall be designed to withstand 120% of rated speed for 2 minutes without any mechanical damage.

5.03.00 **Stress During Bus Transfer**

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

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

5.04.00 **Locked Rotor Withstand Time**

5.04.01 The locked rotor withstand time under hot condition at 110% rated voltage shall be more than motor starting time by at least 3 seconds for motors up to 20 seconds starting time and by 5 seconds for motor with more than 20 seconds starting time.

5.04.02 Starting time mentioned above is at minimum permissible voltage of 80% rated voltage.

5.04.03 Hot thermal withstand curve shall have a margin of at least 10% over the full load current of the motor to permit relay setting utilising motor rated capacity.

6.00.00 **SPECIFIC REQUIREMENTS**

6.01.00 **Enclosure**

6.01.01 All motor enclosures for outdoor, semi-outdoor & indoor application shall conform to the degree of protection IP-55 unless otherwise specified. Motor for outdoor or semi-outdoor service shall be of weather-proof construction with canopy.

6.01.02 For hazardous area approved type of increased safety enclosure shall be furnished.

6.02.00 **Cooling**

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

6.02.02 For large capacity motors not available with above type of cooling may be accepted with IC 81W or IC 91W, closed air circuit water cooled (CACW) subject to the approval of the owner.

6.03.00 **Winding and Insulation**

6.03.01 All insulated winding shall be of copper.

6.03.02 All motors shall have class F insulation but limited to class B temperature rise.

6.03.03 Windings shall be impregnated to make them non-hygroscopic and oil resistant.

6.04.00 **Tropical Protection**

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

6.04.02 All fittings and hardwares shall be corrosion resistant.

6.05.00 **Bearings**

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

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

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

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

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

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

6.05.07 Forced lubricated or water cooled bearing shall not be used without prior approval of Owner.

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

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

6.06.00 **Noise & Vibration**

6.06.01 All HT motors shall be provided with vibration pads for mounting of vibration detectors. Vibration monitoring devices shall be provided on DE and NDE side in x&y direction with remote DCS monitoring, alarm and tripping.

6.06.02 The maximum double amplitude vibrations for HT motors upto 1500 rpm shall be 25 microns and 15 microns upto 3000 rpm. For 415V motors, maximum double amplitude vibrations upto 1500 rpm shall be 40 microns and 15 microns upto 3000 rpm.

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

6.07.00 **Motor Terminal Box**

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

6.07.02 Terminal box shall be capable of being turned 360 Deg. in steps of 180 Deg. for HT motors and 90 Deg. for LT motors unless otherwise approved.

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

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

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

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

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

6.07.08 For 11000V and 3300V motor, the terminal box shall be phase-segregated type. The neutral leads shall be brought out in a separate terminal box (not necessarily phase segregated type) with shorting links for star connection.

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

6.07.10 The gland plate for single core cable shall be non-magnetic type.

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

Voltage Rating of Motor		Minimum Ph-Ph & Ph-Earth clearance
0.415 kV	:	25 mm
3.3 kV	:	65 mm
11.0 kV	:	140 mm

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

6.08.00 **Grounding**

6.08.01 The frame of each motor shall be provided with two separate and distinct grounding pads complete with tapped hole, GI bolts and washer.

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

Rating			Conductor Size
Above	Up to		
-------	5.5 kW	:	8 SWG GI Wires.
5.5 kW	22 kW	:	25mm X 4mm GS Flat.
23 kW	55 kW	:	40mm X 6mm GS Flat.
56kW	174kW	:	50mm X 8mm GS Flat.
175kW	ABOVE	:	75mm X 10mm GS Flat.

6.08.03 The cable terminal box shall have a separate grounding pad.

6.09.00 **Minimum Cable Size for LT & HT Motors shall as be as follows-**

a) For 415V, 3-Ph, LT Motors-

Rating			Cable Size
Above	Up to		
-------	5.5 kW	:	1R X 3C X 6 Sq.mm
5.5 kW	11 kW	:	1R X 3C X 10 Sq.mm
11 kW	22 kW	:	1R X 3C X 35 Sq.mm
22 kW	37.5 kW	:	1R X 3C X 70 Sq.mm.
37.5kW	55 kW	:	1R X 3C X 150 Sq.mm
55 kW	75 kW	:	1R X 3C X 300 Sq.mm
75 kW	110kW	:	2R X 3C X 150 Sq.mm
110 kW	175kW	:	2R X 3C X 300 Sq.mm

b) For 3.3kV & 11kV, 3-Ph, HT Motors-

Rating			Cable Size
Above	Up to		

175 kW	1000 kW	:	1R X 3C X 240 Sq.mm
1000 kW	2000 kW	:	2R X 3C X 240 Sq.mm
2000 kW	4500 kW	:	2R X 3C X 300 Sq.mm
4501 kW	10,000 kW	:	9R X 1C X 1000 Sq.mm.

Note: During detail engineering if higher cable size is required same shall be provided.

6.10.00 **Rating Plate**

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

a) Temperature rise in Deg.C under rated condition and method of measurement.

b) Degree of protection.

c) Bearing identification no. and recommended lubricant.

d) Location of insulated bearings.

7.00.00 **ACCESSORIES**

7.01.00 **General**

Accessories shall be furnished, as listed below, or if otherwise required by driven equipment specification or application.

7.02.00 **Space Heater**

7.02.01 Motor of rating 30 kW and above shall be provided with space heaters, suitably located for easy removal or replacement.

7.02.02 The space heater shall be rated 240 V, 1 Phase, 50Hz and sized to maintain the motor internal temperature above dew point when the motor is idle.

7.02.03 Minimum Cable Size for space heater shall be as listed-

i) For LT motors: 2.5 sq.mm, 2-Core copper cable complying with IS-1554(Part-1).

ii) For HT motors: 6 sq.mm, 2 Core aluminium cable complying with IS-1554(Part-1).

7.03.00 **Temperature Detectors**

7.03.01 All 11000V and 3300V motors shall be provided with twelve (12) nos. simplex type winding temperature detectors, four (4) nos. per phase.

7.03.02 11000V and 3300V motor bearing shall be provided with duplex type temperature detectors.

7.03.03 The temperature detector mentioned above shall be resistance type, 3 wire, platinum wound, 100 Ohms at 0 ¢C.

7.03.04 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 DDCMIS connectivity.

7.03.05 0.5 sq.mm annealed tinned copper conductor complying with IS-1554(Part-1). shall be used for RTD/BTD wiring.

7.04.00 Indicator/Switch

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

a) 11000 V and 3300V motor bearing temperature.

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

7.04.02 Flow switches shall be provided for monitoring cooling water flow of CACW motor and oil flow of forced lubrication bearing, if used. CACW motor shall be provided with water leakage detector with remote alarm and tripping.

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

7.05.00 Current Transformer for Differential Protection

7.05.01 Motor 1000 kW and above shall be provided with three differential current transformers mounted over the neutral leads within the enclosure.

7.05.02 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.

7.06.00 Accessory Terminal Box

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

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

7.07.00 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.

7.08.00 **Lifting Provisions**

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

7.09.00 **Dowel Pins**

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

7.10.00 **Painting**

For paint shade finish, refer Section-X of Volume: II-A : Lead Specification.

8.00.00 **TESTS**

Routine and Type Tests are to be conducted in presence of customer's representative as per IS:325 and in addition,any special test called for in the driven equipment specification shall be performed and required copies of test certificates are to be furnished for approval. In addition, following tests shall have to be carried out on the motors in presence of OWNER's representative on 3.3kV/11kV motors.

a. Impulse test by 1.2 / 50 micro sec. On sample coil of Stator winding insulation as type test as per IEC-60034, part -15 test voltages as under :

Voltage rating of motor	Impulse Test Voltage
3.3 kV	18 kV peak
11 kV	49 kV peak

b. Tan delta, charging current and dielectric loss measurements on each phase of motor stator winding as routine test.

c. Polarization Index Test as per IS: 7816 as routine test

d. Test for suitability of IPW– 55(Weather proof) as per IS 4691 as type test. Type test certificate for first numeral shall be acceptable in lieu to test, provided the test motor is identical to motor being supplied. Second numeral test shall be carried out on one motor of each type and rating.

e. Fault Withstand Test for main terminal box as type test. Type test certificate shall be acceptable, if the test is conducted on exactly identical terminal box.

f. Test for noise level as routine test.

g. Test for vibration as routine test.

h. Tan delta measurement on coils.

i. Surge withstand test for inter turn insulation.

j. Test to diagnose rotor bar failure during manufacture.

k. Over speed test as routine test.

l. Temperature rise test.

Temperature rise under normal condition above ambient temperature shall be limited to-

Specified Design Ambient temperature	Thermometer Method	Resistance Method
50 deg.C	60 deg.C	70 deg.C
45 deg.C	65 deg.C	75 deg.C
40 deg.C	70 deg.C	80 deg.C

Tests indicated at (h), (i), (j) shall be carried out during manufacture of the coils and shall be furnished for verification.

9.00.00 **DRAWINGS, DATA & MANUALS**

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

9.02.00 **To be Submitted with the bid**

a) List of the motors

b) Individual motor data sheet as per format of the proposal data sheets.

c) Scheme & write-up on forced lubrication system, if any

d) Type test report

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

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

ANNEXURE-A

DESIGN DATA

1.0 AUXILIARY POWER SUPPLY

Supply		Description	Consumer
H.V. Supply		11000 V, 3Ø, 3W, 50 Hz, Non-effectively earthed Fault level 44 kA symm. for 1 sec.	Motors 1500 kW & above
M.V. Supply		3300 V, 3Ø, 3W, 50 Hz, Non-effectively earthed Fault level 40 kA symm. for 1 sec.	Motors 175 kW and Up to less than 1500 kW.
L.V. Supply	(i)	415V, 3Ø, 3W, 50 Hz effectively earthed Fault level 50 kA symm. for 1 sec.	Motors above 0.2kW and below 175kW.
	(ii)	240V AC/415V AC	Motors upto 0.2kW.
		240V, 1Ø, 2W, 50 Hz effectively earthed	Lighting, Space heating , A.C supply for Control & protective devices.
D.C. Supply		220V, 2W, unearthed Fault level 25* kA. for 1 sec.	D.C. alarm, control & protective devices

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

Note-

- 415V or 3.3 kV may be adopted by the bidder for the drives in the range of 160-210 kW.
- 3.3 kV AC supply for CHP conveyor motors of rating above 160 kW is to be used.
- The voltage rating of the drives indicated above is for basic guideline. Minor variations can be accepted on case to case basis based on techno-economic considerations of the various sub-systems.
- Voltage rating for special purpose motors viz, VFD and screw compressors, shall be as per manufacturer's standard. All the motors ratings on Stacker/ reclaimer shall be 415V ac supply only.

2.0 RANGE OF VARIATION

A.C. Supply :

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

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

D.C. Supply :

Voltage	:	187 to 242 Volt

Annexure 5- C: General Electrical Specification

VOLUME : V-A

SECTION-I

GENERAL ELECTRICAL SPECIFICATION

CONTENT

ATTACHMENTS

VOLUME : V-A
SECTION-I
GENERAL ELECTRICAL SPECIFICATION

1.00.00 **GENERAL REQUIREMENT**

1.01.00 **General**

1.01.01 Contractor shall provide fully compatible electrical system, equipments, accessories and services for the entire station/plant in his scope as well as those specifically required by the Owner.

1.01.02 All the equipment, material and systems shall, in general, conform to the latest edition of relevant National and International Codes & Standards, in particular the Indian Statutory Regulations.

1.01.03 Drawings and annexure appended to this specification shall form part of this specification and supplement the requirements specified herein. This specification shall be read and construed in conjunction with the drawings and annexure to determine the scope of work and terminal points.

1.01.04 It is not the intent to specify completely herein all details of the system or equipment. Nevertheless, the system/equipment shall be complete and operative in all aspects and shall conform to highest standard of engineering, design and workmanship.

1.01.05 Any system, material or accessory which may not have been specifically mentioned but which is necessary or usual for satisfactory and trouble-free operation and maintenance of the equipment shall be furnished without any commercial implication to the Owner.

1.01.06 In case of a conflict between this Section (GENERAL ELECTRICAL SPECIFICATION) and the other Sections of Volume V-A & Volume V-B, the stipulation under this Section shall prevail, unless the Owner advises otherwise on a specific issue at the Bidding stage.

1.01.07 Proposal Data Sheets

The Proposal Data Sheets annexed to this specification shall be filled in without any ambiguity by typing in appropriate place on each page. These pages must be properly signed by authorized representative of the Bidder as verification of the data and submitted along with the bid to form part of the Bidder's formal proposal.

1.01.08 Guaranteed Performance

The performance figures quoted in Technical Particular Sheets shall be guaranteed within the tolerance permitted by relevant standards. In case of failure of the equipment to meet the guarantee, the equipment may be liable for rejection at any stage.

1.01.09 Deviation

Should the Bidder wish to deviate from this specification in any way, he shall draw specific attention to such deviation. All such deviations shall be clearly mentioned on the Deviation sheet enclosed, with reference to the respective clause of the specification. Unless such deviations are recorded in the Deviation sheets and submitted with the offer, it shall be taken for granted that the offer is made in conformity with this specification in all respects.

1.01.10 Drawing Approval

Before starting manufacture of any equipment, the contractor shall have to take approval of relevant drawings and data from Engineer in writing. Any manufacture done prior to the approval of drawings/data shall be rectified in accordance with the approved drawings/data by the Contractor at his own cost and the equipment shall be supplied within the stipulated period.

1.01.11 Site Condition

For the purpose of equipment design, reference ambient temperature shall be taken as 50°C. Other site conditions shall be as indicated in the Lead Specification.

1.01.12 The Contractor shall furnish calculations of maximum loading and fault levels under the most onerous conditions for the various equipment/systems as defined elsewhere in the specification to prove adequacy of their parameters. In case any equipment or system is found to be inadequate, it shall be changed/ modified without any additional financial liability to the Owner.

1.01.13 Transformer voltage ratios, taps, impedances and tolerances thereon, shall be so optimized so that the auxiliary system voltages under various grid and loading conditions are always within permissible limits and equipment are not subjected to unacceptable voltages during operation and starting of large motors such as MDBFP etc. The vector groups of the transformers shall be so selected that all the buses of particular voltage level have same vector throughout the plant.

1.01.14 Responsibility of coordination with electrical agencies /TAC/Pollution control board/Electrical Inspectorate and obtaining all necessary clearances shall be of the contractor.

1.01.15 Special Tools & Tackles

A set of special tools & tackle which are necessary or convenient for erection, commissioning, maintenance and overhauling of the equipment shall be supplied.

The tools shall be shipped in separate containers, clearly marked with the name of the equipment for which they are intended.

1.01.16 Spares

(a) The Bidder shall submit a list of recommended spare parts for three (3) years satisfactory and trouble-free operation, indicating the itemized price of each item of the spares. The final quantity shall be decided during placement of order.

(b) The Bidder shall quote and supply mandatory spare parts as per list attached in Vol. IIA, Sec.8. The final quantity shall be decided during placement of order.

(c) Each list shall be complete with specification, make, identification number, unit rate, quantity etc.

1.02.00 **Codes & Standards**

1.02.01 Equipment

Requirement of conformance with Codes and Standards is described in individual Sections.

1. 02.02 Installation

All electrical installation work shall comply with the provisions of the Indian Electricity Act, the Indian Electricity Rules as amended up to date, relevant IS Codes of Practice and recommendations of the Tariff Advisory Committee (TAC). In addition, other rules or regulations applicable to the work shall be followed. In case of any discrepancy, the more restrictive rules shall be binding.

1. 02.03 Nothing in this enquiry specification shall be construed to relieve the Contractor of his responsibility to abide by the Standards or Codes.

1.03.00 **Environmental Conditions**

1.03.01 The equipment will be installed in hot humid and tropical atmosphere highly polluted with coal dust and fly ash.

1.03.02 Sensitive relay and other electrical and electronic devices shall be located in controlled environment such as control room, electronic equipment room etc. as applicable.

1.03.03 For equipment installed outdoor and exposed to direct sun rays, the effect of solar heat shall be considered in determining the design ambient temperature.

1.04.00 **Auxiliary Voltages**

1.04.01 Auxiliary AC voltage supply arrangement shall have 11 kV, 3.3 kV and 415V systems. It shall be designed to limit voltage variations as given below under worst operating condition:

a) HT & LT AC System - ± 10%
b) 220V DC - -15% to +10%

1.04.02 Following auxiliary voltages will be envisaged for LT auxiliary power, control and instrumentation.

a) 240 V ± 10%, 1 Ph, 50 Hz +3% to -5%

b) 220 V DC +10% to (-) 15%, two wire, ungrounded

c) 240 V, 1 Ph, 50 Hz, UPS System

d) 24 V / 48 V DC, as required

1.04.03 Nominal voltage of main DC system shall be 220V. DC batteries shall be designed for continuous float operation with trickle charging, hence all the associated components like batteries, battery chargers, DC motors, relays, contactors, timers etc shall be suitable for continuous operation at the maximum continuous battery float voltage including suitable temperature correction factors.

In addition, the bidder may propose 48V or 24V systems as per requirements of control and instrumentation of his equipment and design.

1.05.00 **Equipment Protection**

1.05.01 The Contractor shall design the plant with the primary objective to mitigate the damage of the plant and equipment during fault or system disturbances.

1.05.02 Automatic trip functions will be initiated for isolation of fault, which could cause immediate and severe damage.

1.05.03 Every effort shall be made to avoid unnecessary trip. There will be annunciation to alert the operator to take corrective action in time.

1.05.04 At least two protective devices, preferably operating in parallel on different principles, will be utilized in protecting major equipment, where possible.

1.05.05 Major protections envisaged for various equipment are listed under relevant sections of this specification.

1.06.00 **Type & Rating of Equipment**

1.06.01 Number of types and sizes of standard products like motors, switchgear and control gear components etc. shall be kept to a minimum so that the requirement of spares is reduced.

1.06.02 Equipment shall be rated for the load and duty cycle of the intended service Circuit breakers and fuses shall be rated to withstand and interrupt the maximum fault current at the point of application in the circuit.

1.07.00 **Control Philosophy for plant Electrical System**

1.07.01 In line with the present-day practice centralised control of the electrical system/equipment has been envisaged for the plant. Control of electrical system of main plant and EHV breakers of generator bay shall be provided from DDCMIS with soft HMI. The details of the same are specified in relevant sections of Control and Instrumentation.

1.07.02 Generator will be controlled from Central Control Room in the Power House. However, bus selection for generator shall be done from Switchyard Control Room by operation of associated disconnecting switches.

1.07.03 400kV side of Standby Transformer feeder, when fed from 400kV switchyard, shall be controlled from Switchyard Control Room. OLTC control for such Standby Transformer shall also be done from Switchyard Control Panel.

1.07.04 Control & metering of Generator, GT, UT, ST etc. will be from Central Operating Console as well as from ECP. The protection of above shall be effected through redundant (2x100%) numerical protection relays. Separate set of CTs & PTs shall be used for implementation of such redundancy. Protection of GT, ST, UT shall be achieved through discrete numerical relay protection. Two (2) groups of different make numerical protection relays shall be adopted for Generator protection relays.

1.07.05 The control, indication, metering and monitoring of the electrical auxiliary power distribution system comprising of 11 kV & 3.3 kV circuit breakers (except those for motor feeders), 11/3.6kV Auxiliary transformers, LT transformers, 415 V switchgear breakers for incomers and bus couplers, DG system, etc. shall be achieved from operator's consoles through DDCMIS/PLC and ECP (as applicable). For details relevant section of C & I shall be referred.

1.07.06 All equipment/components, viz., transducers, etc. required to interface with plant DDCMIS/PLC system shall be provided in switchgear/control panels. The minimum protection required for different equipment and system are indicated in other Sections.

1.07.07 STOP pushbutton shall be provided in the local control panel for motors and this STOP annunciation signal shall be provided to the DDCMIS by hardware connection.

1.07.08 Control panels for service systems like Ash, C.W. pumps, ash dyke etc. shall be located in the respective control room. In addition, some local panels shall be provided near respective system/equipment such as boiler feed pump, hydrogen seal oil system, electrostatic precipitator, PMCC, ash dyke PMCC etc.

1.07.09 In case of internal faults in the generator transformer both turbine and generator will automatically trip. For faults external to the generator and transformer, the generator transformer breaker will open and the turbine, generator shall operate on house load.

1.07.10 Suitable unit interlock and protection scheme shall be developed to ensure safety of equipment and stable operation of the unit within permissible limits. Apart from this, the Generator Transformer, the Unit Transformer and the Standby Transformer have to be provided with necessary safety interlock.

1.07.11 In case of tripping of the unit, Fast bus change over scheme is proposed to change supply of the Boiler and the Turbine Auxiliaries from Unit to Standby system automatically and thereby avoiding trip out of the Boiler and providing uninterrupted supply to vital Turbine auxiliaries. Under this `Fast bus change over' scheme the Boiler shall be operating with 60% HP-LP Bypass even if there is trip out of Turbine & Generator.

1.07.12 Suitable operational logic shall be developed to operate and control the unit from Central Control Room along with its sub-group and sub-loop control. House load operation of this Unit has been contemplated.

1.08.00 **Scheme For Auxiliary Power Distribution**

1.08.01 Owner has chosen ‘Generator Circuit Breaker Scheme’ for the project as indicated in the Electrical Single Line Diagram enclosed with the specification documents.

1.08.02 Auxiliary Power Distribution scheme shown in the attached Electrical Single Line Diagram is for the Bidder’s guidance. The Bidder shall develop his own scheme maintaining the reliability and redundancy criteria. It shall be subject to the Owner’s acceptance.

1.08.03 In order to ensure safe shut down of the plant under emergency condition and to provide backup in case of total power failure, one (1) Diesel Generating set shall be provided.

1.08.04 Overall system shall be such that failure of any unit auxiliary like transformer, DC battery, Battery charger and DG set shall not reduce the plant's generating capability or affect the safe shut down requirements of the unit.

1.08.05 Wherever plant auxiliary supply is extended outside the plant boundary, suitable isolation through transformer shall be done.

1.09.00 **Islanding Scheme**

The unit shall be designed to operate in islanding mode of operation by tripping all the lines and the unit shall run with the available plant load under such condition. Necessary control philosophy shall be submitted by the Bidder.

1.10.00 Power Evacuation

The generated power will be stepped up to 400kV and evacuated through 400KV transmission lines. For new unit at KTPS (Kothagudem), power evacuation will be through 3 nos. new 400kV lines.

1.11.00 Insulation Level

The insulation level for the transformer windings and bushings shall be as under :

	Winding		Bushing	
Highest System Voltage	Rated Power Freq. withstand Voltage (kVrrns)	Rated lightning Impulse withstand Voltage (kVp)	Rated Power freq. withstand voltage (kV rms)	Rated lighting Impulse withstand Voltage (kVp)
0.433 kV	3		3	
3.6 kV	10	40	10	40
7.2 kV	20	60	20	60
12 kV	28	75	28	75
17.5 kV	38	95	38	95
24kV	50	125	50	125
36kV	70	170	70	170
72.5 kV	140	325	140	325
145kV	275/*	650	275	650
245kV	395*	950/1050**	460	1050
420kV	630/*	1425/1570**	630	1425

* In case of non-uniformly insulated (refer IEC 60076-3, Table D.2)

**Chopped Wave BIL

1.12.00 Neutral Grounding

1.12.01 Neutral earthing equipment shall be designed duly taking into account the maximum permissible operating voltage of the generator, voltage rise on load throw off (subsequent to detection of earth fault) field suppression time, ferro resonance, etc. The generator shall be grounded through distribution transformer with secondary loading resistor, limiting the earth fault current to about 5-10 A and to restrict the over voltages caused due to capacitive currents. The neutral earthing equipment shall be rated to carry this current for at least 5 minutes considering the generator terminal voltage under maximum field forcing conditions.

1.12.02 11 kV/3.3kV system earthing shall be low resistance earthed type to limit earth fault current to 300A. The resistor shall be rated to carry this current at least for 10 seconds.

400kV system is solidly grounded.

Neutrals of Generator Transformers (on 400kV side) and all LT Transformers (415V) shall be solidly earthed through bolted links.

220V DC system shall be kept ungrounded.

Diesel generator shall also be kept ungrounded (earthing through PT).

1.13.00 **Motor Voltage**

The voltage level for motors shall be as follows:

a)	Up to 0.2 kW	-	240V AC / 415V AC
b)	Above 0.2 kW and up to less than 175 kW	-	3 ph, 415V AC
c)	175 kW and up to less than 1500 kW	-	3 ph, 3.3KV AC
d)	1500 kW & above	-	11 kV

415V or 3.3 kV may be adopted by the bidder for the drives in the range of 175-210 kW.

3.3 kV AC supply for CHP conveyor motors of rating above 160 kW is to be used.

The voltage rating of the drives indicated above is for basic guideline. Minor variations can be accepted on case to case basis based on techno-economic considerations of the various sub-systems.

Voltage rating for special purpose motors viz, VFD and screw compressors, shall be as per manufacturer's standard. All the motors ratings on Stacker/ Reclaimer shall be 415V AC supply only.

1.14.00 **Tropical Protection**

1.14.01 All electrical equipment, accessories and wiring shall have fungus protection involving special treatment of insulation and metal against fungus, insects and corrosion.

1.14.02 Fine mesh screen of corrosion resistant material shall be furnished on all ventilating openings to prevent entry of insects.

1.15.00 **Enclosure Protection**

1.15.01 Degree of protection of enclosures as per IS:13947 shall be as follows:

	Item	Degree of Protection
1	11kV & 3.3kV Switchgears	IP4X
2	415V MCC / DBs / Fuse Board	IP52 for indoor and IP65 for outdoor
3a	Motor	IP55
3b	Motor Actuator	IP65
4a	Control and Relay Panel in AC area	IP3X
4b	Control and Relay Panel in normal area	IP42
5a	Pushbutton Station/Kiosk/Panel - Indoor	IP55
5b	-Do - Outdoor	IP65
6	Indoor Junction boxes for cables / wires	IP55
7	Outdoor lighting fixtures	IPW55
8	Battery Charger Panel	IP42

1.15.02 In fire hazardous areas like gas/ liquid fuel storage/ handling areas, lighting fixtures, switchgears shall be of tested and certified flame proof design.

1.16.00 Painting For Electrical Equipment

Unless explicitly stated in relevant chapters of the specification, the painting of all electrical equipment shall be as follows:

Epoxy based with suitable additives. The thickness of finish coat shall be minimum 80 microns (minimum total DFT shall be 100 microns). However in case electrostatic process of painting is offered for any electrical equipment, minimum paint thickness of 80 microns shall be acceptable for finish coat. Paint shade shall be as per technical specification.

Paint shade of finish coat shall be as per Section-X of Volume – IIA: Lead Specification.

1.17.00 Redundancy

The Contractor shall develop the system configuration based on the concept that failure of any one auxiliary transformer or supply feeder will not affect full load operation or start up/shut down of the unit.

1.18.00 Quality Assurance

1.18.01 The Contractor shall follow his standard procedures for quality assurance and control. A copy of the said standard procedures shall be submitted to the Owner / Purchaser for his reference. However, Owner / Purchaser reserves the right to review the same and give his observations, if any, for compliance.

1.18.02 The procedures shall be in such a form as to clearly delineate the manufacturing sequence, inspection points, tests and test procedures, acceptable ranges / values, reference drawings etc.

1.18.03 The Owner / Purchaser shall inform the Contractor as to which of the inspection points and tests shall be witnessed. As a minimum, inspection and testing of the finished equipment shall be made prior to shipment, unless specifically waived by the Owner / Purchaser. The contractor shall give at least fifteen (15) days advance notice regarding readiness of the equipment.

1.18.04 Manufacturing and quality control procedures shall be available for audit to the Owner / Purchaser and/or its representative at the place of manufacture.

1.18.05 The Owner / Purchaser reserves the right to inspect the equipment at the point of manufacture and witness factory and other such tests as may be necessary to ensure conformance to the specification.

1.18.06 The Owner / Purchaser reserves the right to inspect the Contractor's facilities prior to award of contract.

1.18.07 The Owner / Purchaser reserves the right to witness any or all of the tests stipulated in the relevant standards and this specification.

1.18.08 The Owner / Purchaser may conduct surveillance of the Contractor's facilities for compliance to his standard procedures of Quality Assurance and Quality Control while work on the specified equipment is in progress.

1.19.00 **Drawings / documents for Approval**

1.19.01 The Contractor shall submit his Master Deliverable Schedule considering the priority of the listed documents with respect to the project execution schedule to enable the Owner's Consultants (DCPL) to plan manpower deployment. The documents in the Schedule should be marked in two categories viz. (a) 'For Approval' (A) and (b) 'For Reference' (R).

1.19.02 The Contractor shall assign the basic engineering documents in 'For Approval' category and obtain approval of those documents prior to submittal of corresponding detail engineering documents. For the Bidder's guidance - such documents shall include, but not limited to the following:

a) Master Deliverable List – Electrical with schedule of submission
b) Electrical key single line diagram for the entire plant indicating rating of equipment
c) Electrical system study (load flow, short circuit, motor starting) with software output.
d) Diagram of Generator, GT, UT & ST with Metering & Protection
e) Design Memorandum & Sizing Calculation for–
    i. Generator and Excitation System
    ii. GCB
    iii. Generator Busduct
    iv. GT, UT, ST and other auxiliary transformers
    v. MV busduct
    vi. DC System
    vii. DG Set
    vii. UPS
    viii. HT & LT Switchgears
    ix. HT & LT Cables
f) General Technical Particulars (GTP) of all electrical equipment
g) Logic diagram for Generator, GT, UT, ST.- Protection & Annunciation
h) Logic diagram for HT & LT Switchgears – Incomer, Tie, Bus-coupler, Feeders, Drives
i) Test protocol for all electrical equipment
j) Integrated unit protection scheme
k) Relay setting calculation for Generator, Transformer, 11kV/3.3kV/0.415kV system relay panels
l) CT and VT calculations for Generator circuit
m) Electrical single line diagram for auxiliary power distribution system
n) Design Memorandum - Grounding system
o) Design Memorandum – Lightning protection system
p) Design Memorandum – Cable raceway system
q) Design Memorandum – Station lighting system
r) Design Memorandum – Chimney & Cooling Tower electrical
s) Cable numbering scheme
t) Drive control & measurement philosophy and Plant Control Philosophy
u) Layout for -
    i. Transformer Yard
    ii. 400kV Switchyard
    iii. HT & LT Switchgear Rooms
    iv. Electrical Control Rooms
    v. Battery & Battery Charger Rooms
    vi. Inter-plant Cable Raceway

vii. Area Lighting
viii. Station Grounding Mat

u) All drawings/data relevant to the equipment like QAP, Guaranteed Technical Particulars, General Arrangement Drawing, Bill of Material, Foundation Plan, Single Line Diagram, Control Schematic, Wiring Diagram, Sizing calculations, etc. shall be furnished for approval of Owner/Owner's Consultant.

1.19.03 The Owner's Consultants may review a document assigned in 'For Reference' category as they deem necessary and furnish comments for compliance by the Contractor.

2.00.00 SCOPE OF SUPPLY & WORK

2.01.00 General

2.01.01 The scope of work related to electrical system is an intrinsic part of the total EPC Contract.

The Bidder's scope shall include design, engineering, manufacture, type testing, inspection & shop testing at supplier's works, packing, forwarding to site including customs clearance/ port clearance (if required), receipt and unloading, in-plant transportation, handling and storage (preservation & conservation of equipment) at site, erection including associated civil and structural works, testing and commissioning of the Electrical equipment/ system and works indicated in subsequent sections of Volumes – V-A, V-B & IIC (Generator) for one (1) unit and balance of plant (BOP) as indicated in this chapter. The scope includes all interface/ interconnections with the electrical systems under this contract as required for main plant, balance of plant, switchyard and other systems mentioned elsewhere. Electrical scope shall be as described briefly in the following clauses but not limited to it.

2.01.02 Scope of work shall also cover the design, manufacture, assembly, testing at manufacturer's works/laboratory, supply, delivery, properly packed for transport to site, storing at site of mandatory spares, 3 years O & M spares as detailed hereinafter in subsequent sections of Volumes- V-A, V-B & IIC as required for efficient and trouble free operation.

2.02.00 Generator and Auxiliary System

2.02.01 Generator complete in all respects including stator, rotor, bearings, couplings, terminal pads with palms and all its associated supervisory and instrumentation system.

2.02.02 Complete hydrogen cooling, carbon dioxide and nitrogen gas systems as applicable including the necessary piping and pipe supports, valves, measuring system along with the control panel and gas cylinders.

2.02.03 Complete seal oil system including the necessary tanks, pumps, motors, coolers, strainers, piping and pipe supports, valves, measuring system along with control panel.

2.02.04 Complete water cooling system where applicable including the necessary tanks, pumps, motors, heat exchangers, strainers, piping and pipe supports, valves, measuring system along with control panel.

2.02.05 Complete excitation system (brushless or static type) with main exciter, excitation transformer, thyristors, pilot exciter, rectifiers and filters, field flashing and field forcing

b) Data Concentrators with redundant Servers (not more than 100 relays shall be connected to one such Data Concentrators); 50 Nos of additional relays (Owner's requirement) shall be considered while designing Data Concentrators

c) LAN Network along with 61850 Ethernet Switches for both MV & LV Switchgears

d) HMI station (with Operator Work Station, Engineering Workstations and printers)

e) Fiber Optical cable & HDPE Conduit (length as required), Terminal equipment such as LIU, etc. (quantity as required), GPS (Two Nos) and Laptops (at least 10 Nos)

f) Any other equipment required to the intended specification

g) Suitable gateway to interface DDCMIS and Numerical relay network (at Data concentrator level)

The typical configuration of such a proposed system is enclosed. The numerical relay network shall include relays on all MV & LV switchgears being supplied under this package. Data concentrators shall be distributed functionally and geographically and shall be interconnected through Fibre Optic cables. Required number of FO ports for interface to DDCMIS with Fibre Optic cables shall be made available on all Data concentrators. Provision for connection and arrangement for termination of Fibre Optic cables from DDCMIS at Data concentrator end shall be made.

2.07.00 **DC System**

2.07.01 Lead acid plante type batteries and battery chargers, with the battery taking over and catering to all the loads connected to the D.C. system, including emergency loads for main plant, switchyard and all other areas in the scope of the contractor, as per system requirement.

2.07.02 Following DC systems shall be supplied to cater to various DC loads in the plant:

a) Two nos. 220V batteries with each battery having Float & Float cum Boost chargers, each rated for 100% capacity for the main plant loads and one 100% capacity Standby Boost charger.

b) 220V battery with Float & Float cum Boost chargers each rated for 100% capacity to meet CHP requirement.

c) 220V battery with Float & Float cum Boost chargers each rated for 100% capacity to meet loads of other far-away auxiliary systems like AWRS, make-up water, ash silo (if any) etc.

d) Two nos. 220V batteries, each battery having Float & Float cum Boost chargers, each rated for 100% capacity for 400kV Switchyard.

e) Two nos. 24V batteries, each battery having Float & Float cum Boost chargers, each rated for 100% capacity for plant DCS system.

2.07.03 Design / sizing criteria shall be as described in subsequent clauses of this Section.

2.07.04 DC System shall be supplied from a single manufacturer.

2.08.00 **Motors**

Motors along with couplings and coupling guards for all rotating auxiliaries covered under this package.

2.12.02 **LT Power and Control Cables**

LT Power and Control cables as required for the complete plant, building, equipment and switchyard system etc.

2.12.03 **Fire Survival Cables**

Fire Survival Cables, suitable for a minimum temperature of 750 deg. C for 3 hours, for both power & control, shall be provided for the following –

i. DC emergency lube oil pump

ii. DC hydrogen seal pump

iii. Turbine lube oil pump/barring gear

iv. DC emergency lighting for main building and service building

v. DC cables for battery to charger & DC distribution boards

vi. Jacking oil pump

vii. Emergency turbine trip in control room

viii. Boiler Turbine : Generator inter trip which include the interconnection between -

- Boiler master fuel trip and turbine trip relays
- Generator trip relays & turbine trip relays
- Generator trip relays & generator breaker
- Generator trip relays & field breaker
- Generator trip relays & unit auxiliary transformer breaker
- Incomer cables for DG board, emergency board, DC lighting board etc.

2.13.00 **Grounding & Lightning Protection**

2.13.01 Scope of grounding system for the power station complex includes in principle:

a) System grounding to facilitate ground fault relaying and to reduce the magnitude of transient over voltage

b) Equipment grounding to provide protection to personnel from potential caused by ground fault currents and lightning discharges.

c) Electronic Equipment grounding for multiple purpose of signal return, safety, EMI control, and antenna function

2.13.02 System grounding involves grounding of the neutrals of generators, transformers, DG sets etc. as discussed in Clause No. 1.12.00.

2.13.03 Scope also includes stable ground grid for grounding of equipment and structures and for maintaining the step and touch potentials within safe limits. An earth mat buried at a suitable depth of 1.0m below the ground will be laid in and around the power station including transformer yard and switchyard. All metallic parts of equipment, supposed to be kept at earth potential, will be connected to the grounding mat. Buildings, structures, transmission towers, plant railroad tracks, the perimeter fencing will also be connected to the grounding mat. The grounding mat will be interconnected with each other with in the plant area. Switchyard earth mat and main plant earth mat shall be connected at minimum two (2) places with test links.

5.06.02 The Numerical Relay Network system be offered from a Integrator /Manufacturer who has designed and successfully done FAT for a network on IEC 61850 with least 100 nos of Communicable Numerical Relays prior to date of Techno-Commercial bid opening.

5.07.00 **HT Motor**

5.07.01 **CW Motor**

The CW pump drive motors should be sourced from a manufacturer who have supplied at least two nos. of 11KV or above, vertical, DOL started squirrel cage induction motors of cooling type specified having rating 2000KW or more and motor speed not exceeding 500 rpm synchronous, which are in successful operation for at least two (2) years as on the date of Techno-Commercial bid opening.

5.07.03 **BFP Motor**

The offered Squirrel cage Induction motor shall be from such a manufacturer who has manufactured and supplied motor of 10MW or above rating, which is in successful operation in at least one (1) plant for a period not less than one (1) year as on the date of Tech no-Commercial bid opening.

5.07.04 **ID Fan Motor**

The offered Squirrel cage Induction motor shall be from such a manufacturer who has manufactured and supplied motor of 4MW or above rating, which is in successful operation in at least one (1) plant for a period not less than one (1) year as on the date of Techno-Commercial bid opening.

5.08.00 **LT Control Cables**

Sub-Vendor should have manufactured and supplied as on date of Techno-Commercial bid opening the following:

(a) At least 300 km of PVC insulated, PVC sheathed stranded copper conductor 1.1 kV grade cables in one single contract

(b) At least one (1) km of Flame retardant low smoke cables.

5.09.00 **LT Power Cables**

Sub-Vendor should have manufactured and supplied as on date of Techno-Commercial bid opening the following:

a) At least 100 km of aluminium conductor, XLPE insulated, PVC sheathed power cables of 1.1 kV or higher grade in one single contract

b) At least 100 km of aluminium conductor, PVC insulated, PVC sheathed power cables of 1.1 kV or higher grade in one single contract

c) At least one (1) km of flame retardant low smoke cables.

d) 1.1kV or higher grade power cable of minimum 630sq.mm. conductor size.

5.10.00 **HT Cables**

Sub-Vendor should have manufactured and supplied following cables, as on date of Techno-Commercial bid opening

(a) At least 50kms of XLPE insulated power cables of 6.35/11 kV or higher

voltage grade, executed in one or more orders.

(b) At least one (1) km of flame retardant low smoke cables of any voltage level.

5.11.00 **DG Sets**

Sub-Vendor should have supplied at least two (2) numbers of DG set of rating not less than 1250 kVA, at least one (1) each at two (2) different installations, which should be in successful operation for at least two (2) years as on date of Techno-Commercial bid opening. The make of the DG set (Alternator and Engine) shall be same as that of reference plant DG set.

5.12.00 **DC Batteries**

Sub-Vendor should have manufactured and supplied at least two (2) numbers of highest offered rating or above of high discharge type Plante positive plate type battery at least one (1) each at two (2) different industrial installations, which should be in successful operation for at least two (2) years as on date of Techno-Commercial bid opening.

5.13.00 **Battery Charger**

Sub-Vendor should have manufactured and supplied at least two (2) numbers of static automatic voltage regulator type Battery Chargers of highest offered rating or above, at least one (1) each at two (2) different industrial installations, which should be in successful operation for at least two (2) years as on date of Techno-Commercial bid opening.

5.14.00 **Generator Circuit Breaker (GCB)**

Sub-Vendor should have designed, manufactured, tested, supplied, erected & commissioned/supervised erection and commissioning of at least two numbers of generator circuit breakers (sulphur hexaflouride) of ratings not below that offered for this project, which are in successful operation for at least two (2) years as on date of Techno-Commercial bid opening. The ratings will constitute of:

a) Rated voltage and current rating.

b) Rated short circuit current carrying capability for one (1) second.

c) Rated short circuit peak making and latching current carrying capability.

d) Rated symmetrical RMS short circuit current interrupting capability.

The type (sulphur hexaflouride) and rating of breaker offered should also have been successfully type tested as on date of Techno-Commercial bid opening.

5.15.00 **400kV Switchyard Equipment (AIS)**

5.15.01 SF6 Circuit Breakers being offered should be from manufacturer who has manufactured and supplied minimum fifteen (15) nos. of SF6 Circuit Breakers of offered voltage class or higher, and which must have been in successful operation for a minimum period of two (2) years as on date of Techno-Commercial bid opening.

5.15.02 Disconnecting switches being offered should be from manufacturer who has manufactured and supplied minimum thirty (30) nos. of Disconnecting switch of offered voltage class or higher, suitable for air insulated substation/ switchyard and which must have been in successful operation for a minimum period of two (2) years as on date of Techno-Commercial bid opening.

4.02.03 **Battery Racks**

Battery racks for supporting battery cells shall be constructed of best quality FRP forming a rigid structure. Racks shall be painted with at least three (3) coats of electrolyte-resistant paint of approved shade. Batteries shall be preferably be located in single tier arrangement. Racks shall be free standing type, mounted on porcelain / electrolyte–resistant high impact plastic insulators. Numbering tags for each cell shall be attached on to the racks.

4.03.00 **Battery Charger**

4.03.01 **General**

a) The charger shall be natural air cooled, solid-state type with full wave, fully controlled, bridge configurations.

b) The charger shall be provided with (but not limited to) microprocessor based automatic voltage control, current limiting circuitry, smoothing filter circuit and soft-start feature, under/ over voltage protection and earth fault detection.

c) Voltage/current control shall be stepless, smooth and continuous. Voltage control shall be possible either in “Auto“ mode or in “Manual” mode. An “Auto-Manual” selector switch shall be provided for this purpose.

d) The charger shall be self-protecting against all AC and DC transients and steady state abnormal currents and voltages.

e) Charger AC input and DC output shall be electrically isolated from each other and also from panel ground.

f) Isolation shall also be provided between power and control circuits.

g) Radio frequency suppressor/screening shall be provided with the charger to limit the noise level/interference to radio and other communication equipment to be installed in the same building.

h) The design of the equipment will be such that during the period both trickle charger unit and boost charger units are working independently, the tap connection from various taps of the battery cell to the load circuit should not involve any circulating current.

4.03.02 **Construction**

a) The charger shall comprise a continuous line up of free-standing, floor mounted sheet steel panels, with access from both from front as well as from rear.

b) In between float and float-cum-boost charger panels, a central panel shall be provided. This panel shall house the battery terminals, load terminals, battery blocking diodes, meters, annunciator and indicating lamps.

c) The panel shall conform to the degree of protection IP 42. Minimum thickness of sheet metal used shall be 2 mm for load bearing members and 1.6 mm for non-load bearing members.

d) Access doors shall be with concealed hinges and neoprene gaskets. Ventilating louvers shall be covered with fine wire mesh. Door over 600 mm width shall be of double-leaf design.

e) All equipment within the panels shall be arranged in modular units and laid out with sufficient space for easy maintenance.

f) All indicating instruments, control switches etc. shall be flush mounted on the front face of the panels. However potentiometer shall be provided inside the panel. Nameplates of approved size and type shall be provided for all circuits and devices both at front & inside of the panel.

g) All bus bar and bus connections shall be of high conductivity copper and adequately sized to limit the maximum temperature within the permitted value. All bus connection shall be silver plated.

h) Heat –shrinkable insulating sleeves shall be provided for bus bars. All bus connections shall be color coded for easy identification.

i) Bus bars shall be supported and braced to withstand the stress due to maximum short circuit current and also to take care of any thermal expansion.

4.03.03 **Charger Equipment**

a) All power diode and control rectifiers shall be silicon type. Rectifier transformer shall be resin impregnated in vacuum, dry type, double wound with copper conductor and class-F insulated with temperature rise limited to class-B having off-circuit tap +(-)2x2.5% on primary side. LC filter suppressor shall be provided in the output to minimize ripple content and to keep the value within the specified limit.

b) The diode & bridge elements shall be liberally sized for forward current, minimum momentary overloads & voltage spikes. The current & peak inverse voltage (PIV) should be chosen accordingly. Wherever necessary power semiconductor device shall be provided with over current and over temperature protection by using special fuses.

Blocking diodes shall be fully rated and shall have redundancy so that failure of a single diode shall not incapacitate the system in any way.

c) Isolating switches shall be heavy duty, load break type, operated by an external handle with provision for padlocking in ON & OFF position.

d) AC Changeover switch shall be 3 position, 4 pole, load break type with 2 NO + 2 NC auxiliary contacts. The switch shall be installed in such a manner that the operating handle shall be accessible only after opening the front door.

e) Double pole, double throw DC switch shall be load break type with 2 NO + 2 NC auxiliary contacts.

f) Control switches shall be dust protected, heavy duty, switchboard type complete with escutcheon plates. Contacts shall be silver plated, rated 10A at operating voltage.

Selector switch shall be maintained contact, lockable stay-put type with knob handle. Meter selector switch shall be four-position type.

Ground fault detection switch shall be three-position type spring return to neutral.

g) Push button shall be heavy duty, shrouded, push to actuate type with colored button and inscription plate. Each push button shall have 2 NO + 2 NC contacts, rated 10A at 240V AC and 5.0A at 220V DC.

h) Contactor shall be air-break type with hand reset type thermal overload relays having in built temperature compensator and single phase preventor. Contactor duty class shall be AC-3.

i) Fuses shall be HRC type, mounted on insulated fuse carriers, which are mounted on fuse bases. Wherever it is not possible to mount fuses on carriers, fuses shall be directly mounted on plug-in type of base. In such cases, one set of insulated fuse pulling handles shall be supplied with each board. Kick-off fuses (trip fuses) with alarm contacts shall be provided for all DC fuses. Semi conducting device fuses shall be fast-acting. All upstream fuses shall be properly coordinated with corresponding down stream fuses.

j) Indicating lamps shall be clustered of LEDs suitable for the duty involved. The body shall be made of polycarbonate Unbreakable lens. LEDs shall be protected by inbuilt fuse with surge suppressor or leakage voltage glow protection. Both lamps and lens shall be replaceable from front.

k) Each battery charger shall be provided with one (1) no. voltage transducer and one (1) no. current transducer for monitoring the DC output. These transducers shall have twin-channel output of 4-20mA and will be used for analog inputs to central DDCMIS/ EDMS.

l) Ground fault relay shall be provided to detect DC system ground leakage current.

m) Switch fuse shall be provided to receive incoming AC supply.

n) Charger shall be equipped with LCD display, so the system or particular module operation parameters can be locally or remotely viewed / monitored. Following parameters to be displayed:

- Input AC voltage
- Input AC current
- Charging voltage

- Charging current
- Load voltage
- Load current
- Battery voltage
- Battery current

4.03.04 **Alarms**

a) Solid–state, audio visual annunciation system shall be provided for battery chargers. Annunciation system shall operate on 220V DC.

b) One (1) minimum twelve-points alarm facia shall be provided on float-cum-boost charger panel, complete with proper actuating devices, circuitry, legends, push buttons (Accept, Reset and Test) and hooter.

c) Each central panel shall be provided with one (1) minimum eight point alarm facia complete with proper actuating devices, circuitry, legends, push- buttons (Accept, Reset and Test) and hooter.

d) The arrangement shall be such that on occurrence of a fault the corresponding window will light up and stays lighted until the fault is cleared and reset button is pressed.

e) Each time a window lights up, a master relay will get energized to provide group alarm signals for Owner/Purchaser's remote panel.

f) The requirements of indication/metering/alarms are given in the annexure.

g) The alarm shall be compatible with central DCS/SCADA

4.03.05 **Meters**

Meters shall be 96 x 96 mm switchboard type, 90 deg scale, antiglare glass, accuracy class 2.0, with zero adjuster on the front. Charger panel shall be provided with the following meters:

a) Input voltmeter (0 – 500 V AC) with voltmeter selector switch.

b) Output DC voltmeter at each charger output.

c) Output DC voltmeter at battery output.

d) Output DC ammeter at each charger output (0 – 150% of rated full load charger output)

e) Battery charging / discharging ammeter.

4.03.06 **Transducers**

Each battery charger shall be provided with one (1) no. voltage transducer and one (1) no. current transducer for monitoring the DC output. Transducer shall have 4-20mA dual output.

Charger panel shall be provided with the following transducers:

a) DC voltage transducer at each charger output.

b) DC current transducer at each charger output.

c) DC voltage transducer at battery output.

4.03.07 **Controls**

The following (but not limited to) manual controls shall be provided on the front of each charger panel :

a) Charger ON/OFF push button.

b) Selection of float or boost charge in case of float-cum-boost charger.

c) Voltage setters for setting the output of float/ equalizing / boost charge. Setting shall be independent of each other so that setting of one voltage shall not require resetting other.

d) Ground fault detection switch with indicating lamps.

e) Current limit setter/ charging rate.

f) Under/Over voltage relay including battery earth fault monitoring relay.

g) Acknowledge-Reset-Test push buttons for annunciation system. The color of reset buttons shall be BLACK.

4.03.08 **Lamp/Space heaters/receptacles**

a) The charger panels shall be provided with :-

- Internal illumination lamp with door switch, the lamp shall be located in the ceiling and guarded with protective cage.
- Space heater with thermostat control
- 5 pin 6A receptacle with plug
- Communication plug.

b) Lamp, heater and receptacle circuits shall have individual ON-OFF switch fuse units and shall be suitable for 240V AC supply.

4.03.09 **Wiring/Cabling**

a) The panels shall be completely wired-up. All wiring shall be routed through wiring troughs.

b) Wiring shall be done with flexible, 1100V grade, fire resistance PVC insulated switchboard wires with stranded copper conductors of 2.5 mm^2 for control and current circuits and 1.5 mm^2 for voltage circuits.

c) Each wire shall be identified, at both ends, with interlocking type permanent markers bearing wire numbers as per Bidder's Wiring Diagrams. AC / DC wiring shall have separate color-coding.

d) Wire termination shall be made with crimping type connectors with insulating sleeves. Wires shall not be spliced between terminals.

e) All spare contacts of relays, timers, auxiliary switches and other devices shall be wired up to the terminal block.

f) Gland plate shall be of 4 mm thick, non-magnetic material and suitable for single-phase cable entry from bottom. Cable terminal board with cable lugs and double compression cable glands shall be provided in each panel for termination of incoming and outgoing cable.

4.03.10 **Terminal Block**

a) 1100V grade, multi way terminal block complete with mounting channel, binding screws and washers for wire connections and marking strip for circuit identification shall be provided for terminating the panel wiring. Terminals shall be stud type, suitable for terminating 2 nos. 2.5 mm2 stranded copper conductor and provided with acrylic insulating cover.

b) Not more than two wires shall be connected to any terminal. Spare terminals equal in number to 20% active terminals shall be furnished. Separate terminal blocks shall be used for AC/ DC wiring termination.

c) Terminal blocks shall be located to allow easy access. Wiring shall be so arranged that individual wires of an external cable can be connected to consecutive terminals.

d) Terminal blocks used for interface with DDCMIS via termination cabinet shall be suitably sized to facilitate proper termination of interconnecting cables.

4.03.11 **Grounding**

a) The charger panels shall have fully rated ground bus with two ground terminals, one at each end.

b) Each terminal shall comprise two-bolt drilling with G.I. bolts, nuts and bimetallic washers for connecting to 50x6 mm G.I. flat. Ground bus shall be bolted to the panel structures, effectively grounding the entire assembly. The cases of meters, relays and switching devices shall be grounded through sheet steel structure.

c) Wherever, the schematic diagrams indicate a definite ground at the panel, a single wire for each circuit thus grounded shall be run independently to the ground bus and connected thereto.

4.03.12 **Tropical protection**

a) All equipment accessories and wiring shall have fungus protection, involving special treatment of insulation and metal against fungus, insects and corrosion.

b) Screens of corrosion resistant material shall be furnished on all ventilating louvres to prevent the entrance of insects.

4.03.13 Painting

a) The sheet metal of the panels shall be thoroughly cleaned by chemical agents (7-tank process) as required to produce a smooth clean surface free of scales, grease and rust.

b) Both interior and exterior surfaces of the panels shall be powder coated and finished with two (2) coats of paints of approved shades. Refer to clause no.1.16.00 of Section -I, Volume V-A.

c) The paint shall be carefully selected to withstand tropical heat, rain etc. The paint shall not scale off or crinkle or removed by abrasion due to normal handling.

d) Sufficient quantity of touch up paint shall be furnished for application after installation at site.

4.03.14 Nameplate

a) Name plate shall be provided for each panel and for each equipment/device mounted on it.

b) The material shall be anodized aluminum/ lamicoid, 3mm thick, with white letter on black background.

c) Name plate shall be held by self-tapping screws. The size of name plates shall be approximately 20mm x 75mm for equipment and 40mm x 150mm for panels.

d) Name plates for panels shall be provided both on the front, rear and also inside the panels.

e) Control and meter selection switches shall have integral nameplates. Nameplates for all other devices shall be located below the respective devices both inside and outside the panel.

f) Instrument and devices mounted on the face of the panels shall also be identified on the rear with the instrument / device number. The number may be painted on or adjacent to the instrument or device case.

g) Caution notice of suitable metal plate shall be affixed at the back of each panel.

h) Bus bar clamp-on sensor, maximum DC current: 50A

4.04.00 Battery Discharge Resistor Unit / Portable Single Cell Charger

ANNEXURE-B

FITTINGS & ACCESSORIES

1.0 BATTERY

Each set of battery shall be equipped with fittings and accessories as listed below.	
1	One battery log book.
2	Two copies of printed instruction sheet.
3	Two nos. cell testing voltmeter (3-0-3 volts) complete with leads.
4	One no. rubber syringe type hydrometer suitable for specific gravity reading.
5	Three nos. pocket thermometer.(Digital type)
6	Two nos. thermometer (0 to 100°) with specific gravity correction scale.
7	One set cell bridging connector.
8	Two nos. each Electrolyte resistant plastic funnels and plastic jugs
9	Battery racks suitable for accommodating the cells coated with paint.
10	Insulator (with 5% extra), rubber pad etc. for rack.
11	Two nos. plastic filling bottle for filling up.
12	One pair of spanners.
13	Requisite quantity of electrolyte with 10% extra in non-returnable containers.
14	Two pairs of rubber hand gloves.
15	Two nos. cell lifting straps.
16	One set of inter cell, inter tie and inter bank connectors as required for complete installation.
17	Self adhesive PVC stickers for cell numberings
18	Goggles.
NOTE:	Any other accessories if required for satisfactory operation of the complete battery system shall also be included in Bidder's offer and to be supplied accordingly.

ANNEXURE-C

LIST OF ALARMS & AND INDICATIONS

1.0 Following list of alarm / annunciation shall be provided at each charger.

a) AC supply failure.

b) Charger overload.

c) SCR fuse blown.

d) Filter fuse blown.

e) DC output fuse blown.

f) DC system under voltage.

g) DC system over voltage.

h) Battery earth fault.

i) AC Input fuse blown

2.0 Initiating contacts wired to two terminals at battery charger panel shall be provided for group annunciation “Battery Charger Trouble” of the events mentioned above, at central control room. Separate contacts shall be provided for “Battery earth fault” annunciation at central back-up panel.

3.0 Initiating contacts for all alarm points shall also have electrically separate spare set of contacts wired to the terminal block for future use.

4.0 All alarm contacts shall be rated 5.0A at 220V DC and 10 Amp. at 240V AC.

5.0 In addition to the alarm points mentioned above, any other alarm point, if required for battery charger, shall be provided.

6.0 Charger panel shall also have the following minimum indications:

a) Charger power supply ON (at all three phases)

b) Charger DC output healthy.

c) Control supply ON.

d) DC supply healthy.

e) Float / boost charger in operation (in float-cum-boost charger)

Annexure 5- D: C&I Specification

VOLUME: VI

SECTION-VII

TECHNICAL SPECIFICATION –

FIELD INSTRUMENTS & FLOW ELEMENTS , CONTROL VALVES , I&C CABLES , ERECTION HARDWARES , TOOLS & TACKLE

CONTENT

VOLUME : VI
SECTION-VII
SUB SECTION - A
FIELD INSTRUMENTS & FLOW ELEMENTS

1.00.00 SPECIFICATION FOR ELECTRONIC TRANSMITTERS

1.01.00 PRESSURE TRANSMITTER

1.	Working Principle	:	Smart (HART Compatible)
2.	Type	:	Microprocessor based, 2 – Wire
3.	Output Signal	:	4-20 mA DC along with superimposed digital signal
4.	Measuring Element	:	Capsule / Diaphragm
5.	Element material	:	SS-316 (Stainless Steel) or better
6.	Static Pressure	:	150 % of maximum span continuously, without affecting the calibration
7.	Turn-down ratio	:	100: 1
8.	Span and Zero	:	Continuous, tamper proof, remote as well locally adjustable with zero elevation and suppression by 100% of span
9.	Enclosure Class	:	IP-65 (Explosion proof for NEC Class-1, Division 1 area)
10.	Output Indicator	:	LCD (Integral indicator of 5 digit display)
11.	Nameplate	:	Tag number, service engraved in SS tag plate
12.	Body	:	SS
13.	Operating Voltage	:	24V DC
14.	Load	:	600 Ohms (min.) at 24 Volts D.C.
15.	Ambient Temperature	:	0 - 50 ^{O}C
16.	Performance:	:	
	i. Accuracy		0.075% of Span or better

	ii. Repeatability		0.05% of Span or better
17.	Sealing/Isolation	:	Extended diaphragm (Silicon oil/ Flurolub filled) with 5 meters SS armoured capillary for corrosive/viscous/solid bearing or slurry type fluid applications
18.	Accessories	:	a. Universal mounting bracket suitable for 2" pipe mounting b. High tensile carbon steel U-bolts c. Siphon for steam and hot water services d. ½" NPT 2-valve stainless steel manifold, constructed from SS316 bar stock e. Companion flange with nuts, bolts and gaskets f. ½" NPT cable gland g. Handheld calibrator
19.	Adjustment/Calibration/ Maintenance	:	From handheld calibrator/ HART management system

Notes: For primary air/ secondary air/ flue gas applications, DP type transmitters shall be provided for pressure measurement.

LVDT type is not acceptable.

1.02.00 DIFFERENTIAL PRESSURE TRANSMITTER / FLOW TRANSMITTER

1.	Working Principle	:	Smart (HART Compatible)
2.	Type	:	Microprocessor based, 2 – Wire
3.	Output Signal	:	4-20 mA DC along with superimposed digital signal
4.	Measuring Element	:	Capsule / Diaphragm

5.	Element material	:	SS-316 (Stainless Steel) or better
6.	Static Pressure	:	150 % of maximum span continuously, without affecting the calibration
7.	Turn-down ratio	:	100: 1
8.	Span and Zero	:	Continuous, tamper proof, remote as well locally adjustable with zero elevation and suppression by 100% of span
9.	Enclosure Class	:	IP-65 (Explosion proof for NEC Class-1, Division 1 area)
10.	Output Indicator	:	LCD (Integral indicator of 5 digit display)
11.	Nameplate	:	Tag number, service engraved in SS tag plate
12.	Body	:	SS
13.	Operating Voltage	:	24V DC
14.	Load	:	600 Ohms (min.) at 24 Volts D.C.
15.	Ambient Temperature	:	0 - 50 ^{O}C
16.	Performance:		
	i. Accuracy	:	0.075% of Span or better
	ii. Repeatability	:	0.05% of Span or better
17.	Sealing/Isolation	:	Extended diaphragm (Silicon oil/ Flurolub filled) with 5 meters SS armoured capillary for corrosive/viscous/solid bearing or slurry type fluid applications
18.	Accessories	:	a. Universal mounting bracket suitable for 2” pipe mounting b. High tensile carbon steel U-bolts

c. Siphon for steam and hot water services

d. ½" NPT 5-valve stainless steel manifold, constructed from SS316 bar stock

e. Companion flange with nuts, bolts and gaskets

f. ½" NPT cable gland

g. Handheld calibrator

19. Adjustment/Calibration/ Maintenance : From handheld calibrator/ HART management system

1.03.00 Displacer Type Level Transmitters

1.	Type	:	Smart (HART Compatible)
2.	Stages of operation	:	Continuous
3.	Material	:	
4.	i. Displacer		SS-316
5.	ii. Suspension wire		SS-316
6.	iii. Torque tube housing		SS
7.	iv. Torque tube		Inconel
8.	v. Displacer chamber		SS
9.	vi. Transmitter Housing		SS
10.	Operating Voltage	:	24 V DC
11.	Transmission	:	Microprocessor based, 2-wire
12.	Output Signal	:	4-20 mA DC along with superimposed digital signal
13.	Static / overload	:	Maximum static pressure without

	pressure		permanent deformation or loss of accuracy
14.	Turn-down ratio	:	10 : 1 or better
15.	Zero & Span	:	Continuous, tamper proof, remote as well locally adjustable with zero elevation and suppression by 100% of span
16.	Enclosure Class	:	IP-65
17.	Output Indicator	:	LCD type (Integral indicator of 5 digit display)
18.	Nameplate	:	Tag number and Service engraved in stainless steel tag plate
19.	Ambient Temperature	:	0 - 50 ^{O}C
20.	Load Impedance	:	600 Ohms at 24 Volts (minimum)
21.	Process Connection	:	2” Flanged
22.	Performance - Accuracy	:	$\pm$ 0.075 % of span or better
23.	Accessories	:	a) Counter Flange, nuts, bolts, gaskets etc b) Weights for 5 point calibration of instruments c) Vent and drain plugs d) ½” NPT Glands e) Handheld calibrator
24.	Preferred Features	:	a) Test plug connection and cutout terminals physically separated from other electronics b) Electronic Damping facility (adjustable)
25.	Adjustment/Calibration/ Maintenance	:	From handheld calibrator/ HART management system

26.	Applications	:	During detail engineering on Owner's approval

1.04.00 MASS FLOW METER

1.04.01 SENSOR

1.	Measuring Principle	:	Coriolis Mass flow
2.	Primary Element	:	Flow Tube of 316SS or better
3.	Heating Arrangement	:	Integral
4.	Temperature Control	:	For heavy fuel oil application
5.	Process Connection	:	Flanged of rating as per process requirement
6.	Drain	:	Self-draining facility
7.	Enclosure	:	Stainless steel
8.	Accessories	:	Counter flanges, Mounting nuts, bolts, gaskets etc.

1.04.02 TRANSMITTER

1.	Measured quantities	:	Mass Flow rate, Total Mass Flow, Density
2.	Input Signal Processing	:	Smart (HART compatible)
3.	Display	:	LCD
4.	Output	:	2 nos. isolated output of 4-20mA DC selectable from four measured quantities
5.	Load	:	< 750 ohms
6.	Power supply	:	240V AC, 50 Hz

7.	Turn Down	:	100:1
8.	Accuracy	:	± 0.2 % of measured value
9.	Housing	:	IP 65 (Explosion proof)
10.	Nameplate	:	Tag number, service engraved in stainless steel tag plate
11.	Accessories	:	a) Handheld calibrator b) Mounting U-bolts, nuts, bolts, prefab cable etc c) ½"NPT cable gland
12.	Adjustment/Calibration/ /Maintenance	:	From handheld calibrator/ HART management system
13.	Applications	:	Fuel Oil service

1.05.00 RADAR TYPE LEVEL MEASUREMENT

1.	Type	:	Smart (HART Compatible)
2.	Antenna	:	Co axial / guided wave radar /–Overspill protection
3.	Principle	:	TDR (Time Domain Reflectometry)
4.	Communication	:	Two wire 4-20mA DC with HART
5.	Environmental temperature	:	0 – 50 ºC
6.	Enclosure	:	IP-65 (Explosion proof for NEC Class-1, Division 1 area)
7.	Calibration	:	a) Self calibration with internal reference
		:	b) Zero & Span calibration
8.	Process Connection	:	External cage mounting Flanged /screwed
9.	Electronic Housing	:	Epoxy painted Die-Cast aluminium

			alloy
10.	Antenna / Flange assembly	:	316 SS or Hestalloy (as required)
11.	Power supply	:	24 V DC
12.	Output Indicator	:	LCD
13.	Accuracy	:	5 mm or 0.1% of probe length
14.	Accessories	:	a) Handheld calibrator
		:	b) Counter Flange, nuts, bolts, gaskets etc
		:	c) ½"NPT cable gland
		:	d) SS Nameplate
15.	Adjustment/Calibration/ /Maintenance	:	From handheld calibrator/ HART management system
16.	Applications	:	Vessels under vacuum or low pressure applications, solid levels

1.06.00 ULTRASONIC LEVEL TRANSMITTER

1.	Type	:	Microprocessor based, 2-wire, Smart (HART Compatible)
2.	Operating Principle	:	Detection of reflected ultrasonic pulse
3.	Output Signal	:	4-20 mA DC along with superimposed digital signal
4.	Operating frequency	:	10 KHz to 50 KHz (typical)
5.	Display	:	LCD
6.	Temperature Compensation	:	Built in –Programmable
7.	Power supply	:	24 V DC
8.	Enclosure	:	SS, IP-65 (Explosion proof for NEC Class-1, Division 1 area)

9.	Zero & Span	:	Continuous, tamper proof, remote as well locally adjustable. It shall be possible to calibrate the instrument without any level in the sump/ tank	
10.	Accuracy & Repeatability	:	0.15 % of span or better	
11.	Resolution	:	0.1 % of span	
12.	Operating temp.	:	Transmitter- 500 C and Sensor - 800 C	
13.	MOC Sensor	:	SS-316/Body- PVC and Face – Polyurethene	
14.	Mounting	:	4” Flanged/ 2” NPT for sensor and Transmitter on panel	
15.	Accessories	:	a)	Handheld calibrator
			b)	Weather canopy for protection from direct sunlight and direct rain
			c)	½”NPT cable gland
			d)	All mounting hardware (SS-316), Prefab cable
			e)	SS Nameplate
16.	Diagnosis	:	On-line	
17.	Status Indication	:	Power On, HI, HI-HI, Lo, LO-LO, Fault	
18.	Output Contacts	:	2 SPDT, 230V, 5A	
19.	Adjustment/Calibration/ /Maintenance	:	From handheld calibrator/ HART management system	
20.	Applications	:	Coal Bunker, Water Service etc.	

1.07.00 ULTRASONIC FLOW TRANSMITTER

1.	Type	:	Ultrasonic – Clamp On
2.	Accuracy	:	+/- 1 % of reading
3.	Repeatability	:	+/- 0.3 % of reading
4.	Rangeability	:	400 : 1
5.	Output Signal	:	4-20 mA DC with HART
6.	Measured Parameter	:	Volumetric flow, Totalized flow and flow Velocity
7.	Display	:	LCD with internal Key Pad (Flow rate & Totalization)
8.	Power Supply	:	24 V DC (2 Wire)
9.	Enclosure	:	SS (IP- 68 – Submersible)
10.	Mounting	:	SS Chain or Strap
11.	Accessories		1. Handheld calibrator 2. ½"NPT cable gland 3. Transducer cable 4. All mounting hardware (SS-316) 5. SS Nameplate
12.	Adjustment/Calibration/ /Maintenance	:	From handheld calibrator/ HART management system
13.	Applications	:	Plant water service

Note: Multi-path insertion type (minimum 4 path) Ultrasonic Flow meter shall be provided for Raw water/ Cooling Water flow measurements.

2.00.00 **HART HAND HELD CALIBRATOR**

Hand held calibrators (5 nos. for each type) shall be provided for adjustment/ calibration/maintenance of the HART compatible

transmitters. The hand held calibrator shall be suitable for all types of transmitters supplied in the package. If one type of hand held type calibrator is not suitable for communicating with all types of transmitters then separate hand held calibrator will be provided.

3.00.00 PROCESS ACTUATED SWITCHES

3.01.00 PRESSURE SWITCH

1.	Type	:	i. Piston for high pressure application ii. Bellow / Diaphragm for low pressure application
2.	Sensing element material	:	SS-316. All other wetted part SS316
3.	Case Material	:	SS
4.	Setter Scale	:	Black graduation on white linear scale. Graduation 0-100% with red pointer for set points
5.	Over range	:	150 % of maximum pressure
6.	Adjustments	:	a) Internal Set Point
		:	b) Differential adjustment
7.	End Connection	:	1/2" NPT bottom connected
8.	Switch configuration	:	Two SPDT (240V, 5A AC/220V, 0.5A DC)
9.	Switch Type	:	Snap acting, shock & vibration proof
10.	Terminal Block	:	Suitable for full ring lugs
11.	Enclosure Class	:	IP-65 (Explosion proof for NEC Class-1, Division 1 area)
12.	Performance	:	a) Repeat accuracy r 1.0%
		:	b) Accuracy of Setting Indication of $\pm$ 1.5%
13.	Ambient temperature	:	0 – 50 Deg.C

14.	Nameplate	:	Tag number, service engraved in SS tag plate
15.	Accessories	:	a) Silicon oil/ Flurolub filled Remote diaphragm seal with SS-316 capillary for corrosive/ viscous/ solid bearing or slurry type fluid applications b) Snubbers for pulsating fluid applications c) Siphons for steam and hot water services d) Retention ring and screws for surface mounting e) 1/2" NPT 2 Valve SS-316 barstock manifold f) ½" NPT cable gland
16.	Applications	:	During Detail Engineering on Owner's approval

3.02.00 DIFFERENTIAL PRESSURE SWITCH

1.	Type	:	i. Piston for high pressure application ii. Bellow / Diaphragm for low pressure application
2.	Sensing element material	:	SS-316. All other wetted part SS316
3.	Case Material	:	SS
4.	Setter Scale	:	Black graduation on white linear scale. Graduation 0-100% with red pointer for set points
5.	Over range	:	150 % of maximum pressure

6.	Adjustments	:	a) Internal Set Point
		:	b) Differential adjustment
7.	End Connection	:	1/2" NPT bottom/ back connected
8.	Switch configuration	:	Two SPDT (240V, 5A AC/220V, 0.5A DC)
9.	Switch Type	:	Snap acting, shock & vibration proof
10.	Terminal Block	:	Suitable for full ring lugs
11.	Enclosure Class	:	IP-65 (Explosion proof for NEC Class-1, Division 1 area)
12.	Performance	:	a) Repeat accuracy r 1.0%
			b) Accuracy of Setting Indication of ± 1.5%
13.	Ambient temperature	:	0 – 50 Deg.C
14.	Nameplate	:	Tag number, service engraved in SS tag plate
15.	Accessories	:	a) Silicon oil/ Flurolub filled Remote diaphragm seal with SS-316 capillary Diaphragm seals for corrosive/ viscous/ solid bearing or slurry type fluid applications
			b) Snubbers for pulsating fluid applications
			c) Siphons for steam and hot water services
			d) Retention ring and screws for surface mounting
			e) 1/2” NPT 5 Valve SS-316 barstock manifold
			f) ½” NPT cable gland
16.	Applications	:	During Detail Engineering on Owner’s

approval

3.03.00 LEVEL SWITCH

3.03.01 FLOAT OPERATED

1.	Float material	:	SS-316
2.	Wetted parts	:	SS-316
3.	Float chamber	:	Stainless steel/Carbon steel, construction welded
4.	Float chamber mounting	:	Side mounted
5.	Fluid connection	:	Side – Side
6.	Fluid connection size	:	1" ANSI RF Flange (rubber line, if required)
7.	Drain	:	½ inch NPT with Plug
8.	Pressure rating of chamber	:	Minimum 1.5 times of design pressure
9.	Repeatability	:	+/- 1.5 mm or better
10.	Switch housing	:	Stainless Steel
11.	Switch housing type	:	IP- 65
12.	Type of switch	:	Snap acting magnetically operated hermetically sealed
13.	Switch configuration	:	2 SPDT (5A, 240 V AC, 0.5A, 220V DC)
14.	Accessories	:	a) Counter flange, nuts & bolts, suitable gasket etc. b) Steel globe type drain valve c) ½"NPT cable gland

			d)	Stainless steel nameplate with alpha-numeric engraved for service and tag
	15. Application	:	During Detail Engineering on Owner's approval	

3.04.00 FLOW SWITCH

1.	Type	:	Paddle /Piston/Disk	
2.	Wetted part material	:	Stainless steel or Hastelloy for acidic application	
3.	End connection	:	a)	Threaded upto 1" line size with integral Tee
		:	b)	Flanged for line size > 1 ½"
4.	Enclosure material	:	Stainless Steel	
5.	Enclosure class	:	IP 65	
6.	Switch configuration	:	2 SPDT (5A, 240 V AC, 0.5A, 220V DC)	
7.	Repeatibility	:	2%	
8.	Cable connection	:	½"NPTF	
9.	Accessories	:	a)	Tee, Counter flange, nuts & bolts, suitable gasket etc
			b)	½"NPT cable gland
			c)	Stainless steel nameplate with alpha-numeric engraved for service and tag

3.05.00 RF LEVEL SWITCH

1.	Type	:	RADIO FREQUENCY
	Sensing probe		
2.	Material	:	SS-316
3.	Mounting	:	Threaded
4.	Application Temperature	:	250°C (Max.)
	Electronic Controller		
5.	Input Supply Voltage	:	240V AC ±10%, 50 Hz.
6.	Relay Output	:	2 SPDT (240V AC, 5A)
7.	Ambient Temperature	:	50 °C
8.	Enclosure Protection	:	IP-66
9.	Enclosure Housing	:	SS
10.	Local LED Indication	:	Normal Level Power On Alarm Level Probe Healthy
11.	Switching Repeatability	:	±0.5%
12.	Accessories	:	Co-axial cable for probe connection to controller SS Tag plate ½" NPT Cable Glands
13.	Application	:	Solid level

3.06.00 CONDUCTIVITY TYPE LEVEL SWITCH

1.	Type	:	Conductivity discrimination
2.	Probe MOC	:	SS-316
3.	Mounting	:	Flanged on external cage
4.	Application Temperature	:	250°C (Max.)
5.	Test Pressure	:	Two times rated pressure

6.	Input Supply Voltage	:	240V AC ±10%, 50 Hz.
7.	Input	:	Four independent channel with selectable switching threshold for water conductivity
8.	Relay Output	:	2 SPDT (240V AC, 5A)
9.	Ambient Temperature	:	50 °C
10.	Enclosure Protection	:	IP-65 (Explosion proof for NEC Class-1, Division-1 area)
11.	Enclosure Housing	:	SS
12.	Local LED Indication	:	HI,LO, HIGH-HIGH, LOW-LOW Power Fault
13.	Accessories	:	a) Interconnecting cable from probe to electronics b) Mounting accessories c) External cage d) Washer & Gasket e) ½" NPT Cable Glands f) SS Tag Plate
14.	Application	:	During Detail Engineering on Owner's approval

3.07.00 TEMPERATURE SWITCH

1.	Type	:	Bimetallic or gas filled
2.	Sensing Element Material	:	SS-316
3.	Bulb Material	:	SS-316
4.	Capillary	:	Stainless Steel armored

5.	Movement Material	:	Stainless Steel
6.	Case material	:	Stainless Steel with neoprene gasket and clear glass where applicable cover conforming to IP-65. (Explosion proof for NEC Class-1, Division 1 area).
7..	Scale	:	Black graduation on white linear scale. Graduation 0-100% with red pointer for set points
8.	Over range Protection	:	120 %
9.	Instrument connection	:	Bottom
10.	Switch configuration	:	Two SPDT (240V, 5A AC/220V, 0.5A DC)
11.	Switch type	:	Snap acting, shock and vibration-proof
12.	Adjustability	:	Internal Set point adjustable over span range
13.	Compensation	:	a) Capillary compensation with invar wire throughout the capillary length b) Case compensation
14.	Performance		
	a) Scale Accuracy	:	1.0 % of full scale
	b) Repeatability	:	< 0.5 % of full range
	c) Response time	:	Less than 40 seconds with thermowell
15.	Capillary length	:	5 meters (minimum) for local mounting/15 meters for local panel mounting
16.	Nameplate	:	Tag number, service engraved in stainless steel tag plate
17.	Accessories	:	Mounting accessories, ½" NPT cable gland
18.	Applications	:	During Detail Engineering on Owner's

approval

4.00.00 LOCAL INSTRUMENTS

4.01.00 PRESSURE GAUGE AND DIFFERENTIAL PRESSURE GAUGE

1.	Type	:	Bourdon/Bellows/Diaphragm
2.	Sensing & Socket	:	SS-316
3.	Movement Material	:	SS-316
4.	Case Material	:	Stainless steel. IP-65 (Explosion proof for NEC Class-1, Division 1 area)
5.	Dial Size	:	Generally 150 mm
6.	Scale	:	Black lettering on white in 270 O arc.
7.	Window	:	Shatterproof glass
8.	Range Selection	:	Normal process pressure: 50~70 % of range
9.	Over-range Protection	:	125% of maximum range by internal stop. External stop at zero
10.	Adjustment	:	For Zero adjustment (Micrometer screw external) For Range adjustment (Micrometer screw internal).
11.	Element Connection	:	Argon welding
12.	Process Connection	:	1/2" NPT (M) Bottom for local, back for panel mounting
13.	Performance	:	Accuracy of 1.0 % of span or better
14.	Operating ambient	:	0 - 50 ^{O}C
15.	Safety Feature	:	Blow out disc /diaphragm at the back
16.	Accessories	:	a) Snubbers for pulsating fluid application.discharge b) Stainless steel Diaphragm seals

			for corrosive/ viscous/ solid bearing or slurry type fluid applications
		c)	3-Way SS316 Gauge cock for pressure gauges
		d)	5-valve SS316 manifold from barstock for differential pressure gauge
		e)	Siphons for steam and hot water services
	17. Nameplate	:	Tag number, service engraved in stainless steel tag plate

4.02.00 LEVEL INDICATOR (FLOAT & BOARD TYPE)

1.	Type	:	Float and Board
2.	Float Material	:	SS-316
3.	Float Cable	:	SS-316
4.	Indicator Assembly	:	Epoxy painted Aluminium
5.	Guide wire spring assembly	:	SS-316 (2 Nos.)
6.	Guide Wire Anchor	:	SS-316
7.	Scale Board	:	Anodized Aluminium with engraved marking (Minimum graduation 10mm), mounting brackets and suitable hardware required as per tank height
8.	Elbow Assembly	:	Anodized Aluminium
9.	Flanges	:	RF , ANSI 150 , SS (3 Nos.)
10.	Accuracy	:	$\pm$ 10 mm or better
11.	Accessories	:	All mounting accessories including counter flange, nuts & bolts, suitable

gasket etc. as applicable, SS Tag plate

4.03.00 GAUGE GLASS

1.	Type	:	Reflex /Transparent
2.	Material		
	Glass	:	Toughened borosilicate resistant to thermal shock
	Body Material	:	~~Carbon Steel~~ Stainless Steel
	Enclosure	:	IP-65 (Explosion proof for NEC Class-1, Division 1 area)
3.	Integral cocks & valves/Fittings	:	i. SS 316
4.		:	ii. Rubber lined corrosion resistant stainless steel (for DM/RO service)
5.	Vessel Connection	:	ANSI Flanged SS316
6.	Accessories	:	i. Integral cocks ii. Drain Valves iii. Companion Flanges, Bolts, nuts, gaskets, SS Tag plate iv. Illuminating lamps, Mica shield as required v. Calibrated scale
7.	Pressure rating	:	Twice the maximum working pressure
8.	Temperature	:	300 ^{O} C
9.	Other details	:	For larger lengths (greater than 1200mm), additional gauge glasses shall be provided with minimum of 50 mm overlap.

4.04.00 SLIGHT GLASS

1.	Type	:	Flap-type.
2.	End connection	:	Screwed / Flanged
3.	Material		
	a) Body	:	SS- 304
	b) Cover plate	:	SS- 304
	c) Indicator	:	SS- 316
4.	Sight Glass	:	Toughened Borosilicate
5.	Gasket	:	Neoprene
6.	Bolts & Nuts	:	High tensile steel.
7.	Hydraulic Test Pressure	:	1.5 times maximum working pressure
8.	Accessories	:	Companion Flanges, Bolts, nuts, gaskets as required, SS Tag plate.

4.05.00 ROTAMETER

1.	Type	:	ON-LINE for line upto and including 50 mm NB. Borosilicate BY-PASS for line size above 50 NB
2.	Metering tube	:	Toughened Borosilicate
3.	Float	:	SS-316
4.	End fittings	:	SS-316
5.	Packing material	:	Teflon / PTFE
6.	Casing	:	Stainless Steel
7.	Gland Rings /Followers/ Other wetted parts	:	Stainless Steel
8.	Orifice Plate	:	Stainless Steel (for bypass type)
9.	Operating Temperature	:	0-50 Deg. c

10.	Test Pressure	:	200% of maximum operating pressure
11.	Scale	:	250 mm nominal length
12.	Graduation	:	Direct reading
13.	Process Connection	:	Flanged (RF) to line size as per ANSI standards (150#)
14.	Tapping	:	D & D/2
15.	Accuracy	:	+/- 2% of full scale reading
16.	Reproducibility	:	Within 0.5% of instantaneous reading
17.	Accessories	:	SS Tag Plate, orifice plate

5.00.00 TEMPERATURE ELEMENTS & ACCESSORIES

5.01.00 RESISTANCE TEMPERATURE DETECTOR

1.	Type	:	Platinum (Duplex), Ungrounded
2.	Platinum (Duplex), Ungrounded	:	100 ohm at 0 ^{O}C
3.	Base	:	Wound on ceramic (anti-inductive)
4.	Wiring	:	3 Wire
5.	Protecting Tube		
	a) O.D.	:	6 mm
	b) Material	:	SS-316, Seamless
	c) Filling	:	Magnesium oxide (Purity above 99.4%).
6.	Response time	:	a) 15 sec. (bare).
			b) 30 sec. (with thermowell)
7.	Calibration	:	DIN 43760
8.	Accuracy	:	0.5%
9.	Head		
	a) Type	:	IP-65 universal screwed type

	b)	Material	:	Stainless Steel
	c)	Terminal blocks	:	Nickel plated Brass-screw type / silver plated
	d)	Cable connection	:	½" NPT gland and grommet
	e)	Others	:	Terminal head cover with SS chain and suitable gasket.
				Head of TE to be provided with sufficient space and arrangement to mount head mounted temperature transmitter (as applicable).
10.	Accessories		:	a) Adjustable nipple-union-nipple [1/2" Sch 80 X ½" NPT] with thermowell connection
				b) Compression fittings/unions
				c) Flanges etc. (for flanged connections only)
				d) Thermowell (As specified below)
11.	Thermowell connection		:	½" NPT (M) or 150 RF Flanged
12.	Nameplate		:	Tag number, service engraved in stainless steel tag plate

Note: The specifications for RTDs of winding/ bearing of motor/pump, can be as per their manufacturer standards. The manufacturer shall submit the adequate supporting documents for establishing their standard practice. However, the type of RTD shall be Pt-100.

5.02.00 THERMOCOUPLES

1.	Type	:	a) 16 SWG wire of Chromel Alumel) (Type-K) b) Duplex c) Ungrounded
2.	Protecting Tube		
	a) O.D.	:	6 mm
	b) Material	:	SS-316, Seamless
	c) Filling	:	Magnesium oxide (Purity above 99.4%).
3.	Response time	:	a) < 20 seconds for measurement b) < 10 seconds for control
4.	Accuracy	:	r 1.1^0 C up to 300 ^{0} C & 0.4% of measured temperature range above 300 ^{0}C
5.	Head		
	a) Type	:	IP-65 universal screwed type
	b) Material	:	Stainless Steel
	c) Terminal blocks	:	Nickel plated Brass-screw type / silver plated
	d) Cable connection	:	½" NPT gland and grommet
6.	e) Others	:	Terminal head cover with SS chain and suitable gasket.

			Head of TE to be provided with sufficient space and arrangement to mount head mounted temperature transmitter (as applicable).
7.	Accessories	:	a) Adjustable nipple-union-nipple [1/2" Sch 80 X ½" NPT] with thermowell connection b) Compression fittings/unions c) Flanges etc. (for flanged connections only) d) Thermowell (As specified below)
8.	Thermowell connection	:	½" NPT (M) or 150 RF Flanged
9.	Nameplate	:	Tag number, service engraved in stainless steel tag plate

5.03.00 TEMPERATURE GAUGE

1.	Type	:	Expansion type (Liquid filled system)
2.	Sensing Element Material	:	Bourdon – SS-316
3.	Bulb and Capillary Material	:	SS-316
4.	Capillary Tubing	:	Inner sheath - solid drawn Material copper tube Outer sheath - PVC tube
5.	Movement Materials	:	Stainless Steel / Direct Bourdon tip connection to pointer spindle
6.	Case Material	:	Stainless Steel stove enameled, black finish, threaded bezel ring, clear glass

			cover conforming to IP 65.
7.	Dial size	:	150 mm
8.	Scale	:	Black lettering on white background in 270 Deg.C arc
9.	Over range protection	:	125 percent of FSD
10.	Capillary Glanding	:	1/2" NPT(M) x compression fitting (SS) to suit capillary
11.	Instrument Connection	:	Bottom connection for local mounting, back connection for panel mounting
12.	Process Connection	:	½" NPT (M) or 150 RF Flanged
13.	Extension Neck Length	:	50 mm
14.	Compensation	:	a) Capillary compensation
15.		:	b) Case compensation
16.	Performance	:	a) Accuracy : + /- 1.0 percent of full scale Deflection
		:	b) Repeatability : Less than 0.5 percent of full range
		:	c) Response time: 15 seconds (max.).
17.	Capillary length	:	3.0 meters (local) / 15.0 metres (local panel)
18.	Other features	:	Shatter proof glass
19.	Nameplate	:	Tag number, service engraved in stainless steel tag plate
20.	Accessories	:	SS316 Thermowell

5.04.00 THERMOWELL

1.	Material	:	SS-316
2.	Manufacture	:	Drilled from bar stock, Hex Head, Tapered design (As per ASME PTC 19.3)

3.	Process connection	:	M33x2
4.	Certification	:	Not applicable
5.	Bore concentricity	:	+5% of wall thickness
6.	Identification mark	:	Tag number punched on head
7.	Surface treatment	:	Polish after machining
8.	Element connection	:	½" NPT (M) or 150 RF Flanged
9.	Head	:	Hex
10.	Length of the hex head	:	31.75 mm (min.)
11.	Accessories	:	SS Plug and chain for test thermo wells SS Nameplate, Flange with companion flange & all required accessories for flanged connections.

Note: Wake frequency calculations shall be furnished for all thermowells for approval.

Thermowells shall be designed such that the resonant frequency is above the exciting frequencies generated by vortex shedding in the process fluid.

5.05.00 METAL TEMPERATURE THERMOCOUPLE

1.	Measuring medium	:	Metal temperature
2.	Type	:	Chromel Alumel (Type-K) Duplex, Ungrounded
3.	Insulation	:	Mineral Insulation Magnesium Oxide
4.	Wire gauge	:	16 AWG
5.	Protective sheath	:	SS
6.	Protective sheath diameter	:	8 mm O.D.
7.	Characteristics	:	Special limits of error as in ANSI thermocouple MC 96.01
8.	Accessories	:	½" BSP SS sliding end connector, weld pad, clamps of heat resistant steel

9.	Cold end sealing	:	SS pot weal with colour coded PTFE headed sleeve insulated flexible tails. Sealing compound Epoxy resin
10.	Minimum bending radius	:	30 mm
11.	Length of T/C	:	30 Mtr. (minimum)

Notes:

The specification for thermocouples of bearings metal temp measurements can be as per their manufacturer standards. The manufacturer shall submit the adequate supporting documents for establishing their standard practice. However, type of thermocouples shall be K-type.

6.00.00 FLOW ELEMENTS

6.01.00 ORIFICE PLATE

6.01.01 The orifice plate shall be either concentric square edge type or segmental bored type as per type of process .

6.01.02 Manufacturing, installation and use will be in accordance to the standard BS1042.

6.01.03 Orifice plates will be made of type 316 stainless steel.

6.01.04 The plate thickness of the orifice shall be 3 mm minimum. However the orifice thickness shall be determined by the actual process parameter.

ORIFICE FLANGE

6.01.05 Orifice flange rating will be the same as the piping class.

6.01.06 Flange shall be Standard / Slip on / socket weld/ weld neck raised face as per ANSI B 16.5

6.01.07 Gasket shall be CAF type depend on application.

CARRIER RING

6.01.08 Male female carrier ring of SS316 material shall be provided.

6.01.09 Beyond line size 500 mm, disc type orifice plate will be used.

PRESSURE TAP

6.01.10 Corner taps with Annular Grooves on Carrier Rings as per BS 1042

6.01.11 Numbers of tappings as per approved P&IDs of size ½" NPT shall be provided. However, one pair spare tapping shall also be provided with each orifice.

VENT HOLE/ DRAIN HOLE

6.01.12 Suitable Vent hole for water service shall be provided.

BETA RATIO

6.01.13 The ratio of throat diameter to inlet diameter (beta ratio) of the Orifice will be limited between 0.30 and 0.70.

ACCURACY

6.01.13 Accuracy (uncertainties on discharge coefficient 'c') of flow measurement shall be +/-1% for orifice plates according to BS 1042 except for critical measurement (performance calculation).

ISOLATION VALVES

6.01.14 Each tapping point shall be equipped with one primary isolating valve for low pressure and two primary isolating valves for high pressure installations (greater than 40 bar and/or 450 deg c).

6.01.15 Material of isolating valve shall be SS316

6.01.16 ½ inch NPT (M) SS316 Nipples shall be used to interface valve with orifice.

NUTS/BOLTS/ GASKETS

6.01.17 Jack bolt shall be provided for easier removal.

6.01.18 Studs and nuts material shall be ASTM A193 Gr. B7 / A194 Gr. 2H

TAGGING

6.01.19 Orifice plate will be provided with a Handle. Tag number, orifice plate material, measured bore and id of the pipe will be stamped or deep engraved on the upstream face of the Handle.

6.02.00 FLOW NOZZLE

6.02.01 The Flow Nozzle shall be ASME long radius type.

6.02.02 Manufacturing, installation and use will be in accordance to the standard ASME PTC CODE 19.5.

6.02.03 Nozzle shall be made of Forged 316 stainless steel.

6.02.04 Nozzle shall be machined on latest CNC machines to ensure accuracy.

END CONNECTION

6.02.05 End connection shall be Butt Welded.

BRANCH PIPE

6.02.06 Branch pipe material shall be of same process pipe material.

6.02.07 Length of the branch pipe shall be minm. 4D upstream and 2D downstream.

6.02.08 Branch pipe assemblies shall be properly machined to acquire required smoothness

TAPPINGS

6.02.09 D & D/2 tapping on pipe shall be provided.

6.02.10 Tapping size shall be of 15 NB and number of tappings shall be as per approved PID. However, one pair of spare tapping for each element shall also be provided for each nozzle.

BETA RATIO

6.02.11 Beta ratio shall be limited between 0.30 and 0.70.

ACCURACY

6.02.12 Accuracy (uncertainties on discharge coefficient) of measuring flow measurement shall be equal or better +/-2 % except for critical measurement (Performance calculation)

ISOLATION VALVES

6.02.13 Each tapping point shall be equipped with one primary isolating valve for low pressure and two primary isolating valves for high pressure installations (greater than 40 bar and/or 450 deg c).

6.02.14 Material and size of SW isolating valve shall be SS316 and 15 NB respectively.

6.02.15 Suitable Nipples and adaptors shall be used to interface valve with Flow Nozzle .

TAGGING

6.02.16 Nozzle tag no. , material, id , Flow direction will be stamped

TEST & EXAMINATION

6.02.17 All orifices and Flow Nozzles shall be tested in accordance with the quality assurance programme, which shall meet the requirements of applicable codes.

6.02.18 Instruments offered shall be of type tested and proven type. Type test certificates for test conducted earlier on similar product shall be furnished. Routine tests, Acceptance tests and all special tests (if any) shall be carried out for all the instruments as per quality plan and applicable standards.

6.02.19 Calibration shall be done in reputed laboratory like IIT.

6.02.20 IBR certification shall be provided wherever the process pipes come under IBR regulation.

6.02.21 The type, routine & acceptance tests shall be witnessed by Inspection agency as per requirements given by the quality plan. Contractors shall give at least 15 days advance notice for witnessing the test. Copies of the certified reports of all tests carried out at the works should be furnished. The equipments shall be dispatched from works, only after receipt of purchasers' written approval of the test reports.

Certified reports of all the tests carried out at the works shall be furnished for approval of Owner. Test reports shall be completed with all details and also contain specified limiting values, wherever applicable, to facilitate review. The instruments shall be dispatched from works only after receiving the owner's approval of the test reports. The bidders shall have to carry out all the tests within his quoted price and no extra payment can be claimed by bidders.

6.03.00 AEROFOIL

VOLUME : VI
SECTION-VII
SUB SECTION - C
INSTRUMENTATION AND CONTROL CABLES

1.00.00 **GENERAL TECHNICAL REQUIREMENTS**

1.01.00 Cables shall be flame retardant low smoke (FRLS) type. In hazardous areas cables of suitable R/L ratio shall be provided for intrinsic safety. Repaired cables are not acceptable.

1.02.00 FRLS marking shall be provided on the surface of the cable at intervals not exceeding 5 mtrs. Durable marking at intervals not exceeding 625mm shall include Manufacturer's name, Year of manufacture, Voltage grade, Type of cables (Conductor size & no. of pairs / type of compensating /extension cable), Insulation material, FRLS etc.

1.03.00 Progressive sequential length marking shall also be provided at every meter interval on outer sheath of cable.

1.04.00 Non returnable standard seasoned wooden drum containing minimum 500 /1000 M ± 5% length. Drum shall be anti rodent, anti termite and smooth finish. Both end of cable shall be capped by means of non hygroscopic sealing material.

1.05.00 Thermocouple Extension & Compensating Cable

01.	Conductor	:	Solid conductor
02.	Conductor size	:	16 AWG (1.31 Sq. mm)
03.	Type	:	KX (Compensating) (Chromel Alumel) RX (Compensating) (Copper-Copper alloy) JX (Compensating) (Iron Constantan)
04.	Conductor Insulation	:	HR PVC Type-C (IS-5831,1984) 0.6 mm thick
05.	Operating Voltage	:	650V
06.	Twisting	:	Pair twisted with lay of 60 mm (max)
07.	Twisting Direction	:	All pairs in the same direction. Lapped to form bunch with mylar tape.
08.	Screen (Pair & Overall)	:	Aluminium mylar tape with a thickness of 28 µm (min.) for individual pair screen and 60 µm (min.) for overall screen with 100% coverage and 25% overlapped edges. Over the individual pair screening tape two laps of 0.05 mm thick (min.) polyester tape shall be applied with minimum overlap of 25%. Metallic side of the screen shall be in contact with drain wire.
09.	Drain wire	:	Annealed tinned copper wire, stranded. Size 0.5 Sq. mm. (No. of strands / size:- 7 / 0.3mm) (For both individual and overall screen)
10.	Inner Sheath	:	Extruded FRLS PVC (anti rodent, anti termite & moisture resistant properties)

			HR PVC Type ST2 of IS-5831,1984
			Thickness as per IS-1554Part-I 1976
11.	Rip Cord	:	Non metallic under sheath
12.	Armouring	:	GI wire / strip as per IS 3975
13.	Outer Sheath	:	Extruded FRLS PVC (anti rodent, anti termite & moisture resistant properties)
			HR PVC Type ST2 of IS-5831,1984
			Thickness 1.8 mm (Min)
14.	Filler	:	Non hygroscopic with FRLS property
15.	Temperature Range	:	Up to 85 ¢C
16.	Insulation at 20^0 C	:	100 MOhms/Km [Min]
17.	Capacitance at 800 Hz	:	200 nf/km
18.	Cross talk	:	60 dB
19.	Attenuation	:	1.2 dB/Km
20.	Codes & Standards	:	a) IEC 332-1
			b) ANSI MC 96.1
			c) IS-8784-1987
21.	Tests	:	a) Oxygen Index: Min.29 at room temp. (ASTM-D-2863)
			a) Acid Gas Gen.: Max.20% by weight as per IEC 754 Part-I
			b) Temp Index : Min 250 DEG C at 21Oxy. Ind. (ASTM-D-2863)
			c) Smoke Density Rating : Max.60% (ASTM-D-2843).
			d) Flammability Test : as per IEC 332 Part-I /IEEE-383
			Swedish Chimney Test - SS-424-1475 F3
			e) High voltage test
			Core to core- 2.0 KV for 1 min.
			Core to screen- 2.0 KV for 1 min.
			f) Insulation Resistance 100 M Ohm / Km Min
			g) Rodent & Termite repulsion test (Presence of lead shall be confirmed)

22. Conductor material & sheath color for thermocouple cable as per ANSI MC 96.1

CABLE TYPE	OVERALL SHEATH COLOR	WIRE	SHEATH COLOR	CONDUCTOR MATERIAL
KX	Yellow	Positive	Yellow	Nickel / Chromium
		Negative	Red	Nickel / Aluminum
JX	Black	Positive	White	Iron
		Negative	Red	Constantan
RX	Green	Positive	Black	Copper
		Negative	Red	Copper Nickel Alloy

23. Durable printed or embossed numbering at regular interval of 50mm shall be provided for identification of pairs. Each core printed with number or numbered binder tape shall be provided on each pair.

1.06.00 Instrumentation multi Paired Signal Cable

01.	Conductor type	:	Stranded (7) annealed tinned copper
02.	Conductor size	:	0.5
03.	Conductor resistance	:	39 Ω
04.	Conductor Insulation	:	HR PVC Type-C (IS-5831,1984) 0.6 mm thick
05.	Operating Voltage	:	650V
06.	Twisting	:	Twin twisted with lay of 60 mm
07.	Twisting Direction	:	All pairs in the same direction. Lapped to form bunch with mylar tape.
08.	Screen (Pair & Overall)	:	Aluminium mylar tape with a thickness of 28 Pm (min.) for individual pair screen and 60 Pm (min.) for overall screen with 100% coverage and 25% overlapped edges. Over the individual pair screening tape two laps of 0.05 mm thick (min.) polyester tape shall be applied with minimum overlap of 25%. Metallic side of the screen shall be in contact with drain wire. Analog signals- Individual pair & overall shield to be considered. Binary signals- overall shield to be considered.
09.	Drain wire	:	Annealed tinned copper wire, stranded. Size 0.5 Sq. mm. (No. of strands / size:- 7 / 0.3mm)

10.	Inner Sheath	:	Extruded FRLS PVC (anti rodent, anti termite & moisture resistant properties) HR PVC Type ST2 of IS-5831,1984 Thickness as per IS-1554, Part-I 1976
11.	Rip Cord	:	Non metallic under sheath
12.	Armouring	:	GI wire / strip as per IS 3975
13.	Outer Sheath	:	Extruded FRLS PVC (anti rodent, anti termite & moisture resistant properties) HR PVC Type ST2 of IS-5831,1984 Thickness 1.8mm (Min)
14.	Filler	:	Non hygroscopic with FRLS property.
15.	Temperature Range	:	85 ^{O}C
16.	Insulation at 20 Deg.C	:	100 MOhms/Km [Min]
17.	Capacitance at 800 Hz	:	120 nf/km
18.	Cross talk	:	60 dB
19.	Attenuation	:	1.2 dB/Km
20.	Codes & Standards	:	a) IPCEA-S-61-402 b) BS 5308 c) IEC 332-1 d) ASTM-B-33 e) IS-8130-1984 f) IS 1554 Part-1 g) IS 10810
21.	Sheath colour	:	Inner- Black and Outer- Gray
22.	Tests	:	a) Oxygen Index: Min.29 at room temp. (ASTM-D-2863) b) Acid Gas Gen.: Max.20% by weight as per IEC 754 Part-I c) Temp Index : Min 250 ^{O} C at 21Oxy. Ind. (ASTM-D-2863) d) Smoke Density Rating : Max.60% (ASTM-D-2843). e) Flammability Test : as per IEC 332 Part-I f) Swedish Chimney Test-SS-424-1475 F3 g) Insulation Resistance 100 M Ohm / Km Min h) High voltage test

Core to core- 2.0 KV for 1 min.

Core to screen- 2.0 KV for 1 min.

i) Rodent & Termite repulsion test
(Presence of lead shall be confirmed)

23. Colour of core for Instrumentation Cable (As per IS-9938)

PAIR	CORE	COLOR
1st	1st	Blue
1st	2nd	Red
2nd	1st	Gray
2nd	2nd	Yellow
3rd	1st	Green
3rd	2nd	Brown
4th	1st	White
4th	2nd	Black

Above 4 Pairs, 4 Pairs making a unit shall have indelible printed colour coded bands like Pink for 1st unit, Orange for 2nd unit and Violet for 3rd unit and so on. In addition band marking, for example single band for 1st. unit, double band for 2nd. unit and so on, shall be provided on each conductor for identification of unit. Band marking on individual core shall be provided at regular intervals not exceeding 50 mm.

1.07.00 Cables near high temperature zone shall be capable of withstanding high temperature and terminated in junction box / panel in normal temperature zone. Teflon insulated and sheathed thermocouple extension cables and copper conductor cables shall be used in high temperature zone. Conductor and sheath shall be extruded FEP (Teflon) as per VDE 0207 Part 6 and ASTMD 2116. These cables shall be pair, multipair, and twisted & shielded.

1.08.00 Control & power Cable

Bidder shall refer to Volume IIF of the electrical specification for detail.

1.09.00 Optical Fiber Cable

Bidder shall supply and install optical fiber cable and all cable accessories and fittings like Light Interface Unit, Surge suppressors, Opto isolators, Interface converters, Fiber Optic Card Cage, Fiber Optic Line Driver, Repeater/ Modem, cable glands, grommets, lugs, termination kits etc on as required basis.

Optical Fiber Cable shall be 4/8/12 core. Each core shall be of ultra pure fused silica glass with UV cure acrylate suitable to withstand temperature between 20 and 80ºC. The cable shall have multiple mono mode fiber. On as required basis so as to avoid usage of any repeaters. . Fiber optic cable shall be of loose buffer tube design with 4 fibers per buffer tube (minimum). Interstices and buffer tubes shall be filled with water blocking compound such as thixotropic gelly to protect against moisture and vibration.Buffer tube shall

be made of materials like Poly-Butelene Terathylate (PBT). They shall be colored for easy identification.. Buffer tubes shall be stranded around Central Strength Member utilizing Reverse Oscillating Lay (ROL). Blank fillers shall be used as necessary to maintain circular cable structure.

The central strength member shall be Fiber Reinforced Plastic (FRP) or other material with equivalent mechanical strength to provide both tensile and anti-buckling strength to cable.

The interstices between buffer tube and jacket layers shall be protected from water intrusion by a combination of dry water blocking yarns and tapes. These dry materials shall be easily removable from core during cable preparation without use of cleaning solvent.

In addition to central strength member, additional strengthening substance like aramid yarns shall be applied helically over the cable core to provide additional tensile strength to cable.

The cable shall be of dual jacket and armoured. Inner sheath consists of medium density poly ethelyne extruded over cable core. Two highly visible ripcords are placed under the jacket to aid in sheath removal. Electrolytically chrome plated corrugated steel taped (ECCST) armouring is provided around inner jacket to provide additional cable compression strength and rodent protection. The armour is covered with outer black MDPE sheath with FRLS and UV resistance properties. A ripcord is also placed under neath the armour for easy outer sheathing removal. The cable shall be suitable for a maximum tensile force of 2000N during installation and once installed, a tensile force of 1000N minimum. The compressive strength of cable shall be 3000N minimum and crush resistance 4000N minimum. Minimum bending radius shall be equal to or more than 15D.

Specification for G.652 Monomode Fiber:

Sl. No.	Attribute	Value
1	Core Diameter	9±1 micrometer
2	Cladding Diameter	125±1 micrometer
3	Cladding non circularity	≤1.0%
4	Attenuation coefficient at (i) 1290 nm to 1340 nm (ii) 1525 nm to 1575 nm	 <0.36 Db/km <0.25 Db/km
5	Chromatic dispersion coefficient at (i) 1310 nm (ii) 1550 nm	 <3.5 ps/ nm.km <18 ps/ nm.km
6	Polarization Mode Dispersion (PMD)	≤0.5 ps/√km

	coefficient	
7	Mode field diameter at (i) 1310 nm (ii) 1550 nm	9.2±0.4 micrometer 10.50±1.0 micrometer
8	Mode field concentrality error	≤0.5 micrometer
9	Proof test	≥1%
10	Fiber Curl	≥ 4.0 m
11	Macro bend test on fiber at 1550 nm	≤0.1 dB

The entire length of the cable shall be marked with the manufacturer name, month and year of manufacture, coded description of the cable based on Telcordia's(Bellcore) SR-2014 Suggested Optical Cable Code (SOCC),progressive sequential length marking at every meter interval on outer sheath.

Following tests as per anty approved standards such as FOTP, IEC etc shall be carried out on the cables:

a. Attenuation and dispersion characteristics test
b. Proof test
c. Macro-Bend Resistance Test
d. Mechanical Tests
e. Low and High Temperature Cable Bend Test
f. Impact Resistance Test
g. Compressive Strength Test
h. Tensile Strength Test
i. Cable Twist Test
j. Cable Cyclic Flexing Test
k. Environmental Characteristics Test
l. Temperature Cycling Test
m. Color Performance Test
n. Cable Aging Test
o. Water Penetration Test
p. Lightning Test
q. Routine Test/ Sample Test
r. Site Test (Continuity and Attenuation)

s. FRLS Test

1.10.00 Coaxial Cable

1	Standard	: MIL-17G, IS-5026
2	Inner conductor	: Tinned copper (Cu Sn)
3	Size	: 0.94 mm dia (19 stranded)
4	Dielectric insulation	: Cellular foam polyethelyne
5	Overall diameter	: 2.95 mm
6	Shielding	: Aluminium mylar tape
7	Outer conductor	: Cu Sn- Braid, 96% lapping (Overall dia 3.60 mm)
8	Armoring	: Galvanized mild steel
9	Outer sheath	: FRLS PVC
10	Temperature range	: 85°C
11	Attenuation	: Up to max 39.5 Db/100 m

VOLUME : VI

SECTION-VII

SUB SECTION - D

PANELS , DESKS , RACKS AND JUNCTION BOXES

1.00.00 **GENERAL REQUIREMENT**

1.01.00 ENCLOSURES FOR INSTRUMENTS AND OTHER EQUIPMENT

1.01.01 All panels, cabinets, distribution boxes, junction boxes, terminal boxes and all other field mounted equipment / enclosures shall have suitable environmental protection as detailed in Section-I of this volume of the specification.

1.02.00 SURFACE PREPARATION & PAINTING

1.02.01 All sheet metal panel/ desk exterior steel surfaces shall be sand blasted, ground smooth and painted as specified below.

1.02.02 Suitable filler shall be applied to all pits, blemishes and voids in the surface. The filler shall be sanded so that surfaces are level and flat; corners are smooth and even. Exposed raw metal edges shall be ground burr-free. The entire surface shall be blast clean to remove rust and scale and all other residue due to the fabrication operation. Oil, grease and salts etc. shall be removed from the panels by one or more solvent cleaning methods prior to blasting.

1.02.03 Two spray coats of inhibitive epoxy primer surfacer shall be applied to all exterior and interior surfaces, each coat of primer surfacer shall be of dry film thickness of 1.5 mil. A minimum of two spray coats of final finish color (Catalyzed epoxy or polyurethane) shall be applied to all surface of dry film thickness 2.0 Mil. The finish colors for exterior and interior surfaces shall conform to the following shades:

- Exterior – Opaline green shade 275 of IS: 5 or equivalent international code..
- Interior - Brilliant White.

1.02.04 Paint films, which show sags, cheeks, blisters, teardrops, fat edges or other painting imperfections, shall not be acceptable.

1.03.00 WIRING

1.03.01 All spare contacts of relays, switches and push buttons shall be wired up to the terminal blocks. All intercommunications between sections of panels/desks shall be furnished.

1.03.02 Each wire shall be identified at both ends with wire designation as per approved wiring diagram. Heat shrinkable type ferrules with indelible computerized ink print shall be used with cross- identification.

1.03.03 All wire termination shall be made with insulated sleeve and crimping type lugs. Wire shall not be spliced or tapped between terminals. Open-ended terminal lugs will not be accepted. Wires shall not be looped around the terminal screws or studs.

1.03.04 Internal wiring should be terminated uniformly on one side of the terminal block leaving the other side available for termination of outgoing cables. Internal wiring shall be grouped so that all outgoing wiring to each particular remote location is terminated on adjacent terminal blocks. Interior wiring and jumperings shall be arranged so that external connections can be made from internal side of terminal blocks. Common connections shall be limited to two (2) wires per terminal.

1.03.05 Wiring shall be arranged to ensure free access to all instrument or devices for maintenance. No wire shall be routed across the face or rear of any device in a manner, which will impede the opening of covers or obstruct access to leads, terminals or devices

1.03.06 Wires shall be dressed and run in trays or troughs with clamp-on type covers. Wirings may be neatly bunched in groups by non-metallic cleats or bands. Each group shall be adequately supported along its run to prevent sagging or strain on termination.

1.03.07 Shield wires shall be terminated on separate terminal blocks. Common connections shall be limited to two wires per terminal. Signal circuit shields shall be grounded at the power supply end only or as recommended by manufacturer.

1.03.08 All low level signal cables shall be separately bundled to from control cable and maintained at 300 mm minimum spacing from control bundles.

1.03.09 Panel internal wiring shall follow distinct color-coding to segregate different voltage levels viz. 24V DC, 48V, 110V AC, 240V AC, 220V DC etc.

1.03.10 Thermocouple lead wires, analyzer measuring lead wires, or any other lead wires carrying measuring signal of the order of low milli volt or micro volt shall be electrically and physically isolated from other AC and DC wiring. Shielded wires used in such cases for panel internal wiring shall be continuous and ungrounded with the shield terminated individually and separately in panel terminal block.

1.03.11 Wiring to door mounted devices shall be provided with multi-strand wires of (49 strands minimum) adequate loop lengths of hinge-wire so that multiple door openings will not cause fatigue failure of the conductor.

1.03.12 Internal wiring in factory pre-wired electronic systems cabinets may be installed according to the Contractor's standard wire size, insulation, and method of termination on internal equipment. Insulation for all wiring, including circuit board wiring, back panel wiring, power supply wiring and interconnecting cables between devices shall pass the vertical flame test per IPCEAS-1981. Identification of conductors may be done by insulation color-coding identified on drawings or by printed wiring lists.

1.04.00 TERMINAL BLOCKS

1.04.01 All terminal blocks shall be rail mounted/ post mounted type, cage clamp type with high quality non-flammable insulating material of melamine suitable for working temperature of 105 Deg C. The terminal blocks in field mounted junction boxes, instrument enclosures racks etc. shall be suitable for cage clamp connections. The terminal blocks in Control Equipment Room termination/ marshalling cubicles shall be suitable for post mounted cage clamp connection at the field input end. The exact type of terminal blocks to be provided by Bidder shall be subject to Owner.

1.04.02 All terminal blocks shall be provided complete with all required accessories including assembly rail, locking pin and section, end brackets, small partitions, transparent covers, support brackets, distance sleeves, warning level, marking etc. For RTDs ring - tong type lugs shall be used at Junction Boxes.

1.04.03 The characteristics of the terminal blocks shall be as follows.

i) High contact force, independent of conductor cross-section and large contact surface area.

ii) Integrated self-loosening protection to avoid shifting of contact surface that may allow contamination of connection point.

iii) Inspection and maintenance free (resistant to thermal aging and vibration)

iv) Low and constant voltage drop

1.04.04 The insulation of the terminal blocks shall be of suitable thermoplastic material.

1.04.05 The spacing between Terminal blocks channels in panels and cubicles shall be adequate for routing the cable troughs and to allow adequate free workspace for termination and removal of wires. The terminal blocks shall be arranged with atleast 100 mm clearance between two sets of terminal blocks and junction box walls.

1.04.06 Signals of different voltage levels shall be clearly segregated by providing separate rows to each type of signal and by using terminal blocks of different color for each type of signal and by providing barrier strips between them.

1.04.07 Terminal blocks shall be provided with white marking strips / self-adhesive marker cards and where permitted by the safety codes and standards, shall be without covers. Power terminals and high voltage (above 48 volts) terminals shall have protection covers. All terminals shall be provided with permanent terminal identification numbers on both sides.

1.04.08 At least 20% spare unused terminals shall be provided on each terminal block for circuit modifications and for termination of all conductors in a multi-conductor control cable.

1.04.09 The bottom of the terminal block shall be at least 200 mm above the cable gland for bottom entry type panels.

1.04.10 For extending 24 V DC supply to panels, the size of the terminals shall be decided based on voltage drop and not based on current.

1.04.11 Other requirements of the terminal blocks are as follows:

i) The last terminal in a rail-mounted assembly shall be closed with an end plate and end bracket.

ii) For visual and electrical separation of terminal groups, partition plates shall be provided, which can be push fitted after forming an assembly.

iii) Design shall permit testing of incoming and outgoing signals by using suitable test plug and socket without disconnecting the cable connections.

iv) It shall be possible to use jumper plugs through the above test plug socket to connect adjacent terminals. Adequate number of short circuit jumper plugs shall be provided for the purpose.

v) Where more than one connection to a terminal block is required, two tier terminals shall be used.

1.05.00 GROUNDING

1.05.01 Separate Protective and Electronic system ground as required shall be provided.

1.05.02 All panels, desks, cabinets shall be provided with a continuous bare copper ground bus (Frame ground), bolted to the panel structure at bottom on both sides and effectively ground the entire structure. The bolts shall face inside of panels.

1.05.03 For electronic system cabinets the electronic system ground bus (Electronic ground) shall be similar but insulated from the cabinet and shall be separately connected to the system ground .The same ground may be used to earth the shield of shielded signal cables, otherwise a separate ground bus shall be provided for connecting the signal cable shields. Cable shields shall be grounded at the panel end only and shall never be left open .The electronic ground between panels of a shipping section shall be firmly looped.

2.00.00 **CONTROL DESKS & PANELS**

2.01.00 GENERAL

2.01.01 All control desk, panels etc. shall be furnished fully wired with necessary provision for convenience outlets, internal lighting, utility receptacles, grounding, ventilation, space heating, anti-vibration pads, internal piping &

accessories as required for completeness of the system.

2.01.02 The design shall conform to the EN ISO 11064 (Ergonomical design of Control Room), Part 1, 2 and 3.

2.01.03 The exact dimensions, material, construction details, grounding, general arrangement etc. shall be as per actual requirement and shall be finalized during detail engineering and subjected to Owner's approval.

2.01.04 Incoming power supply feeders shall be duplicated. Alarm shall be provided for failure of a power supply feed.

2.01.05 For Control desk/ panel mounted instruments/ devices etc. which are to be powered from UPS, all required conversion of interface equipments/ accessories to make such devices compatible with UPS supply shall be provided. All necessary hardware like input switches/ fuse unit for each feeder as well as switch fuse unit for each instrument/ device on the power supply line shall be provided. From UPS redundant feeders shall be provided wih suitably rated MCB and provision of fast auto changeover of UPS feeders.

2.01.06 Crating of the panels and desks shall be suitable for protection against shock, vibration, inappropriate handling and inclement weather conditions during transportation and warehousing. Mounted equipment shall have adequate protection against damage during handling, transit and storage. Suitable desiccant shall be used inside the packing case.

2.01.07 Nameplate

a) Nameplate shall be provided for instrument or device mounted on the panel.

b) Nameplates for panels shall be provided both in front and rear.

2.02.00 CONTROL DESK

2.02.01 Control desk shall be free standing, floor mounting, table top type with doors at back and shall be constructed of 3 mm thick (minimum) CRCA steel or Aluminium extrusion. Aluminium structure shall be anodized or powder coated paint finish. The top surface of control desk shall be 30 mm (minimum) thick with the top 12 mm (minimum) of acrylic solid surface and the remaining 18 mm of laminated medium density fibre (MDF) board.

2.02.02 Monitors with retractable keyboard shall be provided on the desk. Desk shall be arranged in arc-like shape without any sharp edges. Edges shall be extruded PVC or rounded post-formed laminate.

2.02.03 Desks shall be of modular, scalable and industrially ruggedized design and shall have connections for PA system handsets & telephone sets.

2.02.04 Desks shall have concealed cable trays for wire dressing. Both Horizontal & Side Managers (2 separate horizontal cable routing wire baskets for power & data cables) shall be provided.

Each User station will be provided with 2 separate power distribution units (1 for Main line & 1 for UPS line). Each power distribution unit will have 6 points of 5/13 Amp sockets, Mains MCB On/Off Switch & Indicator.

Adequate heat management provision for Exhaust of heat from within the Console Desk Assembly shall be provided. There will be multiple fans provided in the Main Control Desk. Each Fan will be of 230 VAC 250 CFM Ball Bearing based. Ventilation louvers will be provided on both Front & Rear Modesty with special Air Filters. Adequate space for CPU & Other equipments placed with in the desk.

2.02.05 Design shall include Earthing bolts.

2.02.06 Back installed items shall be suitably concealed from front view.

2.02.07 All operator workstations for SG, TG, Auxiliaries & Off-site Plants shall be mounted on this Control Desk. The cabling / wiring between OWS & CPUs, power supply cables etc. shall be aesthetically routed and concealed from view.

2.02.08 HARDWIRED DEVICES ON CONTROL DESK (DRAW OUT SECTION)

Release and Lamp Test push buttons shall be provided for a set of push buttons (decided during detail engineering stage). Depending on the type of control/ function, required number of push buttons/ indicating LEDs & their color, push button stations shall be selected. The size of push button stations shall be 24 x 48 mm or 25 x 50 mm and shall have service inscription details at the front. Emergency push buttons (with cover) shall be mounted on top of Control Desk.

2.03.00 BACK UP PANEL

2.03.01 Construction shall be from CRCA steel of thickness not less than 3mm.

2.03.02 Upright back-up panel shall be provided where hardwired devices shall be mounted on a mosaic grid type console. The mosaic grid tiles shall be of 24 mm x 48 mm (or 25 mm x 50 mm) size, made of heat & flame retardant, self extinguishing and non-hygroscopic material with flat matt finish without glare and non reflecting type.

2.03.03 DDCMIS Back-up Panel (referred as Unit Control Panel-UCP) shall also mount annunciation fascia (minimum 500 nos.) and the flame monitoring cameras along with other hardwired devices as decided during detail engineering stage by Owner. Color coding shall also subject to Owner's approval.

2.03.04 Colored Mimic for different Off-site plant control systems (as enumerated elsewhere in this specification) and hardwired annunciation system shall also

be mounted on the back up panels.

2.04.00 PANELS/CABINETS

2.04.01 All DDCMIS system modules, power supply components and other Local Control panels (PLC/Relay based) shall be housed in cabinets as specified below.

2.04.02 The cabinet mounted equipments shall be fully assembled, installed in mounting racks, wired and fully tested as per specification requirements and Owner approved drawings prior to shipment to the project site.

2.04.03 The Bidder shall ensure that the cabinets are complete & ready for installation before dispatch from manufacturing works. The installation work at project site for these cabinets shall only involve connections through multi-pair cables from marshalling cabinets (wherever provided) to system cabinets and inter-cabinet/cabinet to Control Desk/ Back up Panel.

2.04.04 All electronic cards, network components, power supply modules etc. located shall be suitably housed in cabinets and shall be neatly arranged in sub-racks. Network components shall be visible in door closed condition (e.g. Glass doors etc.) as approved by Owner.

2.04.05 Bidder shall design the cabinet internal arrangement, floor cutout and cable gland plate such that all the cables entering or leaving the cabinet can be properly glanded in the gland plate.

2.04.06 The packaging density of panels shall be such that the temperature rise within the panels shall never exceed 10°C above ambient even under worst operating conditions. Cooling Fans shall be provided wherever required and this shall be of industrial grade.

2.04.07 TECHNICAL PARTICULARS

1.	Material of Construction	:	Cold Rolled Coal Annealed (CRCA) steel sheet	
2.	Thickness of Sheet	:	a)	2.0 mm for faces supporting instruments / terminals
		:	b)	1.6 mm for other sides and top
3.	Construction	:	Welded throughout as per approved National Standards	
4.	Post welding operation	:	a)	Grounding of all welds to smoothness
		:	b)	Rounding of corners

		:	c)	Cleaning of weld spatters
5.	Panel height	:	2300 mm (approx)	
6.	Corners	:	7 mm inner radius	
7.	Dimensional Tolerances	:	a)	In height & length - 3 mm
			b)	In height between adjacent sections - 2 mm
			c)	Total for a group - 6 mm
8.	Doors	:	Double, recessed, turned back edges, full height front & rear	
	i) Thickness of Sheet	:	2 mm	
	ii) Hinges	:	Stainless steel	
	iii) Door latches	:	Three point type	
	iv) Door gaskets	:	Neoprene rubber on fixed frame to result dust proof/weatherproof enclosure	
	v) Opening of the doors	:	Outward	
	vi) Louvers	:	With removable wire mesh to ensure dust and vermin proof	
9.	Gland plates	:	Removable in sections 4 mm thick (bottom)	
10.	Cable entry	:	Bottom	
11.	Hardware	:	a)	Anti vibration pad- 15 mm
			b)	Predrilled base channel ISMC – 100 or equivalent for all sides
			c)	Stainless steel buff- finished 2 mm thick kick plate for all sides
			d)	Stainless steel scratch strips along desk edges fixed with pan-head recessed screws
			e)	Rubber strips to ensure air

tightness between kick plate and finished floor

f) Lifting hook / Eye bolt

g) Drawing pocket

h) Door switch, lamps, thermostat, heaters and industrial grade cooling fans,, illumination fixures

12.	Name Plate	:	Both at front and back surface of the panel
13.	Fixing of name plate	:	Stainless steel pan head screws
14.	Name plate material	:	Laminated phenolic (3 layers)
15.	Lettering	:	Black with white engraved
16.	Mounting of terminal blocks	:	Vertical angle support bracket tack welded on sheet steel plate, screwed on internal wall of enclosure

2.05.00 FURNITURE

All the furnitures in the Central / Local control Room (s), Engineers' rooms, Instrument laboratory , SWAS Room & any other rooms with C&I equipments located in different plant buildings under Bidder's scope shall be included in Bidder's scope of supply. Bidder shall provide following industrial grade furniture items as a minimum from reputed manufacturers/suppliers meeting International Standards. The furniture shall be modular and latest with ease of operational features. The furniture shall be modern, aesthetically designed, modular, flexible, space saving and future safe.

2.05.01 WORK STATION FURNITURE

Modular work station furniture, suitable for mounting servers & historians, programmer stations, PC based systems, printers (A4/A3 color laserjet) etc. shall be provided.

2.05.02 PC RACK

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

2.05.03 CHAIRS

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

2.05.04 TABLES

Industry standard computer tables shall be provided & shall be as approved by Owner during detailed Engineering. Glass top teak wood horse shoe shaped table with vertical file mounting arrangement (two layers to house approx. 40 Nos of files and lockable drawers at both ends) for Engineering Room shall be provided.

2.05.05 ALMIRAHS

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

2.05.06 KEYPAD

One keypad per unit shall be provided for the storing of keys of relevant areas of the unit in the control room.

2.05.07 LOCKERS

Suitable lockers shall be provided in the room adjacent to the control room for storing of personal articles of control room personnel. Also, lockers of bigger size shall be provided in documentation Room for storing of personal documents. Details shall be finalized and approved by Employer during detailed engineering.

3.00.00 LVS PANEL

3.01.00 An arc shaped Large Video Screen (LVS) panel shall be supplied for mounting large video screens in number of tiers in various Control rooms as specified elsewhere in this specification.

Biddr shall provide and fix ACP cladding around the LVS screen including covering the LVS back side and LVS stand. The cladding will be from floor finish to 600 mm above LVS screen like a self-standing partition with necessary openings for system requirement. ACP paneling shall be with 304 grade & approx. 0.5 mm mirror finish SS strip.

3.02.00 The profile, dimensions and the general arrangement shall be finalized & approved by Owner during detailed engineering. Recommendations, if any, for the control room lighting in order to ensure continuous proper viewing of the LVS screen by the operator & shift incharge (without any fatigue) shall be

clearly brought out by the Contractor in his offer, alongwith all relevant details/basis.

3.03.00 Any other requirement for proper LVS mounting & functioning & viewing shall also be specifically brought out by the Contractor in his offer, along with all relevant details.

4.00.00 **LOCAL INSTRUMENT RACK (LIR) & LOCAL INSTRUMENT ENCLOSURE (LIE)**

4.01.00 GENERAL

4.01.01 Devices (Transmitters/ Switches) located in the field shall be suitably grouped together to the extent possible and installed in the LIE (Closed Rack) and LIR (Open Rack) in Boiler/TG Building and Off-site plant areas.

4.01.02 Racks and enclosure shall be factory prefabricated & painted and shall complete with internal piping, tubing, manifold, isolation valves, blowdown valves, integral junction box, illumination etc.

4.01.03 No more than six instruments shall be grouped in a single rack / enclosure.

4.01.04 Racks shall be installed above the tapping points for air, flue gas and coal air mixture application whereas for applications such as for water and steam, racks to be installed below the source point.

4.01.05 Attention shall be paid in the layout to avoid air traps in liquid piping and water accumulation in air /gas piping.

4.01.06 Racks used for furnace, flue gas and air application shall be provided with intermittent & continuous air purging

4.01.07 Welding of impulse lines shall comply with the provisions of the latest applicable ANSI Code for Pressure Piping.

4.01.08 Earth stud shall be furnished at rack for safety grounding.

4.02.00 LOCAL INSTRUMENT ENCLOSURE (LIE)

4.02.01 Enclosure shall be free standing type. Racks shall be adequately reinforced to ensure true surfaces and to provide support. Major load - bearing posts shall be suitably supported by gusset plates or moment members.

4.02.02 Enclosure outer shall be constructed from at least 3 mm thick steel plate and epoxy painted to shade gray. Base frame shall be made of ISMC 100 and black colour finish.

4.02.03 2” NB galvanized pipes shall be laid horizontally and supported at two end channels to mount transmitters at accessible height. Center posts or any

member, which would reduce access, shall be avoided.

4.02.04 Double leaf interlocking front opening doors with three point locking shall be provided and shall be arranged for maximum possible access to the interior. Key shall be of identical for all enclosures.

4.02.05 Doors shall have concealed quick removal type pinned stainless steel hinges and locking handles. Gaskets shall be used between all mating sections to achieve dust and weather proof enclosure rated for IP-65 including the internal junction box. All enclosures shall have access doors on front side.

4.02.06 Removable type bulkhead plates of thickness not less than 6 mm shall be mounted at the racks with suitable high temperature gasket. Impulse lines within the enclosures shall be properly clamped.

4.02.07 All internal wirings between the instruments and junction box shall run through flexible conduits. No exposed wirings within transmitter racks both open and closed type, is admissible.

4.02.08 Racks shall have a common blowdown drain header, which will connect individual instrument blowdown line after suitable pressure breaking through regulating globe type blowdown valves. Covered funnels shall be used for saturated liquid and steam service, whereas, open funnels may be used for cold liquid services. Header (2" NB ASTM A 106, Sch-80 Gr. C) shall be suitably sloped and shall have one end flanged and extending beyond the rack for connection to plant drain header..

4.02.09 Each rack shall be provided with one receptacle, light fixtures with wire guard and one lighting switch each at instrument & Junction box compartments with wire guard. Lighting switches may be door actuated & mounted inside the panel. Outlet box, switch box and device covers shall be of galvanized stamped steel. Light switches and receptacles shall be installed inside the enclosure on the wall near the latch side of the enclosure door. Light fixtures shall be installed on the ceilings of the enclosures.

4.02.10 Power supplies for miscellaneous devices shall be provided with MCB located within the enclosures. MCB shall be mounted in fuse blocks. Nameplates shall be furnished above the MCB blocks, identifying the devices being served.

4.02.11 Vibration dampeners shall be installed for supporting each enclosure. The loading at each corner of the enclosure shall be determined by actual test weighting when construction is complete to determine the correct length of each dampener for proper loading of the dampener in accordance with manufacturer's recommendations

4.03.00 LOCAL INSTRUMENT RACK (LIR)

4.03.01 Rack shall be free standing type constructed from 6 mm thick steel channel frame provided with a canopy to protect the instrument from dripping water or

falling objects and shall be epoxy painted. Canopy shall be of CRCA steel sheet of at least 3 mm thickness.

4.03.02 Rack Major load-bearing posts shall be suitably supported by gusset plates or moment members. Suitable fenders grill shall be welded to the end-posts of the rack to outline a boundary beyond which no mounted equipment shall project to protect instrument from accidental contact during personnel movement. Center posts or any member, which would reduce access, shall be avoided.

4.03.03 2" NB galvanized pipes laid horizontally and supported at two end channels shall be employed at working accessible height for mounting of instruments.

4.03.04 All internal wirings between the instruments and junction box shall run through flexible conduits. No exposed wirings are admissible.

4.03.05 Racks shall have a common blowdown drain header, which will connect individual instrument blowdown line after suitable pressure breaking through regulating globe type blowdown valves. Covered funnels shall be used for saturated liquid and steam service, whereas, open funnels may be used for cold liquid services. Header (2" NB ASTM A 106, Sch-80 Gr. C) shall be suitably sloped and shall have one end flanged and extending beyond the rack for connection to plant drain header..

Each rack shall be provided with one receptacle, one light fixture with wire guard and one lighting switch. Outlet box, switch box and device covers shall be galvanized stamped steel. Light fixtures shall be installed on the canopy of the rack

4.03.06 Power supplies for miscellaneous devices shall be provided with MCB located within the enclosures. MCB shall be mounted in fuse blocks. Nameplates shall be furnished above the MCB blocks, identifying the devices being served.

4.04.00 JUNCTION BOX

1.	Type of Enclosure	:	Dust tight & weatherproof conforming to IP 65
2.	Material	:	3 mm sheet steel / fiberglass reinforced polyester(UV stabilized)
3.	Type of Cover	:	Solid unhinged with retention chain / Screwed at all four corners
4.	Paint	:	i) Exterior : Opaline green shade 275 of IS: 5 ii) Interior - Brilliant Glossy White.

			Surface / Two (2) inch Pipe stanchion
5.	Mounting	:	(At a dry compartment at one side of the enclosure / rack with front opening type door)
6.	Cable Entry	:	3 mm (min) Bottom / side Gland plate
7.	Gasket	:	Neoprene
8.	Grounding	:	Brass earth lug with green screw head External-2 nos , Internal-1no. (M6)
9.	Number of Drain Holes	:	Two at bottom capped
10.	Identification	:	Label for JB and Tags for cable
11.	Accessories	:	a) Rail mounted cage clamp type screwless terminals (suitable for conductor size up to 2.5sq.mm of suitable voltage grade) with markers and 20% spare terminals b) Cable gland (Brass) & raceways c) Ferrules & lugs (Brass) d) Aluminum back panel e) Canopy at top f) Mounting brackets g) bolts and nuts made of brass etc.

VOLUME : VI

SECTION-VI

SUB SECTION - B

PROGRAMMABLE LOGIC CONTROLER (PLC) / PROPRIETARY CONTROL SYSTEM

Annexure-5E

1.00.00 **GENERAL**

1.01.00 Each of the relevant BOP areas and different auxiliary systems shall be provided with dedicated PLC or proprietary control systems for overall operation and control.

1.01.01 The Common DDCMIS network shall also control and monitor the packages envisaged for PLC based local control systems. Operator workstations shall be provided in CCR for the overall control and monitoring of each system through network.

There shall be redundant bidirectional OPC link between this Common DDCMIS network and each Packge PLC including PADO for monitoring / performance activities.

These areas have been indicated with other details in Section-V of this volume of the specification.

1.02.00 These control systems shall conform to high standard of engineering meeting all applicable codes and standard, design and workmanship and shall meet the functional requirements in all respects and shall be capable of performing satisfactorily in continuous commercial operation under the specified environmental condition.

1.03.00 Further this part of the specification details the common technical and functional requirements applicable for all the systems unless specified elsewhere in the specification. Only specific requirements are indicated in this section .However ,Bidder shall also adhere to the Section-VI , Subsection A (DDCMIS) of this volume of the specification for other basic and detailed scope & services , philosophy & technical requirements of different hardwares and softwares including response time , loading , interface , redundancy criteria , display , logs ,spares criteria , drawings and document submission etc.

1.04.00 All local PLCs shall be supplied from one manufacturer for all plants and shall provide single unified hardware and software platform for realizing all the control and monitoring functions.

1.05.00 In general local PLC, ,Proprietary control system by third party system integrators shall not be allowed and only main PLC/ Proprietary control system manufacturer shall be allowed to do the design engineering , system integration etc. Owner will be the final authority in allowing third party system integrators , if required , for only small applications

1.06.00 Common DDCMIS shall basically control and monitor the BOP package systems , as detailed in section V of the volume of specification , through the workstations from the Central Control Room (CCR) during normal operation of the plant.. However, local control and monitoring facility of the equipments from the respective package control room and local panels shall also be available. However, if required, based on operator choice, normal and emergency operation from the local PLC system shall also be done. The control room operator shall have also access to common database for all the packages.

1.06.01 The redundant upper level network of each Package PLC system will be connected to redundant server to be located in Plant Engineer's room. Suitable Fibre optic cable shall be used for redundant interconnections.

1.06.02 The hot redundant Server shall continuously update all the inputs. The switchover to the hot standby Server shall be smooth and bump less with proper indication to the operator.

1.06.03 In addition to local PLC Workstations , programming activities for control systems of all the packages including set point change , logic build up & modifications , graphics build up & modifications etc . shall also be achieved through Common DDCMIS network workstation.

1.06.04 Common DDCMIS Network workstations stations, local workstations shall have access to the processor of the individual package control system for programming. Programming shall not require special computer skills. On the programming console, it shall be possible to do the programming, self-diagnostics, testing of sequence, simulation and any sequence modification.

1.06.05 All the screens as available in the local package monitors will be also available one to one basis in the Common DDCMIS network screens. Alarm monitoring / reporting, generation of logs, trends, calculations, printing of logs & reports etc. shall be available in local workstations as well as in remote Common DDCMIS network workstations .In case of failure of Common DDCMIS network, control and monitoring of the individual packages shall still be possible from the Operator Work Stations in the respective package control room

1.06.06 There shall be flexibility in operation from CCR Common DDCMIS network operator workstations. Any of the BOP packages can be controlled and monitored from any of the workstations. .

1.06.07 The system shall permit carrying out of the on-line dynamic test and self-diagnostic checks while maintaining safe condition and without endangering the safety of equipment without having any influence on the process being controlled.

2.00.00 GENERAL TECHNICAL REQUIREMENTS

2.01.00 Bidders scope of supply shall include , but not limited to , Hot standby local PLC / Proprietary control & monitoring system for each of BOP areas and shall consist of IO cards, remote and Local IO rack, control rack, redundant Power supply modules, redundant communication /networking and interconnection Cables, redundant processor and communication cards, redundant Servers, operator work stations / GUI , LVS , printer, redundant networking hardware, redundant interface hardwares / softwares with DDCMIS , MCS , PADO etc. , system cabinets ,startup, commissioning, mandatory and recommended spares, drawing, documents and training to owner's personnels at site and at vendors works etc.

2.02.00 All types of programming packages shall be licensed with facility of editing and configuration. For each of the PLC / proprietary control system, the programming software shall be supplied in a laptop for each package

preloaded with package in addition to other types of devices such as CD, DAT etc.

2.03.00 In addition to the Operator and/ cum Engineering workstations , Bidder shall also supply LCD screen based display unit, control switches and other operational keys (GUI). Bidder shall also provide minimum of one no. laptop computer for each PLC based package and with latest hardware configuration and loaded with suitable operating , application program including licensed softwares as a backup engineering cum programming and configuration station. This loaded laptop shall be handed over by Bidder well in advance of FAT to Owner's head office at Hyderabad .

2.04.00 The System shall allow dependable and effective control of the process equipment and shall be designed for maximum integrity and reliability. Integrity shall be maintained by providing a dual hot redundant system .The System shall have a capability to monitor and take actions for distributed functions from a central location.

2.05.00 The control & Instrumentation shall be through dedicated microprocessor based PLC ,Common DDCMIS network ,proprietary system for the each of the respective plants covering the total functional requirement of sequence control, regulatory control, interlock & protection, monitoring, alarm, data logging.

2.06.00 The loop cycle time shall be less than 1 sec for close loops and open loops. The switchover from main controller to redundant controller shall be bumpless; and shall be within one cycle time i.e. within 50 msec.

2.07.00 Each controller shall have 40% functional capacity to implement additional functional blocks over and above implemented logic / loops under worst loading conditions.

2.08.00 Field Input/Outputs

The System shall meet the following I/O card requirements.
The maximum number of inputs / outputs to be connected to each type of module shall be as follows:

a)	Analog input module	8
b).	Analog output module	8
c)	Binary input module	16
d)	Binary output module	16

2.09.00 Communications System

2.09.01 The Bidder shall include a dual hot redundant communication system

2.09.02 The data highway speed shall be 1000 Mbps.

2.10.00 Operator Interface

Operator Work Station (OWS) / GUI / LVS shall perform control monitoring and operation of all auxiliaries/ drives . However , Push button stations are

also to be provided with RIOs as detailed out in Section V of this volume of the specification .

2.11.00 Interface with Common DDCMIS system

Each PLC , proprietary control systems shall be interfaced to Common DDCMIS network with bidirectional OPC link .The link shall be redundant.

2.12.00 PLC shall be of latest version and all the modules like Control modules, communication modules, IO modules, network interface modules etc., modules shall be from the same family of hardwares and softwares and shall be sourced from Bidder's Original Principlal's works.

2.13.00 PLC shall have also , but not limited to, the following requirements ,

2.13.01 I/O LAN Speed shall be minimum 5 Mbps - 100 MBPS on Deterministic LAN.

2.13.02 I/Os shall be Rack based and not Din Rail Mountable .

2.13.03 Processors and I/Os shall be of same family.

2.13.04 Channel Level Diagnostics for DI/DO, AI & AO shall be provided . Each individual Channel healthiness shall be monitored at workstation / GUI level.

2.13.05 All PLC I/O Rack Power Supplies shall be redundant. Only Bulk power supply redundancy will not be acceptable.

2.13.06 Processor shall have minimum 256 PID loops execution capability. Minimum memory shall be 10 MB. It should be 32 Bit.

2.13.07 SOE module (if applicable) must stamp and store 250+ events at card level.

2.13.08 PLC shall store tag details and bit word addresses on upload of logic as well as tag descriptions.

2.13.09 I/O Bit forcing in Primary to reflect in secondary immediately. (single scan update)

2.13.09 Remote I/O Rack outside control room shall be on Fiber Optic communication only.

2.13.10 Processor shall be self learning in case of failure. No need to configure and program replaced processor.

2.14.00 Operating work stations must be Runtime license/servers. Client server architecture no acceptable.

2.15.00 Each operator work station must have minimum 8000 tags handling capability.

2.16.00 Auto Tuning feature of PIDs at PLC controller level shall be available.

2.17.00 Floating IP selection of Controller under PLC processor switchover condition

2.18.00 Automatic Program update on secondary on loading to Primary Processor.

2.19.00 Programming facility shall be available from Remote IO stations.

2.20.00 Processor shall support minimum 22000 IO handling capacity in Redundant configuration.

2.21.00 Online editing of Program shall be possible.

2.22.00 Processors shall be Hot back up.

2.23.00 Automatic synchronization of primary processor/controller of PLC with secondary processor/controller.

2.24.00 Bumpless switchover to secondary processor/controller of PLC when the primary fails.

2.25.00 Power supply module redundancy shall be true power supply redundancy

2.26.00 Automatic program and data equalization of primary processor/controller of PLC.

2.27.00 Automatic Forcing Bit update in the secondary processor/controller of PLC when any Forcing is applied in the primary processor/controller of PLC. (Forcing Bit Table of both the PLCs must be automatically synchronised.)

2.28.00 Communication speed of 5 Mbps between PLC and I/O module network

2.22.00 Softwares

The latest version of all necessary applications and networking software shall be supplied for the system. The software tool shall have facility to interface with third party software packages. Window base operating system shall be provided. The system shall be OPC compliant. Easy upgradation and future expansion facility shall be available.

All softwares used shall be licensed versions only. All software user licenses shall be valid for entire life of power plant. User shall not have to pay any recurring license fee during the usage period of the system.

It shall be possible to upgrade the installed system with the latest available version of the software model during the plant life.

2.23.00 Redundant Uninterrupted Power Supplies (UPS) shall be provided for each Local PLC.. UPS specification shall be as per requirements indicated in Section V of this specification.

6.00.00 **INSPECTION AND TESTING**

6.01.00 The Contractor shall carry out the following specific tests and inspections to ensure that the equipment furnished lies in strict conformance with the specification and also in accordance with applicable codes/standards and good engineering practice.

a) Identification and Testing

i) All materials used for pump construction shall be of tested quality. Material shall be tested as per the relevant standards and test certificates shall be made available to the Owner.

ii) Tests for each pump included under this section shall include but not be limited to the following :

- The entire surface of the impeller castings shall be subjected to Dye Penetration Test as per ASTM Specification no.: E165-65.
- Shaft shall be subjected to Dye Penetration and Ultrasonic Tests.
- Wearing rings shall be subjected to Dye Penetration Test.
- Verification of material, witnessing of pouring, casting and inspection of finalized fabricated/cast castings.
- Inspection of finished castings for impeller and verification of materials.
- Inspection of pump shaft and verification of material.
- Witnessing of NDT/review of NDT reports.
- Static balancing test for impeller and dynamic balancing of complete rotating parts as per ISO- 1940.
- Complete Inspection of assembled pump.

b) Hydrostatic Testing

The pump casing shall be hydrostatically tested at 150% of the shut-off pressure. Pressure shall be maintained for a period of not less than one (1) hour. While arriving at the above values maximum suction pressure shall be taken into account.

c) Performance Test at Shop

i) Each pump shall have to be tested to determine the performance curves of the pumps. These tests are to be conducted in presence of Owner's representative as per the requirements of the Standards of Hydraulic Institute of USA (ASME-Power Test Code PTC 8.2/BS-599) or any other equivalent standard but the tolerances on head discharge and power shall be as specified in HIS, USA.

ii) Performance tests are to be conducted to cover the entire range of operation of the pumps. These shall be carried out to span 130% of rated capacity up to pump shut-off condition. A minimum of five combinations of head and capacity are to be achieved during testing to establish the performance curves, including the design capacity point, shut-off point and the two extremities of the range of operation as specified in the annexures. After completion of performance test, all pumps shall be stripped down for inspection of internals.

iii) Tests shall be conducted with actual drive motors being furnished.

iv) NPSH tests are to be conducted on one pump of each type at 3% head drop conditions, if specified in the pump Annexures.

v) Mechanical run test shall be carried out on all pumps to determine the vibration levels, noise levels etc. This test shall be conducted at site also. However, test value at site shall be used for the acceptance of the equipment.

7.00.00 DRAWINGS, DATA, CURVES AND INFORMATION

7.01.00 The Bidder shall submit the following along with his formal proposal besides the different information plate required as indicated elsewhere in this section.

7.01.01 Drawings

a) General arrangement drawings showing the principal dimensions, weight and location of the suction and discharge connections of the pumps offered. Details of lubrication and sealing arrangement shall be included.

b) Typical cross-section drawing showing various components of the pumps offered materials of construction etc.

7.01.02 Data and Curves

a) Determination of pump total dynamic head and rated capacity as per guidelines specified in Section-I of this Volume. Detailed calculations shall be shown by the Bidder.

b) Anticipated performance curves showing the following characteristics :

i) Capacity vs. head

ii) Capacity vs. power

iii) Capacity vs. efficiency

iv) Capacity vs. NPSH required

v) System resistance curves

c) Speed vs. torque curve of the pump corresponding to recommended mode of pump starting superimposed on speed vs. torque curves of the drive unit corresponding to 80%, 90%, 100% of the rated voltage (applicable only in the cases of pumps with drive motor power rating of 100 KW and above).

d) Completely filled-in Technical particulars enclosed under Volume-IX of this specification.

7.02.00 The successful Bidder shall furnish the following drawings/data for Purchaser/Engineer's approval after award of the contract.

7.02.01 Final versions of all the drawings, documents as specified in clause no. 7.01.00 above.

7.02.02 Pump foundation details along with all design loads, direction and points of application.

7.02.03 Test reports, test certificates and other particulars.

7.02.04 All other applicable drawings and documents as specified in Volume-IIA of this specification.

b) The inspection plan with verification, inspection plan check points, verification sketches, if used and methods used to verify that the inspection and testing points in the inspection plan were performed satisfactorily.

c) Non-destructive examination results /reports including radiography interpretation reports.

d) Factory tests results for testing required as per applicable codes and standards referred in the specification.

e) Welder identification list listing welder's and welding operator's qualification procedure and welding identification symbols.

f) Sketches and drawings used for indicating the method of traceability of the radiographs to the location on the equipment.

g) Stress relief time temperature charts.

h) Inspection reports duly signed by QA personnel of the Owner and Contractor for the agreed inspection hold points. During the course of inspection, the following will also be recorded :

i) When some important repair work is involved to make the job acceptable.

ii) The repair work remains part of the accepted product quality.

i) Letter of conformity certifying that the requirement is in compliance with finalised specification requirements.

4.00.00 **INSPECTION, TESTING AND INSPECTION CERTIFICATES**

4.01.00 The Owner's Engineer, or his duly authorised representative and/or an outside inspection agency acting on behalf of the Owner shall have access inside the workshops, test labs, establishments at all reasonable times to inspect and examine the materials and workmanship of the works during its manufacture or erection and if part of the works is being manufactured or assembled on other premises or works, the Contractor shall obtain for the Owner's Engineer and for his duly authorised representative permission to inspect as if the works were manufactured or assembled on the Contractor's own premises or works.

4.02.00 The Contractor shall give the Owner's Engineer/ Authorized Inspector twenty one (21) days written notice for "CHP" / "W" points of any material being ready for testing by owner' engineer / Authorized inspector. Such tests shall be to the Contractor's account except for the expenses of the Inspector. The Engineer/ Inspector, unless the witnessing of the tests is virtually waived, will attend such tests within fifteen (15) days of the date on which the equipment is notified as being ready for test/inspection. If owner's Engineer / Authorised Inspector fail to attend the inspection, next mutually convenient date for test shall be agreed with Contractor. Contractor shall, in

SURFACE PREPARATION AND PRETREATMENT OF FERROUS SURFACE PRIOR TO PAINTING

1 GENERAL

This standard, details the surface preparation and pre-treatment of ferrous surfaces prior to painting. This includes removal of oil, grease, dirt and swarf followed by removal of rust by means of mechanical or chemical treatment.

Assistance has been taken from IS 8629, Part 2–1977 and Swedish Standard SIS 05 5900–1967 in preparing this standard.

2 REMOVAL OF OIL, GREASE, DIRT AND SWARF

Before application of paint, it is very essential to have a very clean surface. All oil, grease, dirt and swarf to be removed by means of solvent, alkali, emulsion or steam cleaning. Refer to specific MSDS (Material Safety Data Sheet) for precautions to be taken during storage, handling and disposal of such chemicals used.

2.1 Solvent cleaning

This shall be done by using petroleum solvent (other than CTC) or trichloroethylene.

2.1.1 Petroleum solvent cleaning

The method involves use of petroleum solvents like white spirit to BHEL specification AA56701. The process of cleaning such as immersion or brushing is decided depending on the size/shape of the component. However, sufficient time should be allowed for removal of the contaminants and in no case for less than one minute. Cleaning with brushing or wiping is used for the "insitu" cleaning of articles too large for immersion tanks or spray cleaning surfaces. The surface of the fabricated panel shall be cleaned with brush or cloth soaked in white spirit to BHEL specification AA56701 to remove stains of oil, grease etc. before rust removal. The solvent should be allowed to evaporate before next operation. If required, clean cotton cloth can be used for wiping the surface. The cloth shall be changed every time or the contaminants on the cloth will adhere to the substrate.

a) Process

Two main methods are given below. Details depend upon the quantity and characteristics of the parts or assemblies to be cleaned.

i) Immersion

This method may be used for unit parts or assemblies when contamination is light and when the highest degree of cleanliness is not essential; it is particularly suitable for hand cleaning in small tanks. The articles should be immersed in the solvent long enough to allow removal of the contaminants, and in no case for less than one minute. Agitation is desirable, and brushing or scrubbing with wire brushes will aid quick cleaning.

ii) Brushing or wiping

This method is intended for the removal of oil, grease and light contamination from bare metal areas or assemblies containing painted surfaces or non-metallic inserts that might be damaged by general application of solvent. It may also be used for the 'in-situ' cleaning of articles too large for immersion tanks or spray cleaning systems.

Revisions:			APPROVED: INTERPLANT MATERIAL RATIONALISATION COMMITTEE – MRC (CPO&NM)		
Rev. No. 02	Amd. No.	Reaffirmed	Prepared Corp. R&D	Issued Corp. R&D	Dt. of 1st Issue 01-02-1982
Dt: 02-04-2018	Dt:	Year:			

b) Handling precautions

Articles should be placed on hooks or racks or in suitable containers that permit adequate draining. They should not be handled with bare hands after cleaning. Clean gloves or similar protection should be used and handling kept to a minimum.

c) Safety precautions

Petroleum solvents should be used at room temperature in a well ventilated area and suitable exhausts and fire extinguishers should be provided, as these solvents are flammable. Oil-resisting synthetic rubber gloves should be worn when handling articles during cleaning, to protect the articles from sweat residues and to avoid any possible effect of the solvent on the skin. Care should be taken to avoid breathing the petroleum solvent vapour. Aprons, respirators and safety glasses shall be used by the operators who are responsible for the above operations.

d) Limitations

Petroleum solvent cleaning suffers from the following drawbacks:

i) Fire risk

ii) Brush or wipe or immersion methods being manual in operation are slow and time consuming and therefore unsuitable on their own for continuous production lines, and

iii) The degree of cleanliness achieved by such methods is not high and they are generally used for preliminary cleaning to supplement a proper degreasing operation.

2.1.2 Trichloroethylene cleaning

The method relates to surface cleaning with trichloroethylene solvent. This can be done by placing the equipment in the vapours of trichloroethylene or by immersing it in boiling trichloroethylene or by jetting trichloroethylene at high pressure on surfaces to be cleaned.

a) Degreasing

The three main processes are described below

The precise details of the equipment and the method of operation for each process depends on the quantity and characteristics of the parts or assemblies to be cleaned; the plant manufacturers' recommendations should be followed.

i) Vapour process

The remove simple films of oil and grease, articles may be subjected to the vapour process, in which the parts are exposed in a bath of solvent vapour. The vapour condenses on the cold surface of the articles and the condensate dissolves the oil and grease, taking it away to the base of the tank. To ensure the maximum condensation, the temperature of the articles should be as near to the room temperature as possible at the time of immersion. They should be passed through or suspended in the solvent vapour until no further condensation occurs, after which no further degreasing will take place. Articles with a very heavy film of grease may need a second exposure after cooling.

ii) Liquid process

Loosely bound contamination (too much for vapour treatment) such as polishing compound, swarf and road dirt may be removed by immersing the parts in vigorously boiling trichloroethylene.

iii) Jetting process

Articles with obstinate dirt deposits that cannot be removed by boiling trichloroethylene may require jetting at high pressure with the hot solvent. The jetting should be carried out only in equipment, specially designed for the purpose.

b) Handling precautions

During processing, the articles should be placed on hooks or racks or in a suitable container. They should be so arranged that there is adequate opportunity for the solvent to drain from holes, crevices, pockets and other irregularities. Parts or assemblies that would trap solvent should be rotated or tilted during the degreasing process to prevent drag-out of trichloroethylene. Handling may be reduced by

using mechanical and conveyor type degreasing plants which automatically rotate or tilt the articles. After cleaning, articles should not be handled with bare hands. Clean gloves or similar protection should be used.

c) Safety precautions

Trichloroethylene is a toxic substance. All safety precautions like wearing aprons, rubber gloves, respirators and safety glasses shall be used by the operator responsible for the above operations. Care should be taken to avoid breathing the vapour near degreasing equipment.

2.2 ALKALINE CLEANING

Cleaning of surface can be done by using alkaline degreasing agents, which are very good for cleaning but by and large injurious to skin. This process can be followed either by immersion in hot alkaline mixture or by electro cleaning process or by using jet cleaning process. In the electro cleaning process tank to be used as one electrode while job to the cleaned to other electrode. In the jet cleaning process, job to be cleaned is subjected to jet of hot alkaline solution at high pressure. Details of safety and handling as per IS 8629 Part 2.

2.3 EMULSION CLEANING

These are diphase cleaners of oil/water emulsion type. These cleaners may be applied by spray or dip, though spray is more common. Details of safety and handling as per IS 8629 Part 2.

2.4 STEAM CLEANING

This method related to the use of a jet of high pressure steam for the “in-situ" cleaning of large unit parts, assemblies and machinery that cannot be accommodated in a cleaning apparatus. The cleaning may be carried out with pure steam or with alkaline solution/steam mixture. Details of safety and handling as per IS 8629, Part 2.

3 REMOVAL OF RUST AND SCALE BY MECHANICAL OPERATIONS

3.1 HEAVY LOCALISED RUST

If rusting has occurred locally, but to such an extent that some pitting with hard rust flakes, is exhibited, the rust shall be first removed by using hand scraping or scraping with mechanical power tools or flame cleaning. The affected surface shall be treated as that mentioned for "Light Rust” in Clause 4.1.

3.1.1 Hand scraping

Scraping with a hand scraper generally follows by steel wire brushing and finally sanding the surface with a coarse sand paper, steel wool or emery paper.

3.1.2 Scraping with mechanical power tools

This gives better and quicker results than above, but it may not be possible to remove firmly adhering mill scale even with this method.

3.1.3 Flame cleaning

This is done by heating the surface with oxy-acetylene torch. Because of the difference in expansion between the heated mill scale and the bulk of the steel, the scale becomes loose and either falls off or is easily removed with wire brush. This process is not suitable for plates less than 6 mm thick because of buckling problem that may result during this process.

3.2 GENERAL RUSTING

If the surface is widely rusted to such as extent that pitting with hard flakes is exhibited, generally the job shall be grit or shot blasted. The principle is to impinge under pressure of air, a jet of sharp granulated steel (steel or non-metallic grit) on to the metal surface removing in the process any rust and scale, including firmly adhering mill scale. A steel surface properly cleaned by blasting may be immediately recognised by its silver grey surface and the criterion for good shot blasting is the evenness of the colour of the surface so cleaned. Precautions shall be taken when shot blasting light gauge steel to see that buckling does not occur as a result of continuous impingement of grit or steel shot under high velocity.

Before the process of blast, cleaning is carried out, may be cleaned by emulsion/steam cleaning to remove dirt, dust, grease etc.

3.3 BLAST CLEANING

The process of surface preparation by Blast Cleaning is described below:

3.3.1 White metal blast cleaning

A white metal blast cleaned surface when viewed without magnification shall be free of all visible oil, grease, dirt, dust, mill scale rust, paint oxides, corrosion products and other foreign materials.

3.3.2 Commercial blast cleaning

A commercial blast cleaned surface when viewed without magnification shall be free of all visible oil, grease, dirt, dust, mill scale rust, paint oxides, corrosion products and other foreign materials.

Staining shall be limited to no more than the 33% of each square inch of surface area and may consist of light shadows, slight streaks or minor discolouration caused by stains of rust. Stains of mill scale or stains of previously applied paint, slight residues of rust and paint may also be left in the bottom of the pits if the original surface is pitted.

3.3.3 Brush -off blast cleaning

A brush-off blast cleaned surface when viewed without magnification, shall be free of all visible oil, grease, dirt, dust, loose mill scales, loose rust and loose paint.

The entire surface shall be subjected to the abrasive blast. The remaining mill scale, rust or paint shall be tight.

When painting is specified, the surface shall be roughened to a degree suitable for the specified paint system.

Immediately prior to paint application, the surface shall comply with the degree of cleaning as specified.

3.3.4 Near white blast cleaning

A near white blast cleaned surface, when viewed without magnification, shall be free of all visible oil, grease, dirt, dust, mill scale, rust, paint, oxide corrosion products and other foreign matter, except for staining as noted below:

Staining shall be limited to no more than 5% of each square inch of surface area and may consist of light shadows, slight streaks or minor discolouration caused by stains of rust, stains of mill scale or stains of previously applied paint.

3.4 SURFACE PREPARATION BEFORE BLAST CLEANING

Before blast cleaning, visible deposits of oil or grease shall be removed by solvent cleaning.

Before blast cleaning the surface, imperfections shall be removed from the surface as specified below:

Weld spatter shall be removed by using chipping hammer, spud bar, scrapper or by grinding.

Areas of unacceptable porosity should be filled or closed over with a needle gun or peening hammer.

Sharp edges may be removed by grinding, mechanical sanding, filling etc.

Deep corrosion pits, gouges, clamp marks or other surface discontinuities may be repaired by grinding or filling.

Areas of poor design for corrosion protection such as tack or spot welded connections, back to back angles, crevices (narrow openings) may require corrections by structural or design modifications where this is not possible, particular consideration should be devoted to minimise the effect of such deficiencies.

Substrate Chemical contamination (for blasting): shall be conducted with any suitable method to identify salt contamination.

– Type of check : Measurement
– Quantam of check : One Test/abrasive lot used
– Acceptance Norm : Chloride < 15 µg/cm² (ppm), Sulphate < 20 ppm

3.5 BLAST CLEANING METHOD AND OPERATION

3.5.1 Clean, dry compressed air shall be used for nozzle blasting (moisture separators, oil separators, traps or other equipment may be necessary to achieve this requirement).

3.5.2 The various method of surface preparation to achieve a blast cleaned surface are as follows:

a) Dry abrasive blasting using compressed air, blast nozzles and abrasive.

b) Dry abrasive blasting using a closed cycle, recirculating abrasive system with compressed air, blast nozzles and abrasives with or without vacuum for dust and abrasive recovery.

c) Dry abrasive blasting using a closed cycle recirculating abrasive system with centrifugal wheels and abrasive.

3.6 PROFILE OF ROUGHNESS OBTAINED DURING BLASTING

This will depend upon the abrasive used, the air pressure and the technique of blasting. Too low a profile may not provide a sufficient key for a coating while too high a profile may result in uneven coverage of high sharp peaks leading to premature coating failure, particularly for thin coatings such as blast primers apart from higher paint consumption.

The following table gives a brief guide to typical roughness profiles obtained using various types of abrasives

Types of abrasive	Mesh size	Maximum height of profile
Very fine sand	80	37 microns
Coarse sand	12	70 microns
Iron shot S 390 Typical non metallic "Copper slag"	14	90 microns
1.5 to 2 mm grain size	--	75/100 microns
Iron grit no. G16	12	200 microns

Profile measurement shall be made using appropriate profile gauge supplied with calibration standards.

3.7 ABRASIVE SELECTION

The selection of the size and type of abrasives which will most effectively and economically produced the desired surface finish, shall be as per Section-5 of "Surface preparation commentary (SSPC-SP-COM)", encl.no.25.

In general, select the smallest size abrasive that will produce the desired cleaning results. Usually, this will give the fastest, most economical cleaning operation.

3.8 SURFACE PREPARATION AFTER BLAST CLEANING AND IMMEDIATELY PRIOR TO PAINTING

Visible deposits of oil, grease or other contaminants shall be removed by solvent cleaning.

Dust and loose residues shall be removed from prepared surfaces by brushing, blowing off with clean, dry air, or vacuum cleaning.

After blast cleaning, surface imperfection which remain shall be removed to the extent required as explained at 4.2.

Any visible rust that forms on the surface of the surface steel after blast cleaning shall be removed by re-blasting the rusted areas.

3.9 INSPECTION

All work and material supplied under this specification shall be subject to timely inspection by Q.C.

Conditions not complying with this specifications shall be corrected.

The engineering and process documents, sub-contract, scope-procurement documents should establish responsibility for inspection and for any required affidavit certifying full compliance with this specifications.

The appearance of the surface after cleaning should correspond to pictorial standard as mentioned below

	Blast cleaning method	Pictorial standard	For Pictorials
1	White metal blast cleaning (blast cleaning to visually clean steel)	A Sa 3, B Sa 3 C Sa 3 & D Sa 3	Annexure 1a
2	Commercial blast cleaning (light blast cleaning)	B Sa 1, C Sa 1 & D Sa1	Annexure 1b
3	Brush-off blast cleaning (through blast cleaning)	B Sa 2, C Sa 2 & D Sa2	Annexure 1c
4	Near white blast cleaning (very through blast cleaning)	A Sa 2 ½, B Sa 2 ½, C Sa 2 ½ & D Sa 2 ½	Annexure 1d

Alternatively, NACE Visual Comparators may also be used for inspection purposes.

The test for assessment of dust on steel surfaces prepared for painting can be carried out as per the Pressure-sensitive Tape method as per ISO 8502-3.

NOTE:

1) All jobs are generally to be shot/grit blasted.
2) For pictorial standard only coloured profile should be used. (xerox copy not to be referred)
3) Blast cleaning surface should be measured after cleaning.

4 REMOVAL OF RUST BY CHEMICAL CLEANING

4.1 Light Rust

If a thin film of very light rust exists on the work, it shall be removed by means of de-rusting solution /rust converter. After degreasing as above, the de-rusting solution shall be applied in a thin film, using brush or swab and left for 10 to 15 minutes. At the end of the period and before it has dried, it shall be wiped off with a clean dry cloth and the surface examined any red rust is still visible, further similar application shall be made until the surface exhibits a grey colour only.

The surface shall then be followed to dry and be brushed down with a clean dry brush before painting. The drying may be accelerated by swabbing or brushing the surface with Industrial Methylated Spirit (AA56705). This is recommended for faster drying and removal of un-reacted acid.

NOTE:

In case of Epoxy painting system like BHEL standard AA0674104 and AA0674111 shot blasting of surface shall conform to Sa 2 ½ minimum of Swedish Pictorial Standard SIS 055900.

4.2 SULPHURIC ACID, HYDROCHLORIC ACID OR PHOSPHORIC ACID PICKLING

To remove scale and rust, pickling can be done by using sulphuric acid 5 to 20% concentration by volume at 60 to 80°C or hydrochloric acid 20 to 50% concentration by volume at room temperature or phosphoric acid at 5 to 25% concentration by vol. At 60 to 85°C.Appropriate inhibitors shall be used in the pickling bath to reduce acid attach on the base metal. This shall be followed by washing in water followed by dipping in phosphoric acid solution, 1-2% concentration by volume.

NOTE:

The pickling acid selection should be made on the basis of the material pickled.

4.2.1 Process details

The components to be treated shall be immersed in the tanks made of steel with suitable lining with chemicals, temperature and dipping time as given below:

(Suitable chemicals as per applicable purchase specification from time to time shall be used according to the process)

Concentration process	Pointage (Chemical in water) see note below	Bath dipping see note below	Temp. (deg. C)	Time
Degreasing (if hot)	3-5% WT/VOL	27 - 45	80 - 90	10-15 minutes
Degreasing (if cold)	10-15% WT/VOL	80 - 90	Room temp.	10-15 minutes
Rinsing in cold running water tank with over flow arrangement				
De-rusting (cold)	20-40% VOL/VOL	20 - 40	Room temp.	10-20 minutes
Rinsing in cold running water tank with over flow arrangement				
Phosphating (cold)	5-6% VOL/VOL	25 - 30	Room temp.	20-30 minutes
Rinsing in cold running water tank with over flow arrangement				
Passivation (if hot)	0.1-0.2% VOL/VOL	Free acid: 0.1-0.2ml per 25ml; Total acid: 2.5ml max. per 25ml	50 - 60	30-45 seconds
Passivation (if cold)	Same as above	Same as above	Room temp.	2-3 minutes

NOTE

a) The values are indicative. The chemical concentration, temperature (hot or cold), dipping time are to be maintained as given by the manufacturer of the chemical and the nature of oil/soil/rust on the component.

b) Pointage: is the value of the titrate (chemical used for titration)

Of a given strength, when a sample (whose concentration is to be checked) of 10ml is taken for titration (for convenience of titration, add 100ml water, value will not be different if water is added or not). For example, when a 10ml of degreasing solution is titrated using 0.1 N hydrochloric acid, if the titrate value is 25ml, then the pointage of degreasing solution is 25.

4.2.2 Analysis of pre-treatment baths

a) Take 10ml of sample solution + 100ml water + 6 to 8 drops of indicator given. Pour into a 250ml conical flask and shake well.

b) Titrate against the chemical given and observe for the change in colour. Note the value of titrate used. That is the pointage, which shall be as per the process details given earlier.

Solution	Indicator	Titrate with	Turning point
Degreasing	Phenolpthalin	0.1 N Hydrochloric acid	Pink to clear
De-rusting	Methyl orange	1.0 N Sodium hydroxide	Orange to yellow
Phosphating	Phenolpthalin	0.1 N Sodium hydroxide	Colourless/slight yellowish to pink atleast for 10 seconds

Passivation - given in further pages

NOTE

Toner concentration checking: Dip starch iodide paper for one minute in solution, observe the change in colour.

Colour change	Inference
Remains white	Toner insufficient
Turns blue	Toner sufficient
Turns dark blue	Toner excess

Passivation solution Titration Analysis:

For free acid strength:

Take 25ml sample in a measuring flask and pour into 100ml conical flask. Add 6 to 8 drops of Bromocresol green solution. See the colour remains yellow, titrate using 0.1 N sodium hydroxide until colour changes to green or blue. Note the value of standard solution.

For total acid strength:

Continue titration adding phenolphalin indicator to 0.1 N sodium hydroxide until solution changes to purple. Note the volume of sodium hydroxide.

4.3 ELECTRO - CHEMICAL CLEANING

It is possible to remove rust and scale by cathodic treatment in acid solution, cathodic treatment in alkaline solution, anodic treatment or alkaline de-rusting process as per IS 6005.

NOTE

Within 8 hours of surface preparation, the job should be subjected to phosphating or application of priming paint.

Surface cleaning and painting should not be carried out when the humidity in the chamber is above 80% (RH).

5 INSPECTION FOR PROCESS CONTROL

Quality control inspector shall visually inspect the prepared surface for freedom from rust, stain, oil or grease before application of priming paint. The records of surface cleanliness (extent of cleaning and profile) shall also be inspected. It shall also be ensured that the shot blasted surface should be subjected to phosphating or application of priming paint within 4 hours except the jobs which need pressure testing due to code requirements.

A comparative table showing the various equivalent standards is presented in the ANNEXURE 2.

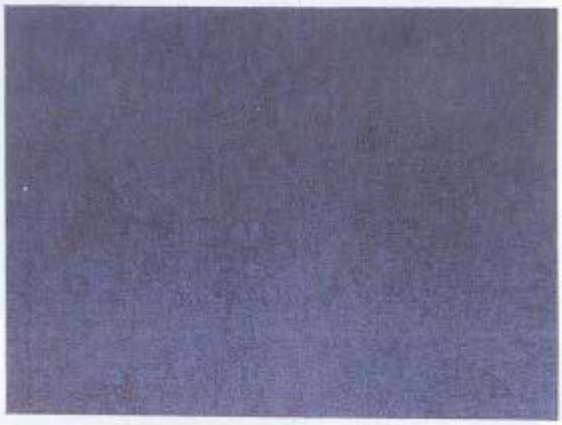
6 REFERRED STANDARDS (Latest Publications Including Amendments)

1) AA56701
2) AA56705
3) AA0674104
4) AA0674111
5) IS 6005
6) IS 8629 Part 2
7) ISO 8502
8) Swedish standard SIS: 05 5900-1967

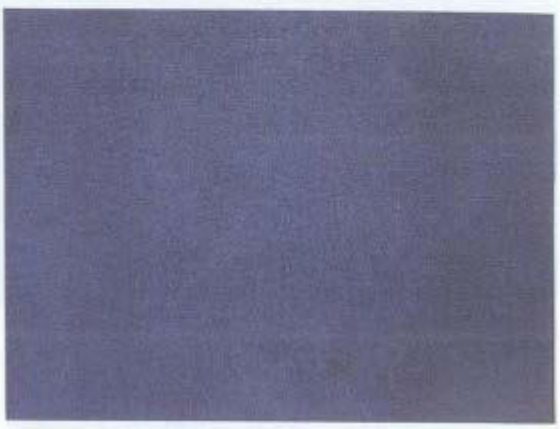
Annexure-1a
(Clause 3.9)

SURFACE FINISH RUST GRADE

A



A Sa 2 ½



A Sa 3

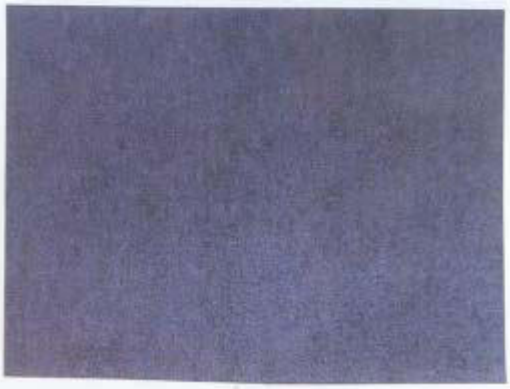
Annexure-1b
(Clause 3.9)

SURFACE FINISH RUST GRADE

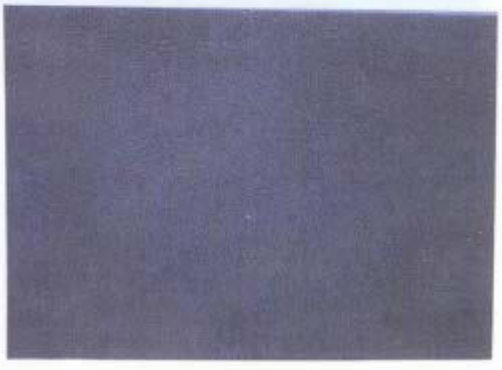
B

B Sa 1

B Sa 2



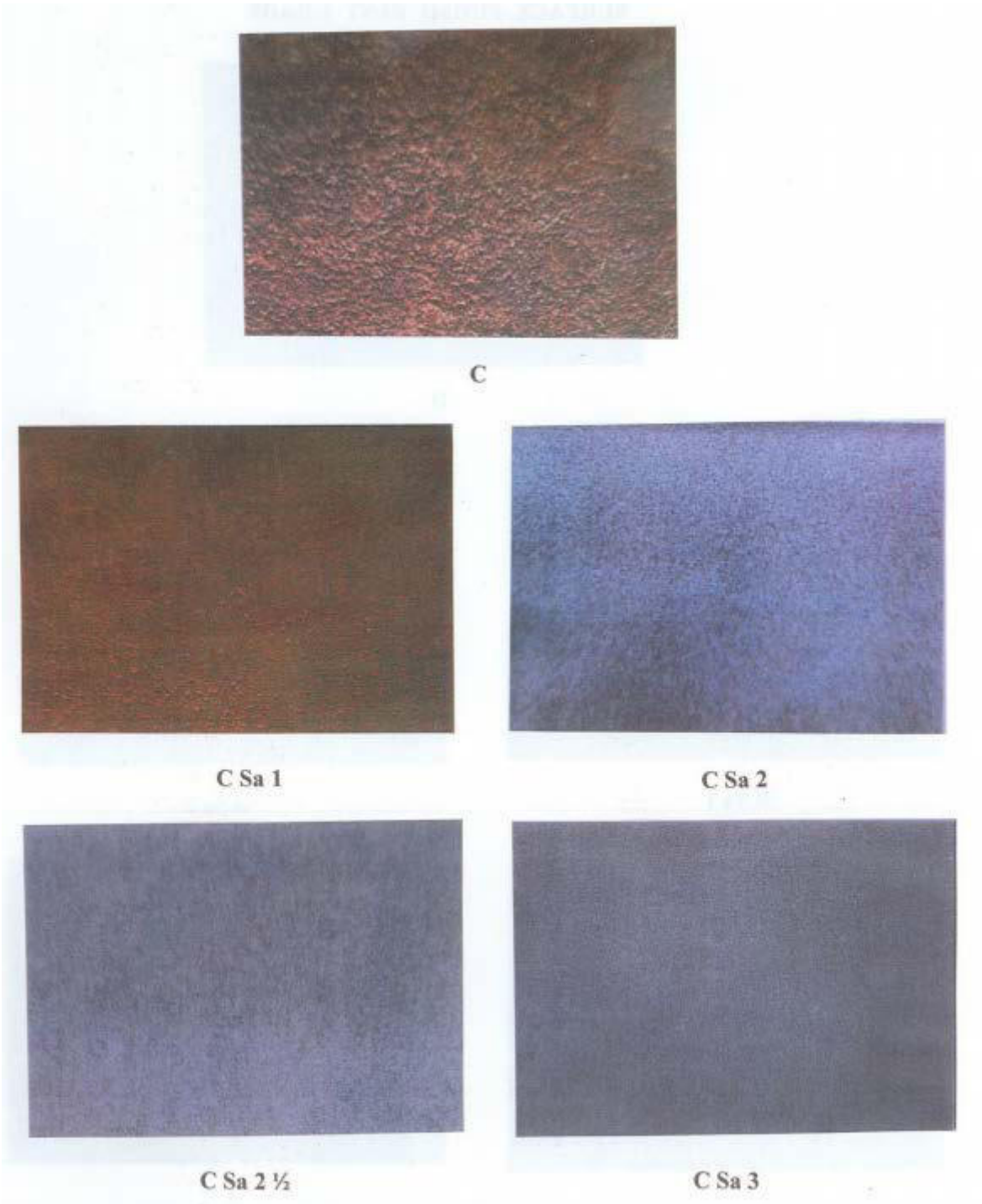
B Sa 2 ½



B Sa 3

Annexure-1c
(Clause 3.9)

SURFACE FINISH RUST GRADE



Annexure-1d
(Clause 3.9)

SURFACE FINISH RUST GRADE

D

D Sa 1

D Sa 2

D Sa 2 ½

D Sa 3

Annexure-2
(Clause 5)

INTERNATIONAL STANDARDS FOR SURFACE PREPARATION – A COMPILATION OF NEAREST EQUIVALENTS

Sl No.	Surface preparation	Swedish standard SIS: 055900	German standard DIN: 55928 Part-4	SSPC standard	BS 4232	A.S. 1627 Part-4	BSI standard IS:477	NACE standard
1	Blasting cleaning to white metal	Sa 3	Sa 3	SSPC-SP 5	1st Quality	Class 3	Class A1.1	1
2	Blast cleaning to near white metal	Sa 2½	Sa 2½	SSPC-SP10	2nd Quality	Class 2½	Class A1.2	2
3	Blast cleaning to commercial quality	Sa 2	Sa 2	SSPC-SP 6	3rd Quality	Class 2	Class A1.3	3
4	Brush-off blast cleaning	Sa 1	Sa 1	SSPC-SP 7	--	Class 1	Class A 1.4	4
5	Power tool cleaning	St 3	St 3	SSPC-SP 3	--	AS 1627 Part 2	Class 6.2.1.2	--
6	Hand tool cleaning	St 2	St 2	SSPC-SP 2	--	AS 1627 Part 7	Class 6.2.1.2	--

NOTES FOR ABOVE Sl. Nos. :

1) Removal of all visible rust, mill scale, paint and other contaminants.
2) 95% of any section of surface area is free from all rust, mill scales and other visible residues.
3) Two-thirds of any section of the surface area is free from all rust, mill scales, etc.
4) Removal of all loose mill scales, rust and foreign matter.
5) Through scraping and wire brushing to remove loose mill scales, rust and foreign matter using power operated tools.
6) Removal of loose rust and soil by wire brushing without using power tools.

LOG SHEET FOR SURFACE PREPARATION AND PAINTING

1 GENERAL

This standard is devised to document the details of the process of surface preparation and painting followed. It also includes Do's and Don't to obtain product.
The document sheets have been prepared for recording various aspects of surface preparation and painting as recommended in BHEL standards AA0674101 & AA0674112.

2 SCOPE

Log sheets format devised have to be duly recorded for each job and document preserved by appropriate authority.
Do's and Don'ts provided in the document are guide lines pertaining to application and storage of paints. However the safety precautions provided in AA0462802 have to be observed while executing the job.

3 LOG SHEET

Drg no:	Description of the job:	Mono / Wo. No. PO No.
Customer:	Name of the item to be painted:	
Quality Plan no.	Customer specification	Painting scheme:

1.Surface preparation:	Start Date:		Finish date:	
Degreasing & shot Blasting	Chemical Cleaning	Surface Roughness	Zinc Phosphating	

2.Painting Process:					
Painting Scheme:			*Deviations if any:*		
2.1 Stripe Coat:	Start date:		Finish date:		
Method of Application					
Type of paint	Thinner	Make	Batch no	Carried out by	DFT
Temperature: wet bulb:		Dry Bulb:	Humidity	Surface Temp:	

2.2 Primer:	Start date:		Finish date:		
Type of paint	Thinner	Make	Batch no	Carried out by	DFT
1st coat					
2nd coat					
Temperature: wet bulb:		Dry Bulb:	Humidity:	Surface Temp:	

2.3 Intermediate Coat:	Start date:		Finish date:		
Type of paint	Thinner	Make	Batch no	Carried out by	DFT
1st coat					
2nd coat					
Temperature: wet bulb:		Dry Bulb:	Humidity:	Surface Temp:	

2.4 Finish Coat:	Start date:		Finish date:		
Method of Application					
Type of paint	Thinner	Make	Batch no	Carried out by	DFT
1st coat					
2nd coat					
3rd coat					
Temperature: wet bulb:		Dry Bulb:	Humidity:	Surface Temp:	

3. Quality checks: Inspected/ Tested by	Shop Incharge	Third Party Inspection
Visual Inspection		
Adhession Test		
Gloss level		
Finish		
Shade		
Holiday/ Pin hole Test (O.K. / NOT O.K.)		

4 Remarks:

The equipment used for holiday testing is & rating volts

5 GOOD PAINTING PRACTICES

5.1 DO'S

1) Remember, painting is an important value adding activity. Give it all your care.
2) Store paints in covered places. Avoid direct exposure to sunlight on paints.
3) Ensure the validity of the shelf life of the paint before use.
4) Roll the paint drum several times to ensure thorough mixing of the paint before use.
5) Use proper tools to open lid of the drum.
6) Mix the paints thoroughly to ensure homogeneity.
7) Apply strip coat on edges, corners and weld beads.
8) Follow instructions on the paint can or literature whenever a new scheme / source of paint is used.
9) Draw only the required quantity of the paint for the job and immediately recap the can.
10) Ensure proper ratio of mixing in case of two-pack system, as per norms.
11) Use only the specified thinner prescribed by the supplier or standard.
12) Ensure good quality of compressed air (free from moisture and oil) prior to spray painting.
13) Use only clean/new brushes of definite size for painting.
14) Clean the bristles well in the thinner before they are used for painting.
15) Painting shall be done in a well-ventilated area/identified area.
16) Ensure proper surface preparation as per the painting scheme.
17) Ensure that the blasted surface be painted within 4 hours after blasting.
18) Ensure that the surface to be painted is free from oil, grease, stray arcs, dents etc.
19) Adhere to the no. of coats shade, dry film thickness and inter-coat curing time interval as specified. Clarity with lab, if needed.
20) Use lint free cloth/clean wiping rags for cleaning the surfaces prior to painting.
21) Maintain the right distance between the surface and spray gun (6 inches to 8 inches).
22) Ensure that mixed paints will be used before the expiry of its pot life in case of two-pack systems.
23) Ensure that the items to be painted/painted are inspected and cleared by the QC personnel concerned.
24) Preserve the balance thinned paints in a separate closed container for future use, if they don't have any restricted pot life.
25) Clean the brush before and immediately after painting. Keep them clean during interruption too.
26) Apply a coat of weldable primer at site on weld edge preparation zone.
27) Use appropriate safety appliances for painting viz., face masks (for spray guns), nose respirator, gloves etc.
28) Mask the surface of wherever required.

5.2 DON' T S

1) Do not use the paint, which has crossed its expiry date.
2) Do not draw more paint than necessary from the stores.
3) Do not make holes in the drum to draw the paint.
4) Do not keep the paint drum open for a long time.
5) Do not inter-change the thinners for the same generic paint between suppliers.
6) Do not use kerosene as thinner.
7) Do not smoke while painting.
8) Do not leave the brush without cleaning after painting.
9) Do not paint close to a welding area.
10) Do not paint when there is rain or sandstorm or when the relative humidity is about 90%.
11) Do not paint when the metal is chill or very hot.
12) Do not paint when the surface is not cleaned/prepared for painting requirements.
13) Do not paint the finish coat if the primer coat is not satisfactory.
14) Do not leave the balance paint open after painting.

PROCESS FOR PAINTING OF METAL COMPONENTS AND STEEL SURFACES

1.0 GENERAL:

This standard details the process to be followed to provide a coating on metal components and technical information regarding generic of paint medium and application related information. The paint shall be applied by spray/brush/airless spray and dried by stoving/air drying. The painted surface shall be protecting the components in their environment of exposure. This specification supersedes other AA 0674111 and 0674122.

SPECIFIC DEFINITIONS:

DFT : Dry Film Thickness; the thickness of the dried or cured paint coating film.

Operating Temp. : Temperature at which painting is to be performed.

TDFT : Total Dry Film Thickness, the thickness of the total number of coatings specified after curing.

VS% : Volume Solids Percent

1.1 METHODS OF PAINT APPLICATION

The paint shall be applied in accordance with the paint manufacturer's product data sheet, which shall include the mixing ratio, the maturation time, the method of application, the use of thinners and coating intervals. The dry film thickness of individual coatings shall be as specified. Areas with inadequate coating thickness shall be thoroughly cleaned, if necessary, abraded and additional compatible coats shall be applied until they meet the required film thickness.

Painting shall not be performed when the temperature is less than 3°C above the dew point of the surrounding air or when the relative humidity of the air is greater than 85% unless local conditions dictate otherwise and the Principal is in agreement. Guidance on the estimation of the probability of condensation can be found from the Table referred in Annexure-I.

In addition, paints shall not be applied under the following conditions:

- when the surface temperature is greater than 40°C (unless a higher temperature is recommended by the paint manufacturer).
- when the air temperature is less than 10°C (depending on local conditions).
- when there is the likelihood of an unfavorable change in the weather conditions within two hours after painting.
- when there is deposition of moisture in the form of rain, condensation, frost etc. on the surface.
- when the available light, ventilation is not adequate for painting.

If condensation, rain, dust or other foreign materials contaminate the surface of a paint coating which is not dry to the touch, the paint shall be removed, the surface re-cleaned and fresh paint is applied in accordance with this specification.

Paints shall not be applied within 50mm of edges which will later have to be welded. Such weld areas should be taped for a distance of 50mm on either side of the weld line.

Extra coats of paint shall be applied on the areas where the shape and/or plane of application result in thinly applied coatings etc., at edges, welds, corners etc. To compensate for these effects, stripes coats of paints shall be applied (normally applied first so that they will be covered by the full coat).

When zinc rich primers are used, care shall be taken to avoid any possibility of over spraying onto duplex or austenitic stainless steels, nickel alloys or 9% nickel steel components.

Note : Zinc rich primers shall not be applied on equipment made from the above mentioned materials unless such equipment is located in a shielded position which will minimise the risk of molten zinc falling onto the equipment in the event of a fire.

Proper application of protective coatings is an important criterion in giving the paint system its required life. To achieve good finish out of paint systems recommended paint putty mastic compound may be used after primer / under coat compatible with system and recommended by manufacturer.

Given below are the four main application procedures along with the advantages and disadvantages of each.

1.1.1 Brush application :

Used frequently for decorative paints, in protective coatings this is in vogue in painting complex areas where the use of spray methods would increase the loss factor. However, a word of caution about brush application, it is difficult to achieve higher thickness with a high build coating by brush application in one coat. The process is relatively slow and may result in a poor finish for thixotropic or high viscosity top coats.

1.1.2 Conventional spray:

A widely accepted method of paint application where liquid paint is atomised by an air stream. A correct combination of air pressure, air volume and fluid flow has to be selected to achieve full atomisation and a paint film free of defect. One may also face problems like sagging, pin holing and poor paint flow if the control parameters are not monitored properly.

The major disadvantage of conventional spray is that high build coatings cannot be applied by this method, as most paints have to be thinned to a suitable viscosity for satisfactory atomisation.

1.1.4 Airless spray

This is by far the fastest and most versatile method because it enables application at variable thicknesses. The equipment utilises an electric or air driven motor and a high pressure fluid pump to compress the coating to extreme pressures. The paint is then made to pass through a special tip which atomises it, and thus controls the application properties.

The main advantages of this method are :

a) High build coatings can be applied without thinning.
b) Fast rate of application achievable.
c) Reduce pollution and environmental friendly.
d) Reduced wastage of material.
e) Less air consumption and saving of power.

As already indicated, the special tips used in the spray gun and the pressure control enables one to monitor application of very low to very high viscosity products. Similarly, different slot angles produce spray fans of different widths. The selection of a particular fan width is dependent on the shape and size of the structure to be painted. The choice of fan width is also related to orifice size. For the same orifice size the paint applied per unit area will be less, wider the spray fan. The general indication of orifice sizes is given below to help in choosing the proper orifice size for a paint.

Wet film thickness	**Orifice size(mm)**
Upto 50 microns	0.02 – 0.03
100-200 microns	0.03 – 0.04
>200 microns	0.04 – 0.07
Mastics	0.10 – 0.15

There are several designs of tips available, the choice of which depends upon the finish required, the ease of application and ease of cleaning blockages from tips.

Table-1.

Mode of Application	FORD CUP: 4 Viscosity in secs.
Brushing	40-60
Spraying	30±2

Note: Viscosity measurement of high build epoxy paint may be done by viscometer.

Above table gives general guideline about consistency to be maintained for brush/spray/airless spray painting unless otherwise specified by paint manufacturer.

1.2 PREPARATION OF PAINT :

All industrial paints generally consist of a binder medium, pigment, thinner and accelerator. The composition of constituents varies based on performance requirements.

The primer which form first coat on a surface has higher concentration of pigments and extenders than the finish paint which has higher concentration of medium. The concentration and type of accelerator depends on drying cycle requirements. Air drying paints are generally single pack systems except aluminum paints, epoxy, polyurethane etc. Some of the stoving compositions are also available in single pack. The binder mediums generally used in paints are oil based Alkyd phenolics, epoxy, silicone, vinyl ester and urethane resins. Generic information is provided in Cl.3 of this specification. All the paint manufacturers mostly provide processing conditions to be followed before application. However, a few are given below :

(a) When the containers of air drying paints are opened, the material is observed for skin formation. The skin formed should be carefully removed and settled pigment has to be broken up and loosened by vigorous stirring preferably mechanically to ensure homogenous dispersion. Care should be taken to avoid air entrapment while stirring. The paint, if required may be strained through muslin cloth or 60mesh sieve.

(b) **Maturation process** :

Maturation is an important criterion for two pack products where curing takes place through chemical reaction when the components are mixed before application. The mixed paint is normally matured for about 30 minutes to initiate the reaction process which ensures thickness build up and proper drying of the paint film unless otherwise specified.

Maturation time is, however, to be adjusted depending on pot life and ambient temperature. Products having a short pot life should be allowed less maturation time as recommended by supplier to provide the adequate effect during film formation.

1.3 APPLICATION LOSSES AND SPREADING RATE ESTIMATION

It is extremely complicated to estimate accurately the quantity of paint required for a particular job since the theoretical spreading rate does not take into account the various “losses” involved during application.

In the following paragraphs general guidelines are described taking into account major areas of losses and to arrive at appropriate requirement. Usually two types of losses are considered : **“Apparent Losses”** where the paint-though on the surface-does not contribute to the required thickness, and **“Actual Losses”** where the paint is wasted.

Apparent Losses

Effect of blast profile: On a blasted surface the film thickness over the peaks is less than the thickness over the troughs. However, it is the thickness over the peaks which is most important in relation to performance of the paint coating and hence it can be considered that the paint which does not contribute to this thickness is "lost in the steel profile". The extent of paint "loss" is proportional to the surface roughness produced by blasting or in other words, the dimension and type of abrasive used.

Typical "losses" in dry paint film thickness for given blast profiles are given below:

Surface	Blast profile	DFT loss
- Steel blasted using round - Shot And shop primed	0-50 microns	10 microns
- Fine open blasting	50-100 microns	35 microns
- Coarse open blasting	100-150 microns	60 microns
- Old pitted steel-reblasted	150-300 microns (or more)	125 microns (or more)

Paint distribution loss : This is loss of paint resulting from over-application when an attempt is made to achieve the minimum specified paint thickness with reasonable certainty.

The extra paint consumed over and above that calculated from the theoretical spreading rate is dependent on the method of application as well as on the type of structure being painted. A simple structure with a high proportion of flat surfaces should not incur heavy losses, but for complex structure losses will be high. Typical details given below:

Application	Type of structures	Loss(%)
Brush + Roller	Simple structures	5%
-do-	Complex structures	10-15%
Spray } Air / Airless	Simple structures	20%
Spray }	Complex structures	60% for single coat 40% for two coats 30% for three coats

When an open complex structure is sprayed, no realistic estimate can be made of paint distribution loss. In case the specification calls for a minimum thickness at all measured points, the distribution losses would be higher than those indicated above.

Actual losses: These include the paint loss during application and wastage

Application Loss: The paint which drips from a brush or roller during transfer from the container to the surface being painted can be termed as application loss. With care, this can be discounted as a significant contribution to overall "loss".

When application is done by spraying, losses are inevitable and their extent is dependent largely on the shape of the structure being painted together with atmospheric conditions.

The following spray losses are common:

Well ventilated but confined space	5%
Outdoors in almost static air	5 – 10%
Outdoors in windy conditions	Over 20% (This figure can be abnormally high if painting is done in unsuitable windy conditions).

Paint wastage: Some wastage is inevitable like paint spill, certain amount remaining in discarded containers and in case of two pack materials mixed paint left beyond its pot life.

The following losses are common:

Single pack materials	Not more than 5%
Two pack materials	5-10%

Spreading rate estimation:

Having given by the paint supplier the theoretical spreading rate and with the preceding loss factors, it is possible to calculate the practical spreading rate, as is illustrated by the following example for guidance.

Example :

Two coats of two pack paint are to be applied by spray in a confined space to a blasted surface of complete structure to yield a DFT of 100 microns per coat. The theoretical spreading rate is 6.0 sq. mtr/ltr. What is the practical spreading rate?

	First coat
Required DFT	100 microns
Loss due to surface roughness	10 microns
Loss due to distribution 40% i.e. 100x0.4	40 microns
	150.0 microns
Loss due to application 5% i.e. 150x0.05	7.5 microns
	157.5 microns
Loss due to wastage 10% ie. 157.5x0.1	15.75 microns
	173.25 microns

Extra paint used (173.25-100) $= \frac{73.25 \times 100}{100} = 73.3\%$

	Second coat
Required DFT	100 microns
Loss due to surface roughness	Nil
Loss due to distribution 40% i.e. 100 x 0.4	40 microns
	140 microns
Loss due to application 5% i.e. 140x0.05	7 microns
	147 microns
Loss due to wastage 10% i.e. 147 x 0.1	14.7 microns
	161.7 microns

Extra paint used (161.7 – 100) $= \frac{61.7 \times 100}{100} = 61.7\%$

Total loss for two coats $= \frac{73.3 + 61.7}{2}$ 67.5%

In other words, for the two coat of two pack system, 67.5% more paint is required than would be calculated from the theoretical spreading rate.

Loss factors : In the above example the theoretical spreading rate is 6 sq.mtr/ltr. In practice 1.68 ltr. Of paint can be expected to cover 6 sq.mtr.
Therefore, the practical spreading rate is $\frac{6}{1.68}$ = 3.6 sq.mtr. /ltr.

The loss factor is usually expressed as the difference between the theoretical and practical spreading rates expressed as a percentage of the theoretical spreading rate. In the above example the loss factor is:

$$\frac{6 - 3.6}{6} = 40\%$$

Calculation of Volume Solids :

The volume solid of a paint can be calculated as follows :

$$\% \text{ volume solid} = \frac{\text{DFT(microns)} \times \text{Theoretical coverage(sq.mtr./ltr)}}{10}$$

The volume solids of a paint is an indicator of the mileage it will give at a specified thickness. A service life data published on life of paint with various polymeric medium in different environments is given in Table-II.

1.4 THINNER CONSUMPTION:

This is another important parameter and has to be closely monitored to obtain the desired performance from the paint film. In each Data Sheet a special section is devoted to thinner consumption which should be strictly adhered to. However, it should be noted that the mentioned quantity is only for adding to the paint. The consumption for an optimum environment depends on prevailing temperature, application methods, nature of surface, weather conditions and may require adjustment in thinner volume. The thinner used should be compatible with the paint and corresponds to the same batch of paint.

Adding a small percentage of extra thinner does not necessarily impair the film properties, but excess thinning increases the quantity of liquid paint without contributing to the solid content. The volume solid, after thinning, should be calculated and the resultant coverage worked out to achieve the recommended film thickness.

$$\text{Volume solid percentage after thinning} = \frac{\%\ \text{Volume solid} \times 100}{\%\ \text{thinner added} + 100}$$

2.0 SURFACE PREPARATION :

Surface preparation may be carried out as per BHEL STANDARD AA 0674101. However following instructions in general should be adhered to unless otherwise agreed upon

- Surfaces not to be painted shall be properly masked.
- Surfaces shall be cleaned by solvent cleaning method to remove oil, grease, dirt, cutting fluids and other contaminants.
- Surfaces to be coated shall be blast cleaned with suitable abrasive to the required surface finish for operating temperatures above 120 qC and a minimum of a commercial blast cleaning for operating temperatures below 120 qC.
- The average maximum blast profile shall be between 3.5 to 6.0 mils. For sand castings, average maximum surface profiles after blasting to be specified.
- All traces of abrasive and other debris shall be removed by brushing, sweeping, blowing with clean compressed air, and vacuuming before the application of any coating.

3.0 GENERIC PAINT CHARACTERISTICS:

Paint have polymeric resigns as binder mediums. These mediums are selected depending on the environment in which it has to operate.

For ease of reference, a generic description of the paint mediums are indicated below together with a specific characterisation of some of their properties.

- High solids, amine-cured epoxies:
  Polyamine-cured epoxies generally have a good resistance to chemicals and solvents.
- High build, polyamide-cured epoxies :
  Polyamide-cured epoxies exhibit a longer pot life, superior flexibility and durability compared with amine-cured epoxies. They possess adequate chemical resistance.
- High build, aliphatic polyurethanes :
  Two component isocyanate-free urethanes produce extremely hard, resistant and durable coatings. Aliphatic urethanes are preferred over aromatic urethanes because of their excellent durability and gloss retention.

- Phenolic epoxies :
  Two component, high build, amine-cured phenolic epoxy coatings have excellent resistance to a wide range of solvents and (organic) acids.

- (Alkyl) zinc silicate :
  Two component, moisture curing, zinc (alkyl) silicate coating, containing a minimum of 75% metallic zinc, is a hard, abrasion resistant coating that can withstand temperatures up to 400°C.

- Aluminium pigmented silicate :
  One component, (alkyl) silicate, zinc-free coating is suitable for temperatures up to 600°C.

- Aluminium silicones :
  Aluminium pigmented, silicone resin-based paint. Heat resistant up to 600°C. A minimum temperature of 200°C is required for 2 hours to obtain a sufficient cure.

- Silicone acrylics :
  One component, aluminium (or colour) pigmented acrylic-modified silicone resin. Heat resistant up to 350°C. Full cure can be achieved at ambient temperature.

- Zinc-rich epoxy primer :
  Two component, epoxy based primer. Developed to provide sacrificial protection to steel surfaces.

- Solvent free epoxies :
  Two component, amine cured, modified epoxies without solvent. They can be applied as a heavy duty coating up to 28 mil thick.

- Polysiloxane :
  Two component, inorganic polysiloxane. Used for heat resistance (continuous and cyclic) up to. 1110°C Current experience with this coating is good but still very limited.

- Thermally sprayed metal coatings :
  Thermally sprayed metal coatings may be used in applications where organic coatings are ineffective or cause product contamination.

- Black coal tar epoxy :
  Generally, Thixotropic amine cured two pack system. Conventional epoxy blended with high purity coal tar to impart flexibility, is mostly recommended for inner sides of water tanks.

The estimated life of the resin systems for various environments is given in Table-2.

Lead containing paints, should not be used because of the associated health and environmental restrictions that apply unless otherwise insisted upon.

Paints specifically intended for use on austenitic stainless steels or high nickel-chromium alloys shall not contain free chlorides or other halides after curing, although trace amounts in the raw materials is accepted. Chlorides or other halides tied up within the cured resin's chemical molecule are acceptable, unless they are subject to release through ageing within the temperature range specified. Such paint formulations shall also not contain metallic zinc, because of the possibility of inducing liquid metal embrittlement.

Note: It has been shown that zinc oxide or zinc phosphate, which are the more recent non-lead, non-chromate, corrosion inhibitive pigment developments, do not cause embrittlement even at 850°C.

3.1.0 PREPARATION OF THE PAINT AIR DRYING ENAMEL:

3.1.1 Removal of skin from the paint:

Before application, any skin formed on the paint in the container shall be carefully removed, any settled pigment broken up and loosened and the paint thoroughly stirred to ensure complete and uniform mixing of the constituents. Care shall be taken to avoid entering air into the paint while stirring. The paint shall be strained through a muslin cloth or 60 mesh sieve.

3.1.2 Consistency of the paint:

The paint shall be used at an appropriate consistency depending on the mode of application. Table 1 provides the general guidance.
The above consistency shall be adjusted using white spirit or recommended thinner to AA 56701depending on mode of application.

3.2.0 PREPARATION OF THE PAINT (ETCH PRIMER AND EPOXIDE PAINTS):

3.2.1 Etch primer:

Etch primer, as supplied, consists of two separate ingredients viz., primer base and accelerator. Shortly before use, mix together the primer base and accelerator in the proportions as per the recommendation of the supplier. The paint prepared as above does not require any thinning.

IMPORTANT NOTE:
After mixing, the paint shall be allowed to mature for 30 minutes unless otherwise specified. The mixed paint shall be used within 8 hours.

3.2.2 COMPOSITION:

The paint shall consist of a two pack system viz., base and accelerator, as per AA 56103.

Generally the base, shall consist of zinc tetroxy chromate pigment dispersed in Polyvinyl butyl resin solution while accelerator shall consists of orthophosphoric acid in suitable solutions like butanol, industrial methylated spirit, etc.

The base shall be in such a condition that uniform and smooth dispersion material is obtained by stirring. There shall not be any tendency for viscosity build up, gelling and pigment settlement throughout the shelf life of the paint.

Etch primer may be applied prior to epoxy paint wherever recommended.

3.2.3 Mixing of the constituents of epoxide paints:

a) These paints, as supplied, consist of two separate ingredients, namely base and accelerator. Shortly before mixing and use, these shall be thoroughly stirred. The base and the accelerator shall be accurately mixed together in the proportions as per the recommendations of the supplier.

   Accelerator should be added to the base but not the base to the accelerator. The paints shall be mixed with continuous stirring until a uniform consistency is obtained.

b) Consistencies of the paints :
   The paints mixed shall be used at an appropriate consistency depending on mode of application. Table 1 provides general guidance.

   Important Note:
   After mixing, the paint shall be allowed to mature for 30 minutes and the mixed paint shall be used within 8 hours, unless otherwise specified in, by the paint supplier. All other properties should be as per individual specification.

3.2.4 Safety precautions:

Etch primer and epoxy paints are liable to cause irritation to the skin. This may transpire into inflammation, swelling, rash or pustules on the hands, arms and occasionally on the whole body.

Following precautions should be observed while handling these materials:

i) Work place and storage rooms shall be adequately ventilated.
ii) Before starting the work, hands should be washed with soap and water and good barrier cream applied.
iii) Maximum care should be taken to avoid splashes on the skin
iv) Splashing on the skin should be immediately washed with soap and water.
v) After the work, hands, arms and face should be washed with soap and water followed by thorough drying with a clean towel.

3.3.0 PREPARATION OF THE PAINTS (ALUMINUM SILICON):

3.3.1 Mixing of paint material shall be in strict accordance with manufacturer's instructions

3.3.2 Thinning shall only be done if necessary for the workability of the paint and in accordance with manufacturer's instructions. Petroleum or mineral spirits shall be used for thinning and shall not exceed 5% by volume.

3.3.3 Application over ethyl silicate zinc -rich primer:

(a) Underlying inorganic zinc primer shall be completely cured before application of aluminum silicone topcoat.

(b) Apply one coat of aluminum silicone paint to achieve a dry film thickness of 15 - 30 µm. A thin mist coat may be necessary before full coat application to avoid top coat bubbling.

Allow to air dry for 16 hours before direct exposure to operating conditions of the heat or before curing.

All other properties should be as per relevant corporate supplier's standard.

3.4.0 PAINT APPLICATION :

3.4.1 Paint application shall comply with the requirements of individual specification and with the paint manufacturer's printed instruction.

3.4.2 Paint shall be applied at ambient temperatures preferably not below 10^{o} C.

3.4.3 Conventional air spray or airless spray application is acceptable. Brush application is also acceptable for surfaces inaccessible to spray and for touch up coats.

3.4.4 After thorough mixing of the product of two component systems, the maturation time as indicated in the manufacturer's product data sheet is to be allowed before applying the paint.

3.4.5 Short shelf life / two component paint mixture thickens as the time progresses and at the end of the pot life period, the mixture becomes highly viscous and unusable. It is best to consume mixed paint at least one hour before the end of the pot life.

3.4.6 Avoid using excess solvent than the recommended volumes since this leads to reduced dry film thickness, sagging and longer curing time.

3.4.7 Apply Epoxy Primer paint to achieve a dry film thickness of 35-50 microns and a coat of etch primer wherever recommended.

3.4.8 Allow the painted substrate to dry for 16 hrs before direct exposure to outside weather conditions or heat. In case of stoving paints, it is to be stoved at temperature and time specified in a suitable oven.

3.4.9 Apply a coat of finish paint after ensuring removal of dust, dirt and other contaminants from the primed surface. Intermediate coats of paints may be applied wherever recommended.

3.4.10 All measurements and instrument calibration shall be in accordance with the specification AA 067 41 05 and the data to be recorded in accordance with AA 067 41 06 for each job.

3.5.0 QUALITY CHECKS & INSPECTION:

3.5.1 Following points shall be ensured to achieve overall quality of the job:

(a) Compressed air used for spray application shall be free from oil, moisture and other contaminants.

(b) Steel surfaces to be painted shall be free from burrs, sharp edges, lamination, surface imperfections and any other contamination detrimental to paint adhesion finish or appearance.

(c) All surfaces to be coated have been cleaned in accordance with the requirements of BHEL STANDARD AA 067 4101.

(d) All surfaces to be coated shall be completely dry before paint application.

(e) Paint components shall be mixed as prescribed / recommended and mixed paint shall be consumed with in specified pot life.

(f) Drying / curing requirements shall be fully satisfied.

(g) Damaged paint coating shall be properly touched up before another coating application.

(h) All paint coating measurements like thickness gloss, finishing and adhesion shall be usable as per AA 067 41 05.

3.5.2 INSPECTION:

a) VISUAL:
The painted surfaces shall be free from spacks of iron, salt or dust. It shall be smooth and uniform and there will be no visible porosity, pot holes, or any other paint coating defects. If runs and sags dry spray and over spray are present these defects shall not be more than 5% in any given area (sq. feet) and cumulatively not more than 2% of total surface area unless otherwise specified.

b) Dry film thickness DFT: Dry film thickness should be measured with an appropriate measurement gauge calibrated as per AA 067 41 05. Unless otherwise specified.

c) ADHESION:
The adhesion of the primer to the steel substrate and the intercoat adhesion of the subsequent coat(s) after curing shall be determined by the application of a cross-cut test in accordance with BHEL Standard AA 067 41 05.

d) Gloss level: As per AA 067 41 05.

e) Finish: as per AA 067 41 05.

f) Shade: As per IS : 5 unless otherwise specified.

g) Coated surfaces are smooth and uniform in coverage.

h) There is no visible porosity or pot holes.

i) Unacceptable defects such as peeling, blistering cracking and damage caused by external sources are clearly marked with a mark-free chalk and with in the specification requirements.

j) Runs and sags, dry spray and over spray are not present in excess of 5% in any given square foot and cumulatively not in excess of 2% of any surface. Unless otherwise specified

k) Drying time/curing time requirements have been satisfied.

l) Holiday / pinhole detection shall be conducted on all conventional thin film thickness, having total DFT 0.5mm or less, by low voltage wet sponge method as per ASTM D5162. This is carried out after top coat applied & fully cured / dried. For tank & vessel internals 100% of the surface shall be tested. Special attention shall be paid to welds, edges & irregular surfaces for holiday / pinhole testing. For external surfaces, random inspection, which shall be representation of entire surface shall be tested. No pinhole is acceptable.

3.6.0 PAINTING SCHEMES:

Selection of painting scheme has to be made on specific operational and environmental requirements. Similarly, selection of colours have to be made suitably unless both are specified by the customer. – BHEL painting scheme for various power equipment and related components is given in annexure - II. However, any deviation from number of coats and thickness specified by customer shall be followed.

Typical painting schedules for various industrial components and painting systems are also given in Annexure III and IV respectively. For general reference.

The list of BHEL Corporate Standards on Paints is enclosed in Annexure-V.

ANNEXURE-I.

RELATIONSHIP BETWEEN `DEW POINT', AIR TEMPERATURE AND RELATIVE HUMIDITY.

Air Temp. °C	`Dew Point' in °C at Relative Humidity of								
	50%	55%	60%	65%	70%	75%	80%	85%	90%
5	-5	-3	-2	-1	0	1	2	3	4
6	-3	-3	-1	0	1	2	3	4	4
7	-3	-1	0	1	2	3	4	5	5
8	-2	-1	1	2	3	4	5	6	6
9	-1	0	1	3	4	5	6	7	7
10	0	1	3	4	5	6	7	8	9
11	1	2	4	5	6	7	8	9	9
12	2	3	5	5	7	8	9	9	10
13	3	4	5	6	8	9	10	10	11
14	4	5	6	7	8	10	11	12	12
15	5	6	7	8	9	11	12	12	13
16	5	7	8	9	10	12	12	13	14
17	7	8	9	10	12	12	14	14	15
18	7	9	10	11	12	13	14	15	16
19	8	10	11	12	13	14	15	16	17
20	9	11	12	13	14	15	16	17	18
21	10	12	13	14	15	16	17	18	19
22	11	13	14	15	16	17	18	19	20
23	12	14	15	16	17	18	19	20	21
24	13	14	16	17	18	19	20	21	22
25	14	15	17	18	19	20	21	22	23
26	15	16	18	19	20	21	22	23	24
27	16	17	18	20	21	22	23	24	25
28	17	18	19	21	22	23	24	25	26
29	18	19	20	22	23	24	25	26	27
30	18	20	21	23	24	25	26	27	28

BHEL PAINTING SCHEME FOR PRODUCT Annexure II

Sl. No.	System	Environment (See note 1)	General description	** Painting Scheme reference	Total Dry film Thickness, In µm TDFT	Remarks
1	Power Boiler	Rural	Epoxy Two pack (organic) Zinc rich and Two pack Polyurethane.	1	80	
		Industrial	Inorganic alkyl Zinc silicate, Epoxy Two pack chemical resistant and Two pack Polyurethane.	2	180	
		Coastal	Inorganic alkyl Zinc silicate, Epoxy Two pack chemical resistant and Two pack Polyurethane	3	180	
		Industrial and coastal	Inorganic alkyl Zinc silicate, Epoxy Two pack chemical resistant and Two pack Polyurethane	8	180	
2	HRSG /Industrial Boilers	Rural	Chlorinated Rubber Based, chemical resistant	4	120	
		Industrial	Epoxy Two pack (Organic) Zinc rich and Epoxy Two pack chemical resistant and Two pack Polyurethane	5	155	
		Coastal	Inorganic alkyl Zinc silicate, Epoxy Two pack chemical resistant and Two pack Polyurethane	3	180	
		Industrial and Coastal	Inorganic alkyl Zinc silicate, Epoxy Two pack chemical resistant and Two pack Polyurethane	8	180	
3	Column, Pressure Vessel, Heat Exchanger	Rural	Epoxy Two pack (organic) Zinc rich and Two pack Polyurethane	1	80	
		Industrial	Epoxy Two pack (organic) Zinc rich, Epoxy Two pack chemical resistant and Two pack Polyurethane	5	155	

** **Refer Annexure - II (a)**

Note -1 : The painting scheme specified provides life to first maintenance of 5 years, under specified environment.

Sl. No.	System	Environment (See note 1)	General description	** Painting Scheme reference	Total Dry film Thickness, in µm TDFT	Remarks
		Coastal	Inorganic alkyl Zinc silicate, Epoxy Two pack chemical resistant and Two pack Polyurethane	3	180	
		Industrial and Coastal	Inorganic alkyl Zinc silicate, Epoxy Two pack chemical resistant and Two pack Polyurethane.	8	180	
4	Tankage	Rural	Chlorinated Rubber Based, chemical resistant	4	120	
		Industrial	Epoxy Two pack chemical resistant and Two pack Polyurethane	7	175	
		Coastal	Inorganic alkyl Zinc silicate, Epoxy Two pack chemical resistant and Two pack Polyurethane	3	180	
		Industrial and coastal	Inorganic alkyl Zinc silicate, Epoxy Two pack chemical resistant and Two pack Polyurethane	8	180	
5	Rotating Equipment, Pumps, Compressors	Rural	Epoxy Two pack (organic) zinc rich and Epoxy Two pack chemical resistant and Two pack Polyurethane	5	155	
		Industrial	Epoxy Two pack chemical resistant and Two pack Polyurethane	7	175	
		Coastal	Inorganic alkyl Zinc silicate, Epoxy Two pack chemical resistant and Two pack Polyurethane	3	180	
		Industrial and coastal	Inorganic alkyl Zinc silicate, Epoxy Two pack chemical resistant and Two pack Polyurethane	8	180	

**** Refer Annexure - II (a)**

II Continued..

Sl. No.	System	Environment (See note 1)	General description	** Painting Scheme reference	Total Dry film Thickness, in µm TDFT	Remarks
6	Piping Valve Fittings	Rural	Chlorinated Rubber based, chemical resistant	4	120	
		Industrial	Epoxy Two pack chemical resistant and Two pack Polyurethane.	7	175	
		Coastal	Inorganic alkyl Zinc silicate, Epoxy Two pack chemical resistant and Two pack Polyurethane	3	180	
		Industrial and coastal	Inorganic alkyl Zinc silicate, Epoxy Two pack chemical resistant and Two pack Polyurethane	8	180	
7	Transformers Tank conservation Bushing Turact Header, Piping work support structure	Rural	Epoxy Two pack (organic) Zinc rich and Two pack Polyurethane.	1	80	
		Industrial	Inorganic alkyl Zinc silicate, Epoxy Two pack chemical resistant and Two pack Polyurethane	2	180	
		Coastal	Epoxy Two pack chemical resistant and Two pack Polyurethane	7	175	
		Industrial and Coastal	Inorganic alkyl Zinc silicate, Epoxy Two pack chemical resistant and Two pack Polyurethane	8	180	
8	Control Cubicles	For indoor installation	Epoxy Two pack chemical resistant and Two pack Polyurethane	10	170	appln. Only by spray

**** Refer Annexure -I I (a)**

Note 1: Rural = Exterior, Exposed non-polluted inland atmosphere, operating temperature upto 90º C
Industrial = Exterior, Exposed polluted inland atmosphere, operating temperature upto 90º C
Coastal = Exterior, Exposed non-polluted inland atmosphere, operating temperature upto 90º C
Industrial & Coastal = Exterior, Exposed polluted inland atmosphere, operating temperature upto 90º C

Note 2: For operating temperature 91 - 400 º C and 401 to 600 º C, the painting scheme reference no: 6 and no: 9 respectively shall be followed

BHEL Painting Schemes Details ANNEXURE - II (a)

Paint reference Scheme	Surface Prepn. Grade/ Surface profile	Primer Coat			Intermediate coat			Finish coat			Total DFT, L Q P
		Primer paint	No. of coats	DFT L Q P	Intermediate paint	No. of coats	DFT L Q P	Finish paint (See note)	No. of coats	DFT in P	
1	Shot Blasting to Sa 2 1/2 35 to 50 P	Epoxy zinc rich primer (Two pack) AA 561 14	1	50	- -	--	--	Full gloss polyurethane finishing paint AA 561 42	1	30	80
2	Shot Blasting to Sa 2 1/2 35 to 50 P	Inorganic Ethyl zinc silicate primer AA 561 13	1	75	High build intermediate Epoxy paint AA 561 12	1	75	Full gloss Polyurethane finishing paint AA 561 42	1	30	180

II (a) Continued….

Note: The shade of finish paint shall be decided based on the option of concerned unit / customer's requirement.

Paint reference Scheme	Surface Prepn. Grade/ Surface profile	Primer Coat			Intermediate coat			Finish coat			Total DFT, in P
		Primer paint	No. of coats	DFT in L Q P	Intermediate paint	No. of coats	DFT in P	Finish paint (See note)	No. of coats	DFT in L Q P	
3	Shot Blasting to Sa 2 1/2 35 to 50 µm	Inorganic Ethyl zinc silicate primer t AA 561 13	1	75	High build intermediate epoxy paint AA 561 12	1	75	Full gloss Polyurethane finishing paint t AA 561 42	1	30	180
4	Shot Blasting to Sa 2 1/2 35 to 50 µm	Chemical resistant Chlorinated Rubber base priming paint AA 561 07	2	70				Chemical resistant chlorinated rubber based finishing paint AA 561 36	2	50	120

II (a) Continued….

Paint reference Scheme	Surface Prepn. Grade/ Surface profile	Primer Coat			Intermediate coat			Finish coat			Total DFT, L Q P
		Primer paint	No. of coats	DFT L Q P	Intermediate paint	No. of coats	DFT L Q P	Finish paint (See note)	No. of coats	DFT in P	
5	Shot Blasting to Sa 2 1/2 35 to 50 µm	Epoxy based zinc rich primer (Two pack) AA 561 14	1	50	High build intermediate Epoxy paint AA 561 12	1	75	Full gloss Polyurethane finishing paint AA 561 42	1	30	155
6	Shot Blasting to Sa 2 1/2 35 to 50 µm	Inorganic Ethyl zinc silicate primer AA 561 13	1	75				Heat resistant air dry Aluminium paint Gr - I AA 561 49	2	40	115
7	Shot Blasting to Sa 2 1/2 35 to 50 µm	Chemical resistant epoxide redoxide zinc phosphate priming paint AA 561 05	2	70	High build intermediate epoxy paint AA 561 12	1	75	Full gloss Polyurethane finishing paint AA 561 42	1	30	175

II (a) Continued….

Paint reference Scheme	Surface Prepn. Grade/ Surface profile	Primer Coat			Intermediate coat			Finish coat			Total DFT, L Q P
		Primer paint	No. of coats	DFT L Q P	Intermediate paint	No. of coats	DFT in P	Finish paint (note See)	No. of coats	DFT L Q P	
8	Shot Blasting to Sa 2 1/2 35 to 50 P	Inorganic Ethyl zinc silicate primer t AA 561 13	1	75	High build intermediate epoxy paint AA 561 12	1	75	Full gloss Polyurethane finishing paint AA 561 42	1	30	180
9	Shot Blasting to Sa 2 1/2 35 to 50 P	Two pack, air drying heat resistant Polysilaxone paint AA 561 43	1	100	--	--	--	--	--	--	100

II (a) Continued….

Paint reference Scheme	Surface Prepn. Grade/ Surface profile	Primer Coat			Intermediate coat			Finish coat			Total DFT, in P
		Primer paint	No. of coats	DFT in P	Intermediate paint	No. of coats	DFT in P	Finish paint (See note)	No. of coats	DFT in P	
10	Shot Blasting to Sa 2 1/2 35 to 50 µm or Phospha-ting to coating weight of 16.15 gm per sq.m	Chemical resistant epoxide redoxide zinc phosphate priming paint AA 561 05	1	35	High build intermediate epoxy paint AA 561 12	1	75	Full gloss Polyurethane finishing paint AA 561 42	2	60	170

ANNEXURE-III

TYPICAL PAINTING SCHEDULE

PIPING, VESSELS, COLUMNS, EXCHANGERS, REACTORS, STRUCTURAL STEEL AND FIRE-FIGHTING SYSTEMS.

ITEM	OPERATING TEMPERATURE (°C)	SUBSTRATE	PAINT SYSTEM No.(Annexure-V)
PIPING, VESSELS, COLUMNS, EXCHANGERS, REACTORS etc.	<120	Carbon steel, low alloy steel	1
	<120	9% Ni steel	2
	120-200	Carbon steel, low alloy steel	3
	200-450	Carbon steel low alloy steel	4
	Ambient – 200	Stainless steel	5
	200-450	Stainless steel	6
	Ambient – 1100	Carbon steel, stainless steel	7
STRUCTURAL STEEL, LADDERS, GRATINGS etc.	-	Carbon steel, low alloy steel	1
	-	Hot dip galvanized carbon steel	8
FIRE FIGHTING SYSTEMS(above ground)	<120	Carbon steel	9

Current experience with this polysiloxane coating is good but still very limited.

This duplex system shall only be applied to hot dip galvanized steel in cases where access for future maintenance is difficult.

ANNEXURE-III (continued..)

ITEM		OPERAT-ING TEMPERA-TURE (°C)	SUBSTRATE	PAINT SYSTEM NUMBER (Annexure-V)
CRUDE OIL TANKS BOTTOM and LOWEST SHELL COURSE	INTERNAL Non-corrosive	<80	Carbon steel, low alloy steel	10*
	INTERNAL Corrosive	<80	Carbon steel, low alloy steel	11
CRUDE OIL TANKS ROOF and SHELL	INTERNAL	<80	Carbon steel, low alloy steel	10*
	EXTERNAL	<80	Carbon steel, low alloy steel	1
STORAGE TANKS	INTERNAL	<120	Carbon steel, low alloy steel	10*
	EXTERNAL	<120	Carbon steel Low alloy steel	1
		50-200	Stainless steel	5
	INTERNAL, Chemical Resistant	<60	Carbon steel, Low alloy steel	12
	INTERNAL Industrial water **	<80	Carbon steel, low alloy steel	11
LPG SPHERES and BULLETS	INTERNAL	<120	Carbon steel, low alloy steel	10
	EXTERNAL	<120	Carbon steel, low alloy steel	1
MOUNDED LPG STORAGE ***	EXTERNAL	Ambient	Carbon steel	13

* This treatment is a shop-applied temporary protection only. No further painting is required after construction.

** Primer is optional for use in industrial water tanks

*** For full details about this system, manufacturer's instructions may be followed.

CORPORATE STANDARD

Annexure-III (Continued…)

ITEM	OPERATING TEMPERATURE (° C)	SUBSTRATE	PAINT SYSTEM NUMBER (Annexure-V)
FURNACES, STACKS, FLARE STACKS And FLUE DUCTS	<120	Carbon steel, low alloy steel	1
	120-200	Carbon steel, Low alloy steel	3
	200-550	Carbon steel, Low alloy steel	14
	<400	Carbon steel, hot-dip galvanised*	15
	<200	Stainless	5
	200-450	Stainless	6
	Ambient-1100	Carbon steel, stainless steel	7**
OFF SHORE STRUCTURES, TIDAL ZONES	<120	Carbon steel, Low alloy steel	11
TOP SIDDE FACILITIES, EQUIPMENT and PIPING	<120	Carbon steel, Low alloy steel	9
	120-200	Carbon steel, Low alloy steel	3

* For long life time service (>20 years) a hot dip galvanised duplex system is preferred.

** Current experience with this polysiloxane coating is good but still very limited.

ANNEXURE-IV

TYPICAL PAINT SYSTEMS.

SYS. No.	SURFACE PREPARATION	PAINT SYSTEM		
		Primer	Inter-coat	Top-coat
1	Sa 2 ½	Alkyl zinc silicate DFT 75 microns	High build, epoxy sealer DFT 75 microns	High build, aliphatic polyurethane DFT 75 microns
2	Sa 2 ½	High build, polyamide cured, (zinc free) epoxy DFT 100 microns	-	High build, high solids, polyamide-cured epoxy DFT 100 microns
3	Sa 2 ½	Alkyl zinc silicate DFT 75 microns	-	2 coats silicone acrylic TDFT 60 microns
4	Sa 2 ½	Alkyl zinc silicate	-	2coats heat resistant, aluminium silicone TDFT 50 microns
5	Light sweep blast (steam clean if not possible)	Silicone Acrylic DFT 25 mic.	-	Silicone acrylic DFT 25 microns
6	Light sweep blast (steam clean if not possible)	Heat-resistant, Aluminium silicone DFT 25 micrones	-	Heat resistant, aluminium silicone DFT 25 microns
7	Carbon steel SA 2 ½ Stainless steel-sweep blast to surface profile of 40 microns		Polysiloxane DFT 125 microns	Polysiloxane DFT 125 microns
8.	Hot dip galvanized after light sweep blast	Zinc-rich epoxy primer DFT 40 mic.	-	High build, aliphatic polyurethane DFT 100 microns
9	Sa 2 ½	Alkyl zinc silicate DFT 75 microns	Polyamide cured, MIO pigmented, Epoxy tie coat DFT 40 mic.	2coats high solids Aluminium-pigmented epoxy TDFT 200 microns

CORPORATE STANDARD

Annexure-IV (Continued…)

SYS. No.	SURFACE PREPARATION	PAINT SYSTEM		
		Primer	Inter-coat	Top-coat
10	Sa 2 ½	Zinc-rich epoxy DFT 25 microns	-	-
11	Sa 2 ½	Polyamide-cured epoxy primer DFT 75 microns	-	Solvent-free high solids, amine-cured epoxy DFT 500 microns
12	Sa 2 ½	Amine cured, phenolic epoxy primer DFT 100 microns	Amine adduct-cured, Phenolic epoxy DFT 100 microns	High build, amine adduct-cured epoxy DFT 100 microns
13	Sa 2 ½	-	-	Solvent-free, high solids epoxy (hot applied) DFT 800 microns
14	SA 2 ½	Zinc silicate DFT 75 microns	-	Alkyl silicate Aluminium-pigmented DFT 40 microns
15	Hot dip galvanized (slightly sweep blast if aged)	Zinc-rich epoxy primer DFT 75 microns	Polyamide-cured, MIO pigmented, Epoxy tie coat DFT 40 mic.	High solids, Aluminum-pigmented epoxy DFT 100 microns

ANNEXURE-V.

LIST OF CORPORATE PAINT SPECIFICATION.

AA 561 01	ANTI-CORROSIVE PRIMING PAINT
AA 561 03	ETCH PRIMER
AA 561 05	CHEMICAL RESISTANT EPOXIDE RED OXIDE ZINC PHOSPHATE PRIMING PAINT
AA 561 07	CHEMICAL RESISTANT CHLORINATED RUBBER BASED PRIMING PAINT.
AA 561 11	ALKYD BASE RED OXIDE ZINC PHOSPHATE ANTI CORROSIVE PRIMING PAINT
AA 561 12	HIGH BUILD INTRMEDIATE EPOXY PAINT
AA 561 13	INORGANIC ETHYL ZINC SILICATE PRIMER
AA 561 14	EPOXY BASED ZINC RICH PRIMER -TWO PACK
AA 561 26	HIGH QUALITY FULL GLOSSY OUTDOOR FINISHING PAINT
AA 561 27	NON-YELLOWING FULL GLOSSY WHITE PAINT
AA 561 28	ALUMINIUM PAINT FOR GENERAL PURPOSES
AA 561 31	CHEMICAL RESISTANT EPOXIDE FINISHING PAINT
AA 561 32	OIL RESISTANT, AIR DRYING, SYNTHETIC ENAMEL
AA 561 34	HEAT RESISTANT AIR DRY ALUMINIUM PAINT - Gr. 2 (TEMPERATURE UPTO 400^0 C)
AA 561 35	HIGH BUILD BLACK COAL TAR EPOXIDE PAINT
AA 561 36	CHEMICAL RESISTANT CHLORINATED RUBBER BASED FINISHING PAINT .
AA 561 40	EXTRA HIGH BUILD BLACK COAL TAR EPOXIDE PAINT
AA 561 42	POLY URETHANE FINISHING PAINT
AA 561 43	TWO PACK, AIR DRYING, HEAT RESISTANT POLYSILOXANE PAINT.
AA 561 49	HEAT RESISTANT AIR DRY ALUMINIUM PAINT - Gr.1 (TEMPERATURE UPTO 600^0 C)
AA 561 59	EPOXY POLYESTER POWDER COATING MATERIAL
AA 561 60	EPOXY POWDER COATING MATERIAL

CORPORATE STANDARD

TABLE - II
Estimated Service Life Years, Before First Maintenance Painting) of Paint Protective Coating, Galvanizing and Zinc-Rich Systems.

Sl. No.	Number of coats	Coating system	Surf. Prep SSPC *	Minimum DFT mill or microns.	Maint.sched	Sea coast Maint.	Sea coast Heavy Industrial	Caustic	Acid	Fresh water Immersion	Salt water / Brine immersion	Ammonia	Chlorine	Solvents / Gasoline	Mild	Moderate	severe	Dry heat resistance °C
1	2	Alkyd primer/top	2/3	4.0 100	I	1	1	0.5	0.5	N	N	0.5	0.5	0.5	3	2	1	66-94
2	3	Alkyd primer/top	2/3	6.0 150	I	2	2	1	1	N	N	1	1	1	6	4	2	66-94
3	2	Alkyd primer/ silicone alkyd	6	4.0 100	I	2.5	2.5	1	1	N	N	1	1	1	7	5	2.5	149-177
4	2	Universal primer /HB epoxy	2/3	6.0 150	I	4	3	3	2	N	N	3	2	3	7	5	3	121-149
5	3	Universal primer/ HB epoxy/ Acrylic polyurethane	2/3	7.5 180	I	5	3	3	3	N	N	3	3	3	9	6	4	149
6	2	Epoxy primer / HB epoxy	2.3	6.0 150	I	4	3	3	2	N	N	3	2	3	7	5	3	121-149
7	2	Epoxy zinc/ HB epoxy/ Acrylic polyurethane	6	7.0 175	I P	6 9	3 4.5	3 4.5	4 6	N N	N N	3 4.5	4 6	5 7.5	11 16.5	8 12	5 7.5	149
8	3	Epoxy zinc/HB Epoxy / Acr. Ure	10	9.0 225	I P	8 12	6 9	6 9	7 10.5	N N	N N	6 9	7 10.5	6 9	15 19.5	10 15	7 10.5	149

* Rust grades as per SSPC Vis-2 or SSPC D- 610:

	CORPORATE STANDARD	AA0490004
		Rev. No. 01
		PAGE 1 of 8

SEAWORTHY PACKING
(PACKING INSTRUCTIONS FOR GENERAL COMPONENTS / ASSEMBLIES / EQUIPMENT)

1 GENERAL

This standard lays down packing instructions for seaworthy packing of Components /Assemblies/ Equipment to be dispatched against Customer's contracts, for which there are no special instructions issued by the Engineering Departments.

The Components/Assemblies need to be packed suitably to avoid physical damage & corrosion during transit for storage. For specific applications the concerned engineering department shall issue a product standard. Reference of this standard, must appear in the Shipping list/Packing List.

2 SCOPE

This procedure gives minimum guidelines for seaworthy packing to be complied with for packing of Components /Assemblies / Equipment. This packing shall be suitable for different handling operations and for the adverse conditions during transportation and during indoor / outdoor storage for periods more than one year.

3 CROSS REFERED SPECIFICATION

- Multi-layered cross laminated plastic film : AA51420
- Packing Wood : AA51401
- Silica gel : AA55619
- Thermocole : AA51416
- Packing slip holders : AA7240901
- Corrugated Fibre Board : AA51414
- Rubber sheet : AA59001
- VCI paper : AA51406
- High quality full glossy out door finishing paint : AA56126
- Polyethylene air bubble film : IS 12787
- Structural steel - standard quality (plates, sections, strips flats & bars) : AA10108
- International Standards For Phytosanitary Measures No. 15 : ISPM-15:2009

4 WOOD SPECIFICATION FOR PACKING

The wood shall conform to specification AA51401.

5 TYPE OF PACKING

The following 5 types of packings have been standardized for packing of General Components /Assemblies.

- 'OP' - Open Type
- 'PP' - Partially Packed
- 'CP' - Crate Packing - Components/Equipment requiring physical protection

Revisions: Committee changed from MRC-M&CD to PGC-Packing			**APPROVED:** PROCEDURAL GUIDELINES COMMITTEE – PGC (Packing)		
Rev. No. 01	Amd. No.	Reaffirmed	Prepared HPEP, Hyderabad	Issued Corp. R&D	Dt. of 1st Issue 17-08-2013
Dt: 12-06-2018	Dt:	Year:			

– 'CQ' - Case Packing - Small medium Components/ Assemblies/ Equipment which require corrosion & physical protection
– 'CR' - Case Packing - Electrical Components/Assemblies which require special packing viz. Water Proof, Shock Proof, etc.

6 DESCRIPTION OF TYPES OF PACKING

The various types of packing, as standardized above, are described below.

6.1 'OP' - Open Type

In case, of components which are not affected by water & dust & do not require special protection &, are generally not machined, shall be sent as open packages. However these components may be sent in crates, wherever necessary.

6.2 'PP' - Partially Packed

Components which need special protection, at selected portions only, shall be dispatched partially packed. Machined surfaces should not be allowed to come directly in contact with the wood. Such surfaces after application of TRP should be protected with Multi-layered cross laminated plastic film to AA51420.

6.3 'CP' - Crate Packing – General

Assemblies/Components which need only physical protection from the point of view of handling shall be dispatched duly packed in crates.

6.4 'CQ' - Case Packing - Machined Components/Assemblies/Equipment

a) Small & Medium sized components/assemblies/equipment due to size/weight & to avoid handling, and pilferage, problems shall be packed in Case/Containers.
b) Wherever required adequate quantity of silica gel to AA55619 or VCI Powder/ Tablets, packed in thin muslin cloth cotton bags shall be suitably placed.
c) Small machines/components of less weight shall be provided with suitable cushioning. Wood Wool/Expanded Polyethylene Foam Sheet, if used, shall be sandwiched between polyethylene sheets and sealed.
d) The components inside the case shall be entirely covered with Multi-layered cross laminated plastic film to AA51420, where-ever required.

6.5 'CR' - Case Packing - Electrical & Electronic Components/Assemblies

Delicate components likely to be damaged e.g. Gauges, Instruments etc. are to be wrapped in waxed paper or polyethylene air bubble film and packed in cartons.

a) Adequate quantity of Silica gel to AA55619 packed in cotton bags, of 100 grams each are to be suitably placed in the cartons. The cartons shall be entirely covered with Multi-layered cross laminated plastic film to AA51420, before being packed in the cases.
b) VCI Powder/Tablets can be used as an alternative to Silica Gel to AA55619.
c) Empty space in the cartons shall be filled with small chips of Expanded Polystyrene (Thermocole), Wood Wool etc. Polyethylene air bubble film shall conform to IS 12787/AA51420 Expanded polystyrene (Thermocole) shall conform to AA51416.
d) The cartons shall be manufactured from corrugated Fibre Board, meeting requirements of AA51414.

6.6 Volatile Corrosion Inhibitor (VCI) Paper

a) Un-protected surfaces of steel and cast iron components, tools bearing, shaft seals etc. are covered with VCI paper. VCI paper has been impregnated with corrosion inhibitors which by evaporation and chemical conversion protect metals in an enclosed area against corrosion.
b) 7 m^3 VCI paper is necessary for 1 m^3 of packed item approximately as per AA51406.

Application Limitation:

VCI paper shall not be used for components made of aluminium, aluminium alloys as well as Zinc, copper, brass, cadmium and silver.

VCI powder is sprinkled inside the piping components ends shall be protected with end cover as specified in plant standards, drawings.

6.7 Moisture Absorber

Silica gel is used for this purpose to protect the contents over sufficiently long time from corrosion. At the time of use, silica gel should be so dried that its colour becomes dark blue. These shall be filled in small cotton bags. Before sealing the equipment, the silica gel bags should be kept inside the polyethylene film cover at different locations. The quantity of silica gel should not be less than 1.0 kg per cubic metre volume of the packing box

7 TYPE OF CASES

For specific requirement of packing the cases are to be provided with Tongue and Groove joints.

8 PREPARATION OF PACKING CASE

1) The base of the case shall be made of wooden batons for planks giving necessary reinforcement, such that the bottom of the equipment is at a height of 100 to 200 mm from the ground level depending upon size, ft weight of equipment. However for packing cases of smaller size equipment can be at a height of 40 mm from the ground level.
2) In case of 'CR1 - Packing Viz. Electrical ft Electronic components for instruments/assemblies, a rubber sheet, Self-expanded polyethene foam sheet, preferably 10 mm thick, shall be fixed on to the base to act as cushioning to the equipment.
3) The four sides, shall be lined, from inside with multi-layered cross-laminated polyethylene sheet of 90GSM as per AA51420 and tacked at suitable places.

   Whenever specified the top cover will have a layer of multi-layered cross laminated polyethylene sheet of 90 GSM over the cover. This should project about 100 - 250mm on all sides.

   It is preferable to have a single piece of the above Multi-layered cross laminated polyethylene sheet fixed on the four sides. In case jointing is unavoidable, it should be done by overlapping of approximately 100mm.
4) Place the Components/cartons with corrosion inhibitors duly applied wherever necessary for place suitably, thin muslin cloths bags containing 100 grams (approx.) of activated Blue Silica Gel to AA55619, wherever necessary. Alternatively VCI Powder or Tablet may be used.
5) In case, depression is formed, at the top, after the equipment is lowered, provide ply board/wooden batons.
6) Cover the whole equipment with polyethylene sheet of at least 100 micron thickness, on all sides preferably by a single piece.
7) For indoor panels/equipment, provide suitable packing batons with covering of Thermocole/expanded soft polyethylene foam/polyethylene air bubble film wrapped with suitable cords, to avoid cutting of the polyethylene sheet so that finished surface is not damaged.
8) Empty space in the box shall be filled with adequate cushioning material e.g. Thermocole Chips, Wood Wool etc. to avoid movement for shocks. Alternatively put wooden blocks/batons wherever necessary.
9) The inner side of the top cover shall be lined with polyethylene sheet, of at least
10) 100 micron thickness, which shall project approximately 25 to 150 mm depending upon the size of the case on all sides of the top cover shall be provided below the top cover. This projection, after nailing the top cover, shall be folded over, on the sides of the crates ft tacked, to, prevent ingress of water from the top.

9 STEEL CONTAINERS

Steel containers for packing can be used in case of repeated supplies of the same equipment. Empty steel containers are to be returned back from customer's end and to be reused for the next supplies.

The containers are to be made of structural steel as per AA10108 with proper reinforcement with I, C and T Sections.

Following precautions are to be taken during packing:

– Put the Components/Assemblies/Equipment in the steel container properly. Cover the Components/Assemblies/Equipment with polythene.
– To arrest the movement in the steel container necessary wooden Blocks/Batons may be put.
– Put cover on steel, container and Bolt Properly.

10 SEALED PACKING

Components sub-assemblies and assemblies sensitive to climatic conditions shall be packed seal tight. All the openings of the sensitive components, sub-assemblies and assemblies shall be blanketed to prevent the ingress of dust and moisture.

The components sub-assemblies and assemblies are completely covered with 2 layers of polyethylene sheet. All sharp corners and edges are to be protected by rubber mats to prevent the polyethylene sheet from damage. Top surface of the case shall be free from dents to prevent rain water pockets.

11 SLING PLATE

Sling plate shall be provided to prevent damage to the packing box during lifting. Size of the sling plate shall be selected depending upon the net weight of the consignment.

12 PACKING SLIP HOLDERS

Two nos. steel packing slip holders, specification no. AA7240901 containing the packing list, sealed in thick polyethylene film, shall be fixed one inside and the other outside the packing box.

13 GENERAL PRECAUTIONS

a) While fixing nails during packing, necessary care shall be taken to ensure that materials used for protection inside the case e.g. paper, polyethylene sheet, coir etc. do not get damaged.
b) Sling protection brackets to be provided on cases wherever required.
c) It shall be ensured that all stencil marks external, front & rear sides of the casing shall be of water proof Material to prevent obliteration in transit.
d) The various caution signs shall be marked with stencil on both sides of the packing box.
e) Do not pack any other Mechanical items with this case.

THE FOLLOWING DETAILS ARE TO BE MARKED ON THE PACKING CASES.

a) Address of consignee.
b) Purchase Order No./ SO No/WO No.
c) Description of item or title of packing list.
d) Case identification Number/ Packing List No.
e) Net Weight.
f) Gross Weight.
g) Dimensions of box
h) Marking showing upright position.
i) Marking showing sling position.
j) Marking showing umbrella (i.e. for machines/components to be stored under covered storage.

k) Loading and unloading precautions

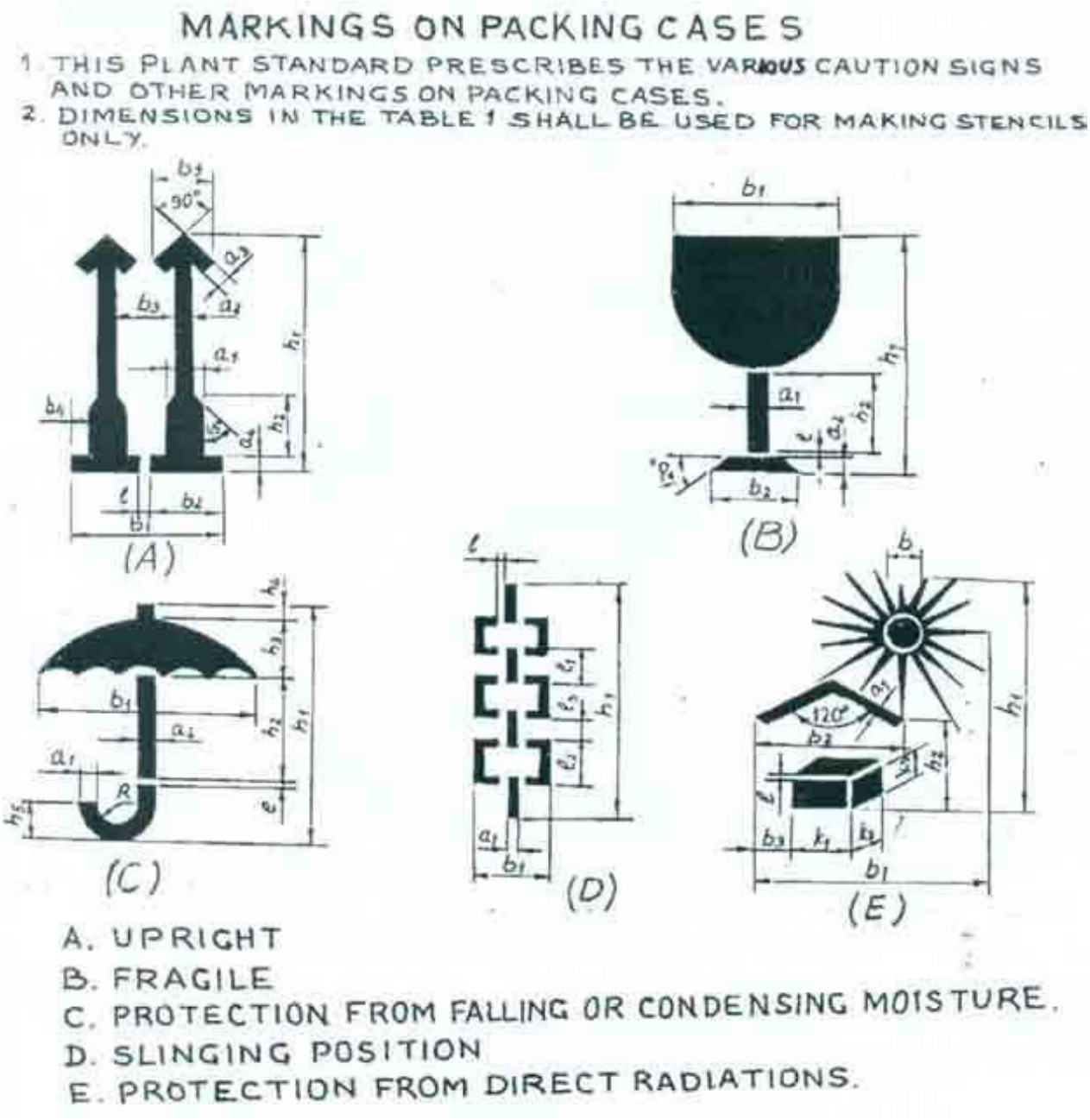


Figure 1

CENTER OF GRAVITY

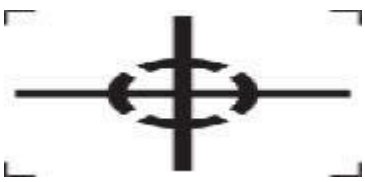


Figure 2

CORPORATE STANDARD

Table 1

DESIGNATION		DIMENSIONS IN mm.																						
		a_1	a_2	α_3	a_4	b_1	b_2	b_3	b_4	b_5	b	ℓ	h_1	h_2	h_3	h_4	h_5	K_1	K_2	K_3	ℓ_1	ℓ_2	ℓ_3	R
A	1	12	5	5	4	52	25	19	8	21	–	2	84	23	–	–	–	–	–	–	–	–	–	–
	2	17	7	7	6	75	36	29	11	30	–	3	119	33	–	–	–	–	–	–	–	–	–	–
	3	24	10	10	8	104	50	38	16	42	–	4	168	46	–	–	–	–	–	–	–	–	–	–
	4	34	14	14	11	147	71	59	23	60	–	5	239	65	–	–	–	–	–	–	–	–	–	–
B	1	5	5	–	–	50	33	–	–	–	–	2	84	25	–	–	–	–	–	–	–	–	–	–
	2	7	7	–	–	71	47	–	–	–	–	3	119	36	–	–	–	–	–	–	–	–	–	–
	3	10	10	–	–	100	66	–	–	–	–	4	168	50	–	–	–	–	–	–	–	–	–	–
	4	14	14	–	–	142	94	–	–	–	–	5	239	71	–	–	–	–	–	–	–	–	–	–
C	1	4	3	–	–	66	–	–	–	–	–	2	80	39	19	5	11	–	–	–	–	–	–	6
	2	6	4	–	–	85	–	–	–	–	–	3	114	55	27	7	16	–	–	–	–	–	–	9
	3	8	6	–	–	120	–	–	–	–	–	4	160	78	38	10	22	–	–	–	–	–	–	12
	4	11	9	–	–	170	–	–	–	–	–	5	227	110	54	14	31	–	–	–	–	–	–	17
D	1	6	–	–	–	30	–	–	–	–	–	4	148	–	–	–	–	–	–	–	30	30	10	–
	2	9	–	–	–	42	–	–	–	–	–	5	209	–	–	–	–	–	–	–	42	42	14	–
E	1	3	–	–	–	69	47	10	–	–	16	2	91	26	–	–	–	17	8	11	–	–	–	–
	2	4	–	–	–	98	67	15	–	–	23	3	128	33	–	–	–	24	11	16	–	–	–	–
	3	6	–	–	–	138	94	20	–	–	32	4	182	62	–	–	–	34	16	22	–	–	–	–

Black and Red Marking Ink to IS: 1234 "Ink, Stencil, Oil Base, For Marking Porous Surfaces" or duplicating ink stencilling, oil base for marking porous surfaces.

All cases containing fragile items are to be stencilled with red marking and stencilling paint/ink.

"HANDLE WITH CARE", "FRAGILE DO NOT TURN OVER".

Besides the caution signs the product information shall be stencilled of letters with 13mm to 50mm height.

In case of consignment consists of more than one package, each package shall carry its Package No. as given in shipping list. All caution signs shall be stencilled in higher quality full glossy out door finishing paint red in colour (AA56126). All other markings shall be carried out in black enamel (AA56126).

Caution signs & other markings shall be stencilled on both the end shooks & the side shooks. Caution sign (for slinging) shall be stencilled only on side shooks at the appropriate place.

Note: In case the size of package is small for using the stencils, then hand written letters/figures shall be allowed.

14 PROCEDURE FOR HANDLING OF COMPONENTS

The purpose of this procedure is to protect the quality of the components/equipment while handling in various stages of manufacturing packing & despatching.

14.1 Adequate care shall be taken in handling the material, and components to avoid damage during receipts, storage issue manufacture & despatch operations.

14.2 Appropriate material handling equipment like fork lifters, cranes etc. Shall be used where needed.

14.3 Lifting by crane and transportation by trolley of critical items and large components like rotors castings etc. Shall be done carefully.

14.4 For critical items, where specified, special handling fixtures shall be used for lifting.

14.5 Slings and shackles used for lifting the components/equipment shall be checked for fitness and suitability before use.

14.6 Slings used on machined surfaces shall be suitably padded. No slings shall be used on journal surfaces.

14.7 Precision machined components like blades, catches, rollers etc. Shall be lifted using suitable wooden pallets.

14.8 HANDLING OF COMPONENTS ON RECEIPT/DESPATCH:

Before loading/unloading a packing case from the carrier look for the following shipping instructions painted on the packing case.

– The markings showing the upright position.

– The markings showing the sling position

– Markings showing the fragile contents.

– Other required markings as per Clause No. 13

14.8.1 Appropriate cranes and slings should be used for different components/ cases. Slings should normally make an angle as minimum as possible (width wise) but in no case more than 15º.

14.8.2 Handling and lifting should be done without jerks or impacts.

14.8.3 Immediately after receipt of the goods, the packing should be examined all-round for any sign of damage. If necessary, lift the cover or a number of boards of the case so as to make the contents visible. In the event of sealed packing being used the plastic sheeting should not be damaged. It is imperative that the packing material is restored in original condition after the inspection.

14.8.4 On receipt of the equipment it should be checked with the shipping list and missing or damage if any should be reported immediately. It is important to arrange for immediate examination to determine the extent of the damage, the cause of the damage and where applicable the person or persons responsible for the damage. According to general practice when transporting by railway or by road vehicle the carrier concerned should be immediately called upon (within specified periods) for jointly establishing a statement of the damage. This is essential as a basis for a subsequent claim and possible damage report to the insurance company.

14.8.5 Protective coating applied on machined surfaces should not be disturbed. The plastic covering should be put back carefully so that it prevents ingress of dust and moisture. Some packing may have vapour phase inhibitor (VPI) paper enclosed inside the packing cases. This should be restored to its original place as far as possible.

14.8.6 Silica gel and such other chemicals kept in the box as desiccants and indicators should also be left in the box itself.

15 GI SHEET

The packing cases are covered with GI sheet on outside for sides and top; inside for bottom as per the Figure-3.

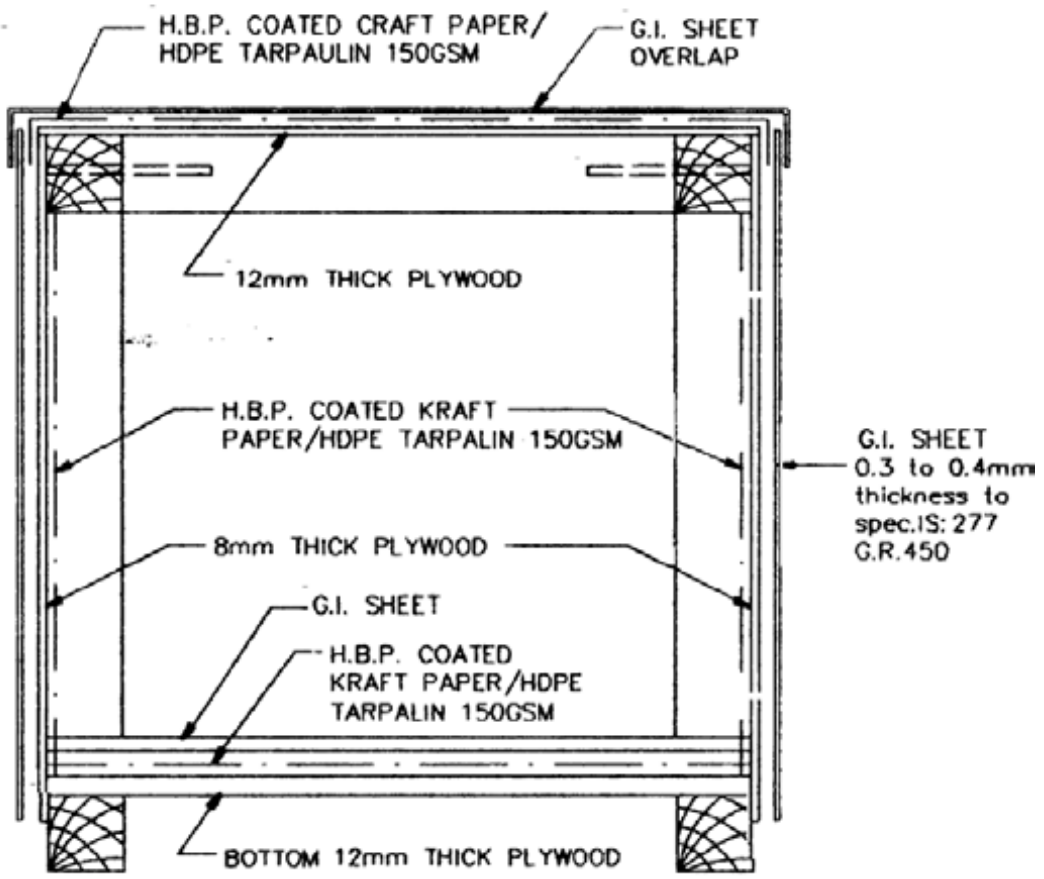
16 TREATMENT of Wood

Treatment of wood is as per ISPM 15: 2009

17 PROVISION FOR INSPECTION

This clause is applicable only where contractual requirement of customer is there. For other packings this is not applicable.

Each transportable packing's shall have provision for inspection by customer authority etc. during transport from origin of dispatched till destination. This inspection may require opening of the package and subsequently closing it again. For this purpose suitable designed opening with bolted cover shall be provided. Such an opening shall be clearly marked as "OPENING" with clear instruction for opening & closing written on this cover. For large consignment the size of the opening shall be suitable to facilitate entry of personnel.



CLOSED PACKING CASE WITH G.I.SHEET SHOWING LAYERS OF PACKING MATERIALS

Figure 3

VACUUM PACKING FOR STAMPINGS

1 GENERAL

This standard lays down the packing instructions for packing of Stamping to be dispatched against Customer contracts.

2 SCOPE

This procedure covers method of packing stamping in a wooden packing boxes with vacuum packing.

3 OBJECTIVE

To establish a rust proof safe packing procedure and where the components required to protect against temperature and humidity. In general minimum temperature +5 deg C and maximum temperature 45 deg C, and relative humidity between 10% to 40%.

4 PACKING BOX

Wooden Box shall be made as per BHEL Standard AA0490010 for Domestic/ AA0490009 for Export/ AA0490004 for Seaworthy packing. Size of the box as per the contract requirement which has to be checked by QC.

5 PACKING PROCEDURE

a) Only QC cleared packing wooden Boxes shall be used for Packing of stampings.

b) Stampings marked by QC with “OK” stickers only need to be packed. Varnished stampings are to be brought down to room temperature before labelling them “OK” for packing. Do not pack hot/warm stampings that have just received after varnishing.

c) Stampings are to be stacked in proper alignment and to be kept in packing wooden boxes of specific size.

6 Vacuum Packing

a) Turbo generator stamping of HEEP-Haridwar and Hydro stator and Hydro rims stamping of HEP-Bhopal will be packed in Vacuum Bag.

b) The stack of stampings shall be placed over porous plastic sheets (for Cushioning) with total thickness of at least 5mm and shall be wrapped with first layer of aluminium barrier bag (vacuum bag), second layer of VCI Paper (Vacuum Corrosion Inhibitor as per BHEL Standard AA51406). The VCI paper must contact stacked stampings. (Refer Figure-1).

c) Silica gel packets are to be placed inside the vacuum bag (between stamping and VCI paper) uniformly distributed around the stampings to remove/ prevent moisture. Total quantity per box should be a minimum 1.5 kg for packing box with a single stack and minimum of 2 kg for a double stack box. In order to cover the maximum space inside the box, small quantity packets 25 gm, 50 gm and 100 gm uniformly distributed all-round the box.

d) After final clearance from QC by putting green stickers on stack stampings, Vacuum bag should be secured in position and properly sealed using heat sealing machine and air to be drained using vacuum pump. At the time of the evacuation the vacuum inside the pack should be less than 0.5 ata.

e) The top covers of boxes shall be sealed only after final clearance from QC for confirmation of above.

f) All boxes should be covered by water proof tarpaulin over top and on all sides.

g) The packing boxes shall be covered with GI sheets (0.25-0.40mm thick) on all the sides for Export/ Seaworthy packing.

h) Vacuum packing room temperature and Relative Humidity should be maintained as mentioned below:

Min. +5 deg. C and Max. 45 deg. C, Relative humidity between 10% to 40%.

7 Aluminium Barrier Laminated Bags

Material must be a first ply of a relatively tough, bi-axially oriented film of organic polymer adhered to second ply of metallic foil/coating and a third ply of a tough polymer such as polyethylene with proper flexibility.

Bags are to be supplied with five sides' sealed and top cover in loose form. Sealing width should be 8 mm minimum.

Properties	Units	Value
Weight	g/m^2	150+ 5 GSM
Tensile Strength	N/mm^2 MD	40 (min)
	N/mm^2 TD	41 (min)
Water vapour Transmission	g/m^2	0.01 in 24 hrs. at 38 degree C & 90% RH (max)
Oxygen Transmission	cm^3/m^2	0.02 in 24 hrs at 38 degree C & 90 % RH (max)
Sealing Temp.	Degree C	180 - 220 degree C

8 MARKING OF PACKING BOX

a) Box No.

b) P.O. No.

c) Product Name

d) Project / Customer Name

e) Consignee

f) Water proofing (Umbrella Stencilling)

g) Upside direction

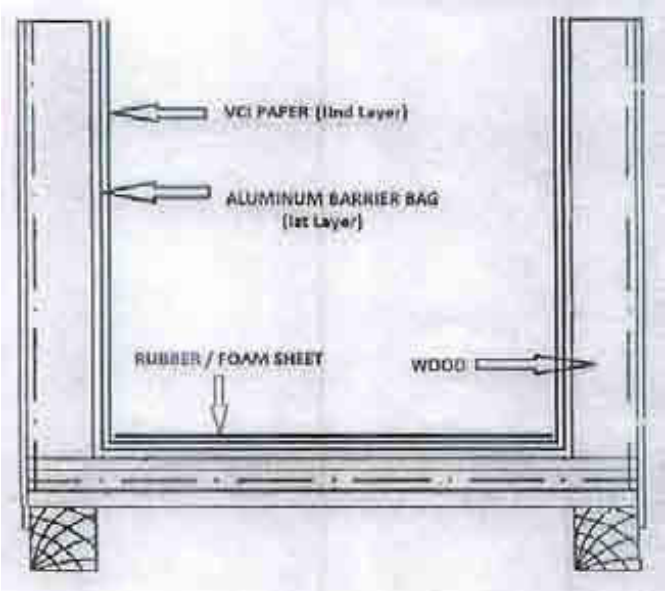


Figure 1

Figure 2

Figure 3

Figure 4

Figure 5

Figure 6

Figure 7

Figure 8

Figure 9

Figure 10

Figure 11

Figure 12

VACUUM PACKING FOR ELECTRONIC COMPONENTS

1 GENERAL

This standard lays down the packing instructions for packing of components / Electronic module / Assemblies to be dispatched against Customer contracts.

2 SCOPE

This procedure covers method of packing electronic components using vacuum packing in a wooden packing boxes.

3 OBJECTIVE

To establish a rust proof safe packing procedure and where the components required to protect against temperature and humidity. In general minimum temperature +5 deg C and maximum temperature 45 deg C, and relative humidity between 10% to 40%.

4 PACKING BOX

Wooden Box shall be made as per BHEL Standard AA0490010 for Domestic/ AA0490009 for Export/ AA0490004 for Seaworthy packing. Size of the box as per the contract requirement which has to be checked by QC.

5 PACKING PROCEDURE

a) Cleaning parts shall be thoroughly cleaned just before VCI (Volatile Corrosion Inhibitor) Vacuum packing. Finger prints on cleaned items are to be avoided as the same are very corrosive.

b) VCI Rust preventive oil (Ferrous grade oil base) shall be applied to all the components to withstand any corrosion.

6 VCI VACUUM PACKING

a) Bubble wrapping the items VCI vacuum packing.

b) Appropriate vapour corrosive packets one pouch (1 gm. /pouch) of VCI Anticorrosive Powder and one pouch (10gm./ pouch) of VCI Desiccant per 1000 cub. meter packing space shall be placed inside the VCI vacuum packing.

c) All the components shall be separately packed using VCI laminated Aluminium foils from which air/moisture are removed by the air vacuum device and sealed thoroughly using heat sealing machine. At the time of the evacuation the vacuum inside the pack should be less than 0.5 ata.

d) One identification slip containing component information such as description of item, Material No. Customer PO, Item No. Quantity etc. shall be put inside the VCI vacuum packing.

e) Top cover of the wooden box shall be sealed only after final clearance from QC for confirmation of above.

f) All boxes should be covered by water proof tarpaulin over top and on all sides.

g) The packing boxes shall be covered with GI sheets (0.25 -0.4mm thick) on all the sides for Export / Seaworthy packing.

h) Vacuum packing room temperature and Relative Humidity should be maintained as mentioned below:

Min. +5 deg. C and Max. 45 deg. C, Relative humidity between 10% to 40%.

7 COMPONENTS REQUIRED

7.1 VCI laminated Aluminium foil

Volatile Corrosion Inhibitor (VCI) safe foil shall be with aluminium barrier laminated which is flexible, heat sealable, water vapour and anticorrosion resistant barrier laminate of polyester, Aluminium foil and VCI Polyethylene. It is used as a primary packaging material for packing metal components and sealed with the help of a heat sealer after vacuuming with vacuum machine maintaining the humidity level below 40 RH inside the package.

7.2 Composition construction of VCI laminated Aluminium foil

a) PET Film : 12 Microns
b) Bonding layer : 2 Microns
c) Aluminium Foil : 9 Microns
d) Bonding layer : 2 Microns
e) VCI Poly film : 100 Microns
f) Total thickness : 125 Microns + or – 5%

7.3 Properties of VC Laminated Aluminium foil

a) Basic Weight : 138 gsm +/- 8%
b) Sealing condition : 180 C/ 2 sec
c) Tensile strength
   MD: 20 kgf
   CD: 18 kgf
d) Tear Strength
   MD 4.8 kg
   CD:3.4 kg
e) Heat Seal Strength : 30.380 N/cm
f) WVTR Value : 0.05gms/m /24 hrs.
g) OTR Value : 0.1 cc/m/24 hrs

8 MARKING OF PACKING BOX

Mark the following information on the two adjacent sides of the each package

a) Material No.
b) Customer PO
c) Item No.
d) Quantity
e) Storage Requirement : Indoor
f) Content Description : Electronic Module
g) Net weight (in kg)
h) Dimension (L x W x H in centimetres)
i) Project Name
j) Consignee
k) Water proofing (Umbrella Stencilling)
l) Upside direction

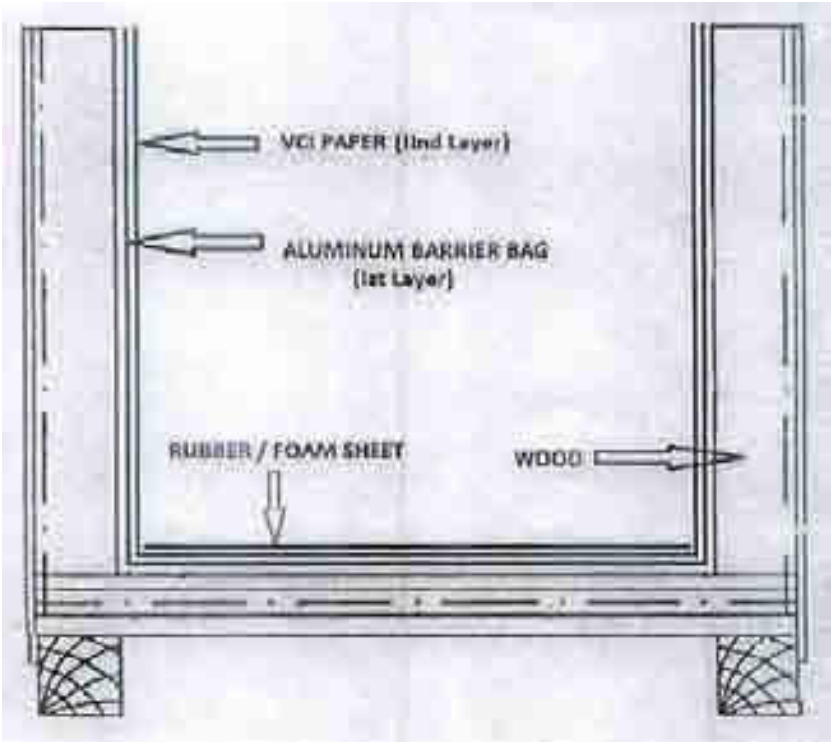

VCI PAPER (IInd Layer)
ALUMINUM BARRIER BAG
(Ist Layer)
RUBBER / FOAM SHEET
WOOD

Figure 1

VACUUM PACKING FOR ELECTRICAL COMPONENT

1 GENERAL

This standard lays down the packing instructions for packing of components / Electrical components Stator/ Rim punching, Wound Pole/ Field Coils and Stator coils / bars to be dispatched against Customer contracts.

2 SCOPE

This procedure covers method of packing component in a wooden packing boxes.

3 OBJECTIVE

To establish a rust proof safe packing procedure and where the components required to protect against temperature and humidity. In general minimum temperature +5 deg C and maximum temperature 45 deg C, and relative humidity between 10% to 40%.

4 PACKING BOX

Wooden Box shall be made as per BHEL Standard AA0490010 for Domestic/AA0490009 for Export/ AA0490004 for Seaworthy packing. Size of the box as per the contract requirement, which has to be checked by QC.

5 PACKING PROCEDURE

a) All items packed are to be marked by QC with “OK” stickers. Varnished stator punchings are to be brought down to room temperature before labelling them “OK” for packing. Do not pack hot/warm stator punchings that have is just received from the varnishing.

b) Packing of stator punchings, wound pole/ field coils and stator coils / bars should be done in a covered shed.

c) Packed materials are to be stacked in proper alignment and to be kept in wooden packing.

6 Additional Packing Methodology for Stator / Rim Punchings (Double stacking) only

In order to eliminate the use of studs avoid double stack packaging per box. Where double stacked packing boxes are unavoidable, the stator /rim punchings are to be securely tightened using GI studs, nuts and soft material washers (rubber/plastic). GI studs, nuts and soft material only to be used in case of double stacking of rim / stator punchings (with holes). Use soft rubber washers to seal the punctured opening at the bottom from where the studs pass in each layer of VCI (Volatile Corrosion Inhibitor) paper, polythene and tarpaulin sheet in case of rim /stator punchings (with holes).

a) GI studs with rubber washer to be placed initially inside the wooden packing box.

b) Over the wooden base, place water proof tarpaulin sheet.

c) Rubber washer shall be placed after the layer of tarpaulin sheet.

d) Then place a layer of porous plastic sheet with total thickness of at least 5mm (for cushioning and reduces the chances of damage to punchings).

e) Place the Aluminium Barrier laminated Bags over this porous sheet, place the rubber washer over it.

f) Place VCI papers on the Aluminium barrier bag and fix with rubber washer.

g) PVC Pipes shall be inserted over the GI studs. These pipes are to be used to cover each stud, to protect its direct contact and hence rubbing with punchings.

h) Now place the stack of punchings over the VCI paper and securely tighten the punchings using nuts and soft material, washers.

i) Each layer should be secured in position. Wrap the punchings with VCI paper and properly sealed separately using an adhesive tape.

j) Silica Gel packets are to be placed over the VCI paper and uniformly distributed inside the boxes on the VCI paper to remove/prevent moisture.

k) Aluminium barrier laminated bag has secured in position and properly sealed by using heat sealing machine and air to be drained out by using vacuum pump. At the time of the evacuation the vacuum inside the pack should be less than 0.5ata.

Use two separate VCI papers for doubled stacked boxes independently covering each stack. Similarly two Aluminium barrier laminated bag are to be used to wrap the two stacks independently, as explained above.

7 Additional Packing Methodology for Wound Pole/ Field Coils and Stator Coils/Bars only

a) Over the wooden base, place the waterproof tarpaulin sheet.

b) Then place a layer of porous plastic sheet with total thickness of at least 5mm (for cushioning and reduces the chances of damage to Wound pole/field coils and stator coils/ bars.

c) Place the Aluminium barrier laminated bag over this porous sheet.

d) Place the VCI paper (Volatile Corrosion Inhibitor as per BHEL Standard AA51406) on the Aluminium barrier laminated bag along with rubber washer.

e) Bare copper portion of field coils and stator coils / bars to be covered by VCI paper pouch and fasten with VCI tape.

f) Now place the wound pole, stack of field coil and stator coil / bars over the VCI paper.

g) Each layer should be secured in position. Wrap wound pole / field coils and stator coils / bars with VCI paper and properly sealed separately using an adhesive tape.

h) Silica Gel packets are to be placed and uniformly distributed inside the boxes on the VCI paper to remove/prevent moisture.

i) Then Aluminium barrier laminated bag has secured in position and properly sealed by using heat sealing machine and air to be drained out by using vacuum pump. At the time of evacuation the vacuum inside the pack should be less than 0.5ata.

j) The VCI paper must contact the stator / rim punchings, wound pole / field coils and stator coils/bars. It has to ensure that the VCI paper, Aluminium barrier bag should not get damage / puncture during the packing process.

k) Top cover of the wooden box shall be sealed only after final clearance from QC for confirmation of above.

l) All boxes should be covered by water proof tarpaulin over top and on all sides.

m) The packing boxes shall be covered with GI sheets (0.25 -0.4mm thick) on all the sides for Export / Seaworthy packing.

n) Vacuum packing room temperature and Relative Humidity should be maintained as mentioned below:

Min. +5 deg. C and Max. 45 deg. C, Relative humidity between 10% to 40%.

8 COMPONENT REQUIRED

8.1 VCI laminated Aluminium foil

Volatile Corrosion Inhibitor (VCI) safe foil shall be with aluminium barrier laminated which is flexible, heat sealable, water vapour and anticorrosion resistant barrier laminate of polyester, Aluminium foil & VCI Polyethylene. It is used as a primary packaging material for packing metal components and sealed with the help of a heat sealer after vacuuming with vacuum machine maintaining the humidity level below 40 RH inside the package.

8.2 Composition construction of VCI laminated Aluminium foil

a) PET Film : 12 Microns
b) Bonding layer : 2 Microns
c) Aluminium Foil : 9 Microns
d) Bonding layer : 2 Microns
e) VCI Poly film : 100 Microns
f) Total thickness : 125 Microns + or – 5%

8.3 Properties of Aluminium Barrier laminated Bag

a) Basic Weight : Unit: g/sq. m 150 +/- 5
b) Tensile strength : Unit: N/sq. mm MD: 40 (min.)
Unit: N/sq. mm TD: 41 (min.)
c) Water Vapour Transmission : Unit: g/m^2 0.01 in 24 hrs. at 38 deg C & 90% RH(max)
d) Oxygen Transmission : Unit: cm^3/m^2 0.02 in 24 hrs. at 38 deg C & 90% RH (max)
e) Sealing Temp. : Unit : Degree C 180-220 deg C

9 MARKING ON PACKING BOX

Mark the following information on the two adjacent sides of the each package.

a) Box No.
b) Customer PO
c) Product Name.
d) Project Name
e) Quantity
f) Storage Requirement : Indoor
g) Net weight (in kg)
h) Dimension (L x W x H in centimetres)
i) Consignee
j) Water proofing (Umbrella Stencilling)
k) Upside direction
l) Sling position indicator

CORPORATE STANDARD

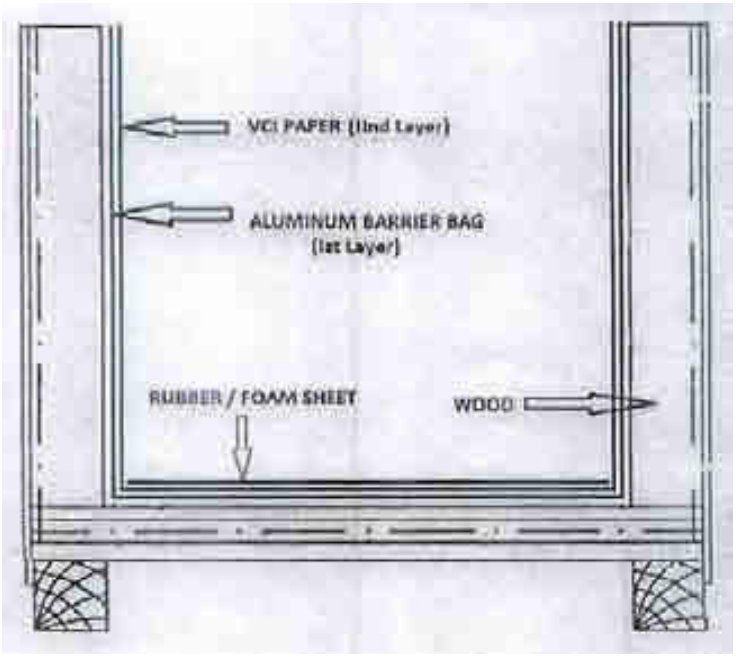


Figure 1

Figure 2

Figure 3

Figure 4

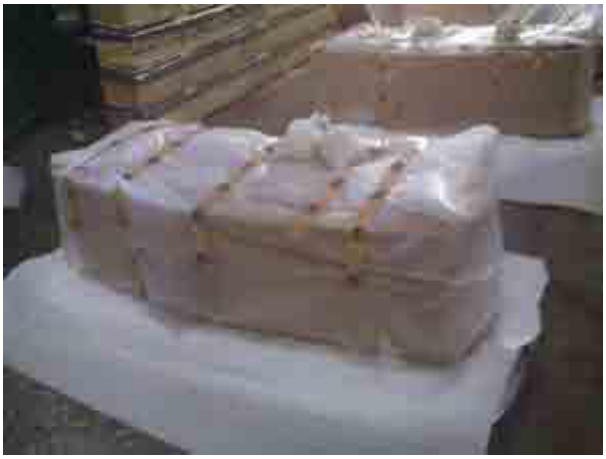


Figure 5

EXPORT PACKING

(PACKING INSTRUCTIONS FOR GENERAL COMPONENTS / ASSEMBLIES / EQUIPMENT)

1 GENERAL

This standard lays down packing instructions for export packing of components/assemblies/equipment to be dispatched against Customer's contracts, for which there are no special instructions issued by the Engineering Departments.

The components/assemblies need to be packed suitably to avoid physical damage & corrosion during transit for storage. For specific applications, the concerned engineering department shall issue a product standard. Reference of this standard, must appear in the Shipping list/Packing List.

2 SCOPE

This procedure gives minimum guidelines for export packing to be complied with for packing of components/assemblies/equipment. This packing shall be suitable for different handling operations and for the adverse conditions during transportation and during indoor / outdoor storage for periods more than one year.

3 WOOD SPECIFICATION FOR PACKING:

a) The wood shall conform to specification AA51401.

b) Ply Wood planks as per specification IS:303 Gr. “MR” Type A,B are used for the sides, top & bottom of the packing cases.

c) Ply Wood of marine grade as per IS:710 for packing of control equipment and for support batten pinewood to be used as per specification AA51401.

4 TYPE OF PACKING:

The following types of packings have been standardized for packing of general components/assemblies.

4.1 Open Type:

Packing subjected to BHEL approval.

4.2 Closed packing cases:

a) Export packing of the specific items requiring additional protection shall be covered with G.I. sheet covering as per customer/contractual/engineering requirements. G.I. shall conform to specification AA10166.

b) Any other special or export seaworthy packing (improvement or equivalent to the above) shall be subjected to BHEL Engg & QC approval).

4.3 Special Packing

Components requiring special packing (as per customer/contractual/ engineering requirements) not included in this specification shall be covered by product standards.

5 TREATMENT OF WOOD AS PER ISPM-15

As per customer requirement for export packing, wood to be treated as per International Standards for Phytosanitary Measures ISPM:15.

6 PREPARATION OF PACKING CASE:

1) Export items are to be packed in sea worthy wooden/Ply board cases.
2) The base of the case shall be made of wooden battens for planks giving necessary reinforcement, such that the bottom of the equipment is at a height of 100 to 200mm from the ground level depending upon size & weight of equipment. However for packing cases of smaller size equipment can be at a height of 40mm from the ground level.
3) The four sides & top cover shall be lined, from inside with multi-layered cross-laminated polyethylene sheet of 90GSM as per AA51420 and tacked at suitable places.

   Whenever specified the top cover will have a layer of multi-layered cross laminated polyethylene sheet of 90 GSM over the cover. This should project about 100 - 250mm on all sides.

   It is preferable to have a single piece of the above Multi-layered cross laminated polyethylene sheet fixed on the four sides. In case jointing is unavoidable, it should be done by overlapping of approximately 100mm.
4) Put the job on the base and wherever necessary may be screwed / fastened.
5) In case of delicate component Packing Viz. Electrical & Electronic components for instruments/ assemblies, a rubber sheet, Self-expanded polyethene foam sheet as per AA51423, preferably 10mm thick, shall be fixed on to the base to act as cushioning to the equipment.
6) Place the Components/cartons with corrosion inhibitors duly applied wherever necessary for place suitably, thin muslin cloths bags containing 100grams (approx.) of activated Blue Silica Gel to AA55619, wherever necessary. Alternatively VCI Powder or Tablet may be used.
7) In case, depression is formed, at the top, after the equipment is lowered, provide ply board/wooden batons.
8) Whole Equipment shall be covered and sealed with Multi-layered cross-laminated Polyethylene sheet to AA51420.
9) For indoor panels/equipment, provide suitable packing batons with covering of Thermocole/ expanded soft polyethylene foam/polyethylene air bubble film wrapped with suitable cords, to avoid cutting of the polyethylene sheet so that finished surface is not damaged.
10) Empty space in the box shall be filled with adequate cushioning material e.g. Thermocole Chips, Wood Wool etc. to avoid movement for shocks. Alternatively put wooden blocks/batons wherever necessary.
11) The inner side of the top cover shall be lined with M.L.C. laminated polyethylene sheet of at least 90GSM, which shall project approximately 25 to 150mm depending upon the size of the case on all sides of the top cover shall be provided below the top cover. This projection, after nailing the top cover, shall be folded over, on the sides of the crates & tacked, to, prevent ingress of water from the top.
12) For specific applications requiring additional protection the packing cases are covered with GI sheet on outside for sides and top; inside for bottom as per specification AA10166, thickness of G.I. sheet shall be 0.25mm.
13) For specific applications requiring inspection, additional inspection window has to be provided for custom clearance for export jobs.

7 SEALED PACKING:

Components sub-assemblies and assemblies sensitive to climatic conditions shall be packed seal tight. All the openings of the sensitive components, sub-assemblies and assemblies shall be blanketed to prevent the ingress of dust and moisture.

The components sub-assemblies and assemblies are completely covered with 2 layers of M.L.C. laminated poly film. All sharp corners and edges are to be protected by rubber mats to prevent the polyethylene sheet from damage. Top surface of the case shall be free from dents to prevent rain water pockets.

Certain special precautions are required for seal tight packing of specific item have to be covered by product standard.

8 OTHER PACKING MATERIAL

8.1 Volatile Corrosion Inhibitor (VCI) Paper as per AA51406:

a) Un-protected surfaces of steel and cast iron components, tools bearing, shaft seals etc. are covered with VCI paper. VCI paper has been impregnated with corrosion inhibitors which by evaporation and chemical conversion protect metals in an enclosed area against corrosion.

b) 7m3 VCI paper is necessary for 1 m3 of packed item approximately as per AA51406.

Application Limitation:

VCI paper shall not be used for components made of aluminium, aluminium alloys as well as Zinc, copper, brass, cadmium and silver.VCI powder is sprinkled inside the piping components ends shall be protected with end cover as specified in plant standards, drawings.

8.2 Moisture Absorber:

Silica gel is used for this purpose to protect the contents over sufficiently long time from corrosion. At the time of use, silica gel should be so dried that its colour becomes dark blue. These shall be filled in small cotton bags. Before sealing the equipment, the silica gel bags should be kept inside the polyethylene film cover at different locations. The quantity of silica gel depends on the dimension of the polyethylene sheet as well as transit and storage time.

8.3 Sling Plate:

Sling plate shall be provided to prevent damage to the packing box during lifting. Size of the sling plate shall be selected depending upon the net weight of the consignment.

8.4 Packing Slip Holders:

Two nos. of packing list with suitable protecting cover shall be fixed one inside and the other outside of the packing box as per specification AA7240901.

8.5 Nails

The length and diameter of the nails depends upon the size of planks

8.6 Strapping Strips:

These are used for strapping the boxes. Suitable size of box strapping strip can be used as per size and weight of consignment. The material shall be free from rust.

8.7 Brackets:

These brackets are used for nailing to the corners of cubicle boxes.The brackets shall be of “L" shape, suitable holes shall be provided towards the end of each side for screwing /nailing.

8.8 Fasteners:

Bolts, double nuts, spring washers of suitable size will have to be used for packing of some special items like transformers, reactors, breakers, etc., to hold the job to the bottom plank of the box.

8.9 Polyethylene Sheet:

The polyethylene sheets are used to make covers to the jobs individually.multi-layered cross laminated polyethylene sheet as per AA 51420 can be used for packing of jobs.

8.10 Expanded Poly Foam Sheet and Air Bubble Film:

This item is used for covering the delicate items, Expanded Polyethylene Foam Sheet as per specification AA51423 and air bubble film as per specification AA51426

8.11 Thermocol (Expanded Polystyerene) Sheets:

This is used for covering delicate items. This material shall be as per spec. no AA51416

8.12 Cotton Bags:

These are used for holding silica gel.

8.13 Marking Ink:

The ink used normally is black in color. In some special cases other color also will have to be used. The ink shall be non-fading/indelible and non-washable by water

8.14 Polyethylene Bags:

These are to be used for keeping the, Packing slips. The bag shall be of size 70 mm X 100 mm (minimum).

8.15 Mechanical Latching Clamps:

For specific items self locking clamps can also be used on need basis in conjunction with or apart from regular bolt and nut fixing arrangement, if needed.

9 DESIGN OF PACKING BOXES

Design/drawing of packing boxes shall be prepared based on actual weight and size of the equipment and shall be covered by concern product standards.

10 GENERAL PRECAUTIONS:

1) While fixing nails during packing, necessary care shall be taken to ensure that materials used for protection inside the case e.g. paper, polyethylene sheet, coir etc. do not get damaged.
2) Sling protection brackets to be provided on cases wherever required.
3) It shall be ensured that all stencil marks external, front & rear sides of the casing shall be of water proof Material to prevent obliteration in transit.
4) For packing of small/delicate items - Item may be wrapped properly with M.L.C. laminated polyethylene and wrapped item may be further wrapped with air bubble film as per spec. AA51426, these curtains will be subsequently packed in wooden/ply boxes as at clause 8.0.
5) The various caution signs shall be marked with stencil on both sides of the packing box.
6) Instructions on handling,storage, preservation, represervation and transport of export order components at works and site shall be covered by product standards.

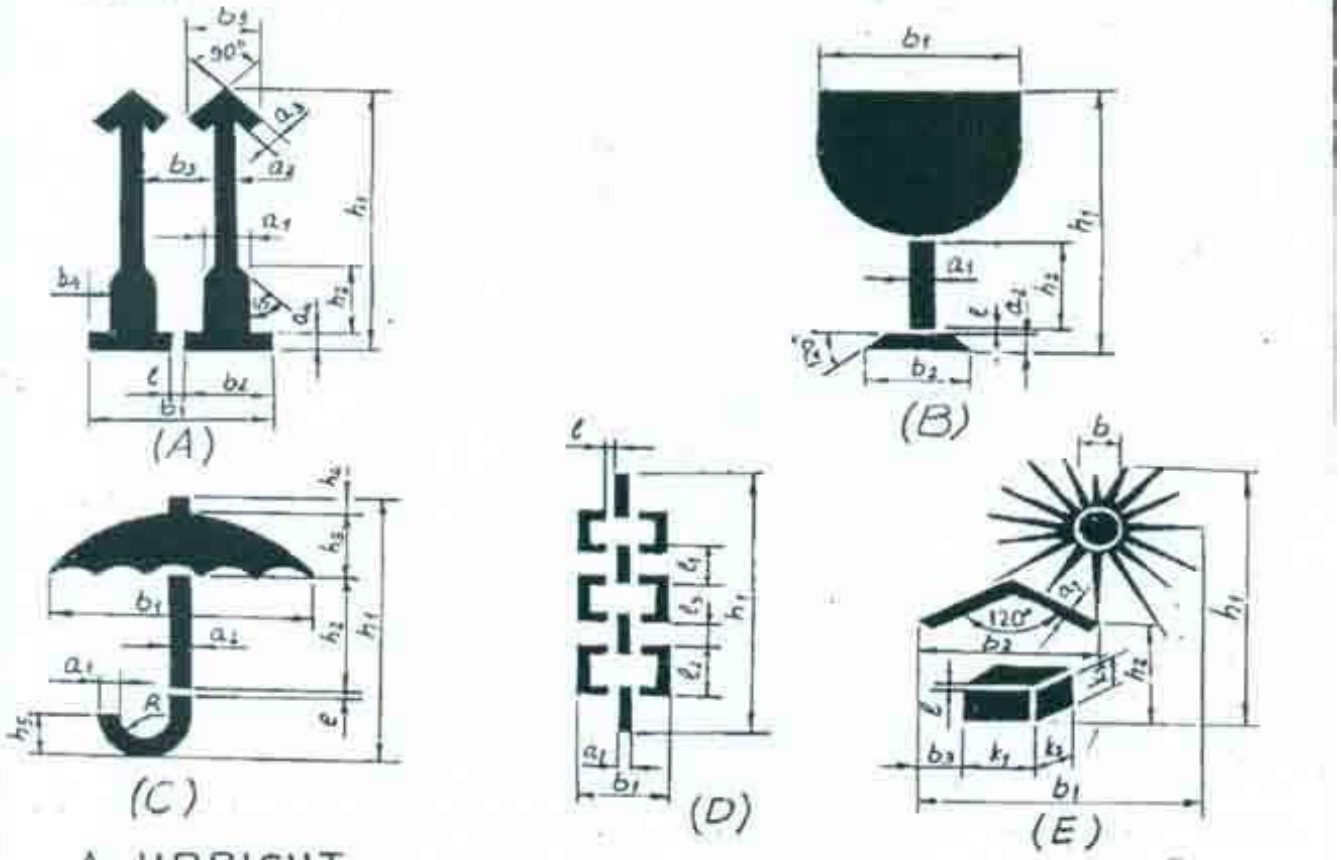
11 MARKING

The following details are to be marked on the packing cases.

a) Address of consignee.
b) Purchase Order No.
c) Description of item or title of packing list.
d) Case identification Number.
e) Net Weight.
f) Gross Weight.
g) Dimensions of box
h) Marking showing upright position.
i) Marking showing sling position.
j) Marking showing umbrella (i.e. for machines/components to be stored under covered storage.

MARKINGS ON PACKING CASES

1. THIS PLANT STANDARD PRESCRIBES THE VARIOUS CAUTION SIGNS AND OTHER MARKINGS ON PACKING CASES.
2. DIMENSIONS IN THE TABLE 1 SHALL BE USED FOR MAKING STENCILS ONLY.



A. UPRIGHT
B. FRAGILE
C. PROTECTION FROM FALLING OR CONDENSING MOISTURE.
D. SLINGING POSITION
E. PROTECTION FROM DIRECT RADIATIONS.

CENTER OF GRAVITY

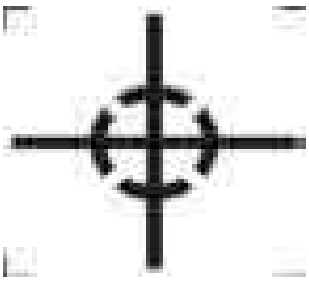


Figure 1 – Markings

DESIGNATION		DIMENSIONS IN mm.																						
		a_1	a_2	a_3	a_4	b_1	b_2	b_3	b_4	b_5	b	l	h_1	h_2	h_3	h_4	h_5	K_1	K_2	K_3	l_1	l_2	l_3	R
A	1	12	5	5	4	52	25	19	8	21	–	2	84	23	–	–	–	–	–	–	–	–	–	–
	2	17	7	7	6	75	36	29	11	30	–	3	119	33	–	–	–	–	–	–	–	–	–	–
	3	24	10	10	8	104	50	38	16	42	–	4	168	46	–	–	–	–	–	–	–	–	–	–
	4	34	14	14	11	147	71	59	23	60	–	5	239	65	–	–	–	–	–	–	–	–	–	–
B	1	5	5	–	–	50	33	–	–	–	–	2	84	25	–	–	–	–	–	–	–	–	–	–
	2	7	7	–	–	71	47	–	–	–	–	3	119	36	–	–	–	–	–	–	–	–	–	–
	3	10	10	–	–	100	66	–	–	–	–	4	168	50	–	–	–	–	–	–	–	–	–	–
	4	14	14	–	–	142	94	–	–	–	–	5	239	71	–	–	–	–	–	–	–	–	–	–
C	1	4	3	–	–	66	–	–	–	–	–	2	80	39	19	5	11	–	–	–	–	–	–	6
	2	6	4	–	–	85	–	–	–	–	–	3	114	55	27	7	16	–	–	–	–	–	–	9
	3	8	6	–	–	120	–	–	–	–	–	4	160	78	38	10	22	–	–	–	–	–	–	12
	4	11	9	–	–	170	–	–	–	–	–	5	227	110	54	14	31	–	–	–	–	–	–	17
D	1	6	–	–	–	30	–	–	–	–	–	4	148	–	–	–	–	–	–	–	30	30	10	–
	2	9	–	–	–	42	–	–	–	–	–	5	209	–	–	–	–	–	–	–	42	42	14	–
E	1	3	–	–	–	69	47	10	–	–	16	2	91	26	–	–	–	17	8	11	–	–	–	–
	2	4	–	–	–	98	67	15	–	–	23	3	128	33	–	–	–	24	11	16	–	–	–	–
	3	6	–	–	–	138	94	20	–	–	32	4	182	62	–	–	–	34	16	22	–	–	–	–

Black and Red Marking Ink to IS:1234 "Ink, Stencil, Oil Base, For Marking Porous Surfaces" or duplicating ink stencilling, oil base for marking porous surfaces.

All cases containing fragile items are to be stencilled with red marking and stencilling paint/ink

"HANDLE WITH CARE", "FRAGILE DO NOT TURN OVER".

Besides the caution signs the product information's shall be stencilled of letters with 13mm to 50mm height.

Incase of consignment consists of more than one package; each package shall carry its package no as given in shipping list. All caution signs shall be stencilled in higher quality full glossy out door finishing paint red in colour (AA56126). All other markings shall be carried out in black enamel (AA56126).

Caution signs & other markings shall be stencilled on both the end shooks & the side shooks. Caution sign (for slinging) shall be stencilled only on side shooks at the appropriate place.

Note: Incase the size of package is small for using the stencils, and then hand written letters/figures shall be allowed.

12 PROCEDURE FOR HANDLING OF COMPONENTS

The purpose of this procedure is to protect the quality of the components/equipment while handling in various stages of manufacturing packing & despatching.

1) Adequate care shall be taken in handling the material, and components to avoid damage during receipts, storage issue manufacture & despatch operations.
2) Appropriate material handling equipment like fork lifters, cranes etc. Shall be used where needed.
3) Lifting by crane and transportation by trolley of critical items and large components like rotors castings etc. Shall be done carefully.

4) For critical items, where specified, special handling fixtures shall be used for lifting.

5) Slings and shackles used for lifting the components/equipment shall be checked for fitness and suitability before use.

6) Slings used on machined surfaces shall be suitably padded. No slings shall be used on journal surfaces.

7) Precision machined components like blades, catches, rollers etc. Shall be lifted using suitable wooden pallets.

8) **HANDLING OF COMPONENTS ON RECEIPT/DESPATCH**:

Before loading/unloading a packing case from the carrier look for the following shipping instructions painted on the packing case.

- The markings showing the upright position.
- The markings showing the sling position
- Markings showing the fragile contents.
- Other required markings as per Cl.No:11

a) Appropriate cranes and slings should be used for different components/ cases. Slings should normally make an angle as minimum as possible (width wise) but in no case more than 15º.

b) Handling and lifting should be done without jerks or impacts.

c) Immediately after receipt of the goods, the packing should be examined all-round for any sign of damage. If necessary, lift the cover or a number of boards of the case so as to make the contents visible. In the event of sealed packing being used the plastic sheeting should not be damaged. It is imperative that the packing material is restored in original condition after the inspection.

d) On receipt of the equipment it should be checked with the shipping list and missing or damage if any should be reported immediately. It is important to arrange for immediate examination to determine the extent of the damage, the cause of the damage and where applicable the person or persons responsible for the damage. According to general practice when transporting by railway or by road vehicle the carrier concerned should be immediately called upon (within specified periods) for jointly establishing a statement of the damage. This is essential as a basis for a subsequent claim and possible damage report to the insurance company.

e) Protective coating applied on machined surfaces should not be disturbed. The plastic covering should be put back carefully so that it prevents ingress of dust and moisture. Some packing may have vapour phase inhibitor (VPI) paper enclosed inside the packing cases. This should be restored to its original place as far as possible.

f) Silica gel and such other chemicals kept in the box as desiccants and indicators should also be left in the box itself.

13 PROVISION FOR INSPECTION:

This clause is applicable only where contractual requirement of customer is there. For other packings this is not applicable.

Each transportable packing's shall have provision for inspection by customer authority etc. during transport from origin of dispatched until destination. This inspection may require opening of the package and subsequently closing it again. For this purpose, suitable designed opening with bolted cover shall be provided. Such an opening shall be clearly marked as "OPENING" with clear instruction for opening & closing written on this cover. For large consignment, the size of the opening shall be suitable to facilitate entry of personnel.

14 REFERRED STANDARDS (Latest publications including amendments):

1) AA51401	2) IS:303	3)IS:710	4)AA10166
5)ISPM:15	6)AA51420	7)AA51423	8)55619
9)AA51406	10)AA51416	11)AA51426	12)AA56126

DOMESTIC PACKING

COMMON GUIDELINES

1 GENERAL:

This standard lays down packing instructions for domestic packing of Components/Assemblies/Equipment to be despatched against Customer's contracts, for which there are no special instructions issued by the Engineering Departments.

The Components/Assemblies need to be packed suitably to avoid physical damage & corrosion during transit & storage. For specific applications the concerned engineering department shall issue a product standard. Reference of this product standard, must appear in the Shipping list/Packing List.

2 TYPES OF PACKING:

The following 5 types of packings have been standardized for packing of General Components/Assemblies.

1) '**OP**' - Open Type.
2) **'PP**' - Partially Packed.
3) '**CP**' – Crate/Box Packing - Components/Equipment requiring physical protection.
4) '**CQ**' - Case Packing - Small & Medium Components/ Assemblies/ Equipment which require corrosion & physical protection.
5) '**CR**' - Case Packing - Electrical Components/Assemblies, which require special packing viz. Water Proof, Shock Proof etc...

3 DESCRIPTION OF TYPES OF PACKING:

The various types of packing, as standardized above, are described below.

3.1 'OP' - Open Type

In case, of components which are not affected by water & dust and do not require special protection, are generally not machined, shall be sent as open packages. However, these components may be sent in crates, wherever necessary.

3.2 'PP' - Partially Packed

Components which need special protection at selected portions only shall be despatched partially packed. Machined surfaces should not be allowed to come directly in contact with the wood. Such surfaces should be protected with 70GSM(Colourless) Multi Layered Cross Laminated Polyethylene Film to Specification No.AA51420. All sharp corners and edges shall be protected by rubber mats to prevent damage to the polyethylene film

3.3 'CP' - Crate Packing

Assemblies/Components which need only physical protection from the point of view of handling shall be despatched duly packed in crates.

3.4 'CQ' - Case Packing - Machined Components/Assemblies/Equipment

Small and medium sized components/assemblies/equipment due to size/weight and to avoid handling and pilferage problems shall be packed in Case/Containers. Wherever required adequate quantity of

silica gel to AA55619 or VCI Powder/Tablets, packed in thin muslin cloth cotton bags shall be suitably placed. Small machines/components of less weight shall be provided with suitable cushioning by Rubberised coir. The components inside the case shall be entirely covered with 70GSM(Colourless) Multi Layered Cross Laminated Polyethylene Film Specification No. AA51420, wherever required.

3.5 'CR' - Case Packing - Electrical & Electronic Components/Assemblies

Delicate components likely to be damaged e.g. Gauges, Instruments etc. are to be wrapped in waxed paper or polyethylene air bubble film and packed in cartons. Adequate quantity of Silica gel to AA55619 packed in cotton bags of 100grams each are to be suitably placed in the cartons. The cartons shall be entirely covered with 70GSM(Colourless) Multi Layered Cross Laminated Polyethylene Film Specification No. AA51420 before being packed in the cases. VCI Powder/Tablets can be used as an alternative to Silica Gel to AA 55619.

Empty space in the cartons shall be filled with rubberized coir to get proper cushioning effect. The cartons shall be manufactured from corrugated Fiber Board, meeting requirements of AA51414.

4 PREPARATION OF PACKING CASES

4.1 DOMESTIC:

Based on the availability, the wood shall be Rubber wood (Havea Brasiliensis)/Pine wood for packing of cubicles, loose items, spares and photovoltaic items meant for customers in India**.**

4.2 DIMENSIONS:

a) Thickness of planks for Front, rear, top and bottom sides and binding, jointing battens shall be 25 +2/-3 mm.

b) Width of all planks including the tongue shall be more than 125mm and after plaining it shall be minimum 100mm.

c) Minimum number of planks shall be used for a shook.

d) Horizontal, vertical, diagonal planks shall be given for binding (number of such planks depend on the dimension of panel.

e) External sides of front and rear planks to be plained to facilitate writing of address and other markings.

f) Width of binding planks shall be minimum 100mm.

g) Distance between any 2 binding planks shall be less than 750mm.

h) diagonal planks shall be used in between vertical binding planks when distance between inner to inner of vertical planks is more than 750mm

i) Distance of the outer edges of these planks from the edge of case shall be less than 250mm.

j) Diagonal planks are not required for top planks and width side, if the width of pallet is less than 750mm.

4.3 JOINTING OF PLANKS

Single length planks shall be used for cubicles whose overall length is less than 2400mm. For cubicles of length more than 2400mm, jointing is permitted. The jointing shall be done with one single or maximum of 2 planks of wood same as other planks of width 250 mm (minimum) with two rows of nails on either side of the joint in zigzag manner. From the joint along height side, it shall be of lap joint with overlap of at least the width of plank.

4.4 TONGUE AND GROOVE JOINTS

Two Consecutive planks shall be joined by tongue and groove joint. Depth of tongue shall be 12+1 mm, thickness of tongue shall be 8 +1 mm. The groove dimensions shall be such that the tongue fits tightly into the groove to make a good joint. This type of joint can be done based on the product requirement wherever required.

4.5 PERMISSIBLE DEFECTS

Wood shall be free from knots, bows, visible sign of infection and any kind of decay caused by insects, fungus, etc.

End splits: Longest end splits at each end shall be measured and lengths added together. The added length shall not exceed 60mm per meter run of shook's. Wood pins shall be used to prevent further development of split.

Surface cracks: Surface cracks with a maximum depth of 3mm are permissible. A continuous crack of any depth all along the length is not allowed.

4.6 CHEMICAL TREATMENTS FOR PRESERVATION OF WOOD

1) This treatment provides protection to the packing wood against deterioration due to fungi and attack by termites, borers and marine organism and any kind of infections.
2) The wooden planks, after making tongues / grooves shall be treated with chemicals. For pine wood, treatment with ASCU/ CCA solution need not be done.
3) The chemical used shall be ready mix ASCU paste. This consists of Arsenic pent oxide, copper sulphate sodium dichromate. This Paste shall be mixed at the rate of 1 kg of paste per 10 liters of water to the extent of water used. Alternate this CCA paste as mentioned at Para 4.6.5) can also be used.
4) The chemical treatment shall be done at the premises of the contractor. A cement concrete tank of capacity to hold a minimum of 2000liters of solution shall be constructed. The solution shall be prepared in the presence of BHEL Representative by contractor. The wooden planks shall be soaked in the solution for a minimum of 12 hours. The solution shall be replenished after treating a maximum of 12 cubic meters of wood. A log book shall be maintained by the contractor to give the details of date of preparation of solution, quantity of solution prepared, quantity of chemicals used, Quantity of wood treated and the details of replenishment. Samples of solutions before mixing will be tested at the laboratories designated by BHEL. The testing fees to be paid to the laboratories will have to be borne by the contractor. The paste shall be tested as and when required.
5) Specifications for water soluble type wood preservatives: Copper – Chromium – Arsenic [CCA]: Copper – Chromium – Arsenic preservative formulation shall be as per IS:10013 Part – II – 1981 shall consist of following active ingredients in nominal proportions by weight as shown below:

– Arsenic Pent oxide	AS2O52H2O	12.5
– Copper Sulphate	CuSO45H2O	37.5
– Sodium Dichromate	Na2Cr2O75H2O	50.0
– Or Potassium Dichromate	K2Cr2O7	

4.7 OTHER MATERIALS

4.7.1 NAILS

The dia. of the nails shall be 3.15mm. The length of the nails shall be 65mm wherever two planks of 25mm thickness are joined and 75mm wherever a 25mm planks is joined to a 50mm plank.

4.7.2 BLUE NAILS

These are used for nailing bituminized Kraft paper/hessian cloth to the planks. The length of the nails shall be 16mm.

4.7.3 HOOP IRON STRIPS

These are used for strapping the boxes. The width of the strips shall be 19+1mm and thickness 0.6 +0.01mm. The material shall be free from rust.

4.7.4 CLIPS

These shall be used for strapping the hoop iron strips on the boxes.

4.7.5 BRACKETS

These brackets are used for nailing to the corners of cubicle boxes. The brackets shall be of mild steel of thickness min 2mm and width 25+1mm. The brackets shall be of "L" shape, the length of each side being 100+2mm. Two holes shall be provided towards the end of each side for screwing /nailing.

4.7.6 FASTENERS

Bolts, double nuts, spring washers will have to be used for packing of some special items like transformers, reactors, breakers, etc., to hold the job to the bottom plank of the box. The bolts, nuts, washers will be provided by the vendor. Drilling of holes will have to be done using contractor's tools.

4.7.7 MULTI LAYERED CROSS LAMINATED POLYTHELENE FILM

70GSM (Colourless) Multi Layered Cross Laminated Polythelene Film Specification No: AA51420 are used to make covers to the jobs individually. The cross lamination gives qualities of extra toughness, together with flexibility and lightness coupled with good weather resistance to ultra violet rays.

4.7.8 RUBBERISED COIR:

The rubberized coir is used as cushioning material. For the packing of loose items, items are to be arrested by using rubberized coir. For the packing of cubicles rubberized coir of thickness 25mm and width 75mm shall be used.

4.7.9 FOAM RUBBER / 'U' FOAM:

This is used for covering the delicate items. This material is provided by the vendor.

4.7.10 MARKING PLATE:

This shall be of anodized aluminium sheet. Details and specifications are given in Fig-4

4.7.11 PACKING SLIP HOLDER:

This shall be of galvanized iron tinned sheet /Aluminium sheet

4.7.12 SILICA GEL:

This shall be of indicating type to conform to IS: 3401/AA55619.

4.7.13 COTTON BAGS:

These are used for holding silica gel. The bags shall have the following matter indicated on them:

BHEL-UNIT NAME	PLACE-PINCODE
SILICA GEL	INDICATING TYPE
BLUE :	ACTIVE
ROSE :	REDUCED ACTIVITY
WHITE :	NO ACTIVITY. TO BE REPLACED WITH FRESH SILICA GEL

4.7.14 COTTON/ PLASTIC TAPE:

This is used for tying small items. And also to prevent vibrations of moving parts within the cubicles.

4.7.15 MARKING INK:

The ink used normally is black in color. In some special cases other color also will have to be used. The ink shall be non-fading/indelible and non-washable by water.

4.7.16 POLYETHYLENE BAGS:

These are to be used for keeping the Packing slips. The bag shall be of size 70mm X 100mm (minimum).

4.7.17 Hessian cloth, twine thread, paint will have to be used in packing cer tain items.

4.7.18 Mechanical Latching clamps:

For CLW Railway panels and similar Panels self-locking clamps can also be used on need basis in conjunction with or apart from regular bolt and nut fixing arrangement. For reusable boxes, these clamps provide easy locking and unlocking arrangement. These clamps will be made available from BHEL in some cases.

4.7.19 STICKERS

The following stickers to be put by the vendor on cubicles/Boxes after packing.

1. Case No sticker: 2 nos. Size 25.Cm x 0.45Cm
6) BHEL Monogram sticker: 1 no. Size 1.75Cm x 2.3Cm
7) Address sticker: 2 nos. Size 3.8Cm x 3.0Cm
8) Direction sticker " Front " & " Back " - 4 nos. Size 2.0Cm x 0.75Cm
9) Chain Mark Sticker: 4 Nos. Size – 3.0Cm x 0.75Cm
10) "Fragile " sticker: 2 Nos Size. 2.1Cm x 1.5Cm
11) "DO NOT STACK " sticker - 2 Nos. Size 3.0Cm x 2.2Cm

5 PACKING OF CUBICLES WITH RUBBER WOOD:

5.1 The packing is to be done as per clause 4 in all respects.

5.2 The cubicles are already fixed on wooden pallets. Hence the contractor need not arrange the bottom pallets normally.

5.3 The cubicles will be of different sizes both widthwise and lengthwise. The cubicles may be made up of single suite, 2 Suite, 3 Suite, 4 Suite, etc., The width of the cubicles generally varies from 400 mm to 1650mm.The length of the cubicle, generally varies from 1500 mm to 4800 mm. The height is normally 2430 mm. In some cases, the height may be less/more.

5.4 MULTI LAYER CROSS LAMINATED POLY FILM

The inner surface of 4 sides of shook's shall be nailed with Multi-layer cross laminated poly film (as per 4.7.7) using blue nails (as per 4.7.2) wherever 2 pieces of Cross laminated poly film are used, the joint shall have an overlap of minimum 20mm.

The inner surface of top cover shall be nailed with Multi-layer cross laminated poly film (as per 4.7.7). This sheet shall project outside on 4 sides by at least 100mm and shall be nailed properly on sides. Joining of sheets should have overlap of minimum 20mm.

The cubicles shall be covered with Multi-layer cross laminated poly film (as per 4.7.7).

5.5 SILICA GEL:

Silica gel (as per 4.3.15) packed in cotton bags shall be kept at different places inside the cubicle as per BHEL-Unit directions. Each suit of cubicle shall be provided with 1 kg of Silica gel (for a 4 suit cubicle 4 kgs of Silica Gel to be used. The bag containing silica gel to be as per 4.7.13).

5.6 LOOSE PARTS:

Any loose parts in the cubicles shall be tied using cotton/ plastic tape. Wooden battens shall be provided wherever necessary.

5.7 WOODEN BATTENS:

In case of cubicle which are not rectangular in shape like control desks, sufficient number of wooden rafters/battens of proper size shall be provided to give strength to the package.

5.8 RUBBERISED COIR:

Gap between the cubicle and the case shall be filled with rubberized coir (as per 4.7.8) with distance between consecutive layers less than 500mm.

5.9 CLAMPING:

Packing shall be bound at edges by nailing M.S. Clamps / Brackets (as per 4.7.5). Each vertical edge shall have minimum 3 clamps. Top horizontal edges will have one clamp for every meter length of package. However, minimum 4 clamps shall be nailed at the top for any cubicle.

5.10 PACKING SLIP:

Packing slip kept in the polyethylene bag (As per 4.7.16) shall be placed in the box at appropriate place. In addition, one more packing slip covered in polyethylene cover and packing slip holder (as per 4.7.11) shall be nailed to front / rear of case.

5.11 MARKING PLATE:

One no. (As per 4.7.10) shall be nailed to the front side of the case.

5.12 CASE MOUNTING:

After complete packing, stencil marking of various details and marking of symbols shall be done as per BHEL instructions using indelible / non washable marking ink.

5.13 Different types (Typical) of Cubicles with sizes for Packing

1. Single suite cubicle - 900 x 950 x2500
2. Two suite cubicle - 1650 x 950 x 2500
3. Three suite cubicle - 2400 x 950 x2500
4. Four suite cubicle - 3150 x 950 x 2500
5. Regulation cub - 1300 x 1350 x 2500
6. Thy cub - 2870 x 1350 x 2500
7. VFD Cub - 3800 x 1550 x 2500

5.14 PACKING OF CUBICLES WITH PINE WOOD

Packing of cubicles for export shall be done exactly in same manner as described at Cl.No 5 except for the following changes: -

Wood shall be Silver oak/ Pine wood instead of rubber wood.

– Double polyethylene petticoat instead of one.
– Fumigation may have to be done if required (BHEL Scope).

6 PACKING OF LOOSE ITEMS/SPARES USING RUBBER WOOD:

1) Shape of cases shall be square, rectangular with single gabled roof or with double gabled roof depending on the nature of the job to be packed. Construction shall be as per drawings enclosed. Only gable will be additional as required.
2) Wood shall be rubber wood with Tongue and Groove joint as per clause 4.4.
3) Chemical treatment as per Clause 4.6 to be done.
4) Width of planks shall be at least 100 mm. Width of binding planks (battens) shall be at least 75mm.
5) External surface of planks on front and rear shall be plane 100% (except bottom plank).
6) Inner surfaces of all 6 sides shall be lined with bitumen coated hessian polyethylene Kraft paper (as per clause 4.7.7) using blue nails.
7) Rubberized coir of minimum 25mm thickness and 100 mm width shall be nailed to inner surfaces of bottom and 4 sides of box.
8) Internal packing: Items that go into the box shall be packed using 70GSM, (Colourless) Multi Layered Cross Laminated Polyethylene Film Specification No: AA51420. Any space left Between the job and the sides and the top of the box shall be filled with rubberized coir to get proper cushioning effect .
9) Certain items like transformers, reactors, breakers, etc., shall be bolted to the bottom of the box using bolts, nuts and washers.

10) Silica gel as per clause 4.7.12 held in cotton bags as per clause 4.7.13 shall be kept at proper places in the box.

11) Packing slip kept in polyethylene bag (clause 4.7.16) shall be placed in the box.

12) Marking plate as per clause 4.7.10 shall be nailed to side of the box.

13) Two numbers of hoop iron strips as per clause 4.7.3 shall be strapped tightly on the case using clips.

14) Stencil marking of various details and marking of various symbols shall be done as per BHEL instructions using indelible/non-washable marking ink.

15) Loose items to be kept inside the cubicle

- The components which are removed from cubicle for shipping purpose only, such as meters shall be kept inside the cubicle individually, kept in wooden box and tied firmly in bottom of Cubicle.

- Other items which are given loose in addition to cubicle shall be packed in separate boxes.

7 BOX SIZES

7.1 BOX SIZES

Table 1 – SPARES WOODEN BOX DETAILS

SNO	BOX TYPE	BOX SIZE (in mm)	BOX Wt (in KG)	Carrying Capacity
1	A	800 X 200 X 200	15	
2	B	1500 X 200 X 200	22	
3	C	2000 X 200 X 200	27	
4	D	1100 X 200 X 200	15	
5	E	200 X 200 X 200	5	
6	F	320 X 250 X 260	13	
7	G	320 X 250 X 430	16	
8	H	430 X 370 X 430	23	
9	I	1100 X 400 X 400	45	
10	J	1500 X 500 X 400	65	
11	K	2000 X 500 X 400	93	
12	L	2500 X 500 X 400	88	
13	M	900 X 600 X 600	100	
14	N	3000 X 400 X 400	60	
15	P	600 X 500 X 400	35	
16	Q	710 X 630 X 600	90	
17	R	850 X 630 X 670	102	
18	S	1000 X 770 X 670	140	
19	T	2500 X 850 X 800	180	
20	U	1500 X 700 X 700	120	
21	W	1200X900X600	120	
22	Y	450 X 200 X 200	10	

7.2 BOX SIZES

Table 2 – VALVES WOODEN BOX DETAILS

BOX TYPE	BOX SIZE (in MM)	BOX Wt (in KG)	Carrying Capacity
1A	320X250X260	10	
1	320X250X430	15	
2	430X370X430	25	
3	670X670X470	65	
4	720X630X600	75	
6	1000X770X660	100	
7	1100X430X670	80	
8	1200X1200X900	80	
10	1300X770X1050	155	
11	2500X850X800	225	
12	2000X1500X1200	305	
14	1850X1050X1250	260	
15	2000X800X800	180	
17	2600X1500X1600	470	
21	250X250X600	20	
22	250X250X880	30	
23	300X300X700	25	
24	380X380X880	45	
25		25	
26	510X510X1400	60	
27	570X570X1400	80	
28	575X575X1875	105	
29	3600X1100X1100	390	
30	900X500X800	110	
52	2000X950X740	225	
53	1600X1120X700	220	
54	2500X2000X1200	490	
55	2900X1900X1400	525	
56	3000X1000X900	370	
57	3200X2200X950	450	
58	2150X1100X750	325	
61	2000X2000X700	130	
62	700X1200X1325	130	

TYPICAL PATTERN OF WOODEN BOX

Figure 1

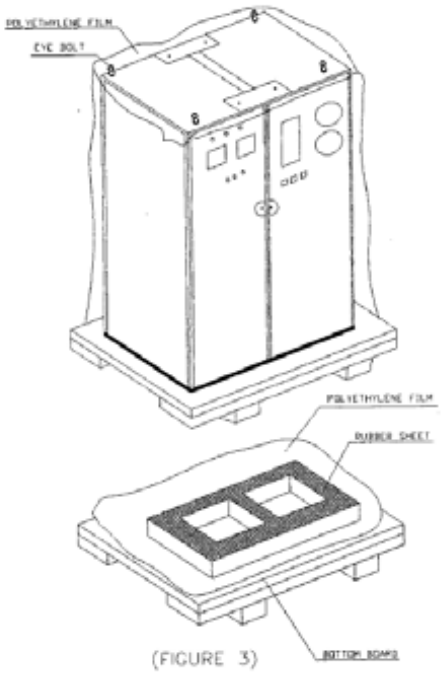


Figure 2

7.3 STANDARD BOX SIZES

WOODEN BOXES:

SL NO	TYPE	DIMENSION IN MM			WEIGHT	CARRYING CAPACITY (KGS)
		LENGTH	BREADTH	HEIGHT		
01	I	2370	1570	1650	675	4000
02	IIA	1570	720	885	200	2500
03	II	1200	900	600	150	2000
04	III	900	600	600	100	1000
05	IV	600	450	450	40	750
06	V	600	300	300	35	500

STEEL BOXES:

SL NO	TYPE	DIMENSION IN MM			WEIGHT	CARRYING CAPACITY (KGS)
		LENGTH	BREADTH	HEIGHT		
07	I	2480	1680	1500	339	4500
08	II	1200	900	600	061	2000
09	IIB	1800	850	950	115	2500
10	III	900	600	600	029	1000
11	IV	600	450	500	019	750
12	V	400	350	300	011	500

Table 3

7.4 STEEL CONTAINERS

Steel containers for packing can be used in case of repeated supplies of the same equipment. Empty steel containers are to be returned back from customer's end and to be reused for the next supplies. The containers are to be made of structural steel as per AA10108 with proper reinforcement with I, C and T Sections.

a) Following precautions are to be taken during packing: -

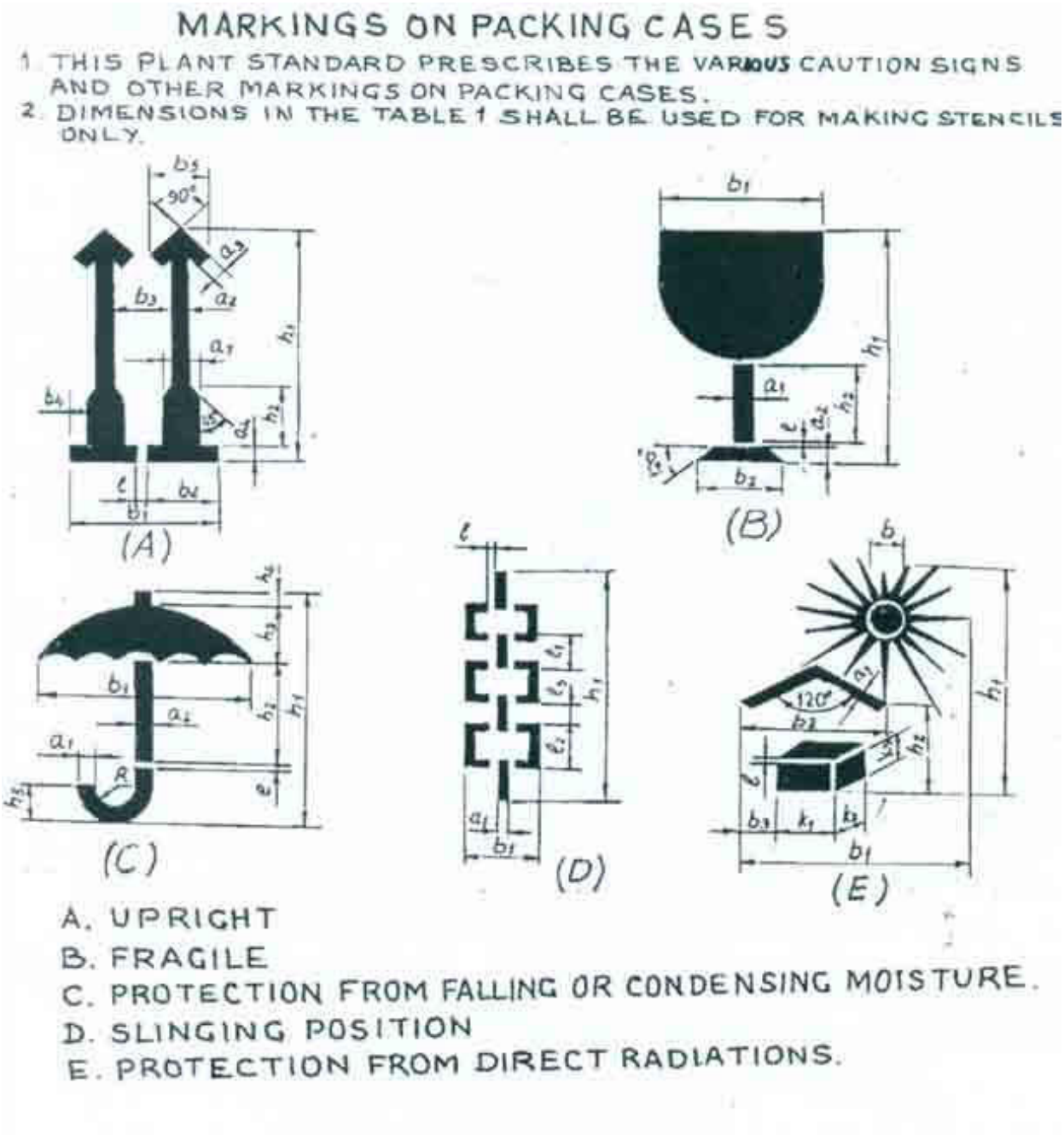
b) Put the machine in the steel container properly,

c) Cover the machine with polythene.

d) To arrest the movement in the steel container necessary wooden Blocks/Battons may be put.

e) Put cover on steel, container and Bolt Properly

8 MARKINGS/STENCILINGS



Center of Gravity

Figure 3

CORPORATE STANDARD

DESIGN-ATION		DIMENSION IN MM																						
		a1	a2	a3	a4	b1	b2	b3	b4	b5	b	l	h1	h2	h3	h4	h5	k1	k2	k3	l1	l2	l3	R
A	1	12	5	5	4	52	25	19	8	21		2	84	23										
	2	17	7	7	6	75	36	29	11	30		3	119	33										
	3	24	10	10	8	104	50	38	16	42		4	168	46										
	4	34	14	14	11	147	71	59	23	60		5	239	65										
B	1	5	5			50	33					2	84	25										
	2	7	7			71	47					3	119	36										
	3	10	10			100	66					4	168	50										
	4	14	14			142	94					5	239	71										
C	1	4	3			66						2	80	39	19	5	11							6
	2	6	4			85						3	114	55	27	7	16							9
	3	8	6			120						4	160	78	38	10	22							12
	4	11	9			170						5	227	110	54	14	31							17
D	1	6				30						4	148								30	30	10	
	2	9				42						5	209								42	42	14	
E	1	3				69	47	10			16	2	91	26				17	8	11				
	2	4				98	67	15			23	3	128	33				24	11	16				
	3	6				138	94	20			32	4	182	62				34	16	22				

Table 4

Black and Red Marking Ink to IS:1234 "Ink, Stencil, Oil Base, For Marking Porous Surfaces" or duplicating ink stencilling, oil base for marking porous surfaces.

All cases containing fragile items are to be stencilled with red marking and stencilling paint/ink

"HANDLE WITH CARE", "FRAGILE DO NOT TURN OVER".

Besides the caution signs the product information's shall be stencilled of letters with 13mm to 50mm height.

In case of consignment consists of more than one package, each package shall carry its package no as given in shipping list. All caution signs shall be stencilled in high quality full glossy out door finishing paint red in colour (AA56126). All other markings shall be carried out in black enamel(AA56126).

Caution signs & other markings shall be stencilled on both the end shooks & the side shooks.

Caution sign (for slinging) shall be stencilled only on side shooks at the appropriate place.

Note: Incase the size of package is small for using the stencils, then hand written letters/figures shall be allowed.

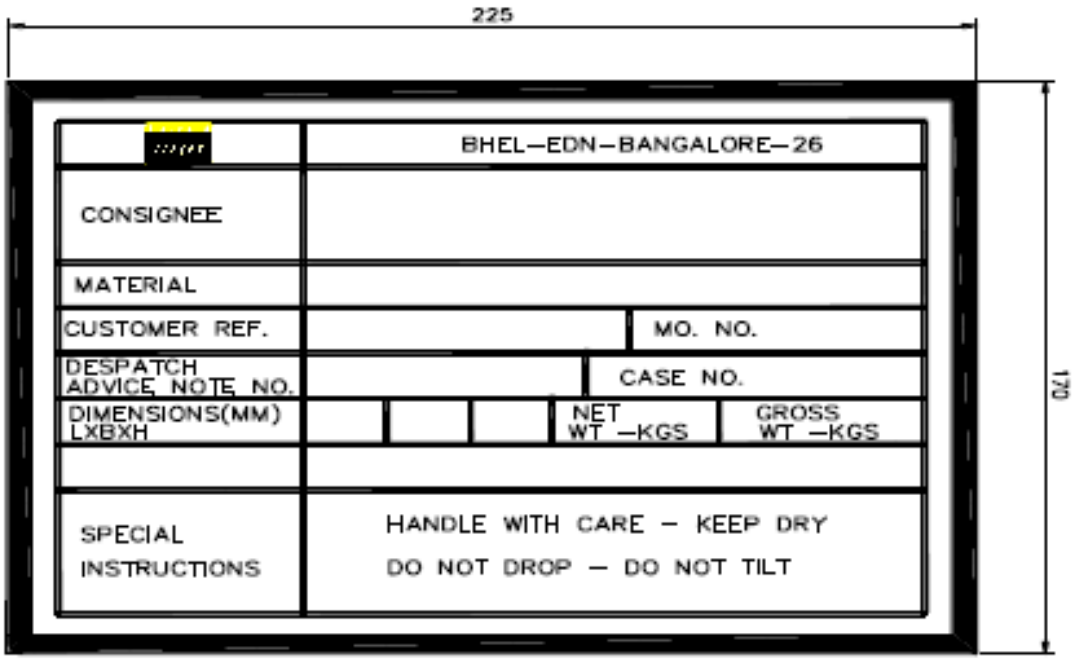


Figure 4 – TYPICAL MARKING PLATE

Figure 5

Easy spares [Initial and O&M] Traceability and Identification at units and as well as at sites:

9 RECYCLING OF INCOMING WOODEN PACKING CASES

OBJECTIVES

– To utilize useable wood of incoming packing cases, for manufacturing of new packing boxes.
– To recycle incoming wooden packing cases, as such, wherever possible.

1) All incoming wooden packing cases received from suppliers /customers will be opened carefully, with the intention of reusing them, by Shop.
2) After carefully taking out the contents, the empty wooden packing cases will be shifted by Shop to the specified locations i.e. bin / nearly spaces, already earmarked in stores.
3) Material shifting contractor engaged by store, will collect all such wooden packing cases and scrap wood from specified points, on a regular basis.
4) After collecting / loading the empty packing cases/ scrap wood, contractor will take thecarrier first to weighment bridge for weighment, thereafter, he will go to Carpentry, where Carpentry representative will identify the packing cases which can be used by Carpentry for manufacturing of New Packing Boxes. All such identified packing boxes will be unloaded and handed over to Carpentry by contractor.
5) These packing boxes will be made re-useable after necessary rectification and additional work.
6) Contractor will again take the carrier for weighment and this second reading will also berecorded on the same “Weighment Slip”.
7) Weight of empty packing cases / scrap wood taken will be calculated on thebasis of 1st and 2nd weighment readings recorded on the “Weighment Slip”. A copy of“Weighment Slip” (where both the weighment readings are recorded) will be given by the contractor to the carpentry representative. Based on this “Weighment Slip”, carpentry will maintain a register in which details of quantity received will be recorded.
8) All “Weighment Slips” will invariably be signed by carpentry representative (even when no boxes have been unloaded by carpentry). Store will accept the scrap wood only if “Weighment Slips” are signed by carpentry representative.
9) Balance empty packing cases / scrap wood will be handed over by contractor to Store, for storing in scrap yard.
10) A separate area in Scrap yard will be provided, for executing the work of de-nailingof wooden packing cases, under supervision of carpentry.
11) Carpentry contractor will identify packing cases / scrap wood for denailing, which will behanded over to him by Store, at Scrap yard, for denailing and further operation.
12) Quality and Carpentry will jointly inspect the wood generated by de-nailing process and will prepare “INSPECTION CUM RECEIPT REPORT OF USEABLE WOOD RECEIVED FROM TPS –STORE BY CARPENTRY”.
13) After acceptance of the wood by Quality and Carpentry, the same will be shifted to carpentry for receipt and its record will be maintained by carpentry.
14) This will be a Permanent Productivity Project executed by carpentry. “Productivity Savings “duly verified at the current Purchase Order rate of wood, will be sent every month to Resource Management Department, for highlighting it in their monthly progress report.

10 STANDARD METHOD OF PACKING

Table 5 –

STANDARD METHOD OF PACKING

DESCRIPTION	CASE	CRATE	SKID	BUNDLE	BARE	DRUM	METAL DRUM	FIBRE DRUM
PRESSUE VESSELS								
TOWERS					O			
TANKS					O			
VESSELS					O			
GASKETS	O							
FASTENERS	O							

STANDARD METHOD OF PACKING

DESCRIPTION	CASE	CRATE	SKID	BUNDLE	BARE	DRUM	METAL DRUM	FIBRE DRUM
COVERS		O						
EXCHANGERS								
HEAT EXCHANGERS					O			
TUBE BUNDLE	O							
SHELL					O			
AIR FIN COOLERS					O			
COLOUMNS, MOTOR SUSPENSIONS, PLENUM CHAMBERS, SCREEN GUARDS, ETC					O			
BEARING BLOCKS	O							
FANS	O	O						
MOTORS	O							
GASKETS	O							
FASTENERS	O							
TEST FLANGES			O					
TEST RINGS			O					
COVERS			O					

DESCRIPTION	CASE	CRATE	SKID	BUNDLE	BARE	DRUM	METAL DRUM	FIBRE DRUM
CRYOGENIC VESSELS								
COLD CONVERTERS					O			
HORIZONTAL STORAGE TANKS					O			
TRANSPORTATION TANK					O			
COLD BOX					O			
DRYING UNIT					O			
DRYING BOTTLES					O			
MOISTURE SEPARATORS					O			
SILENCERS					O			
ONGC SKIDS					O			
VAPORISER		O						
SPECIAL PRODUCTS								
SI/VI PIPING		O						
CRO BIO CONTAINERS	O							
AIR BOTTLES	O							
TITANIUM BOTTLE	O							
WAR HEAD CONTAINER	O							
MISSILE CONTAINER	O							
FUEL CONTAINER	O							
AIR LOCK ASSEMBLY	O							

DESCRIPTION	CASE	CRATE	SKID	BUNDLE	BARE	DRUM	METAL DRUM	FIBRE DRUM
BOILERS								

CORPORATE STANDARD

BOILER DRUMS					O			
BOILER ITEMS								
COILS			O					
PANELS					O			
HEADERS			O		O			
FEEDERS								
MACHINED ITEMS								
SHELL SEGMENTS					O			
SHELL SEGMENTS IN STACKS					O			
SPHERE PETALS								
COLOUMNS, BASE PLATES, TIERCOS, PIPES, NOZZLE E1, F1, INTERNAL PIPES, PADS ETC.					O			
ROLLERS	O							
VALVE TRAYS								
VALVE TRAY COMPONENTS	O							
LATTICE GIRDERS		O						
FASTENERS	O							
GASKETS	O							

DESCRIPTION	CASE	CRATE	SKID	BUNDLE	BARE	DRUM	METAL DRUM	FIBRE DRUM
SUB CONTRACTS								
FAB STRUCTURALS					O			
SUPPORTING STRUCTURALS					O			
STRUCTURE SUB ASSEMBLY					O			
FAB PIPES					O			
GRATINGS					O			
STAIR CASES					O			
HANDRAILS/ PLATFORMS					O			
BOUGHT OUT COMPONENTS								
IRON & STEEL (LIKE PLATES, BEAMS, ANGLES, CHANNELS ETC.)					O			
PIPE FITTINGS								
CS PIPES, TUBES					O			
SS PIPES, TUBES					O			
FIN TUBES	O							
ELBOWS		O			O			
FLANGES	O	O						
VALVES	O							
GAUGES	O							
DEMISTERS		O						
DESCRIPTION	CASE	CRATE	SKID	BUNDLE	BARE	DRUM	METAL DRUM	FIBRE DRUM

ABSCRBANTS (LIKE MOLECULAR SIEVES, ACTIVATED ALUMINA, MOBILE SORBID)						O		
PAINT TINS		O						
PAINT DRUMS						O		
IGNITORS	O							
SPRAY NOZZLES	O							
ELECTRICAL INSTRUMENTATION								
MOTORS, PUMPS, COMPRESSORS, TURBINES	O							
SWITCH BOARDS, DISTRIBUTION BOARDS, STARTERS, JUNCTION BOXES		O						
INDICATORS, VIBRATOR SWITCHES	O							
CABLE BUNDLES, CABLE DRUMS					O			
CABLE TRAYS, CABLE RACKS, EARTHING MATERIAL		O						
OPERATIONAL SPARES	O							

11 PROCEDURE FOR HANDLING OF COMPONENTS

The purpose of this procedure is to protect the quality of the components/equipment while handling in various stages of manufacturing packing & despatching.

11.1 Adequate care shall be taken in handling the material, and components to avoid damage during receipts, storage issue manufacture & despatch operations.

11.2 Appropriate material handling equipment like fork lifters, cranes etc. shall be used where needed.

11.3 Lifting by crane and transportation by trolley of critical items and large components like rotors castings etc. shall be done carefully.

11.4 For critical items, where specified, special handling fixtures shall be used for lifting.

11.5 Slings and shackles used for lifting the components/equipment shall be checked for fitness and suitability before use.

11.6 Slings used on machined surfaces shall be suitably padded. No slings shall be used on journal surfaces.

11.7 Precision machined components like blades, catches, rollers etc. shall be lifted using suitable wooden pallets.

11.8 HANDLING OF COMPONENTS ON RECEIPT/DESPATCH

Before loading/unloading a packing case from the carrier look for the following shipping instructions painted on the packing case.

a) The markings showing the upright position.

b) The markings showing the sling position

c) Markings showing the fragile contents.

d) Other required markings as per Cl.no:08

11.8.1 Appropriate cranes and slings should be used for different components/ cases. Slings should normally make an angle as minimum as possible (width wise) but in no case more than 15º.

11.8.2 Handling and lifting should be done without jerks or impacts.

11.8.3 Immediately after receipt of the goods, the packing should be examined all-round for any sign of damage. If necessary, lift the cover or a number of boards of the case so as to make the contents visible. In the event of sealed packing being used the plastic sheeting should not be damaged. It is imperative that the packing material is restored in original condition after the inspection.

11.8.4 On receipt of the equipment it should be checked with the shipping list and missing or damage if any should be reported immediately. It is important to arrange for immediate examination to determine the extent of the damage, the cause of the damage and where applicable the person or persons responsible for the damage. According to general practice when transporting by railway or by road vehicle the carrier concerned should be immediately called upon (within specified periods) for jointly establishing a statement of the damage. This is essential as a basis for a subsequent claim and possible damage report to the insurance company.

11.8.5 Protective coating applied on machined surfaces should not be disturbed. The plastic covering should be put back carefully so that it prevents ingress of dust and moisture. Some packing may have vapour phase inhibitor (VPI) paper enclosed inside the packing cases. This should be restored to its original place as far as possible.

11.8.6 Silica gel and such other chemicals kept in the box as desiccants and indicators should also be left in the box itself.

12 GENERAL GUIDELINES FOR ODC TRANSPORTATION/DESPATCH

Based on the Dimensions/Weight indicated in the Transportation Sketch, the type of Trailer is decided and indicated in the Tender Enquiry.

12.1 TRANSPORTATION:

1. LOW BED TRAILERS (LB 8):

Well Bed Length:	10000mm
Over Gooseneck:	13000mm
Width:	3000mm
Carrying Capacity:	40MT

2. LOW BED TRAILERS (LB 16):

Well Bed Length:	12000mm
Over Gooseneck:	16000mm
Width:	3000mm
Carrying Capacity:	75MT

3. TOW TYPE TRAILERS (WITH FRONT DOLLEY 16 TYRES): 12000MM length
(for Exceptional equipment length: 30000mm and above)

Bigger Dia equipment are loaded in the Well with overhanging.

Smaller Dia equipment with excess length are loaded over Gooseneck with rear hanging.

The Vehicle Dimensions are defined above are only guidelines for selection based on actual Dimensions/ Weight of the Consignment

12.2 PACKING:

For all ODCs, Wooden Saddles are cut to the diameter of equipment as per the Transportation Sketch.

For Diameter up to 4000mm

Wooden Saddles Length: 1836/2743mm (6'0"/9'0")
Width: 300mm (1'0")
Height: Saddle + one/two wedges a top.
For Diameter up to 4000mm
Wooden Saddles Length: 3353mm (11'0")
Width: 300mm (1'0")
Height: Saddle + three/four wedges a top.

NUMBER OF SADDLES:
Minimum: 3 in case of Loading inside Well
+ 1 when loaded on Gooseneck.
Maximum: 4 in case of Loading inside Well
+2 when loaded on Gooseneck.

For Securing the equipment firmly on the Trailer, 19mm (3/4"), wire rope with 25mm (1") Heavy Duty Turn Buckles / BD Clamps are used as Lashing for the equipment.

12.3 NUMBER OF LASHINGS ARE:

	CONSIGNMENT LOADED INSIDE WELL BED	CONSIGNMENT LOADED OVER GOOSENECK
a) up to 40MT	4 (2 Single Line lashing 2 Double Line Lashing)	5 (3 Single Line Lashing 2 Double Line Lashing)
b) 40MT to 60MT	5 (3 Single Line Lashing 2 Double Line Lashing)	5 (Single Line Lashing 3Double Line Lashing)
c) 60MT and above	5 (2 Single Line Lashing 3 Double Line Lashing)	6 (3 Single Line Lashing 3 Double Line Lashing)

13 GUIDELINES FOR HANDLING/LOADING/LASHING

13.1 HANDLING

Figure 6

Before unloading the jobs Completely painted and neatly stencilled will be checked.

Pipes with split type end cover will be checked

Figure 7

All Coil Tubes to be provided with End Caps.

Figure 8

Neatly stacked Coil Assemblies.

Figure 9

Columns to be lifted with Nylon belts. This protect painting, edges and attachments.

Figure 10

13.2 LOADING

All the components to be transported by putting inside the properly fabricated Crating

Figure 11

Small components may fall down while transporting without closed crating and there are chances of missing of small parts. Hence, it is always better to transport small components in closed containers/crating. Loose to be being shipped in a closed crating.

Figure 12

No component loaded over the crating.

Figure 13

Headers supported with wooden V blocks at 3 meters interval.

Figure 14

Spacers in between each coil assembly.

Figure 15

Goose pipe to be provided with rubber pad protects removal of painting and damage to the job.

Figure 16

13.3 LASHING

Use Nylon belts only for lashing of all components. It prevents removal off painting and cut in the materials.

Figure 17

Nylon Belts used for lashing the beams.

Figure 18

14 PRODUCT WISE SPECIAL INSTRUCTION

Additional instructions of packing not included in this standard shall be covered by individual product standard

15 REFERRED STANDARDS (Latest publications including amendments):

1) AA51420 2) AA55619 3) AA51414 4) IS:3401

5) AA10108 6) AA56126

Annexure-6

Vendor shall meet the Equipment Qualification Criteria (EQC)/Pre-Qualification Criteria (PQC) specified elsewhere in the specification/NIT documents and shall furnish duly filled-in Experience Record Proforma /Pre-qualification Criteria in the prescribed format.

The purchaser reserves the right to prescribe / request for additional drawings / documents / information / clarifications / justifications during the evaluation of the PQC & Offer, in order to satisfy himself regarding capability and capacity of Bidder / its sub-vendor(s) and the proposed arrangement.

The purchase shall also reserves right to verify the information furnished by bidder. In case the information / documents / data furnished by bidder are found to be false / incorrect, the technical offer that bidder will be liable for rejection.

QAP GUIDELINES & FORMAT

(ANNEXURE -)

The QAP format and guidelines for filling up the format shall be used by vendor for preparation and submission of QAP after order placement.

Note :

1. Typical /Indicative /Standard QAP(s) for equipment/package attached is reference document and to use by successful bidder in future for preparation and submission of QAP for BHEL /CUSTOMER approval.

2. No deviation to reference document is acceptable.

GUIDELINES TO VENDORS FOR PREPARATION OF QUALITY ASSURANCE PLAN

1. QAP shall be made in landscape mode on A4 size paper as per the format enclosed. Font size shall be minimum 10.

2. Each page of QAP shall contain the following information.
   a) Vendor's name & address.
   b) Customer: BHEL, Hyderabad.
   c) Project.
   d) BHEL Product Standard Number/revision number as referred in P.O.
   e) BHEL Purchase Order Number & Date.
   f) Product as per P.O. description.
   g) QAP Number (unique and shall not repeat)/revision number/date.
   h) Page number and number of pages

3. QAP shall contain four parts / stages as follows.
   a) Raw materials and bought out items.
   b) In process Control / Inspection.
   c) Final assembly, Inspection & Testing.
   d) Painting, preservation & packing.

4. Under 'Component', indicate name of the component (say casing, rotor, pressure gauge, etc).

5. Under 'Characteristics', indicate appropriately (say chemical analysis, mechanical properties, NDT (UT,DP etc.), hydrostatic test, calibration check etc.)

6. Under 'Class', indicate minor, major or critical depending on the importance of characteristic.

7. Under 'Type of check', indicate appropriately (say chemical, mechanical, UT, DP etc.)

8. Under 'Quantum of check', indicate appropriately (say 100%, 10%, sample, per melt, per heat, all pieces etc.)

9. Under 'Reference document' and 'Acceptance norms', appropriate National & International standards, BHEL standards, approved drawing references etc. should be indicated. It is not correct to mention as "Vendor's internal standards or Vendor's standard practice etc.". If vendors' internal standards are referred, same shall be in line with BHEL Spec. indicated in the P.O. These may require review & approval by our Engineering dept.

10. Under 'Format of record', indicate appropriately supplier's test certificate, calibration certificate, lab report, inspection report etc.

11. Please refer 'Agency' in QAP format.
    Under P: Perform, W: Witness, V: Verify
    Indicate against each characteristic 1: (BHEL CQS/Nominated inspection agency), OR
    2: (Vendor / Sub vendor)

Note: Performing agency is normally vendor or his sub vendor (Legend 2). Where witness points are indicated in specification, P.O., Drawing etc., for such operations, Under Witness (W) column use 1. Under 'Verify' column, use code1.

12. Under 'D' please put (□ Tick) against each characteristic where vendor proposes to submit test certificate/report etc. OR as required as per BHEL Specification.

13. Vendor's signature & stamp should be available on each page of QAP.

14. Vendor should read the BHEL Product Standard thoroughly and QAP should be made only inline and relevant to the Specification & Approved Drawings.

15. The following operations/characteristics/check points may be included (AS APPROPRIATE)
   a) Visual check
   b) Dimensional check
   c) Mechanical and Chemical properties.
   d) Surface preparation before painting (by chemical cleaning, sand blasting, shot blasting etc. as the case may be.)
   e) Painting check for shade, Dry Film Thickness (DFT), Adhesion/ peel off test etc.
   f) Check for correctness for all components mounted as per General arrangement Drawing, Bill Of Materials (BOM), etc. for range, rating, make, color, size, location as per GA, quantity, label description including tag nos., annunciator facia, loose components, accessories, spares etc.
   g) Verification of test certificate for protection class for the enclosures.
   h) Mechanical functioning of switches.
   i) Continuity of earthing and provision of earth points.
   j) Colour coding of wiring, size, tightness & dressing of wiring.
   k) Review of test certificates of assembled items, raw materials, internal test reports etc.
   l) Witness of functional checks, which may include mechanical run & electrical run, H.V.test, IR measurement, Electrical and Mechanical tests etc.
   m) PQR, WPS, Welder Qualification Record, welding records (fit up, DP) etc.
   n) Material identification (for punch marks of serial numbers, Heat No, Melt No, Inspector's stamp etc.)
   o) Hydraulic Pressure Test, Pneumatic Pressure Test, Liquid Penetration Examination and other Non-Destructive Tests.
   p) Tests on Galvanised items (Visual, Hammer Test, Knife Test, Thickness, Pierce Test (Copper sulphate test), Hydrogen evaluation test, Stripping test (for Mass of Zinc coating)
   q) All tests as per BHEL Product Standard & approved drawings including Type tests and Routine tests on individual items and on System as a whole.
   r) Packing and Preservation.

16. **QAP Format enclosed.**

17. Main Equipment Typical Manufacturing QAP(s) is /are attached.

VENDOR'S NAME & ADDRESS:	**MANUFACTURING QUALITY PLAN**		QP. NO.:	
	CUSTOMER: BHEL, HYDERABAD – 32. PROJECT: PRODUCT:	BHEL P.O.NO.: P.O.DATE: BHEL SPEC: REV:	REV NO:	DATE:
			PAGE 1 OF 1	

SL NO	COMPONENTS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	* D	AGENCY P	AGENCY W	AGENCY V	REMARKS
1.0	**RAW MATERIALS & BOUGHT OUT ITEMS**												
2.0	**INPROCESS INSPECTION**												
3.0	**FINAL INSPECTION & TESTING**												
4.0	**PRESERVATION & PACKING**												

VENDOR TO NOTE: THIS FORMAT IS IN MICROSOFT WORD. HEADER & FOOTER SHALL BE AVAILABLE IN EACH PAGE OF QP. QP SHALL BE IN LANDSCAPE & A4 SIZE ONLY. FONT SIZE SHALL BE MIN 10. VENDOR SHALL SIGN & STAMP IN EACH PAGE OF QP. LOI REF. & DATE ARE NOT ACCEPTABLE. P.O.NO. & DATE SHALL BE INDICATED. QP NO. SHOULD BE UNIQUE AND SHALL NOT REPEAT. ALL THE TESTS / CHECKS INDICATED IN THE BHEL SPEC. SHALL BE INDICATED IN THE QP.

LEGEND: P: PERFORM, W: WITNESS, V: VERIFICATION. INDICATE 1 FOR BHEL CQS (OR BHEL NOMINATED INSPECTION AGENCY) & 2 FOR VENDOR/SUB VENDOR AS APPROPRIATE AGAINST EACH COMPONENT /CHARACTERISTIC UNDER P, W & V COLUMNS. * FOR ITEMS MARKED ✓ (TICK) IN COLUMN 'D', TEST CERTIFICATES SHALL BE SUBMITTED TO BHEL FOR RECORDS.	PREPARED BY VENDOR'S SIGNATURE & STAMP	APPROVED BY BHEL QA SIGNATURE & STAMP	APPROVED BY CUSTOMER'S SIGNATURE & STAMP

	TYPICAL MANUFACTURING QUALITY PLAN							MQP. NO.:						
	PROJECT ENGINEERING & SYSTEMS DIVISION BHEL, RC PURAM, HYD-502032			PROJECT: 5X800MW YADADRI TPS TSGENCO PACKAGE: FOAM PUMP BHEL TECH SPEC:				REV NO:		DATE:				
								PAGE 1 OF 4						
SL NO	COMPONENTS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	* D	AGENCY P	AGENCY W	AGENCY V	REMARKS	
1.0	**RAW MATERIALS & BOUGHT OUT ITEMS**													
1.1	Casing	Visual check	Major	Visual	100%	Tech Spec/ Approved Datasheet/ Approved Drawing		--	--	2	2	--		
1.2		Dimensional check	Major	Measurements	100%			--	--	2	2	--		
1.3		Chemical & Mech. Properties	Major	Chemical & Mech. analysis	1 per heat/lot			MTC	√	2	2	1&3		
1.4		Heat treatment for all castings	Major	HT	100%			HT chart	√	2	2	1&3		
1.5	Gear and Shaft	Chemical & Mech. Properties	Major	Chemical & Mech. analysis	1 per heat/lot			MTC	√	2	2	1&3		
1.6	Mechanical seal	Material and leakage check (Air test)	Major	OEM's certificate review	100%			OEM's certificate	√	2	2	1&3		
1.7	Bearing and bearing housing	Make and Model	Major	OEM's certificate review	100%			OEM's certificate	√	2	2	1&3		
1.8	Coupling	Chemical & Mech. Properties	Major	Chemical & Mech. analysis	1 per heat/lot			MTC	√	2	2	1&3		
1.9	Interconnecting pipes and fittings (as applicable)	Chemical & Mech. Properties	Major	Chemical & Mech. Analysis	1 per heat/lot			MTC	√	2	2	1&3		
1.10	Wear rings, Gaskets, Flanges, and Fasteners	Chemical & Mech. Properties	Minor	Chemical & Mech. Analysis	1 per heat/lot			MTC	√	2	2	1&3		

LEGEND: P: PERFORM, W: WITNESS, V: VERIFICATION. INDICATE 1 FOR BHEL CQS (OR BHEL NOMINATED INSPECTION AGENCY), 2 FOR VENDOR/SUB VENDOR & 3 FOR TSGENCO/TCE AS APPROPRIATE AGAINST EACH COMPONENT /CHARACTERISTIC UNDER P, W & V COLUMNS. * FOR ITEMS MARKED ✓ (TICK) IN COLUMN 'D', TEST CERTIFICATES SHALL BE SUBMITTED TO BHEL FOR RECORDS.

	TYPICAL MANUFACTURING QUALITY PLAN		MQP. NO.:	
	PROJECT ENGINEERING & SYSTEMS DIVISION BHEL, RC PURAM, HYD-502032	PROJECT: 5X800MW YADADRI TPS TSGENCO PACKAGE: FOAM PUMP BHEL TECH SPEC:	REV NO:	DATE:
			PAGE 2 OF 4	

SL NO	COMPONENTS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	* D	AGENCY P	AGENCY W	AGENCY V	REMARKS
2.0	**INPROCESS INSPECTION**												
2.1	Casing	NDE	Major	DPT/MPI	100%			NDE reports	√	2	2	1&3	
2.2		Leakage	Critical	Hydrostatic test	100%			Test reports	√	2	2	1&3	
2.3	Motor	Visual Inspection, Routine test & type test	Major	Visual & TC review	100%			Test report or manufacturer's test certificates	√	2	2	1&3	
2.4	Diesel Engine & DECP	Visual Inspection, Engine & DECP Test reports	Major	Visual & TC review	100%			Test report or manufacturer's test certificates	√	2	2	1&3	
2.5	Gear	NDE	Major	DPT / MPI	100%			NDE reports	√	2	2	1&3	
2.6	Shaft	NDE	Major	DPT / MPI and UT (if shaft diameter > 50 mm)	100%			NDE reports	√	2	2	1&3	
2.7	Wear rings	NDE and hardness test	Major	DPT and hardness test	100%			DP and hardness test reports	√	2	2	1&3	
2.8	Coupling	Dynamic balancing	Critical	Balancing	100%			IR	√	2	2	1&3	
2.9	Gear	Dynamic balancing	Critical	Balancing	100%			IR	√	2	2	1&3	
2.10	Gear assembly	Dynamic balancing	Critical	Balancing	100%			IR	√	2	2	1&3	
3.0	**FINAL INSPECTION & TESTING**												

LEGEND: P: PERFORM, W: WITNESS, V: VERIFICATION. INDICATE 1 FOR BHEL CQS (OR BHEL NOMINATED INSPECTION AGENCY), 2 FOR VENDOR/SUB VENDOR & 3 FOR TSGENCO/TCE AS APPROPRIATE AGAINST EACH COMPONENT /CHARACTERISTIC UNDER P, W & V COLUMNS. * FOR ITEMS MARKED ✓ (TICK) IN COLUMN 'D', TEST CERTIFICATES SHALL BE SUBMITTED TO BHEL FOR RECORDS.

	TYPICAL MANUFACTURING QUALITY PLAN		MQP. NO.:	
	PROJECT ENGINEERING & SYSTEMS DIVISION BHEL, RC PURAM, HYD-502032	PROJECT: 5X800MW YADADRI TPS TSGENCO PACKAGE: FOAM PUMP BHEL TECH SPEC:	REV NO:	DATE:
			PAGE 3 OF 4	

SL NO	COMPONENTS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	* D	AGENCY P	AGENCY W	AGENCY V	REMARKS
3.1	Motor driven pump with job motor, job coupling and job base plate etc. and Engine driven pump with job engine, job coupling and job base plate etc.	Overall Dimensions	Major	Measurement	100%	Tech Spec/ Approved Datasheet/ Approved Drawing		IR	¥	2	1	3	100% witness by BHEL / BHEL's TPIA.
3.2		Performance test	Critical	Testing	100%			IR	¥	2	1	3	
3.5		Mechanical run test	Critical	Testing	100%			IR	¥	2	1	3	
3.6		Strip Examination (In case of abnormal noise & vibration)	Major	Dismantling	100%			IR	¥	2	1	3	
3.7		Complete unit test with job drives and job accessories.	Major	Testing	100%			IR	¥	2	1	3	
3.8		Accessories and Spares (if any)	Major	BOM check	100%			IR	¥	2	1	3	
4.0	PRESERVATION & PACKING												
4.1	Pump and its components	Direction of rotation, Stamping and Painting	Major	Visual, Shade & DFT	Random	Tech Spec/ Approved Datasheet/ Approved Drawing		IR	¥	2	2	1&3	
4.2		Inspection reports/ certificate traceability index	Major	Visual	100%			Index	¥	2	2	1&3	
4.3		Packing #	Major	Visual	100%			Packing List	¥	2	1	--	#Packing shall be witnessed by BHEL/BHEL's TPIA.

LEGEND: P: PERFORM, W: WITNESS, V: VERIFICATION. INDICATE 1 FOR BHEL CQS (OR BHEL NOMINATED INSPECTION AGENCY), 2 FOR VENDOR/SUB VENDOR & 3 FOR TSGENCO/TCE AS APPROPRIATE AGAINST EACH COMPONENT /CHARACTERISTIC UNDER P, W & V COLUMNS. * FOR ITEMS MARKED 9 (TICK) IN COLUMN 'D', TEST CERTIFICATES SHALL BE SUBMITTED TO BHEL FOR RECORDS.

SL NO	COMPONENTS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	* D	AGENCY P	AGENCY W	AGENCY V	REMARKS

Notes: -

1. This MQP should be read along with specification, approved drawings & approved datasheet. (Latest revisions to be considered as per PO).
2. Specification/Drawing/datasheet shall prevail over quality plan for contradiction if any.
3. PMI to be witness by inspection agency for all accessible SS or AS parts.
4. Material test certificate shall include tensile, impact, hardness, bend, IGC, hot tensile, grain size, chemical analysis etc. as required by applicable material code /approved drwg./data sheet.
5. WPS/PQR/WPQ to be submitted for review wherever required. All welding shall be done by quali ¿ H G Z H O G H U V ' X O \ H Q G R U V H G G R F X P H Q W BHEL/TPIA's review.
6. Hydro test shall be done in un-painted condition as per approved procedure/relevant code.
7. Any other tests/ checks indicated in specification, P.O., or drawing/data sheet & any additional checks envisaged by BHEL/Customer as part of correspondence to ensure workmanship, finish, aesthetics, etc. shall also be conducted and witnessed/verified by BHEL /TPIA /Customer as per project requirement.
8. All documents issued by statutory authorities such as CCOE /IBR, CMRI, ATEX etc., shall be submitted during inspection.
9. Only type test certificate of same design and same Material of Construction of equipment to be submitted, wherever required.
10. All the relevant test reports /certi ¿ F D W H V V K D O O E H V X E P L W W H G G X U L Q J I L O [illegible] submitted (QAP cl no wise with page nos) to BHEL as documentation package.
11. All sub-ordered items, bought out items, electrical & instrumentation Items shall be procured from approved / agreed vendor list with BHEL/BHEL's Customer.
12. All test reports shall be from NABL accredited lab only.

Abbreviations: -

MTC	-	Material Test certificate	WPS	-	Welding Procedure Specification
IBR	-	Indian Boiler Regulations	PQR	-	Procedure Qualification Record
DFT	-	Dry Film Thickness	WPQ	-	Welder Performance Qualification
TC	-	Test Certificate	NDE	-	Non Destructive Examination
UTS	-	Ultimate Tensile Strength	Appd. Dwg.	-	Approved Drawing
PMI	-	Positive Material Identification	OD	-	Outer Diameter
G.I	-	Galvanized Iron	ID	-	Internal Diameter
MOC	-	Material of construction			

LEGEND: P: PERFORM, W: WITNESS, V: VERIFICATION. INDICATE 1 FOR BHEL CQS (OR BHEL NOMINATED INSPECTION AGENCY), 2 FOR VENDOR/SUB VENDOR & 3 FOR TSGENCO/TCE AS APPROPRIATE AGAINST EACH COMPONENT /CHARACTERISTIC UNDER P, W & V COLUMNS. * FOR ITEMS MARKED 9 (TICK) IN COLUMN 'D', TEST CERTIFICATES SHALL BE SUBMITTED TO BHEL FOR RECORDS.

Annexure-8

Sub-vendor List

BTPS PESD additional vendor approval

Sl.no	Material Description	Vendor	Remarks
6	ERW Pipes	FUTNANI STEELS PVT LTD., SECUNDERABAD, TELANGANA	Approved
		INDUS TUBES LIMITED, DELHI	Approved
7	Pipe Fittings	U I PIPE FITTINGS PVT. LTD., HYDERABAD, TELANGANA	Approved
		TUBE PRODUCTS INCORPORATE, VADODARA, GUJARAT	Approved
		GUJARAT INFRAPIPES PVT LTD., VADODARA, GUJARAT	Approved
		TRUE FORGE PVT LTD., FARIDABAD, HARYANA	Approved
		DEE DEVELOPMENT ENGINEERS LTD.,FARIDABAD, HARYANA	Approved
		TRUE FAB ENGINEER (P) LTD., FARIDABAD, HARYANA	Approved
		P.K. TUBES & FITTINGS PVT. LTD., GURGOAN	Approved
		K. S. PIPE FITTINGS PVT. LTD.,TATARPUR, PALWAL, HARYANA	Approved
		TUBE TURN (INDIA) P. LTD., NAVI MUMBAI, MAHARASTRA	Approved
8	Flanges	PRESHZINGER ENGINEERING, HYDERABAD, TELANGANA	Approved
		THE PUNJAB STEEL WORKS, NEW DELHI	Approved
		METAL FORGINGS P. LTD., NEW DELHI	Approved
		TUBE PRODUCTS INCORPORATE, VADODARA, GUJARAT	Approved
		C.D. INDUSTRIES, GHAZIABAD, UTTARPRADESH	Approved
		CHW FORGE PRIVATE LIMITED, GHAZIABAD, UTTARPRADESH	Approved
		KISAAN STEELS (PVT) LTD., GHAZIABAD, UTTARPRADESH	Approved
9	Gate valves	FOURESS ENGINEERING (I)PVT.LTD, HYDERABAD, TELANGANA	Approved
		L & T VALVES LIMITED, HYDERABAD, TELANGANA	Approved
		FLOSTEER ENGINEERS PVT. LTD., AHMEDABAD, GUJARAT	Approved
		VALVITALIA S.P.A, ITALY	Approved
		B.F.E.SRL BONNEY FORGE, ITALY	Approved
		WEIR BDK VALVES, HUBLI, KARNATAKA	Approved
		NSSL LIMITED, NAGPUR, MAHARASTRA	Not Acceptable
		MICON VALVES (I) PVT. LTD., MUMBAI, MAHARASTRA	Approved
		NITON VALVE INDUSTRIES LTD, MUMBAI, MAHARASTRA	Approved
		SKILT FABRICATORS PVT.LTD,MUMBAI, MAHARASTRA	Not Acceptable
		SHALIMAR VALVES PVT. LTD., NAVI MUMBAI, MAHARASTRA	Not Acceptable
		STEEL STRONG VALVES (I) PVT. LTD., NAVI MUMBAI, MAHARASTRA	Approved
		LEADER VALVES LIMITED, JALANDAR, PUNJAB	Approved
		K.S.B PUMPS LTD., CHENNAI, TAMIL NADU	Approved

14	Control Cables	UNIVERSAL CABLES LTD, HYDERABAD, TELANGANA	Approved
		THERMO CABLES LIMITED, HYDERABAD, TELANGANA	Approved
		KEC INTERNATIONAL LIMITED, HYDERABAD, TELANGANA	Not Acceptable
		NICCO CORPORATION LTD HYD, HYDERABAD, TELANGANA	Approved
		POLYCAB INDUSTRIES PVT.LTD., HYDERABAD, TELANGANA	Approved
		CORDS CABLE INDUSTRIES LTD., NEW DELHI	Approved
		CMI LIMITED, NEW DELHI	Not Acceptable
		KEI INDUSTRIES LIMITED, NEW DELHI	Approved
		DELTON CABLES LIMITED, NEW DELHI	Approved
		PARAMOUNT COMMUNICATIONS LTD, NEW DELHI	Approved
		SPECIAL CABLES PVT. LTD., NEW DELHI	Approved
		SRIRAM CABLES PVT. LTD., NEW DELHI	Not Acceptable
		GEMSCAB INDUSTRIES LTD., NEW DELHI	Not Acceptable
		SUYOG ELECTRICALS LTD, VADODARA, GUJARAT	Not Acceptable
		ELKAY TELELINKS LIMITED, FARIBADAB, HARYANA	Approved
		RAVIN CABLES LTD, MUMBAI, MAHARASTRA	Not Acceptable
		ASSOCIATED CABLES PVT LTD., MUMBAI, MAHARASTRA	Not Acceptable
15	Diesel Engine	Greaves Cotton (R&H) - Pune	Approved
		Cummins- Kothrud / Viman Nagpur	Approved
		Caterpillar - USA	Approved
		Ashok Leyland - Chennai (For booster Pump)	Approved
		KOEL - Pune (For booster pump)	Approved

Electricalvendor list 1

2	BATTERY CHARGER	1	AMAR RAJA POWER SYSTEMS, TIRUPATHI	Approved
		2	CHLORIDE POWER SYSTEMS & SOLUTIONS LIMITED	Not Approved
		3	CHABBI ELECTRICALS, MUMBAI	Approved
		4	EMERSON NETWORK POWER (PUNE) PVT.LTD., BANGALORE	Approved
		5	UNIVERSAL INSTRUMENTS MANUFACTURING Co. Pvt. Ltd.	Not Approved
		6	SERVILINK ENGINEERS PVT.LTD., VADODARA	Not Approved
		7	DUBAS ENGG.PVT.LTD., BANGALORE	Not Approved
		8	Electronic Systems	Not Approved
		9	Power & Protection	Not Approved
		10	Statcon Power Controls Ltd.	Approved
		11	SIGNOTRON (INDIA) PVT LTD.	Not Approved
		12	System Aid	Not Approved
		13	SHERENE ELECTRO CONTROL PVT LTD	Not Approved
3	BATTERIES	1	AMAR RAJA BATTERIES, TIRUPATHI	Approved
		2	HBL NIFE POWER SYSTEMS LTD.	Approved
		3	EXIDE INDUSTRIES LIMITED	Approved
		4	Grid power conversion Pvt Ltd.	Not Approved
		5	SIGNOTRON (INDIA) PVT LTD.	Not Approved
		6	System Aid	Not Approved
		7	AMCO SAFT INDIA LTD.	Not Approved
4	DRAW OUT MCC (PANELS) ***	1	CROMPTON GREAVES LTD.	Not Approved
		2	C & S ELECTRIC LTD	Approved
		3	GE INDIA INDUSTRIAL PRIVATE LIMITED	Not Approved
		4	LARSEN & TOUBRO LIMITED	Approved
		5	SIEMENS India Ltd.	Approved
		6	BCH Electric Limited	Not Approved
		7	KMG ATOZ SYSTEMS (P) LTD.,	Not Approved
		8	Tricolite Electrical Industries, Sahibabad	Not Approved
		9	SCHNEIDER ELECTRIC INDIA PVT.LTD.,	Approved
		10	Unilec Engineers Limited , New Delhi	Not Approved
		11	VRL Automation Engineering & Projects Ltd	Not Approved
		12	Pyrotech Electronics Pvt. Ltd., Unit - 4	Not Approved
		13	CONTROL & SCHEMATICS LTD.,	Not Approved
		14	AMBIT SWITCHGEAR PVT LTD	Not Approved
		15	POWER CONTROL EQUIPMENTS	Not Approved
		16	CUBIC CONTROL SYSTEMS	Not Approved
		17	MEDITRON	Not Approved
		18	SYSTEM INFOTECH	Not Approved
		19	Nitya Electro Controls Pvt Ltd, Noida	Approved

7	JB/ CT BOX/PUSH BUTTON STATION / CABLE BOX/LCB/MLDB/SLDB	1	ELKTRISCHEN POWER GEARS (P) LTD.	Not Approved
		2	HI-POWER CONTROLS	Approved
		3	ORVEEM INDUSTRIES, BANGALORE	Not Approved
		4	VEE VEE CONTROLS PRIVATE LIMITED	Not Approved
		5	CYCLO ELECTRIC DEVICES & SERVICES CO.	Not Approved
		6	SWITCHING CIRCUITS, KOLKATA	Not Approved
		7	SARVANNA SWITCHGEARS, BANGALORE	Not Approved
		8	PATNY SYSTEMS, HYDERABAD	Not Approved
		9	JASPER ENGINEERS PVT.LTD.	Approved

9/4/13

		10	PRIYADARSHINI ENTERPRISES	Not Approved
		11	prammen Industries	Not Approved
		12	Dynaspede Integrated Systems Pvt. Ltd.,	Not Approved
		13	Power & Proection	Not Approved
		14	Unilec Engineers Limited , New Delhi	Not Approved
		15	Hensel Elecric india Pvt. Ld.	Not Approved
		16	Shrenik & Company	Approved
		17	CONTROL DEVICES	Not Approved
		18	JOLLY ENGINEERING INSUSTRIES,	Not Approved
		19	VRL Automation Engineering & Projects Ltd	Not Approved
		20	Nitya Electro Controls Pvt Ltd, Noida	Approved
		21	S.B. POWER SYSTEMS	Not Approved
		22	Pyrotech Electronics Pvt. Ltd., Unit - 4	Approved
		23	SAMCON INDUSTRIAL CONTROLS PVT LTD	Not Approved
		24	POWERTECH SWITCHGEARS (I) PVT LTD	Not Approved
		25	CUBIC CONTROL SYSTEMS	Not Approved
		26	POSITRONICS PRIVATE LIMITED	Not Approved
		27	GEMCO CONTROLS LTD	Not Approved
		28	HI-TECH SERVICES	Not Approved

9	LT AC MOTORS	1	JYOTI, VADODARA	Not Approved
		2	BHARAT BIJLEE Limited., MUMBAI	Approved
		3	ABB, FARIDABAD	Approved
		4	ALSTOM T&D INDIA LIMITED	Not Approved
		5	SIEMENS India Ltd.	Approved
		6	KIRLOSKAR ELECTRIC COMPANY LIMITED.,	Approved
		7	WEG ELECTRIC (INDIA) PRIVATE LTD.,	Not Approved
		8	CROMPTON GREAVES LTD.	Approved
		9	Triangle agencies & Sales PLtd ,	Not Approved
		10	Laxmi Hydraulics Pvt. Ltd.,	Not Approved

12	LT POWER & CONTROL CABLE	1	UNIVERSAL CABLES LIMITED	Approved
		2	CRYSTAL CABLES, KOLKATA	Not Approved
		3	PLAZA CABLES, NEW DELHI	Not Approved
		4	RALLISON ELECTRICALS PVT. LTD. (OLD NAME ROOLEX ELECTROPRODUCTS PVT. LTD.),	Not Approved
		5	NICCO CORPORATION LTD	Approved
		6	TORRENT CABELS, THANE	Not Approved
		7	POLYCAB WIRES PVT LTD	Approved
		8	DELTON CABLES, NEW DELHI	Approved
		9	FINOLEX CABLES, MUMBAI	Not Approved
		10	BROOKS CABLES, MUMBAI	Not Approved
		11	SPECIAL CABLES PVT. LTD.	Not Approved
		12	RADIANT CABLES PVT LIMITED	Not Approved
		13	TOSHNIWAL CABLES, JAIPUR	Not Approved
		14	TCL CABLES LTD	Not Approved
		15	CORDS CABLE INDUSTRIES LTD.	Approved
		16	HAVELL'S INDIA LTD., NEW DELHI	Approved
		17	SBEE CABLES LTD., BANGALORE	Not Approved
		18	KEI INDUSTRIES LMITED	Approved
		19	NATARAJ PLAST INDUSTRIES LTD., NEW DELHI	Not Approved
		20	SUYOG ELECTRICALS LTD., BARODA	Not Approved
		21	TECHMECH ENGINEERS , BANGALORE	Not Approved
		22	GEMSCAB INDUSTRIES LTD	Approved
		23	EPSILLON CABLES PVT. LTD	Not Approved
		24	INDO ASIAN FUSE GEAR LIMITED	Not Approved
		25	GOYOLENE FIBRES (INDIA) PVT LTD., DAMAN	Not Approved
		26	TERACOM Limited	Not Approved
		27	Paramount Communications Ltd.	Approved
		28	Suraj Cables	Not Approved
		29	Govind Cable Industries	Not Approved
		30	Shyam Cable Industries Delhi	Not Approved
		31	Mansfield Cable Co.	Not Approved
		32	KEC INTERNATIONAL LIMITED	Not Approved
		33	Nangalwala Impex (P) Ltd	Not Approved
		34	Windsor Cbles Pvt. Ltd.	Not Approved

		35	ShivaPriya Cables Ltd.	Not Approved
		36	KRISHNA ELECTRICAL INDUSTRIES LTD	Not Approved
		37	HINDUSTAN VIDYUT PRODUCTS LTD.	Not Approved
		38	Gupta Power Infrastructure Ltd	Not Approved
		39	CMI Limited	Not Approved
		40	THERMO CABLES LIMITED	Not Approved
		41	DIAMOND POWER INFRASTURCTURE LTD	Not Approved
		42	RAVIN CABLES LIMITED	Not Approved
		43	VARSHA CABLES PVT LTD	Not Approved
		44	BHANSALI CABLES & CONDUCTORS PVT LTD	Not Approved
		45	CABLE CORPORATION OF INDIA LTD,	Not Approved
		46	Vikas Cable Company	Not Approved
		47	APAR INDUSTRIES LTD., (Unit : Uniflex Cables)	Not Approved
		48	CHANDRESH CABLES LIMITED	Not Approved
		49	TC COMMUNICATION PVT LTD.,	Not Approved
		50	SPM POWER & TELECOM PVT LTD.,	Not Approved
		51	RR KABEL LIMITED	Not Approved
		52	MANOJ CABLES LTD.,	Not Approved
		53	ELKAY TELELINKS, NEW DELHI	Not Approved
13	HT XLPE CABLES	1	UNIVERSAL CABLES LIMITED	Approved
		2	TORRENT CABELS, THANE	Approved
		3	NICCO CORPORATION LTD	Approved
		4	POLYCAB WIRES PVT LTD	Approved
		5	Paramount Communications Ltd.	Approved
		6	TERACOM Limited	Not Approved
		7	Sri ram cables	Not Approved
		8	KEC INTERNATIONAL LIMITED	Not Approved
		9	KEI Industries Ltd., Bangalore	Approved
		10	KRISHNA ELECTRICAL INDUSTRIES LTD	Not Approved
		11	HINDUSTAN VIDYUT PRODUCTS LTD.	Not Approved
		12	Gupta Power Infrastructure Ltd	Not Approved
		13	DIAMOND POWER INFRASTURCTURE LTD	Not Approved
		14	RAVIN CABLES LIMITED	Not Approved
		15	CABLE CORPORATION OF INDIA LTD,	Approved
		16	APAR INDUSTRIES LTD., (Unit : Uniflex Cables)	Not Approved
		17	GEMSCAB INDUSTRIES LTD	Approved
14	INSTRUMENT/SIGNAL/ SCREENED/TELEPHONE SPECIAL CABLES	1	DELTON CABLES, NEW DELHI	Not Approved
		2	TOSHNIWAL CABLES, JAIPUR	Not Approved
		3	RELIANCE ENGG.	Not Approved
		4	ELKAY TELELINKS, NEW DELHI	Not Approved
		5	UNIVERSAL CABLES LIMITED	Not Approved
		6	ASSOCIATED FLEXIBLES & WIRES, PUNE	Not Approved
		7	BROOKS CABLES, MUMBAI	Not Approved
		8	SBEE CABLES LTD., BANGALORE	Not Approved

		9	RALLISON ELECTRICALS PVT. LTD. (OLD NAME ROOLEX ELECTROPRODUCTS PVT. LTD.),	Not Approved
		10	THERMO CABLES LIMITED	Approved
		11	CORDS CABLE INDUSTRIES LTD.	Approved
		12	Thermo Cables Limited	Approved
		13	Govind Cable Industries	Not Approved
		14	IMT Cables Private Ltd.,	Not Approved
		15	Paras Wires Pvt Ltd	Not Approved
		16	ShivaPriya Cables Ltd.	Not Approved
		17	POLYCAB WIRES PVT LTD	Approved
		18	KEI INDUSTRIES LMITED	Approved
		19	Advance Cable Technologies Pvt Ltd	Approved
		20	Gupta Power Infrastructure Ltd	Not Approved
		21	CMI Limited	Not Approved
		22	THERMO CABLES LIMITED	Approved
		23	Nangalwala Impex (P) Ltd	Not Approved
		24	Mansfield Cable Co.	Not Approved
		25	LAPP INDIA (P) LTD	Not Approved
		26	BHANSALI CABLES & CONDUCTORS PVT LTD	Not Approved
		27	APAR INDUSTRIES LTD., (Unit : Uniflex Cables)	Not Approved
		28	CHANDRESH CABLES LIMITED	Not Approved
		29	Paramount Communications Ltd.	Not Approved
		30	TC COMMUNICATION PVT LTD.,	Approved
		31	RR KABEL LIMITED	Not Approved
		32	SPECIAL CABLES PVT. LTD.	Not Approved
		33	MANOJ CABLES LTD.,	Not Approved

16	CABLE GLANDS, LUGS, FERRULES, TYING WIRES	1	SUNIL & COMPANY	Not Approved
		2	ELECTROMAC INDUSTRIES, MUMBAI	Approved
		3	MAHAVEER ENGG. KOLKATA	Approved
		4	RAHUL BROTHERS, BANGALORE	Not Approved
		5	BLACK BURN & CO., KOLKATA	Not Approved
		6	BENGAL ELECTRICAL INDUSTRIES, KOLKATA	Not Approved
		7	BRACO ELECTRICALS (INDIA) PVT., LTD.,	Approved
		8	LAPP INDIA (P) LTD	Approved
		9	LOTUS ELECTRICALS	Not Approved
17	HT/LT CABLE TERMINATION KIT	1	SOUTH ELECTRIC CO., PVT LTD., BANGALORE	Not Approved
		2	FRONTIER TECHNOLOGIES PVT.LTD.	Not Approved
		3	FRONTLINE ELECTRICALS, BANGALORE	Not Approved
		4	YAMUNA POWER & INFRASTRUCTURE LTD.	Not Approved
		5	HARI CONSOLIDATED PVT.LTD, NEW DELHI	Not Approved
		6	EVERSHINE ELECTRICALS	Not Approved

21	EARTHING MATERIALS	1	SHIVA ENGG.WORKS, KOLKATA	Not Approved
		2	MAHAVEER ENGG. KOLKATA	Not Approved
		3	AARPEE ASSOCIATES, KOLKATA	Not Approved
		4	VATCO ELEC-POWER PVT LTD.	Not Approved
		5	PATNY SYSTEMS, HYDERABAD	Not Approved
		6	SHREEM CAPACITORS PVT.LTD.	Not Approved
		7	INDIA ELECTRICALS SYNDICATE,	Not Approved
		8	RUKMANI ELECTRICAL & COMPONENTS PVTLTD.,	Approved
		9	PREMIER POWER PRODUCTS PVT.LTD, KOLKATA	Approved
		10	Inar Profiles Pvt. Ltd.,	Not Approved
		11	Jamna Metal Company	Approved
		12	UCIC PRIVATE LIMITED	Not Approved
		13	RABI ENGINEERING WORKS PVT LTD	Not Approved
		14	R.S. VALVES & PRODUCTS	Not Approved
		15	INDUSTRIAL PERFORATION (INDIA) PVT. LTD.	Not Approved
		16	RATAN PROJECTS & ENGINEERING CO PVT LTD	Not Approved
		17	UNITECH FABRICATORS & ENGINEERS PVT LTD	Not Approved
22	PLC / SCADA	1	ROCKWELL AUTOMATION INDIA PVT., LTD.,	Approved
		2	GE INTELLIGENT PLATFORMS PVT LTD	Approved

3/4/15

		3	SIEMENS India Ltd.	Approved
		4	LARSEN & TOUBRO LIMITED	Not Approved
		5	ABB LIMITED	Not Approved
		6	SCHNEIDER ELECTRIC INDIA PVT.LTD.	Approved
		7	SYNERGY SYSTEMS & SOLUTIONS	Not Approved
		8	YOKOGAWA INDIA LIMITED,	Not Approved
		9	Megatech Controls Ltd.	Not Approved
		10	Pyrotech Electronics Pvt. Ltd.	Not Approved
		11	HoneyWell Automation India Ltd.	Approved
		12	I-Logicon Control Automation Pvt Ltd.	Not Approved
		13	AUTOMATION NETWORKS & SERVICES	Not Approved
		14	SUNLUX TECHNOLOGIES PRIVATE LIMITED	Not Approved
		15	EMCONS	Not Approved
		16	VASUNDRA AUTOMATION & ENGG.SERVICES PVT LTD.,	Not Approved
		17	POWERTECH SWITCHGEARS (I) PVT LTD	Not Approved
		18	GEMCO CONTROLS LTD	Not Approved

28	RTD/THERMOCOUPLE	1	NAGMAN SENSORS, CHENNAI	Not Approved
		2	ALTOP INDUSTRIES, VADODARA	Not Approved
		3	PYROTECH ELECTRONICS PVT. LTD.	Approved
		4	GENERAL INSTRUMENTS CONSORTIUM, BOMBAY	Approved
		5	BELLS CONTROLS LIMITED	Approved
		6	WAREE INSTRUMENTS LIMITED,	Approved
		7	Tempsens Instruments (I) Pvt. Ltd.	Not Approved
		8	Radix Electrosystems Pvt. Ltd.	Not Approved
		9	Radix Sensors Pvt. Ltd.	Not Approved
		10	Toshniwal Industries Pvt. Ltd.	Not Approved
		11	PROTOCONTROL INSTRUMENTS (I) PVT LTD	Not Approved
		12	PYRO ELECTRIC INSTRUMENTS GOA PVT LTD	Approved
		13	WIKA INSTRUMENTS INDIA PVT LTD.,	Approved
29	PRESSURE GUAGES	1	MANOMETER INDIA PVT LTD., THANE	Approved
		2	BELLS CONTROLS LIMITED	Approved
		3	KROHNE MARSHALL PVT LTD., PUNE	Not Approved
		4	A. N. INSTRUMENTS PRIVATE LIMITED	Approved
		5	GENERAL INSTRUMENT CONSORTIUM	Approved
		6	WAREE INSTRUMENTS LIMITED,	Approved
		7	Hirlekar Precision Engg. Pvt. Ltd.	Not Approved
		8	GOA INSTRUMENTS INDUSTRIES PVT LTD	Approved
		9	WIKA INSTRUMENTS INDIA PVT LTD.,	Not Approved
30	HOOTER / HORN	1	WAVES ELECTRONICS, COCHIN	Not Approved
		2	PROCON INSTRUMENTATION, CHENNAI	Approved
		3	KHERAJ ELECTRICALS INDIA PVT LTD, MUMBAI	Not Approved
		4	Industrial Controls & Drives (I) Pvt. Ltd.,	Approved

			[illegible]	[illegible]
32	ACTUATORS/TRANSMITTERS /Level / Flow / Pressure Switches/ Level Gauge / Magnetic / Radar Level Gauge	1	ROTORK CONTROLS (I) LTD., CHENNAI	Approved
		2	TOSHBRO CONTROLS (P) LIMITED.,	Not Approved
		3	ENDRESS + HAUSER(INDIA) PVT LTD	Approved
		4	SAAB TANK CONTROLS INDIA PVT LTD	Not Approved
		5	SWITZER INSTRUMENTS LTD.	Approved
		6	S B E M PVT LTD.	Not Approved
		7	NIVO CONTROLS, INDORE	Not Approved
		8	D.K.INSTRUMENTS PVT LTD.,	Not Approved
		9	EMERSON PROCESS MANAGEMENT	Approved
		10	LEVCON CONTROLS PVT.LTD., KOLKATA	Approved
		11	HoneyWell Automation India Ltd.	Approved
		12	CHEMTROLS SAMIL INDIA PVT LTD	Approved
		13	VEGA INDIA LEVEL & PRESSURE MEASUREMENT PVT LTD	Not Approved
		14	Orbinox India Pvt Ltd	Not Approved
		15	Shanghai Sailtor Automation Instrument Co., Ltd (Indian Representative : M/s Powertherm Engg Pvt Ltd., Hyderabad)	Not Approved
		16	PROTOCONTROL INSTRUMENTS (I) PVT LTD	Not Approved
		17	SIEMENS India Ltd.	Approved

AHP Mech

12	Piping and valves			
	a) MS Pipes - SW/ERW (Black and Galavanized)	a	Sail	Approved
		b	Surya Roshni	Not Approved
		c	Welspun	Approved
		d	ASIAN MILLS PRIVATE LIMITED	Approved
		e	JNB Steel Industries Pvt. Ltd.,	Not Approved
		f	APL Apollo Tubes Ltd.,(Formerly Bihar Tubes Limited)	Not Approved
		g	Jotindra Steel & Tubes Ltd.	Not Approved
		h	Amardeep Steel Centre	Not Approved
		i	JCO GAS PIPE LIMITED	Not Approved
		j	Tubes India	Not Approved
		k	M.J. Patel (India) Limited	Not Approved
		l	ADS PRO - SHIELD	Not Approved
		m	RATNAMANI METALS & TUBES	Approved
	b) Pipe Fittings	a	TURBO ENGINEERS (CBE)	Not Approved
		b	Enviro Bulk Handling Systems Pvt Ltd.	Not Approved
	c) Cast Basalt lined Pipes and Pipe Fittings	a	TURBO ENGINEERS (CBE)	Not Approved
13	Ball Valves	a	Surya Valves	Approved
		b	Hawa Engineers Ltd	Approved
		c	A. V. VALVES LIMITED	Approved
		d	DEMBLA VALVES LTD	Approved
		e	MICON VALVES (INDIA)	Approved
14	GATE, GLOBE, CHECK Valves			
	a) Cast Steel	a	AV Valves	Approved
		b	ATAM Valves	Approved
	b) Cast Iron	a	AV Valves	Approved
	c) Bronze	a	AV Valves	Approved

Approved additional vendors for 1x800 MW KTPS B&W

9	LT AC MOTORS	LAXMI HYDRAULIC PVT. LTD, Secunderabad	NOT APPROVED
		SIEMENS INDIA LTD., Chennai	APPROVED
		ABB LTD., Hyderabad	APPROVED

		Secunderabad	
CONTROL & INSTRUMENTATION ITEMS			
1	PRESSURE GAUGES	FORBES MARSHALL (HYD) PVT LIMITED, Hyderabad	APPROVED
		BAUMER TECHNOLOGIES, Mumbai	APPROVED
		GAUGES BOURDON INDIA, Navi Mumbai	APPROVED
		A.N. INSTRUMENTS PVT. LTD.,Chennai	APPROVED
2	DIFFERENTIAL PRESSURE INDICATOR / GAUGES	BAUMER TECHNOLOGIES,Mumbai	APPROVED
		GAUGES BOURDON INDIA, Navi Mumbai	APPROVED
		SWITZER PROCESS INSTRUMENTS, Chennai	APPROVED
3	PRESSURE AND DIFFERENTIAL PRESSURE SWITCHES	GAUGES BOURDON INDIA, Navi Mumbai	APPROVED
4	PR. & DIFF. PR. TRANSMITTERS (ELECTRONIC - SMART)	EMERSON PROCESS MGT (I) PVT LTD, Secunderabad	APPROVED
		ABB LIMITED,Hyderabad	APPROVED
		FUJI ELECTRIC SYSTEMS CO. LTD., ANDHERI (EAST) MUMBAI	APPROVED
		YOKOGAWA INDIA LIMITED, Bangalore	APPROVED
		EMERSON PROCESS MGT (I) PVT LTD,	

6	RESISTANCE TEMPERATURE DETECTORS (RTD & THERMOCOUPLES)	GOA INSTRUMENTS INDUSTRIES	NOT APPROVED
		PYRO ELECTRIC INSTRUMENTS GOA, MAPUSA	APPROVED
		TECHNO INSTRUMENTS, GANDHI NAGAR	NOT APPROVED
		BAUMER TECHNOLOGIES,ANDHERI EAST , MUMBAI	APPROVED
		THERMAL INSTRUMENT INDIA, DIST SINDHUDURG Maharashtra	NOT APPROVED
		TEMPSONS INSTRUMENTS (I) PVT.LTD., UDAIPUR	NOT APPROVED
7	THERMOMETERS (BIMETALLIC)	GOA INSTRUMENTS INDUSTRIES	APPROVED
		ASHCROFT INDIA PVT. LTD-Gujarat, GANDHINAGAR	APPROVED
		NUOVAFIMA SPA	NOT APPROVED
		H.GURU INSTRUMENTS(S.I)PVT.LTD, Bangalore	APPROVED
		BAUMER TECHNOLOGIES,VAPI	APPROVED
		GAUGES BOURDON INDIA, Navi Mumbai	APPROVED
8	THERMOMETERS (GAS FILLED)	ASHCROFT INDIA PVT. LTD.-Gujarat	APPROVED
		H.GURU INSTRUMENTS(S.I)PVT.LTD, Bangalore	APPROVED
		BAUMER TECHNOLOGIES, VAPI	APPROVED
		GAUGES BOURDON INDIA, Navi Mumbai	APPROVED
9	THERMOWELLS	CARLO DYNATECH INDUSTRIES, Patancheru	NOT APPROVED
		GOA INSTRUMENTS INDUSTRIES, Goa	APPROVED
		ASHCROFT INDIA PVT. LTD.-Gujarat	APPROVED
		MICRO PRECISION PRODUCTS (P) LTD., Haryana	NOT APPROVED
		H.GURU INSTRUMENTS(S.I)PVT.LTD, Bangalore	APPROVED
		PRECISION ENGINEERING INDS.,Mumbai	APPROVED
		THERMAL INSTRUMENT INDIA, Maharashtra	NOT APPROVED
		TOSHNIWAL INDUSTRIES PVT. LTD., Ajmer	APPROVED
		INDUSTRIAL INSTRUMENTATION, Kolkata	APPROVED

\□

16	FOUNDATION BOLTS	A.V. Forgings Ropar Punjab	Not Approved
		Advance Steel Tubes Ltd Ghaziabad Uttar Pradesh	Not Approved
		Deepak Fastners Ltd Ludhiana Punjab	Approved
		M/s Arhant Industries Meerut Uttar Pradesh	Not Approved
		N.L. ENGINEERS PVT. LTD. Punjab	Not Approved
		New Modern Technomech Pvt Ltd Mayurbhanj Orissa	Not Approved
		Nexo Industries Limited Ludhiana Punjab	Not Approved
		VSP Enterprises Pvt. Ltd. Sonipat Haryana	Not Approved
17	GI PIPE	Advance Steel Tubes Ltd Ghaziabad U.P	Approved
		Good Luck Steel Tubes Ltd Bulandshahar U.P	Approved
		Hi-Tech Pipes Limited Sikandrabad Uttar Pradesh	Not Approved
		Metalman Industries Ltd Indore Madhya Pradesh	Approved
		Modern Tools & Electric Co Delhi	Approved
		Ravindra Tubes Limited Hissar Haryana	Approved
		Siddhartha Tubes Ltd Rajgarh Madhya Pradesh	Approved
		Surya Roshni Ltd Haryana	Approved
		UTKARSH TUBES & PIPES LIMITED Kolkata	Approved
		Vishal Pipes Ltd. Sikandrabad Uttar Pradesh	Approved

26	STRUCTURE HARDWARE / EQUIPMENT FIXING HARDWARE	A.V. Forgings Ropar Punjab	Approved
		Asp Private Ltd Howrah West Bengal	Approved
		Deepak Fastners Ltd Ludhiana Punjab	Approved
		Fitwell Fasteners Bhopal Madhya Pradesh	Approved
		Forex Fastners Pvt. Ltd. Ludhiana Punjab	Not Approved
		Lakshmi Precision Screws Limited Rohtak Haryana	Approved
		Arhant Industries Meerut Uttar Pradesh	Not Approved
		Turbo Industries Pvt. Ltd. Ludhiana Punjab	Not Approved
		New India Engineering Corporation Jaipur Rajasthan	Approved
		Nexo Industries Limited Ludhiana Punjab	Approved
		Nishant Steel Industries Ludhiana Punjab	Not Approved
		Paramhari Engineers Nagpur Maharashtra	Not Approved
		Pioneer Nuts And Bolts Pvt. Ltd. Ludhiana Punjab	Not Approved
		Precision Auto Engineers Ludhiana Punjab	Approved
		Remax (India) Ludhiana Punjab	Approved
		Techman (India) Chandigarh	Approved

15	FLOW NOZZLES	1	ENGINEERING SPECIALITIES PVT LTD.,	India	Not Approved
16	GAUGES:DP GAUGES	1	A.N.INSTRUMENTS PVT. LIMITED,	India	Approved
		2	GENERAL INSTRUMENTS CONSORTIUM	India	Approved
		3	H GURU INSTRUMENTS(SI) P.LTD.,	India	Approved
		4	SWITZER INSTRUMENT LTD.,	India	Approved
		5	WIKA INSTRUMENTS INDIA PVT.LTD	India	Approved
17	GAUGES:PRESSURE GAUGE	1	BAUMER TECHNOLOGIES INDIA PVT.LTD,	India	Approved
		2	BUDENBERG GAUGE CO LTD.,	United Kingdom	Approved
		3	GENERAL INSTRUMENTS CONSORTIUM	India	Approved
		4	MANOMETER (INDIA) PVT.LTD.,	India	Not Approved
		5	WIKA INSTRUMENTS INDIA PVT.LTD	India	Approved
18	GAUGES:TEMPERATURE GAUGE	1	BAUMER TECHNOLOGIES INDIA PVT.LTD,	India	Approved
		2	GOA INSTRUMENT INDUSTRIES PVT LTD.	India	Approved
		3	H GURU INSTRUMENTS(SI) P.LTD.,	India	Approved
19	LOCAL INSTRUMENT ENC	1	SAJAS ELECTRICALS		

26	MOTORS:L.T.MOTORS:WP	1	KIRLOSKAR ELECTRIC CO.LTD.	India	Approved
		2	LAXMI HYDRAULICS PVT.LTD.,	India	Approved
		3	MARATHON ELECTRIC MOTORS (INDIA) LT	India	Not Approved
		4	PRECISION ENGINEERING WORKS,	India	Not Approved

		4	UNIVERSAL HOIST-O-FABRIK,	India	Approved
40	PUMP:FUEL OIL PUMP	1	ALEKTON ENGG.INDUSTRIES P.LTD.	India	Approved
		2	TUSHACO PUMPS PVT.LTD.,	India	Approved
		3	U.T.PUMPS & SYSTEMS PVT. LTD.,	India	Approved

13	CABLE GLANDS	116	AUTOMATION & GENERAL ELECTRIC CO., BHOPAL	NOT APPROVED
		117	COMET BRASS PRODUCTS, MUMBAI	APPROVED
		118	CENTRAL HARDWARE INDUSTRIES , BARODA(GUJRAT).	APPROVED
		119	FCG FLAMEPROOF CONTROL GEARS ,MUMBAI	NOT APPROVED
		120	FCG POWER INDUSTRIES P. LTD. , MUMBAI	NOT APPROVED

R.E.JOINT, BF VALVES, MISC. TANK, FLASH TANK

7	TEMPERATURE GAUGES / DIAL THERMOMETERS WITH THERMOWELL	1	B. C TECHNOMATION PVT LTD, BHOPAL	NOT APPROVED
		2	NEW SCIENTIFIC REPAIRS TRADING CO. , KOLKATA	APPROVED
		3	PRESSURE & TEMP. CONTROLS, KOLKATA	APPROVED
		4	A. N INSTUMENTS PVT LTD, KOLKATA	APPROVED
		5	PROFESSIONAL MARKETING SERVICE, BHOPAL	NOT APPROVED
		6	GENERAL INSTRUMENTS CONSORTIUM, MUMBAI	APPROVED
		7	SATURN ENGG. SERVICES, INDORE	NOT APPROVED
		8	BAUMER TECHNOLOGIES INDIA PVT LTD, MUMBAI	APPROVED
		9	LORDS ELECTIC CO., BHOPAL	NOT APPROVED
		10	DETRIV INSTRUMENTATION & ELECTRONIC LTD, MUMBAI	APPROVED
8	LIQUID LEVEL GAUAGES	1	LEVCON INSTRUMENTS PVT LTD, KOLKATA	APPROVED
		2	V. AUTOMAT & INSTRUMENTS PVT LTD INDIA, NEW DELHI	APPROVED
		3	GENERAL INSTRUMENTS CONSORTIUM, MUMBAI	APPROVED
		4	ASIAN INDUSTRIAL VALVES, CHENNAI	NOT APPROVED
		5	PROFESSIONAL MARKETING SERVICE, BHOPAL	NOT APPROVED
9	VALVES (GATE, GLOBE, NEEDLE, ETC.)	1	LEADER VALVES LTD, JALANDHAR	APPROVED
		2	KRISHNA ENGG. CO. , BHOPAL	NOT APPROVED
		3	BHEL, TIRUCHIRAPALLI	APPROVED
		4	NITON VALVES INDUSTRIES PVT LTD, MUMBAI	NOT APPROVED
		5	PROFESSIONAL MARKETING SERVICE, BHOPAL	NOT APPROVED
		6	LEVCON VALVES PVT LTD, KOLKATA	APPROVED
		7	FLOTEK INDUSTRIES	NOT APPROVED
		8	STEELSTRONG VALVES(I) PVT.LTD.	NOT APPROVED
		9	PANDA TECHNOLOGIES INDIA PVT LTD, BHOPAL	APPROVED
		10	WEIR BDK VALVES, A UNIT OF WEIR ENGG. SERVICES INDIA PVT LTD, HUBLI	APPROVED

BHEL□Trichy□

24	L.T.MOTORS	BHARAT BIJLEE LIMITED,	India	Approved
		CROMPTON GREAVES LIMITED,	India	Approved
		KIRLOSKAR ELECTRIC CO.LTD.	India	Approved

□

□

□

□

□

□

EDN BANGALORE

2	24 V DC thyristor based Battery Charger	M/s KELTRON POWER ELECTRONICS,TRIVENDRUM	Approved
		M/s AMARARAJA POWER SYSTEMS LTD, TIRUPATI.	Approved
		M/s CHLORIDE POWER SYSTEMS, KOLKATA	Approved
		M/s CHHABI ELECTRICALS, JALGAON.	Approved
		M/s HBL POWER SYSTEMS,HYDERABAD	Approved
3	24 V DC SMPS based Battery Charger	M/s AMARARAJA POWER SYSTEMS LTD, TIRUPATI.	Approved
		M/s CHHABI ELECTRICALS, JALGAON.	Approved
		M/s MASTECH,MUMBAI	Approved

6	Junction Box (FRP)	M/s SHRENIK & COMPANY, AHMEDABAD	Approved
		M/s FICOM ENGG. PVT. LTD, BANGALORE	Approved
		M/s K.S. INSTRUMENTS, BANGALORE.	Approved
		M/s MANISHA ENTERPRISES, PUNE	Approved
		M/s SUCHITRA INDUSTRIES, BANGALORE.	Approved
7	Junction Box (Metal)	M/s PYROTECH, UDAIPUR	Approved
		M/s CHEMIN CONTROLS, PONIDCHERRY	Approved
		M/s MANISHA ENTERPRISES, PUNE	Approved
8	RTD - TT Junction Box (FRP)	M/s MANISHA ENTERPRISES, PUNE	Approved
9	RTD - TT Junction Box (Metal)	M/s CHEMIN CONTROLS, PONIDCHERRY	Approved
10	CJC Box / PDB for CJC Boxes	M/s CREATIVE INSTRUMENTS AND CONTROLS, BANGALORE	Approved
11	Junction Box (Die Cast Aluminium)	M/s MANISHA ENTERPRISES, PUNE	Approved
12	Electronic Transmitter - Pr. / Diff. Pr.	M/s ABB,GERMANY/FARIDABAD	Approved
		M/s YOKOGAWA, JAPAN / BANGALORE	Approved
13	Level Transmitter (Displacement type)	M/s DRESSER MASONIELAN, FRANCE. /	Approved
		M/s ECKARDT, GERMANY	Approved
14	Level Transmitter (Ultrasonic type)	M/s ENDRESS+HAUSER, GERMANY/INDIA	Approved
15	Level Transmitter (RADAR type)	M/s EMERSON PROCESS , USA / NAVI MUMBAI (formerly FISHER ROSEMOUNT- USA)	Approved
		M/s ABB,GERMANY/FARIDABAD	Approved
		M/s ENDRESS+HAUSER, GERMANY / INDIA	Approved
		M/s YOKOGAWA, JAPAN / BANGALORE	Approved
16	Field mounted (Dual Input) Temperature Transmitter	M/s EMERSON PROCESS , USA / NAVI MUMBAI	Approved
		(formerly FISHER ROSEMOUNT- USA)	Approved
		M/s ENDRESS+HAUSER, GERMANY / INDIA	Approved
		M/s YOKOGAWA, JAPAN / BANGALORE	Approved
17	DIN-rail mounted Temperature Transmitter	M/s EMERSON PROCESS , USA / NAVI MUMBAI	Approved
		(formerly FISHER ROSEMOUNT- USA)	Approved
		M/s ENDRESS+HAUSER, GERMANY / INDIA	Approved
		M/s ABB,GERMANY/FARIDABAD	Approved

22	Cable Glands	M/s ELECTROMAC INDUSTRIES, MUMBAI	Approved
		M/s BRACO ELECTRICALS, MUMBAI	Approved
23	Cable Lugs	M/s BRACO ELECTRICALS, MUMBAI	Approved
24	Cable trays	M/s JAMNA METAL COMPANY, NEW DELHI	Approved
25	Instrumentation, Control & Compensting / Thermocouple extension cables (PVC, FRLS Type)	M/s CORDS CABLES, RAJASTHAN	Approved
		M/s DELTON CABLES,FARIDABAD	Approved
		M/s INCAB, PUNE	Approved
		M/s T C COMMUNICATION PVT. LTD, NEW DELHI	Approved
		M/s POLYCAB,DAMAN	Approved
		M/s THERMO CABLES, HYDERABAD	Approved
26	LT Power Cables (PVC/XLPE Insulation)	M/s CORDS CABLES, RAJASTHAN	Approved
		M/s DELTON CABLES,FARIDABAD	Approved
		M/s KEI INDUSTRIES LTD ,CHENNAI	Approved
		M/s HAVELLS, NEW DELHI	Approved
		M/s PARAMOUNT CABLES,ALWAR	Approved
		M/s POLYCAB, DAMAN	Approved
		M/s THERMO CABLES, HYDERABAD	Approved
		M/s UNIVERAL CABLES,SATNA	Approved

35	Temperature Elements	M/s DETRIV INSTRUMENTATION AND ELETRI MUMBAI	Approved
		M/s PYRO ELECTRIC INSTRUMENTS GOA PVT.L MAPUSA, GOA	Approved
36	Temperature Gauges	M/s A.N.INSTRUMENTS PVT LTD CHENNAI	Approved
		M/s GENERAL INSTRUMENTS CONSORTIUM MUMBAI	Approved
		M/s GOA THERMOSTATIC INSTRUMENTS GOA	Approved
		M/s H.GURU INSTRUMENTS(SOUTH INDIA)PVT. BANGALORE	Approved
37	Level Gauge	LEVCON INSTRUMENTS P LTD KOLKATA	Approved
		SBEM PRIVATE LIMITED PUNE	Approved
		V.AUTOMAT & INSTRUMENTS PVT. LTD. NEW DELHI,	Approved

75	INDICATING LAMPS	ABB(I) LTD.	Approved
		ESSEN & DEINIKI	Approved
		GE POWER CONTROLS	Approved
		SIEMENS	Approved
76	MCB	SCHNEIDER ELECTRIC	Approved
		SIEMENS AG / SIEMENS(I) LTD.	Approved

EPD□

12	Thermal Overload Relay (OLR)	L & T	Approved
		GE-power	Approved
		Siemens	Approved
		C & S Electric	Approved
		ABB	Approved
13	TimerI TIME DELAY RELAY	L & T	Approved
		GE-power	Approved
		Siemens	Approved
		ABB	Approved
		HAVELLS	Approved

□

34	Cable Gland	HEX	Approved
		Commet Brass Products	Approved
		DOWELLS	Approved
		3D	Approved
		Sunil & Co.	Approved
35	Cable Lugs	Commet Brass Products	Approved
		DOWELLS	Approved
		Baliga Lighting Eqpt.	Approved

□

□

KTPS□Approved□vendors□of□HPEP□

3	RESISTANCE TEMP.DETECTOR	PYRO ELECTRIC INSTRUMENTS GOA	Approved
		DETRIV INSTRUMENTATION	Approved
		GOA INSTRUMENTS INDUSTRIES	Approved
		GENERAL INSTRUMENTS CONSORTIUM	Approved

□

3	IT.SD.102	Connecting coupling (Membrane)	EUROFLEX LTD, Hyderabad; JOHN CRANE, UK; RATHI TURBOFLEX *BIBBY TURBOFLEX.*	Approved

□

□

□

PEM Vendor List of Kothagudem STPP

2	DC LEAD ACID BATTERIES	1	EXIDE INDUSTRIES LTD	NA	APPROVED
		2	HBL POWER SYSTEMS LTD	NA	APPROVED
		3	HOPPECKE BATTERIEN GMBH & CO.KG,	NA	APPROVED

TBG

BATTERY	Amara Raja Power Systems Ltd. Tirupathi Andhra Pradesh		Approved
	Exide Industries Ltd NEW Delhi		Approved
	Hbl Power Systems Ltd Hyderabad Andhra Pradesh		Approved
	Hoppecke Batterien GMBH & CO KG		Approved
	Exide Plante		Approved
BATTERY CHARGER	Amara Raja Power Systems Ltd. Tirupathi Andhra Pradesh		Approved
	Chhabi Electricals Pvt Ltd Jalgaon Maharashtra [**MSME**]		Approved
	Hbl Power Systems Ltd Hyderabad Andhra Pradesh		Approved
	Statcon Power Controls Limited Hapur Uttar Pradesh(MSME)		Approved
CABLE GLANDS & ACCESSORIES	Central Hardware Industries Vadodara Gujarat		Approved
	Comet Brass Products Mumbai Maharastra		Approved
	EX-Protecta Anand Gujarat		Approved

CABLE TERMINATION KIT	3M Electro & Communication India Pvt Ltd Pune Maharashtra		Approved
	ABB Limited Faridabad Haryana		Approved
	Raychem RPG (P) Limited Panchmahal Gujarat		Approved
	Raychem RPG Private Limited Thane Maharashtra		Approved
CAPACITOR VOLTAGE TRANSFORMER	ABB India Limited Vadodara Gujarat		Approved
	Crompton Greaves Ltd Nashik Maharashtra		Approved
CIRCUIT BREAKER	ABB India Limited Vadodara Gujarat		Approved
	Alstom T & D India Ltd. Kanchipuram Tamil Nadu		Approved
	Siemens Ltd Aurangabad Maharashtra		Approved
CLAMPS & CONNECTORS	Electromech & Transtech Private Limited Kolkata West Bengal		Approved
	Klemmen Engineering Corporation Chennai Tamil Nadu [**MSME**]		Approved
	Peevee Engineering Enterprises Bangalore Karnataka [**MSME**]		Approved
	Premier Power Products (Calcutta) Pvt. Ltd. Chennai Tamil Nadu		Approved
	Rashtraudhyog Ltd Kolkata West Bengal		Approved
	Raychem RPG (P) Limited Panchmahal Gujarat		Approved
	The Megha Engineering Enterprises Industri Chennai Tamil Nadu [**MSME**]		Approved
	Utsav Electro-Mech Pvt Ltd Vadodara Gujarat		Approved
CONTROL PANELS & METERS	ABB India Limited Bangalore Karnataka		Approved
	Secure Meters Ltd. Udaipur Rajasthan		Approved
	Siemens Limited Margaon Goa		Approved
	Siemens Ltd Thane Maharashtra		Approved

FOUNDATION BOLTS	Fitwell Fasteners Bhopal Madhya Pradesh	bolts nuts washers(flat spring)	Approved
	Forex Fastners Pvt. Ltd. Ludhiana Punjab		Approved
	Precision Auto Engineers Ludhiana Punjab		Approved
	Premier Power Products (Calcutta) Pvt Ltd Howrah West Bengal		Approved
GI PIPE	Already given in BHEL-EDN LIST		Approved
JUNCTION BOX	C & S ELECTRIC LIMITED New Delhi Delhi		Credentials to be submitted
	Pyrotech Electronics Pvt Ltd Udaipur Rajasthan		Credentials to be submitted
	Tenco Systems & Switchgears Pvt Ltd Indore Madhya Pradesh		Credentials to be submitted
LT POWER and CONTROL CABLE	Cords Cable Industries Ltd Alwar Rajasthan	It pvc(power and control)	Approved
	Delton Cables Ltd. Faridabad Haryana	SCREENED CABLE , HF CABLE	Approved
	Finecab Wires & Cables Pvt Ltd Medak Andhra Pradesh MS**ME**	It pvc(power and control)	Approved
	Gemscab Industries Limited Alwar Rajasthan	HT XLPE Power cable upto 33 kV	Approved
	Havells India Ltd Alwar Rajasthan	LT PVC XLPE (power and control) & HT XLPE Cables(upto 33kV)	Approved
	KEI Industries Ltd. Bhiwadi Rajasthan	(it ht pvc xlpe & ehv upto 132 kV) power and control	Approved
	Nicco Corporation Ltd 24 Pargana (N) West Bengal	LT HT PVC XLPE (POWER & CONTROL)	Approved
	Paramount Communications Ltd. Rewari Haryana	HT Power cable(up to 33kV)	Approved
	Polycab Wires Pvt Ltd Daman Daman & Diu	LT HT PVC XLPE (POWER & CONTROL)	Approved
	Universal Cables Ltd Satna Madhya Pradesh	LT HT EHV PVC XLPE (power & control)	Approved

Trichy Boughtout

3	LT-PVC CONTROL CABLE	CORDS CABLE INDUSTRIES LIMITED.,	India	Approved
		DELTON CABLES LIMITED,	India	Approved
		KEC INTERNATIONAL LIMITED,	India	Approved
		KEI INDUSTRIES LIMITED,	India	Approved
		POLYCAB WIRE PVT. LTD,	India	Approved
4	LT-XLPE POWER CABLE	CORDS CABLE INDUSTRIES LIMITED.,	India	Approved
		DELTON CABLES LIMITED,	India	Approved
		KEI INDUSTRIES LIMITED	India	Approved
		POLYCAB WIRE PVT. LTD,	India	Approved

24	L.T.MOTORS	BHARAT BIJLEE LIMITED,	India	Approved
		CROMPTON GREAVES LIMITED,	India	Approved
		KIRLOSKAR ELECTRIC CO.LTD.	India	Approved

27	FRP JUNCTION BOX	K.S.INSTRUMENTS PVT. LTD,	India	Approved
		MANISHA COMPOSITEKS PVT LTD	India	Approved
		SUCHITRA INDUSTRIES	India	Approved

11	FUEL OIL PUMP	ALEKTON ENGG.INDUSTRIES P.LTD.	India	Approved
		TUSHACO PUMPS PVT.LTD.,	India	Approved
		U.T.PUMPS & SYSTEMS PVT. LTD.,	India	Approved

Annexure-9

Master DOC List Format

Annexure-10

Deviation Format

ANNEXURE-10: DEVIATION FORMAT

Sl. No.	Section / Part/Subsection	Page No.	Clause No.	Bid Specification Requirement	Bidder's Deviation

Notes:

1. Bidder to furnish duly filled format along with SEAL & SIGN along with their offer.
2. All the pre-bid queries (if any) shall be raised before submission of the offer as per pre-bid query format (Annexure- 11).
3. Deviations, which are impractical, and the same were raised during pre-bid stage as per pre-bid query format (Annexure-12), but still purchaser's reply/clarifications could not be met shall only be raised in this format.
4. If there are no deviations, bidders shall indicate as "No deviation" and submit the same along with their offer.

5. Deviations indicated elsewhere in bidders offer except raised through this format shall not be considered and reviewed during technical evaluation of their offer.

SIGNATURE : _____
NAME : _____
DESIGNATION : _____
COMPANY : _____
DATE : _____

COMPANY SEAL

Annexure-11

Prebid Clarification Format

ANNEXURE-11: PRE-BID QUERIES FORMAT

Sl. No.	Section / Part/Subsection	Page No.	Clause No.	Bid Specification	Bidder's Query	Purchaser's Reply

Note: **During Preparation of Pre-Bid Queries, Complete Tender Specification (along with all Annexures) shall also be referred.**