CORRIGENDUM-1

PACKAGE NAME: ASH SLURRY PUMPS

GEM Bid No: GEM/2023/B/3498869 Dated 29.05.2023

Project Name: UDANGUDI S.T.P.P (2X660MW), TAMILNADU

Technical Clarification/Amendment

1. Technical specification in GEM Bid

a. GeM bid Page – 4 of 18 , in that specification document shall be replaced by revised specification as enclosed.

Earlier Specification was 553 page shall be replaced with 198 page of specification.

Doc No - IS-4-PQR-714-300-M003 **Date-26-May-2023**

2 X 660 MW TANGEDCO UDANGUDI TPS

Pre-Qualification Criteria for Ash Slurry Pump Package

The bid is open for participation to those bidders who satisfy the following Technical requirements: -

1.1 Bidder should have designed, engineered, manufactured, tested & supplied at least Two (2) numbers of Ash Slurry Disposal pumps of similar rating & specification as given below for Ash slurry disposal pumping application for Ash Handling plant of two different thermal power stations of minimum 250 MW rating.

Pump Type	Horizontal Centrifugal, Double Casing, close non-clog, Ash Slurry Pump.
Capacity	Minimum 395 m^3/hr.

1.2 Bidder should have established service facilities (incl. assembly/ testing) in India and the same shall be indicated in the offer.

1.3 Bidder shall provide documentary evidence in support of his claim for having experience in design, manufacture, testing, supply, performance of Ash Slurry Disposal Pumps meeting the requirements mentioned in sl. Nos. 1.1 & 1.2 for Ash Handling Plants which are in operation on the date of submission of bid.

1.4 The bidder of offered Ash Slurry Disposal Pumps Package shall be subjected to approval by Customer / Customer's consultant. The bidder who is not approved by customer/ customer's consultant will not be considered for evaluation of their offer.

1.5 The bidder shall be OEM (Original Equipment Manufacturer) or their authorized distributor. In case, the offer is submitted by their authorized distributor, the OEM shall furnish undertaking on their letter head stating that "The OEM shall be responsible and stand guarantee for the quality of material, timely execution of the order and submission of drawings/documents for approval for the order placed on their distributors. The OEM must clearly state the role of their distributor regarding their distributor to participate in the technical discussion and price negotiations. The OEM shall also confirm that the equipment and spares supplied through their distributor will be under their standard guarantee/warranty and OEM shall be liable for the services, repairs and replacements of the equipment/spares, if any.

1.6 BHEL-ISG reserves the right to assess the capabilities and capacity of the Bidder to perform the contract, should the circumstances warrant such assessment in the overall interest of the Employer.

BHEL-ISG reserves the right to reject any or all bids or cancel/withdraw the Bids without assigning any reason whatsoever and in such case no bidder / intending bidder shall have any claim arising out of such action.

1.7 Financial criteria:

The bidder shall have Rs 0.70 crore or more as Average annual financial turnover during the three consecutive Financial Years (FYs) (FY to be considered shall be 2019-20, 2020-21 & 2021-22)

Sreeraj C
Mgr.- (Engg. Mech)

Maheshwaran R
DGM.- (Engg. Mech.)

R S Pujari
Sr. DGM. – HOD/ (Engg. Mech.)

2 X 660 MW Udangudi Super Critical Thermal Power Project

Technical Enquiry Specification of

Ash Slurry Pumps

Bharat Heavy Electricals Limited

Industrial Systems Group

Bengaluru

SECTION	PREPARED BY	CHECKED BY	APPROVED BY
MECHANICAL	SREERAJ C	R MAHESHWARAN	RAJSHEKHAR S PUJARI
ELECTRICAL	HEMANTHA UDUPA YJ	HEMANTHA UDUPA YJ	M A SANGEETHA

TABLE OF CONTENTS

Section-I

01.00.00 **Project Information**

01.01.00 The specification has been prepared for supply of complete Ash Slurry Pump sets with the drive, base frames & all accessories for 2x660 MW Udangudi Supercritical Thermal Power Project for which TCE, Bangalore, is the consultant for the End User, TANGEDCO.

01.02.00 BHEL is the principal contractor who is responsible for the establishment of the project. Industrial Systems Group (ISG) of BHEL located at Bengaluru will be executing the Ash Handling System.

01.03.00 Plant details -

Location	The proposed power project will be located at Udangudi; at about 45km South of Thoothukudi in Tamil Nadu.
Nearest Airport	Vagaikulam (approx. 60 km from site)
Nearest Port	Tuticorin (approx. 45 km from site)
Nearest Railway Station	Thiruchendur (approx. 12 km from site)
Road access to site	East Coast road – State highway 176

01.04.00 Site conditions -

Ambient Temperature	41^0C (Max), 17^0C (Min) ,
Relative Humidity (RH)	84% (Max), 62% (Min),
Plant Elevation	4.0 M above MSL
Mean Wind speed	20.6 Km/hr
Wind direction	North, North East, North West, East

Section-II

02.00.00 **Scope & Responsibilities**

02.01.00 The scope of supply & work includes design, manufacture, supply, assembly, inspection & testing at manufacturer's work, delivery to & supervision of E&C and PG Test of 10 (Ten) nos. ash slurry disposal pumps [Six (6) for bottom ash slurry & four (4) for fly ash slurry application], complete with the drives, motors, base frames & all accessories; to project site.

02.02.00 Supply of mandatory & commissioning spares as per this specification is also in scope of supply of bidder.

02.03.00 Bidder shall include 20 (Twenty) man days over 5 (Five) visits at site for supervision of erection, commissioning & PG test of ash slurry pumps.

03.00.00 **Detailed Scope of Supply & Work**

03.01.00 The slurry pumps shall be supplied with required V-belt, belt guards, coupling guards, pump & motor side pulleys, flexible coupling between pump & gear box, companion flanges with nuts and bolts for expander/reducer at pump suction & discharge, pump suction & discharge gaskets, common/split base frame for slurry pump, gear box, variable speed fluid coupling with manual operated scoop with manual override including oil circulation pump and motor along with alignment nuts and bolts, foundation bolts with nuts & washers, equipment mounting bolts for pumps and motor and shaft keys for the pumps.

03.02.00 All the fasteners shall be of SS316L to suit sea water application.

03.03.00 The pump manufacturer shall make his own arrangement for testing of ash slurry pump-equipment at shop floor as per approved QAP.

03.04.00 The bidder shall include the expense of accommodation/stay, air travel expenses, transportation of End User inspector during the period of inspection in their scope.

03.05.00 LT Motors, scoop coupling control panel, local JB, etc. shall be supplied by the bidder as per the electrical specification [section III] & Annexure IV of this specification.

03.06.00 The gear boxes shall be supplied with required lubricating oil, oil level indicator/gauge, etc. as per this specification.

03.07.00 The variable speed fluid coupling with manually operated scoop shall be supplied with all equipment and accessories like fusible plug, differential pressure switch across the filter, pressure switch, pressure gauge, SS mesh Y-Strainer, temperature gauge, temperature switch, isolation valves, oil circulation pump with motor, shell and tube type heat exchanger with copper tubes, shaft input and output side multi disc flexible coupling with nuts and bolts and spacer plates (as applicable), required lubricating oil, oil level gauge, hose pipe (oil service), drain plug etc. as per this specification.

03.08.00 Each pump will be of identical duty conditions.

03.09.00 The gearbox and fluid coupling manufacturers shall make their own arrangement for testing of equipment at shop floor as per approved QAP.

03.10.00 Bidder to note that the efficiency of pump with ash slurry shall not be less than 70% for Bottom ash slurry pumps & Fly ash slurry pumps.

03.11.00 Bidder to consider & supply motor of rating– maximum160 kW for 1st stage slurry pumps & maximum 132 KW for 2nd stage slurry pumps.

03.12.00 Items and accessories which are not mentioned specifically but are essential for the best performance of the equipment shall be supplied by bidder without any cost implication to BHEL.

03.13.00 For scope related to Electrical and C&I, bidder to refer section-III.

03.13.01 For commissioning purpose, bidder shall include 20 (Twenty) man-days over 5 (Five) visits at site excluding travel time for supervision of commissioning of slurry pumps & fluid couplings. The visit shall be inclusive of accommodation/stay at site, travel expenses, transportation etc. Bidder shall ensure the availability of engineers with necessary tools/instruments (on returnable basis) at project site; who shall be made available to BHEL/BHEL's E&C contractor at project site for system integration with the ash handling plant and for conducting PG Test of slurry pumps. In case additional visits are desired/required by BHEL, then the bidder shall be paid as per price quoted.

03.14.00 For commissioning of the fluid couplings, manufacturer's service engineer shall be arranged by the bidder at site. The visit shall be inclusive of accommodation/stay at site, travel expenses, transportation, etc. and same shall be in bidder's scope.

03.15.00 **Accessories**

03.15.01 Bidder shall include following items/accessories as part of ash slurry pump in their scope

- Expander and reducer with fasteners, gaskets & companion flanges to suit pressure rating of PN 25 at pump suction and discharge side to suit the following -
  - For bottom ash & fly ash slurry pumps – Cast basalt lined MS pipes of ID 287mm & MS OD 355.6mm.
- V-belt and Pulleys [of Cast Iron] along with belt guard for five (5) nos. pumps [three (3) nos. for bottom ash slurry & two (2) nos. for fly ash slurry] and motors.
- Flexible Couplings between pump & gear box, gear box & fluid coupling and fluid coupling & motor.
- Coupling guards for couplings between pump & gear box, gear box & fluid coupling and fluid coupling & motor.
- Pump shaft keys.
- Suction & discharge gaskets & other accessories, which are not mentioned specifically but are essential for sound performance of the equipment.
- HT bolts for ash slurry pumps and motors.
- Base frame with foundations bolts, V-belt guard, anti-vibration pads, eye bolts etc. as required for the ash slurry pump. The base frame shall be provided with epoxy/ equivalent paint/coating to suit sea water atmosphere.
- All necessary instruments to ensure smooth and satisfactory operation of the ash slurry pump and also for the safe and reliable operation of the pump.

- Tool kit for operation and maintenance of the ash slurry pump, gearbox, fluid coupling and motor.
- Lubrication fittings as necessary for proper and easy lubrication of the equipment.
- Base frames [five (5) sets] for 1st pump of each series shall be supplied by pump manufacturer. The 1st pump shall be direct motor driven along with fluid coupling and gear box in between pump and motor.
- Base frames [five (5) sets] for balance pumps and motors in the series shall be supplied by pump manufacturer and shall be V-belt motor driven.
- No equipment shall be mounted on the floor directly without a base frame.
- All the above pump, drives, & accessories shall be dispatched from successful bidder's manufacturing works.

03.15.02 Bidder shall include following items/accessories as part of Gear Box in their scope

- HT Bolts, nuts and washers for fitting the gear box on base frame.
- Tool kit for operation and maintenance of the gear box.

03.15.03 Bidder shall include following minimum accessories as part of each fluid coupling

- Companion couplings (gear box side and motor side) along with nuts & bolts and spacer plates (as applicable).
- HT bolts for fixing fluid coupling on base frames.
- All necessary instruments to ensure smooth and satisfactory operation of the fluid coupling and also for the safe and reliable operation of the equipment.
- Tool kit for operation and maintenance of the fluid coupling.
- Lubrication fittings as necessary for proper and easy lubrication of the equipment.
- All other accessories, which are not mentioned specifically but are essential for sound performance of the equipment.

03.16.00 **Mandatory Spares**

03.16.01 Bidder shall include the supply of mandatory spares as listed in clause no. 07.02.00 of section IV of this specification, in their scope.

03.16.02 Bidder shall dispatch mandatory spares only after confirmation from BHEL ISG. Shelf life of mandatory spares and preservation requirements shall be submitted along with the bid.

03.16.03 Spares shall be dispatched in pre-decided lots in containers/secure boxes. The containers/secure boxes should only contain spares and no other items which are part of main supply. All boxes/containers shall be distinctly marked in red color with boldly written "S" mark on each face of the containers/secure boxes as indication of items to be directly handed over to customer.

03.16.04 BBU number should be put on the items in a durable manner (Punching/painting, etc.) so that the items can be easily linked with approved BBU for ease of handing over to customer.

03.16.05 Expiry date for short shelf life items (oils, chemicals, insulation materials, etc.) should be put on the item as well as the packing box.

03.16.06 In case spares indicated in the list are not applicable to the particular design offered by the bidder, the bidder should offer spares applicable to offered design with quantities generally in line with approach followed in the above list.

03.16.07 In case the bidder indicates against any item mentioned above as "Not applicable (NA)" and later it is found to be applicable, bidder shall supply such spares free of cost without any price implication.

03.16.08 The description of various items is only indicative and shall be supplied according to approved drawings/ Data sheets.

03.16.09 In case, if found at any stage of the project, that the spares supplied by the bidders are not compatible, the compatible ones shall be supplied again by the bidder without any cost implication to BHEL.

03.17.00 **Commissioning Spares**

03.17.01 Bidder shall include the supply of commissioning spares as listed in clause no. 07.03.00 of section IV of this specification, in their scope.

04.00.00 **Technical Details, Design & Construction features**

04.01.00 Specifications for Ash Slurry pumps

Description	Technical Particulars
Type	Horizontal Centrifugal, double casing, closed Non- clog type Ash slurry pump
Applicable codes	ISO 1940 Balancing ISO 9906/IS 5120/ IS 9137 Performance test Any other relevant International / DIN standard.
Duty	Continuous-24 hrs./day (Bottom Ash Slurry Pump) Intermittent (Fly Ash Slurry Pumps)
Capacity	Bottom Ash Slurry Pumps: 530 m^3/hr to 540 m^3/hr Fly Ash Slurry Pumps : 516 m^3/hr to 540 m^3/hr *Capacity of pump shall be finalized at the time of placement of order.
Rated Head	Bottom Ash Slurry Pumps: 38mwc to 39mwc /(max.) Fly Ash Slurry Pumps: 37mwc to 39mwc (max.) *Pump head shall be finalized at the time of placement of order.
Drive transmission arrangement	1st stage by variable speed fluid coupling & gear box. Range of speed variation of the pump shall be (-) 20% to (+) 10% of the rated RPM of slurry pump 2nd stage by V-belt & fixed pitch pulley drive
Design Conditions	Pumps shall handle highly abrasive ash slurry (up to 25% concentration w/w basis). Ash slurry pump shall be suitable to handle max 40 mm size ash clinkers. 65 deg. C temperature for ash slurry.
Maximum operating	1000 rpm

pump speed	
Impeller tip Speed	1676m/min (maximum, considered at duty point)
Suction Condition	Flooded Suction with suction lift of 2m for Ash slurry pumps.
Specific Gravity of slurry	1.1 for bottom ash slurry & 1.18 for fly ash slurry

04.02.00 Specifications for Gear Box

Description	Technical Particulars
Type	Helical Gear Box
Duty	Continuous-24 hrs. /day
Location	Indoor
Applicable codes	As per manufacturer's standard
Type of loading	Continuous designed for Heavy Shock Loading
Type of Cooling	Air cooled

04.03.00 Specifications for Fluid Coupling

Description	Technical Particulars
Type	Variable Speed scoop coupling with manual scoop
Duty	Continuous-24 hrs. /day
Location	Indoor
Applicable codes	As per manufacturer's standard
Range of Speed Regulation Provided	(+) 10% to (-) 20 %
KW/RPM Rating of Motor	4 Pole/50Hz for Bottom ash and fly ash slurry pumps (Motor rating selected shall be suitable for the entire range of slurry pump operation)
Maximum Slip Permissible	3% at duty point
Mounting Arrangement	Horizontal- Foot Mounted
Noise Level	85 dBA at 1.0 meter from equipment.
Selection criteria	The fluid coupling shall be selected to suit the selected motor rating for bottom ash slurry pumps and fly ash slurry pumps. In no case, the fluid coupling shall be selected at shaft power of pump (at duty point).

04.04.00 Material of Construction/Design features for ash slurry pumps

Description	Technical Particulars
Impeller and Impeller ring	Chrome nickel cast iron Ni hard Type IV, 550 BHN **OR** 24% Chromium cast iron of 550 BHN
Outer casing	Outer casing shall be cast steel ASTMA216 **OR**

	Spheroid graphite ductile iron ASTM 636, 65-45-12. **OR** 24% Chromium cast iron of 550 BHN
Inner casing	Inner casing (volute liner) shall be chrome nickel cast iron NI hard Type IV,550 BHN **OR** 24% Chromium cast iron of 550 BHN
Suction & Discharge Adopters	Chrome nickel cast iron Ni hard Type IV, 550 BHN **OR** 24% Chromium cast iron of 550 BHN
Shaft	Carbon steel to AISI K-1040/EN 8
Shaft Sleeve	Hardened and ground SS (550 BHN) OR SS ASTM A 743 CA 15 (550 BHN)
Stuffing box	Alloy CI 400 (BHN)
Gland	Carbon Steel ASTM 216 GR.WCB
Gland packing	Asbestos Rope
Noise level	85 dB (max) at 1.5mtr from equipment.
Drive motor speed	1500 RPM for bottom & fly ash slurry pumps
Drive motor rating	Maximum 160 kW LT motor
Pump design & performance standard	IS 5120 / IS 5639/ API 610
Wear plate (Bracket side and suction side)	Chrome nickel cast iron NI hard Type IV, 550 BHN OR 24% Chromium cast iron of 550 BHN

04.05.00 Material of Construction/Design features for gear box

Description	Technical Particulars
Casing	Cast Iron FG-260 to IS210
Gear & Pinion	SAE 8620/Eqiv
Output Shaft	45C8N, IS:1875
Input Shaft	42CrMo4-T, DIN EN-10083

04.06.00 Material of Construction/Design features for fluid coupling

Description	Technical Particulars
Impeller	Aluminum Alloy LM6 BS 1490
Runner	Aluminum Alloy LM6 BS 1490
Scoop housing	Aluminum Alloy LM6 BS 1490
Scoop housing bracket	MS Fabricated
Coupling box & cover	IS 2062 GR-B Fabricated
Scoop casing	Aluminum Alloy LM6 BS 1490
Back casing	Aluminum Alloy LM6 BS 1490

04.06.01 Material of Construction/Design features for fluid coupling oil cooler

Description	Technical Particulars
Type	Water operated oil cooler, Shell and Tube type Heat exchanger
Shell	ERW Pipe
Tubes	Copper
Oil circulation pump & motor	Gear Pump with relief valve/ As per proven standard of manufacturer.
Accessories as applicable	As per manufacturer's standard
JB [control]	JB shall be provided as suitable for Instruments with connection oil circulation from the motor.

04.07.00 Design & Construction Features for slurry pumps

04.07.01 There shall be two (2) nos. pumps in each series & there are five (5) such series [3 for BA Slurry & 2 for FA Slurry]. Each pump shall be interchangeable and casing for all the pumps shall be designed for the total discharge head of the series i.e. 114 MWC for BA Slurry pumps & 111 MWC for FA Slurry pumps for this project (considering one additional stage of slurry pumps for future).

04.07.02 Bidder shall submit the GA drawing of 1st& 2ndstage ash slurry pumps with arrangement of suction and discharge of the pumps.

04.07.03 Pulleys for Ash slurry pumps shall be designed to withstand shock loads also. Bidder shall furnish the calculations for selection of the pulley & number of grooves in the pulley and V-belt selection.

04.07.04 Life of oil lubricated anti-friction type bearings shall be at least 40,000 running hours. Pump Bearings shall be of SKF/FAG/TIMKEN make.

04.07.05 The rotational speed of the impeller at duty point shall not exceed 1000 rpm.

04.07.06 Vibration level of each ash slurry pump shall be limited to as per the VDI-2056/BS 4675 standards.

04.07.07 Pump-motor set shall run smooth without undue noise and vibration. Acceptable peak to peak vibration limits shall generally be guided by Hydraulic Institute Standards.

04.07.08 All centrifugal pumps shall have a drooping characteristics curve with the head continuously increasing with decreasing flow to maximum head and the pumps shall preferably be non-overloading type beyond rated duty point.

04.07.09 The characteristic curves of each set of pumps shall match each other for equal load sharing in case of parallel operation and such pumps shall be identical and all parts shall be fully interchangeable. Standard type pumps with a proven record of reliability only shall be provided.

04.07.10 Complete technical data from pump supplier regarding head drop v/s mixture concentration and clearance diagram for impeller and casing and complete information shall be furnished.

04.07.11 The ash slurry pump shall be such that the maximum noise shall not exceed 85 dB (A) when measured at 1m away from noise emission source.

04.08.00 Design& Construction Features for gear box

04.08.01 The maximum rise of oil temperature shall not be more than ambient +45 deg. C.

04.08.02 The gear box shall be such that the maximum noise shall not exceed 85 dB (A) when measured at 1m away from noise emission source.

04.08.03 Vibration level of Gear Box shall not exceed 75 microns or shall be accepted as per VDI 2056 / BS 4675.

04.09.00 Design& Construction Features for fluid coupling

04.09.01 The operating pressure of clarified water of fluid coupling cooler shall be 6.0 kg/cm^2 (g). The oil cooler shall be tested to withstand min. 10 kg/cm^2 (g) water pressure during inspection.

04.09.02 Oil cooler shall be designed to withstand hydro test pressure of 1.5 times the working pressure of the liquid.

04.09.03 Pressure switches, pressure gauges, temperature switches and temperature switches shall be weather and dust proof as per IP65. Certificate for the same shall be submitted for review during inspection.

04.09.04 The dial size of the pressure/temperature gauge shall be 150 mm with white background and black lettering.

04.09.05 The model no. and maximum operating range of pressure/temperature gauges/switches shall be as per manufacturer's standard. The over range protection for gauges/switch shall be 150% of the maximum design pressure. The maximum operating temperature shall be as per system requirement.

04.09.06 Vibration level of fluid coupling shall not exceed 75 microns or shall be accepted as per VDI 2056 / BS 4675.

04.09.07 Maximum noise level shall not exceed 85 dB (A) when measured at 1.0 m away from noise emission source.

05.00.00 **Painting**

05.01.00 The surface preparation and painting shall be as follows:

05.01.01 Surface preparation- Blast cleaning SA 2$_{1/2}$

05.01.02 Primer - Zinc Phosphate Epoxy – 2 coats [Total DFT 75 microns]

05.01.03 Intermediate paint – 2 pack HB Epoxy Polyamide MIO- 1 coat [Total DFT 100 microns]

05.01.04 Finish coat – Polyurethane- 2 Coats[Total DFT 100 microns] Shade blue(5012)

05.01.05 Total DFT shall be 275 microns.

05.02.00 For motors, painting shall be suit to seawater application.

Section-III

06.00.00 **Electrical Power Distribution System**

06.01.00 Electrical System and Equipment for the Ash Slurry Pumps system package shall be designed to operate satisfactorily under the following site conditions:

Voltage levels shall be considered as follows:

Power evacuation and Start-up power: 400 kV (±5%), 3 phase, 3 wire, 50 Hz, effectively earthed.

Generation voltage: Manufacturer's standard voltage, 3 phase, 50 Hz

HT supply for external CHP: 33 kV (±10%), 3 phase, 3 wire, 50 Hz, solidly earthed

HT auxiliary supply: 11 kV (±10%) & 6.6 kV (±10%), 3 phase, 3 wire, 50 Hz, earthed through resistance.

LT auxiliary supply: 415 V (±10%), 3 phase, 4 wire, solidly earthed.

LT emergency supply: 415 V (±10%), 3 phase, 4 wire, solidly earthed.

DC supply: 220 V (+10% & -15%), DC, 2 wire, unearthed.

UPS supply: 230 V (±10%), 1 phase, 2 wire, 50 Hz, AC

Communication system DC supply: 48 V (+10% & -15%), DC, 2 wire, +ve pole earthed.

Control supply for MCC feeders: 110 V AC, 1 phase, 2 wire

Permissible frequency variation: +3% to – 5%

Combined variation of voltage & frequency: 10%

Voltage level for AC motors

Up to 0.2 kW: 230 V, 1 phase, 50 Hz

Above 0.2 kW up to 200 kW voltage: 415 V, 3 phase, 50 Hz

Above 200 kW & up to 2000 kW: 6.6 kV, 3 phase, 50 Hz

Above 2000 kW: 11 kV, 3 phase, 50 Hz

The three phase symmetrical short circuit ratings of the switchgear and equipment at different voltage levels shall be not less than the following values:

Sl. No.	Voltage level	Symmetrical Short time withstand current	Dynamic withstand Current
a)	400 kV	63 kA for 1 second	163 kAp
b)	33 kV	25 kA for 3 second	63 kAp
c)	11 kV	50 kA for 3 second	125 kAp
d)	6.6 kV	31.5 kA for 3 second	80 kAp
e)	415 V	65 kA / 50 kA for 1 second	137 kAp / 105 kAp

06.02.00 **Table of Reference**

06.02.01 For equipment/system description/specification bidder to consider the End-user NIT specification attached in Annexure. Following documents are part of this enquiry specification and provided with Electrical annexure.

Sl. No	Item	Customer NIT Reference
1	Electrical Annexure-A	LV Switchgear
2	Electrical Annexure-B	Motors
3	Electrical Annexure-C	Instrumentation & Control Works
4	Electrical Annexure-D	Mandatory Spares

Electrical –Commissioning and Mandatory spares list shall be considered as per attached in Electrical Annexure D - Mandatory Spares applicable to this Ash Water Pumps package for electrical and C&I items considered. Mechanical Vendor must follow the Electrical Annexure D- Mandatory Spares of End-user specifications for their scope of items supplied for this package.

06.03.00 Scope division between BHEL-ISG and Mechanical Vendor

Sl. No.	Equipment Description	BHEL-ISG Scope.	Mechanical Vendor (Bidder) Scope.
1	415V AC LT Motors (up to 200KW)	Erection and commissioning of LT Motors is in BHEL Scope. BHEL Shall provide the DOL Feeder in their respective LT MCC.	Design and supply of LT Motors up to 200KW is in mechanical vendor scope. Mechanical vendor shall supply LT motors of Energy efficient level IE3 as per IS 12615 and shall also arrange motor foundation bolts & half coupling.
2	Local Push Button Station (LPBS)	Erection and commissioning of LPBS is in BHEL Scope.	Design and Supply of LPBS required for this package by mechanical Vendor.
3	Equipment mounted Instruments(if any) required for the successful operation.	Erection & Commissioning of the equipment mounted instruments is in BHEL Scope.	Design and Supply of all the equipment mounted instruments required for system operation is in the scope of mechanical vendor.
4	Power Junction Box (PJB)	Erection and commissioning of Power JB's is in BHEL Scope.	Design and Supply of all the Power JB's required for this package is by mechanical Vendor. Actual size of the cable will be shared to successful bidder based on KW rating. Accordingly bidder to select the PJB if required depending upon motor termination size

5	Mandatory Spares -Electrical and C&I	NIL	Supply of all the Electrical and C&I Mandatory Spares shall be considered as per the customer specification (i.e., as per Electrical Annexure D - Mandatory Spares without any deviation is in mechanical vendor scope.
6	General requirement	NIL	Equipment list with rating, duty, functional write up control philosophy, process interlock, Process & Instrumentation diagram (PID) with KKS Tag names etc. ,start stop/shut down sequence etc. for DCS /HMI software development shall be provided by mechanical vendor
7	Control Junction Box (CJB) if applicable	Erection and commissioning of CJB is in BHEL Scope.	Design and Supply of Control JB required for this package by mechanical Vendor.
8	Power requirement for Fluid coupling	DOL or Power feeder arrangement will be made available at MCC	Bidder to confirm the type of feeder requirement
9	Fluid Coupling / Oil Pump Local Control Panel if applicable	Erection & Commissioning of Fluid Coupling/Oil Pump Local Control Panel is in BHEL Scope.	Design & Supply of Fluid Coupling / Oil Pump Local Control Panel with power and Control Schematic shall be in Mechanical vendor's scope.
10	Power, Control and Instrumentation Cables	Supply, Laying and Termination of Power, control & instrumentation cables for Ash Water Pumps package is in BHEL Scope.	Design and Supply of any special cable required for this package will be in mechanical vendor scope. Vendor shall furnish BOQ for Cables during detailed Engineering.
11	Instruments (Gauges, Switches and Transmitters / Elements / Meters)/field devices/other equipment for system operation.	Erection and commissioning of all the instruments, Solenoid valves and any other instruments/switches required for system operation is in BHEL Scope.	Design and Supply of all the instruments, Solenoid valves and any other instruments/switches required for system operation is in the scope of mechanical vendor.
12	Level switches, Pressure switches, Pressure Gauge, Differential Pressure switch, Differential Pressure Gauge, Temperature Switch and Temperature Gauge and any type of limit switches required for the successful operation.	Erection and commissioning is in BHEL scope.	Design and supply of these items required for this package is in Mechanical Vendor scope.

06.04.00 Additional Notes

06.04.01 All LT AC motors shall be of as per the customer specification.

06.04.02 Makes of all electrical equipment shall be as per approved bidder list furnished by BHEL.

06.04.03 Bidder should obtain prior customer approval for make, GA, Data sheet, QAP for all sub vendor items.

06.04.04 Total feeder list with type, rating and power requirement shall be furnished by Bidder. Total drive list with calculation and load curves shall be furnished by Bidder as part of their bid for further evaluation.

06.04.05 Design and Supply of LPBS connected with mechanical equipment's and instruments (wherever required) shall be in Bidders scope.

06.04.06 Base frames, foundation bolts, both half couplings for all equipment (including BHEL supplied HT motors (if any)) shall be in the scope of Bidder.

06.04.07 Training of Customer and BHEL personnel for operation and maintenance of Bidder supplied equipment is included in the bidder's scope.

06.04.08 For successful implementation of control system, the bidder shall furnish detailed Control philosophy/write-up, drive list and all other details/drawings/data/information which shall be used for preparation of logic diagrams for controls, interlock and protection of Bidder's equipment. Any other data as might be required by the customer during detailed engineering stage shall also be forwarded without any cost repercussions. Bidder shall depute his engineer to customer office for approval of above documents.

06.04.09 All the instruments/equipment which are required to implement the control philosophy as specified in corresponding mechanical sections shall also be provided by the bidder.

06.04.10 List of Drawings to be submitted for each equipment/system shall be intimated to the successful bidder during detailed engineering and drawings shall be submitted in line with the list.

06.04.11 Local stop push button stations shall be provided for all equipment's supplied by bidder.

06.04.12 Type test reports shall be submitted as per specification wherever applicable. Order shall be placed to sub vendors having valid type test reports to avoid the time delay in getting type test conducted. In case of non-availability vendor having valid type test reports for the similar rating/type, bidder shall conduct the type test at no extra cost to BHEL. No time extension will be given for conducting type tests. The type tests report for the tests conducted on the equipment similar to those to be supplied under this contract and the test(s) should have been conducted at an independent laboratory not earlier than five (5) years prior to supply under this contract.

06.04.13 Potential free NO-NC contacts are required from all instruments for interlocking purpose to DDCMIS.

06.04.14 Design Basis Report / Flow & P&I Diagram / GA / Layout Drawing for Equipment's& Subsystems etc involved in this tender shall be submitted for Approval from TANGEDCO/DESEIN/BHEL ISG.

06.04.15 Actuators if any used shall be as per customer NIT.

06.04.16 Any item exclusively which is not covered /mentioned in the above scope matrix but it is required as per customer spec. (Annexure attached with this specification) and as per the system requirement the same to be provided without any extra cost to BHEL.

06.04.17 All the Pushbuttons must have 2No+2NC contacts and wiring up to Terminal Box (TB's).

06.04.18 Any additional electrical/control & Instrumentation requirement mentioned in Mechanical technical specification not specified in Electrical specification shall also be considered by the bidder.

06.04.19 In case of any conflict & ambiguity, decision of BHEL/customer shall be final and binding.

Section-IV

07.00.00 Bill of Quantities

07.01.00 Main Supply

Sl.	Item Description	Qty.	Units
1	Bottom ash slurry disposal pumps [first stage] complete with Gear box, Variable Speed Fluid Coupling with Manual Scoop along with its accessories, instrumentation, local JB, etc.; Set of Base frames along with foundation bolts, nuts & washers for slurry pump, fluid coupling, gear box & motor.; Set of one Increaser at discharge and one no. Reducer at Suction of each ash slurry pump along with Companion Flanges with nuts, bolts and gaskets for each Increaser/reducer for each ash slurry pump; LT Motors for ash slurry pumps & Miscellaneous items for ash slurry pumps as per specifications (Like flexible coupling between gear box and ash slurry pump equipment mounting bolts for pumps and motor, coupling guards for coupling, pump shaft keys, etc.)	3	Sets.
2	Bottom ash slurry disposal pumps [second stage] complete with Pulleys (Pump side & Motor side), V-Belt and Belt Guard; Set of Base frames along with foundation bolts for each fly ash slurry pump, belt drive and its motor; Set of one Increaser at discharge and one no. ACI Reducer at Suction of each ash slurry pump. Set includes Companion Flanges with nuts, bolts and gaskets for each Increaser/reducer for each bottom ash slurry pump; LT Motors for ash slurry pumps; Miscellaneous items for ash slurry pumps as per specifications (Like pump shaft keys, etc.)	3	Sets.
3	Fly ash slurry disposal pumps [first stage] complete with Gear box, Variable Speed Fluid Coupling with Manual Scoop along with its accessories, instrumentation, local JB, etc.; Set of Base frames along with foundation bolts, nuts & washers for slurry pump, fluid coupling, gear box & motor.; Set of one Increaser at discharge and one no. ACI Reducer at Suction of each ash slurry pump along with Companion Flanges with nuts, bolts and gaskets for each Increaser/reducer for each ash slurry pump; LT Motors for ash slurry pumps & Miscellaneous items for ash slurry pumps as per specifications (Like flexible coupling between gear box and ash slurry pump equipment mounting bolts for pumps and motor, coupling guards for coupling, pump shaft keys, etc.)	2	Sets.
4	Fly ash slurry disposal pumps [second stage] complete with Pulleys (Pump side & Motor side), V-Belt and Belt Guard; Set of Base frames along with foundation bolts for each fly ash slurry pump, belt drive and its motor; Set of one Increaser at discharge and one no. ACI Reducer at Suction of each ash slurry pump. Set includes Companion Flanges with nuts, bolts and gaskets for each Increaser/reducer for each bottom ash slurry pump; LT Motors for ash slurry pumps; Miscellaneous items for ash slurry pumps as per specifications (Like pump shaft keys, etc.)	2	Sets.

07.02.00 **Mandatory Spares**

Sl. No.	Item Description	Qty	Units
1	Impeller with wearing parts	4	Nos. for each pump model
2	Casing liners	4	Nos. for each pump model
3	Liners (suction & gland side)	4	Nos. for each pump model
4	Shaft sleeve	2	Nos. for each pump model
5	Lantern ring	2	Nos. for each pump model
6	Gland packing	2	Sets. for each pump model
7	Bearings for pump with bearing seal	2	Sets. for each pump model
8	Labyrinth seal complete set	2	Sets. for each pump model
9	V-belts (complete set for pump)	2	Sets. for each pump model
10	Bearings for motors	2	Sets. for each pump model
11	Pump shaft	4	Nos. for each pump model
12	Twin casing pumps inner casing	4	Nos. for each pump model
13	Electrical and C&I Mandatory Spares as per the specification	1	Lot

07.02.01 If the model of the pumps for bottom ash & fly ash slurry application are same, bidder has to consider mandatory spares for one pump model only. However, BHEL reserve the right to order additional items (spares) at same quoted price at a later stage.

07.02.02 Bidder to supply the Electrical & C&I Mandatory Spares as per the electrical annexure with this specification.

07.03.00 **Commissioning Spares**

07.03.01 The required commissioning spares shall be included in bidder's scope.

07.03.02 The list of commissioning spares for Ash slurry disposal Pump shall be furnished along with offer.

07.03.03 These commissioning spares shall be supplied immediately after Boiler Light up (BLU) of any unit which shall be intimated to the bidder by BHEL.

07.03.04 The following minimum commissioning spares for fluid coupling shall be included in bidder's scope:

- 6 nos. Rubber spacer between couplings of oil pump and motor.
- 2 Nos. Fusible plug.
- 1 No. Pressure gauge of each type and size.
- 1 No. pressure switch of each type and size.
- 1 No. Temperature gauge of each type and size.
- 1 No. Temperature switch of each type and size.
- 1 Sets* Oil Seal
- 1 Sets* O –Ring
- Oil/ Grease for pump-as required
- Grease for Motors-as required
- Oil for Fluid coupling and Gearbox-as required for initial flushing, first fill and initial operation

* Sets comprise fulfill the requirements of 1 No fluid coupling

Section-V

08.00.00 **Inspection & Testing**

08.01.00 All Quality plans shall be submitted in soft copy for BHEL/End User approval.

08.02.00 Successful bidder shall give 15 days' advance written notice of equipment being ready for testing.

08.03.00 Type & routine test report / certificates shall include details of standard to which the tests are performed, test parameters, acceptance criteria, test set up etc. used during the testing along with the test piece details/rating and the detailed test record and final test result.

08.04.00 Motors shall be separately inspected by BHEL/End-user at motor manufacturer's shop prior to inspection of slurry pump along with job motor inspected by BHEL/End-user.

08.05.00 All inspection, measuring and test equipment used by the successful bidder shall be calibrated periodically. Successful bidder shall maintain all relevant records of periodic calibration & instrument identification.

08.06.00 The details of the checks to be carried out for various components (MQP) are to be submitted within one month from the date of purchase order by the successful bidder for BHEL/End User approval.

08.07.00 One complete assembly of slurry pump set with fluid coupling, gear box, job motor for first stage & V-belt, pulley & job motor for second stage for each type [bottom ash & fly ash] shall be offered for witness at pump manufacturer's works.

08.08.00 After completion of inspection the material will be treated as cleared for dispatch by BHEL/End User/End User's Consultant inspector, if inspection is OK as observed by Inspection Engineers.

08.09.00 Rated capacity, head and power consumption at motor input terminal of each slurry pump are to be tested and proved at shop applying correction for slurry density. Power consumption of the pump shall be measured during inspection of the pumps with job motor at Manufacturer's shop at duty point.

08.10.00 Refer TANGEDCO Specification (Annexure-I) for Inspection and QA details.

09.00.00 **Testing Parameters**

09.01.00 <u>Pumps</u>

09.01.01 Hydro test of the Pumps shall be hydro tested at 2 times of the pump rated head or at 1.5 times of pump shut-off head whichever is higher. For Ash slurry pumps the Rated/shut off head for each slurry pump shall be taken after adding the rated/shut off head for all the pumps coming in a series. The testing for each pump shall be done at the above pressure.

09.01.02 During inspection, the performance test (for head, capacity and power) of pump shall be carried out at reduced speed with calibrated test bed motor and readings for performance curve shall be taken on different points from shut off head to 120% of the rated flow (including rated flow).

Section-VI

10.00.00 **Technical inputs to be furnished/ confirmed along with the offer**

Following documents are to be necessarily enclosed for each type of Pump by the Bidder as a part of the Offer:

10.01.01 Bidder to specify the design standard followed for design of Fluid coupling and also specify the equivalent Indian Standard/MOC for foreign standards

10.01.02 Bidder shall submit signed copy of all the pages of enquiry specification.

11.00.00 **Documents to be furnished before supply**

Successful bidder shall furnish the following in proper drawing/document format within 1 week after receiving L.O.I

11.01.01 GA, Data sheet and Sectional assembly drawings of ash slurry pump, gearbox complete with bill of material and its part numbers.

11.01.02 GA drawings for V-Belt Drive, GA drawing with scoop type Fluid coupling and gearbox drive.

11.01.03 Performance curve and Torque Speed Curves

11.01.04 Operational and Maintenance manual.

11.01.05 Storage and Installation Manual

11.01.06 Sizing calculations of pulley and V-belt selection.

11.01.07 Lubrication schedule.

11.01.08 QAP for BHEL/Customer/customer's Consultant approval.

11.01.09 Painting Schedule for approval.

11.01.10 Load Data for designing Civil Foundation.

11.01.11 GA drawings of base frames, MS flange, pump and motor side pulleys, flexible coupling between pump and gearbox.

11.01.12 Successful bidder shall submit all the above with proper title block within a week of receipt of LOI.

11.01.13 Successful bidder shall furnish the detailed packing /shipment box details with information such as packing box size, type of packing, weight of each consignment, sequence no. of dispatch, no. of consignment for each deliverable item against each billing break up units/ billable blocks.

11.01.14 All the equipment GA drawings shall be submitted with separate sheet indicating complete BOM. The same shall be reflected in BBU.

11.01.15 Successful bidder shall submit "Storage Instructions" for the storage (at site) for the entire equipment in bidder's scope of supply and the bidder shall ensure that the Shipment list/ Packing list and Storage Instructions are available at site before the items/equipment reach the site.

11.01.16 Any other relevant document which may be felt necessary during execution of Contract.

11.01.17 The approval time for Drawings/Documents from BHEL/Customer shall be considered by bidder as three weeks for their planning of supply of equipment within time frame.

12.00.00 **Operation & Maintenance Manual**

O & M manual shall contain the following -

12.01.01 Principle of operation of the equipment.
12.01.02 Details of preventive / repair maintenance for equipment and accessories used.
12.01.03 Details about the general specifications, design capacities of equipment, their function.
12.01.04 Equipment Bidder's address, telephone nos., contacts person details to be furnished.
12.01.05 Required Dismantling devices, tools etc.,
12.01.06 List of DO's and DO NOT's.
12.01.07 Test certificates.
12.01.08 All drawings.
12.01.09 Calculations.
12.01.10 Erection manual
12.01.11 O& M Manual for Fluid coupling.
12.01.12 O& M Manual for oil circulating pump and motor.
12.01.13 O& M Manual for oil cooler.
12.01.14 Storage instructions.
12.01.15 Proper procedures & sequence of operation.
12.01.16 Lubrication Schedule including charts showing lubrication checking, testing and replacement procedure to be carried daily, weekly, monthly & at longer intervals to ensure trouble free operation.
12.01.17 Where applicable, fault location charts shall be included to facilitate finding the cause of mal-operation or break down.
12.01.18 Detailed specifications for all the consumables including lubricant oils, greases, and chemicals etc. system/equipment/assembly/sub D assembly - wise required for the complete system.
12.01.19 Note

- All manuals shall be supplied in proper bound books or in folders, preferably in A4 size.
- The volume and section number shall be intimated by the Bidder.
- Bidder shall directly send O&M Manuals [10 (ten) hard copies & soft copy] to BHEL-ISG HQ with covering letter copy to Project Manager, BHEL-ISG Bengaluru.
- BHEL Project Manager shall co-ordinate and shall ensure submission to End User/End User's Consultant for the equipment as per BHEL standard practice.

Section-VII

13.00.00 **Note to bidders**

13.01.00 Clarifications, if any shall be sorted out before submission of the bid. Bidder's shall raise all ambiguities, conflict in the standard & specification and/or interpretation of clauses, if any, in this enquiry spec. and its enclosures during pre-bid stage itself, failing which it shall be understood that bidder has no issue and at later date successful bidder shall have no right to take any technical and commercial deviation out of any ambiguity, conflict in the standard & specification and/or interpretation of clauses and the decision of BHEL shall be final and binding and any change due to this shall have no price implication on BHEL and shall have to be absorbed by successful bidder.

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

13.03.00 Bidder shall submit the signed and stamped copy of all the pages which constitutes this technical enquiry specification signed by authorized signatory.

13.04.00 Successful bidder's visit to site for system integration (Pre-commissioning, commissioning & PG test) shall be intimated by BHEL when required and the payment towards the same shall be only on pro-rata basis.

13.05.00 The bidder shall be OEM (Original Equipment Manufacturer) for the slurry pumps or their authorized distributor.

13.06.00 In case, the offer is submitted by their authorized distributor, the OEM shall furnish undertaking on their letter head stating that "The OEM shall be responsible and stand guarantee for the quality of material, timely execution of the order and submission of drawings/documents for approval for the order placed on their distributors. The OEM must clearly state the role of their distributor regarding their distributor to participate in the technical discussion and price negotiations. The OEM shall also confirm that the equipment and spares supplied through their distributor will be under their standard guarantee/warranty and OEM shall be liable for the services, repairs and replacements of the equipment/spares, if any.

13.07.00 The bidder shall be subjected to approval by BHEL/End User/End User's consultant. The End User's list of approved vendors for gearbox, fluid coupling & LT motors is attached as an annexure with this specification. However, in case bidders suggest alternate vendors for the gearbox, fluid coupling & LT motors, the same shall be of reputed and proven make and shall be subject to approval by BHEL/End User during detailed engineering. In case the alternate vendors for the gearbox, fluid coupling & LT motors are not acceptable to BHEL/End User, successful bidder shall source the items from the vendors in the End User's approved vendor list without any cost implication to BHEL.

14.00.00 **List of Annexure**

14.01.00 Annexure I – TANGEDCO specification

14.02.00 Annexure II – Painting Specification

14.03.00 Annexure III – GA of FA Slurry Pump house & BA Slurry Pump house

14.04.00 Annexure IV – Electrical Annexure

- Annexure A – LV Switchgear
- Annexure B – Motors
- Annexure C – Control & Instrumentation works
- Annexure D – Mandatory spares

14.05.00 Annexure V – BHEL HSE Manual

14.06.00 Annexure VI- Approved Sub vendors.

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ANNEXURE I

TANGEDCO SPECIFICATIONS

VOLUME II

SUB-SECTION - 2.11.7

ASH SLURRY PUMPS

1.0.0 CODES & STANDARDS

Design

The design, manufacture and performance of the horizontal pumps for handling abrasive slurry as specified herein, shall comply with the requirements of all applicable codes, the latest applicable India/ British/ American/Din standards, in particular the following:

IS: 5120: Technical requirement - rotodynamic special purpose pumps.

IS: 5639: Pumps for handling chemicals & corrosive liquids.

API: 610: Centrifugal pumps for general services.

2.0.0 DESIGN REQUIREMENT

Ash Slurry Pumps

For pumping the bottom ash or fly ash slurry from the slurry sump to the ash disposal area, Respective slurry pumps will be used. Each set shall comprise of two horizontal ash slurry pumps, operating in series (if required) having a provision of installing 1 more additional pump in future. The first stage of ash slurry pumps shall be provided with fluid coupling with gear box arrangement and the second stage with V-belt drive (if applicable) as required, depending upon the disposal distance and/or wear of the impeller.

The pump shall be designed to have best efficiency at the specified duty point and shall be suitable for continuous operation at any point within the 'range of operation' specified.

Pumps shall have a continuously rising head capacity characteristics from the specified duty point towards shut off point, the maximum being at shut off.

The pump-motor set shall be designed in such a way that there is no damage due to reverse flow through the pump.

Each pump shall have single stage and shall be specially designed to handle abrasive slurry as specified in data sheet. Pumps shall be suitable for connection in series where system head requirement exceeds the head developed by one pump.

Pump Casing

Pump casing shall be of double casing type construction. The outer casing shall be designed to withstand the maximum shut-off pressure developed by the pump in series at the pumping temperature. The inner casing shall be replaceable type. Single casing pump shall not be accepted

Casing drain as required shall be provided complete with drain valves.

In case of pumps handling hot fluid, the pump casing nozzles will be subjected to reactions from external piping. Pump design must ensure that the nozzles are capable of withstanding external reactions not less than these specified in API-610.

In the case of installation, where an expansion joint or sleeve type coupling is located at pump suction and discharge, the pump assembly will be subjected to an additional thrust which will

be transmitted to the foundation. The pump shall be designed to withstand this additional load, calculated on the basis of pump/series shut-off head.

When system head requirement is more than the head developed by one pump, two or more pumps will be connected in series in the same pipe line, all the pump casings shall be hydrostatically tested to the requirement of last stage pump.

Each pump casing and internals shall be designed such that the casing can be rotated so that its discharge outlet covers 360° angle in vertical plane, at steps of 45°. The casing position shall be changeable at site at steps of 45° to suit pipe arrangement.

Impeller
The impeller shall be non-clog type, suitable for handling maximum size of solids specified.

The impeller shall be overhung type, shall be secured to the shaft and shall be retained against circumferential movement by keying, pinning or lock rings. The overhung shaft impellers should be secured to the shaft by an additional locknut or cap screw. All screwed fasteners shall tighten in the direction of normal rotation. Means shall be provided to prevent loosening during reverse flow condition/reverse rotation.

Shaft
Shaft size selected shall take into consideration the critical speed, which shall be away from the operating speed as recommended in applicable code/standard mentioned earlier. The critical speed shall also be at least 10% away from run away speed

Shaft Sleeves
Renewable type fine finished shaft sleeves shall be provided at the stuffing boxes. Length of the shaft sleeves must extend beyond the outer faces of gland packing so as to distinguish between the leakage between shaft & shaft sleeve and that past the gland.

Shaft sleeves shall be securely fastened to the shaft to prevent any leakage or loosening. Shaft & shaft sleeve assembly should ensure concentric rotation.

Bearings
Bearings of adequate design shall be furnished for taking the entire pump load arising from all probable conditions of continuous operation throughout its 'range of operation' and also at the shut-off condition. The bearing shall be designed on the basis of 20,000 working hours minimum for the load corresponding to the duty point.

Sleeve/ball/roller type bearings shall be provided to take care of radial loads.

In case of ball/roller type radial bearings, the same may be utilized for taking axial loads also by adopting suitable design.

In case sleeve type radial bearings are acceptable, axial thrust shall be absorbed in suitable thrust bearings.

Proper lubricating arrangement for the bearings shall be provided. The design shall be such that the bearing lubricating element does not contaminate the liquid being pumped. Where there is a possibility of liquid entering the bearing, suitable arrangement in the form of deflectors or otherwise must be provided ahead of assembly.

Bearings shall be easily accessible without disturbing the pump assembly. A drain plug shall be provided at the bottom of each housing.

Stuffing Boxes
Stuffing box design should permit replacement of packing without removing any part other than gland.

Stuffing boxes shall be sealed/cooled by the liquid being pumped and necessary piping, fittings, valves, instruments etc. shall form an integral part of the pump assembly.

If external cooling/sealing water is required, all items like piping, fitting, valves, interlocking and supervising instruments etc. required for this purpose shall be supplied under this specification.

For the seals under vacuum service, the seal design must ensure sealing against atmospheric pressure, even when the pumps are not operating.

Base Plate & Sole Plate

For directly couple pump-motor set, a common base plate mounting both for the pump and motor shall be furnished. The base plate shall be of rigid construction, suitably ribbed and reinforced. Base plate and pump supports shall be so constructed and the pumping unit so mounted as to minimize misalignment caused by mechanical force such as normal piping strain, internal differential thermal expansion and hydraulic piping thrust. Suitable drain taps and drip lip shall be provided.

Variable speed Drive (Fluid Coupling)

The first stage pump of each series of ash slurry pumps shall be driven at a variable speed using a scoop type fluid coupling. The pump speed shall be manually adjustable within the range specified in data sheet.

ANNEX 2.11.7.1

SPECIFIED DESIGN DATA FOR SLURRY DUTY HORIZONTAL CENTRIFUGAL PUMP

Sl.No.	Description	Unit	Data
	Horizontal Centrifugal Slurry Pumps		
1	Application		Ash slurry pumps in ash slurry pump house B.A overflows pumps.
2	Medium		Ash slurry
3	Pump Efficiency		MIN. 70%
4	No. of Pumps for each unit.		Refer Flow diagram
5	Capacity	m3/hr	As per system requirement
6	Suction head discharge of 1st pump.		For the 1st pump in each set flooded.
7	Features of construction		
8	Type of Pump		Volute casing
9	Impeller		Non clog
10	Volute Casing		Double
11	Coupling		Ash slurry pump
11	Maximum permissible tip speed for pump impeller		28 m/sec
12	Slurry concentration		25-30% by weight
13	Maximum operating speed of the pump		Not exceeding 1500 rpm.
			Variable speed hydraulic /fluid coupling for first stage and gear box to achieve speed variation of (+) 10%, (-) 20% of rated speed.
			For second stage onwards- Belt drive
14	Lubrication		Grease/Oil
15	Type of sealing		External water sealing
16	Separate pumps for sealing/ cooling acceptable		Contractor to indicate
17	Pump and foundation to be designed for expansion joint/ sleeve coupling at pump suction & discharge		Yes
18	Bearings		Ball/roller
19	Thrust bearing to be designed for pump shut-off operation		Yes
20	No. of pumps per chain		As per Flow Diagram and system requirement
21	Duty		Continuous
	Scope of Supply		Yes
1	Pumps with drive motors		Yes
2	Driving power transmission device, fluid and flexible coup-ling as applicable		Yes
3	Motor slide rails		No
4	Guard for couplings/belts		Yes
5	Adopters for pump suction		Yes

Sl.No.	Description	Unit	Data
	and discharge		
6	Companion flange with bolts, nuts & gaskets for pump suction and discharge		Yes
7	Base plate for pump and drive unit		Yes
8	Foundation bolts, nuts, sleeve for all equipment		Yes
9	Eye bolts, lifting tackles etc.		Yes
10	Painting and protective coating		Yes
11	Erection, testing and commissioning service required		Yes
12	Supervision of erection required		Yes
13	Cooling/ sealing/ lubrication system with necessary pumps, piping, valves, tank, instruments etc.		Yes
14	Water for cooling/ sealing/ lubrication to be taken from		From seal water system by Contractor
15	Discharge pressure gauge		Yes
16	Suction pressure/ combination gauge		No
17	**Materials of Construction**		
17.1	Impeller and impeller ring		Chrome nickel cast iron Ni hard Type IV, 550 BHN OR 24% Chromium cast iron of 550 BHN
17.2	Outer Casing		Outer casing shall be cast steel ASTM-A216 or Spheroid graphite ductile iron ASTM 636, 65-45-12. OR 24% Chromium cast iron of 550 BHN
17.3	Inner casing		Inner casing (volute liner) shall be chrome nickel cast iron NI hard Type IV, 550 BHN OR 24% Chromium cast iron of 550 BHN
17.4	Wear plate (Bracket side and suction side)		Chrome nickel cast iron NI hard Type IV, 550 BHN OR 24% Chromium cast iron of 550 BHN
17.5	Suction Adopters		Chrome nickel cast iron Ni hard Type IV, 550 BHN OR 24% Chromium cast iron of 550 BHN
17.6	Discharge Adopters		Chrome nickel cast iron Ni hard Type IV, 550 BHN OR 24% Chromium cast iron of 550 BHN
17.7	Shaft		Carbon steel to AISI K-1040/EN 8
17.8	Shaft Sleeve		Hardened and ground SS (550 BHN) OR SS ASTM A 743 CA 15 (550 BHN)
17.9	Stuffing box		Alloy CI 400 (BHN)
17.10	Gland		Carbon Steel ASTM 216 GR.WCB
17.11	Gland packing		Asbestos Rope

VOLUME II

SUB-SECTION 2.23

INSPECTION AND TESTING AT MANUFACTURER'S WORKS

1.0.0 GENERAL

This section is intended to provide the scope, functional requirements for Inspection and Testing of various mechanical equipment, material, parts, and workmanship of the Plant during manufacture, to demonstrate compliance with specification, codes and standards and to ensure overall reliability of plant operation and performance.

2.0.0 INSPECTION AND TESTING REQUIREMENTS

The equipment to be supplied under this Contract shall be subject to works' inspections and workshop tests.

The Bidder shall issue a quality assurance programme, indicating the kind and extent of inspections and tests to be carried out on plant components. These inspections and tests shall prove whether the equipment fulfils the requirements of the Contract in view of

- Design & functional requirement of equipment/system
- safety conditions
- consideration of the applied standards and regulations
- execution of workmanship
- Conformity with the present state of modern technology.

2.1.0 Material tests

Test specimens shall be taken in accordance with the relevant standards and codes. Dimensions shall be adequate for the purpose intended and the test specimen shall accompany the component through all phases of the heat treatment. Before cutting or otherwise removing the test specimens, these shall be permanently banded together with the forgings, castings or components which they represent and, if requested, in the presence of the Owner's Engineer. Except where expressively otherwise approved, all test specimens shall be machined to the dimensions specified in the relevant standards find codes. Steel castings and forgings, in all cases; be annealed before the test specimens are withdrawn.

Chemical analysis and mechanical properties of the material concerned shall also be submitted.

All casting components shall be tested for compliance with the relevant standards and codes and shall be suitable for the purpose for which the castings are to be used. The chemical analysis and mechanical properties of the material tested shall be provided by the Bidder. The results obtained from these material tests shall be in compliance with the values contained in the relevant standards and codes and with the figures quoted in the relevant sections of the Contract, X-ray examination and ultrasonic examination of circumferential, longitudinal, nozzle welded joints, stiffening rings, etc., shall be carried out by the Bidder in compliance with the standards under which the relevant equipment will be designed.

All castings and forgings of critical components of the equipments viz ST, BFP, CEP, CW pumps etc, pressure vessels, alloy & stainless steel material shall be subjected to X-ray and/or ultrasonic tests before the start of machining procedures, in order to detect defects as early as possible and to replace in time defective parts, thus avoiding undue delay in the manufacture and delivery of plant components. After partial machining in the Bidder's workshop, further tests may be performed. No repair welding machining of castings and forgings of major components shall be carried out without prior inspection and confirmation by

the Owner's Engineer. In case of a rejection, written and certified notice must be given to the Owner/ Owner's Engineer, indicating also measures undertaken by the Bidder in order to cope with the requirements of the Contract.

Major steel forgings

Purchase specifications shall clearly state the quality and inspection requirements and should include, but not be limited to:

a) chemical composition range
b) heat treatment
c) mechanical test specimen locations
d) mechanical properties
e) magnetic properties (when applicable)
f) non-destructive testing
   - methods and procedures
   - stage and extent of application
   - recordable indication size
   - allowable indication size
g) thermal stability test (HP and reheat turbine shafts only)

Each forging shall be suitably marked with an identification number which shall transferred throughout all machining stages. The identification number shall be indicated on all documents relating to the forging.

Repair welding will not be permitted on rotating parts and on other components the proposal will be subject to approval by the Owner's Representative.

Rotor forgings

The profile of forgings at the stage of final ultrasonic Inspection should be such as to minimize the regions where complete coverage is not possible.

Ultrasonic indications should be measured by the equivalent flat bottomed hole or AVG (DGS) method.

The toughness of rim and core (where applicable) material shall be evaluated by testing charpy V impact specimens over a range of temperatures and thus determining the 50% fibrosity fracture appearance temperature.

Allowable indication size and material toughness are interdependent design related criteria and the Bidder must be prepared, if requested by the Owner's Representative, to justify his proposals by reference to fracture mechanics calculations.

Bores, when provided, shall be magnetic particle inspected and a suitable intrascope used for examination.

Major steel castings

Purchase specifications shall clearly state the quality and inspection requirements and should include:

a) chemical composition range
b) heat treatment
c) mechanical test specimen locations
d) mechanical properties
e) non-destructive testing
   - methods and procedures

- stage and extent of application
- recordable indication size
- allowable indication size

f) other tests
g) standard weld repair procedure.

Each casting shall be identified by hand stamped or cast-on reference numbers which shall be Indicated on all documents relating to the casting.

Non-destructive testing

Minimum requirements are as follows:

a) Crack detection of critical areas of castings which in the case of castings to operate at high temperature or high pressure shall consist of 100% of all accessible areas. Magnetic particle inspection shall be used for ferritic steel castings.
b) Ultrasonic inspection of all surfaces of castings to operate at high temperature or high pressure.
c) Ultrasonic thickness check of critical areas.
d) Radiographic examination adjacent to future butt weld regions (Acceptance Standard Level 1 of ASTM E446 or E186 as appropriate).
e) Radiographic examination shall also be used to assist in defining defects indicated by ultrasonic inspection.

In addition to being applied as necessary quality control on as cast items, inspections outlined in a) and b) above shall be applied to the finally heat treated casting.

Prior to non-destructive testing all surfaces shall be satisfactorily prepared and visually examined.

Repair welding

Unacceptable defects observed by visual examination or indicated by nondestructive testing shall be excavated by chipping or thermal gauging and grinding and their complete removal proved by crack detection.

In the case of excavations which penetrate more than 25 mm or 50% of the wall thickness or cover more than 10,000 mm^2 area the Owner's Representative written approval of the proposed repair must be obtained.

Only welders qualified by performance tests on similar cast materials shall be used.

On completion of repair welded areas shall be ground smooth and carefully blended into the surrounding material. The repaired areas shall be surface crack detected, magnetic particle inspection being used for ferritic steel castings and in addition ultrasonic inspection shall be used on castings to operate at high temperature or high pressure.

Steel plates and sections

The following requirements, which may be supplementary to the applicable material standards, shall be considered when selecting material grades:

- impact testing of plate or sections over 50 mm thick (impact requirements to be dependent on application)
- ultrasonic testing of plate where the presence of non-metallics may interfere with the interpretation of ultrasonic testing of future welds

- ultrasonic testing and through thickness ductility measurement, where the application involves the risk of lamellar tearing in the material at regions of high restraint (e. g. at set-on nozzle locations or cruciform joints)
- ultrasonic testing clad materials to detect lack of bonding (proposed rectification procedures shall be submitted for the approval of the Owner's Representative).

Reinforced thermosetting resin pipes

Checks shall be made on all raw materials to ensure that they comply with the relevant ASTM Standard.

All deliveries of resin shall be checked for consistency by viscosity and reactivity. Any resins deviating from the manufacturer's published figures shall not be used.

Testing of reinforced thermosetting resin pipes:

- Long term hoop strength (type test for pressure pipes only)

  In accordance with ASTM D2992 Procedure B with the exception that the test results shall be extrapolated to determine the stress which the pipe can withstand for a period of 60 years without failure. The lower 95% confidence limit at 60 years shall also be calculated.

- Hydraulic test

  100% of the pipes shall be subjected to an internal hydraulic pressure test at the manufacturer's works prior to delivery. The test shall be applied to a pressure equal to 1.5 times the maximum working pressure stated for each classification of pipe. The test pressure shall be applied for a minimum period of 5 minutes without signs of leakage.

- In addition to the above the first pipe and every thirtieth thereafter of each class and diameter shall be maintained at test pressure for a minimum of 4 hours without signs of leakage.

  Each pipe and fitting shall be subjected to an internal low pressure air test at the manufacturer's works prior to delivery. The test pressure shall be an overpressure of 0.1 bar and this shall be applied for a minimum period of 5 minutes without signs of leakage or distress. Fittings which are of mitred construction shall be manufactured from pipes which have successfully passed the tests defined above.

- Dimensions

  The dimensions and tolerances of all pipes shall be determined in accordance with ASTM-D 2122Stiffness

  A minimum of one pipe for every 30 pipes manufactured shall be tested for stiffness in accordance with ASTM-D 2412 "Method of Test for External Loading Properties of Plastic Pipe by Parallel Plate Loading". A minimum of one pipe of each class and diameter of pipe shall be tested.

  Longitudinal and hoop tensile strength. The tensile strength properties of a minimum of one pipe for every 100 pipes manufactured shall be measured in accordance with ASTM-D 638. A minimum of one pipe of each class and diameter of pipe shall be tested.

- Cure

  Curing, to be tested by the Barcol Hardness test determined in accordance with ASTM-D 2583 standard: 100 % of the produced pieces. Minimum acceptable hardness is 90% of the value recommended by the resin manufacturer of the particular resin used, when non-reinforced. The sample pipe shall also withstand a commercial acetone test on the internal portion of the laminate.

- Loss on ignition

  A minimum of one pipe for every 30 pipes manufactured shall be tested in accordance with ASTM-D 2584 "Standard Method of Test for Ignition Loss of Cured Reinforced Resins".

- Joint tests

  A minimum of two pipes in every 100 pipes manufactured shall be jointed and tested in accordance with the requirements of section 7.2 of ASTM-D 3262.

- Visual inspection

  Each pipe and fitting shall be subjected to a complete visual inspection before shipment in accordance with ASTM-D 2563.

- Vacuum test

  Vacuum test of pipe shall be carried out for each diameter once at beginning of production. The vacuum to be applied shall be equivalent to the condition which occurs during full vacuum. The corresponding derated vacuum for this test shall be proved by the pipe manufacturer.

- Failure of tests on completed pipes

  In the event of a specimen not fulfilling the minimum requirements for strain corrosion resistance, all pipes of that class and diameter which have been manufactured shall be rejected and shall be replaced entirely.

  Any pipe or fitting which fails any of the quality control tests which are to be carried out on each and every pipe or fitting shall be rejected. In the event of any pipe failing any of the remaining tests outlined above that pipe shall be rejected and the relevant test shall be carried out on a further ten pipes of that class and diameter. If any one of these ten pipes fails than the manufacture of pipes of that class and diameter shall cease and the Owner reserves the right to reject all the pipes of that class and diameter.

Thermal insulating materials

Materials shall be tested for bulk density, specific heat, compressive strength, fire resistance under pressure, service temperature limit in accordance with VDI 2055 or equivalent standards.

Workshop manufacturing and pre-assembly

All workshop fabricated components and parts of the plant shall, to the fullest practical extent, be formed, machined, fitted, welded, stress-relieved, X-rayed, adjusted, tested, cleaned and painted. The equipment shall be pre-assembled in the workshop of the Bidder or his sub-supplier to the maximum possible extent, then dismantled only as far as required for safe and proper shipment, in order to keep erection work on site to a

minimum. Equipment and parts shall be marked, labelled or otherwise identified to facilitate assembly and erection on site. Marks and labels shall be fixed in such a manner so that deformation or obliteration shall not 'occur during shipment, storage and erection on site.

2.2.0 Manufacturing tests

2.2.1 Welding

Welding procedures shall be qualified in accordance with the requirements of the construction code/specification for the item of plant concerned and in the case of critical plant items the tests shall be witnessed by an internationally recognised inspection authority.

Welders shall be qualified in accordance with the requirements of the construction code/specification for the item of plant concerned for all types/positions of welding he may perform.

A system of positively identifying the work of each welder shall be maintained and any welder whose work is the subject of multiple rejections shall be required to undergo a requalification test. Any welder failing the retest may, at the discretion of the Owner's Representative be disqualified from further welding on items under this contract.

Welded fabrications shall be stress relieved when specified by the applicable standard or for dimensional stabilisation prior to machining.

Copies of temperature charts referenced with load items shall be included in the test certification supplied for the relevant items.

All welds shall be visually examined and shall be of smooth contour, free from cracks, undercut and other significant defects. Wherever possible the interior of tubes etc. shall be examined using a suitable optical device where necessary.

Fillet welds shall be checked for size using suitable gauges which shall be available for use on request by the Owner's Representative during an inspection visit.

Non-destructive examination of pressure and vacuum containment welds

Welds shall be non-destructively tested in accordance with the construction standard applicable to the item of plant. In addition the requirements of the **following Table 1** shall be observed. This table shall also apply in cases where the standards used for design and construction of an item of plant does not specify the quality requirements for welds. Fault limitations to be subject of agreement with the Owner's Representative prior to fabrication.

Table 1 : Non-Destructive Testing

Type of Steel	Design Factor (shell)	Wall thickness (mm)	Inside diam. (mm)	Type and Extent of Non-Destructive Testing			Remarks
				Butt	Nozzle	Fillet	
C and C-Mn steels with C content not exceeding 0.25%	≤ 0.85	≤ 10	all	-	-	-	Only applicable to: Atmospheric systems (excluded sys-tems, which handle chemicals, toxics or flammable media).

Type of Steel	Design Factor (shell)	Wall thickness (mm)	Inside diam. (mm)	Type and Extent of Non-Destructive Testing			Remarks
				Butt	Nozzle	Fillet	
		≤	all	10% R	-	-	
		> 40	all	100% R	10% M	10% M	
	> 0.85	≤ 40	≤ 100	10% R	-	-	
			> 100	100% R	10% M	10% M	
		> 40	all	100% R	100% M	100% M	Test before stress relief
C-Mn steels with C content 0.25 to 0.35% and C 1/2 Mo steels		≤ 30	all	10% R	10% M	10% M	Applicable below 50 bar
	all	> 30	all	100% R	100% M	100% M	Test before stress relief
Low alloy steels except CrMoV and 2 CrMo	all	all	all	100% R	100% U	100% M	Test before stress relief
CrMoV and 2CrMo steels and 12% Cr ferritic/ martensitic steels	all	all	≤ 100 > 100	100% R 100% R* 100% U	100% M 100% M 100% U	100% M 100% M	Test before stress relief Test before stress relief
* Radiographic examination may be omitted if done on as-welded joint							
Austentic Stainless Steels	≤ 0.85	≤ 15	all	-	-	-	Not applicable to: Butt welds made from one side only Operating temperatures exceeding 200 ℃
		≤ 30	all	10% R	-	-	
		> 30	all	10% R	10% D	10% D	
			≤ 100	10% R	-	-	
	> 0.85	≤ 30					
			> 100	100% R	10% D	10% D	
		> 30	all	100% R	100% D	100% D	

Legend:
R = Radiographic examination
U = Ultrasonic examination
M = Magnetic particle examination
D = Dye penetrant examination

Note:

1. Where 10% examinations are shown for pipe work under 100 mm diam bore this shall be the circumference of 10% of the welds by each welder selected at random with a minimum of one per welder.
2. Where 10% examinations are shown for vessels or large diameter pipework this shall be 10% of each weld length and must include all intersections of longitudinal and circumferential welds.
3. Where partial examinations reveal rejectable defects, adjacent welds or areas of weld shall be examined. In the event of rejectable defects being found welds shall be subject to 100% examination.
4. Welds in clad materials shall be tested in accordance with the requirements of the base material and the surface of the overlaid welds shall be dye penetrant tested throughout their length.

Non-destructive examination of structural welds

Welds shall be non-destructively tested in accordance with the construction standard applicable to the item of plant. Where appropriate, the following requirements shall also be observed:

Magnetic particle testing of the tension side welds In major fabricated girders and sections.

Ultrasonic examination of heavily restrained welds (e. g. cruciform joints) where there is a risk of lamellar tearing in the parent material.

Weld repairs

Unacceptable defects observed by visual examination or indicated by nondestructive testing shall be completely removed by chipping or thermal gouging and grinding. The resulting excavation shall be crack detected prior to rewelding.

Details of the original defects and repair shall be recorded.

Repaired welds shall be subjected as a minimum requirement to the same inspection requirements as the original welds and test records should indicate that a repaired weld is referred to.

2.2.2 Pressure testing

All items subjected in service to internal pressure or vacuum shall, unless otherwise agreed, be pressure tested in the manufacturer's works and prior to any internal or external coating.

Hydrostatic testing

All pressure vessels, inserts or other parts of such vessels, which are subject to an internal pressure or vacuum during operation shall undergo a hydraulic or other approved test. Unless otherwise stated in the specification, the test pressure shall be maintained for a sufficient period to permit complete examination by the inspector.

Should it be necessary to carry out repair welding on stress-relieved equipment, it must undergo a stress-relieving process again with prior approval of the Owner’s Representative. In all such cases, the hydraulic test must be repeated.

Particular attention must be paid to the temperature of water used for hydraulic testing which shall not be less than 20℃. Prior to testing, metal temperatures shall also not be less than 20℃. Where pressure parts 600 mm in diameter and above are being tested, the hydraulic pressure shall be raised to the test pressure in stages, during which the item shall be examined and all defects rectified before the full test pressure is reached.

Suitable water shall be used as the test media unless otherwise agreed and test pressures shall be in accordance with the applicable construction standard but if none is specified then the test pressure shall be 1.5 times the design pressure but not less than an overpressure of 3.5 bar. Test pressure of vacuum containment items shall be agreed with the Owner’s Representative.

The test pressure shall be maintained for sufficient time to permit complete visual examination of all surfaces and joints and in no cases less than specified in the applicable construction standard.

The chloride content of water used for testing austenitic stainless steel items shall not exceed 30 ppm unless immediate flushing with water of this quality is done after the test.

Pneumatic testing

The Bidder shall apply pneumatic testing in cases where hydrostatic testing is impractical or undesirable. Safety precautions, test pressures/ duration and degree of prior non-destructive examination of the subject items shall be agreed with the Owner's Representative.

Pneumatic or gas leak testing supplementary to hydraulic testing shall be applied in appropriate cases where specified by the applicable construction standard.

2.2.3 Testing of corrosion protection

Surface coatings

Following tests have to be performed before, during and after coating:

- visual inspection of blasted surfaces according to DIN 55928 part 4, annex 1
- checking of coating material
- measurement of air humidity, air temperature and coating area temperature (determination of dew point)
- visual inspection of coating
- checking of dryfilm thickness (DFT)
- checking of adhesion.

Galvanised zinc coatings

Surfaces shall be visually inspected. Bare patches, lumps blisters or inclusions of foreign matter shall be cause for rejection.

Zinc coating thickness shall be determined non-destructively in accordance with DIN 50981 or coulometrically in accordance with DIN 50932. For coatings with a weight exceeding 900 g/m^2 the coulometric test method specified in DIN 50932 shall be used.

Hard rubber linings

Surfaces shall be visually inspected. Uneven surfaces, splits, blisters or inclusion of foreign matter shall be cause for rejection.

The thickness of linings shall be measured in accordance with VDI Standard 2539 or equivalent. A tolerance of + 10% is permitted for rubber coatings of 3 mm nominal thickness.

Hardness tests shall prove compliance with the rubber manufacturers standards.

The absence of pores shall be proved by the induction sparking test method. The potential used shall be 5,000 Volts for each mm of thickness plus an additional 5,000 Volts (i. e. potential of 20,000 Volts for 3 mm thick lining).

2.3.0 Mechanical equipment

2.3.1 Rotating units

Balance testing of rotating units

Each rotating unit shall be first statically balanced and then dynamically balanced (in the case of impellers this shall be done before and after mounting of the service rotor shaft). A check balance of items that have undergone overspeed test shall also be made.

Vibration testing of rotating units

The vibration characteristics of rotating units shall be measured during performance tests. Locations of measurement and standards to be achieved shall, on request, be subject to agreement by the Owner's Representative.

2.3.2 Steam turbine

The turbines shall be completely assembled with their control, stop and governing valves on a suitable erection rig at the manufacturer's works and shall be carefully inspected and measured for manufacture and assembly tolerances. Functional tests shall be performed on the safety equipment.

Important items of turbine control equipment which cannot be adequately tested during the main tests shall be separately bench tested.

Furthermore testing shall comprise:

- balancing and overspeed test of the assembled rotor
- measurement of radial clearances
- assembling inspection.
- Bearing oil temperature rise
- Vibration levels over the operating speed range
- AOP cut-in and cut-out pressures
- Check for assembly clearance after the test

2.3.3 Steam Generator

As per the requirement of IBR / ASME

2.3.4 Pumps

Running tests and performance tests shall be conducted on all pumps:

Performance tests shall be conducted through the full operation range of the pump to closed valve conditions. Graphs indicating flow/head, flow/power absorbed, flow/efficiency, flow/NPSH and speed shall be produced.

The lubricating oil used in the test shall be of the same brand and grade as that recommended by the manufacturer for service use.

Bearing oil temperature rise and Vibration levels over the operating speed range shall be measured and shall be as per the standard.

Dismantling of the pump for visual examination of parts for damage following test shall be done when required by the inspection standard, when considered necessary by the manufacturer, or when requested by the Owner's representative witnessing the running or performance tests. Replacement of parts following test shall necessitate repeat testing.

Job motor shall be used for testing the BFP, CEP CW, ACW booster and CCW pumps.

NPSH test shall be performed for BFP and CEP pumps. For vertical pumps minimum submergence test shall be conducted.

For all the pumps in the plant, the Testing and acceptance std shall be IS 5120/HIS/PTC code. However no negative tolerance is allowed for Flow, Head, Shut off head & Efficiency at Guarantee point. However positive tolerance of 3% on Heat at Guarantee point and 5% on shut off head is permitted.

2.3.5 Fan

All fans shall be tested in accordance with the BS 848 part 1 and other applicable standards.

The particular test procedure to be applied to each type of fan shall be agreed with the Owner. The tests shall be conducted strictly to the requirements of the agreed test procedure so that all points on the performance curves are within agreed tolerances.

2.3.6 Deaerator, Condenser and Plate heat Exchanger

- Hydro Test as per ASME sec VIII , Div 1
- Air test / hydrostatic test of tube to tube sheet joints for condenser.

2.3.7 Gate, Globe, Regulating and Check valves

- As per IBR / ASME
- Shell Hydro test
- Seat leakage test as per BS 6755 part 1 Rate A with Air test & Hydro test.

2.3.8 Control Valve, Pneumatic block valve and PRDS

- As per IBR / ASME
- Shell hydro test as per ASME 16.34
- Seat leakage test , Actuator chamber leakage test, as per ASME 16.104
- Operation test (calibration , Hysteresis)
- Flow characteristics test

2.3.9 Butter Fly valves

- Shell hydro test & Disc strength test as per BS 5155
- Seat leakage test BS 5155
- Open & close operation check for more than 14 “ valve
- Flow characteristics test

2.3.10 Air compressors

Air compressors shall be tested in accordance with the requirements of BS 1571, class C.1 part 1, ISO 1217, ASME PTC-9 or similar standards. Any request for deviation from the test conditions shall be accompanied by the manufacturers' proposals for the adjustment of the correction factors contained in the standard.

No Tolerance on guaranteed values of energy consumption, volumetric efficiency, air drier capacity, dew point of air, is allowed.

2.3.11 Air Drying Plant

Leakage test, Auto sequential test, operating time for regeneration cycle, Dew point test

Performance test for the air dryer shall be conducted at site to prove the following parameters:

a) Rated dew point temperature

b) No spikes in the dew point temperature during changeover from one tower to the other in the dryer

2.3.12 Cranes and hoists

Where size permits cranes and hoists shall be completely assembled at the manufacturer’s works and functional tests including load, speed, deflection etc shall be load conducted.

2.3.13 Fire fighting system

All testing requirement as per TAC / NFPA.

The stand post assembly along with the hydrant valve (valve being open and outlet closed) shall be pressure tested at a hydrostatic pressure of 21 Kg/cm2 to detect any leakage through defects of casting.

Flow test shall be conducted on the hydrant valves. The flow through valves shall not be less than 900 Litres/min.

Leak tightness test of the valve seat shall be conducted at a hydrostatic test pressure of 14 Kg/cm2(g).

2.3.14 HVAC

a) Chiller

Each chiller shall undergo a series of factory tests to ensure that the vacuum section is leak tight and meets the manufacturer's strict quality control standards. The chiller-heater shall be covered with helium charged bell and the vacuum section shall be evacuated. The leakage rate shall be measured by a helium mass spectrometer.

Performance Tests

All chiller units shall be performance tested at the manufacturer's work. During the test reading shall be taken for various parameters like

- Chilled water inlet/outlet temperatures
- Capacity
- Steam consumption (for absorption chiller)
- Power consumption
- Cooling water inlet / outlet temperatures.
- Vibration & noise level.
- Temperature rise of lubricating oil.

Pressure Tests

A standard Pressure test shall be conducted on the evaporator, refrigerant piping, condenser and steam line as per code. In Shell and tube heat exchangers, Water side and refrigerant side shall be hydraulic and pneumatic pressure tested respectively. The compressors shall be pressure tested pneumatically at 1.5 times the design pressure. Pressure build up test and leak back test shall also be carried for the compressor as per the applicable standards.

b) Air Handling Unit

Visual and dimensional check shall be done for quality workmanship and completeness of each section and component and their assembly. The cooling coils shall be pressure tested (hydraulic for chilled water, pneumatic for direct expansion type) for minimum 1.5 times the design pressure.

Performance Tests

All Air handling units shall be performance tested at the manufacturer's work. During the test reading shall be taken for various parameters like

- Air flow rate and static pressure developed by the air handling fan.
- Cooling capacity of the cooling coil.

- Noise level at specified distance form the unit and Vibration.
- Power consumption.
- Leak tightness for the assembled unit.
- Smooth operation and responsiveness of the face and bypass damper.

c) Cooling Tower

All testing as per ATC-105 : Acceptance test code for water cooling towers

2.3.15 Water treatment plants

Functional tests on completed individual equipment shall include:

- Pumps performance test
- Interlock and protection panels.

2.3.16 Hangers & Supports

All shop tests shall be conducted in accordance with ANSI standards and other applicable codes/standards.

Each Constant load hanger shall be tested before delivery to ensure that the variation in supporting capacity provided through specified range does not exceed 5%.

Each variable load spring hangers shall be tested before delivery for its spring stiffness.

ANNEXURE II

PAINTING SPECIFICATION

VOLUME II

SUB-SECTION 2.25

CLEANING, PROTECTIVE COATING AND PAINTING

1.0.0 GENERAL

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

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

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

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

Machined surfaces shall be protected during the cleaning operations.

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

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

2.0.0 CODES AND STANDARDS

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

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

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

IS: 2339	Aluminum paint for general purposes, in dual container.
IS: 2395	Code of practice for painting of concrete, masonry and plaster surfaces: Part 2 schedules.
IS: 2524	Code of practice for painting of non-ferrous metals in buildings (Parts I & II).
IS: 2932	Specification for enamel, synthetic, exterior (a) undercoating, (b) Finishing
IS: 3140	Code of practice for painting asbestos cement building products.
IS: 6158	Recommended practice for design safeguarding against Embrittlement of hot dip Galvanized Iron & steel products.
IS: 6159	Recommended practice for design & fabrication of Iron &steel products prior to Galvanizing & metal spraying.
IS: 6278	Code of practice for white washing and Color - Washing.
IS: 10221	Code of practice for coating & wrapping of underground mild steel pipelines.
IS: 33	Inorganic pigments and extenders for paints –Methods of sampling & test.
IS: 13183	Aluminum paint, Heat resistant - specifications.
IS: 144	Specification for ready mixed paint brushing, petrol resisting, Air drying for Interior paints of tanks and containers, Red oxide.
IS: 9954	Pictorial surface preparation standards for painting of steel surfaces.
IS: 11883	Specification for Ready Mixed Paint, Air Drying, Red Oxide Priming for metals.
IS: 9404	Color code for identification of pipelines used in the Thermal Power Plants.
IS: 12744	Specification for Ready Mixed Paint, Air Drying, Red Oxide-Zinc Phosphate Priming.
BS: 2015	Glossary of paint selected terms.
BS: 5252	Final coat color.
BS: 7079A1/S1	Specification for rust grades and preparation grades of uncoated substrates after overall removal of previous coating.
BS: 7079A2	Preparations grades of previously coated steel substrates.
BS: 7079GrC	Surface roughness characteristics of blast cleaned steel substrates.
BS: 7079GrD	Methods for surface preparation.
BS-4232	Surface Finish of Blast cleaned steel for painting.
ASTM	American Standard for Testing Material.
ASTM A 780	Standard practice for repair of damaged galvanized coatings.
AWWA	American Water Works Association.
ASA-A-13.1-1981	Scheme for identification of piping system (American National Standard Institution).
DIN	Deutsehes Institute for Normung
S1S-055900-1967	Surface preparation standards for painting steel surfaces. (Swedish standard Institution)
SSPC-SP	Preparation Specifications (Steel structures painting council, U.S.A.).
	National Association of Corrosion Engineers, U.S.A. (NACE).

3.0.0 SCOPE OF WORK AND GENERAL REQUIREMENTS

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

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

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

The paint to be applied shall be approved by Owner.

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

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

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

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

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

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

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

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

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

Painting records shall contain:

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

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

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

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

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

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

4.0.0 CLEANING AT MANUFACTURER'S WORKS

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

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

Surface condition:

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

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

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

Abrasives:

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

For austenitic materials only, abrasives containing 98% or more of alumina, $Al_2 O_3$, shall be used.

Removal of abrasive and debris:

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

5.0.0 PROTECTION AT MANUFACTURER'S WORKS

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

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

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

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

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

6.0.0 WEATHER CONDITIONS

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

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

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

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

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

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

7.0.0 SURFACE PREPARATION

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

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

All surfaces should be blast cleaned whenever possible.

Surface preparation methods:

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

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

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

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

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

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

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

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

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

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

d. Very thorough mechanical scraping and wire brushing St 3

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

e. Thorough scraping and wire brushing St 2

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

f. Air Blasting with Non-Metallic Abrasives Powder

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

8.0.0 PREPARATION OF COATING MATERIALS

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

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

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

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

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

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

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

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

8.1.0 Primer Paint

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

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

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

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

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

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

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

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

8.2.0 Rub down and Touch Up of Primer

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

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

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

8.3.0 Non Compatible Shop Coat Primer

a) The compatibility of finishing coat shall be confirmed from the paint manufacturer. In the event of use of primer such as zinc rich epoxy, inorganic zinc silicate etc., the paint system shall depend on condition of shop coat. If the shop coat is in satisfactory condition showing no major defect, the shop coat shall not be removed. The touch up primer and finishing coat(s) shall be identified for application by Engineer. Shop coated (coated with primer & finishing coat) equipment shall not be repainted unless paint is damaged.

b) Shop primed equipment and surfaces shall only be 'spot cleaned' in damaged areas by means of power tool brush cleaning or hand tool cleaning and then spot primed before applying one coat of field primer unless otherwise specified. If shop primer is not compatible with field primer then shop coated primer shall be completely removed before application of selected paint system for particular environment. For package units/equipment, shop primer shall be as per the paint system given for particular environment.

c) In case of existing paint, compatibility between finishing coat and new selected finish coat shall be ascertained before application of finish coat. In case, the coat is selected for upgrading existing alkyd coating to high performance coating then, surface preparation shall be by manual/mechanical means to remove loose rust, peeled off/damaged paint, but sound old coating need not be removed. It shall be touched with suitable primer wherever it has peeled of before application of tie coat. The tie coat shall be applied after 7 days of curing of the primer. If, new paint system is not suitable to upgrade existing coating then complete paint shall be removed by mechanical or blast cleaning before application of new coating system.

8.4.0 Finish Paint

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

9.0.0 STEEL STRUCTURES PAINTING

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

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

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

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

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

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

10.0.0 PAINT MATERIALS

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

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

11.0.0 STORAGE

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

12.0.0 APPLICATION

Health and safety of work

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

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

Methods

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

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

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

All doors, windows, stairways, handrails (if painted), bolts, flanges and equipment supports shall be finish painted by brush.
Spray guns should not be used outside in windy weather or near surfaces of a contrasting colour unless the latter is properly protected.

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

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

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

Dry film thickness (DFT)

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

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

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

Consumption of paints

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

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

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

The minimum total dry film thickness of the paint systems shall be as recommended in the **Annex 25.1.2**. The DFT is given in microns (millionths of a metre).

13.0.0 PROTECTIVE COATINGS AND PAINT SYSTEMS

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

The type and number of protective coats for any item requiring painting are to be in accordance with DIN 55928 and are to be at least of a quality as shown in the attached Annex-25.1.1- Paint System.

Alternative to the Annex-25.1.1- Paint System specified, are to be presented on the schedule Departure from Specification, as indicated elsewhere.

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

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

Types of Substrate, Base metal:

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

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

- Hot dip galvanized surfaces.

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

- SS (EN ISO 12944:1998 conditionally applicable)

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

  The following formula applies:
  W = Cr + 3.3 x Mo + 22.45 N2

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

  If W < 28 & W > 23, then the surface to be painted if splash contact with the media (i.e. sea) is possible. This may also occur if there is a strong wind carrying drops to the surface.
  If W > 28, then the surface need not be painted.

- Aluminium

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

14.0.0 GALVANIZING

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

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

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

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

All defects of the steel surface including cracks, surface laminations, laps and folds shall be removed in accordance with B.S. 4360. All drilling, cutting, welding, forming and final

fabrication of unit members and assemblies shall be completed, where feasible, before the structures are galvanized. The surface of the steelwork to be galvanized shall be free from paint, oil, grease and similar contaminants in accordance with DIN 55928, part 4 and DIN 50976. The weight of zinc coating per unit area has to be noted in the manufacturing documents in accordance with DIN 50976.

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

Structural steel items shall be initially grit-blasted to B.S. 4232, second quality,
(Sa 21/2) or by pickling in a bath and the minimum average coating weight on steel sections 5 mm thick and over shall be 610 g/m^2 (DFT = 85µ) .

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

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

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

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

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

- Cleaning the area of any weld slag rust and other impurities and by thorough wire brushing to give a metallic clean surface.

- Application of suitable number of coats of zinc-rich paint containing more than 90 % w/w of zinc in dried film. The dry film thickness shall exceed at least 50 % the thickness of the desired galvanization. In case of application of a low melting point zinc alloy repair rod, the rods shall be in accordance with DIN1707, the thickness of the alloy shall be at least as of the desired galvanization.

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

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

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

15.0.0 SPRAYED METAL COATINGS

Corrosion protection may be also achieved by spraying of suitable metals as zinc and/or aluminum on the surfaces of structures. For special cases tin, copper, lead can be used as well. Methods of surface preparation have to conform to B.S. 2569 or to DIN 8567. A proper treatment of the surface followed by an immediate spraying is to apply to ensure adhesion of the sprayed metal. The surface has to be clean, free of impurities, rust, mill scale and rough enough to have binding properties to ensure good enticulation with the sprayed layer. Suitable roughness can be achieved by blast cleaning acc. to BS 4232 or DIN 8567. Welds are to be cleaned and prepared with special care. All surfaces to be treated have to be dry and accessible.

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

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

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

Safety of work:

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

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

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

The cleaning can be achieved by

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

16.0.0 WARNING NOTES / SIGNALS

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

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

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

17.0.0 COLOUR CODE FOR PIPING

a. The colour code scheme is intended for identification of the individual group of the pipeline. The system of colour coding consists of a ground colour and colour bands superimposed on it. The colour coding for the identification of pipelines shall comply with **Annex – 25.1.1** of this specification.

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

i. At battery limit points

ii. Intersection points & change of direction points in piping ways.

iii. Other points, such as midway of each piping way, near valves, junction joints of service appliances, walls, on either side of pipe culverts.

iv. For long stretch/yard piping at 50 M interval.

v. At start and terminating points.

b. Flow direction shall be indicated by an arrow in the location stated above and as directed by Engineer. Colors of arrows shall be black or white and in contrast to the color on which they are superimposed. The size of the arrows shall confirm to IS:2379. Product names shall be marked at pump inlet, outlet and battery limit in a suitable size as approved by Engineer. As a rule minimum width of color band shall conform to 75 mm up to 300 NB and to 100 mm over 350 NB. Whenever it is required by the Engineer to indicate that a pipeline carries a hazardous material, a hazard marking of diagonal stripes of red and golden yellow as per IS:2379 shall be painted on the ground color.

c. All uninsulated piping systems, hangers and supports shall have two coats of suitable primer coats and with suitable finish paints as per Annex 25.1.2 Painting system. Shades shall be as per IS 5 or as indicated by Owner /Engineer. Service of the pipe/line designations shall be painted on all pipes at visible locations.

18.0.0 IDENTIFICATION OF VESSELS, PIPING ETC.

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

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

19.0.0 INSPECTION AND TESTING

a) All painting materials including primers and thinners brought to site for application shall be procured directly from manufacturer as per specifications and shall be accompanied by manufacturer's test certificates. Paint formulations without certificates are not acceptable. Engineer at his discretion, may call for tests for paint formulations. Contractor shall arrange to have such tests performed including batch wise test of wet paints for physical & chemical analysis. All costs thereof shall be borne by the contractor. The paints shall be tested as per IS: 101 / equivalent international standard and approved by the Owner.

b) The painting work shall be subject to inspection by Engineer at all times. In particular, following stage wise inspection shall be performed and contractor shall offer the work for inspection and approval of every stage before proceeding with the next stage. The record of inspection shall be maintained in the registers. Stages of inspection shall be surface preparation, primer application and each coat of paint. In addition to above, record shall include type of shop primer already applied on equipment e.g. red oxide zinc chromate or zinc phosphate or Silicate primer etc.

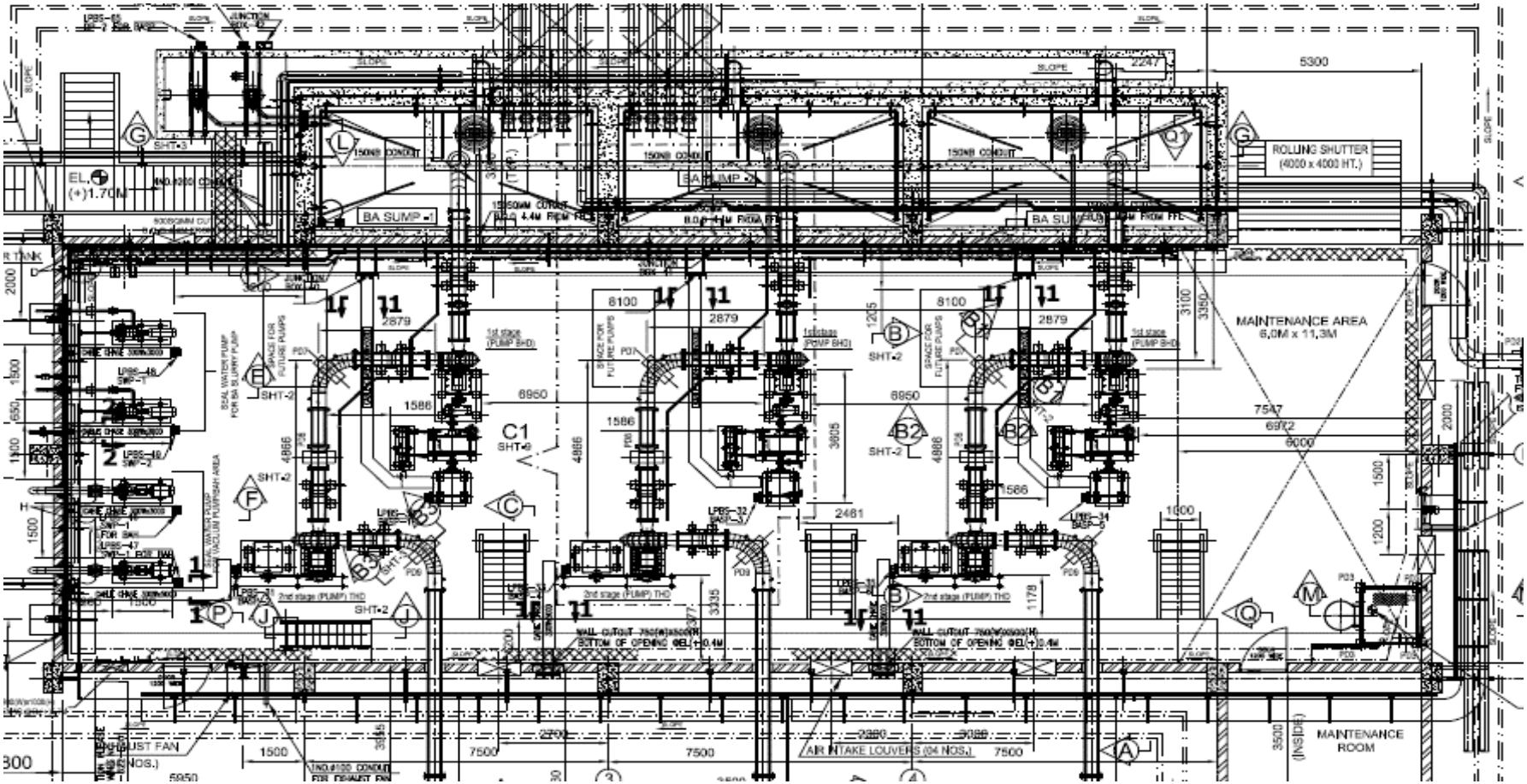
c) Any defect noticed during the various stages of inspection shall be rectified by the contractor to the entire satisfaction of Engineer before proceeding further. Irrespective of the inspection, repair and approval at intermediate stages of work, contractor shall be responsible for making good of any defects found during final inspection/guarantee period/defect liability period as defined in general condition of contract. Dry film thickness (DFT) shall be checked and recorded after application of each coat and extra coat of paint shall be applied to make-up the DFT specified without any extra coat to the Owner.

20.0.0 GUARANTEE

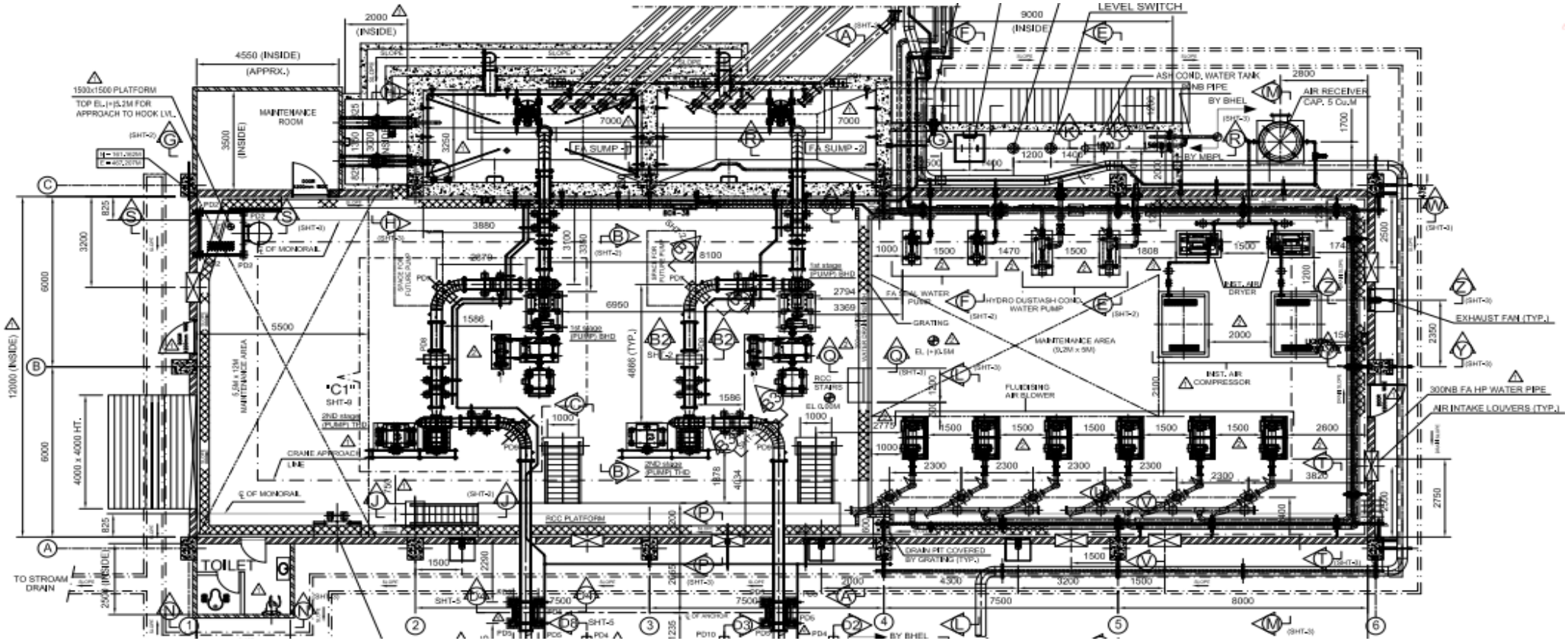
The contractor shall guarantee that the chemical and physical properties of paint materials used are in accordance with the specifications contained herein/to be provided during execution of work. The contractor shall produce test reports from the manufacturer regarding the quality of the particular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

ANNEXURE III

LAYOUT OF PUMP HOUSES



Layout of BA slurry Pump house



Layout of FA slurry Pump house

ANNEXURE IV

ELECTRICAL ANNEXURE

ANNEXURE - A

LV SWITCH GEAR

SECTION-3.10: LOW VOLTAGE (LV) SWITCHGEAR

1.0.0 INTENT OF SPECIFICATION

This section covers the technical requirements of low voltage switchgear.

2.0.0 SCOPE OF WORK

The scope of work shall include supply, installation, testing and commissioning of the following:

a) 415 V, AC intelligent Power control centres (PCC) for units, station, auxiliary plant and non plant buildings.
b) 415 V, AC intelligent Motor control centres (MCC) for units, station, auxiliary plant and non plant buildings.
c) 415 V, AC distribution boards for units, station, auxiliary plant and non plant buildings.
d) 415 V, AC Emergency PCC and emergency MCC for each unit.
e) 220 V DC distribution boards for units, station and auxiliary plants.
f) 415 V heater control panels for electrical heat tracing of fuel pipe lines
g) Local starters for units, station and auxiliary plants.
h) Local panels for units, station and auxiliary plants.
i) Local push button stations for various units, station and auxiliary plants.
j) Commissioning spares and consumables
k) Mandatory spares
l) Tools & tackles
m) Any other equipment required for the system

3.0.0 CODES AND STANDARDS

The equipment to be furnished under this specification shall be in accordance with the applicable section of the latest version of the relevant IS/IEC standards including amendments, if any, except where modified and/or supplemented by this specification. Some of the applicable standards are listed below:

a)	IS 8623	Specification for low voltage switchgear and control gear Assemblies
b)	IS 10118	Code of practice for selection, installation and maintenance of switchgear and control gear
c)	IS/IEC 60715	Dimensions of low-voltage switchgear and control gear - standardized mounting on rails of mechanical support of electrical devices in switchgear and control gear installations
d)	IS 12021	Specification for control transformers for switchgear and control gear for voltages not exceeding 1000 V
e)	IS 13032	Miniature circuit breaker boards for voltages not exceeding 1000 V
f)	IS/IEC60947	Specification for low voltage switchgear and control gear
g)	IS 694	Specification for PVC insulated cables for working voltage up to and including 1100 V
h)	IS 5	Colour for ready mixed paints and enamels
i)	IS 14372	Specification for volt-ampere hour meters for full power factor range
j)	IS 14415	Specification for volt-ampere hour meters for restricted power factor range
k)	IS 1248	Direct acting indicating analogue electrical measuring instruments and their accessories

l)	IS 2705	Specification for current transformers
m)	IS 3156	Specification for voltage transformers
n)	IS 3231	Specification for electrical relays for power system protection
o)	IS 6005	Code of practice for phosphate of iron and steel
p)	IS 11353	Guide for uniform system of marking and identification of conductors and apparatus terminals
q)	IS/IEC 60529	Degrees of protection provided by enclosures (IP code)
r)	IEC 60439	Low voltage switchgear and control gear assemblies
s)	IEC 60947	Low voltage switchgear and control gear
t)	IEC/TR 61641	Enclosed low-voltage switchgear and control gear assemblies – Guide for testing under conditions of arcing due to internal fault

4.0.0 TECHNICAL REQUIREMENTS

4.1.0 Power supply voltage shall be considered as follows:

- Motors rated > 0.2 kW and up to 200 kW : 415 V, 50 Hz, 3 Phase
- Motors rated up to 0.2 kW : 240 V, 50 Hz, Single Phase
- Panel lighting & Space Heater : 240 V, 50 Hz, Single Phase
- Control Supply : 220 V DC

4.2.0 **Current Rating**

4.2.1 Ambient temperature prevailing inside the switchgear while carrying rated current, when the outside air ambient temperature is 50˚C shall be considered as design ambient temperature for sizing the equipment/device/bus rating. Continuous current rating shall be such that the temperature does not exceed 90˚C. For silver plated joints the temperature shall not exceed 105˚C.

4.2.2 The continuous current rating of the feeders shall be based on the name plate current rating of the connected equipment with 10% margin at design ambient condition, rounded off to next higher standard rating unless specified otherwise.

4.2.3 The continuous current rating of the incomers/tie feeders/main bus bars of PCC shall be based on the name plate rating of the upstream transformer with 10% margin at design ambient condition, rounded off to next higher standard rating unless specified otherwise.

4.2.4 The continuous current rating of the incomers/tie feeders/main bus bars of other switchgear shall be based on the continuous current rating of the all the connected loads with 10% margin at design ambient condition, rounded off to next higher standard rating unless specified otherwise.

4.2.5 For switchgear having two bus sections, each bus section, bus coupler and incomer shall be rated for the combined load requirements of both the bus sections.

4.2.6 Similar equipment and components shall be of same make. Equipment / Module of same type and rating shall be interchangeable.

4.2.7 The design of the LV Switchgear shall include all devices required for remote control & monitoring from DCS. It shall be monitored from the EMS system also.

4.2.8 The power control centres and motor control centres shall be intelligent type.

4.3.0 **Protection**

4.3.1 The Contractor shall be responsible for selection of protective devices so as to provide optimum protection and discrimination of various circuits and equipment including the safety of the devices. For motor feeders, coordination of overload relay and MPCB/MCCB with the thermal characteristics of the motor shall be ensured.

4.3.2 MCCB / MPCB, contactor and Electronic overload relay for motor feeders shall meet type-2 coordination as per applicable standard.

4.3.3 The incomer modules shall be interlocked with their upstream breaker such that they can be closed only when upstream breaker is closed and trip automatically when upstream breaker is tripped.

4.3.4 Each breaker module shall be provided with multifunction numerical relay for protection. Relays shall have built in protection, control & metering and communication modules suitable for IEC-61850 protocol.

4.4.0 **Control**

4.4.1 Incomers and bus coupler of PCCs shall have air circuit breaker (ACB). PCC refers to LV switchgear connected to load center transformer which consists of outgoing power feeders and outgoing motors feeders.

4.4.2 Outgoing feeders of PCC shall be controlled by ACB / moulded case circuit breakers (MCCBs) depending on their ratings / applications.

4.4.3 Incomers and bus couplers of MCCs shall be breaker controlled. Outgoing feeders of MCCs shall be controlled by MCCBs / Motor protection circuit breakers (MPCBs) and contactors depending on their ratings / applications.

4.4.4 Feeders rated above 630 A shall be controlled by ACBs, unless specified otherwise. Feeders rated up to 630 A may be controlled by MCCBs. However ACB shall be used for 400 A and 630 A feeders where auto changeover is envisaged at incomer / bus coupler.

4.4.5 ACBs shall be used for motor feeders rated above 125 kW for direct-on-line (DOL) starting.

4.4.6 MCCB/MPCB Contactor starter units shall be used for motor feeders rated up to 125 kW for DOL starting.

4.4.7 Feeders of 415 V PCC/MCC shall be controlled from DCS or Respective control system and Local Push Button (LPB) Station as per scheme requirement.

4.4.8 Remote selection shall enable control from DCS/Respective control system.

4.4.9 The control/interlock schemes for various types of feeders shall be commensurate with their applications.

4.4.10 Local start push button shall be hardwired to DCS/Respective control system so as to check the process permissive for starting the drives, whereas local stop push button shall be directly hard wired to concerned switch gear for tripping.

4.5.0 **Changeover Scheme**

4.5.1 All PCCs and ACB operated MCCs shall be normally operated with the bus coupler breaker open. Auto-changeover facility shall be provided such that if there is a prolonged under voltage on any one of the bus sections, the respective incoming breaker shall trip and the bus coupler breaker shall close, provided on the other bus section is healthy. This auto-changeover shall be

blocked if the incoming breaker had tripped either on a bus fault or manually. Changeover back to the normal source of supply shall be done manually.

4.5.2 Planned changeover facility shall be provided for PCC and ACB operated MCC. When planned outage of one of the normal incoming supplies is required, the respective incomers shall be tripped automatically after the bus coupler breaker is closed manually through synchro-check relay. For this purpose, a trip selection shall be provided in DCS/Respective control system for selecting the incomer to be tripped. Thus, depending on the selection made incomer A or incomer B shall be tripped once bus coupler breaker is closed manually, thus maintaining continuity of supply. A timer for annunciation of the running breaker failing to trip within a pre-set time, (i.e. if the two sources remain paralleled for more than a pre-set time) shall be provided. When the normal supply is to be brought back into operation, the incomer breaker shall be closed through synchro-check relay whereupon the bus section breaker shall trip automatically. All hardware required for meeting the functional requirements stated above, shall be included.

4.6.0 Emergency MCC

4.6.1 Emergency MCC to supply power to important emergency loads/motors for safe shut-down of unit shall be provided for each unit. It shall have two bus sections (A&B) with a bus coupler. Bus section-A shall have two incomers, one from Unit PCC and the other from emergency PCC. Bus section-B shall have one incomer from station PCC. All the incomer breakers in the emergency MCC shall be 4 Pole. Bus coupler shall be normally closed.

4.6.2 In case of failure of unit supply to the Emergency MCC, the station supply shall be switched ON automatically and in case of total failure of AC supply of the power station, the supply from emergency PCC shall be switched ON automatically.

4.6.3 DG PCC shall have two incomers, one incomer fed from respective Unit DG set and second incomer fed from standby DG set. In case of failure of unit DG set, the stand-by DG set shall be switched ON.

4.6.4 All service like essential motors for safe shutdown of the unit, UPS incomers, battery charger AC supply, lighting, etc. shall be connected to this MCC. DG supply shall be extended to emergency MCC in less than 15 sec from loss of power.

4.6.5 On restoration of normal supply, the changeover of DG supply to normal supply at Emergency MCC shall be done with synchronizing facility to avoid interruption of supply.

4.6.6 For DG paralleling / load testing, separate breaker shall be provided in main plant AC MCC & Emergency MCC. Load test of DG set can be carried out using connected loads on the AC MCC switchgear.

4.7.0 Essential Service Modules

During auto changeover of the supply, the contactors in the affected bus would have dropped off. The services, which shall be restarted immediately without time lapse to keep unit running, are considered essential service. (For e.g. seal oil pumps, lube oil pumps, auxiliary cooling water pumps etc.) Such auxiliaries shall restart automatically without any action by the operator after an auto change over. These modules shall have additional hardware like timer, aux contactors and associated circuitry in the module or shall have restart feature programmed in DCS. Such essential services shall be identified during the detailed engineering stage and suitable module / scheme shall be provided.

The modules of some of the critical application motors like barring gear motor, air heater motor, lube oil pump, jacking oil pump etc. irrespective of their kW rating shall be provided with a CT, ammeter and a current transducer with remote metering in DCS.

5.0.0 CONSTRUCTIONAL FEATURES

5.1.0 General

5.1.1 PCC/MCC/DB shall be metal enclosed, indoor, floor mounted and free standing type. Switchgear frames, load bearing members, doors and covers and gland plates shall be fabricated using CRCA sheet steel. The thickness of sheet shall be not less than 1.6 mm for non-load bearing members and 2.0 mm for load bearing members. Gland plate thickness shall be minimum 3.0 mm.

5.1.2 PCC / MCC shall be drawout type and distribution boards can be fixed type with compartmentalized construction.

IP-55

5.1.3 Suitable synthetic rubber gaskets shall be provided to make switchgear completely dust-proof and vermin-proof with a degree of protection of IP 52 for all switchgear. However, degree of protection for bus bar chamber where the bus bar is rated above 1600 A can be IP 42.

5.1.4 All switchgear shall be compartmentalized (conforming to Form 4b of IEC 60439-1) with uniform height not exceeding 2450 mm. Module size of switchgear shall not be less than 200 mm.

5.1.5 The switchgear shall be arc proof tested. In the event of an internal fault in a functional unit, the damage shall be confined to that unit alone, so that the busbar system and all other functional units remain fit for further service. Switchgear assemblies shall comply with IEC 61641 with regard to internal arc testing.

5.1.6 The arrangement of feeders in the switchgear shall take into consideration the number and size of cables required for the feeders. Incomer and bus section ACB shall be limited to one per panel. ACB outgoing feeders shall be limited to two per panel for ratings up to 1000 A. For ratings 1250 A and above, the number of outgoing feeders shall be limited to one per panel.

5.1.7 Bus duct entry shall be from top and cable entry shall be from bottom for PCCs/MCCs/DBs. Switchgear shall be divided into distinct vertical sections (panels), each comprising of the following compartments:

- Main bus bar compartment
- Switchgear/feeder compartment
- Cable alley of at least 300 mm width
- Auxiliary bus bar compartment
- Control compartment for relays for ACB feeder

5.1.8 Switchgear shall be of modular design, consisting of modules, segregated into single or multi-tier compartments. Each module shall be placed in individual compartment. All module grouped together shall form the complete switchgear. Completed switchgear shall be of flush-fronted design having a neat appearance and shall be readily extensible.

Door shall be provided at the front of each compartment to give full access to all the components and the compartment.

Switchgear covers (including doors without interlock) shall be bolted type and shall be designed to give access to individual circuits without exposing other circuits, which may be live. Alternatively, circuits exposed by the removal of the cover shall be individually shrouded.

5.1.9 The switchgear shall be designed to prevent contact with live parts both within the modules and in the cable alley. Following are the minimum segregations to be provided amongst the different parts of the switchgear:

a) Main horizontal bus bar chamber and vertical bus bar chamber

b) Between different modules
c) Between modules and cable chamber
d) Between auxiliary bus bars and the rest of the switchgear
e) Between vertical bus bars and modules

All insulating materials used as partitions guards and shrouds shall be non-hygroscopic and flame retardant.

5.1.10 Interlock between compartment door and modules shall be provided such that the door cannot be opened without switching off the power supply to the module. Defeat interlock shall be provided for the module comprising of MCCB/MPCB as a means of isolation, such that it is possible to open the door with device ON and the module in 'SERVICE' position. The following shall apply under these conditions:

a) It shall not be possible to close the door till the interlock has been reinstated
b) Attempted withdrawal of the module under such conditions shall be cautioned against by providing warning label affixed at an appropriate place

5.1.11 Switchgear shall be equipped with thermostatically controlled space heaters in each panel (separate for front and rear in case of double front panels having separate cable alleys) so as to maintain interior temperature 5˚C above the ambient. They shall have MCB for protection.

5.1.12 All LT switchgear modules shall be provided with lock and Key arrangement with key rack located in respective control room.

5.1.13 At least 20% of feeder modules covering the range of motors/ outgoing feeders used subject to minimum of one module in each bus section shall be provided as spare. Spare modules shall be completely wired up.

5.1.14 20% of control terminals in each module shall be provided as spare subject to a minimum of 2 terminals.

5.2.0 **Feeder Modules**

5.2.1 Drawout modules shall have the following features:

a) Withdrawal of module shall be possible without disconnecting wires.
b) Drawout units of similar type and rating shall be interchangeable.
c) Secondary connections to the drawout module shall be through self-aligning and self-isolating contacts. In case of circuit breakers, easily disconnecting type plug and socket shall be acceptable in place of self-aligning and self-isolating type contacts.
d) With the drawout module fully removed from its housing, live parts exposed shall either be finger proof or shall have means to shroud them totally to prevent contact. Suitable add-on type shrouds shall be provided where automatic shutters or in-built shrouds are not provided.

5.2.2 All single front switchgear shall be provided with single leaf, hinged or bolted covers at the rear. The bolts shall be of captive type. The covers shall be provided with 'DANGER' labels.

5.2.3 Drawout modules shall have distinct 'SERVICE' and 'TEST' positions. The equipment pertaining to a drawout type module shall be mounted on a fully withdrawable chassis, which can be drawn out without having to unscrew any wire or cable connection. Suitable arrangement with cradle/rollers and guides shall be provided for smooth movement of the chassis.

5.2.4 Each switchgear shall be provided with removable type gland plate, which shall cover the entire cable alley. For all single core cables, gland plate shall be of non-magnetic material.

5.2.5 The arrangement of the feeders shall ensure that operating handle of the switch/breaker shall be above 350 mm but below 1800 mm from finished floor level.

5.3.0 **Bus Bars and Insulators**

5.3.1 Each PCC/MCC/DB shall be provided with three phase bus bars and one neutral bus bar. DC distribution boards shall have two bus bars.

5.3.2 Bus bars (including neutral bus bar) shall be capable of carrying the short time current for the duration as specified, without any damage. Current carrying capacity of neutral bus bar shall be minimum half that of the phase bus bar.

5.3.3 For double front type of board, separate vertical bus bars for each front shall be used.

5.3.4 All bus bars shall be made of high conductivity copper/aluminium alloy. They shall be supported on insulators of material such as fiber reinforced polyester or epoxy cast resin.

5.3.5 Minimum air clearance for horizontal and vertical bus bar termination shall be 25 mm between phases and 20 mm between phase and earth. For all other components the clearance shall be 10 mm minimum.

5.3.6 All bus bars shall be adequately supported by non-hygroscopic, non-combustible, track-resistant and high strength insulators. All bus bar joints shall be provided with high tensile steel bolts, belleville/spring washers and nuts. All bus bars and bus taps shall have HRPVC sleeves, colour coded as follows:

- Red, yellow & blue for R, Y & B phases respectively
- Black for neutral
- Grey & white for positive and negative respectively

5.3.7 All horizontal and vertical bus bars and joints shall be covered by insulating shrouds.

5.3.8 Contact surfaces at all joints shall be silver plated or properly cleaned and anti-oxide grease applied to ensure an efficient and trouble free connection. In case of dissimilar metal connections (copper to aluminium), proper treatment shall be given to minimize bimetallic effect. All such joints shall be silver/tin plated or suitable bimetallic washers shall be provided.

5.3.9 Auxiliary bus bars each of minimum 25 sq.mm thick electrolytic tough pitch copper shall be provided for the following applications.

- 240 V AC supply for panel space heater/motor space heater/panel illumination
- 220 V DC control supply for breaker tripping and closing, spring charging motors, indication circuits
- 110 V AC control supply for contactor operated motor starter control circuits as applicable

5.4.0 **Control Supply and Space Heater Supply**

5.4.1 PCC and ACB operated MCC shall have redundant 220 V DC control supply and shall have diode auctioneering. Each panel shall receive control supply through bus wires tapped off from auxiliary copper bus bar through MCBs provided in the respective panel. It shall be possible to isolate any panel without disturbing the power supply to other panels. Each sub-circuit shall have separate MCB.

5.4.2 An under voltage relay to monitor control supply shall be provided. A contact of the relay shall be wired to the terminal for external use. Control Supply Failed' indication shall be provided.

5.4.3 PCC/MCC shall derive 110 V AC control supply through 2X100% rated 415 /110 V transformer and shall be provided with changeover arrangement. Changeover shall be blocked for control

bus bar fault. The control transformers shall be of insulation class 'B' or better. The sizing of control transformers shall be carried out considering the load of power contactors, auxiliary contactors, indicating lamps and other equipment including remote auxiliary relays and lamps in the circuit with 20% design margin. One pole of secondary winding shall be earthed.

5.4.4 For PCC and MCC 240 V AC Space heater supply shall be derived from 415/230 V control supply transformer located one in each bus section. Necessary MCB to isolate and distribute the supply shall be provided. For DB, 240 V AC space heater supply can be derived from incoming supply itself.

5.4.5 All motors rated 30 kW and above shall be provided with power supply for space heater. Circuit for motor space heater shall be wired through auxiliary NC contact of breaker/contactor and MCB.

5.4.6 Each panel of PCC/MCC/DB shall be equipped with the following as required:

- Thermostatically controlled space heater(s).
- Illumination lamp with door switch
- 5 Amp 3 pin socket with MCB protection.

5.5.0 **Air Circuit Breakers**

5.5.1 Air circuit breakers shall be stored energy, trip free, air break and horizontal drawout type and shall have fault making and breaking capacities as specified. There shall be 'SERVICE', 'TEST' and 'ISOLATED' positions for the breakers. In 'TEST' position the circuit breaker shall be capable of being tested for operation without energizing the power circuits i.e. the power contacts shall be disconnected, while the control circuits shall remain undisturbed. Locking facilities shall be provided so as to prevent movement of the circuit breaker from the 'SERVICE', 'TEST' or 'ISOLATED' position. It shall be possible to close the door in 'TEST' position.

5.5.2 Breakers of different ratings shall not be interchangeable. Front fascia cut-outs for all ratings of breakers shall be identical.

5.5.3 The spring charging mechanism of the circuit breaker shall be motor operated. The close/trip control switch shall be interlocked to trip before close. The closing and tripping circuits shall be self-opening on completion of their respective functions irrespective of the position of the control switch. Manual closing devices shall also be provided. The circuit breaker shall be electrically and mechanically trip free. For all circuit breakers electrical anti-pumping device shall be provided.

5.5.4 The fixed portion of the circuit breaker shall have rail arrangement over which the chassis can move smoothly. Proper mechanical indication shall be provided for the three positions ('SERVICE', 'TEST' and 'ISOLATED') without opening the compartment door. It shall be possible to bring the circuit breaker to isolated position with the help of external lever without opening the compartment door. The circuit breaker can be padlocked in OFF position with door interlock defeat facility.

5.5.5 The following interlocks shall be provided on the circuit breaker:

- It shall not be possible to withdraw the circuit breaker from the service position with the contacts of the breaker closed
- It shall not be possible to close the circuit breaker unless any one of the three positions is located
- It shall not be possible to open the compartment door when the circuit breaker is ON

5.5.6 It shall not be possible to close the breaker under following conditions:

- Stored energy mechanism is not charged
- Shunt release is energized
- OFF push button is locked in OFF position

5.5.7 The circuit breaker shall be provided with mechanical ON/OFF, 'TRIP', 'SPRING CHARGED/DISCHARGED', 'READY TO CLOSE' and breaker position indications and mechanical trip push button. An operating handle shall also be provided to charge the spring manually.

5.5.8 The circuit breaker shall be provided with automatic safety shutters, so that before the breaker reaches 'ISOLATED' position the main isolating contacts are completely shrouded. In the drawout condition, it shall be possible to inspect the breaker fixed contacts condition by lifting the shutters.

5.5.9 When the circuit breaker compartment door is open, it shall not be possible to touch the live parts. All removable covers protecting live parts shall be clearly labeled with warning notices reading 'LIVE PARTS. ISOLATE ELSEWHERE BEFORE REMOVING COVER'. It shall be possible to readily remove the arc chutes for routine inspection of the contacts with the circuit breaker in the withdrawn position. Contact erosion indicator shall be provided on moving contacts of breaker for visual indication of contact life.

5.5.10 Each breaker feeder shall be provided with the following:

- An anti-pumping relay
- Motor charged spring operating mechanism
- Manual spring charging and manual closing mechanism
- Mechanical indication of spring charge
- Mechanical position indicator (to show whether the breaker is in the 'ON' or 'OFF' positions and in the 'SERVICE', 'TEST' or 'ISOLATED' positions)
- Closing coil
- Shunt trip coil
- CTs for protection
- Manual trip push button
- Phase barriers
- Shutter assembly
- Door interlock kit
- Operation counter
- Intelligent control unit

5.5.11 The closing coil and spring charging motor shall operate satisfactorily for all values of control supply voltage between 80% and 110% of the rated voltage. But, the shunt trip coil shall be designed such that it shall operate satisfactorily for all values of control supply voltage between 70% and 110% of the rated voltage. One open-close-open operation of the circuit breaker shall be possible after failure of power supply to motor.

5.5.12 Telescopic trolley or suitable arrangement shall be provided for maintenance of circuit-breaker module in a cubicle. The trolley shall be such that the topmost breaker module can be withdrawn on the trolley and can be lowered for maintenance purpose. Also, it shall be such that all types, sizes and ratings of breakers can be withdrawn / inserted in the switchgear.

5.6.0 Contactor Starter Unit

5.6.1 All motors rated up to 125 kW shall be controlled by direct-on-line contactor starters. MPCB shall be used for motor feeders rated up to 15 kW. For feeders rated above 15 kW and up to 125 kW, MCCB shall be used. The starting circuit shall consist of the following:

- Isolating device (MCCB/MPCB)
- Contactor as main means of starting and stopping of motor
- A short circuit protective device (Inbuilt feature of MPCB/MCCB)
- Electronic overload protection relay with current display unit & built-in single phasing prevention feature
- CT operated numerical relay for motor feeders rated 75 kW and above
- Intelligent control unit

5.6.2 Withdrawable contactor starter units shall be provided with means for mechanically indicating the 'SERVICE' and other positions.

5.7.0 **Moulded case Circuit Breakers (MCCB) / Motor Protection Circuit Breakers (MPCB)**

5.7.1 MCCBs shall be of three / four pole construction for panel mounting. The MCCBs shall be provided with front operating handles and mechanical ON / OFF indicators.

5.7.2 MCCB shall be provided with spring assisted quick-make, quick-break, current limiting type manually operated trip free mechanism, mechanical ON/OFF/TRIP position indicators, thermal tripping devices of inverse characteristics, instantaneous short circuit tripping devices and necessary auxiliary and alarm contacts. The MCCB module shall be provided with service, test and isolated position. The thermal and short circuit tripping device shall be adjustable type.

5.7.3 The MPCB's shall be in general similar to that of MCCB's in all the features mentioned above.

5.7.4 MCCBs/MPCBs shall be provided with overload thermal release setting range of 50% to 100% of rated current and adjustable short circuit magnetic release of 5 to 10 times rated current.

5.7.5 MCCBs/MPCBs shall be capable of withstanding the thermal stresses caused by overloads and locked rotor currents of values associated with protective relay settings of the motor starting equipment and the mechanical stress caused by the peak short circuit current of value associated with the switchgear rating. The maximum tripping time under short circuit shall not exceed 20 m. Second. When used for motor circuit, shunt trip devices shall be provided and the let through power of controlling MCCB/MPCB shall be lower than the respective contactor, Contactor and overload relays shall be selected so as to withstand the let-through energy of the connected MCCB/MPCB in the feeder and consequent thermal and dynamic effects. All power feeder module MCCBs shall be equipped with earth fault release.

5.7.6 The DC circuits shall be provided with DC rated MCCB / MCBs.

5.7.7 MCCBs/MPCBs shall have following accessories and features:

a) Shunt trip release
b) Under voltage release
c) Auxiliary contact for ON/OFF/ trip position
d) Fault signaling contact
e) Insulation shields to isolate the connection between each pole
f) Finger protection plate to prevent accidental contact
g) The compartment door shall be interlocked with handle of MCCB/MPCB.

5.8.0 **Control and Selector Switches**

5.8.1 All circuit breaker operating switches shall be of the pistol grip type, spring return to neutral and lockable in that position. The trip, neutral and close positions shall be clearly indicated.

5.8.2 Ammeter and voltmeter selector switches shall have four stay put positions with adequate number of contacts for 3 phase 4 wire system. These shall have oval handles. Ammeter

selector switches shall have make before break type contacts to prevent open circuiting of CT secondary

5.8.3 Local/Remote selector switch shall be provided as per control requirement.

5.9.0 **Contactors**

5.9.1 Contactors shall be of air break, electromagnetic type rated for uninterrupted duty. Contactors shall be double-break, non-gravity type and their main contacts shall be silver faced copper. Direct-on-line contactors shall be of utilization category AC3. Full voltage reversing starters shall comprise of forward and reverse contactors mechanically and electrically interlocked with each other. These contactors shall be of utilization category AC4. DC contactor shall be of utilization category DC3. The contactor rating shall be chosen to provide type-2 discrimination. However, the minimum rating shall be 16 A.

5.9.2 Electronic over load relay shall have selectable setting, self-powered, ambient temperature compensated, sensitive to phase loss/unbalance, trip free mechanism, with trip indication, test and stop function, current display etc. Type-2 coordination shall be ensured between MCCB/MPCB, contactor and overload relay.

5.10.0 **Miniature Circuit Breaker (MCB)**

MCB shall be rated for atleast 10 kA short circuit rating. It shall be quick make, quick break, and independent manual type with trip free feature. MCB shall have overcurrent protection, ON/OFF position indicators and auxiliary contact block for ON/OFF/Trip positions.

5.11.0 **Instrument Transformers**

All current and voltage transformers shall be completely encapsulated, cast resin insulated type suitable for continuous operation at the temperature prevailing inside the switchgear enclosure, when the switchgear is operating at its rated condition and the specified ambient temperature. The class of insulation shall be 'B' or better.

Current Transformers shall be cast-resin type with 1 A secondary. Separate cores shall be used for metering and protection. Accuracy class of the current transformers shall be class 5P20 for relaying and Class 0.5 and ISF<5 for metering.

Voltage transformers shall be cast-resin drawout type and shall have an accuracy class of 0.5/3P for metering & protection. Voltage transformer mounted on breaker carriage is not acceptable. It shall have a continuous voltage factor of 1.2 with short time over voltage factor of 1.5 for 30 seconds. The VT shall be provided with MCCB on the primary side and MCBs on secondary side.

5.12.0 **Relays and Timers**

5.12.1 Relays and timers in protective circuits shall be flush mounted on panel front with connections from the inside. They shall have transparent and dust tight covers removable from the front. They shall either have built-in test facilities, or shall be provided with necessary test blocks and test switches located immediately below each relay.

5.12.2 Relays shall have lock-out facility with manual reset. Each circuit breaker feeder shall be provided with separate latched lockout relay (86), trip circuit supervision relay, necessary auxiliary relays, timers, etc. to meet circuit requirements. In addition self-reset type lockout relay to be provided on Bus PT Panel for Under voltage tripping the motor feeders.

5.12.3 Lock out relay contacts shall only be provided for protection trip & reset status for use in close and trip interlocks of the circuit breaker.

5.12.4 Auxiliary supply voltage for relays and transducers shall be 220 V DC. Relays shall be capable of satisfactory continuous operation between 80-120% of the rated voltage.

5.12.5 Failure of a control or auxiliary supply and de-energisation of a relay shall not initiate any circuit breaker operation. All relays shall withstand a minimum test voltage of 2 KV AC Rms for one minute.

5.12.6 The relays shall have provision of both current and voltage inputs. The current operated relay shall have provision for 5 sets of CT inputs, 3 nos. for phase fault and 1 CT input for earth fault & 1 CT input for CBCT. Relay shall be suitable for both residually connected CT input as well as CBCT input. Relays shall be suitable for CT secondary current of 1 A / 5 A selectable at site. The voltage-operated relay shall have provision for 3 PT inputs. Relays shall be rated for operation on 110 V, VT secondary voltage. Relays used in Incomers and bus couplers shall have provision of two sets of voltage signal inputs for the purpose of synchronization.

5.12.7 All CT and PT terminals shall be provided as fixed type terminals on the relay to avoid any hazard due to loose connection leading to CT opening or any other loose connection. In no circumstances Plug In type connectors shall be used for CT/ PT connections.

5.12.8 All numerical relays shall have key pad / keys to allow relay settings from relay front. All hand reset relays shall have reset button on the relay front. Relay to be self or hand reset shall be software selectable. Manual resetting shall be possible from remote. Relays shall have suitable output contact for breaker failure protection.

5.12.9 Relays shall have self-diagnostic feature with self-check for power failure, programmable routines, memory and main CPU failures.

5.12.10 The numerical relay shall be able to provide supervisory functions such as, circuit breaker state monitoring, PT and CT supervisions and recording facilities with Post fault analysis

5.12.11 The numerical processor shall be capable of measuring and storing values of a wide range of quantities, all events, faults and disturbance recordings with a time stamping using the internal real time clock. Battery backup for real time clock in the event of power supply failure shall be provided.

5.12.12 Relays shall have event recording feature, recording of abnormalities and operating parameters with time stamping.

5.12.13 Numerical relays shall be capable of storing Minimum of 150 time tagged events/ records with time stamping. The numerical relays shall be able to store last 5 faults including the indication, waveforms, protection operated, fault location relay and operating time, currents, voltage and time. All Setting parameters, Fault data, waveforms & event logs shall be stored in Non-volatile memory only.

5.12.14 Sequence of events shall have 1 ms resolution at device level.

5.12.15 Measurement accuracy shall be 1 % for RMS Current and voltage.

5.12.16 Relay shall be immune to capacitance effect due to long length of connected control cables. Any external hardware, if required for avoiding mal operation of the relay due to cable capacitance shall be included as a standard feature. All IOs shall have optical isolation. Analog inputs shall be protected against switching surges, harmonics etc.

5.12.17 The alarm/status of each individual protection function and trip operation shall be communicated to DCS/Respective control system. The numerical relay system shall have built-in features/hardware interface to provide such inputs to Respective control system for analog/digital values.

5.12.18 Relays shall have at least two sets or groups of two different sets of adaptable settings. Relays shall have multiple IEC/ ANSI programmable characteristics.

5.12.19 Numerical relays shall have two level pass word protections, one for read only and other for authorization for modifying the setting etc.

5.12.20 Timer functions shall be programmable for on/off delays.

5.12.21 The protective relays shall have at least 10 nos. potential free contacts (Programmable) Auxiliary relays shall have contacts as required. Relay output contacts shall be suitable for directly wiring in the breaker closing and trip circuit operating from 220 V DC control voltage.

5.12.22 Making, carrying and breaking current ratings of their contacts shall be adequate for the circuits in which they are used. Interrogation voltage for the binary inputs shall be suitably selected to ensure avoidance of mal operation due to stray voltages.

5.12.23 No separate earth bus shall be required for the relays. It shall be possible to connect the relay earth to the common earth bus in the switchgear panel which shall be connected to the plant earth mat.

5.12.24 All protective relays shall be latest numerical type, having following features/functions:

- Protection functions as required
- IEC IDMT characteristics
- Measurements
- Event/fault/disturbance recording
- Binary input/output relays as required
- LEDs to indicate status of the relay
- LCD display for measurements, settings, faults etc.
- Key pad on the front of the relay
- Communication ports for transmitting settings, measurements, alarms, faults, events, disturbance records to DCS/Respective control system/SAS (Substation Automation System)
- Communication port for software setting/access measurements/maintenance/fault analysis
- Self-monitoring

5.12.25 All protective relays shall be latest numerical type with one USB port at the front for connecting to Laptop and one port (RJ45/FO port) at rear suitable for communication on IEC 61850 protocols.

5.12.26 The Numerical relays shall be networked through Ethernet switch, Gateway/Data Concentrators and shall be further integrated with SCADA based electrical monitoring system (for monitoring, measuring, fault data analysis & relay parameterization).

5.12.27 All necessary hardware including Managed Ethernet switches, accessories and licensed software shall be supplied by the vendor.

5.12.28 Ethernet switches shall be ‘substation hardened’ and shall comply with IEC61850-3 for communications and environment requirements. The Ethernet switches shall be of managed type with two (2) no. of fibre optic cable ports for ring network and Fourteen/Sixteen of Copper ports to achieve the LAN configuration. These switches shall be mounted inside the switchgear Panel.

5.12.29 The switchgear shall be provided with DC fail relay and DC fail indication lamp.

5.12.30 Breaker auxiliary contacts used for interlocking purposes shall be multiplied using electrically latched relay.

5.12.31 Protection relays shall include, protection functions but not limited to the following:

a) Incomer feeder from transformers:
- IDMT & DMT overcurrent protection (50/51)
- IDMT & DMT Earth fault protection (50N/51N)
- Under voltage relay (27)

b) Normal Incomer feeder (Direct from Upstream switchgear):
- IDMT & DMT overcurrent protection (50/51)
- IDMT & DMT Earth fault protection (50N/51N)
- Under voltage relay (27)

c) Bus Coupler feeder:
- IDMT & DMT overcurrent protection (50/51)
- IDMT & DMT Earth fault protection (50N/51N)
- Check Synchronizing relay (25C)

d) Outgoing ACB operated Motor feeder:
- IDMT & DMT overcurrent protection (50/51)
- IDMT & DMT Earth fault protection (50N/51N)
- Over load (49)
- Negative sequence (46)
- Phase Reversal (46 R)
- Restart inhibit with startup counter (37)
- Locked rotor (48-LR)
- Under current (66)

e) Other Outgoing feeder:
- IDMT & DMT overcurrent protection (50/51)
- IDMT & DMT Earth fault protection (50N/51N)

f) Bus PT:
- 3 phase Under voltage relay

5.13.0 Indicating Instruments

5.13.1 All indicating instruments and meters shall be capable of carrying continuously their full load currents and full voltage across their coils. They shall not be damaged by the passage of fault currents or the existence of over voltage on the primary side of their instrument transformers for the maximum permitted duration of fault conditions which may occur during normal operation. All instruments and meters shall be back connected.

5.13.2 Meters and transducers for 415 Volts PCCs

For incomers feeders following Meters and transducers shall be provided:
- Current transducer on ‘Y’ phase
- Voltage transducer on ‘Y-B’ phase
- 1.0S class energy accounting and audit meter
- 1.0 class digital multi-function meter

For Bus Coupler following Meters and transducers shall be provided:
- Current transducer on ‘Y’ phase
- 1.0 class digital multi-function meter

For ACB outgoing feeders following Meters and transducers shall be provided:
- Current transducer on 'Y' phase
- 1.0 class digital multi-function meter

For ACB motor feeders following Meters and transducers shall be provided:
- Current transducer on 'Y' phase
- 1.0 class Analog meter on 'Y' phase

For contactor motor feeders 15 kW & above following Meters and transducers shall be provided:
- Current transducer on 'Y' phase
- 1.0 class Analog meter on 'Y' phase
- Electronic overload relay with current display in switchgear.

For contactor motor feeders less than 15 kW following Meters and transducers shall be provided:
- Electronic overload relay with current display in switchgear.

For Bus PT following Meters and transducers shall be provided:
- Digital Voltmeter measuring all three phases
- Voltage transducer on three phases
- Power factor transducer

5.13.3 Meters and Transducers for 415 Volts MCCs

For incomers feeders following Meters and transducers shall be provided:
- Current transducer on 'Y' phase
- Voltage transducer on 'Y-B' phase
- 1.0 class digital multi-function Meter.

For Bus Coupler following Meters and transducers shall be provided:
- Current transducer on 'Y' phase
- 1.0 class digital multi-function Meter.

For Bus PT following Meters and transducers shall be provided:
- Digital Voltmeter measuring all three phases
- Voltage transducer on three phases

For contactor motor feeders 15 kW & above following Meters and transducers shall be provided:
- Current transducer on 'Y' phase
- 1.0 class Analog meter on 'Y' phase
- Electronic overload relay with current display in switchgear.

For contactor motor feeders less than 15 kW following Meters and transducers shall be provided:
- Electronic overload relay with current display in switchgear.

5.13.4 Meters and Transducers for 415 Volts DBs

For incomers feeders following Meters shall be provided:
- Digital voltmeter measuring all three phases
- Digital ammeter measuring all three phases

For Bus PT following Meters shall be provided:
- Digital Voltmeter measuring all three phases

5.13.5 Energy accounting and audit meters shall meet CEA regulation. It shall be integrated with integrated energy management system. The energy audit meters shall be suitable for measurement, recording and display of cumulative active energy with date and time. It shall

have data storage capacity for at least 35 days in a non-volatile memory. It shall have facility to download the parameters through meter reading instruments as well as remote transmission of data over communication network. It shall also have the facility to measure, record and display the following parameters. All parameters excluding instantaneous electrical parameters shall also be stored in memory.

(a) Apparent power
(b) Phase wise kilowatt at peak KVA
(c) Phase wise KVA(reactive) at peak KVA
(d) Phase wise voltage at peak KVA
(e) Power down time
(f) Average power factor
(g) Line currents
(h) Phase voltages
(i) Date and time
(j) Tamper events

5.13.6 Digital Multifunction Meters shall be provided with bright LED/LCD display for local indication and shall be provided with communication port suitable for communicating on MODBUS protocol to EMS/DCS. It shall display various parameters like 3 phase currents, voltages, PF, MD, KW, KVA, etc. for local indication and shall be provided with minimum 8 nos. of user programmable registers for communicating any of the displayed parameters to the remote.

5.13.7 For motor feeder, analog ammeter with accuracy class 1.0, of 96x96 sq.mm square with 240° scale. Shall be provided. It shall have cramped scale above 2 times to 8 times the rated current for indicating the starting current.

5.13.8 Transducers shall be of dual output type, class 0.5, 4-20 mA DC linear output & 750 ohm load.

5.13.9 Transducers shall be provided in all the buses so that algebraic summation in electrical system shall be Zero.

5.14.0 **Push Buttons**

5.14.1 Push buttons shall be of heavy duty, spring return and push-to-actuate type. Their contacts shall be rated to make, continuously carry and break 10 A at 240 V AC and 1 A (inductive) at 220 V DC.

5.14.2 All push buttons shall have two nos. NO and two nos. NC contacts, unless specified otherwise. The contact faces shall be of silver alloy. All push buttons shall be provided with integral escutcheon plates marked with their functions.

5.14.3 The colour of the button shall be as follows:

- Green for motor START and breaker CLOSE
- Red for motor STOP and breaker OPEN
- Black for valve/damper OPEN/CLOSE commands
- Black for all annunciation functions, overloads, reset and miscellaneous commands

5.14.4 All push buttons on panels shall be located in such a way that red push buttons shall always be to the left of green push buttons. All emergency push buttons shall have mushroom knobs.

5.15.0 **Indicating Lamps**

5.15.1 Indicating lamps shall be of the panel mounting clustered LED type. The lamps shall have escutcheon plates marked with their functions, wherever necessary. Bulbs and lamp covers shall be easily replaceable from the front of the cubicles. Low Voltage Glow Prevention (LVGP) feature shall be provided for indicating lamps. Lamps shall have translucent lamp covers of the following colour, as warranted by the application :

- Red for motor ON, valve/damper OPEN and breaker CLOSE
- Green for motor OFF, valve/damper CLOSE and breaker OPEN
- Amber for TRIP
- Blue for 'SERVICE' position indications
- White for all healthy conditions (e.g. control supply, lockout relay healthy, spring charged condition etc.)
- White for 'TEST' position indications
- Red, yellow, blue for R, Y and B phases respectively

5.15.2 Indicating lamps shall be located just above the associated push button/control switch. Red lamps shall invariably be located to the right of green lamps. When associated with push buttons, red lamps shall be directly above the green push button and green lamp shall be directly above the red push button.

5.15.3 All indicating lamps shall be suitable for continuous operation at 85% to 110% of their rated voltage.

5.15.4 For incomer and bus, indicating lamps for R, Y and B phases shall be provided.

5.16.0 **Wiring**

5.16.1 Wiring shall be by 1100 volt grade multi-stranded PVC insulated copper wire having a cross-sectional area of not less than 1.5 sq.mm. All connections from CT leads up to instruments, relays and terminal board shall be made by copper wires of minimum 2.5 sq.mm size. The cables shall be tested for flammability test as per applicable standards and shall also withstand service temperature without deterioration.

All wiring shall use the colour codes specified below:

- 3 phase AC connections — Red, yellow & blue for R, Y & B phases respectively
- 1 phase AC connections — Red and black for phase and neutral respectively
- DC connections — Grey & white for positive and negative respectively
- Earth connection — Yellow-Green

5.16.2 Wiring shall be run mostly clear of all metal parts in insulated cleats, properly routed and neatly bunched. However, PVC wire holders and channels shall be preferred for running of wiring. Where wiring passes from one compartment to another, the aperture shall be 'bushed' to prevent damage of wires against sheet metal edges. Bushes may comprise of good quality rubber grommets.

5.16.3 Where single phase conductors are associated with the 3 phase system from which they are derived, the phase conductor shall use the same colour as the phase from which it is derived.

5.16.4 Inter-module bus wires shall be kept separate from all other wiring. AC or DC terminations shall be grouped function-wise as far as possible and labels of the function shall be affixed.

5.16.5 Terminal boards shall have separate terminals for incoming and outgoing wires with not more than two wires connected to any one terminal. Terminal boards shall be mounted vertically at the side of the cubicle or in horizontal rows and properly spaced to have clean wiring

arrangement, adequate access for putting ferrules, making terminations etc. It shall be possible to read the ferrule numbers when the wiring is complete. Where terminals may be live when the equipment is isolated from the main supply, these shall be clearly marked on the panel.

5.16.6 Extra flexible wires shall be used for wiring to devices mounted on moving parts such as hinged doors. The wire bunches from the panel inside to the doors shall be properly sleeved or taped. All internal wiring terminations shall be made with solder less crimping type heavy duty tinned copper lugs. Insulation sleeves shall be provided over the exposed parts of lugs.

5.16.7 Engraved core identification plastic ferrules marked to correspond with panel wiring diagrams shall be fitted at both ends of each wire.

5.16.8 Control terminal blocks shall be of 650 V grade, rated for 10 A and in one piece molding. It shall be complete with insulating barriers, clip-on type terminals and identification strips. Marking on terminal strip shall correspond to the terminal numbering on wiring diagrams. Terminal blocks for CT and VT secondary leads shall be provided with test links and isolating facilities. CT secondary leads shall be provided with short circuiting and earthing facilities.

5.16.9 In all the panels, at least 20% spare terminals for external connections shall be provided and these spare terminals shall be uniformly distributed on all terminal blocks.

5.16.10 All interlocks shall be hardwired in the switchgear itself.

5.16.11 The wiring shall be complete in all aspects so as to ensure proper functioning of control, protection and interlocking scheme. All the wiring shall be complete up to terminal blocks on the side of each unit/module.

5.16.12 Adjacent rows of terminal blocks shall be spaced not less than 100 mm apart.

5.16.13 The terminal blocks shall be mounted inside the module (and not in cable way) in a manner so as to provide easy access to terminals and to enable ferrule numbers to be read without difficulty.

5.16.14 All inter-panel wiring shall be carried out within the switchgear before dispatching the panel.

5.16.15 A typed circuit directory, card holder and card with clear plastic covering shall be provided on the inside of each cabinet door. The directory card shall provide space to identify each circuit in the panel board. An electronic copy of the circuit directory shall be provided to the Owner.

5.17.0 **Cable/Busduct Termination**

a) PMCC/MCC/DB shall be designed for cable entry from the bottom. Sufficient space shall be provided for ease of termination and connection. Add-on panels shall be considered for cables, if any.

b) Cable termination compartment and arrangement for power cables shall be suitable for heavy duty, 1.1 kV grade, stranded aluminium conductor, XLPE insulated, armoured and FRLS PVC sheathed cables.

c) Sufficient space and support arrangement shall be provided in the cubicles to accommodate cables.

d) Cables shall be PVC insulated, armoured, extruded FRLS PVC overall sheathed with 2.5 sq.mm for control & current circuits and 1.5 sq.mm for voltage circuits and PVC insulated, armoured, extruded FRLS PVC overall sheathed with stranded copper / aluminium conductor for power circuits.

e) All provisions and accessories shall be furnished for termination and connection of cables, including removable gland plates, cable supports, crimp type tinned copper lugs, brass compression glands with tapped washer and terminals blocks.

f) The gland plates and supporting arrangement for 1/C power cable shall be such as to minimize flow of eddy current.

g) For all DG sets & service transformers rated 1000 KVA and above shall be connected through bus ducts to the respective switchgear panel. Busduct entry shall be from the top.

5.18.0 **Name plates and labels**

5.18.1 Nameplates shall be of 3 ply laminate with black lettering on white background. The following shall be provided with nameplates/warning labels as described below:

- Main name plate for PCC/MCC/DB on front and back sides
- All incomers and outgoing feeders indicating description, rating, equipment no., feeder no., etc.
- All door mounted components
- Panel numbers on front and rear
- Warning labels for interlocks

All name plates shall be fastened by means of screws to the panel.

Danger labels shall be provided for the following:

- MCC as per statutory regulations
- Bus bar chamber
- Cable alley housing live terminals

5.18.2 Name plate or polyester adhesive stickers shall be provided inside the panel for all equipment (lamps, push buttons, switches, relays, auxiliary contactors etc.) mounted on the switchgear.

5.18.3 Special warning plates, one each on each front of a shipping section, shall be provided on removable covers of doors giving access to cable terminals and bus bars. Special warning labels shall be provided inside the switchgear also, wherever considered necessary. Identification tags shall be provided inside the panels matching with those shown on the circuit diagram.

5.18.4 All major components such as breakers, switches, contactors, CTs etc. shall be provided with labels indicating their ratings.

5.18.5 For single front switchgears, similar panel and board identification labels shall be provided at the rear also.

5.19.0 **Earthing**

5.19.1 Two earth terminals shall be provided on each switch cubicle, at the rear side. An earth bar of at least 50 x 10 mm aluminium shall be fixed to these terminals. The earth bar shall be electrically continuous and shall run the full extent of each board. This earth bar shall be on the same side as the cable entry and shall be extended on both sides of the panel.

5.19.2 Each unit shall be constructed to ensure satisfactory electrical continuity between all metal parts not intended to be alive and earth terminals of the unit. Suitable holes with bolts and nuts shall be provided at each end of earth bar of switchgear for connection to a main earthing grid.

5.19.3 The earth bar shall be accessible in each cable entering compartment either directly or through a branch extension to earth the cable armour and shields. 10 mm diameter holes shall be drilled and hardware for connection provided through the earth bus.

5.19.4 The cores of transformer (bus voltage transformer, control transformer, heating transformer etc.) shall also be earthed through copper wire. Doors shall have a copper wire for earth

connection to fixed unit. VT and CT secondary neutral point earthing shall be at one place only on the terminal block.

5.19.5 All non-current carrying metal work of the switchgear/panel shall be effectively bonded to the earth bus. All metallic cases of relays, instruments and other panel mounted equipment shall be connected to earth bus by independent stranded copper wires of size not less than 2.5 sq.mm. Insulation colour code of earthing wires shall be green. Earthing wires shall be connected to terminals with suitable clamp connectors and soldering shall not be acceptable. All hinged doors shall be earthed through flexible earthing braid.

5.20.0 **Wall Mounted Distribution Boards**

5.20.1 Wall mounted distribution boards shall be metal enclosed, suitable for outdoor mounting on wall or steel structures with suitable hood on the top. The enclosure shall be cold rolled sheet steel of at least 1.6 mm thickness. Gland plate shall be of 2 mm thick. The board shall be dust and vermin-proof and shall have a degree of protection of IP-55. MCB/motor protection circuit breaker (MPCB) shall be rated for 10 kA short circuit rating. MPCB shall have adjustable overload setting and short circuit release.

5.20.2 Wall mounted distribution boards shall comprise the following as a minimum:

- Adequately rated TPN MCB isolator as incomer
- 3 phase & neutral bus bar
- Required number of TPN/SP MCBs or MPCBs with contactor and start/stop PBs for outgoing feeders
- R,Y, B indicating lamps (LED)

5.21.0 **Local Motor Starters**

5.21.1 Local motor starters shall be metal enclosed, suitable for outdoor mounting on wall or steel structures with suitable hood on top. The enclosure shall be cold rolled sheet steel of at least 1.6 mm thickness. The local motor starters shall be dust and vermin-proof and shall have a degree of protection of IP-55.

5.21.2 Local motor starters shall comprise of the following:

- A 3-pole contactor, mechanically latched type
- Start push button, coloured green
- Stop push button, coloured red
- 'ON' indicating lamp
- Electronic overload relay with single phasing protection

5.22.0 **Local Push Button (LPB) Stations**

5.22.1 The local push buttons station enclosure shall be with hood on top suitable for outdoor mounting on wall or steel structures. The enclosure shall be provided with a protective guard, to avoid inadvertent operation of push buttons. The local push button stations shall be dust and vermin-proof and shall have a degree of protection of IP-55 as per IS 13947.

5.22.2 LPB shall be of following types:

- Type-A: With Stop Push Button in FRP enclosure
- Type-B: With Start & Stop Push Buttons in FRP enclosure
- Type-C: With Forward, Reverse & Stop Push Buttons in FRP enclosure
- Type-D: With Stop Push Button in flame-proof enclosure
- Type-E: With Start & Stop Push Buttons in flame-proof enclosure
- Type-F: With Forward, Reverse & Stop Push Buttons in flame-proof enclosure

5.22.3 Push buttons shall be with two NO and two NC contacts. Emergency stop push buttons shall be mushroom, latched type. Start push button shall be self-reset type.

6.0.0 PAINTING

Painting shall be carried out by approved process. After preparation of the under surface the equipment shall be painted with epoxy based paint by powder coating. The final thickness of paint film on sheet steel shall not be less than 85 microns. Final shade shall be RAL-7035.

7.0.0 TESTS

7.1.0 All tests shall be conducted as per relevant IS/IEC standards and shall be performed in the presence of Owner's representative, if so desired by the Owner. All equipment/ components/materials shall be of type tested and proven type.

7.2.0 Type test reports shall be submitted for switchgear panel and breaker of each current rating as per applicable standard. The switchgear panel shall be subjected to routine tests in accordance with the relevant IS/IEC standards. Test reports shall be submitted to the Owner for approval.

7.3.0 Type Tests

7.3.1 Type test reports for the following shall be submitted for switchgear panel of each current rating:

- Power frequency withstand test on power circuit and auxiliary and control circuits
- Temperature rise test
- Measurement of resistance of the main circuit
- Short time withstand current and peak withstand current test
- Degree of protection test

7.3.2 Type test reports shall be submitted for circuit breaker as per applicable standard by the Bidder for Owner's review. The list of type tests shall include the following:

- Dielectric tests
- Measurement of the resistance of the main circuit
- Temperature rise tests
- Short time withstand current and peak withstand current tests
- Electromagnetic compatibility tests
- Mechanical and environmental tests including mechanical operation test
- Short circuit current making and breaking tests
- Mechanical endurance test
- Electrical endurance test

7.3.3 The contactors, relays, switches, breakers, local push buttons, local motor starters, instruments, VTs, CTs and control transformers shall be subjected to type tests in accordance with the relevant IS/IEC standards.

7.4.0 Routine Tests

7.4.1 The switchgear panel shall be subjected to routine tests in accordance with the relevant IS/IEC standards. The tests shall include the following:

- Power frequency voltage dry test on the main circuit
- Voltage test on control and auxiliary circuits
- Measurement of resistance of the main circuit
- Mechanical operating tests

7.4.2 The circuit breakers, contactors, switches, local push buttons, local motor starters, VTs, CTs and control transformers shall be subjected to routine tests in accordance with the relevant IS/IEC standards. Routine test reports shall be furnished by the Vendor for Owner's review.

7.4.3 For circuit breaker, the list of routine tests shall include the following:

- Dielectric tests on the main circuit
- Dielectric tests on the control circuit & auxiliary circuit
- Measurement of the resistance of the main circuit
- Mechanical operating tests
- Design and visual checks

7.5.0 **Site Tests**

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

a) General
- Check name plate details according to specification
- Check for physical damage
- Check tightness of all bolts, clamps and connecting terminals
- Check earth connections
- Check cleanliness of insulators and bushings
- Check heaters are provided
- HV test on complete switchgear with CT and breaker/ contactor in position
- Check all moving parts are properly lubricated
- Check for alignment of busbar with the insulators to ensure alignment and fitness of insulators
- Check for interchange ability of breakers/ contactors
- Check continuity and IR value of space heater
- Check earth continuity for the complete switchgear board

b) Circuit Breaker/ Contactors
- Check alignment of trucks for free movement
- Check correct operation of shutters
- Check slow closing operation (if provided)
- Check control wiring for correctness of connections, continuity and IR values
- Manual operation of breakers completely assembled
- Power closing/ opening operation, manually and electrically at extreme condition of control supply voltage
- Closing and tripping time
- Trip free and anti-pumping operation
- IR values, resistance and minimum pick up voltage of coils
- Simultaneous closing of all the three phases
- Check electrical and mechanical interlocks provided
- Checks on spring charging motor, correct operation of limit switches and time of charging
- Check SF6 pressure/ vacuum (as applicable)
- All functional checks

c) Current Transformers
- Insulation resistance between windings and winding terminals to body
- Polarity tests
- Ratio identification checking of all ratios on all cores by primary
- injection of current
- Magnetisation characteristics and secondary winding resistance
- Spare CT cores, if any to be shorted and earthed

d) Voltage Transformers
- Insulation resistance test
- Ratio test on all cores
- Polarity test
- Line connections as per connection diagram

e) Cubicle Wiring
- Check all switch developments
- It should be made sure that the wiring is as per relevant drawings. All interconnections between panels shall similarly be checked
- Insulation resistance of all wires with respect to earth
- Functional checking of all control circuit e.g. closing, tripping interlock, supervision and alarm circuit including proper functioning of component/ equipment
- Check terminations and connections
- Wire ducting
- Gap sealing and cable bunching

f) Relays
- Check internal wiring
- Insulation resistance between all terminals and body
- Insulation resistance between AC and DC terminals
- Check operating characteristics by secondary injection
- Check minimum pick up voltage of DC coils
- Check operation of electrical/ mechanical targets
- Check CT connections with particular reference to their polarities for differential type relays
- Relay settings

g) Meters
- Insulation resistance of all insulated portions
- Check CT and VT connections with particular reference to their polarities for power type meter

8.0.0 TECHNICAL PARAMETERS OF LV SWITCHGEAR

Sloe.	Description	Unit	Parameters
1.0	**LV Switchgear – General**		
a)	Type		Metal clad, Form 4b
b)	Type of cooling		Natural air cooled
c)	One minute power frequency withstand voltage • Main circuit • Auxiliary circuit	 kV kV	 2.5 2.0
d)	Rated voltage	V	415 ±10%, 3 phase, 4 wire
2.0	**PCC/MCC**		
a)	Short circuit withstand current rating for switchgear fed from 2500 kVA transformer		65 kA (rms) for 1 sec & 137 kA (peak)
b)	Short circuit withstand current rating for all other switchgear		50 kA (rms) for 1 sec & 105 kA (peak)
c)	Degree of protection of switchgear with modules in service and all doors closed		IP-52

Sloe.	Description	Unit	Parameters
d)	Degree of protection for bus bar chambers (above1600 A)		IP-42
3.0	**AC Distribution Board**		
a)	Short circuit withstand current rating	kA	50 kA (rms) for 1 sec 105 kA (peak)
b)	Degree of protection		IP-52
4.0	**Air Circuit Breaker**		
a)	Type		ACB
b)	No. of poles		TPN/TP/4P
c)	Short circuit performance category		P2
d)	Rated operating duty		O-3min-CO-3min-CO
e)	Short time current for 1 sec. for 2500 kVA transformer	kA(rms)	65
f)	Rated short circuit breaking current for 2500 kVA transformer	kA(rms)	65
g)	Rated short circuit making current for 2500 kVA transformer	kA(peak)	137
h)	Short time current for 1 sec. for all other breakers	kA(rms)	50
i)	Rated short circuit breaking current for all other breakers	kA(rms)	50
j)	Rated short circuit making current for all other breakers	kA(peak)	105
k)	Control supply voltage • Closing coil, spring charging motor • Tripping coil	V	 220 V DC, (80-110%) 220 V DC, (70-110%)
4.0	**Moulded Case Circuit Breaker (MCCB)**		
a)	No. of poles		TPN/TP
b)	Short time current for 1 sec.	kA(rms)	50/65
c)	Rated short circuit breaking current	kA(rms)	50/65
d)	Rated short circuit making current	kA(peak)	105/137
e)	Overload release setting		Yes
f)	Short circuit release setting		Yes
g)	Undervoltage release		Yes
h)	Shunt trip		Yes
4.0	**Motor Protection Circuit Breaker (MPCB)**		
a)	No. of poles		TP
b)	Rated short circuit breaking current	kA(rms)	50/65
c)	Overload release setting		Yes
d)	Short circuit release setting		Yes

Sloe.	Description	Unit	Parameters
e)	Undervoltage release		Yes
f)	Shunt trip		Yes
5.0	**Bus Bar**		
a)	Temperature rise over design ambient of 50°C (i) Bus bars (ii) Silver plated joints		 40°C 55°C
b)	Short-time current for PCC with incomer from 2500 kVA transformer	kA	65 kA (rms) for 1 sec with 137 kA (peak) dynamic rating
c)	Short-time current for other PCC/MCC/DB	kA	50 kA (rms) for 1 sec with 105 kA (peak) dynamic rating
d)	Bus bar clearance in air (minimum) • Phase to phase • Phase to earth	 mm mm	 25 20

9.0.0 DRAWINGS & DOCUMENTS

The following drawings and documents shall be submitted for approval during detail engineering stage.

- Technical data sheet
- General arrangement and section drawing
- Single line diagram & Schematic wiring diagrams
- Sizing Calculation for busbar
- Short circuit withstand calculation for busbar (Thermal & dynamic)
- Component list & Bill of Quantities for all the boards
- Panel cutout details
- Foundation Plan & loading details
- Erection and commissioning procedures
- CT / VT sizing calculation
- Relay setting calculation
- Catalogues / drawings / leaflets for all items
- Operation and maintenance manual
- Test reports
- Sub-vendor list
- Manufacturing quality plan
- Field quality plan

ANNEXURE - B

MOTORS

SECTION–3.16: MOTORS

1.0.0 INTENT OF SPECIFICATION

This section covers the technical requirements of HT motors, LT Motors and DC motors.

2.0.0 CODES AND STANDARDS

The equipment to be furnished under this specification shall be in accordance with the applicable section of the latest edition (including amendments) of the following Indian Standards (IS), IEC publications and other codes except where modified and /or supplemented by this specification.

a)	IS: 325	Three phase induction motors
b)	IS: 12615	Energy efficient induction motors
c)	IS: 900	Code of practice for installation and maintenance of induction motors
d)	IS: 996	Single-phase AC induction motor for general purpose
e)	IS: 1231	Dimensions of three-phase foot-mounted induction motors
f)	IS: 2223	Dimensions of flange mounted AC induction motors
g)	IS: 4029	Guide for testing three-phase induction motors
h)	IS: 8789	Values of performance characteristics for three-phase induction motors
i)	IS: 13555	Guide for selection and application of 3-phase AC induction motors for different types of driven equipment
j)	IS: 5571	Guide for selection of electrical equipment for hazardous areas
k)	IS: 12065	Permissible limits of noise level for rotating electrical machines
l)	IS: 12075	Mechanical vibration of rotating electrical machines
m)	IS 60034-5	Degree of protection provided by Integral design of rotating electrical machines
n)	IS 60034-8	Terminal marking and direction of rotation
o)	IS 60079-1	Equipment protection by flame proof enclosure
p)	IS 60034-1	Rotating electrical machines.
q)	IS 60079	Explosive atmospheres
r)	IS/IEC 60529	Degrees of protection provided by enclosures (IP code)
s)	IEC 60034	Rotating electrical machines.
t)	IS 3177	Code of practice for Design, Manufacture, Erection and testing of Cranes and Hoists

3.0.0 TECHNICAL REQUIREMENTS

3.1.0 Design ambient temperature

Motors shall be suitable for an ambient temperature of 50 degree C and relative humidity of 95% and shall deliver the rated output without exceeding its guaranteed temperature limits.

3.2.0 Supply voltage

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

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

- Frequency variation : (+) 3% and (-) 5%
- Voltage variation for LT motors : (±) 10%
- Voltage variation for HT motors : (±) 6%
- Combined variation of voltage and frequency : 10% (absolute sum)

All the motors shall be so designed that maximum inrush currents, locked rotor torque and pullout torque developed at extreme voltage and frequency variations do not endanger the motor and the driven equipment.

3.3.0 System Parameters

Sl. No.	Description	11 kV and 6.6 kV System	LT System
1.	Voltage level	6.6 kV : Above 200 kW and upto 2000 kW 11 kV: Above 2000 kW	240 V : up to 0.2 kW 415 V: >0.2 kW and up to 200 kW.
2.	System earthing	Earthed through resistance, limiting earth fault current to 300 Amps	415 V system solidly grounded.
3.	Fault withstand rating of motor terminal box (Breaker operated)	50 kA for 0.2 sec for 11 kV and 31.5 kA for 0.2 sec for 6.6 kV	415 V system : 50/65 kA for 0.2 second

3.4.0 Type

AC Motors shall be squirrel cage induction type unless otherwise it is specified.

3.5.0 Duty

- All AC motors shall be squirrel cage three phase/single phase induction motors. All the motor shall be designed for bi-directional rotation.
- All the motors shall be rated for S1 duty for continuous operation. Motors of crane and hoist application shall be intermittent duty.
- DC motor shall generally be of shunt wound type rated for 220 V DC.
- Motors shall be suitable for installation in hot, humid and tropical atmosphere and polluted at places with coal ash and or fly ash.
- The motors shall be suitable for bus transfer schemes provided on the 11 kV/6.6 kV/415 V systems without any injurious effect on its life.

3.6.0 Design margin

Whenever the basis for motor rating are not specified in the corresponding mechanical specification section maximum continuous motor rating shall be atleast 10% above the maximum load derived of the driven equipment under entire operating range including voltage & frequency variation.

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

Service shall be considered as 1.0 only.

3.7.0 Method of Starting

- All the motors shall be suitable for direct on-line starting on full load. Where variable voltage and variable frequency (VVFD) operation is envisaged through VVFD drives, motors shall be specially designed for such application.
- LT motors rated up to 125 kW shall be controlled through MPCB/MCCB and contactor. LT motors rated more than 125 kW shall be controlled through air circuit breaker.
- HT Motors shall be controlled through vacuum circuit breaker.

3.8.0 Efficiency

All the duty motors shall be energy efficient type. For HT and LT motors, it shall be IE3 class as per IS 12615. For VFD controlled HT and LT motors, it shall be IE2 class as per IS 12615.

3.9.0 Temperature rise

- Winding Insulation shall be Class F.
- Temperature rise of air cooled motors shall not exceed 70°C over air temperature of 50°C by resistance method, while delivering its maximum rated output.
- Temperature rise of water cooled motors shall not exceed 80°C over inlet cooling water temperature by resistance method, while delivering its maximum rated output.

3.10.0 Starting voltage

a) Motors shall be capable of starting and accelerating the load at following starting voltage, with direct on-line starting, without exceeding specified winding temperatures.

- HT Motors (up to 1000 kW) : 85% of rated voltage
- HT Motors (> 1000 kW up to 4000 kW) : 80% of rated voltage
- HT Motors (> 4000 kW) : 75% of rated voltage
- LT motors : 80% of rated voltage

b) During fast changeover of power supply source, vector difference between the motor residual voltage and the incoming supply voltage shall be about 150% of the rated voltage and the motors shall withstand voltage stress and torque stress developed during that time, which may last for a period of one (1) second.

c) The motor shall be capable of operating at full load at a supply voltage of 75% of the rated voltage for 5 minutes.

3.11.0 No. of Starts

Continuous duty motors shall be suitable for the following starting requirements under the specified conditions of load, torque and inertia.

- No. of consecutive hot starts shall be 2 (with initial temperature of the motor at full load operating level).
- No. of consecutive cold starts shall be 3 (with initial temperature of the motor at ambient temperature).
- For conveyor motors, no. of consecutive hot starts shall be 3 (with initial temperature of the motor at full load operating level).

3.12.0 Starting current

- Locked rotor current of HT motors for applications other than listed below shall be limited to 600% of the full load current, and is subject to IS tolerance.
- For energy efficient LT motors, locked rotor current shall be as per IS: 12615.
- Locked rotor current of the VFD controlled AC motors shall be limited to 300% of the full load current, and is subject to IS tolerance.
- Locked rotor current of the BFP motors shall be limited to 450% of the full load current of the motor, and is subject to IS tolerance.

3.13.0 Locked rotor withstand time

- The locked rotor withstand time for HT motors under hot conditions at 110% rated voltage shall be more than the starting time at minimum permissible voltage specified above by atleast three seconds or 15% of the accelerating time whichever is greater. Provision of speed switch shall be avoided to the extent possible. In case the speed switch is required, it shall be indicated by the bidder in his offer
- For the LT motors having starting time up to 20 seconds at minimum permissible voltage, the locked rotor withstand time under hot condition at highest voltage limit shall be at least 2.5 seconds more than the starting time.
- For the motors having starting time more than 20 seconds and up to 45 seconds at minimum permissible voltage, the locked rotor withstand time under hot condition at highest voltage limit shall be at least 5 seconds more than the starting time.
- For motors having starting time more than 45 seconds at minimum permissible voltage, the locked rotor withstand time under hot condition at highest voltage limit shall be more than starting time by at least 10% of the starting time.
- Speed switches mounted on the motor shaft shall be provided in cases where above requirements are not met.
- When a speed switch is mounted on the motor shaft, the same shall remain closed for speeds lower than 20% and open for speeds above 20% of the rated speed. The speed switch shall be capable of withstanding 120% over speed in either direction of rotation.

3.14.0 Torque Requirements

- Accelerating torque at any speed with the lowest permissible starting voltage shall be at least 10% motor full load torque.
- Pull out torque at rated voltage shall not be less than 205% of full load torque.
- Motors subjected to reverse rotation shall be designed to withstand the stresses encountered when starting with non-energized shaft rotating at 125% of rated speed in reverse direction.

3.15.0 Enclosure

a) Motors shall have IP 55 degree of protection.

b) For hazardous location, the enclosure of motors shall following have flame proof construction conforming to applicable standard.
   - Fuel oil area Group – IIB
   - Hydrogen generation plant area : Group – IIC)

3.16.0 Cooling

- LT motors shall be totally enclosed fan cooled (TEFC), type IC411. The cooling shall be effected by self-driven bi-directional centrifugal fan protected by fan cover.
- HT motors can be totally enclosed fan cooled (TEFC) or totally enclosed tube ventilated (TETV) or closed air circuit air cooled (CACA-IC6A1A1) type.
- Motors rated >3000 kW can be closed air circuit water cooled (CACW).
- Motors with CACA/CACW heat exchangers shall have dial type thermometer with adjustable alarm contacts to indicate the following:

  -Hot and cold air temperatures of the closed air circuit for CACA motors.

  -Hot and cold, air and water temperatures for CACW motors.
- The Alarm switch contact rating shall be minimum 0.5 A at 220 V DC and 10 A at 230 V AC.

3.17.0 Winding

- Winding shall be class F insulation with temperature limited to class B. Insulation shall be Non-hygroscopic, oil resistant, and flame resistant. Winding, fittings and hardware shall be corrosion resistant. Winding shall be tropicalized and suitably varnished, baked and treated for operating satisfactorily in humid and corrosive atmosphere.
- For the VFD operated drives, insulation shall be designed to take care of stresses due to high DV/DT. Motors shall be wound with dual coated winding wires and impregnated with VPI process. Further for such application, insulated bearings shall be provided to avoid circulating current caused by shaft induced voltages.
- Space heaters rated for 240 V AC, 50 Hz supply shall be provided for motors rated 30 kW and above to maintain windings in dry condition when motor is standstill.
- For HT motors, insulation shall be Vacuum Impregnated (VPI).
- HT motors shall withstand one minute power frequency voltage test or 1.2/50 micro sec lightning impulse Voltage wave of 4U+5 kV (U=Line voltage in kV) test on main insulation as per IEC 600034-15. The coil inter-turn insulation shall withstand steep front impulse withstand voltage as per IEC 600034-15.
- For HT motors, 12 nos. simplex or 6 nos. duplex RTDs (two per phase), each having D.C. resistance of 100 ohms at 0℃, embedded in the stator winding at locations where highest temperatures may be expected, shall be provided. The material of the ETD's shall be platinum.

3.18.0 Bearings

- Motor shall be provided with antifriction bearings, unless sleeve bearings are required by the motor application. Bearings shall be provided with seals to prevent leakage of lubricant or entrance of foreign matters like dirt, water etc. into the bearing area.
- Sleeve bearings shall be split type, ring oiled with permanently aligned, close running shaft sleeves. Grease lubricated bearings shall be pre-lubricated and shall have provisions for in-service positive lubrication with grease nipple and relief holes. For sleeve bearings, the bearing housing shall be preferably in end shield itself.
- Vertical shaft motors shall be provided with thrust and guide bearings. Thrust bearing of tilting pad type is preferred. However, if anti-friction bearings can take vertical thrust, thrust and guide bearings are not required.

- Lubricant shall not deteriorate under all service conditions. The lubricants shall be limited to normally available types. For motors rated 30 kW and above re-lubrication facility shall be provided.
- For motor with forced lubrication, a shaft driven oil pump shall be provided along with an electrical auxiliary pump. Alternatively, two motor driven pumps may be provided, one working and one standby. All necessary auxiliaries and accessories shall be provided to complete the system. A pressure gauge and pressure switch for low oil pressure warning and to start the standby oil pump automatically shall also be provided. A motor driven jacking oil pump may be provided, for heavy shaft loads.
- Flow switches shall be provided for monitoring oil flow of forced lubrication bearings, if used. Alarm switch contact rating shall be minimum 0.5 A at 220 V DC and 10 A at 230 V AC.
- For bearing temperature measurement, duplex RTDs shall be provided for each bearing and shall be wired up to the terminal box.
- Each bearing shall be provided with dial type thermometer.
- For all VFD operated motors shall have insulated bearings to prevent flow of shaft currents.
- For motors rated above 1000 KW having shaft length more than 1.5 M shall have insulated bearings to prevent flow of shaft currents.
- All the motors rated <15 kW shall be provided with sealed ZZ bearings.
- Lub oil pressure transmitters shall be provided to DCS for remote monitoring. Lub oil pressure very low trip to HT equipment shall be 2 out of 3 logic.

3.19.0 Terminal Boxes

- Separate terminal boxes of IP 55 degree of protection shall be provided for stator leads. For single core cables, gland plate shall be non-magnetic material. Terminal box of HT motors shall be capable of being turned 360° in steps of 180°. Terminal box of LT motors shall be capable of being turned 360° in steps of 90°. The terminal boxes shall be split type with removable cover with access to connections.
- Terminals for motors shall be stud type, thoroughly insulated from the frame. The terminals shall be clearly identified by phase markings, with corresponding direction of rotation marked on the non-driving end of the motor.
- The terminal box shall be capable of withstanding maximum system fault current for 0.2 sec for all breaker operated motors and shall be provided with explosion vent.
- For contactor operated LT motors, the terminal box shall be capable of withstanding the fault current for 0.2 sec minimum and operating time of MPCB/MCCB.
- Removable gland plates of thickness not less than 2.5 mm sheet steel or 3 mm aluminium (for single core cables) shall be provided for cable boxes.
- Cable spreader box shall be provided for larger cable sizes.
- Cable boxes of HT motors shall be phase segregated type. The terminals of three phases shall be segregated by barriers of metal or fiber glass. For HT motors, cable box design shall be suitable for accommodating cable termination kits.
- Separate terminal box for space heaters shall be provided.
- A separate terminal box of IP 55 degree of protection shall be provided for temperature detectors.
- Motors rated >1000 kW shall be provided with neutral current transformers of PS class on each phase for differential protection in neutral side terminal box. The three phases shall be connected to form the star point after passing through the CTs. The CT details shall be

finalized during detail engineering. Neutral terminal box shall have IP 55 degree of protection.

- The secondary leads of CT shall be wired to separate auxiliary terminal box of IP 55 degree of protection
- All the accessory terminal boxes shall be located on the same side of the main (power) terminal box.
- For LT motors, terminal box shall be located on top, unless otherwise specified.

3.20.0 Earthing Terminals

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

3.21.0 Noise and Vibration

- Motors shall be selected with low noise levels in accordance with IS 12065.
- The peak amplitude of the vibration shall also be within the specified limits of IS: 12075.
- All HT motors shall be provided with vibration pads for mounting vibration detectors.

3.22.0 Name Plates

Motor shall have stainless steel nameplate(s) showing diagram of connections, all particulars as per IS: 325 / IS: 12615 and shall also have 'BEE' marking.

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

- Temperature rise in ºC under rated condition and method of measurement.
- Degree of protection.
- Bearing identification no. and recommended lubricant.
- Location of insulated bearings.

3.23.0 Canopy

Canopy shall be provided for all the motors located outdoor. For details, please refer Civil section.

4.0.0 DC MOTORS

DC motors shall be provided where specified/required. DC Motors shall be sized for operation with fixed resistance starting for reliability. DC motors shall be shunt wound type. Motors shall be capable of delivering the rated output at 220 V DC with (+) 10% and (-) 15% variations without exceeding its guaranteed temperature limits. 220 V DC system shall be unearthed. Starting current of the DC motors shall be limited to 200% of the full load current of the motor, and is subject to IS tolerance. DC Motors shall be similar to AC Motors with respect to other features like enclosure type, cooling and class of insulation.

5.0.0 INSTALLATION

Installation shall be carried out as per IS: 900.

6.0.0 PAINTING

Painting shall be carried out by an approved process. Pretreatment shall conform to applicable standard. The equipment shall be subject to a coat of red oxide primer paint. All inside and

outside surface shall be painted with epoxy based paint. The final thickness of paint film on steel shall not be less than 100 microns. Finish shade shall be 631 of IS: 5 (smoke grey).

7.0.0 TESTING AND INSPECTION

7.1.0 Equipment offered shall be of type tested and proven type. Type test certificates for test conducted earlier on similar rating shall be furnished for the motors rated 30 kW and above.

7.2.0 The following type tests shall be conducted on LT motors.

- Measurement of resistance of windings of stator and wound rotor.
- No load test at rated voltage to determine input current power and speed
- Full load test to determine efficiency power factor and slip.
- Temperature rise test.
- Momentary excess torque test.
- High voltage test.
- Test for vibration severity of motor.
- Test for noise levels of motor
- Test for degree of protection
- Over speed test.

7.3.0 The following additional type tests shall be conducted on HT motors.

- No load saturation and loss curves up to approximately 115% of rated voltage
- Measurement of noise at no load.
- Momentary excess torque test
- Full load test
- Temperature rise test at rated conditions.
- Lightning Impulse withstand test on the sample coil shall be as per IEC-60034, part-15
- Surge-withstand test on interturn insulation shall be as per clause no. 5.1.2 of IEC 60034, part-15
- Degree of protection test for the enclosure followed by IR, HV and no load run test.
- Terminal box-fault level withstand test for each type of terminal box.

7.4.0 The following routine tests shall be carried out for the motors as per applicable standards.

- IR of Winding before and after HV tests
- HV test on main winding space heater, RTD, BTD
- Resistance measurement
- No load run test Major Electrical
- Phase sequence and direction of rotation
- Vibration check Major Electrical
- Reduced voltage running test
- Locked rotor test at reduced voltage
- Record of RTD & BTD resistance at the end of no load test
- Test on space heater & RTD
- Visual Control of terminal box and verification of construction with respect to short tested terminal box

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

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

8.0.0 DRAWINGS & DOCUMENTS

The following drawings and documents shall be submitted for approval during detail engineering stage.

- Motor sizing calculation
- Technical particulars
- General arrangement drawings
- Performance curves (Efficiency, power factor, starting current)
- Characteristic curves (Speed torque, Hot/cold with stand time, Negative sequence current)
- Terminal box details
- Test reports
- Sub-vendor list
- Manufacturing quality plan
- Field quality plan

ANNEXURE - C

CONTROL & INSTRUMENTATION WORKS

VOLUME II

SUB-SECTION 4.12

FIELD INSTRUMENTS SPECIFICATION

1.0.0 TECHNICAL REQUIREMENT FOR INSTRUMENTATION

1.1.0 Field Instruments

a) Analog outputs signals from field instrumentation to the control systems are 4-20 Ma DC signals. Instrumentation can be self-powered, or loop powered from the control systems. Self-powered analog signals shall be true “isolated from ground” signals.

b) Field switches will be micro switch type with auto reset. Switches will have NO and NC contacts. Switch contacts shall be snap acting, 2 Nos of SPDT, hermetically sealed, potential-free with a minimum contact rating of 230 V AC 5A/ 24V DC 1A.

c) Transmitters will be used to provide the required 4 to 20Ma signals for all controllers and receivers. Transmitters will be of the electronic, two-wire type, capable of driving an output impedance of 600 ohms minimum at 24 V dc, and will be generally powered from the control system I/O cards. All the transmitters supplied shall be SMART type with HART capability.All the transmitter shall be provided with 5 digit local indicators

d) SMART transmitters’ calibration shall be carried out through a PC based system to be located in the computer room.

e) Pressure and differential pressure transmitters accuracy shall be within + 0.04% or better of FSR for BTG package, + 0.065% or better of FSR for BOP packages and + 0.2% for remote seal type transmitter. Repeatability shall be +0.05% of span or better. Errors caused by change in ambient temperature shall not exceed 0.01% of span per ℃ change. Stability 0.15% for five years.

f) The plant instrument air supply pressure shall be:

1. Maximum supply pressure 7 kg/cm^2
2.Minimum supply pressure 4.5 kg/cm^2

g) All instruments and analyzers shall employ EMI,RF protection in the system design**.**

h) Instrument tags should be permanently attached to the device. If this is not possible, the instrument tag should be fastened to the instrument with stainless steel wire.

i) Speed switches and the actual device should drive transducers, if possible.

j) All instrumentation mounted inside, away from direct exposure to the elements, shall be as a minimum IP-44 construction unless it is in an environmentally controlled environment (e.g the control room). If the instrument is mounted in an environmentally controlled environment the instrument shall be as a minimum IP-32 construction.

k) All instrumentation mounted outside shall be as a minimum IP-65 construction**.** IBR certification shall be provided for instruments / valve / Erection hardware wherever applicable.

l) Vibration switch (alarm, trip) and oil level switch to be provided for the cooling towers.

m) Transmitters and switches shall be grouped depending on the location. Individual instruments shall be mounted on stanchion or pipe mounted.

n) For saline applications and other applications which are corrosive in nature, the wetted part material to be selected which shall meet the process applications, preferably diaphragm seal to be used. Haste alloy C wetted part material and SS316L impulse piping / root valve material to be considered for the above applications.

o) All field instruments junctions boxes & local panels located in hazardous area shall be explosion proof as per the relevant applicable standards.

p) Reverse rotation switches to be provided for High Pressure Boiler Feed pumps, Main condenser cooling Water pumps, Condensate extraction pumps and sea water intake pumps

q) The following metric engineering units shall be used for all instrumentation devices :

1. Pressure – kg/cm^2g
2. Temperature - ℃
3. Steam flow – kg/hr / T/hr
4. Liquid flow – m^3/hr (Feed Water flow (in kg/hr or T/hr)
5. Distance – meters (m) or millimeters (mm)
6. Differential pressure – mmH20

r) For speed varying pumps/fans, speed measurement in 4 – 20 mA shall be connected to DCS.

s) Required Water analyzers for ACW pump discharge header mainly FRC (Free residual chlorine) analyzers shall be considered at CW /ACW common header return line.

t) Wireless transmitters :
For CW sump level, Raw water reservoir level, Turbine oil tank, coal bunkers, Ash Silo, LDO/HFO tank, DM water tanks, CS tank, Acid and alkali applications, only non contact type level transmitters like Ultrasonic or Radar based shall be provided by the bidders as per the specification and as approved by owner.

Considering the type of application, wireless technology to bring signals to DDCMIS may be adopted by interfacing with OPC gateway to avoid cabling from smart level transmitters as specified above. And for other applications, if any shall be decided during Detailed Engineering. However Wireless technology as adopted by Bidder shall be reliable and field proven in power plants and same shall be approved by Owner.

1.1.1 Pressure Instrumentation

a) Pressure transmitters are electronic, analog 2-wire transmitters with isolated 4-20Ma DC output signals.

b) Pressure transmitters will be supplied with integral mounted two valve manifolds.

c) All pressure transmitters shall be capable of withstanding their body rating conditions without permanent damage or loss of calibration.

d) Differential pressure transmitters of the capacitance type, regardless of the applied service, shall be capable of withstanding a differential pressure equal to full process

pressure on either side of the measurement element without damage or loss of calibration.

e) Differential pressure transmitters will be supplied with integral mounted three valve manifolds for air service and 5 way valve manifold for steam & water service. For pressure and differential pressure transmitters, overall Accuracy: + 0.04% or better of FSR for BTG package & + 0.065% or better of FSR for BOP packages. Accuracy shall be + 0.2% for remote seal type transmitter.

f) Pressure gauges will be generally 150mm dial, solid front safety case type with blowout back, ½" NPT bottom connection, drawn stainless steel case, 316SS bourdon and socket, stainless steel movement, micrometer pointer. Pulsation dampers will be provided for pulsating pressure services. Liquid filled gauges shall be used for all pump discharges, vibrating or pulsating services. Pigtail ressu shall be used for the steam service where gauges are mounted close to the tap.

g) Pressure switches will generally be snap acting type, DPDT action, with individual "on" and "off" points to be on a calibrated scale or dial. Pressure switches will have amphoral connection. Repeatability shall be +/- 0.5% or better. Pressure sensor shall be 316 SS with over range protection. Die cast aluminum with stored enamel black finish and epoxy coating for corrosive atmosphere.

h) Dual type control switches such as pressure switches having two sets of contacts with independently adjustable set points shall not be used where set point adjustment and deadband are a problem (e.g. low pressure and vacuum applications). If a potential problem exists, two single purpose switches shall be used. Switch differential shall be adjustable.

i) The indicating type switches are not acceptable. If application requires indication and switching function, then a separate blind switch and a gauge to be used.

j) All the switches are internally connected and brought to the surface with Amphenol male/female connection. Cabling need not be terminated inside the switch. Cable ends are to be soldered in connector and to be inserted for easy maintenance.

k) Condensate pots for pressure transmitters and siphons for gauges shall be used for steam and high temperature applications. Chemical seals to be used for highly corrosive and viscosity applications

l) The switches shall have the following:.

Contact rating	:	230V AC, 5A / 24V DC 1A.
Repeatability	:	±0.5% FSR

m) Turn down ratio to be 100:1

n) Response time for pressure and differential pressure transmitter shall be 100 ms.

o) Protection for gauges fitted in the vibration lines/equipments shall be provided

1.1.2 Temperature Instrumentation

a) For temperature up to 300℃ 3-wire RTD duplex type, PT 100 type shall be used. For temperature beyond 300℃ thermocouples shall be used. Thermocouples shall be manufactured in accordance with the ISA Standard MC96.1, Temperature Measurement Thermocouples. All thermocouples shall be Chromel Alumel (Type K) for 300℃$\leq$ T < 850℃. R or S type for T> 850℃.

b) The Mv signal of thermocouple shall be used as input to the DCS. Cold junction compensation shall be achieved in the DCS

c) Thermocouples shall have duplex elements and ungrounded measuring junction.

d) An extension nipple / union / nipple of sufficient length to extend beyond lagging and connection head shall be furnished for each thermocouple assembly. Terminal blocks shall be marked with polarity and connectors shall be resistant to heat, vibration and galling. The cap shall provide a weather tight enclosure and a chain shall be provided to prevent loss of cap. The cap shall be made of cast aluminium.

e) RTDs of Duplex type furnished by the Supplier shall be of the three-wire type made with 100 ohm platinum resistance elements. They shall be certified to meet the requirements of the International Temperature Scale, calibrated to the IEC-751 standard (Alpha = 0.00385 Ohms/Ohm/℃).The RTDs shall be contained in an insulated material and a sheath or sleeve of stainless steel SS-316 and shall be so mounted that they can withstand the greatest shocks and vibrations that can be imposed upon them in the system piping without deterioration. Specific information shall be furnished concerning type and accuracy of bridge circuits to be used with the RTDs. RTDs shall be directly connected to DCS without any transmitters

f) Unless specified otherwise, each temperature element and thermometer shall be provided with a 1" socket weld type, 316 stainless steel tapered thermowell suitable for the requirements of the given application. Temperature element process connection shall be ½ NPTM.

g) Temperature transmitters of SMART type are to be provided for all temperature measurements that are used in any CLCS. For thermocouple, cold junction compensation shall be implemented within the transmitter.

h) Thermocouples will be of duplex MI type in ISA, K(chromel-Alumel), Platinum-Rhodium/Platinum with sheath OD 6 mm. RTD will be Duplex, Pt 100 ohm, 3 wire type as per DIN standard 43760 or equivalent. Thermo wells will be ASME PTC 19.3 latest revision with process connection M 33x2 for threaded connection and flanged connection for Air and Gas system & tanks.

i) Thermowell immersion length will generally be between 1/3 and ½ the distance to the center of the pipe. Where thermo wells are installed in lines smaller than 4 inches, the piping shall be expanded to 4 inch size to accommodate the thermo well. Thermowell shall be drilled from solid bar stock.

j) All thermo well in a high velocity line or duct shall have an ASME PTC 19.3 calculation for determination of the wells resonant frequency. Thermo wells that do not meet the acceptance criteria shall be resized or relocated as necessary.

k) Thermocouple extension wire is to be solid, shielded, twisted pairs.

l) If intermediate terminal blocks are required in a thermocouple measuring circuit, they need not be the same material as the thermocouple.

m) Dial thermometers shall be bimetallic, minimum 150mm dial, every angle form, hermetically sealed with external recalibration adjustment, ¼" OD SS stem, ½" NPT connection and SS case.

n) Temperature switches shall be actuated by filled bulb-type elements equipped with standard-length armored capillary tubing. All the switches are internally connected and brought to the surface with Amphenol male/female connection.

o) Temperature gauges shall have ±1% accuracy and overage protection of 125%.

p) Switches shall have the following:

Max. contact rating	:	230V AC, 5A
Repeatability	:	±0.5% FSR
Contact type	:	snap acting

Over all accuracy 0.1% of calibrated span

q) Protection for gauges fitted in the vibration lines/equipments shall be provided

r) For measurement of pulverizer outlet temperature, tungsten carbide block thermowell aborium resistant shall be used instead of tungsten carbide coated thermowell. And for sea water titanium sleeve thermowell or better shall be used

s) Switch differential shall be adjustable. Fan DE/NDE, motor DE/NDE temperature are to be fitted with capillary type dial thermometers with standard length.

1.1.3 Flow Instrumentation

a) Flow nozzles will be used for main steam flow, feed-water flow and other critical measurements where weld-in construction is required. Orifice plates will be used for other liquid flow measurements where flanged construction is acceptable. Accuracy of the measuring orifice plates, nozzles and annubar shall be minimum +-1%. Ultrasonic type flow meter shall be used for cooling water flow application with an accuracy of minimum +-0.4% of measured flow or better and haste alloy C wetted part material to be used if insertion type is provided.

b) Flow elements will be accompanied by IBR certification.

c) Flow nozzles and orifice plates shall conform to requirements of ASME “Fluid Meters”.

d) Flow nozzles shall be of the weld-in holding ring type ASME long radius, with dual wall taps and shall be of stainless steel. Flow nozzles shall be furnished complete with metered runs in accordance with ASME PTC 6.1. Metered pipe run and nozzle shall match the pipe material and size that metered section is to be installed in.

e) Orifice plates shall be 316SS, sharp square edge thin plate, and paddle type suitable for installation between raised face orifice flanges. Orifice flanges, gaskets and jacketing screws shall be furnished by the Supplier. Paddle shall be stamped with the orifice ID bore diameter on the upstream side. Orifice flanges will be of the raised face, weld-neck type with dual 2 sets of taps as required for redundancy.

f) Beta ratios shall be between 0.3 and 0.7. Flow elements (flow nozzle & orifice) sizing shall as per BS-1042/ISO-5167.

g) Differential type flow transmitters shall be supplied with three valve manifolds directly mounted to the transmitter for gas applications and five valve manifolds directly mounted to the transmitter for steam and liquid applications

h) Differential type flow transmitters shall be electronic, analog 2-wire transmitters with isolated 4-20 Ma dc output signals.

i) Square root extraction of the flow signal is performed in the DCS.

j) The flow sight glass shall be of rotary type with tempered glass, carbon steel body and bronze wetted parts.

k) Variable area flow indicators to be provided at the common outlet header of the identical equipment, CW blow-down etc. Carbon steel body with SS 316 float and scale shall be provided. Accuracy shall be minimum +-1%.

l) Flow switches to be provided at the common outlet header of the identical equipment. Carbon steel body with SS 316 element and contacts shall be provided.

m) Algebric summation of steam flow and water flow shall be mass balanced for calculating the system efficiency by providing necessary required flow transmitters and process lines

n) Accuracy for mass flow shall be 0.15% of measured value for liquid.

o) Accuracy for Vortex flow meter and turbine flow meter shall be 0.5% of full scale range.

1.1.4 Level Instrumentation

a) Differential pressure type level transmitters are electronic, analog 2-wire transmitters with isolated 4-20 Ma dc output signals. Radar and ultrasonic level transmitters will be 24V DC powered, with isolated 4-20 Ma dc output signals powered from the transmitters.

b) Constant head chambers shall be furnished for all differential pressure-type level transmitters used with ressurized vessels. Reservoir piping connections shall be ½ inch outlet and a ½ inch inlet socket-welded type suitable for the pressure and temperature encountered.

c) Transparent gauge glasses will be used for low-pressure applications. Transparent or reflex gauges will be used for high-pressure applications. All gauge glasses will be equipped with gauge valves, including a safety ball check.

d) Level switches shall generally be cage float / Displacer type, rated for ANSI B31.1 requirements.

e) Non contact type level measurement shall be provided for CW sumps and for CW make-up applications.

f) Electronic level indicator of discrete type based on electric conductivity of water and steam with 50mm gap between successive electrodes in the measuring range shall be provided in addition to level transmitter. The **vessel** holding electrodes **shall be IBR certified**.

1.1.5 Control Valves

a) Control Valves are defined as Pneumatic operated modulating valves.

b) Control valves for regulating service will be pneumatically operated and provided with characterized plugs. In general, equal percentage characteristics will be provided for throttling service; linear characteristics for pressure reducing applications and quick opening characteristics for On/Off service.

c) Control valves will be designed to prevent cavitation, flashing on the downstream side of valve or piping. For cavitation /flashing services, valves with anti-cavitation trims will be provided. Hardened trim material shall be provided for control valves subjected to DP > 7 Kg/cm2 and for flashing applications 17 – 4 PH material is recommended.

d) The control valves will be of straight through globe body double port balanced type or of Angle body except for large cooling water lines.

e) Instrument air shutoff valve shall be provided on each control valve assembly.

f) The following end connections shall be used when weld type connections are specified in the piping line specification :

g) Socket weld end connections : 2 inch and under control valve bodies.

h) Butt weld end connection : 2-1/2 inch and over control valve bodies.

i) Valve bodies shall be Globe, single – port unless otherwise required and shall be not more than two nominal sizes smaller than the line in which they are installed.

j) Valve body material shall be as specified in the piping line specifications.

k) All integrally mounted instrumentation (controllers, positioners, regulators, etc.) to be designed for a maximum instrument air supply pressure of 7kg/cm^{2}g. Minimum instrument air supply pressure is 4.5kg/cm^{2}g. Separate air filter regulators with inlet and outlet gauges shall be provided for each control valve.

l) SMART positioners with HART compatibility shall be provided for all the control valves.

m) Necessary diagnostics software along with SMART positoners shall be provided.

n) Color of the control valve shall be indentified based on the fail safe position of the valve.

o) All the control valve shall be provided with block and bypass valves. The bypass valves shall be automatic inching valve for critical applications only.

p) It is the intent that the valves shall fail either open or closed or fail lock in the event of failure of air signal or electric signal from any valve component (controller or positioner), as well as failure of the main control air supply or voltage to the solenoid.

q) Position transmitters of non-contact, 2-wire 4-20Ma DC type shall be provided for modulating control valves. Also in general limit switches shall be provided for control valves wherever applicable.

r) Pilot solenoid valves for on-off service control valves are to be designed for 24 Vdc with a minimum orifice size of ¼ inch. Limit switches (open and close) to be provided for all on-off valves.

s) Instrument tubing is to be stainless steel, in accordance with the tubing line specifications. Minimum tubing size is ¼ inch, SS-316.

t) Control valve limit switches to be designed to operate at 24 VDC.

u) The control valves shall generally have the max. flow handling capacity of 120% and the limit of valve travel shall generally be between 10% and 80%. The trim characteristics shall be so selected that the control valve is operated in the controlled flow range of 20 – 75 %.

v) The following shall be specified for control valves.

Max. noise – 85 Dba from 1m. distance from the equipment.

The max. permissible outlet velocity shall be as per ISA-S75.01 based on service (liquid, steam or flashing services). The control valve sizing shall be as per ANSI / ISA: S75.01.

Leakage class will be class V as per ANSI FCI 70.2 or better.

For fuel gas applications the valve leakage class shall be minimum class VI.

1.1.6 PH Measurement

a) Micro processor based system supporting HART Protocol with system accuracy of +/- 0.02 Ph, auto span and zero calibration, manual zero and span calibration, integral indicator, automatic ultrasonic cleaner, iso-potential adjustment having flow type cells.

b) Output shall be isolated 4-20 Ma DC linear signal. Accessories shall include preamplifier, screened junction box for electrode.

c) The Ph shall have built-in reference chambers.

d) Stability: ± 0.02% pH per week

e) Repeatability: ± 0.02% pH

f) Self diagnostics feature shall be available.

g) For Ph measurement, reference calomel / silver, silver-chloride electrode shall be of rugged and sealed construction moulded in glass coupled polypropylene. Electrical connection shall be made directly on to the outer end of the element ensuring better electrical performance of the electrode.

h) Annunciation contacts from the electronic module shall be high and low, 2 SPDT, snap action micro switch, ratios of 5A 240V AC, 0.2 A, 220V DC.

Wherever, variations in sample temperature may occur, automatic temperature compensation device shall be provided.

1.1.7 Conductivity Measurement

a) Micro-processor based system supporting HART protocol with an accuracy of +/-0.25%, auto zero and span calibration, integral indicator having flow line (screwed) type cell. Housing for cell and analyzer shall be weather and water proof. Output shall be isolated 4-20 Ma DC linear signal.

b) The conductivity sensors shall have built-in reference chambers.

c) The conductivity cell shall in general be of flow through type or insertion type depending upon the area of application.

d) Conductivity transmitter shall have local indication and provision for automatic temperature compensation up to 100 deg. C.

e) Condenser cooling water conductivity to be remotely monitored for the blow-down purpose.

f) Stability: ± 1% of full scale per month non cumulative

g) Repeatability: ± 0.3% of span.

h) Conductivity comparator with dual cell input and 4 – 20 mA DC isolated with HART outputs for required parameters. Self diagnostics feature shall be available

1.1.8 Silica Measurement

a) Micro-processor based system with an accuracy of +/-1% of span or 2ppb whichever is minimum, response time better than 10 min for 90% change, six numbers of sample streams having features like auto zero & span calibration with manual provision also, ambient temperature compensation and integral indicator.

b) Self diagnostic features shall include alarm for no reagent, calibration fault and silica concentration low/high. Analyzer housing shall be weather and water proof. Output shall be isolated 4-20 Ma DC linear signal.

c) 3 channel instrument is preferred.Auto sampling facility with necessary valves & solenoids in the sample lines shall be provided
d) All chemical reagents for twelve months of operation of analyser shall be supplied with addition to commissioning requirement.
e) One cycle time shall be maximum of twelve minutes.

Liquid handling unit comprising of valves, manifolds, tanks (if required), power supply unit, pressure reducer etc.

1.1.9 DO_2 (Dissolved Oxygen) Measurement

a) The dissolved oxygen analyzer shall be of continuous flow through solid State/micro-processor based system based on electro-chemical type with an accuracy of +/-1% of span or 1ppb whichever is minimum, response time better than 15s for 90% change, ambient temperature compensation and integral indicator.

b) Self diagnostic features shall include alarm for transmitter fault, no reagent, calibration fault, high cell current as a minimum. Analyzer housing shall be weather and water proof. Output shall be isolated 4-20 Ma DC linear signal.

c) Annunciation contacts from the electronic module shall be high and low, 2 SPDT, snap action micro switch, ratios of 5A 240V AC, 0.2 A, 220V DC.

The field mounted cabinets for DO2 analyzer system shall have the following:

a) Auto zeroing and calibration facility

b) Manual overriding

c) Liquid handling unit comprising of valves, manifolds, thermometers, power supply unit, pressure reducer etc.

1.1.10 Phosphate Measurement

a) Micro-processor based system with an accuracy of +/-4% of span or 2ppb whichever is minimum, response time better than 3 min for 90% change, six numbers of sample streams having features like auto zero & span calibration with manual provision also, ambient temperature compensation and integral indicator.

b) Self diagnostic features shall include alarm for no reagent, calibration fault and silica concentration low/high. Analyzer housing shall be weather and water proof. Output shall be isolated 4-20 Ma DC linear signal.

c) All chemical reagents for twelve months of operation of analyser shall be supplied with addition to commissioning requirement.

Liquid handling unit comprising of valves, manifolds, tanks (if required), power supply unit, pressure reducer etc

1.1.11 Hydrazine Measurement

a) The hydrazine analyzer shall work on amperometric method through Micro-processor based system with an accuracy of +/-4% of span or better, response time better than 120 sec for 90% change, ambient temperature compensation and integral indicator.

b) Self diagnostic features shall include alarm for transmitter fault, no reagent, calibration fault as a minimum. Analyzer housing shall be weather and water proof. Output shall be isolated 4-20 Ma DC linear signal.
c) All chemical reagents for twelve months of operation of analyser shall be supplied with addition to commissioning requirement

The field mounted cabinets for hydrazine analyzer system shall have the following:

a) Auto zeroing and calibration facility

b) Manual overriding

c) Liquid handling unit **c**omprising of valves, manifolds, thermometers, power supply unit, pressure reducer etc.

1.1.12 Sodium Measurement

a) The sodium analyzer shall work on potentio-metric method through Micro-processor based system with an accuracy of +/-5% of span or better, response time better than 120 sec, ambient temperature compensation and integral indicator.

b) Self diagnostic features shall include alarm for transmitter fault, no reagent, calibration fault as a minimum. Analyzer housing shall be weather and water proof. Output shall be isolated 4-20 Ma DC linear signal.
c) All chemical reagents for twelve months of operation of analyser shall be supplied with addition to commissioning requirement

The field mounted cabinets for sodium analyzer system shall have the following:

a) Auto zeroing and calibration facility

b) Manual overriding

c) Liquid handling unit comprising of valves, manifolds, thermometers, power supply unit, pressure reducer etc.

1.1.13 Chlorine Analyzer

The chlorine analyzer shall be Micro processor based and the analyser shall be continuous flow through type with accuracy of minimum +/-1% of span with automatic temperature compensation.

Self diagnostic features shall include alarm for transmitter fault, no reagent, calibration fault as a minimum. Analyzer housing shall be weather and water proof. Output shall be isolated 4-20 Ma DC linear signal.
The field mounted cabinets for Chlorine analyzer system shall have the following:

a) Auto zeroing and calibration facility

b) Manual overriding

c) Liquid handling unit comprising of valves, manifolds, thermometers, power supply unit, pressure reducer etc.

1.1.14 Turbidity Analyzer

Turbidity analyzers shall be continuous type with accuracy of ±2% of reading or ±0.2 NTU whichever is better, response time of 2 sec of full scale. Operating principle shall be alternating light source and self cleaing facility shall be available.

The analyzer shall also include features such as auto temperature compensation, auto calibration, zero check and self cleaning system for electrode. The analyzer shall be provided with integral indicator. Housing for analyzer shall be waterproof with IP65 protection. Output shall be isolated 4-20 mA DC linear signal.Fault diagnosis data shall include faults in analog/digital circuits, contamination detection on optical window, failure of cleaning system, calibration fault and power supply failure.

1.1.15 H_2 Gas Analyser (Microprocessor based):

H_2 Gas analysers shall be provided with the following features

Type	:	Conductivity type or multimode oscillation type
Case Purity shall	:	0 to 100% H2 in Air.
Purge	:	0 to 100% H2 in CO2
		0 to 100% air in CO2
Hydrozen Flow rate	:	100 to 700 CC/min.
Output Signal	:	4-20 m Amp.
Display	:	Digital with Gas Purity in real time.
Power Supply	:	(90-250) V, 50 Hz, 1 Phase
Sample gas flow control	:	Required
Reference gas flow	:	Required
Reference gas pressure regulator	:	Required
Cell response	:	95% of change in 30 Sec.(Appox.)
Accuracy	:	2% of full scale
Repeatability	:	1% of full scale
Local Indicator	:	Indicating meter of 1% accuracy
Alarm facility	:	Dual (High & Low) independently adjustable.
Contact rating	:	0.5A at 220 V AC
Accessories	:	As required i.e Flow meter, flow control valve , pump with complete software.
Hazardous duty Version	:	FM Standards.

Calibration gas cylinders and installation accessories such as tubings and fittings for connecting calibration gas cylinders and auto calibration units.

Cylinder ownership certificates, pressure test and explosion proof certificates to be given for refilling the gases by owner for future calibration.

1.1.16 Vortex flow meter

Transmitter type shall be capacitance / piezoelectric , microprocessor based electronics. Reynolds's no. shall be at least 20000 and minimum flow velocity shall be as specified by the manufacturer. For gas/air application, the bluff body shall be in horizontal position to avoid condensate and for liquids in vertical lines the flow shall be upwards to keep the line full. A location with minimum pipe vibration shall be selected. The pipe shall be supported at both ends, as necessary.If pressure and temperature compensation are required for gas/air flow application, the pressure taping shall be placed as close as possible to upstream of flow meter. The temperature tapping point shall be located at least 5D on the down stream of the flow meter. Straight length requirement shall be as specified by manufacturer. If meter is smaller than the line size, concentric pipe reducers shall be used. Eccentric reducers shall not be used as they disturb the flow profile.

1.1.17 Solenoid Valves

On line two (2) way solenoid valves shall be provided, where process line of less than 2 inch with low pressure & temperature application is involved.

Three (3) way solenoid valves shall be provided commonly, where the pressure is admitted or exhausted from a diaphragm valve or single acting cylinder.

Four (4) way solenoid valve shall be provided for operating double acting cylinders. If applicable.

Dual coil Solenoid valves shall be supplied for equipment trips and single coil for balance.

Body material of bronze, plug material of SS316 shall be provided with a leakage class of class IV.

All single coil solenoids shall be of continuous duty operating on 24V DC, 230 V AC and insulation class shall be H.

Double coil solenoid valve shall be provided for BMS services..For operation of the fuel oil corner nozzle valves, fuel oil trip valves etc., double coil solenoid valve (latch coil & relatch coil) shall be adopted.

Single coil usage requires always power and loss of power leads to closure of above valves resulting the unit trip or loss of generation.

On collection of water in the drains of instrument air lines, mechanical automatic drains and periodically solenoid operated drains (with electronic timer - 15m, 30m, 60m and 2 Hours & Timing adjustable) are to be provided.

For mechanical type & Electrical type, the locations to be provided in the instrument air lines of boiler area, Chimney area, turbine area etc., and same shall be decided during detailed Engineering.

For mechanical type & Electrical type, the locations to be provided in the instrument air lines of boiler area, Chimney area, turbine area etc., and same shall be decided during detailed Engineering.

Individual Moisture separator in the instrument air lines for vital final control elements or oxygen analysers shall be provided to enhance the cell life of oxygen probe or continuous operation of final control elements. The numbers and locations shall be finalized during the detailed engineering.

1.1.18 Position Transmitters / Positioners

Position Transmitters shall be provided for all motorized inching valves and control valves. Position transmitters shall be 24 VDC, 2 wire, system. SMART Positioners with HART communication shall be provided for all pneumatically operated control valves, power cylinders etc., for converting controller output of 4-20 Ma to 3-15 PSI (0.2 -1 kg/cm2) for interfacing with pneumatic actuators. Separate moisture separator unit for ensuring dryness of air entering Positioners/ E/P converters as well as the power cylinder is to be supplied. The I to P converters shall retain the pneumatic signal (last value) even in failure of control signal and shall have self volume boosters. The Positioners/ E/P converters shall retain the pneumatic signal (last value) even in failure of control signal and shall have self volume boosters.

1.1.19 I/P Converter

Two wire type I/P convertors with an accuracy of +0.25% accepting 4-20 mA dc signals from control system and converting to 0.2 to 1 kg/cm2 air pressure to operate valve positioner of all final control elements; Housed in cast aluminum casing (with polyurethane paint); NEMA 4 or equivalent degree of protection for enclosure. Material of accessories will be SS. I/P convertors shall have fail freeze (stay put) feature also. Process connection shall be 1/4" NPT (F) and Electrical connection shall be ½" NPT (F). Zero/span adjustment facility shall be provided. The I to P converters shall retain the pneumatic signal (last value) even in failure of control signal and shall have self volume boosters. Necessary air lock devices and pressure switches for air pressure low alarming shall be provided.

1.1.20 Air Filter Regulators

Air filter regulator along with gauges shall be provided in each of the
a) Air supply line to valve positioners /power cylinders
b) Air supply line to electric to pneumatic converters
c) Air supply line to pneumatic interlocked block valves

1.2.0 Vibration Monitoring and Analysis System (VMAS)

1.2.1 General

The vibration monitoring and analysis system shall provide critical analysis of health of rotating machines on continuous on-line basis and shall guide the plant maintenance personnel regarding the nature of fault and the maintenance action required.

The analysis system shall acquire both the vibration and process information from the data acquisition software plus programmed rules to provide clear analysis and recommendations for effective machinery management. It shall be an extensive and accurate knowledge base to enable quick determination of the condition of a machine by providing alarm notification or advisory of the machinery malfunction.

The analysis system shall be able to specifically evaluate the available data while checking for the presence of the most frequently occurring machine mal functions such as
a) High synchronous vibration
b) Shaft bow
c) Fluid induced instability (WHIRL and WHIP)
d) Radiant pre-load force(Including mis alignment)
e) Vector change
f) Rotor hub
g) Loss rotating parts
h) Compressor surge
i) Electric motor non-uniform air gap
j) Gear mesh problems pump cavitations

1.2.2 Design and Functional Requirement

Unit Vibration monitoring & analysis system for each unit and Vibration monitoring system of BOP systems shall be provided.

Vibration monitoring system of BOP systems shall be interfaced with the Unit Vibration monitoring & analysis system

The vibration monitoring and analysis system shall provide condition monitoring and analysis of the bearings of all critical machines, equipments with HT drives and their driven equipment. Vibration monitoring & analysis system shall be in accordance with API 670 standard.

The vibration monitoring system shall be complete with proximity type vibration sensors, signal conditioning cards, amplifiers, special cables, vibration monitor (if required) etc. together with all necessary equipment and accessories.

Vibration sensors shall be provided for measurement in both X (horizontal) and Y (vertical) axis at 90˚ angle to each other for each bearing. Sensitivity of the pick-up shall be minimum 15 mv/mm/s. All outdoor mounted vibration pick-ups, amplifiers, junction boxes and other equipments shall be provided with IP-65 protection class.

For bearings of high speed machines (= / >1500 rpm) accelerometer type sensor and or low speed machines (<1500 rpm) velocity type sensor shall be provided. Necessary, one or two stage integrators for obtaining vibration measurement in terms of displacement shall be provided in the system.

Vibration monitoring system shall provide the vibration measurement in the form of 4-20 Ma DC signals to be directly connected by hardwired cable to plant DCS for monitoring. Limit value generation (soft) for alarm and protection applications for the auxiliaries and their drive equipment shall be carried out in DCS/PLC.

Vibration monitoring and analysis system shall be an independent microprocessor based system (PC based). The system shall be interfaced with the plant DCS through redundant communication link. The system shall interface with plant DCS for any process signals which may be required to perform condition monitoring functions through soft link.

All the turbine supervisory vibration parameters of TG & TD BFP shall also be fed to VMAS for analysis.

1.2.3 VMAS Hardware/ Software/ Interfacing Requirement

Vibration analysis system for each unit & one Common VMAS shall include all hardware and software as required for proper functioning of the system including but not limited to the following:

a) One (1) no Server with necessary Engineering Station & 24” Video Display unit for configuring the VMS modules and for maintenance activities
b) One (1) no user station (With PC, 24” Video Display Unit, Keyboard/ Mouse and Colour Laser Printer)
c) Vibration analysis software with all relevant User’s license.
d) One No. lap top PC with condition monitoring/machine management software and data collection from VMAS through necessary interface system cable shall also be supplied.
e) Server & User PCs operating licenses.
f) Bulk data storage and retrieval facility
g) Redundant OPC communication link with all necessary hardware and software.
h) System cables etc.

The vibration analysis system shall be able to carry out the following tasks:

To determine the exact nature of fault in the rotating machines like misalignment, shaft crack, bearing looseness, dynamic un-balancing of rotor etc. indicating the magnitude of vibration and phase angle information and the corrective action to be undertaken by maintenance personnel. For example, in case of dynamic un-balancing of rotor, the system shall provide the guidance about the approximate mass needed to be added to the rotor with the direction information.

To provide the guidance about predictive maintenance requirement of the machines. Predictive maintenance requirement guide shall also include the "Period of safe operation of machines available at any given point of time'.

Shall be capable of collecting data both asynchronously and synchronously (with a Keyphasor signal) and store the data in the original time domain format.

The analysis system shall be able to carry out the following types of analysis to meet the tasks of analysis system detailed above. The system shall not require the intervention of vibration expert to determine the nature of the fault:

On line spectrum/harmonic analysis of the vibration measurements.

The system shall have facility to generate and analyze the following:

a) Bode Plot
b) Time wave form
c) Orbit Analysis
d) Shaft centerline
e) Cascade Plot
f) Water fall
g) Bar graph
h) Current values
i) Spectrum
j) Alarms – amplitude and spectral
k) Data collection during start up and coast down
l) Operating point for pumps and fans

The analysis software should be capable of outputting direct message on video monitor of the exact nature of fault.

The system shall have facility to store bulk data for 5 years duration with facility for retrieval of the same. The system shall have facility to share all the data in the hard disk/ back up media and provide user friendly utilities to retrieve and analyze stored data.

The system shall be provided with redundant UPS power supply. The power supply provision shall be such that on failure of one power supply the other power supply shall cater to the requirement of the equipment so as never to hinder the functioning of the system in any manner due to power supply failure.

Configuration Softwmare:

The monitoring system shall be software configurable using any standard Windows TM 95/98 and Windows TM NT host computer. The configuration software shall provide a list that establishes the Modbus register locations of all data exportable from the monitoring system. The optional display software shall provide displays including Bargraph displays, trend information, machine train diagrams with real-time values of measurements tagged on the diagram, as well as access to the system events and alarm events lists.

Condition Monitoring/Machinery Management Software:

The condition monitoring software shall run on the Windows NT platform. It shall be capable of collecting data both asynchronously and synchronously (with a Keyphasor signal) and store the data in the original time domain format. From the stored time domain sample, it shall be possible to reproduce a spectrum in addition to other time domain data formats at any time for review of data saved in historical trend files. To accommodate acquisition of non-protection system monitored parameters, there shall be provision for import of data from other systems, (e.g.) DCS, using either OPC, a serial link using Modbus/DDE protocol. The software shall collect and store data from the monitor racks and communication processors or process information from the digital links connected to it. The software shall allow the display of all collected data from the one or more other data acquisition computers when networked together. The software shall have the capability to take process data directly from DCS and correlate this data with vibration data. The software must integrate with thermodynamic performance management without including another software. The software shall display at least the following plots:

Plot display formats: Must have the ability to select and store transit or steady state data, from stored Alarm Event Data, or from Baseline Data. This must include current data, in which case, the computer requests a sample of the current signal(s) from the associated monitor channel:

Steady state plots:	Transient data (during start-up/shutdown conditions) plots:
Virtual probe rotation	Bode plots for 1X & 2X vectors during startups & coast-downs
Current values	Polar plots for 1X & 2X vectors during start-ups & coast-downs
Alarm event and system event listing	Cascade / Full cascade plots
Bargraph of current values	
Machine train diagrams	
Fast trend	
Trend	
Multivariable trend	
Acceptance region	
Time-base	
Orbit & time base	
Shaft centerline	
Both spectrum and full spectrum	
X versus Y (any variables)plot	
Waterfall / Full waterfall	
Plot orbits & plus Spectrums	
Quick-view	

Alarm data acquisition and storage: Condition Monitoring Software shall provide computerized machinery management with continuous, online data acquisition, archiving, and display capabilities. Static and dynamic data shall be collected, the data acquisition modes can be both automatically and manually initiated, based on alarm conditions, startups/shutdowns, and other events.

Software alarms can be implemented in the software as a proactive maintenance tool, these alarms are usually set below the protection system hardware alarm set points (used for machine shutdowns). The information provided by typical software plot format in form of an “Acceptance Region” information provides a machinery user, a valuable indicator of an impending machine malfunction.

ANNEXURE - D

MANDATORY SPARES (Electrical)

Sl.No	Description	Unit	Quantity
20.	**LV Switchgear** Bidder to consider applicable spares from LV switch gear list if LCP is envisaged for Fluid coupling		
a)	**Circuit Breaker Components**		
	i. Spring charging motor of each type	Nos.	3
	ii. Power contacts, complete set	Set*	5
	iii. Auxiliary contact set	Set*	5
	iv. Limit switches of each type	Nos.	5
	v. Charging spring of each type	Nos.	5
	vi. Closing coil of each type	Nos.	5
	vii. Tripping coil of each type	Nos.	5
b)	Auxiliary Contactor with 2NO and 2NC add-on block		3 sets of each type
c)	Contactor complete set – power & Auxiliary contactor	Set*	5
d)	Electronic over load relay with current display unit of each type and rating	Nos.	5
e)	CTs for Overload protection (motor feeder) of each type and rating	Nos.	5
f)	CTs for incomer/ bus coupler and outgoing feeders of each type and rating	Nos.	5
g)	VTs for Incomers and BusVT of each type and rating	Nos.	5
h)	Meters (Multifunction meters, Digital meters, Analog meters) of each type and rating	Nos.	5
i)	Protection Relays of each type and rating	Nos.	5
j)	Control transformer (415V/110V) of each type and rating	Nos.	5
k)	Control transformer (415V/230V) of each type and rating	Nos.	5
l)	Aux. Relay and timer of each type and rating	Nos.	5
m)	Inter posing relays	Nos.	5
n)	Control Switch and selector switch	Nos.	5
o)	MCCB / MPCB / MCB with auxiliary contacts of each type and rating	Nos.	5
p)	Indicating lamps (LEDS) with resistor of different colors	Nos.	10
q)	Annunciation units of each type and rating	Nos.	5
r)	Bus bar supporting insulator	Nos.	10
s)	Anti pumping relay each type & rating	Nos.	5
t)	Lockout replay of each type	Nos.	5
u)	Timers of each type	Nos.	5
v)	Moving contacts of assembly of each installed rating	Set*	10
w)	Stationary (fixed) contact	Set*	10
x)	Air Circuit breaker of each type and rating	Nos.	2

Note: Spares mentioned in Sl No: 20, 11, 12 shall be considered if Fluid coupling is envisaged for slurry Pump in addition to spare mentioned in Sl No: 30 for LT Motors.
In addition to the above Indicating lamps (LED) with resistor of different colours applicable for LPBS shall be considered in bidders scope - 5 each

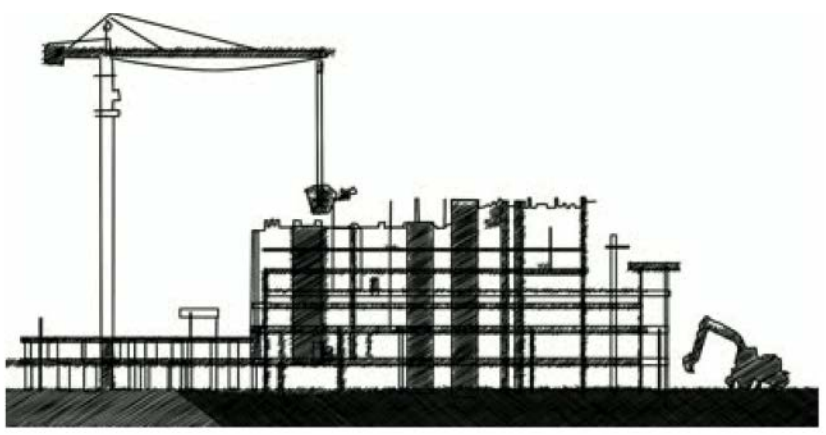
Sl.No	Description	Unit	Quantity
y)	Bus seal off Bushing of each type	Nos.	5
z)	Bus bar support insulator		5% of total population
aa)	Indicating lamps – Qty yo be changed as	Nos.	50
bb)	Ammeter of each type and rating	Nos.	5
cc)	Voltmeter of each type and rating	Nos.	5
dd)	Arc chute (for each rating)	Nos.	5
ee)	Inter phase barriers of each type	Nos.	3
~~21.~~	~~**For Battery of each type and rating**~~		
~~a)~~	~~Inter cell connectors with insulated cover~~	~~Nos.~~	~~10~~
~~b)~~	~~Inter row connectors with insulated cover~~	~~Nos.~~	~~10~~
~~c)~~	~~Battery stand insulators~~	~~Nos.~~	~~10~~
~~d)~~	~~Cell insulators~~	~~Nos.~~	~~10~~
~~e)~~	~~Nuts, bolts & washers-each type~~	~~Set~~	~~1~~
~~f)~~	~~Vent plugs~~	~~Nos.~~	~~10~~
~~g)~~	~~Spare dry cell~~	~~Nos.~~	~~10~~
~~22.~~	~~**For battery charger**~~		
~~a)~~	~~SMPS modules of each type & rating~~	~~Nos.~~	~~5~~
~~b)~~	~~LEDs lamps of each type & rating~~	~~Nos.~~	~~5~~
~~c)~~	~~Contactors~~	~~Set*~~	~~2~~
~~d)~~	~~SMPS module for each type and rating~~	~~Nos.~~	~~10~~
~~e)~~	~~MFM each type and rating~~		~~5% of total population or one number whichever is higher~~
~~f)~~	~~Blocking Diode for each type and rating~~		~~5% of total population or one number whichever is higher~~
~~g)~~	~~Relay for each type and rating~~		~~5% of total population or one number whichever is higher~~
~~h)~~	~~BHMS sensors for each type and rating~~		~~10 % of total population~~
~~i)~~	~~Electronic circuit module~~	~~Set~~	~~1~~
~~j)~~	~~MCCB for each type and rating~~		~~10% of total population or one number whichever is higher~~
~~k)~~	~~Voltage regulator assembly~~		~~10% of total population or one number whichever is higher~~

Sl.No	Description	Unit	Quantity
c)	Termination kits (If elastimod type)	Nos.	2
d)	Termination kits end connections	Nos.	10
e)	Temperature indicators	Nos.	5
f)	Motors of each & rating	No.	**1**
30.	**LT Motors of each type and rating**		
a)	Driving end bearing	Set*	1
b)	Non driving end bearing	Set*	1
c)	Terminal block for motors up to 30 Kw each rating	Nos.	10
d)	Terminal block for motors above 30 Kw each rating	Nos.	5
e)	Motors of each type & rating	Nos.	10% of installed quantity or 1 –no is higher whichever is higher
31.	**DC Motors of each type and rating**		
a)	Driving end bearing	Set*	1
b)	Non driving end bearing	Set*	1
c)	Carbon brushes of each type	Set*	10
d)	Brush assemblies of each type	Set*	2
e)	Terminal blocks of each type	Set*	2
f)	Motor of each type & rating	Nos.	10% of installed qty or 1-no Which ever is higher
32.	**Electrical actuator, complete assembly, of each rating**	Nos.	2
33.	**Substation automation and Electrical management system**		
a)	Keyboard		2 nos. of each type
b)	Mouse		2 nos. of each type
c)	Color laser printer (A4)		1 no.
d)	Printer toner for all printers		2 nos. of each type
e)	132 Column Printer Head		1 no.
f)	Drum for A3 scanner cum copier, printer		1 no.
g)	24" Monitor		1 no.
h)	Ethernet switch		2 nos. of each type.
i)	Control units for LVS		1 no.
j)	Graphical Interface Unit		1 no. of each type & model
k)	Hard disk		2 nos of each type
l)	Gateways		1 no. of each type
m)	Fibre optic Ethernet signal converters		2 nos. of each type
n)	Portable hard disk Drive 1TB		2 Nos.

SI. NO.	PARTICULARS	QUANTITY
	Electrodes	50% of population
	Electronic Cards	20% or 2 nos. of each type and model whichever is more.
	Lamps/LEDs of display units	100%
8	Mill and Air heater Fire detection system.	
	Thermocouple	10%
	Process actuator switches	10%
9	Acoustic steam Leak Detection system (ASLD)	
	Processor and Interface modules	10% or 1 no. of each type and model, whichever is more
	Sensors and Transceivers	10% or 1 no. of each type and model, whichever is more including sensors
10	Temperature elements	
	RTD's of each type and length(with head assembly, terminal block & nipple)	10% or 2 nos. of each type and length, whichever is more
	Thermocouples of each type like K-type, R-type, metal etc. (with head assembly, terminal block & nipple)	10% or 2 nos. of each type and length which ever is more
	Thermowell for application like mill outlet temperature and SH/RH/Eco/ flue gas temp. in furnace	10% or 2 nos. of each type and length whichever is more
	Temperature transmitters	10% of each type and model
11	Local Indicators like temperature gauges, pressure gauges, differential pressure gauges, flow gauges, flow meters etc.,	10% or 2 no. of each make, model and type whichever is more and for each plant (to be divided to various ranges in proportion to main of all make, model, type population)
12	Process Actuated Switch Devices Includes all types of Pressure, differential pressure, flow, temperature, differential temperature, level switch Devices	5% or 1 no. of each type and model whichever is more
13	PD Type Flow Transmitters	1 no. of each type and model
14	Flue Gas Analyzer Instruments for Oxygen (i) Electronic Card Assemblies of each type (ii) Sets of Gaskets/ "O" rings (iii) Temperature Sensor & heater Assembly (iv) Complete Probe with shield assembly. (v) Consumables like filter elements.	1 no. each complete instrument. 2 sets 20% 2 nos 100%
15	CO Analyser Chopper motor Electronic cards	 2 nos. 2 nos. Of each card
16	Opacity monitor Transmitter Receiver Power supply module Signal output module Light source	 2 nos. 2 nos. 2 nos. 2 nos. 2 nos.
17	SOx NOx CO Analyser Electronic cards Chopper motor Light source	 1 no. 2 nos. 2 nos.
18	Water Analysers – pH Transmitter Cell Electronic cards	2 nos. Or 20% of each type which ever is more 1 no. Of each type

ANNEXURE V

BHEL HSE MANUAL



HEALTH, SAFETY and ENVIRONMENT PLAN

For

SITE OPERATIONS

By

SUB-CONTRACTORS

INDUSTRIAL SYSTEMS GROUP

	HEALTH, SAFETY AND ENVIRONMENT PLAN FOR SITE OPERATION by SUBCONTRACTORS	Doc no.:HSEP: 14 REV: 00
	INDUSTRIAL SYSTEMS GROUP	DATE: 10.01.2018

DOCUMENT ISSUE SHEET

	Prepared	Reviewed	Approved
Name	HSE Internal Auditors	RK OJHA	
Designation			
Signature			
Date			

HSE PLAN FOR SITE OPRATIONS BY BHEL'S SUBCONTRACTORS

AT A GLANCE

BEFORE START

SIGNING OF MOU	
Agree to comply to HSE requirement- Statutory and BHEL's	Agree to accept BHEL's decision on release of 1.5% (as specified in the contract) of Gross bill amount or part thereof or otherwise(non-release), based on our HSE performance as evaluated by BHEL during the execution period

PLAN

HSE ORGANISATION	
Manpower • 1 (one) safety officer for every 500 workers or part thereof • l(one) safety-steward/ supervisor for every 100 workers **Qualification** As per Cl. 7.1	**HSE Roles and responsibilities** • **Site In-charge-As per clause 7.2.1** • **Safety officer-As per clause 7.2.2**

HSE Planning
for Man , Machinery/Equipment/Tools & Tackles

PROVIDE

HSE INFRASTUCURE	
• PPEs • Drinking Water • Washing Facilities • Latrines and Urinals • Provision of shelter • for rest • Medical facilities	• Canteen facilities • Labour Colony • Emergency Vehicle • Pest Control • Scrapyard • Illumination

TRAIN

HSE TRAINING, AWARENESS & PROMOTION	
Training • Induction training • Height work and other critical areas • Tool Box talk & Pep Talk	**Awareness & Promotion** • Signage • Poster • Banner • Competition • Awards

COMMUNICATE

HSE COMMUNICATION	
Incident Reporting • Accident- Fatal & Major • Property damage • Near Miss	**Event Reporting** • Celebrations • Training • Medical camp

EXECUTE SAFELY

OPERATIONAL CONTROL PROCEDURES

PERMIT TO WORK
Height work (above 2 metres), Hot Work, Heavy Lifting, Confined Space, Radiography, Excavation (More than 4 meters)

SAFETY DURING WORK EXECUTION	
• Welding • Rigging • Cylinder – storage & Movement • Demolition work • T&Ps • Chemical Handling • Electrical works	• Fire • Scaffolding • Height work • Working Platform • Excavation • Ladder • Lifting • Hoisting appliance

HOUSE KEEPING
WASTE MANGEMENT
TRAFFIC MANAGEMENT
ENVIRONIMENTAL CONTROL
EMERGENCY PREPAREDNESS AND RESPONSE PLAN

CHECKS

HSE AUDITS & INSPECTION	
• Daily Checks • Inspection of PPEs • Inspection of T&Ps • Inspection of Cranes & Winches	• Inspection of Height work • Inspection of Welding and Gas cutting • Inspection of elevators etc

HSE PERFORMANCE EVALUATION PARAMETERS

NON CONFORMANCE

PENALTY for NON CONFORMANCE

Refer Clause 16 Incremental penalty

For repeated violation by the same person, the penalty would be double of the previous penalty

For repeated fatal incident in the same Unit incremental penalty to be imposed. The subcontractor will pay 2 times the penalty compared to previously paid in case there are repeated cases of fatal incidents under the same subcontractor for the same package in the same unit.

	HEALTH, SAFETY AND ENVIRONMENT PLAN FOR SITE OPERATION by SUBCONTRACTORS	Doc no.:HSEP: 14 REV: 00
	INDUSTRIAL SYSTEMS GROUP	DATE: 10.01.2018 Page: 1 of 43

1.0 PURPOSE

1.1 The purpose of this HSE Plan is to provide for the systematic identification, evaluation, prevention and control of general workplace hazards, specific job hazards, potential hazards and environmental impacts that may arise from foreseeable conditions during installation and servicing of industrial projects and power plants.

1.2 This document shall be followed by BHEL's subcontractors at all installation and servicing sites. In case customer specific documents are to be implemented, this document will be followed in conjunction with customer specific documents.

1.3 Although every effort has been made to make the procedures and guidelines in line with statutory requirements, in case of any discrepancy relevant statutory guidelines must be followed.

1.4 In case the customer has any specific requirement, the same is to be fulfilled.

2.0 SCOPE

The document is applicable for BHEL's Subcontractors at all installation/servicing activities of BHEL Industrial systems group as per the relevant contractual obligations.

3.0 OBJECTIVES AND TARGETS

The HSE Plan reflects that BHEL places high priority upon the Occupational Health, Safety and Environment at workplaces.

- Ensure the Health and Safety of all persons at work site is not adversely affected by the work.
- Ensure protection of environment of the work site.
- Comply at all times with the relevant statutory and contractual HSE requirements.
- Provide trained, experienced and competent personnel. Ensure medically fit personnel only are engaged at work.
- Provide and maintain plant, places and systems of work that are safe and without risk to health and the environment.
- Provide all personnel with adequate information, instruction, training and supervision on the safety aspect of their work.
- Effectively control, co-ordinate and monitor the activities of all personnel on the Project sites including subcontractors in respects of HSE.
- Establish effective communication on HSE matters with all relevant parties involved in the Project works.
- Ensure that all work planning takes into account all persons that may be affected by the work.
- Ensure fitness testing of all T&Ps/Lifting appliances like cranes, chain pulley blocks etc. are to be certified by competent person.
- Ensure timely provision of resources to facilitate effective implementation of HSE requirements.
- Ensure continual improvements in HSE performance
- Ensure conservation of resources and reduction of wastage.
- Capture the data of all incidents including near misses, process deviation etc. Investigate and analyze the same to find out the root cause.
- Ensure timely implementation of correction, corrective action and preventive action.

HSE TARGETS

EXPLOSION	ZERO
FATALITY	ZERO
LOST TIME INJURY	ZERO
FIRE	ZERO
VECHILE INCIDENTS	ZERO
ENVIRONMENTAL INCIDENTS	ZERO

4.0 BHEL INDUSTRIAL SYSTEMS GROUP HEALTH, SAFETY & ENVIRONMENT POLICY

INDUSTRIAL SYSTEMS GROUP HSE POLICY

- ✓ Ensure total compliance with applicable legislation, regulations and other requirements concerning Occupational Health, Safety and Environment.
- ✓ Ensure continual improvement in the Occupational Health, Safety and Environment Management System performance.
- ✓ Enhance Occupational Health, Safety and Environment awareness amongst employees, customers and suppliers by proactive communication and training.
- ✓ Review periodically and improve Occupational Health, Safety and Environment Management System to ensure its continuing suitability, adequacy and effectiveness in a continuously changing business environment.
- ✓ Develop a culture of safety through active leadership and provide appropriate training at all levels to enable employees to fulfill their Health, Safety and Environmental obligations.
- ✓ Incorporate appropriate Occupational Health, Safety and Environmental criteria into business decisions for selection of plant, technology and services as well as appointment of key personnel.
- ✓ Ensure availability at all times of appropriate resources to fully implement the Occupational Health, Safety and Environmental policy of the company.

This policy will be communicated to all employees and made available to interested parties.

Sd/-

Date: 10.01.2018 (HSE)

5.0 MEMORANDUM OF UNDERSTANDING:

After award of work, subcontractors are required to enter into a memorandum of understanding as given below:

Memorandum of Understanding

BHEL, INDUSTRIAL SYSTEMS GROUP Region is committed to Health, Safety and Environment Policy (HSE Policy).

M/s_____ do hereby also commit to comply with the same HSE Policy while executing the Contract Number _____

M/S_____ shall ensure that safe work practices as per the HSE plan. Spirit and content therein shall be reached to all workers and supervisors for compliance.

In addition to this, M/S_____ shall comply to all applicable statutory and regulatory requirements which are in force in the place of project and any special requirement specified in the contract document of the principal customer.

M/s_____ shall co-operate in HSE audits/inspections conducted by BHEL /customer/ third party and ensure to close any non-conformity observed/reported within prescribed time limit.

Signed by authorized representative of M/s

Name :

Place & Date:

6.0 TERMS AND DEFINTIONS

6.1 DEFINATIONS

6.1.1 INCIDENT

Work-related or natural event(s) in which an injury or ill health (regardless of severity), damage to property or fatality occurred, or could have occurred.

6.1.2 NEAR MISS

An incident where no ill health, injury, damage or other loss occurs, but it had a potential to cause, is referred to as "Near-Miss".

6.1.3 MAN-HOUR WORKED

The total number of man hours worked by all employees including subcontractors working in the premises. It includes managerial, supervisory, professional, technical, clerical and other workers including contract labors. Man-hours worked shall be calculated from the payroll or time clock recorded including overtime. When this is not feasible, the same shall be estimated by multiplying the total man-days worked for the period covered by the number of hours worked per day. The total number of workdays fora period is the sum of the number of men at work on each day of period. If the daily hours vary from department to department separate estimate shall be made for each department and the result added together.

6.1.4 FIRST AID CASES

First aids are not essentially all reportable cases, where the injured person is given medical treatment and discharged immediately for reporting on duty, without counting any lost time.

6.1.5 LOST TIME IN JURY

Any work injury which renders the injured person unable to perform his regular job or an alternative restricted work assignment on the next scheduled work day after the day on which the injury occurred.

6.1.6 MEDICAL CASES

Medical cases come under non-reportable cases, where owing to illness or other reason the employee was absent from work and seeks Medical treatment.

6.1.7 TYPE OF INCIDENTS & THEIR REPORTING:

The three categories of Incident are as follows:

Non-Reportable Cases:

An incident, where the injured person is given medical help and discharged for work without counting any lost time.

Reportable Cases:

In this case the injured person is disable for 48 hours or more and is not able to perform his duty.

Injury Cases:

These are covered under the heading of non-reportable cases. In these cases the incident caused injury to the person, but he still continues his duty

6.1.8 TOTAL REPORTABLE FREQUENCY RATE

Frequency rate is the number of Reportable Lost Time Injury (LTI) per one Million Man hours worked. Mathematically, the formula reads:

$$\frac{\text{Number of Reportable LTI}}{\text{Total Man Hours Worked}} \times 1{,}000{,}000$$

6.1.9 SEVERITY RATE

Severity rate is the Number of days lost due to Lost Time Injury (LTI) per one Million Man hours worked. Mathematically, the formula reads as:

$$\frac{\text{Days lost due to LTI}}{\text{Total Man Hours Worked}} \times 1{,}000{,}000$$

6.1.10 INCIDENCE RATE

Incidence Rate is the Number of LTI per one thousand manpower deployed. Mathematically, the formula reads as: Number of LTIxlOOO
Average number of manpower deployed

HSE ORGANISATION

Number of safety officers:

The subcontractor must deploy one safety officer for every 500 workers or part thereof in each package. In addition, there must be one safety-steward/safety-supervisor for every 100 workers.

7.1 QUALIFICATION FOR HSE PERSONNEL

Sl.no	Designation	Qualification	Experience
1	Safety officer (Construction Agency)	Degree or Diploma in Engineering with full time diploma in Industrial Safety with construction safety as one of the subjects	Minimum two years for degree holder and five years for diploma holder in the field of Construction of power plant/ major industries

2	Safety-Steward/ Safety- Supervisor	Degree or diploma in any discipline with full time diploma in Industrial Safety with construction safety as one of the subjects	Minimum two years

7.2 RESPONSIBILITIES

7.2.1 SITE IN -CHARGE OF SUBCONTRACTOR

- Shall sign Memorandum of Understanding (MoU) for compliance to BHEL's HSE Plan for Site Operations as per clause 5.0
- Shall engage qualified safety officer(s) and steward (s) as per clause 7.0
- Shall adhere to the rules and regulations mentioned in this code, practice very strictly in his area of work in consultation with his concerned engineer and the safety coordinator.
- Shall screen all workmen for health and competence requirement before engaging for the job and periodicallythereafter as required
- Shall not engage any employee below 18 years.
- Shall arrange for all necessary PPEs like safety helmets, belts, full body harness, shoes, face shield, hand gloves etc. before starting the job. Shall ensure that no working men/women carry excessive weight more than stipulated in Factory Rule Regulation R57.
- Shall ensure that all T&Ps engaged are tested for fitness and have valid certificates from competent person.
- Shall ensure that provisions stipulated in contract Labor Regulation Act 1970, Chapter V C.9, canteen, rest rooms/washing facilities to contracted employees at site.
- Shall adhere to the instructions laid down in Operation Control Procedures (OCPs) available with the sitemanagement.
- Shall ensure that person working above 2.0 meter should use Safety Harness tied to a life line/stable structure.
- Shall ensure that materials are not thrown from height. Cautions to be exercised to prevent fall of material from height.
- Shall report all incidents(FataI/Major/Minor/Near Miss to the Site engineer /HSE officer of BHEL.
- Shall ensure that Horseplay is strictly forbidden.
- Shall ensure that adequate illumination is arranged during night work.
- Shall ensure that all personnel working under subcontractor are working safely and do not create any Hazard toself and to others.
- Shall ensure display of adequate signage/posters on HSE.
- Shall ensure that mobile phone is not used by workers while working.
- Shall ensure conductance of HSE audit, mock drill, medical camps, induction training and training on HSE at site.
- Shall ensure full co-operation during HO/External /Customer HSE audits.

- Shall ensure submission of look-ahead plan for procurement of HSE equipment's and PPEs as per work schedule.
- Shall ensure good housekeeping.
- Shall ensure adequate valid fire extinguishers are provided at the work site.
- Shall ensure availability of sufficient number of toilets /restrooms and adequate drinking water at work site andlabor colony.
- Shall ensureadequate emergency preparedness.
- Shall be member of site HSE committee and attend all meetings of the committee
- Power source for hand lamps shall be maximum of 24 v.
- Temporary fencing should be done for open edges if Hand -railings and Toe-guards are not available

7.2.2 HEALTH, SAFETY AND ENVIRONMENT OFFICER OF SUBCONTRACTOR

- Carry out safety inspection of Work Area, Work Method, Men, Machine & Material, P&M and other tools andtackles.
- Facilitate inclusion of safety elements into Work Method Statement
- Highlight the requirements of safety through Tool-box / other meetings.
- Help concerned HOS to prepare Job Specific instructions for critical jobs.
- Conduct investigation of all incident/dangerous occurrences & recommend appropriate safety measures.
- Advice & co-ordinate for implementation of HSE permit systems, OCPs & MPs.
- Convene HSE meeting & minute the proceeding for circulation & follow-up action.
- Plan procurement of PPE & Safety devices and inspect their healthiness.
- Report to PS Region/HO on all matters pertaining to status of safety and promotional program at site level.
- Facilitate administration of First Aid
- Facilitate screening of workmen and safety induction.
- Conduct fire Drill and facilitate emergency preparedness
- Design campaigns, competitions & other special emphasis programs to promote safety in the workplace.
- Apprise PS-Region on safety related problems.
- Notify site personnel non-conformance to safety norms observed during site visits / site inspections.
- Recommend to Site In charge, immediate discontinuance of work until rectification, of such situations warrantingimmediate action in view of imminent danger to life or property or environment.
- To decline acceptance of such PPE / safety equipment that do not conform to specified requirements.
- Encourage raising Near Miss Report on safety along with, improvement initiatives on safety.
- Shall work as interface between various agencies such customer, package-in-charges, subcontractors on HSE matters.

8.0 PLANNING BY SUBCONTRACTOR

8.1 MOBILISATION OF MACHINERY/EQUIPMENT/TOOLS BY SUBCONTRACTOR

- As a measure to ensure that machinery, equipment and tools being mobilized to the construction site are fit forpurpose and are maintained in safe operating condition and complies with legislative and owner requirement,inspection shall be arranged by in-house competent authority for acceptance as applicable.
- The machinery and equipment to be embraced for this purpose shall include but not limited to the following:
  - o Mobile cranes.
  - o Side Booms.
  - o Forklifts.
  - o Grinding machine.
  - o Drilling machine.
  - o Air compressors.
  - o Welding machine.
  - o Generator sets.
  - o Dump Trucks.
  - o Excavators.
  - o Dozers
  - o Grit Blasting Equipment.
  - o Hand tools.
- Subcontractor shall notify the engineer, of his intention to bring on to site any equipment or any container, withliquid or gaseous fuel or other substance which may create a hazard. The Engineer shall have the right toprescribe the condition under which such equipment or container may be handled and used during theperformance of the works and the subcontractor shall strictly adhere to such instructions. The Engineer shallhave the right to inspect any construction tool and to forbid its use, if in his opinion it is unsafe. No claim due touch prohibition will be entertained.

8.2 MOBILISATION OF MANPOWER BY SUBCONTRACTOR

- The subcontractor shall arrange induction and regular health check of their employees as per schedule VII ofBOCW rules by a registered medical practitioner.
- The subcontractor shall take special care of the employees affected with occupational diseases under rule 230such prohibition will be entertained such job.
- Ensure that the regulatory requirements of excessive weight limit (to carry/lift/ move weights beyond Prescribedlimits) for male and female workers are complied with.
- Appropriate accommodation to be arranged for all workmen in hygienic condition.

8.3 PROVISION OF PPEs

- Personnel Protective Equipment (PPEs), in adequate numbers, will be made available at site & their regular use by all concerned will be ensured
- The following matrix recommends usage of minimum PPEs against the respective job.

Sl. No	Type of work	PPEs
1	Concrete and asphalt	Nose mask, hand glove, apron and gum boot
2	Welders/Grinders/Gas cutters	Welding/face screen, apron, hand gloves, nose mask and ear muffs if noise level exceeds 90dB. Helmet fitted with welding shield is preferred for welders
3	Stone/ concrete breakers	Ear muffs, safety goggles, hand gloves
4	Electrical Work	Rubber hand glove, Electrical Resistance shoes
5	Insulation Work	Respiratory mask, Hand gloves, safety goggles
6	Work at height	Double lanyard full body harness, Fall arrestor (specific cases)
7	Grit/Sand blasting	Blast suit, blast helmet, respirator, leather gloves
8	Painting	Plastic gloves, Respirators (particularly for spray painting)
9	Radiography	As per BARC guidelines

- The PPEs shall conform to the relevant standards as below and bear ISI mark.

Relevant is-codes for personal protection

IS: 2925-1984	Industrial Safety Helmets.
15:4770-1968	Rubber gloves for electrical purposes.
IS: 6994- 1973 (Part-I)	Industrial Safety Gloves (Leather &Cotton Gloves).
IS: 1989- 1986 (Part-I-II)	Leather safety boots and shoes.
IS: 5557-1969	Industrial and Safety rubber knee boots.
IS: 6519-1971	Code of practice for selection care and repair of Safety footwear
IS: 11226-1985	Leather Safety footwear having direct molding sole.
IS: 5983-1978	Eye protectors.
IS: 9167-1979	Ear protectors.
IS: 1179-1967	Eye & Face protection during welding
IS: 3521 -1983	Industrial Safety Belts and Harness
15:8519-1977	Guide for selection of industrial Safety equipment for body protection
IS:9473-2002, 14166-1994, 14746-1999	Respiratory Protective Devices

The list is not exhaustive. The safety officer may demand additional PPEs based on specific requirement.

- Where workers are employed in sewers and manholes, which are in use, the subcontractor shall ensure that themanhole covers are opened and ventilated at least for an hour before the workers are allowed to get intomanhole, and the manholes so opened shall be cordoned off with suitable railing and provided with warningsignals or boards to prevent incident to the public

- Besides the PPEs mentioned above, the persons shall use helmet and safety shoe. The visitors shall use Helmetand any other PPEs as deemed appropriate for the area of work.

Color scheme for Helmets:

1. Workmen: Yellow
2. Safety staff: Green or white with green band
3. Electrician: Red
4. Others including visitors: White

- All the PPEs shall be checked for its quality before issue and the same shall be periodically checked. The users shallbe advised to check the PPEs themselves for any defect before putting on. The defective ones shall be repaired/replaced.
- The issuing agency shall maintain register for issue and receipt of PPEs.
- The Helmets shall have logo or name (abbreviation of agency name permitted) affixed or printed on the f front.
- The body harnesses shall be serial numbered.

8.4 ARRANGEMENT OF INFRASTRUCTURE

8.4.1 DRINKING WATER

- Drinking water shall be provided and maintained at suitable places at different elevations.
- Container should be labeled as " Drinking Water"
- Cleaning of the storage tank shall be ensured atleast once in 3 months indicating date of cleaning and next duedate.
- Portability of water should be tested as per IS10500 at least once in a year.

8.4.2 WASHING FACILITIES

- In every workplace, adequate and suitable facilities for washing shall be provided and maintained.
- Separate and adequate cleaning facilities shall be provided for the use of male and female workers. Such facilities shall be conveniently accessible and shall be kept in clean and hygienic condition and dully illuminatedfor night use.
- Overalls shall be supplied by the subcontractor to the workmen and adequate facilities shall be provided toenable the painters and other workers to wash during the cessation of work.

8.4.3 **LATRINES AND URINALS**

- Latrines and urinals shall be provided in every work place.
- Urinals shall also be provided at different elevations.
- They shall be adequately lighted and shall be maintained in a clean and sanitary condition at all times, byappointing designated person.
- Separate facilities shall be provided for the use of male and fern ale worker if any.

8.4.4 **PROVISION OF SHEL TER DURING REST**

Proper Shed & Shelter shall be provided for rest during break

8.4.5 **MEDICAL FACILITIES**

8.4.5.1 MEDICAL CENTRE (As per Schedule V, X and XI of BOCW central Rules, 1998)

- A medical centre shall be ensured/identified at site with basic facilities for handling medical emergencies. Themedical center can be jointly developed on proportionate sharing basis with permission from BHEL
- A qualified medical professional, not less than MBBS, shall be deployed at the medical centre
- The medical centre shall be equipped with one ambulance, with trained driver and oxygen cylinder.
- Medical waste shall be disposed as per prevailing legislation (Bio-Medical Waste -Management and HandlingRules, 1998)

8.4.5.2 FIRSTAIDER

- Ensure availability of Qualified First-aider throughout the working hours.
- Every injury shall be treated, recorded and reported.
- Refresher course on first aid shall be conducted as necessary.
- List of Qualified first aiders and their contact numbers should be displayed at conspicuous places.

8.4.5.3 FIRST AID BOX (as per schedule III of BOCW)

- The subcontractor shall provide necessary first aid facilities as per schedule III of BOCW. At every work placefirst aid facilities shall be provided and maintained
- The first aid box shall be kept by first aider who shall always be readily available during the working hours of thework place .His name and contact no to be displayed on the box.
- The first aid boxes should be placed at various elevations so as to make them available within the reach and atthe quickest possible time.
- The first aid box shall be distinctly marked with a Green Cross on white background.
- Details of contents of first aid box is given in Annexure No. 01
- Monthly inspection of First Aid Box shall be carried out by the owner as per format no. HSEP:13-F01

The subcontractor should conduct periodical first -aid classes to keep his supervisor and Engineers properlytrained for attending to any emergency.

8.4.5.4 HEALTH CHECK UP (As per schedule VII and Form XI)

The persons engaged at the site shall undergo health checkup as per the format no.

HSEP:13-F02 before induction. The persons engaged in the following works shall undergo health checkup at least

once in a year:

a. Height workers

b. Drivers/crane operators/riggers

c. Confined space workers

d. Shot/sand blaster

e. Welding and NDE personnel

1.4.6 PROVISION OF CANTEEN FACILITY

- Canteen facilities shall be provided for the workmen of the project inside the project site.
- Proper cleaning and hygienic condition shall be maintained.
- Proper care should be taken to prevent biological contamination.
- Adequate drinking water should be available at canteen.
- Fire extinguisher shall be provided inside canteen.
- Regular health check-up and medication to the canteen workers shall be ensured.

1.4.7 PROVISION OF ACCOMODATION/LABOUR COLONY

- The subcontractor shall arrange for the accommodation of workmen at nearby localities or by making a labourcolony.
- Regular housekeeping of the labour colony shall be ensured.
- Proper sanitation and hygienic conditions to be maintained.
- Drinking water and electricity to be provided at the labour colony.
- Bathing/washing bay
  Room ventilation and electrification

1.4.8 PROVISION OF EMERGENCY VEHICLE

- Dedicated emergency vehicle shall be made available at workplace by each subcontractor to handle anyemergency

1.4.9 PEST CONTROL

Regular pest control should be carried out at all offices, mainly laboratories, canteen, labour colony and stores.

1.4.10 SCRAPYARD

- In consultation with customer, scrapyard shall be developed to store metal scrap, wooden scrap, waste,hazardous waste
- Scrap/Waste shall be segregated as Bio-degradable and non-bio-degradable and stored separately.

8.4.11 ILLUMINATION

- The subcontractor shall arrange at his cost adequate lighting facilities e.g. flood lighting, hand lamps, arealighting etc. at various levels for safe and proper working operations at dark places and during night hours atthe work spot as well as at the pre-assembly area.

- Adequate and suitable light shall be provided at all work places & their approaches including passage ways as perIS: 3646 (Part-ll). Some recommended values are given below:

S.NO	Location	Illumination (Lux)
A.	**Construction Area**	
1.	Outdoor area like store yards, entrance and exit roads	20
2.	Platforms	50
3.	Entrances, corridors and stairs	100
4.	General illumination of work area	150
5.	Rough work like fabrication, assembly of major items	150
6.	Medium work like assembly of small machined parts rough measurements etc.	300
7.	Fine work like precision assembly, precision measurements etc.	700
8.	Sheet metal works	200
9.	Electrical and instrument labs	450
B.	**Office**	
1.	Outdoor area like entrance and exit roads	20
2.	Entrance halls	150
3.	Corridors and lift cars	70
4.	Lift landing	150
5.	Stairs	100
6.	Office rooms, conference rooms, library reading tables	300
7.	Drawing table	450
8.	Manual telephone exchange	200

- Lamp (hand held) shall not be powered by mains supply but either by 24V or dry cells.
- Lamps shall be protected by suitable guards where necessary to prevent danger, in case of breakage of lamp.
- Emergency lighting provision for night work shall be made to minimise danger in case of main supply failure.

If the subcontractor fails to take appropriate safety precautions or to provide necessary safety devices and equipment or to carry out instructions issued by the authorized BHEL official, BHEL shall have the right to take corrective steps at the risk and cost of the subcontractor

9.0 HSE TRAININGS AWARENESS

9.1 HSE INDUCTION TRAINING

All persons entering into project site shall be given HSE induction training by the HSE officer of BHEL /subcontractor beforebeing assigned to work.

In-house induction training subjects shall include but not limited to:

- Briefing of the Project details.
- Safety objectives and targets.
- Site HSE rules
- Site HSE hazards and aspects.
- First aid facility.
- Emergency Contact No.
- Incident reporting.
- Fire prevention and emergency response.
- Rules to be followed in the labour colony (if applicable)

- Proper safety wear & gear must be issued to all the workers being registered for the induction (i.e., Shoes/Helmets/Goggles/Leg guard/Apron etc.)
- They must arrive fully dressed in safety wear & gear to attend the induction.
- Any one failing to conform to this safety wear& gear requirement shall not qualify to attend.
- On completing attending subcontractor's in-house HSE induction, each employee shall sign an induction training form (format no. HSEP:13-F03) to declare that he had understood the content and shall abide to follow and comply with safe work practices. They may only then be qualified to be issued with a personal I.D. card, for access to the work site.

9.2 HSE TOOLBOX TALK

- HSE tool Box talk shall be conducted by frontline foreman/supervisor of subcontractor to prior to the start of work. The agenda shall consist of the followings:

o Details of the job being intended for immediate execution.

- o The relevant hazards and risks involved in executing the job and their control and mitigating measures.
- o Specific site condition to be considered while executing the job like high temperature, humidity, unfavorable weather etc.
- o Recent non-compliances observed. o Appreciation of good work done by any person. o Any doubt clearing session at the end.

- Record of Tool box talk shall be maintained as per form at no. HSEP:13-F04
- Tool box talk to be conducted at least once a week for the specific work.

9.3 TRAINING ON HEIGHT WORK

Training on height work shall be imparted to all workers working at height by in-house/external faculty at least twice in a year. The training shall include following topics: . Use of PPEs

- Use of fall arrester, retractable fall arrester, life line, safety nets etc.
- Safe climbing through monkey ladders,
- Inspection of PPEs.
- Medical fitness requirements.
- Mock drill on rescue at height.
- Dos & Don'ts during height work.

9.4 HSE TRAINING DURING PROJECT EXECUTION

- Other HSE training shall be arranged by BHEL/ subcontractor as per the need of the project execution and recommendation of HSE committee of site.
- The topics of the HSE training shall be as follows but not limited to:

- o Hazards identification and risk analysis (HIRA)
- o Work Permit System
- o Incident investigation and reporting
- o Fire fighting
- o First aid
- o Fire-warden training
- o EMS andOHSMS
- o T & Ps fitness and operation

- Electrical safety
- Welding, NDE & Radiological safety
- Storage, preservation & material handling.

- A matrix shall be maintained to keep an up-to-date record of attendance of training sessions carried out.

9.5 HSE PROMOTION-SIGNAGE, POSTERS, COMPETITION, AWARDS ETC

9.5.1 Display of HSE posters and banners

- Site shall arrange appropriate posters, banners, slogans in local/Hindi/English languages at work place

9.5.2 Display of HSE signage

- Appropriate HSE signage shall be displayed at the work area to aware workmen and passersby about the work going on and do's and don'ts to be followed

9.5.3 Competition on HSE and award

- Site will arrange different competition (slogan, poster, essay etc.) on HSE time to time (Safety day, BHEL day, World Environment Day etc.) and winners will be suitably awarded.

9.5.4 HSE awareness programme

- Subcontractor shall arrange HSE awareness programme periodically on different topics including medical awareness for all personnel working at site

10.0 HSE COMMUNICATION

10.1 INCIDENT REPORTING

- The subcontractor shall submit report of all incidents, fires and property damage etc to the Engineer immediately after such occurrence, but in any case not later than 24 hours of the occurrence. Such reports shall be furnished in the manner prescribed by BHEL. (Refer HSE procedure for incident investigation, analysis and reporting for details)
- In addition, periodic reports on safety shall also be submitted by the subcontractor to BHEL from time to time as prescribed by the Engineer. Compiled monthly reports of all kinds of incidents, fire and property damage to be submitted to BHEL safety officer as per prescribed formats.
- HSE incidents of site shall be reported to BHEL site Management as per Procedure for Incident Investigation and Reporting in format no. HSEP:14-F15. Corrective action shall be immediately implemented at the work place and compliance shall be verified by BHEL HSE officer and until then, work shall be put on hold by Construction Manager.

10.2 HSE EVENT REPORTING

- Important HSE events like HSE training, Medical camp etc. organized at site shall be reported to BHEL site management in detail with photographs for publication in different in-house magazines
- Celebration of important days like National Safety Day, World Environment Day etc. shall also be reported as mentioned above.

11.0 OPERATIONAL CONTROL

All applicable OCRs (Operational control procedures) will be followed by subcontractor as per BHEL instructions. This will be done as part of normal scope of work. List of such OCRs is given below. In case any other OCR is found to be applicable during the execution of work at site, then subcontractor will follow this as well, within quoted rate. These OCRs (applicable ones) will be made available to subcontractor during work execution at site. However for reference purpose, these are kept with Safety Officer of BHEL at the Industrial systems group Regional HQ, or available in downloadable format in the website, which may be refereed by subcontractor, if they so desire.

LIST OF OCRs

Safe handling of chemicals	Safety in use of cranes	Hydraulic test
Electrical safety	Storage and handling of gas cylinders	Spray insulation
Energy conservation	Manual arc welding	Trial run of rotary equipment
Safe welding and gas cutting operation	Safe use of helmets	Stress relieving
Fire safety	Good house keeping	Material preservation
Safety in use of hand tools	Working at height	Cable laying/tray work
First aid	Safe excavation	Transformer charging
Food safety at canteen	Safe filling of hydrogen in cylinder	Electrical maintenance
Illumination	Vehicle maintenance	Safe handling of battery system
Handling and erection of heavy metals	Safe radiography	Computer operation
Safe acid cleaning	Waste disposal	Storage in open yard
Safe alkali boil out	Working at night	For sanitary maintenance
Safe oil flushing	Blasting	Batching
Steam blowing	DGset	Piling rig operation
Safe working in confined area	Handling & storage of mineral wool	Gas distribution test
Safe operation of passenger lift, material hoists & cages	Drilling, reaming and grinding(machining)	Cleaning of hot well/deaerator
Electro-resistance heating	Compressor operation	O&M of control of AC plant & system
Air compressor	Passivation	Safe Loading of Unit
Safe EDTA Cleaning	Safe Chemical cleaning of Pre boiler system	Safe Boiler Light up
Safe Rolling and Synchronisation		

11.1 HSE ACTIVITIES

HSE activities shall be conducted at site based on the HSEMSM developed by industrial systems group and issued to site by Regions.

While planning for any activity the following documents shall be referred for infrastructural requirements to establish control measures:

1) HSE Procedure for Register of OHS Hazards and Risks
2) HSE Procedure for Register of Environmental Aspects and Impacts
3) HSE Procedure for Register of Regulations

4) Operational Control Procedures
5) HSE Procedure for Emergency Preparedness and Response Plan
6) Contract documents

11.2WORK PERMIT SYSTEM

- The following activities shall come under Work Permit System
  a. Height working above 2 metres
  b. Hot working at height
  c. Confined space
  d. Radiography
  e. Excavation more than 4 meter depth
  f. Heavy lifting above 50 ton

  Refer Annexure 05 for Work permit formats.

- "HSE Procedure for Work Permit System" shall be followed while implementing permit system. Where customer is having separate Work Permit System the same shall be followed.
- Permit applicant shall apply for work permit of particular work activity at particular location before starting of thework with Job Hazard Analysis
- Permit signatory shall check that all the control measures necessary for the activity are in place and issue thepermit to the permit holde
- Permit holder shall implement and maintain all control measures during the period of permit .He will close the permit after completion of the work. The closed permit shall be archived in HSE Department of site.

11.3 SAFETY DURING WORK EXECUTION

Respective OCPS are to be followed and adherence to the same would be contractually binding

11.3.1 WELDING SAFETY

All safety precautions shall be taken for welding and cutting operations as per IS-818. All safety precautions shall be taken for foundation and other excavation marks as per IS-3764.

11.3.2 RIGGING

Rigging equipment shall not be loaded in excess of its recommended safe working load. Rigging equipment,

when not in use, shall be removed from the original work area so as not to present a hazard to employees.

11.3.3 CYLINDERS STORAGE AND MOVEMENT

All gas cylinders shall be stored in upright position. Suitable trolley shall be used. There shall be flash-back arrestors conforming to IS-11006 at both cylinder and burner ends. Damaged tube and regulators must be immediately replaced. No of cylinders shall not exceed the specified quantity as per OCP

Cylinders shall be moved by tilting and rolling them on their bottom edges. They shall not be intentionally dragged, struck or permitted to strike each other violently

When cylinders are transported by powered vehicle they shall be secured in a vertical position.

11.3.4DEMOLITION WORK

Before any demolition work is commenced and also during the process of the work the following shall be ensured:

- All roads and open areas adjacent to the work site shall either be closed or suitably protected.
- No electric cable or apparatus which is liable to be a source of danger nor a cable or an apparatus used by the operator shall remain electrically charged.
- All practical steps shall be taken to prevent danger to persons employed from the risks of fire or explosion or flooding. No floor, roof or other part of the building shall be so overloaded with debris or materials as to render them unsafe.

11.3.5T&Ps

All T&Ps/ MMEs should be of reputed brand/appropriate quality & must have valid test/calibration certificates bearing endorsement from competent authority of BHEL.Subcontractor to also submit monthly reports of T&Ps deployed and validity test certificates to BHEL safety Officer as per the format/procedure of BHEL.

11.3.6CHEMICAL HANDLING

Displaying safe handling procedures for all chemicals such as lube oil, acid, alkali, sealing compounds etc , at work place.Where it is necessary to provide and/or store petroleum products or petroleum mixture &explosives, the subcontractor shall be responsible for carrying out such provision / storage in accordance with the rules & regulations laid down in the relevant petroleum act, explosive act and petroleum and carbide of calcium manual, published by the chief inspector of explosives of India. All such storage shall have prior approval if necessary from the chief inspector of explosives or any other statutory authority. The subcontractor shall be responsible for obtaining the same.

11.3.7 ELECTRICAL SAFETY

- Providing adequate no. of 24 V sources and ensure that no hand lamps are operating at voltage level above 24 Volts.
- Fulfilling safety requirements at all power tapping points.
- High/ Low pressure welders to be identified with separate colour clothings. No welders will be deployed without passing appropriate tests and holding valid welding certificates. Approved welding procedure should be displayed at work place.
- The subcontractor shall not use any hand lamp energized by Electric power with supply voltage of more than 24 volts in confined spaces like inside water boxes, turbine casings, condensers etc.
- All portable electric tools used by the subcontractor shall have safe plugging system to source of power and be appropriately earthed. Only electricians licensed by appropriate statutory authority shall be employed by the subcontractor to carry out all types of electrical works. Details of earth resource ad their test date to be given to BHEL safety officer as per the prescribed formats of BHEL
- The subcontractor shall use only properly insulated and armored cables which conform to the requirement of Indian Electricity Act and Rules for all wiring, electrical applications at site.

- BHEL reserves the right to replace any unsafe electrical installations, wiring, cabling etc. at the cost of the subcontractor.
- All electrical appliances used in the work shall be in good working condition and shall be properly earthed.
- No maintenance work shall be carried out on live equipment.
- The subcontractor shall maintain adequate number of qualified electricians to maintain his temporary electricalinstallations.
- Area wise Electrical safety inspection is to be carried out on monthly basis as per "Electrical Safety Inspection checklist' and the report is to be submitted to BHEL safety officer
- Adequate precautions shall be taken to prevent danger for electrical equipment. No materials on any of the sites of work shall be so stacked or placed as to cause danger or inconvenience to any person or the public
- The subcontractor shall carefully follow the safety requirement of BHEL/ the purchaser with the regard to voltagesused in critical areas.

11.3.8 FIRE SAFETY

- Providing appropriate firefighting equipment at designated work place and nominate a fire officer/warden adequatelytrained for his job.
- Subcontractor shall provide enough fire protecting equipment of the types and numbers at his office, stores, temporarystructure in labor colony etc. Such fire protection equipment shall be easy and kept open at all times.
- The fire extinguishers shall be properly refilled and kept ready which should be certified at periodic intervals. The date of changing should be marked on the Cylinders.
- All other fire safety measures as laid down in the "codes for fire safety at construction site" issued by safety coordinator of BHEL shall be followed.
- Non-compliance of the above requirement under fire protection shall in no way relieve the subcontractor of any of hisresponsibility and liabilities to fire incident occurring either to his materials or equipment or those of others.
- Emergency contacts nos must be displayed at prominent locations
- Tarpaulin being inflammable should not be used (instead, only non-infusible covering materials shall be used) asprotective cover while preheating, welding, stress relieving etc. at site.

- **11.3.9 SCAFFOLDING**
- Suitable scaffolds shall be provided for workman for all works that cannot safely be done from the ground, or from solidconstruction except in the case of short duration of work which can be done safely from ladders
- When a ladder is used, it shall be of rigid construction made of steel. The steps shall have a minimum width of 45 cm and a maximum rise of 30 cm. Suitable handholds of good quality wood or steel shall be provided and the ladder shall be given an inclination not steeper then % horizontal and 1 vertical.
- Scaffolding or staging more than 3.6 m above the ground floor, swung or suspended from an overhead support or erected with stationery support shall have a guard rail properly bolted, braced or otherwise secured, atleast 90 cm above the floor or platform of such scaffolding or staging and extending along the entire length of the out side and ends thereof with only such openings as may be necessary for the delivery of materials. Such scaffolding or staging shall be so fastened as to prevent it form saver, from swaying, from the building or structure.

11.3.10 WORK AT HEIGHT:

- Guardrails and toe-board/barricades and sound platform conforming to 15:4912-1978 should be provided.

- Wherever necessary, life-line(pp or metallic) and fall arrestor along with Polyamide rope or Retractable lifeline should beprovided.

- Safety Net as per 13:11057:1984 should be used extensively for prevention/ arrest of men and materials falling fromheight. The safety nets shall be fire resistant, duly tested and shall be of ISI marked and the nets shall be located as per site requirements to arrest or to reduce the consequences of a possible fall of persons working at different heights.

- Reaching beyond barricaded area without lifeline support, moving with support of bracings, walking on beams without support, jumping from one level to another, throwing objects and taking shortcut must be discouraged.

- Use of Rebar steel for making Jhoola and monkey-ladder (Rods welded to vertical or inclined structural members), temporary platform etc. must be avoided.

- Monkey Ladder should be properly made and fitted with cages.

- Jhoola should be made with angles and flats and tested like any lifting tools before use.

- Lanyard must be anchored always and in case of double lanyard, each should be anchored separately.

- In case of pipe-rack, persons should not walk on pipes and walk on platforms only.

- In case of roof work, walking ladder/platform should be provided along with lifeline and/or fall arrestor.

- Empty drums must not be used.

- For chimney or structure painting, both hanging platform and men should be anchored separately to a firm structurealong with separate fall arrestor. Rope ladder should be discouraged.

11.3.11 WORKING PLATFORM

Working platforms, gangways and stairways shall be so constructed that they do not sag unduly or unequally and if the height of the platform gangways provided is more than 3.6 m above ground level or floor level, they shall be closely boarded and shall have adequate width which shall not be less than 750 mm and be suitably fenced as described above. Every opening in the floor or a building or in a working platform shall be provided with suitable means to prevent the fall of persons or materials by providing suitable fencing or railing whose minimum height shall be 90 cm.

11.3.12 EXCAVATION

Wherever there are open excavation in ground, they shall be fenced off by suitable railing and danger signals installed at night so as to prevent persons slipping into the excavations.

11.3.13 LADDER SAFETY

Safe means of access shall be provided to all working places. Every ladder shall be securely fixed. No portable single ladder shall be over 9 m in the length while the width between side rails in rung ladder shall in no case be less than app. 29.2 cm for ladder upto and including 3 m in length. For longer ladders this width shall be increased at least %" for each additional foot of length.

A sketch of the ladders and scaffolds proposed to be used shall be prepared and approval of the Engineer obtained prior to Construction.

11.3.14 LIFTING SAFETY

It will be the responsibility of the subcontractor to ensure safe lifting of the equipment, taking due precaution to avoid any incident and damage to other equipment and personnel.

- All requisite tests and inspection of handling equipment, tools & tackle shall be periodically done by the subcontractorby engaging only the Competent Persons as per law.
- Defective equipment or uncertified shall be removed from service.
- Any equipment shall not be loaded in excess of its recommended safe working load.

11.3.15 HOISTING APPLIANCE

- Motors, gearing, transmission, electric wiring and other dangerous parts of hoisting appliances should be provided withefficient safe guards.
- Hoisting appliance should be provided with such means as will reduce to the minimum the risk of any par! of a suspendedload becoming incidentally displaced.
- When workers employed on electrical installations which are already energized, insulating mats, wearing apparel, such as gloves, sleeves and boots as may be necessary should be provided.
- The worker should not wear any rings, watches and carry keys or other materials which are good conductor of electricity.

11.4 ENVIRONMENTAL CONTROL

Environment protection has always been given prime importance by BHEL. Environmental damage is a major concern of the principal subcontractor and every effort shall be made, to have effective control measures in place to avoid pollution of Air, Water and Land and associated life. Chlorofluorocarbons such as carbon tetrachloride and trichloroethylene shall not be used. Waste disposal shall be done in accordance with the guidelines laid down in the project specification.

Any chemical including solvents and paints, required for construction shall be stored in designated bonded areas around the site as per Material Safety Data Sheet (MSDS).

In the event of any spillage, the principle is to recover as much material as possible before it enters drainage system and to take all possible action to prevent spilled materials from running off the site. The subcontractor shall use appropriate MSDS for clean-up technique

All subcontractors shall be responsible for the cleanliness of their own areas.

The subcontractors shall ensure that noise levels generated by plant or machinery are as low as reasonablypracticable. Where the subcontractor anticipates the generation of excessive noise levels from his operations thesubcontractor shall inform to Construction Manager of BHEL accordingly so that reasonable ^practicable precautionscan be taken to protect other persons who may be affected.

It is imperative on the part of the subcontractor to join and effectively contribute in joint measures such as treeplantation, environment protection, contributing towards social upliftment, conversion of packing woods to schoolfurniture, keeping good relation with local populace etc.

The subcontractor shall carry out periodic air and water quality check and illumination level checking in his area ofwork place and take suitable control measure.

11.5 HOUSEKEEPING

Keeping the work area clean/free from debris, removed scaffoldings, scraps, insulation/sheeting wastage /cut pieces, temporary structures, packing woods etc. will be in the scope of the subcontractor. Such cleanings has to be done by.

subcontractor within quoted rate, on daily basis by an identified group. If such activity is not carried out by subcontractor / BHEL is not satisfied, then BHEL may get it done by other agency and actual cost along with BHEL overheads will be deducted from contractor's bill. Such decisions of BHEL shall be binding on the subcontractor

- Proper housekeeping to be maintained at work place and the following are to betaken care of on daily basis.
- All surplus earth and debris are removed/disposed off from the working areas to identified locations.
- Unused/Surplus cables, steel items and steel scrap lying scattered at different places/elevation within the workingareas are removed to identified locations.
- All wooden scrap, empty wooden cable drums and other combustible packing materials, shall be removed fromworkplace to identified locations. Sufficient waste bins shall be provided at
- Different work places for easy collection of scrap/waste. Scrap chute shall be installed to remove scrap from highlocation.
- Access and egress (stair case, gangways, ladders etc.) path should be free from all scrap and other hindrances.
- Workmen shall be educated through tool box talk about the importance of housekeeping and encourage not to litter.
- Labour camp area shall be kept clear and materials like pipes, steel, sand, concrete, chips and bricks, etc. shall notbe allowed in the camp to obstruct free movement of men and machineries.
- Fabricated steel structures, pipes & piping materials shall be stacked properly.
- No parking of trucks/trolleys, cranes and trailers etc. shall be allowed in the camp, which may obstruct the trafficmovement as well as below LT/HT power line.
- Utmost care shall be taken to ensure over all cleanliness and proper upkeep of the working areas

11.6 WASTE MANAGEMENT

Take suitable measures for waste management and environment related laws/legislation as a part of normal construction activities. Compliance with the legal requirements on storage/ disposal of paint drums (including the empty ones), Lubricant containers, Chemical Containers, and transportation and storage of hazardous chemicals will be strictly maintained

11.6.1 BINS AT WORK PLACE

- Sufficient rubbish bins shall be provided close to workplaces.
- Bins should be painted yellow and numbered.
- Sufficient nos. of drip trays shall be provided to collect oil and grease.
- Sufficient qty. of broomsticks with handle shall be provided.
- Adequate strength of employees should be deployed to ensure daily monitoring and service for wastemanagement.

11.6.2 STORAGE AND COLLECTION

- Different types of rubbish/waste should be collected and stored separately.
- Paper, oily rags, smoking material, flammable, metal pieces should be collected in separate bins with close fittinglids.
- Rubbish should not be left or allowed to accumulate on construction and other work places.
- Do not burn construction rubbish near working site.

11.6.3 SEGREGATION

- Earmark the scrap area for different types of waste.
- Store wastes away from building.
- Oil spill absorbed by non-combustible absorbent should be kept in separate bin.
- Clinical and first aid waste stored and incinerated separately.

11.6.4 DISPOSAL

- Sufficient containers and scrap disposal area should be allocated.
- All scrap bin and containers should be conveniently located.
- Provide self-closing containers for flammable/spontaneously combustible material.
- Keep drainage channels free from choking.
- Make schedule for collection and disposal of waste.

11.6.5 WARNING AND SIGNS

- Appropriate sign to be displayed at scrap storage area
- No toxic, corrosive or flammable substance to be discarded into public sewage system.
- Waste disposal shall be in accordance with best practice.
- Comply with all the requirements of Pollution Control Board (PCB) for storage and disposal of hazardous waste.

11.7 TRAFFIC MANAGEMENT SYSTEM

11.7.1 SAFE WORKPLACE TRANSPORT SYSTEM

- Traffic routes in a work place shall be suitable for the persons or vehicles using them. This shall be sufficient in number and of sufficient size. This shall reflect the suitability of traffic routes for vehicles and pedestrians.
- Where vehicles and pedestrians use the same traffic routes there shall be sufficient space between them. Where necessary all traffic routes must be suitably indicated. Pedestrians or vehicles must be able to use traffic routes necessary all traffic routes must be suitably indicated. Pedestrians or vehicles must be able to use traffic routes pedestrian traffic routes.
- For internal traffic, lines marked on roads / access routes and between buildings shall clearly indicate where vehicles are to pass.
- The traffic route should be wide enough to allow vehicles to pass and re-pass oncoming or parked traffic and itmay be advisable to introduce on-way system or parking restrictions.
- Safest route shall be provided between places where vehicles have to call or deliver.
- Avoid vulnerable areas/items such as fuel or chemicals tanks or pipes, open or unprotected edges andstructures likely to collapse

- Safe areas shall be provided for loading and unloading.
- Avoid sharp or blind bends. If this is not possible hazards should be indicated e.g. blind corner.
- Ensure road crossings are minimum and clearly signed.
- Entrance and gateways shall be wide enough to accommodate a second vehicle without causing obstruction.
- Set sensible speed limits which are clearly sign posted.
- Where necessary ramps should be used to retard speed. This shall be preceded by a warning sign or mark onthe road.
- Forklift trucks shall not pass over road hump unless of a type capable of doing so.
- Overhead electric cable, pipes containing flammable hazardous chemical shall be shielded by using goal postsheight gauge posts or barriers.
- Road traffic signs shall be provided on prominent locations for prevention of incidents and hazards and for quickguidance and warning to employees and public. Safety signs shall be displayed as per the project workingrequirement and guideline of the state in which project is done. Vehicles hired or used shall not be parked withinthe 15m radius of any working area. Any vehicle, that is required to be at the immediate/near the vicinity, shall be
- approved by the person in-charge of the site.

11.7.2 TRAFFIC ROUTE FOR PEDESTRIANS

- Where traffic routes are used by both pedestrians and vehicles road shall be wide enough to allow vehicles and pedestrians safely.
- Separate routes shall be provided for pedestrians to keep them away from vehicles. Provide suitable barriers/guard at entrances/exit and the corners or buildings.
- Where pedestrian and vehicle routes cross, appropriate crossing shall be provided.
- Where crowd is likely to use roadway e.g. at the end of shift, stop vehicles from using them at such times.
- Provide high visibility clothing for people permitted in delivery area.

11.7.3 WORK VEHICLE

Work vehicle shall be as safe stable efficient and roadworthy as private vehicles on public roads. Site management shall ensure that drivers are suitably trained. All vehicle e.g. heavy motor vehicle forklift trucks dump trucks mobile cranes shall ensure that the work equipment conforms to the following:

- A high level of stability.
- A safe means of access/egress.
- Suitable and effective service and parking brakes.
- Windscreens with wipers and external mirrors giving optimum all round visibility.
- Provision of horn, vehicle lights, reflectors, reversing lights, reversing alarms.
- Provision of seat belts.
- Guards on dangerous parts.
- Driver protection - to prevent injury from overturning and from falling objects/materials.
- Driver protection from adverse weather.
- No vehicle shall be parked below HT/LT power lines.
- Valid Pollution Under Control certification for all vehicles

11.7.4 DAILY CHECK BY DRIVER

- There should also be daily safety checks containing below mentioned points by the driver before the vehicle is used.
- o Brakes.
- o Tires.
- o Steering.
- o Mirrors.
- o Windscreen waters.
- o Wipers.
- o Warning signals.
- o Specific safety system i.e. control interlocks
- Management should ensure that drivers carry out these checks.

11.7.5TRANSPORTATION OF PERSONNEL AND MATERIALS BY VEHICLES

- All drivers shall hold a valid driving License for the class of vehicle to be driven and be registered as an authorized BHEL driver with the Administration Department.
- Securing of the load shall be by established and approved methods, i.e. chains with patented tightening equipment for steel/heavy loads. Sharp corners on loads shall be avoided when employing ropes for securing.
- All overhangs shall be made clearly visible and restricted to acceptable limits
- Load shall be checked before moving off and after traveling a suitable distance.
- On no account is construction site to be blocked by parked vehicles Drivers of vehicles shall only stop or park in the areas designate by the stringing foreman.
- Warning signs shall be displayed during transportation of material.
  All vehicles used by BHEL shall be in worthy condition and in conformance to the Land Transport requirement.

11.7.6MAINTENANCE

All Vehicles used for transportation of man and material shall undergo scheduled inspections on frequent intervals to secure safe operation. Such inspections shall be conducted in particular for steering, brakes, lights, horn, doors etc. Site management shall ensure that work equipment is maintained in an efficient, working order and in good repair. Inspections and services carried out at regular intervals of time and or mileage. No maintenance shall be carried below HT/LT power lines.

11.8 EMERGENCY PREPAREDNESS AND RESPONSE

Emergency preparedness and response capability of site shall be developed as per Emergency Preparedness and Response plan issued by Regional HO

Availability of adequate number of first aiders and fire warden shall be ensured with BHEL and its subcontractors All the subcontractor's supervisory personnel and sufficient number of workers shall be trained for fire protection systems. Enough number of such rained personnel must be available during the tenure of contract. Subcontractor should nominate his supervisor to coordinate and implement the safety measures. Assembly point shall be earmarked and access to the same from different location shall be shown Fire exit shall be identified and pathway shall be clear for emergency escape.

- Appropriate type and number of fire extinguisher shall be deployed as per Fire extinguisher deployment plan andvalidity shall be ensured periodically through inspection
- Adequate number of first aid boxes shall be strategically placed at different work places to cater emergency need. Holder of the first aid box shall be identified on the box itself who will have the responsibility to maintain the same.

- First aid center shall be developed at site with trained medical personnel and ambulance

- Emergency contact numbers (format given in EPRP) of the site shall be displayed at prominent locations.

- Tie up with fire brigade shall be done in case customer is not having fire station.

- Tie up with hospital shall be done in case customer is not having hospital.

- Disaster Management group shall be formed at site

- Mock drill shall be arranged at regular intervals. Monthly report of the above to be given to BHEL safety Officeras per prescribed BHEL formats

- Mock drill shall be conducted on different emergencies periodically to find out gaps in emergency preparednessand taking necessary corrective action

12.0 HSE INSPECTION

Inspection on HSE for different activities being carried out at site shall be done to ensure compliance to HSEMS requirements. The subcontractor shall maintain and ensure necessary safety measures as required for inspection and tests HV test, Pneumatic test, Hydraulic test, Spring test, Bend testetc as applicable, to enable inspection agency for performing Inspection. If any test equipment is found not complying with proper safety requirements then the Inspection Agency may withhold inspection, till such time the desired safety requirements are met.

12.1 DAILY HSE CHECKS

Both the Site Supervisors and safety officer of Subcontractor are to conduct daily site Safety inspection around work activities and premises to ensure that work methods and the sites are maintained to an acceptable standard. The following are to form the common subjects of a daily safety inspection:

- Personal Safety wears &gear compliance.
- Complying with site safety rules and perm it-to-work (PTW).
- Positions and postures of workers.
- Use of tools and equipment etc. by the workers.

The inspection should be carried out just when work starts in beginning of the day, during peak activities period of the day and just before the day's work ends.

12.2 INSPECTION OF PPE

- PPEs shall be inspected by HSE officer at random once in a week as per format no. HSEP:13-F06 for itscompliance to standard and compliance to use and any adverse observation shall be recorded in the PPE register.

- The applicable PPEs for carrying out particular activities are listed below.

12.3 INSPECTION OF T&Ps

- A master list of T&Ps shall be maintained by each subcontractor.
- All T&Ps being used at site shall be inspected by HSE officer once in a month as per format no. HSEP:13-F07 for its healthiness and maintenance.
- The T&Ps which require third party inspection shall be checked for its validity during inspection. The third party test certificate should be accompanied with a copy of the concerned competent person's valid qualification record.
- The validity of T&P shall be monitored as per "Status of T&Ps" format no. HSEP:13-F08

12.4 INSPECTION OF CRANES AND WINCHES

- Cranes and winches shall be inspected by the operator through a daily checklist for its safe condition (as provided by the equipment manufacturer) before first use of the day.
- Cranes and Winches shall be inspected by HSE officer once in a month as per format no. HSEP:13-F09 for healthiness, maintenance and validity of third party inspection.
- The date of third party inspection and next due date shall be painted on cranes and winches.
- The operators/drivers shall be authorized by sub-contractor based on their competency and experience and shall carry the l-card.
- The operator should be above 18 years of age and should be in possession of driving license of HMV man & goods), vision test certificate and should have minimum qualification so that he can read the instructions and check list.

12.5 INSPECTION ON HEIGHT WORKING

- Inspection on height working shall be conducted daily by supervisors before start of work to ensure safe working condition including provision of
    - Fall arrestor
    - Lifelines
    - Safety nets
    - Fencing and barricading
    - Warning signage
    - Covering of opening
    - Proper scaffolding with access and egress.
    - Illumination
- Inspection on height working shall be conducted once in a week by HSE officer as per format no. HSEP:14-F10.
- Medical fitness of height worker shall be ensured.
- Height working shall not be allowed during adverse weather.

12.6 INSPECTION ON WELDING AND GAS CUTTING OPERATION

- Supervisor shall ensure that no flammable items are available in near vicinity during welding and gas cutting activity.
- Gas cylinders shall be kept upright.
- Use of Flash back arrestor shall be ensured at both ends.

- Inspection during welding and gas cutting operations shall be carried out by HSE officer once a month as per format no. HSEP:14-F11.
- Use of fire blanket to be ensured to avoid falling of splatters during welding or gas cutting operation at height.
- Availability of fire extinguisher at vicinity shall be ensured.

12.7 INSPECTION ON ELECTRICAL INSTALLATION / APPLIANCES

- Ensure proper earthing in electrical installation
- Use ELCB at electrical booth
- Electrical installation shall be properly covered at top where required
- Use appropriate PPEs while working
- Use portable electrical light < 24 V in confined space and potentially wet area.
- Monthly inspection shall be carried out as per format no. HSEP:14-F12.

12.8 INSPECTION OF ELEVTOR

- Elevators shall be inspected by concerned supervisors once in a week as per format no. HSEP:14-F13.
- All elevators shall be inspected by competent person and validity shall be ensured.
- The date of third party inspection and next due date shall be painted on elevator.

13.0 HSE PERFORMANC

HSE performance of the subcontractor shall be monitored as per the following parameters:

Sl.No	Parameters of measurement
1	Timely deployment of qualified safety officer and cumulative number of days in a month the required no. of qualified safety officer is available
2	Shortfall in number of meetings in the month conducted or attended by the safety officer
3	Level of compliance wrt decisions taken in previous meetings/audit/inspection/as reported.
4	Delay in submission of monthly report on safety in the prescribed format
5	Delay in reporting any incident including near-miss to BHEL /Customer/statutory authority! required)
6	Degree of PPE non-compliance
7	Non- conducting of health check-up as per BOCWequirements
8	Non availability of proper first-aid facility , ambulance, adequate labour welfare initiatives
9	Non conductance of induction training and tool box meeting
10	Total number of instances in the month, House keeping NOT attended inspite of instructions by BHEL i.e. removal/disposal of surplus earth/ debris/scrap/unused/surplus cable drums/other electrical items/surplus steel items/packing material

- Suitable HSE reward system shall be developed at site level to promote HSE compliance amongst workmen.
- To decide HSE reward performance towards HSE shall be evaluated for workmen and it shall be awarded regularly in public gathering.
- If safety record of the subcontractor in execution of the awarded job is to the satisfaction of safety department of BHEL, issue of an appropriate certificate to recognize the safety performance of the subcontractor may be considered by BHEL after completion of the job.

14.0 HSE PENALTIES

- As per contractual provision HSE penalties shall be imposed on subcontractors for non- compliance on HSErequirement as per format no. HSEP:14-F14. The list in the format is only indicative. For any other violation, not listed in the format, the minimum penalty amount is to be decided as per BOCW act.

- If principal customer/statutory and regulatory bodies impose some penalty on HSE due to the non-compliance ofthe subcontractor the same shall be passed on to them.
- The penalty amount shall be recovered by Site Finance department from subcontractors from the RA/Final bill.

15.0 OTHER REQUIREMENTS

- In case of any delay in completion of a job due to mishaps attributable to lapses by the subcontractor, BHELshall have the right to recover cost of such delay from the payments due to the subcontractor, after notifying the subcontractor suitably.
- If the subcontractor fails to improve the standards of safety in its operation to the satisfaction of BHEL after being given reasonable opportunity to do so and/or if the subcontractor fails to take appropriate safety precautions or to provide necessary safety devices and equipment or to carry out instruction regarding safety issued by BHEL, BHEL shall have the right to take corrective steps at the risk and cost of the subcontractor after giving a notice of not less than 7 days indicating the steps that would be taken by BHEL.
- If the subcontractor succeeds in carrying out its job in time without any fatal or disabling injury incident and without any damage to property BHEL may, at its sole discretion, favorably consider to reward the subcontractor suitably for the performance.
- In case of any damage to property due to lapses by the subcontractor, BHEL shall have the right to recover the cost of such damages from the subcontractor after holding an appropriate enquiry.
- The subcontractor shall take all measures at the sites of the work to protect all persons from incidents and shall be bound to bear the expenses of defense of every suit, action or other proceeding of law that may be brought by any persons for injury sustained or death owing to neglect of the above precautions and to pay any such persons such compensation or which may with the consent of the subcontractor be paid to compromise any claim by any such person, should such claim proceeding be filed against BHEL, the subcontractor hereby agrees to indemnify BHEL against the same.
- The subcontractor shall not employ men below the age of 18 years and women on the work of painting with products containing lead in any form. Wherever men above the age of 18 are employed on the work of lead painting, overalls shall be supplied by the subcontractor to the workmen and adequate facilities shall be provided to enable the working painters to wash during the cessation of work.
- The subcontractor shall notify BHEL of his intention to bring to site any equipment or material which may create hazard.

- BHEL shall have the right to prescribe the conditions under which such equipment or materials may be handledand the subcontractor shall adhere to such instructions.

- BHEL may prohibit the use of any construction machinery, which according to the organization is unsafe. No claim for compensation due to such prohibition will be entertained by BHEL.

16.NON COMPLIANCE

NONCONFORMITY OF SAFETY RULES AND SAFETY APPLIANCES WILL BE VIEWED SERIOUSLY AND BHEL HAS RIGHT TO

IMPOSE FINES ON THE SUBCONTRACTOR AS UNDER FOR EVERY INSTANCE OF VIOLATION NOTICED:

SN	Violation of Safety Norms	Fine (in Rs)
01	Not Wearing Safely Helmet	200/- *
02.	Not wearing Safety Belt or not anchoring life line	500/-*
03	Not wearing safety shoe	200/-*
04	Not keeping gas cylinders vertically	200/-
05	Not using flash back arrestors	100/-
06	Not wearing gloves	50/-*
07.	Grinding Without Goggles	50/-*
08.	Not using 24 V Supply For Internal Work	500/-
09.	Electrical Plugs Not used for hand Machine	100/-
10.	Not Slinging properly	200/-
11.	Using Damaged Sling	200/-
12.	Lifting Cylinders Without Cage	500/-
13.	Not Using Proper Welding Cable With Lot of Joints And Not Insulated Property.	200/-
14.	Not Removing Small Scrap From Platforms	500/-
15.	Gas Cutting Without Taking Proper Precaution or Not Using Sheet Below Gas Cutting	500/-
16.	Not Maintaining Electric Winches Which are Operated Dangerously	500/-
17.	Improper Earthing Of Electrical T&P	500/-
18	No or improper barricading	500/-
19.	Activity carried out without Safety work permit (Height work, Lifting activity, Hot work-each person/case)	1000/-
20.	Incident Resulting in Partial Loss in Earning Capacity	25,000/-per victim
21.	Fatal Incident Resulting in total loss in Earning Capacity	1,00,000/- per victim for

•Legend:-

": per head. For repeated violation by the same person, the penalty would be double of the previous penalty. Date of "Repeated violation" will be counted from subsequent days.

#: or as deducted by customer, whichever is higher. For repeated fatal incident in the same Unit incremental penalty to be imposed. The subcontractor will pay 2 times the penalty compared to previously paid in case there are repeated cases of fatal incidents under the same subcontractor for the same package in the same unit.

Any other non-conformity noticed not listed above will also be fined as deemed fit by BHEL. The decision of BHEL engineer is final on the above. The amount will be deducted from running bills of the subcontractor. The amount collected above will be utilized for giving award to the employees who could avoid incident by following safety rules. Also the amount will be spent for purchasing the safety appliances and supporting the safety activity at site.

17.0 HSE AUDIT/INSPECTION

- Regular HSE Audit/inspection shall be carried out by Subcontractor as per Site HSE audit calendar.
- **HSE checklist (An nexu re** 02)shall be used for carrying out audit/inspection and report shall be submitted toBHEL sitemangement
- All non-conformities and observations on HSE identified during internal or external HSE audit shall be disposedoff by site in a time bound manner and reported back the implementation status.
- Corrective action and Preventive action on HSE issues raised by certification body issued by Regional HOs shallbe implemented by site and reported to Site management.

18.0 MONTHLY HSE REVIEW MEETING

- Site shall hold HSE review meeting every month to discuss and resolve HSE issues of site and improve HSE
  performance. It will also discuss the incidents occurred since previous meeting,its root causeand Corrective
  action and Preventive action.The agenda is given below:
    - Implementation of earlier MOM
    - HSE performance
    - HSE inspection
    - HSE audit and CAPA
    - HSE training
    - Health check-up camp
    - HSE planning for the erection and commissioning and installation activities in the coming month
    - HSE reward and promotional activities
- The meeting shall be chaired by Construction Manager, convened by HSE coordinator and attended by all HOS,
  Site Incharge of Subcontractors and HSE officer of Subcontractors.
- MOM on the discussion will be circulated to the concerned for implementation.

19.0 FORMATS USEDfDetails available in Annexure-04)

SL. No.	Format Name	Format No.	Rev No.
01	Inspection of First Aid Box	HSEP:13-F01	00
02	Health Check Up	HSEP:13-F02	00
03	HSE Induction Training	HSEP:13-F03	00
04	Tool Box Talk	HSEP:13-F04	00
05	Monthly Site HSE Report	HSEP:13-F05	00
06	Inspection of PPE	HSEP:13-F06	00

07	Inspection of T&Ps	HSEP:13-F07	00
08	Status ofT&Ps	HSEP:13-F08	00
09	Inspection of Cranes and Winches	HSEP:13-F09	00
10	Inspection on Height Working	HSEP:13-F10	00
11	Inspection on Welding & Gas Cutting	HSEP:13-F11	00
12	Inspection on Electrical Installation	HSEP:13-F12	00
13	Inspection on Elevator	HSEP:13-F13	00
14	HSE Penalty	HSEP:13-F14	00
15	Accident /incident / property damage /Tire incident	HSEP:13-F15	00

20.0 ANNEXURES **ANNEXURE 01**

As per Contract Labour (Regulation & Abolition Act), Central Rules, 1971,

(1) The first-aid box shall be distinctively marked with a Red Cross on a white background and shall contain the following items, namely:

(a) For establishments in which the number of contract labour employed does not exceed fifty, each first aid box shall contain the following equipment:

(i)	6 small sterilized dressings
(ii)	3 medium size sterilized dressings
(Hi)	3 large size sterilized dressings
(iv)	6 pieces of sterilized eye pads in separate sealed packets.
(V)	6 roller bandages 1 0 cm wide.
(Vi)	6 roller bandages 5 cm wide.
(vii)	One tourniquet
(viii)	A supply of suitable splints
(ix)	Three packets of safety pins.
(x)	Kidney tray.
(xi)	3 large sterilized burn dressings.
(xii)	1 (30ml) bottle containing a two percent alcoholic solution of iodine
(xiii)	1 (30 ml) bottle containing Sal volatile having the dose and mode of administration indicated on the label
(xiv)	1 snake bite lancet
(XV)	1 (30gms) bottle of potassium permanganate crystals.
(xvi)	1 pair scissors
(xvii)	1 copy of the First-Aid leaflet issued by the Director General, Factory Advice Service and Labour Institutes, Government of India.
(xviii)	A bottle containing 100 tablets (each of 5 grains) of aspirin
(xix)	Ointment for burns
(XX)	A bottle of suitable surgical anti-septic solution

(b) For establishment in which the number of contract labour exceeds fifty each first-aid box shall contain the following equipment:

(i)	12 small sterilized dressings
(ii)	6 medium size sterilized dressings
(iii)	6 large size sterilized dressings.
(iv)	6 large size sterilized burn dressings
(v)	6 (15 grams) packets sterilized cotton wool
(vi)	12 pieces of sterilized eye pads in separate sealed packets.

(vii)	12 roller bandages 10 cm wide.
(viii)	12 roller bandages 5 cm wide.
(ix)	One tourniquet.
(x)	A supply of suitable splints.
(xi)	Three packets of safety pins.
(xii)	Kidney tray.
(xiii)	Sufficient number of eye washes bottles filled indicated by a distinctive sign which shall be visible at all times.
(xiv)	4 per cent Xylocaine eye drops, and boric acid eye drops and soda by carbonate eye drops.
(XV)	1 (60ml) bottle containing a two percent alcoholic solution of iodine
(xvi)	One (two hundred ml) bottle of mercurochrome (2 per cent) solution in water.
(xvii)	1 (120ml) bottle containing Sal volatile having the dose and mode of administration indicated on the label.
(xvi11)	1 roll of adhesive plaster (6 cmX1 meter)
(xix)	2 rolls of adhesive plaster (2 cmX1 meter)
(xx)	A snake bite lancet.
(xxi)	1 (30 grams) bottle of potassium permanqanate crystals.
(xx11)	1 pair scissors
(xx111)	1 copy of the First-Aidleaflet issued by the Director-General, Factory Adive service and
(XX I V)	a bottle containing 1 00 tablets (each of 5 grains) of aspirin
(xxv)	Ointment for burns
(xxvi)	A bottle of a suitable surgical anti septic solution.

(2) Adequate arrangement shall be made for immediate recoupment of the equipment when necessary.

ANNEXURE 02

HSE AUDIT/INSPECTION CHECKLIST CUM COMPLIANCE REPORT

PROJECT: SUBCONTRACTOR:

DATE : OWNERR

INSPECTION BY:

Note : write 'NA' wherever the items is not

Item		NO	Remarks	Action
HOUSEKEEPING				
Waste containers provided and used				
Passageways and walkways clear				
General neatness of working area				
Other				
PERSONNELPROTEC TIVEEQUIPTMENTS				
Goggles; shields				
Face protection				
Hearinq protection				
Respiratory masks etc.				
Safety belts				
Other				
EXCAVATIONS / OPENINGS				
Openings properly covered or barricaded				
Excavations shored				
Excavations barricaded				
Overnight lighting provided				
Other				
WELDING, CUTTING				
Gas cylinders chained upright				
Cable and hoses not obstructing				
Fire extinguisher (s) accessible				
Others				
SCAFFOLDING				
Fully decked platforms				
Guard and intermediate rails in place				
Toe boards in place				
Adequate shoring				
Adequate access				
Others				
LADDER				
Extension side rails 1 m above				
Top of landinq				
Properly secured				

Angle + 70^{U} from horizontal				
Other				
HOISTS, CRANES AND DERRICKS				
Condition of cables and sheaf OK				
Condition of slinqs, chains, hooks OK				
Inspection & maintenance loq maintained				
Outriqqers used				
Signals observed and understood				
Qualified operators				
Others				
MACHINERY, TOOLS & EQUIPMENT				
Proper instruction				
Safety devices				
Proper cords				
Inspection and maintenance				
Other				
VEHICLE AND TRAFFIC				
Rules and regulations observed				
Inspection and maintenance				
Licensed drivers				
Other				
TEMPORARY FACILITIES				
Emerqency instructions posted				
Fire extinguishers provided				
Fire-aid equipment available				
General neatness				
Others				
FIRE PREVENTION				
Personnel instructed				
Fire extinquishers checked				
No smokinq in prohibited areas.				
Hydrants				
Clearance				
Others				
ELECTRICAL				
Proper wirinq				
ELCB's provided				
Ground fault circuit interrupters				
Protection against damage				
Prevention of tripping hazards				
Other				
HANDLING & STORAGE OF MATERIALS				
Properly stored or stacked				
Passageways clear				
Other				
FLAMMABLE GASES AND LIQUIDS				
Containers clearly identified				
Proper storage				
Fire extinguisher nearby				

Other				
WORKING AT HEIGHT				
Safety nets				
Safety belts				
Safety helmets				
Anchoring of safety belt to the life line rope				
ENVIRONMENT				
Lubricant waste/engine oils properly dispose.				
Waste from Canteen, offices, sanitation etc. disposed properly.				
Disposal of surplus earth, stripping materials, expired batteries, oily rags and combustible materials done properly.				
HEALTH CHECKS				
Hygienic conditions at labor camps O.K.				
Availability of first-aid facilities				
Proper sanitation at site, office & labor camps.				
Arrangement of medical facilities.				
Measures for dealing with illness.				
Availability of potable drinking water for workmen &staff.				
Provision of creches for children.				

REFERENCES

ANNEXURE 03

- Contract documents
- Relevant legislations
- HSEMSM
- Relevant Indian standards as listed below (illustrative only):

SL NO	CODE NAME	TITLE
0)	IS : 818-1888 (Reaffirmed 2003)	Code of Practice for safety and health requirements in Electric and Gas Welding and Cutting operations.
(2)	IS: 1179-1967 (Reaffirmed 2003)	Specification for Equipment for Eye & Face protection during welding.
(3)	IS : 1989 (Part 2):1986 (Reaffirmed 1997)	Specification for Leather Safety Boots & Shoes
(4)	13:2925-1984 (Reaffirmed 2010)	Specification for Industrial Safety Helmets
(5)	13:3521 : 1999 (Reaffirmed 2002)	Industrial Safety Belts & Harnesses-Specification
(6)	IS:3646(Part II) - 1966 (Reaffirmed 2003)	Code of Practice for Interior Illumination
(7)	13:3696 (Part IJ-1987 (Reaffirmed 2002)	Safety Code for Scaffolds and Ladders
(8)	IS: 3696(Part 2) : 1991 (Reaffirmed 2002)	Scaffolds and Ladders-Code of Safety
(9)	13:3786-1983 (Reaffirmed 2002)	Method for Computation of Frequency and Severity Rates for Industrial Injuries and Classification of Industrial Incidents
(10)	13:4770 : 1991 (Reaffirmed 2006)	Rubber Gloves - Electricals purposes-Specification
(11)	13:4912 : 1978 (Reaffirmed 2002)	Safety Requirements for Floor and Wall Openings, Railings and Toe Boards
(12)	13:5983-1980 (Reaffirmed 2002)	Specification for Eye-Protectors
(13)	13:6519-1971 (Reaffirmed 1997)	Code of Practice for Selection, Care and Repair of Safety Footwear
(14)	13:9167:1979	Specification for Ear-Protectors
(15)	IS:6994(Partl)-1973 (Reaffirmed 1996)	Specification for Industrial Safety Gloves Leather and Cotton Gloves
(16)	13:8519-1977 (Reaffirmed 1983)	Guide for Selection of Industrial Safety Equipment for Body Protection.
(17)	IS 11006 :2011	Flash Back(Flame Arrestor) Specification

(18)	13:8520-1977 (Reaffirmed 2002)	Guide for Selection of Industrial Safety Equipment for Eye, Face and Ear Protection.
(19)	13:9473:2002	Respiratory Protective Devices-Filtering Half Masks to protect against Particles-Specification.
(20)	13:9944:1992 (Reaffirmed 2003)	Natural and Man-made Fiber Rope Slings-Recommendations on Safe working loads.
(21)	13:11057-1884 (Reaffirmed 2001)	Specification for Industrial Safety Nets
(22)	13:12254:1993 (Reaffirmed 2002)	Polyvinyl Chloride (PVC) Industrial Boots-Specification
(23)	IS:13367(Part 1):1992 (Reaffirmed 20030	Safe Use of Cranes-Code of Practice
(24)	13:14166:1994 (Reaffirmed 2002)	Respiratory Protective Devices-Full Face Masks Specification
(25)	13:14746 : 1999 (Reaffirmed 2003)	Respiratory Protective Devices-Half Masks and Quarter Masks - Specification
(26)	IS : 15397 :2003 (Reaffirmed 2008)	Portable Extinguisher Mechanical Foam Type(Stored PressureJ-Specification
(27)	IS: 19011:2002	Guidelines for Quality and/or Environmental Management Systems Auditing

ANNEXURE 04 : SAFETY FORMATS

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ANNEXURE 05 : WORK PERMIT FORMATS

	INDUSTRIAL SYSTEMS GROUP	FORMAT NO : HSEP:13-F01 REV NO.: 00 PAGE NO. 01 OF 02
	INSPECTION OF FIRST AID BOX	

Name of Site :	
Name of Sub-Contractor :	
Inspected by :	
Date of Inspection :	

Number of employees on the site:-.

Sl. No.	Item	No. Available	Remarks
1	No. of small sterilized dressings		
2	No of medium sized sterilized dressings		
3	No of large sized sterilized dressings.		
4	No of large sized sterilized burn dressings		
5	No of (15 grams) packets sterilized cotton wool		
6	No of pieces of sterilized eye pads in separate sealed packets.		
7	No of roller bandages 10 cm wide.		
8	No of roller bandages 5 cm wide.		
9	Whethertourniquet available		
10	Whether supply of suitable splints available.		
11	No of packets of safety pins.		
12	Whether kidney tray available		
13	Whether sufficient number of eye wash bottles, filled with distilled water or suitable liquid, clearly indicated by a distinctive sign which shall be visible at all times, available.		
14	Whether 4%-xylocaine eye drops, and boric acid eye drops and soda by carbonate eye drops available.		
15	Whether (60ml) bottle containing a two percent alcoholic solution of iodine available		
16	Whether (two hundred ml) bottle of mercurochrome (2 per cent) solution in water available.		

BHEL	**INDUSTRIAL SYSTEMS GROUP**	FORMAT NO : HSEP:13-F01 REV NO.: 00 PAGE NO. 02 OF 02
	INSPECTION OF FIRST AID BOX	

Sl. No.	Item	No. Available	Remarks
17	Whether 120ml bottle containing Sal volatile having the dose and mode of administration indicated on the label, available.		
18	Whether roll of adhesive plaster (6 cmXl meter) available		
19	No of rolls of adhesive plaster (2 cmXl meter)		
20	Whether snake bite lancet available.		
21	Whether (30 grams) bottle of potassium permanganate crystals available.		
22	Whether a pair scissors available		
23	Whether copy of the FIrst-AId leaflet issued by the Director-General, Factory Advice service and labour Institutes, Government of India available.		
24	Whether bottle containing 100 tablets (each of 5 grains) of aspirin available		
25	Whether Ointment for burns available		
26	Whether bottle of a suitable surgical anti septic solution available		

Signature of Subcontractor's Site I/C::

	INDUSTRIAL SYSTEMS GROUP	FORMAT NO : HSEP:13-F02 REV NO.: 00 PAGE NO. 01 OF 02
	HEALTH CHECK UP	

Name of Site :	
Name of Sub-Contractor	
Name of Employee :	

NAME:

History Of past Illness	H/O Epilepsy		
	H/O Drug Allergy		
	H/O Diabetics / Hypertension		
	H/O Unconsciousness		
Personal History			
EXAMINATION			**OBSERVATION**
<u>General Physical Examination</u>			
Height	:		
Weight	:		
BMI	:		
Built And nourishment	:		
Pallor	:		
Temperature	:		
Chest Expansion	:	Inspiration	Expansion
Lymph Node Enlargement	:		
<u>Ear, Nose, Throat</u>	:		
Ear	:		
Nose	:		
Throat	:		

BHEL	**INDUSTRIAL SYSTEMS GROUP**	FORMAT NO : HSEP:13-F02 REV NO.: 00 PAGE NO. 02 OF 02
	HEALTH CHECK UP	

EXAMINATION		**OBSERVATION**
<u>Cardiovascular System Examination</u> :		
Inspection	:	
Palpation	: Pulse	BP
Auscultation (Heart Sounds)	:	
<u>Respiratory System</u> :		
Inspection	: Respiratory Rate	
Palpation	:	
Percussion	:	
Auscultation (Breath Sounds)	:	
<u>Examination of Abdomen</u> :		
Inspection	:	
Palpation	:	
Auscultation (Bowel Sounds)	:	
Any Other	:	
Clinical Impression	:	

Signature of the examining doctor

	INDUSTRIAL SYSTEMS GROUP	FORMAT NO : HSEP:13-F03 REV NO.: 00 PAGE NO. 01 OF 01
	HSE INDUCTION TRAINING	

Name of Site :	
Name of Sub-Contractor	
Date :	
Name of Training Co-ordinator	

Sl No.	**Name**	**Designation**	**Organization**	**Signature**

Signature of Training Co-ordinate :

	INDUSTRIAL SYSTEMS GROUP	FORMAT NO : HSEP:13-F04 REV NO.: 00 PAGE NO. 01 OF 01
	TOOL-BOX TALK	

Name of the Site :	
Sub-Contractors Name :	
Date :	

Topic	**Name of the person delivered Tool Box Talk**	**No. of Participants attended**	**Remarks**

Signature of Site I/C of Subcontractor:

	INDUSTRIAL SYSTEMS GROUP	FORMAT NO : HSEP:13-F06 REV NO.: 00 PAGE NO. 01 OF 01
	PERSONAL PROTECTIVE EQUIPMENTS	

Name of the Site :	
Name ofSub-Contractors Name :	
Inspected by :	
Date of Inspection :	

Item	**Issued this Month**	**No. Issued up to the Month**	**Percentage of usage at site**
Safety Helmet			
Safety Shoes			
Full Body Harness			
Fall Arrestor			
Safety Nets			
Other PPEs.			

Signature of Site I/C of Subcontractor:

	INDUSTRIAL SYSTEMS GROUP	FORMAT NO : HSEP:13-F07 REV NO.: 00 PAGE NO. 01 OF 01
	INSPECTION OF T&Ps	

Name of Site :	
Name of Sub-Contractor	
Date of Inspection :	

Sl. No.	**Description**	**Remarks**
1.0	**Name of equipment**	
2.0	**Basic Information of equipment**	
2.1	**Specification**	
2.2	**Sr. No. of equipment**	
2.3	**Make**	
2.4	**Year of manufacture**	
3.0	**Major repairs /over ha uls(Furnish details of work carried out)**	**Date(s) of major repair/overhaul**
3.1		
3.2		
3.3	**Repairs carried out at site**	
4.0	**Any performance test conducted**	**Yes/No**
5.0	**Document Submitted**	**Yes/No**
6.0	**Manufacturer'stest/ guarantee certificate**	**Available/ Not available**
7.0	**Performance test**	**Done/ Not Done**
8.0	**Acceptance Norms**	
9.0	**Committee Observations**	
10.0	**Date of next review (if accepted)**	

Signature-Site Safety Officer (BHEL)	**Signature-Subcontractor/Subcontractor's Safety Officer**

बी एच ई एल BHEL	**INDUSTRIAL SYSTEMS GROUP**	FORMAT NO : HSEP:13-F08 REV NO.: 00 PAGE NO. 01 OF 01
	STATUS OF T&Ps	

Name of Site	
Name of Sub-Contractor	
Date of Inspection	

Item	Nos. Deployed	Identification No.	Nos. Tested by competent person	Validity of Test Certificate
Winches				
Chain Blocks				
Wire Rope Slings				
Man Cages				
D-Shackles				
Air Compressors				
Crawler Cranes				
Mobile Cranes				
Hydra Cranes				
Others				

Signature of Site I/C of subcontractor :

	INDUSTRIAL SYSTEMS GROUP	FORMAT NO : HSEP:13-F09 REV NO.: 00 PAGE NO. 01 OF 03
	INSPECTION OF CRANES AND WINCHES	

Name of Site	
Name of Sub-Contractor	
Inspected by :	
Date of Inspection	

Crane Reg. No (Make/Model)

Name of Driver/Operator

Sl.no.	Description	Observation	Measures
1	Valid Driving license		
2	HookS Hook Latch		
3	Over Hoist limit switch		
4	Boom limit switch		
5	Boom Angle Indicator		
6	Boom limit cutoff switch		
7	Condition of Boom		
8	Condition of ropes		
9	Number of load lines		
10	Size and condition of the slings		
11	Stability of the cranes		
12	Soil Condition		
13	Swing Break And Lock		
14	Proper BreakAnd Lock		
15	Hoist BreakAnd Lock		
16	Boom BreakAnd Lock		
17	Main Clutch		
18	Leakage in Hydraulic Cylinders		
19	Out riggers filly extendable		
20	Tyre pressure		
21	Condition of Battery And Lamps		

BHEL	**INDUSTRIAL SYSTEMS GROUP**	FORMAT NO : HSEP:13-F09 REV NO.: 00 PAGE NO. 02 OF 03
	INSPECTION OF CRANES AND WINCHES	

Sl.no.	Description	Observation	Measures
22	Guards of moving and rotating parts		
23	Load chart provided		
24	Number and position of pedant ropes		
25	Reverse Horn		
26	Load Test Details		
27	Operator's fitness		
28	Pollution under control certificate		
29	Fire extinguisher of appropriate type.		
30	Training of the operator		

WINCH

Sl. No.	Description	YES	NO	NA	Remarks
1	Has the copy of Third Party Inspection certificate been provided in winch machine shed?				
2	Is winch machine operator experienced enough to operate the winch machine?				
3	Is the winch machine operated by someone otherthan the winch machine operator?				
4	Is there guard provided in all moving parts like wheel and motor's shaft?				
5	Will it protect against unforeseen operational contingencies?				
6	Are brakes, clutch and locking arrangement working properly?				
7	Has it been ensured thatthe guard does not constitute a hazard by itself?				
S	Are the cranks and the connecting rods protected by guardrails?				
9	Is there provision for fully covered shed with wooden plank roof?				

Sl. No	Description	YES	NO	NA	Remarks
10	Is wire rope free from any kind of damage or wear and tear?				
11	Is split pin provided for the protection of clutch and brake locking arrangement?				
12	Is pulley inspected by competent person and certified before use?				
13	Is pulley free from any wear and tear visually?				
14	Is winch rope barricaded with clipsheet for the protection of rope and person?				
15	Is the wire rope lubricated by cardium oil?				
16	Is there any friction in wire rope which may damage the wire rope rather than the rolling parts?				
17	Is there any oil leakage in the hydraulic system of the winch machine?				
IS	Has it been ensured thatthe guard will not cause discomfort or inconvenience to operator?				
	Total Number of NO:				
	Total Number of NA:				
	% Compliance :				

Signature of Site I/C of subcontractor:

	INDUSTRIAL SYSTEMS GROUP	FORMAT NO : HSEP:13-F10 REV NO.: 00 PAGE NO. 01 OF 02
	INSPECTION OF HEIGHT WORKING	

Name of Site :	
Name of Sub-Contractor	
Inspected by :	
Date of Inspection:	

Sl. No.	**Descriptions**	**Observation (Yes/ No)**	**Remarks**
1	All the workers have been explained safe work method?		
2	An established communication system has been established and explained tothe workers.		
3	Adequate illumination has been ensured.		
4	Work area inspected prior to the start of the work.		
5	Area below the work place barricaded, particularly below hot work.		
6	Workers provided with bags /box to carry bolts, nuts and hand tools		
7	Arrangement for fastening hand tools made.		
8	All work platforms ensured to be of adequate strength and ergonomically suitable.		
9	Fabricated makeshift arrangements are checked for quality and type of material welding, anchoring etc.		
10.	Work at more than one elevation at the same segment is restricted.		
	ACCESS/EGRESS		
1	Walkways provided with handrail, mid-rail and toe guard?		
2	All checkered plates, gratings properly welded/ bolted?		
3	Are ladders inspected and they are in good condition?		
4	Are ladders spliced?		
5	Are ladders properly secured to prevent slipping, sliding orfalling?		
6	Do side rails extend 36" above top landing?		
7	Are built up ladders constructed of sound materials?		

	INDUSTRIAL SYSTEMS GROUP	FORMAT NO : HSEP:13-F10 REV NO.: 00 PAGE NO. 02 OF 02
	INSPECTION OF HEIGHT WORKING	

Sl. No.	Descriptions	Observation (Yes/ No)	Remarks
8	Are rugs and cleats not over 12" on center?		
9	Metal ladders not used around electrical hazards.		
10	Proper maintenance and storage.		
11	Ladders placed at right slope.		
12	Ladders / staircases welded/ bolted properly.		
13	Any obstruction in the stairs.		
14	Are landing provided with handrails, knee rails, toe boards etc.?		
15	Whether ramp is provided with proper slope.		
16	Proper hand rails / guards provided in ramps.		
	Housekeeping		
1	Walkways, aisles &all overhead workplaces cleared of loose material.		
2	Flammable materials, if any, are cleared.		
3	All the de shuttering materials are removed after de shuttering is done.		
4	Platforms and walkways free from oil/grease or other slippery material.		
5	Collected scrap are brought down or lowered down and not dropped from height.		
	PPE And Safety Devices		
1	Use of safety helmet, safety belts ensured for all workers		
2	Anchoring points provided at all places of work.		
3	Common lifeline provided wherever linear movement at height is required.		
4	Safety nets are use wherever required.		
5	Proper fall arrest system is deployed at critical workplaces.		
6	Crawler boards/Safety system or works on fragile roof are used.		

Sig nature of Site I/C of subcontractor :

	INDUSTRIAL SYSTEMS GROUP	FORMAT NO : HSEP:13-F11 REV NO.: 00 PAGE NO. 01 OF 02
	INSPECTION OF WELDING AND GAS CUTTING	

Name of Site	
Name of Sub-Contractor	
Inspected by	
Date of Inspection	

Welding				
Sl.no.	Description	Y e s	N o	Remarks
1	Is electric connection given through 30 mA ELCB/RCCB to welding m/c?			
2	Is electric cable fitted properly in junction box on m/c?			
3	Is electrical cable free from joints?			
4	Are the joints attached firmly &insulated with tape?			
5	Is double earthing given to body of m/c?			
6	Isthe physical condition of the m/c good?			
7	Is ON/OFF switch connected to the m/c is working and in good condition?			
8	Are indication lamps on m/c working?			
9	Isthe electrode holder in good condition?			
10	Are the cables of the welding m/c lugged & tight properly?			
11	Are return lead connected properly (Rod, Angle, Channels shall not be used)			
	Total No of NO			
	Total No of YES			

	INDUSTRIAL SYSTEMS GROUP	FORMAT NO : HSEP:13-F11 REV NO.: 00 PAGE NO. 02 OF 02
	INSPECTION OF WELDING AND GAS CUTTING	

Gas Cutting				
Sl.no	**Description**	**Yes**	**NO**	**Remarks**
1	Are Cylinders kept on trolleys?			
2	Physical condition of Gas cylinders Good?			
3	Is there Oil/Grease on valve of the cylinder?			
4	Are pressure regulators in good condition?			
5	Condition of hose pipe OK?			
6	Are hose pipe clamped with hose clip?			
7	Is flash back arrestor & NRV fitted on torch both for 02 and LPG cylinder?			
S	Is nozzle of the torch cleaned?			
	Total Number of NO			
	Total No of YES			
	% Compliance			

Signature of Site I/C of subcontractor :

BHEL	**INDUSTRIAL SYSTEMS GROUP**	FORMAT NO : HSEP:13-F12 REV NO.: 00 PAGE NO. 01 OF 02
	INSPECTION OF ELECTRICAL INSTALLATION	

Name of Site	
Name of Sub-Contractor	
Inspected by	
Date of Inspection:	

Sr. No.	**Contents**	**Yes/No**	**Remarks**
A	**Cable**		
1.	Whether the condition of cable is checked?		
2.	Are cables received from other sites checked for insulation resistance before puttlngthem into use?		
3.	Are all main cablestaken either underground / overhead?		
4.	Are welding cables routed properly above the ground?		
5.	Are welding and electrical cables overlapping?		
6.	Is any improper joining of cables/wires prevailing at site?		
B	**DBs/SDBs**		
1.	Is earth conductor continued upto DB / SDB?		
2.	Whether DBs and extension boards are protected from rain/ water?		
3.	Is there any overloading of DBs / SDBs?		
4.	Are correct/ properfusesS CBs provided at main boards and sub-boards?		
5.	Is energized wiring in junction boxes, CB panels &similar places covered all times?		
C	**ELCB**		
1.	Whether the connections are routed through ELCB?		
2.	Is ELCB sensitivity maintained at 30 mA?		

	INDUSTRIAL SYSTEMS GROUP	FORMAT NO : HSEP:13-F12 REV NO.: 00 PAGE NO. 02 OF 02
	INSPECTION OF ELECTRICAL INSTALLATION	

Sr. No.	Contents	Yes/No	Remarks
3.	Are the ELCB numbered and tested periodically &test results recorded in a logbook countersigned by a competent person?		
D	**Grounding**		
1.	Is natural earthing ensured at the source of power (main DB at Generator or Transformer)?		
2.	Whether the continuity and tightness of the earth conductor are checked?		
3.	Mention the gauge of the earth conductor used at the site.		
4.	Mention the value of Earth Resistance.		
E	**Electrically operated Machines or Accessories.**		
1.	Whether the plug top is provided everywhere.		
2.	Are all metal parts of electrical equipment and light fittings / accessories grounded?		
3.	Is there any shed or cover for welding machines?		
4.	Are halogen lamps fixed at proper places?		
5.	Are portable power tools maintained as per norms?		
6.	Any other information :		

Signature of Site I/C of subcontractor :

	INDUSTRIAL SYSTEMS GROUP	FORMAT NO : HSEP:13-F13 REV NO.: 00 PAGE NO. 01 OF 01
	INSPECTION OF ELEVATOR	

Name of Site	
Name of Sub-Contractor	
Inspected by	
Date of Inspection	

Sr. No.	**Description**	**Remarks**
1.0	Name of equipment	
2.0	Basic Information of equipment	
2.1	Specification	
2.2	Sr. No. of equipment	
2.3	Make	
2.4	Year of manufacture	
3.0	Major repaIrs/overhauls(Furnish details of work carried out)	Date(s) of major repair/overhaul
3.1		
3.2		
3.3	Repairs carried out at site	
4.0	Any performance test conducted	Yes/No
5.0	Document Submitted	Yes/No
6.0	Manufacturer'stest/ guarantee certificate	Available/ Not available
7.0	Performance test	Done/ Not Done
8.0	Acceptance Norms	
9.0	Committee Observations	
10.0	Date of next review (if accepted)	

Signature-Subcontractor/Subcontractor's Safety Officer	**Signature-Site Safety Officer (BHEL)**

	INDUSTRIAL SYSTEMS GROUP	FORMAT NO : HSEP:13-F14 REV NO.: 00 PAGE NO. 01 OF 02
	HSE PENALTY	

Sub: <u>MEMO for Penalty for non compliances in Safety</u>

Following lapse (tick marked) was observed and penalty is imposed as stated at the bottom of this memo. It is requested that such occurrences be please avoided in future.

Safety Are a

SN	**Violation of Safety Norms**	**Fine (in Rs)**
01	Not Wearing Safely Helmet	200/- *
02.	Not wearing Safety Belt or not anchoring life line	500/-*
03	Not wearing safety shoe	200/-*
04	Not keeping gas cylinders vertically	200/-
05	Not using flash back arrestors	100/-
06	Not wearing gloves	50/-*
07.	Grinding Without Goggles	50/-*
08.	Not using 24 V Supply For Internal Work	500/-
09.	Electrical Plugs Not used for hand Machine	100/-
10.	Not Slinging properly	200/-
11.	Using Damaged Sling	200/-
12.	Lifting Cylinders Without Cage	500/-
13.	Not Using Proper Welding Cable With Lot of Joints And Not Insulated Property.	200/-
14.	Not Removing Small Scrap From Platforms	500/-
15.	Gas Cutting Without Taking Proper Precaution or Not Using Sheet Below Gas Cutting	500/-
16.	Not Maintaining Electric Winches Which are Operated Dangerously	500/-
17.	Improper Earthing Of Electrical T&P	500/-
18	No or improper barricading	500/-
19.	Activity carried out without Safety work permit (Height work, Lifting activity, Hot work-each person/case)	1000/-
20.	Incident Resulting in Partial Loss in Earning Capacity	25,0007- per victim
21.	Fatal Incident Resulting in total loss in Earning Capacity	1,00,000/- per victim for first instance #

Legend:-

': per head. For repeated violation by the same person, the penalty would be double of the previous penalty. Date of

"Repeated violation" will be counted from subsequent days.

#: or as deducted by customer, whichever is higher. For repeated fatal incident in the same Unit incremental penalty to be imposed. The subcontractor will pay 2 times the penalty compared to previously paidin case there are repeated cases of fatal incidents under the same subcontractor for the same package in the same unit.

	INDUSTRIAL SYSTEMS GROUP	FORMAT NO : HSEP:13-F14 REV NO.: 00 PAGE NO. 02 OF 02
	HSE PENALTY	

Details (if any) related to non- compliance (Name of persons, Nature of deficiency, etc.)

Penalty imposed:

1, Rate as per above chart_____

2. No. of Persons/ machine/ event/ labour _____

3. Total Penalty^ 1. X 2. =_____

Signature :

Witnessed by: (Sub- Contractor representative) (BHEL Personnel)

Name_____ Name_____

Distribution: 1 Copy: to Sub- contractor,

1 Copy to Site Construction Manager(BHEL)

	INDUSTRIAL SYSTEMS GROUP	FORMAT NO : HSEP:13-F15 REV NO.: 00 PAGE NO. 01 OF 01
	Incident Report **(To be submitted within 24 hours of time of incident)**	

Type of incident: Fatal/Major/ Minor/Fire/Property Damage/Near-miss

1	**NAME OF SITE**	**3**	**ACTIVITY AREA**	
2	**SCOPE OF WORK**	**4**	**NAME OF CONTRACTOR**	
		5	**NAME & DESIDNATION OF**	
6	**DATE & TIME OF ACCIDENT**	**7**	**DATE RESUMED**	
8	**NO. OF WORK-DAYS LOST BY VICTIM (If duty not resumed, give estimated figure)**			
9	**NO. OF MANHOURS LOST BY OTHERS**			

10	**PERSONAL DETAILS OF INJURED AND /OR DETAILS OF MATERIALS /EQUIPMENT /PROPERTY DAMAGED**				
NAME				**NAME OF MATERIAL / EQUIPMENT / PROPERTY**	
PERIOD OF EMPLOYMENT					
AGE YRS	**SEX**	**MALE/FEMALE**		**ESTIMATED COST**	**ACTUAL COST**
MARITAL STATUS		**SINGLE / MARRIED**			
OCCUPATION				**NATURE OF DAMAGE**	
PART OF BODY INJURED					
NATURE OF INJURY					
AGENCY (OBJECT / EQUIPMENT / SUBSTANCE) MOST RESPONSIBLE FOR CAUSING ACCIDENT / INJURY / DAMAGE					
12	**PERSON (NAME & DESIGNATION) WITH MOST CONTROL OVER AGENCY (OBJECT / EQUIPMENT / SUBSTANCE) CAUSING ACCIDENT INJURY / DAMAGE**				
13	**DESCRIBE CLEARLY HOW THE ACCIDENT OCCURRED (USE ADDITIONAL SHEET, IF REQUIRED**				
ANALYSIS					

14	**WHAT ACTS AND / OR CONDITIONS CONTRIBUTED MOST DIRECTLY TO THIS ACCIDENT**	
15	**WHAT ARE THE BASIC REASON FOR THE EXISTENCE OF THESE ACTS AND /OR CONDITION ?**	
16	**WHAT CORRECTIVE ACTIONS HAVE BEEN TAKEN TO PREVENT ACCIDENT RECURRENCE?**	
	DATE:	**SIGNATURE OF SITE HSE COORDINATOR**
17	**COMMENTS OF HEAD /SOX**	
	DATE:	**SIGNATURE OF HEAD/SOX**

SAFETY WORK CLEARANCE	**Permit no.**
Project:	**Emergency Contact Nos:**
Subcontractor:	

BURNING/WELDING /HOT WORK PERMIT

Area :_____ **Date:**_____ **Time:**_____

Name of Site Engineer (Permit Requesting Authority):_____ Sign:_____

Name of Work Performing Contractor:_____

Name of Package In charge:_____ Sign:_____ Date:_____

Description of Work:_____

_____

Work Execution Date:_____ Time Valid from:_____ to_____

The above signing person(s) will be responsible to ensure that the above described work will be done under all the safety precautions mentioned on the permit to work.

The following precautions are to be taken:

No.	Item	Yes	Not required
1.	Proper Access/Exit available		
2.	Proper ventilation and /or lighting provided.		
3.	Proper and safe scaffolding, platform, ladder provided.		
4.	Welding machine located in a clean and dry area.		
5.	Welding machine grounded at the equipment and proper leakage current protection device (ELCB) provided for welding machine.		
6.	Emergency STOP buttons are in working condition. Welder /Helper knows how to operate it.		
7.	Welding machine input/output cables, welding holder and weld return clamp (Holder) are insulated and in good condition.		
8.	Welder & Fitter trained to connect ground/work return clamps (Holder) to work place prior to energization of welding machine.		
9.	Gas cylinders are stacked vertically and not below the welding / cutting area. Regulator key is available with cylinder.		
10.	Pressure gauges/Flash back arrester provided and in working condition.		
11.	Personal Protective equipment Minimum applicable: safety helmet, safety goggles, welding helmet, safety shoes, leather gloves, long sleeve and nose mask -provided		
12.	In case of pits, water removed from the pit and wood/rubber insulation provided.		
13.	Safety signboards are in place.		
14.	Adequate and Suitable nos. of fire fighting extinguisher provided.		
15.	Nearby combustible material removed. Housekeeping done.		
16.	Other		

Name of Contractor Safety Officer:_____ **Sign:**_____ **Date:**_____ **Time:**_____

Reviewed and approved by BHEL Site Engineer (Permit Issuing Authority):

Name of Contractor Safety Officer:_____ **Sign:**_____ **Date:**_____ **Time:**_____

Name of BHEL Safety Representative:_____ **Sign:**_____

I*understand the precaution to be taken as described above and as per project requirement and hereby confirm that work will be executed under my supervision by following all precaution and Safety Rules.*

Name of Work Performing Authority:_____ _____ Sign: _____ Date: _____ Time:_____

Permit Cancellation:

I*hereby declare that the work is complete, all workers under my control have been withdrawn and the site restored to safe tidy condition.*

Name of Work performing Authority:_____ Sign: _____ Date: _____ Time: _____

Name of Site Engr. (Permit Requesting Authority): ____ Sign: _____ Date: _____ Time: _____ _____

Name of BHEL Site Engr. (Permit Requesting Authority): Sign: _____ Date: _____ Time: _____ _____

(This permit is valid only for the date it is issued)

Original at BHEL site	Second Copy-BHEL SAFETY	Third Copy : Contractor

SAFETY WORK CLEARANCE		**Permit no.**
Project:		**Emergency Contact Nos:**
Subcontractor:		

LIFTING ACTIVITY PERMIT

Area :_____ **Date:**_____ **Time:**_____

Name of Site Engineer (Permit Requesting Authority):_____ Sign:_____

Name of Work Performing Contractor:_____

Name of Package In charge:_____ Sign:_____ Date:_____

Description of Work:_____

_____

Work Execution Date:_____ Time Valid from:_____ to_____

The above signing person(s) will be responsible to ensure that the above described work will be done under all the safety precautions mentioned on the permit to work.

The following precautions are to be taken:

No.	Item	Yes	Not required
1.	Crane used for lifting activity tested, certified and approved for rated lifting		
2.	All lifting tackles, gears/appliances are tested and certified for lifting works.		
3.	Crane operator is trained and competent for lifting operation.		
4.	Lifting sling/ belt is protected against sharp edge of the jobs to be lifted.		
5.	Access and exit marked and without obstruction.		
6.	Lifting arrangement adequate.		
7.	Uwanted rubbish material removed from work platform.		
8.	Minimum 2 guidelines have been provided for balancing and guiding jobs to be lifted.		
9.	Periphery area of crane booms as well as lifting job is barricaded and unauthorised/no-entry sign board posted.		
10.	Rigger and signal man is trained and competent for lifting work.		
11.	No lifting activity to be carried out during lightening, heavy wind/rain.		
12.	If scaffolding to be used during lift, scaffolding with valid tag available for use.		
13.	Double lanyards safety harness/belt checked an in working condition.		
14.	Safety shoes (non-slip), helmet with chin strap available with employees.		
15.	Others.		

Name of Contractor Safety Officer:_____ **Sign:**_____ **Date:**_____ **Time:**_____

Reviewed and approved by BHEL Site Engineer (Permit Issuing Authority):

Name of Contractor Safety Officer:_____ **Sign:**_____ **Date:**_____ **Time:**_____

Name of BHEL Safety Representative:_____ **Sign:**_____

I*understand the precaution to be taken as described above and as per project requirement and hereby confirm that work will be executed under my supervision by following all precaution and Safety Rules.*

Name of Work Performing Authority:_____ _____ Sign: _____ Date: _____ Time:_____

Permit Cancellation:

I*hereby declare that the work is complete, all workers under my control have been withdrawn and the site restored to safe tidy condition.*

Name of Work performing Authority:_____ Sign: _____ Date: _____ Time: _____

Name of Site Engr. (Permit Requesting Authority): ____ Sign: _____ Date: _____ Time: _____ _____

Name of BHEL Site Engr. (Permit Requesting Authority): Sign: _____ Date: _____ Time: _____ _____

(This permit is valid only for the date it is issued)

Original at BHEL site	Second Copy-BHEL SAFETY	Third Copy : Contractor

SAFETY WORK CLEARANCE		**Permit no.**
Project:		**Emergency Contact Nos:**
Subcontractor:		

WORKING AT HEIGHT PERMIT

Area :_____ **Date:**_____ **Time:**_____

Name of Site Engineer (Permit Requesting Authority):_____ Sign:_____

Name of Work Performing Contractor:_____

Name of Package In charge:_____ Sign:_____ Date:_____

Description of Work:_____

_____

Work Execution Date:_____ Time Valid from:_____ to_____

The above signing person(s) will be responsible to ensure that the above described work will be done under all the safety precautions mentioned on the permit to work.

The following precautions are to be taken:

No.	**Item**	**Yes**	**Not required**
No.	Item		
1.	All workers on job are medically fit for working at height (Person should not have vertigo)		
2.	Scaffolding with valid tag available for use		
3.	Safety harness with life line support/ fall arrester are checked and in working condition		
4.	Safety shoes (non-slip), Helmet with chin strip available with employees		
5.	Safety nets are provided as per design and provided 25 ft. below working area & extending 8 ft beyond.		
6.	Horizontal life lines are provided to cater to design specification of 2300kg per person.		
7.	Ladders have been inspected and provided as per BHEL standard/contract.		
8.	All lifting /tightening tools, hand tools/equipment checked and in good condition		
9.	Access and exit marked and without obstruction.		
10.	Lighting arrangement adequate.		
11.	Unwanted and rubbish material removed from working platform.		
12.	Electrical cable, welding Hose/Compressed air hose properly secured and lay down without obstruction.		
13.	Signboards provided on working platforms		
14.	Hazards in the vicinity are identified and communicated to the worker.		
15.	Other		

Name of Contractor Safety Officer:_____ **Sign:**_____ **Date:**_____ **Time:**_____

Reviewed and approved by BHEL Site Engineer (Permit Issuing Authority):

Name of Contractor Safety Officer:_____ **Sign:**_____ **Date:**_____ **Time:**_____

Name of BHEL Safety Representative:_____ **Sign:**_____

I*understand the precaution to be taken as described above and as per project requirement and hereby confirm that work will be executed under my supervision by following all precaution and Safety Rules.*

Name of Work Performing Authority:_____ _____ Sign: _____ Date: _____ Time:_____

Permit Cancellation:

I*hereby declare that the work is complete, all workers under my control have been withdrawn and the site restored to safe tidy condition.*

Name of Work performing Authority:_____ Sign: _____ Date: _____ Time: _____

Name of Site Engr. (Permit Requesting Authority): ____ Sign: _____ Date: _____ Time: _____ _____

Name of BHEL Site Engr. (Permit Requesting Authority): Sign: _____ Date: _____ Time: _____ _____

(This permit is valid only for the date it is issued)

Original at BHEL site	Second Copy-BHEL SAFETY	Third Copy : Contractor

ANNEXURE VI

APPROVED SUB VENDORS

ANNEXURE -VI - Approved Vendor List for AHP

Sl.	Equipment / Item	Proposed Sub Supplier	Location	Remarks	TANGEDCO sub vendor approval for Ennore SEZ STPP
32	LT DRIVE MOTORS	CROMPTON GREEVES LTD	AHMEDNAGAR		Approved
		KIRLOSKAR ELECTRIC COMPANY LTD	BANGALORE		Approved
		SIEMENS LTD.	KALWA		Approved
		Jyoti Electric Motors Ltd	VADADORA		Approved
		Laxmi Hydraulics Pvt Ltd	SOLAPUR		Approved
		Marathon Electric Motors (India) Ltd	KOLKOTA		Approved
		ABB Ltd	FARIDABAD / BANGALORE		Approved
		Bharat Bijlee Ltd	MUMBAI		Approved
33	HYDRAULIC COUPLING (SCOOP & TRACTION TYPE)/FLUID COUPLING	Fluidomat Ltd	DEWAS		Approved
		ELECON Engineering Co. Ltd	V V NAGAR		Approved
		VOITH Turbo (P) Ltd	HRDERABAD		Approved
		PREMIUM TranSMIssion Ltd	AURANGABAD		Approved
48	GEAR BOX	PREMIUM Energy TranSMIssion Ltd	PUNE/FALTA/AURANGABAD		Approved
		SIEMENS LTD.	KHARAGPUR		Approved
		SHANTHI GEARS Ltd.	COIMBATORE		Approved
		ELECON Engineering Co. Ltd	V V NAGAR		Approved
		NEW ALLENBERRY Works	KOLKATA		Approved

If the bidder is proposing any other vendor , the same shall be subject to approval of TANGEDCO during detail engineering