STANDARD ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR

PACKAGE : COOLING TOWER (NATURAL DRAFT)
SCOPE OF VENDOR: SUPPLY, CIVIL WORKS, ERECTION & COMMISSIONING OF VENDOR'S EQUIPMENT

PROJECT : 1 X 660 MW PANKI PROJECT

S.NO	DETAILS	SCOPE SUPPLY	SCOPE E&C	REMARKS
1	415V ACDB	Vendor	Vendor	415 V AC, 3 phase, 4 wire supply/ 240 V AC, 1 phase supply shall be provided by BHEL based on load data provided by vendor at contract stage for all equipment supplied by vendor. Makes shall be subject to Customer/ BHEL approval at contract stage.
2	Local starter panel/ Push Button Station (for motors)	BHEL	Vendor	Located near the motor. Makes shall be subject to Customer/ BHEL approval at contract stage.
3	Power cables, control cables and screened control cables for a) both end equipment in BHEL's scope b) both end equipment in vendor's scope c) one end equipment in vendor's scope	 BHEL BHEL BHEL	 BHEL Vendor BHEL	1. Termination at BHEL equipment terminals by BHEL. 2 Termination at Vendor equipment terminals by Vendor.
4	Junction box for control & instrumentation cable	Vendor	Vendor	
5	Any special type of cable like compensating, co-axial, prefab, MICC, fibre Optic cables etc.	Vendor	Vendor	Refer scope/ C&I portion of specification for scope of fibre Optic cables if used between PLC/ micro processor & DCS.
6	Cabling material (Cable trays, accessories & cable tray supporting system, conduits)	Vendor	Vendor	1. Layout details between vendors supplied equipment & installation drawing by vendor. 2. BHEL will provide cable trench along with cabling material up to the terminal point approx. 10 m away from cooling tower. Further cabling (supply and E&C) shall be in vendor's scope.
7	Cable glands ,lugs, and bimetallic strip for equipment supplied by Vendor	Vendor	Vendor	1. Double compression Ni-Cr plated brass cable glands 2. Solder less crimping type heavy duty tinned copper lugs for power and control cables.
8	Equipment grounding & lightning protection	Vendor	Vendor	Material and sizes shall be as per specification and subject to BHEL approval during detailed engineering stage.
9	Below grade grounding	BHEL	Vendor	MS rod material shall be provided by BHEL. All other materials/ consumables are in vendor's scope.

STANDARD ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR

PACKAGE : COOLING TOWER (NATURAL DRAFT)
SCOPE OF VENDOR: SUPPLY, CIVIL WORKS, ERECTION & COMMISSIONING OF VENDOR'S EQUIPMENT

S.NO	DETAILS	SCOPE SUPPLY	SCOPE E&C	REMARKS
10	LV Motors with base plate and foundation hardware (in case applicable for NDCT)	Vendor	Vendor	Makes shall be subject to customer/ BHEL approval at contract stage.
11	Lighting System	Vendor	Vendor	In addition to other lighting system items, vendor shall consider aviation lights & their control as per statutory requirement and Lighting panels (LP) & timer control as per requirement. Further wires, any other material required for lighting system shall also be considered by vendor in their scope. BHEL will provide the power supply for LP from LDB at one location near Cooling Tower. Further distribution from LP including material is in vendor's scope.
12	Aviation Lighting	Vendor	Vendor	Make shall be subject to customer/BHEL approval at contract stage
13	Receptacles/Industrial switch-sockets	Vendor	Vendor	Make shall be subject to customer/BHEL approval at contract stage
14	Any other equipment/ material/ service required for completeness of system based on system offered by the vendor (to ensure trouble free and efficient operation of the system).	Vendor	Vendor	
15	Engineering activities during detailed engineering stage, including those listed below: a. Electrical load data submission in PEM format b. Electrical equipment GA drawings and layout drawings c. Cable trench/ tray layout drawings d. Control cable schedules showing routing details [including cables supplied by PEM for CT equipment]. e. Grounding and lightning protection system layouts f. Cable termination/ interconnection details (diagram)/ Cable block diagram	Vendor	--	1. Documentation shall be submitted as per project schedule for BHEL/ customer approval. 2. Vendor shall be responsible for necessary coordination with BHEL for required engineering interfacing during contract stage. 3. Any approval required from electrical inspection authority for electrical equipment shall be arranged by vendor.

NOTES:

STANDARD ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR

PACKAGE : COOLING TOWER (NATURAL DRAFT)
SCOPE OF VENDOR: SUPPLY, CIVIL WORKS, ERECTION & COMMISSIONING OF VENDOR'S EQUIPMENT

1. Make of all electrical equipment/ items supplied shall be reputed make & shall be subject to approval of BHEL/Customer after award of contract without any commercial implication.

2. All QPs shall be subject to approval of BHEL/Customer after award of contract without any commercial implication.

3. In case the requirement of Junction Box arises on account of Power Cable size mismatch due to vendor's engineering at later stage, vendor shall supply the Junction Box for suitable termination.

4. Wherever BHEL is indicated above, if the scope of supply and E&C of any of the above listed items is in BHEL's Customer scope, then the respective items shall be supplied, erected and commissioned by BHEL's Customer. For such items, BHEL as indicated in SUPPLY and E&C column above shall be read as "BHEL's CUSTOMER".

GENERAL TECHNICAL REQUIREMENTS

FOR

LV MOTORS

SPECIFICATION NO.: PE-SS-999-506-E101 Rev 00

1.0 INTENT OF SPECIFIATION

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

Motors having a voltage rating of below 1000V are referred to as low voltage (LV) motors.

2.0 CODES AND STANDARDS

Motors shall fully comply with latest edition, including all amendments and revision, of following codes and standards:

IS:325	Three phase Induction motors
IS : 900	Code of practice for installation and maintenance of induction motors
IS: 996	Single phase small AC and universal motors
IS: 4722	Rotating Electrical machines
IS: 4691	Degree of Protection provided by enclosures for rotating electrical machines
IS: 4728	Terminal marking and direction of rotation rotating electrical machines
IS: 1231	Dimensions of three phase foot mounted induction motors
IS: 8789	Values of performance characteristics for three phase induction motors
IS: 13555	Guide for selection and application of 3-phase A.C. induction motors for different types of driven equipment
IS: 2148	Flame proof enclosures for electrical appliance
IS: 5571	Guide for selection of electrical equipment for hazardous areas
IS: 12824	Type of duty and classes of rating assigned
IS: 12802	Temperature rise measurement for rotating electrical machnines
IS: 12065	Permissible limits of noise level for rotating electrical machines
IS: 12075	Mechanical vibration of rotating electrical machines

In case of imported motors, motors as per IEC-34 shall also be acceptable.

3.0 DESIGN REQUIREMENTS

3.1 Motors and accessories shall be designed to operate satisfactorily under conditions specified in data sheet-A and Project Information, including voltage & frequency variation of supply system as defined in Data sheet-A

3.2 Motors shall be continuously rated at the design ambient temperature specified in Data Sheet-A and other site conditions specified under Project Information
Motor ratings shall have at least a 15% margin over the continuous maximum demand of the driven equipment, under entire operating range including voltage & frequency variation specified above.

3.3 Starting Requirements

3.3.1 Motor characteristics such as speed, starting torque, break away torque and starting time shall be properly co-ordinated with the requirements of driven equipment. The accelerating torque at any speed with the minimum starting voltage shall be at least 10% higher than that of the driven equipment.

3.3.2 Motors shall be capable of starting and accelerating the load with direct on line starting without exceeding acceptable winding temperature.

The limiting value of voltage at rated frequency under which a motor will successfully start and accelerate to rated speed with load shall be taken to be a constant value as per Data Sheet - A during the starting period of motors.

3.3.3 The following frequency of starts shall apply

i) Two starts in succession with the motor being initially at a temperature not exceeding the rated load temperature.

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

iii) Motors for coal conveyor and coal crusher application shall be suitable for three consecutive hot starts followed by one hour interval with maximum twenty starts per day and shall be suitable for mimimum 20,000 starts during the life time of the motor

3.4 **Running Requirements**

3.4.1 Motors shall run satisfactorily at a supply voltage of 75% of rated voltage for 5 minutes with full load without injurious heating to the motor.

3.4.2 Motor shall not stall due to voltage dip in the system causing momentary drop in voltage upto 70% of the rated voltage for duration of 2 secs.

3.5 **Stress During bus Transfer**

3.5.1 Motors shall withstand the voltage, heavy inrush transient current, mechanical and torque stress developed due to the application of 150% of the rated voltage for at least 1 sec. caused due to vector difference between the motor residual voltage and the incoming supply voltage during occasional auto bus transfer.

3.5.2 Motor and driven equipment shafts shall be adequately sized to satisfactorily withstand transient torque under above condition.

3.6 Maximum noise level measured at distance of 1.0 metres from the outline of motor shall not exceed the values specified in IS 12065.

3.7 The max. vibration velocity or double amplitude of motors vibration as measured at motor bearings shall be within the limits specified in IS: 12075.

4.0 **CONSTRUCTIONAL FEATURES**

4.1 Indoor motors shall conform to degree of protection IP: 54 as per IS: 4691. Outdoor or semi-indoor motors shall conform to degree of protection IP: 55 as per IS: 4691and shall be of weather-proof construction. Outdoor motors shall be installed under a suitable canopy

4.2 Motors upto 160KW shall have Totally Enclosed Fan Cooled (TEFC) enclosures, the method of cooling conforming to IC-0141 or IC-0151 of IS: 6362.

Motors rated above 160 KW shall be Closed Air Circuit Air (CACA) cooled

4.3 Motors shall be designed with cooling fans suitable for both directions of rotation.

4.4. Motors shall not be provided with any electric or pneumatic operated external fan for cooling the motors.

4.5 Frames shall be designed to avoid collection of moisture and all enclosures shall be provided with facility for drainage at the lowest point.

4.6 In case Class 'F' insulation is provided for LV motors, temperature rise shall be limited to the limits applicable to Class 'B' insulation.
In case of continuous operation at extreme voltage limits the temperature limits specified in table-1 of IS:325 shall not exceed by more than 10°C.

4.7 **Terminals and Terminal Boxes**

4.7.1 Terminals, terminal leads, terminal boxes, windings tails and associated equipment shall be suitable for connection to a supply system having a short circuit level, specified in the Data Sheet-A.

Unless otherwise stated in Data Sheet-A, motors of rating 110 kW and above will be controlled by circuit breaker and below 110 kW by switch fuse-contactor. The terminal box of motors shall be designed for the fault current mentioned in data sheet "A".

4.7.2 unless otherwise specified or approved, phase terminal boxes of horizontal motors shall be positioned on the left hand side of the motor when viewed from the non-driving end.

4.7.3 Connections shall be such that when the supply leads R, Y & B are connected to motor terminals A B & C or U, V & W respectively, motor shall rotate in an anticlockwise direction when viewed from the non-driving end. Where such motors require clockwise rotation, the supply leads R, Y, B will be connected to motor terminals A, C, B or U W & V respectively.

4.7.4 Permanently attached diagram and instruction plate made preferably of stainless steel shall be mounted inside terminal box cover giving the connection diagram for the desired direction of rotation and reverse rotation.

4.7.5 Motor terminals and terminal leads shall be fully insulated with no bar live parts. Adequate space shall be available inside the terminal box so that no difficulty is encountered for terminating the cable specified in Data Sheet-A.

4.7.6 Degree of protection for terminal boxes shall be IP 55 as per IS 4691.

4.7.7 Separate terminal boxes shall be provided for space heaters.. If this is not possible in case of LV motors, the space heater terminals shall be adequately segregated from the main terminals in the main terminal box. Detachable gland plates with double compression brass glands shall be provided in terminal boxes.

4.7.8. Phase terminal boxes shall be suitable for 360 degree of rotation in steps of 90 degree for LV motors.

4.7.9 Cable glands and cable lugs as per cable sizes specified in Data Sheet-A shall be included. Cable lugs shall be of tinned Copper, crimping type.

4.8 Two separate earthing terminals suitable for connecting G.I. or MS strip grounding conductor of size given in Data Sheet-A shall be provided on opposite sides of motor frame. Each terminal box shall have a grounding terminal.

4.9 **General**

4.9.1 Motors provided for similar drives shall be interchangeable.

4.9.2 Suitable foundation bolts are to be supplied alongwith the motors.

4.9.3 Motors shall be provided with eye bolts, or other means to facilitate safe lifting if the weight is 20Kgs. and above.

4.9.4 Necessary fitments and accessories shall be provided on motors in accordance with the latest Indian Electricity rules 1956.

4.9.5 All motors rated above 30 kW shall be provided with space heaters to maintain the motor internal air temperature above the dew point. Unless otherwise specified, space heaters shall be suitable for a supply of 240V AC, single phase, 50 Hz.

4.9.6 Name plate with all particulars as per IS: 325 shall be provided

4.9.7 Unless otherwise specified, the colour of finish shall be grey to Shade No. 631 and 632 as per IS:5 for motors installed indoor and outdoor respectively. The paint shall be epoxy based and shall be suitable for withstanding specified site conditions.

5.0 INSPECTION AND TESTING

5.1 All materials, components and equipments covered under this specification shall be procured, manufactured, as per the BHEL standard quality plan No. PED-506-00-Q-006/0 and PED-506-00-Q-007/2 enclosed with this specification and which shall be complied.

5.2 LV motors of type-tested design shall be provided. Valid type test reports not more than 5 year shall be furnished. In the absence of these, type tests shall have to be conducted by manufacturer without any commercial implication to purchaser.

5.3 All motors shall be subjected to routine tests as per IS: 325 and as per BHEL standard quality plan.

5.4 Motors shall also be subjected to additional tests, if any, as mentioned in Data Sheet A.

6.0 DRAWINGS TO BE SUBMITTED AFTER AWARD OF CONTRACT

a) OGA drawing showing the position of terminal boxes, earthing connections etc.
b) Arrangement drawing of terminal boxes.
c) Characteristic curves:
(*To be given for motor above 55 kW unless otherwise specified in Data Sheet*).

i) Current vs. time at rated voltage and minimum starting voltage.
ii) Speed vs. time at rated voltage and minimum starting voltage.
iii) Torque vs. speed at rated voltage and minimum voltage.
For the motors with solid coupling the above curves i), ii), iii) to be furnished for the motors coupled with driven equipment. In case motor is coupled with mechanical equipment by fluid coupling, the above curves shall be furnished with and without coupling.
iv) Thermal withstand curve under hot and cold conditions at rated voltage and max. permissible voltage.

CHAPTER 01 : ELECTRICAL SCOPE OF WORK AND DESIGN CRITERIA

1.00.00 ELECTRICAL WORKS

1.01.00 Introduction

1.01.01 The scope of Contractor shall include but not be limited to complete design, manufacture, packing, assembling, testing at manufacturer's work, supply for site, storage at site, erection, testing and commissioning of all electrical equipments required for the main plant (BTG) and Balance of plant (BoP) auxiliaries complete with all materials and accessories for efficient and trouble free operation of One (1) unit of 660 MW on EPC Basis.

1.01.02 Items not specifically mentioned here but needed to complete the system & equipment and as required to meet the intent of the specification or required for operation of the equipment shall be deemed to be included in the scope of of work of the Bidder unless specifically mentioned in other's scope of work.

2.00.00 The equipments/systems covered under scope of work shall include but not be limited to the same:

a) **400kV Switchyard** - complete with equipment, supporting structures, towers / beams, Main buses, Bay buses, insulators, clamps & connectors, Control & relay panels, ABT tariff Energy meters, shield wire / Lightning Mast, SCADA, OPGW, Earthing and Lightning Protection System, Yard Fencing Gates, etc.

b) **Generator** – Generators and its accessories (cooling system, excitation system, Automatic voltage regulator), Auto Synchronizers, Generator control / metering and Protection Panels.

c) **Isolated Phase Bus Duct** - Isolated Phase Bus Ducts including pressurization system (along with required seal off bushing at A row wall, wall frame assembly at floor crossings) between Generators and Generator Transformers, delta connection of single phase GTs, tap-off to UTs and excitation transformer (static excitation system), LAVT cubicle and CTs for generator phase-side, neutral side and on tap off to UTs, generator neutral formation earthing cubicle (NGT & NGR).

d) **Power Transformers** – Generator Transformers (GTs), Station transformers (STs), Unit Transformers (UTs), , complete with relay panels, remote OLTC (OCTC for GT) Control Cabinet, all fittings and accessories. During transportation Contractor shall supply impact recorders on returnable basis for each power transformer. The recorder will be taken back only after obtaining written permission from Purchaser's Site Incharge.

e) **Auxiliary Power Transformers**– 11/3.45kV transformers for feeding supply to auxiliary loads complete with all fittings and accessories, balance of plant mechanical auxiliary systems, complete with fittings and accessories.

f) **Bus Reactor for 400kV Bus**

g) **LV Service Transformer** -11/0.433 kV and 3.3/0.433kV transformers for

l) **Illumination System Design**.

m) **Electrical System Study/Short Circuit Calculation** for all the systems.

n) All above calculations shall be done through electrical software like ETAP. Results shall also be submitted for study.

o) **Relay Setting and Relay Co- ordination calculations** & graphs/charts

p) Any other calculation as required during detailed Engineering

4.03.00 The contractor shall include the following schedules in his scope:

a) **Cable Schedules** – Power & Control Cables.

b) **Interconnection cable Schedule** - for all cables supplied and installed by contractor – including connection from electrical equipment to Plant DCS/DDCMIS system, TG, SG , BOP etc.

Datasheets for all equipments shall also be included in contractor's scope and shall be submitted.

5.00.00 CODES AND STANDARDS

5.01.00 Equipment

5.01.01 All electrical equipment and materials shall conform to latest applicable standard publications of International Electro technical Commission (IEC) or equivalent standards published by the Bureau of Indian Standards (BIS), Indian statutory regulations in particular CBIP/CEA Manual on 'Layout of Substation', 'Standardization of Electrical Equipments for Thermal Power Stations' and on Transformers and other standards mentioned in the various volumes of sections of this specification. In case of a conflict between IEC and other standards, IEC shall govern. The provisions of tender specifications (except the clause of codes and standards of individual specification) shall however have precedence over all other standards.

5.01.02 Equipment and material conforming to any other standard, which ensures equal or better quality, may be accepted. In such cases, copies of the English version of the standard adopted shall be submitted along with the bid.

5.02.00 Installation

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

5.02.02 Nothing in this specification or in the equipment specification shall be construed to relieve the Contractor of his responsibility.

6.00.00 ELECTRICAL SYSTEM DESIGN CRITERIA

6.01.00 The electrical system shall be designed and engineered to provide a high degree of reliability, operational flexibility and personnel safety. The electrical equipment shall generally conform to the latest Indian Standards & Indian Electricity Rules/Acts.

6.01.01 Standard voltage levels

The standardized voltage level as shall be adopted as specified elsewhere in this specification.

6.02.00 Permissible variations:

The auxiliary power supply system & equipment shall be designed for a voltage & frequency variations as given below under worst operating conditions:

6.02.01 AC System

i. Voltage variation	:	±10%
ii. Frequency variation	:	+5% to –5%
iii. Combined voltage & frequency variation	:	10%(absolute sum)

Note: Generator will be suitable for a voltage variation of ± 5%, frequency variation shall be -5% to +3% and Combined voltage and frequency variation 5% (absolute sum).

6.02.02 DC System

i.	Voltage variation	:	-15% to +10%

6.03.00 All equipments covered under this contract shall be so designed as to withstand & work continuously with the above mentioned variation in AC/DC supplies without any deterioration in performance.

6.04.00 The electrical systems and equipments shall cover all items related to Main plant, Balance of Plant and 400kV switchyard . The proposed electrical system for the complete plant is shown in enclosed proposed key SLD. However the final SLD shall be finalized during detailed engineering taking care of all the required loads.

6.05.00 The system will consist of required Generator Transformer, Bus Reactor, Unit Transformers, Station Transformers, Unit Auxiliary transformers, Service transformers and associated 11 kV/3.3 kV/ 415 V switchgears as shown in the SLD to cater to unit and station auxiliary loads. The feeders shown in the SLD are minimum required and arrangement shown is for the guidance of the bidder/contractor. The bidder/contractor shall mark out his own design as per the system requirement and the actual distribution shall be arranged by him as per load centre to be approved by the Owner. Any additional feeder requirement during detailed engineering shall be arranged by the bidder/contractor without any price implication.

6.06.00 Each section of switchgear/MCC/distribution board shall be fed by 2x100% transformers/feeders and these shall be rated to carry the maximum load expected to be imposed.

6.07.00 All 11 kV, 3.3 kV buses shall have facility for auto/manual live changeover

possibility of ignition. The criteria for determining the appropriate classification are as specified in the relevant codes and standards.

6.20.00 Electrical equipment in areas classified as hazardous such as fuel oil system, sump pumps of fuel oil system, sump pump for transformer pits etc shall be constructed and installed in accordance with the requirements of the appropriate codes and standards.

7.00.00 SYSTEM PARTICULARS

System particulars are as follows:

S. No	Description	400kV System	11 kV System	3.3 kV System	415V System	415 V System (Lighting & Welding Systems)	240 V System	220 V System
1	Nominal Voltage	400kV	11 kV	3.3 kV	415 V	415 V	240 V	220 V
2	Highest System Voltage	440kV	12 kV	3.6 kV	457 V	457 V	264 V	242 V
3	Number of Phases	Three (3)	Three (3)	Three (3)	Three (3)	Three (3)	One (1)	NA
4	Frequency	50 Hz	50 Hz	50 Hz	50 Hz	50 Hz	50 Hz	NA
5	Voltage Variation	± 10%	± 6%	± 6%	± 10%	± 10%	± 10%	+ 10% to – 15%
6	Frequency Variation	± 5%	± 5%	± 5%	± 5%	± 5%	± 5%	NA
7	Combined Voltage & Frequency Variation	10 %	10 %	10 %	10 %	10 %	10 %	NA
8	Neutral Earthing	Solidly grounded	Medium Resistance Grounded	Medium Resistance Grounded	Solidly Grounded	Solidly Grounded	Solidly Grounded	Un-grounded
9	Fault Level	50 kA for 1 second	50 kA for 1 second	40 kA for 1 second	50 kA for 1 second	20 kA for 1 second	9 kA for 1 second	25 kA for 1 second

8.00.00 SYSTEM CONFIGURATION

8.00.01 The overall system shall be configured such that failure of any piece of equipment has the minimum possible effect on plant operating capability. In particular, failure of one unit and/or station auxiliary transformer, dc battery or charger shall not cause reduction in the plant's generating capability or affect the safe shut down of the unit.

8.00.02 Adequate number of dry/oil type service transformers shall be provided to meet the power demand on 415V systems, with the design criteria specified in specification and these shall be rated to carry the maximum load expected to

be imposed. Each of the switchgear/MCC/DB shall be sectionalized except for Emergency PMCC.

8.00.03 The switchgears and bus ducts/cables shall be sized based on transformer ratings at minimum tap.

8.00.04 The battery shall be Ni-Cad/Lead Acid Plante type. Each cell shall be assembled in heat resistant, shock absorbing, robust, clear glass container. Electrolyte level shall be marked on the clear glass container.

8.00.05 HT & LT power cables shall be laid in ladder type cable trays. Control & Instrumentation cables shall be laid in perforated trays.

8.00.06 Maximum continuous motor ratings shall be at least 15% above design duty point or the maximum load demand of the driven equipment under entire operating range taking into account voltage and frequency variation. All motors shall be suitable for DOL starting. Soft starters or star/delta starters are not acceptable.

8.01.00 Generator

8.01.01 Type

The generator shall be three phase, horizontal mounted indoor installed, two-pole, class F winding insulation, Stator water/Hydrogen cooled, cylindrical hydrogen cooled rotor type, machine with brushless or static excitation. The generator shall be directly driven by steam turbine at rated speed conforming to IEC 60034-1, 60034-3 or other equivalent standard.

8.01.02 Excitation system

The system shall be completely a brushless excitation system or static excitation system. The excitation system shall be designed for field forcing capability of minimum 150% of exciter voltage corresponding to the generator MCR output at rated power factor for not less than 30 seconds, even for close-in faults on high voltage outgoing lines or bolted faults at generator terminals. AVR shall have both AC and DC field flashing arrangement.

8.02.00 Generator Busducts and Neutral Grounding Equipments

8.02.01 The busduct shall be isolated phase, continuous (bonded enclosure), and natural air cooled, positive pressure type. The design of busduct shall be based on following factors:

- Continuous current rating with 10 % desing margin as per IS 8084
- Maximum system voltage
- Max. dynamic and transient forces it may be subject to during its life span
- Dielectric requirement of system
- Climatic conditions
- Rated short time current
- The short circuit rating of the main run will correspond to higher of the fault current contributions from generator or transformer side while the tap-offs and delta connection will be designed for sum of the fault contributions from generator and GT side. The fault withstand time rating of the busduct will depend upon the type of excitation & the de-excitation time of the generator.

0 – 5.5 KW	3/C-2.5 / 4 / 6 / 10 mm2 Cu. (As per voltage drop.)
5.6 – 11 KW	3/C - 16 mm2 Al
11.1 – 22 KW	3/C – 35 mm2 Al
22.1 – 45 KW	3/C – 95 mm2 Al
45.1 – 75 KW	3/C – 185 mm2 Al
75.1 – below 90 KW	2x3/C – 185 mm2 Al

Note:

1. For incomer 220V DC supply for control & protection, to HV switchgear shall be minimum 10 sq.mm & for LV switchgear and protection panels minimum sizes of F.S. cable shall be 6 sq.mm.

2. If required by cable sizing calculations which shall include appropriate derating, continuous current considering permissible voltage variations, short circuit rating, and voltage drops etc. the higher sizes shall be provided.

3. Wherever the termination of Aluminium cable is not possible due to size of motor terminal box, local JB to be suitably located near the motor terminal box and then copper cable shall be provided from the local JB to the motor terminal box.

8.05.10 Multicore control cables will generally have atleast 20% spare cores.

Conductors required Cables

Above 19 core Two or more of above control cables shall be used.

8.05.11 Separate cables for each type of following services/functions as applicable shall be used for each feeder. Same multicore cable using different services shall not be acceptable.

a) Power.
b) Control, interlock and indication.
c) Metering and measuring.
d) Alarm and annunciation.
e) C.T. Cables.
f) V.T. Cables.

8.05.12 In power cables maximum conductor size to be used will be 400 sq mm & 630 sqmm for multi core and single core cables. In case of multi core cables not more than 3 runs to be used or otherwise single core cable to be used.

For DC system only single core cables are to be used.

Fire Survival Cables shall be used for important auxiliaries / area as recommended by Standard Technical Specification by CEA as below for the following:

Fire Survival Power & Control Cables shall be used for important auxiliaries/areas like:

i) DC cables for battery to charger & DC distribution boards and

downstream of DCDB cables.

ii) Cables between 220V DCDB and Sub DBs at various elevations

iii) Incomer cables for DG board, emergency board, DC lighting board etc.

iv) 220V DC - incomer cable for protection and control purpose to HV switchgear shall be minimum 10 sq.mm copper and for LV switchgear minimum size shall be 6 sq. mm copper.

8.05.13 The fire survival power & control cables shall be used for the following important auxiliaries/areas:

a. DC emergency lube oil pump.
b. Turbine lube oil pump/barring gear.
c. Jacking oil pump.
d. Scanner air fan.
e. Incoming & outgoing cables for DC lighting distribution board.
f. Fire /smoke detection system.
g. DC seal oil pump.
h. DC emergency lighting cables for Main Plant Building.
i. Batteries to charger and DC distribution board.
j. Emergency turbine trip by push button in control room.
k. Boiler turbine: Generator inter-trip which includes the interconnecting cables between
   1. Boiler master fuel trip and turbine trip relays
   2. Generator trip relays and turbine trip relays
   3. Generator trip relays and 400kV circuit breaker
   4. Generator trip relays and generator field breaker.
   5. Generator trip relays and UAT breaker.
l. Other requirements as per latest CEA guidelines.

8.06.00 Cable Accessories

8.06.01 Termination and Straight Through Joint Kits

a) Cable trays shall be well away from hot steam pipelines and shall not be immediately above or below the steam pipes.

b) Materials of construction for a joint/termination shall perfectly match with the dielectric chemical and physical characteristics of the associated cables. The material and design concepts shall incorporate a high degree of operating compatibility between the cable and joints. The protective outer covering (jacket) used on the joints/terminations shall have the same qualities as that of the cable outer sheath in terms of ambient/operating temperature withstand capability and resistance to hazardous environments and corrosive elements.

c) The materials required for termination and straight through joints shall be supplied in kit form. The kit shall include all insulating and sealing materials apart from consumable items and installation instruction.

d) The termination kits shall be suitable for termination of the cables to indoor switchgear or to a weatherproof cable box of an indoor/outdoor mounted transformer/motor. The termination kits shall preferably be as of the following types.

i) PUSH ON‘ type for LT cables.

ii) Heat Shrinkable sleeve type for LT and HT cables

e) However terminating kits for HT cables shall be of heat shrinkable type of make with specific approval of owner.

f) For outdoor installations, weather shields/sealing ends and any other accessories required shall also form part of the kit.

g) The straight through jointing kits shall be suitable for underground installation with uncontrolled backfill and possibility of flooding by water. Straight through joints shall be used for LT power cable sizes of 70 sqmm and above. The jointing kit shall be one of the following types.

i. 'TAPEX' of M-seal make or equivalent for LT cables
ii. Heat Shrinkable sleeve type for LT and HT cables.

h) However straight through joints for LT and HT cables shall be of heat shrinkable type of make with specific approval of owner.

8.06.02 Raceway & Conduit

The design and specifications for the raceway and conduit systems used in supporting and protecting electrical cable shall be in accordance with the provisions of the appropriate codes and standards.

8.06.03 Cable Trays

a) All cable trays shall be of ladder type or perforated type construction of various sizes with accessories. There shall be a maximum spacing of 1500 mm between cable tray supports, except fittings (elbows, tees, etc.) which shall be supported at each splice.

b) Cable tray fittings shall have a radius equal to and greater than the minimum bending radius of the largest cables they contain.

c) Solid bottom trays shall be provided for all noise sensitive circuits, However all other cables carrying analog instrumentation signals (4-20mA / TC etc) shall be provided with perforated cable trays.

d) Individual tray systems shall be established for the following services: -

i) 3.3 kV and higher voltage power cables.

ii) 415Volt power cables.

iii) Special noise-sensitive circuits or instrumentation cables.

iv) Control cables.

Further subdivision of tray systems shall be provided if required to meet special segregation/separation requirements.

e) Cable depth not to exceed two cables for vertical trays.

f) The minimum design vertical spacing for trays shall be 300 mm measured from the bottom of the upper tray to the top of the lower tray. At least a 250

mm clearance shall be maintained between the top of a tray and beams, piping, or other obstacles to facilitate installation of cables in the tray. A working space of not less than 600 mm shall be maintained on at least one side of each tray.

g) For coal handling plant the cables shall not be routed along conveyer galleries. The cables shall be routed on independent cable trestles.

08.06.04 Conduit

a) Conduit shall be used to protect unarmoured conductors routed to individual devices and where the quantity of cable does not economically justify the use of cable tray.

b) Rigid conduit shall be used for hazardous and outdoor areas.

c) Galvanized rigid steel conduit shall be used for all conduit encased in concrete and all exposed conduit except at cooling towers.

d) All conduits cast in concrete shall be routed in exposed runs parallel or perpendicular to dominant surfaces with right-angle turns made of symmetrical bends or fittings. Conduit shall be routed at least 150 mm from the insulated surfaces of hot water, steam pipes, and other hot surfaces. Where conduit must be routed parallel to hot surfaces, special high temperature cables shall be used.

08.06.05 Duct banks & Manholes

a) Cable trenches shall be provided only in transformer yard and locally near the equipment having lengths not more than 5 metres.

b) All underground duct banks shall consist of plastic conduit encased in reinforced concrete. The minimum nominal diameter/hume pipes of the plastic ducts shall be 125 mm. A 75 mm galvanized steel conduit shall also be installed where required for digital and analog low level circuits requiring noise immunity from adjacent power circuits.

c) Conduits from manholes to the equipment at remote locations shall be changed to rigid steel prior to emerging from below grade. The steel conduit shall be encased in concrete.

d) All underground duct banks shall be installed in accordance with the following methods:-

- Ducts shall be sloped not less than 75 mm per 30 meters to manholes to provide adequate drainage.
- Reinforcing steel shall not form closed magnetic paths between ducts. Non-metallic spacers shall be used to maintain duct spacing.

e) Reinforced concrete manholes shall be provided, where required, so that cable may be installed without exceeding allowable pulling tensions and cable sidewall pressures. Each manhole shall have the following provisions:-

- Provisions for attachment of cable pulling devices.

- Provisions for racking of cables.
- Manhole covers of sufficient size to loop feed the largest diameter cable through the manhole without splicing.
- Sealed bottoms and sumps.

08.06.06 Interplant Cabling

- Interplant cable routing will be on overhead cable trays on pipe cum cable trestle or only cable trestle except where approved by purchaser/consultant. Laying of cables directly buried in ground is not acceptable. Major overhead outdoor interplant cable routes are:

- From Power House to coal handling plant switchgear
- From Power House to AHP switchgear in Ash handling area

- From Power House to C.W./Cooling Tower area, Fire water Building

- From Power House to boiler area.
- From Power house to DM Plant
- From Power house to Fire/Raw water pump house

a) Major routes in boiler area to individual boiler drives, to and from ESP Building, Fly ash conveying compressor building, vacuum pump house & F.O. pump house, will be on overhead Cable trays on pipe cum cable trestle or on only cable trestle.

b) Cables from Power House to 400 kV Switchyard Control Room shall be routed through RCC trenches to be engineered and constructed by the EPC contractor.

08.07.00 System Control & Protection

08.07.01 Generator will be controlled from Control Room. However, bus selection for generators shall be done from Switchyard Control Room by operation of associated disconnecting switches.

08.07.02 All 400 kV side of Station Transformer feeders shall be controlled from switchyard control room as well as Power house control room.

08.07.03 OLTC control for Station Transformers shall be done from Power House Control Room (ECP).

08.07.04 Control & metering (MEAA) of generator, generator transformer, unit transformers, station transformers, etc. will be from Central Operating Console. The protection of GENERATOR shall be effected through redundant (2 x 100%) multifunction, numerical based Digital Protection Relays for Generator two independent group of numerical relays shall be provided. Separate CT & PT shall be used for implementation of such redundancy. Protection of GT, ST, and UT shall be achieved through discrete numerical relay protection.

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

08.07.06 The following general requirements apply to all protective relaying applications:

a) The protective relay system shall be designed to remove or alarm abnormal operating occurrences occurring on equipment designed for electrical power generation, voltage transformation, energy conversion, and transmission and distribution of electrical power. The system shall operate as rapidly as possible, consistent with maintaining proper discrimination, to minimize damage to equipment and disturbance to the electrical system as a whole.

b) To limit damage to faulted equipment.

c) Minimize possibility of fire or explosion.

d) Minimize hazard to personnel.

e) All equipments/components viz. Transducers etc. required to interface with plant DCS system shall be provided in Switchgear/control panels.

f) All digital microprocessor based protection relays of Generator, HT switchgear, GT, ST, UT, UAT, SAT are to be hooked up to DDCMIS. All digital meters & breaker status data of H. T. switchgear & L.T. incomer feeders shall also be hooked up to DDCMIS.

g) The protective relaying system shall be a coordinated application of either individual relays, multi-function relays, or a combination of individual and multi-function relays. Numerical microprocessor based communicable type protective relays with redundant processors shall be provided. For each monitored abnormal condition, there shall exist a designated primary device for detection of that condition. A failure of any primary relay shall result in the action of a secondary overlapping scheme to detect the effect of the same abnormal occurrence. The secondary relay may be the primary relay for a different abnormal condition. Alternate relays may exist which detect the initial abnormal condition but which have an inherent time delay so that the alternate relays shall operate after the primary and secondary relays. Similar to secondary relays, the alternate relays may be primary relays for other abnormal conditions. All protective relays shall be selected to coordinate with protective devices supplied by manufacturers of major equipment and the thermal limits of electrical conductors and electrical equipment, such as transformers and motors.

h) Auxiliary relays, supervision relays, timers etc. as required for completeness of the scheme shall be provided. For lockout relays necessary supervision shall be provided.

i) Minimum accuracy class shall be as follows:

Current Transformer

i) Class PS for differential relaying
ii) Class 5P20 for other relaying
iii) Class 0.2S and ISF <5 for energy accounting and audit metering
iv) Class 1.0 for metering

Voltage transformer

i) Class 0.2 for metering
ii) Class 3P for protection
iii) Class 0.2 for energy accounting and audit metering

08.08.00 Grounding and Lightning Protection

08.08.01 The grounding requirement of the power station complex is divided into the following three main categories:

i. System grounding
ii. Equipment grounding
iii. Electronic Equipment grounding

08.08.02 The system grounding is adopted to facilitate ground fault relaying and to reduce the magnitude of transient over voltage. The system grounding involves grounding of the generators and transformer neutrals. High resistance grounding is envisaged for generator neutral, which would be achieved through a distribution transformer shunted by a resistor in the secondary. The Earth fault current shall be limited to 15 Amps.

08.08.03 For 11 kV & 3.3 kV System, low resistance grounding is envisaged so as to facilitate selective clearance of ground fault through earth leakage relay connected in the residual circuit of phase current transformers.

08.08.04 The 415 Volt System will be solidly grounded with REF and SEF protections. The 220 V DC systems will be ungrounded.

08.08.05 Grounding of equipment body is to be adopted to provide protection to personnel from potential caused by ground fault currents and lightning discharges.

08.08.06 A stable ground grid will be provided for grounding of equipment and structures and for maintaining the step and touch potentials within safe limits. An earth mat will be laid in and around the power station. This mat will be buried at 1000 mm depth below the ground and provided with ground electrodes at 6m at the periphery of the grid. All metallic parts of equipment, supposed to be kept at earth potential, will be connected to the grounding mat. Buildings, structures, transmission towers, plant rail,road tracks, the perimeter fencing will also be connected to the grounding mat. Grounding systems shall be interconnected. Suitable number of risers shall be provided by power plant EPC contractor from his grounding mat for building/equipments within power plant grounding zone. Number of such riser shall be as system requirement stipulated elsewhere in the specification. For every upper/lower floor the distance between two adjacent risers from below the grounding grid shall not be greater than 10m.

08.08.07 For grounding of electronic equipment, a separate earthing system consisting of a number of deep driven earthing rods interconnected with insulated cables and insulated risers are to be installed. This system will be totally isolated from the power equipment earthing mesh risers described above and will be located underground vertically below the electronic equipment room. Provision for connecting electronic earthing grid with power plant grounding grid through earth pit below the ground shall be provided.

08.08.08 Lightning protection system will be installed for protection of the buildings/ structures and equipment against lightning discharge. This will be achieved by providing lightning masts on stacks, cooling towers, power house building, flood light towers etc. and connecting these with ground grid.

08.09.00 LV Switchgear

Power from Unit / Station LV service transformers will be supplied to 415 V switchgears. Power from 415 switchgears to the various ACBDs, MCCs, etc. shall be supplied from redundant incomers. These switchgears will distribute power to LV auxiliary motors and also to other auxiliary loads viz. MCCs / ACDBs, etc. LV switchgears will be of metal enclosed indoor type. Incomers / bus-couplers, outgoing tie feeders rated above 630 amps and motor feeders rated 90 kW and higher, will be equipped with air circuit breakers of fault interrupting capacity of 50 KA rms. Lower rated feeders will be equipped with fully-rated switch-fuse units. Incomers & bus couplers rated below 630A are to be provided with Motorised MCCB.

08.09.01 List of minimum required LV switchgears

S.No	Name of LV Switchgear/MCC/Switchboard/DB
1.	MISC PMCC
2.	Unit PMCC
3.	Station PMCC
4.	WT PMCC
5.	P.H. ACDB
6.	P.H.B. MLDB
7.	VENTILATION MCC
8.	AC MCC
9.	BOILER MCC
10.	SOOT BLOWER MCC
11.	BOILER VALVE DAMPER MCC
12.	MILL SYSTEM MCC
13.	TURBINE AUX. MCC
14.	TURBINE VALVE DB
15.	BOILER ACDB
16.	ESP # 1A PMCC
17.	ESP # 1B PMCC
18.	ESP # 1C PMCC
19.	ESP # 1D PMCC
20.	ESP # 1E PMCC
21.	ESP # 1F PMCC
22.	ESP ACDB
23.	ASH SILO PMCC
24.	CW PUMP HOUSE PMCC
25.	CW TREATMENT MCC
26.	CWPH MLDB

DESIGN DATA (ANNEXURE)			
SR. NO.	**ITEM**	**UNIT**	
1.0	**SERVICE CONDITIONS**		
1.1	Altitude	m	188.500M from MSL
1.2	Ambient Air Temperature	ºC	(a) 44.3 ºC (Max.)
		ºC	(b) 3.7 ºC (Min.)
1.3	Design Ambient temperature for all Electrical System/ equipment	ºC	50 ºC
1.4	Relative Humidity	%	85 % (Max.)
1.5	Seismic Zone		IV
2.0	**AUXILIARY POWER SUPPLY**		
2.1	**H.V. SUPPLY**:		
(a)	11kV, 3Ph , 3W, 50 Hz, non- effectively earthed		Motors rated above 1500 KW
(b)	Fault level.	kA	50 kA (symm) for 1 Seconds
(c)	3.3kV, 3Ph , 3W, 50 Hz, non- effectively earthed		Motors above 200 kW and upto and including 1500 kW
(d)	Fault level.	kA	40 kA (symm) for 1 Second
2.2	**L.V. SUPPLY**		
(a)	415V, 3Ph , 4W, 50 Hz, effectively earthed		Motors upto and including 200 kW
(b)	Fault level	kA	50 kA (symm) for 1 Seconds
(c)	110V, 1Ph , 2W, 50 Hz, effectively earthed		Lighting, space heating, A.C. control & protective devices
2.3	**D.C. SUPPLY**		
(a)	220V, 2W, unearthed & protective devices Fault level 25 kA* for 1 second		D.C. alarm, control
	* Indicative only the actual value will be decided by the bidder, after substantiating the same by calculation.		
3.0	**RANGE OF VARIATION**		
3.1	**A.C. SUPPLY**		

(a)	Voltage		± 10%
(b)	Frequency		± 5 %
(c)	Combined Voltage & Frequency (absolute sum)		10%
	During starting of large motor, the voltage may drop to 80% of the rated voltage for a period of 60 seconds. All electrical equipment, while running, shall successfully ride over such period without affecting system performance.		
3.2	**D.C. SUPPLY**		
(a)	Voltage	V	190 to 240 Volt

TECHNICAL PARAMETERS OF ELECTRICAL SYSTEMS ANNEXURE

SR. NO.	ITEM	UNIT	
1.0	**HT SYSTEM DATA**		
2.1	Voltage System	kV	11 kV&3.3
2.2	System of earthing to be adopted for both unit and station system		Resistance grounding
2.3	Limiting Ground Fault current Value	Amp	300
2.4	Type of Bus transfer scheme to be followed for change over from one source to other.		As described on sheet-2
2.5	Type of switchgear to be selected		Vacuum circuit breaker
2.6	(a) Connection between transformer and 11 kV &3.3 kV switchgear		Segregated phase Busduct
	(b) Connection between transformer and 11 kV & 3.3 kV NGR		GI Flat
2.7	Short circuit current		11kV system : 50 kA for 1 Sec.
			3.3kV system : 40kA for 1 Sec.

3.00.00 FAULT LEVEL

Equipment through fault withstand capabilities under worst operating conditions duly taking into account negative tolerances on transformer, generator & maximum fault levels of source etc. shall be as follows :

i) a) Generator Transformer, Station transformer, - 3 seconds
b) Unit transformer - 3 seconds

ii) All other transformers - 2 seconds

iii)	Generator busduct main run (higher of generator or EHV system & motor fault contribution)	- 1 second
iv)	Delta and tap off run busduct (sum of generator, EHV and motor contribution through UT)	- 1 second
v)	11 kV busduct	- 1 second
vi)	Switchgears	
	11 kV	50 kA for 1 Second
	3.3 kV	40 kA for 1 Second
	415 V	50 kA for 1 Second
vii)	Cables to the feeders protected by breakers	Main protection fault clearing time with 0.12 seconds minimum
viii)	Cables of all other feeders	As per fuse operating time
ix)	11KV & 3.3KV cable screen	- 2 seconds for the adopted ground fault current, except 11KV cable fed from miscellaneous transformer. - 1 second for the adopted ground fault current, for cables connected to miscellaneous switchgear/transformer.
x)	EHV systems	
	400kV	50kA for 1Second

CHAPTER 15A : 415V SWITCHGEARS, NON SEGREGATED PHASE BUSDUCT AND DC BOARDS

1.01.00 SCOPE

1.01.01 This specification is intended to cover design, engineering, manufacture, assembly, shop testing, inspection, packing, delivery to site, erection, testing and commissioning of following with all fittings and accessories for efficient & trouble free operation

1. 415 V Power control Centre (PCC)
2. 415 V Motor Control Centers (MCC)
3. 415 V Motor cum Power control centre (PMCC)
4. 415 V Distribution Boards (DB) and Fuse boards
5. DC starters
6. Solenoid valve boards
7. LPBS
8. 415 V Non segregated phase bus ducts

1.01.02 Base channel frame of all boards and fuse boards along with necessary mounting hardware.

1. Set of accessories as listed below:
2. Breaker lifting & handling trolley
3. Racking in/out handle for breakers
4. Racking in/out handle for drawout MCC modules

1.01.03 20% spare outgoing feeders with atleast one of each type and rating shall be provided in each switchgear.

1.01.03 Mandatory Spares

1.01.04 All provisions and accessories shall be furnished for termination and connection of cables, including removable gland plates cable supports, crimp type tinned copper/aluminium lugs, double compression type brass glands with tapered washer (power cables only) and terminal blocks. Cable Schedules for all Power cables and control cables shall be submitted after final dispatch of the switchboards.

1.01.05 Foundation bolts for all the floor mounted equipment, and fixing bolts and accessories for wall mounted equipment.

1.01.06 All interconnecting wiring between various panels/compartments of a switchgear or MCC shall be carried out internally by the Contractor at his works/site.

1.01.07 Certain switchgears with very long lengths shall be sectionalized and physically separated for ease of operation and maintenance. Interconnection of such sections by bus trunking shall be in Bidder's scope.

1.01.08 Bidder shall supply dummy panels, if required for floor beam crossing without any price implication.

1.01.09 415V Switchgears shall have Air Break Spring Charged D.C. Motor operated stored energy type Circuit Breakers with integral manual spring charging

handle for Incoming and Tie feeders. These Breakers shall be electrically operated type, and shall be provided with electrical and mechanical interlocks to prevent paralleling of two different sources of supply.

1.01.10 All MCCs/Switchgears shall be of single/double front construction. All Switchgears/MCCs shall be sectionalized, and Breakers shall be provided for Incoming and Bus Section feeders as specified. These shall be electrically interlocked (if Incomers are through breakers) and castel-key interlocked (if Incomers are through load break Switch/fuse-switch unit). But provision shall be made to defeat interlock to enable parallel operation in case of emergency.

1.01.11 All Switchgears shall be easily extendable on either side. The Bidder shall supply Switchgear in various shipping sections consisting of Incomer, Ties and Motor modules. Bidder may be required to change module types, sizes and the components in respect of certain feeders even during erection, testing and commissioning.

1.01.12 The Bidder shall furnish calculations and/or type-test certificates prove adequacy of the busbar sizes offered, for specified current and short time current ratings. Bus bars in particular and droppers (HBB/VBB) shall be supported on SMC/DMC/FRP supports and covered with heat-shrunk PVC sleeves which shall be shrunk fit and not capable of being removed without destruction. While continuous current ratings of the droppers in each Switchgear Cubicle shall be at least equal to the corresponding Breaker rating, short time current rating shall be same as that for Horizontal Main Bus bars. Only those dropper ratings will be allowed as have passed a type test.

1.01.13 All fuses, switches, fuse switch combinations, contactors and overload relays shall conform to Type-II class of Co-ordination as per IS-13947. Bidder shall furnish Type-II Co-ordination, p & q type test report as per IS: 13947 for all modules along with Bid. Moreover rating of switch shall be at least same or more than that of associated fuse in all cases. The bidder shall have to carryout the 'p', 'q' test as per IS: 13947 before the supply of equipment at Central Power Research Institute.

1.01.14 The Contractor shall furnish relay application checks/ calculations to check adequacy of the CTs/VTs as well as suitability of relay settings/setting ranges proposed by the Bidder. These checks/ calculations shall be furnished during detailed engineering stage for each and every feeder.

1.01.15 LT Switchgear for stacker reclaimer shall be fixed type and no spare shall be provided.

2.00.00 Auto Changeover

2.01.00 Auto-changeover facility will be provided in PCC and MCCs as required during detailed Engineering. These Switchgears/MCC will normally operate with Buscoupler open. If sustained under voltage is detected on any one of the bus section, the respective Incoming Breaker shall trip and bus - coupler shall close if voltage is available on the other bus section. Auto changeover shall be blocked if the Incoming Breaker has tripped due to bus fault. Manual change over from one source of supply to the other or vice versa shall be possible by momentary paralleling of the two supplies after checking synchronism with the help of a synchro check relay. On closing the Incoming breaker, the running Breaker should trip within a preset time. An annunciation shall be provided if the two bus sections remains paralleled for more than a preset time. If the

running breaker fails to trip within the preset time the incoming breaker shall trip. All necessary voltage/isolating transformer; synchrocheck relay etc. shall be supplied for this.

2.02.00 Emergency switchgear will normally have the four incomers one from Unit PMCC, which is normally closed and second from Misc. PMCC, third from DG Set-1 and fourth from standby DG without any bus coupler. In case of sustained under voltage on already closed first incomer, the same will trip and the second incomer will close automatically after a preset time delay. In case the second incomer also trips due to sustained under voltage; automatic starting signal will be given to DIESEL GENERATOR. After DG has run upto rated speed and voltage is built up, the DG breaker shall be automatically closed. In case the main DG fails to start than command shall be given to the standby DG Set. After the standby DG has run upto rated speed and voltage is built up the standby DG breaker shall be automatically closed. Auto changeover on Emergency PCC shall be blocked if lockout trip relay of any incomer is energized due to fault. Changeover from one source to the other will be manually accomplished by first tripping the running source and then closing the breaker of incoming source. Only reputed make auxiliary relays are to be used for status changeover of contacts used in control circuit, auxiliary contactors are not acceptable.

3.00.00 GENERAL

3.01.00 POWER CONTROL CENTER (PCC)

3.01.01 POWER CONTROL CENTER hereinafter referred to as PCC, shall mean a continuous line-up of breaker panels, used to feed Motor Control Centres. All PCCs shall have duplicate incomers and a bus-section. Incomers, bus- section, and all outgoing feeder of a PCC shall be breaker controlled & SFU. Distribution of outgoing feeders shall be such as to ensure uniform loading on each section of the PCC.

3.01.02 MOTOR CONTROL CENTER, hereinafter referred to as MCC, shall mean a continuous line-up of vertical sections housing breaker panels, switch fuse, contactor operated modules. All incomers and Bus-sections shall be breaker controlled except few, which are castle key inter-locked. Whenever bus-sections are provided, all outgoing feeders shall be breaker/switch fuse controlled, or contactor operated depending upon the rating and application. Distribution of outgoing feeders shall be such as to ensure uniform loading on each section of the MCC.

3.01.03 POWER-CUM-MOTOR CONTROL CENTER, hereinafter referred to as PMCC, shall mean a continuous line-up of vertical sections housing breaker panels, switch fuse, and contactor-operated modules. All PMCCs shall have duplicate incomers and a bus-section. Incomers and bus-sections shall be breaker controlled. Depending upon the rating and application, outgoing feeders may be breaker controlled, switch fuse controlled, or contactor operated. Distribution of outgoing feeders shall be such as to ensure uniform loading on each section of the PMCC.

3.01.04 DISTRIBUTION BOARD, hereinafter referred to as DB, shall mean a continuous line-up of vertical sections housing switch fuse modules only. ACDBs shall have duplicate incomers and a bus-section. Powerhouse main DCDBs shall have two incomers from its associated battery charger with bus sectionaliser. Wherever bus-sections are provided, distribution of outgoing feeders shall be

such as to ensure uniform loading on each section of DB. Two(2) nos Floor wise DC sub DB shall be provided having single Incomer from Each Bus section of main DCDB to cater supply for HT/LT switchgear and Transformer auxiliary supply as source 1 & source 2. Valve DBs shall be provided on floor wise/area wise of boiler and turbine side to cater valve load and will be wall mounted fed from respective boiler/turbine MCC. Valve DBs shall have single incomer only.

3.01.05 SOLENOID VALVE BOARD, hereinafter referred to as SVB, shall mean a continuous line-up of vertical sections housing switch-fuse modules and contactor -operated modules. SVBs may have one incomer, which shall be switch fuse controlled. All outgoing feeders shall be contactor operated. FUSE BOARD, hereinafter referred to as FB, shall mean a continuous line-up of vertical sections housing switch fuse only. FBs Boards may be fed from DBs and may have one incomer.

3.01.06 AC fuse boards shall consist of:

- 1 no. 63A TPN SFU as incomer with lamps and meters.
- 9 nos. 16A SPN SFU & 3 nos 16A TPN SFU as outgoing.

3.01.07 DC fuse boards shall consist of:

- 1 no. 63A switch as incomer with meters, lamps and auxiliary contactors.
- 8 nos outgoing feeders with 16A HRC fuses.

3.01.08 The 110 V supply for HT panel & Motors Space Heater, wherever required shall be derived through 415V/110V isolation transformer.

4.00.00 CODES AND STANDARDS

4.00.01 All equipment and materials shall be designed, manufactured and tested in accordance with the latest applicable Indian Standard (IS) except where modified and / or supplemented by this specification. Indian Standards for the equipment covered under this specification are as follows:

IS:8623	:	Specification for factory built assemblies of switchgear & control gear for voltages upto and including 1000V AC/1200 V DC.
IS:4237	:	General requirements for switchgear and control gear for voltages not exceeding 1000V,
IS:2147	:	Degree of protection provided by enclosures for low voltage switchgear and control gear.
IS:3202	:	Code of practice for climate proofing of electrical equipment.
IS:3072	:	Code of practice for installation and maintenance of Switchgear.
IS:8544	:	A.C. Motor starters of voltage not exceeding 1000 V.
IS:2516	:	A.C. Circuit Breakers.

IS:4064	:	Air-breaker switches, air break disconnectors, air break disconnector and fuse combination units for voltage not exceeding 1000V AC or 1200V DC.
IS:2705	:	Current transformers
IS:3156	:	Voltage transformers
IS:3231	:	Electrical relays for power system protection.
IS:1248	:	Electrical Indicating instruments.
IS:722	:	AC Electricity Meters.
IS:375	:	Marking and arrangements of bus bars.
IS:2208 & IS:9224 (Part-II)}	:	HRC Cartridge Fuses.
IS:2959	:	Contactors
IS:6875	:	Switches and push buttons.
IS:6005	:	Code of practice of phosphating iron and steel.
IS:5082	:	Wrought Aluminium and aluminium alloys for electrical purposes.
IS:2629	:	Hot dip galvanising.
IS:13947	:	Low voltage switchgear and Control Gear.

4.00.02 Equipment and materials conforming to any other standard which ensures equal or better quality may be accepted. In such cases copies of the English version of the standard adopted shall be submitted alongwith the bid.

4.00.03 The electrical installation shall meet the requirements of Indian Electricity Rules as amended upto date and relevant IS codes of practice. In addition, other rules or regulations as applicable to the work shall be followed. In case of any discrepancy, the more restrictive rule shall be binding.

5.00.00 DESIGN CRITERIA

5.01.00 The SWGR/PCC/MCC/BUSDUCT and DBs will be used to supply auxiliary power for normal and start-up operation, control and protection for 415/230V AC and 220V DC auxiliary services of generating units.

5.02.00 Duty involves direct-on-line starting of large induction motors upto 160 KW and also under certain emergency conditions automatic transfer of loads from one source of supply to other. Motor starting current varies from 6 to 8 times full load current with maximum of 3 starts per hour.

5.03.00 The equipment will be located in a clean but hot, humid and tropical atmosphere, highly polluted at places with coal dust and/ or fly ash.

5.04.00 Circuit breaker/ switchgear shall not produce any harmful over voltage during switching off induction motors/ supply. If required, surge protective devices shall be included in the scope of supply to limit over voltage.

5.05.00 For continuous operation at specified ratings, the temperature rise of the various equipment shall be limited to the site permissible values stipulated in this specification.

5.06.00 Incomers, buscouplers & outgoings rated below 630A are to be provided with Motorised MCCB. 630A and above shall be ACB controlled .

5.07.00 Loads of outgoing feeders wherever applicable shall also be considered while sizing the busbars, equipments and components. All equipment and components shall be capable of withstanding the mechanical forces and thermal stresses of the short-circuit currents listed in the annexure without any damage or deterioration of materials.

5.08.00 Busbars for PCC/PMCCs shall be sized to carry continuously the associated transformer secondary current plus a 20 % margin.

5.09.00 Busbars of MCCs/DBs/SVBs/FB shall be sized to carry continuously the running load connected to it with a 20% margin.

5.10.00 In cubicle ratings of incomer and bus section breakers/switches shall be identical to the associated busbar rating.

5.11.00 MCC shall have sufficient number of spare modules (at least 20% of various sizes used with a minimum of 1 no. for each rating). The rating of the incomer shall be selected considering the requirement of spares. The spare feeders shall be provided with all equipment and complete wiring similar to their respective active feeders.

5.12.00 The control circuitry of all modules in respective PCC/MCC shall be suitable for interfacing with plant DCS for remote monitoring switching and control.

6.00.00 SPECIFIC REQUIREMENTS

6.01.00 Construction of SWGR/PCC/ MCC/ DBs

6.01.01 SWGR/PCC/MCC/DBs shall be indoor, air insulated, metal-clad, floor mounting type. All SWGRs/PCCs/MCCs shall be fully draw out type having self aligning type secondary plug in contracts. All DBs shall be fixed type. The design and construction shall be such as to allow extension at either end.

6.01.02 PCCs/DBs/SVBs shall be single front construction and PMCCs/MCCs shall be of double front construction. Breaker panels of PMCCs shall be of single front construction.

6.01.03 The enclosure of the equipment shall be dust and weather proof, conforming to a degree of protection IP-52 for ratings upto 1600A and IP-42 for ratings above 1600A. The switchboard frames shall be fabricated using suitable mild steel structural section or braced and shall be cold rolled sheet steel of thickness of not less than 2 mm. The frames shall be enclosed in cold rolled sheet steel of not less than 1.6 mm. The doors and covers shall also be of cold rolled steel of thickness not less than 1.6mm. Adequate stiffness shall be provided wherever necessary. Gland plates shall be 3.00mm. The design shall

be such that specified degree of protection shall be achieved even after a breaker control module has been taken out of the panel.

6.01.04 SWGR/PCC/MCC/ DB assembly shall comprise a continuous line up of dead front, free-standing vertical sections, housing the control modules in multitier formation. The installations of circuit breakers, however, shall be limited to the single tier formation.

6.01.05 The design shall be fully compartmentalized with metal/ insulating partitions between compartments. FBs shall be non compartmentalized. The working height shall be limited within 300mm to 1900 mm. However for MCC modules minimum height shall be limited to 400mm. Switch boards shall be mounted on base frame of 100 mm height from the finished floor.

6.01.06 Each breaker/ control module/ switch fuse unit shall be housed in a separate compartment, complete with an individual front access door having sufficient opening with concealed type hinges. Each vertical section of single front board shall have a removable back cover.

6.01.07 All doors and covers shall be provided with life long rubber and life long pasting neoprene gaskets. MCC module shall also be dust and vermin proof when the module is taken out from the chassis. Suitable arrangement to achieve this feature shall be provided.

6.01.08 All switches push buttons, lamps, indicating instruments shall be flush/ mounted on respective module compartment whereas relays and other auxiliary devices may be mounted on a separate cubicle. All meters indicating lamps and protective relays shall be visible on the door.

6.01.09 A full height vertical cable alley with cable supports shall be provided in each section to facilitate dressing of unit wiring. The chamber shall be liberally sized to accommodate all cables and shall have hinged doors opening on opposite sides with respect to the module doors and removable cover at back side for access. The width of the cable chamber when viewed from front of the switchboard shall not be less than 250 mm. Base frame of 100 x 50 x 6 mm is to be supplied separately.

6.01.10 Breaker cubicle shall be so sized as to permit easy closing of the front access door when the breaker is pulled out to 'ISOLATED' position. The breaker can be operated both in SERVICE and TEST position with the door closed.

6.01.11 A horizontal wire way, extending the entire length, shall be provided at the top of each SWGR/PCC/MCC/ DB for inter panel wiring. The chamber shall be liberally sized to accommodate all cables and shall have removable cover at the front for access.

6.01.12 In all the motor feeders dual output transducers shall be provided. Further all the incomers, Bus couplers and outgoing feeders shall also have dual output transducers

6.01.13 Local Push button stations shall be in sheet steel (2mm) or cast aluminium enclosure of weatherproof neoprene gasketted construction suitable for outdoor use without canopy conforming to IPW-55 or better. The push buttons of spring return type and stay put type shall be as per enclosed drawing. The push button shall be provide with separate terminal blocks.

6.01.14 Interposing relay (coupling relay) shall be provided for each feeder.

6.01.15 Incomers shall be provided at the ends of an assembly and bus section, wherever required, shall be provided at the middle of the assembly.

6.01.16 Four (4) nos. lifting lugs shall be provided for each section, two (2) nos. on either end of the section.

6.01.17 After isolation of the power and control circuit connections, it shall be possible to safely carry out maintenance in a compartment with the busbar and adjacent circuit live. Necessary shrouding arrangement shall be provided for this purpose over the cable terminations located in cable alley.

6.01.18 The 250A & above feeders up to 630A shall have MCCB, MCCB shall be provided with microprocessor based inbuilt front adjustable releases (overload & short circuit) and shall have adjustable earth fault protection unit also. MCCB shall have current limiting feature. ON and OFF position of the operating handle of MCCB shall be displayed and the rotary operating handle shall be mounted on the door of the compartment housing MCCB. The compartment door shall be interlocked mechanically with the MCCB, such that the door cannot be opened unless the MCCB is in OFF position. MCCB shall be provided with padlocking facility to enable the operating mechanism to be padlock.

6.02.00 BUS AND BUS TAPS FOR SWGR/PCC/MCC/DB

6.02.01 The main, tap off buses and connections shall be of high conductivity aluminium. The size for specified current ratings shall be such that maximum temp. rise at bus bar joints shall be limited to 85 Deg. C (i.e. 35 Deg., C rise over 50 Deg. C ambient).

6.02.02 Vertical bus bars shall be designed as per system requirement.

6.02.03 All bus connections shall be provided with anti-oxide grease. For all bus connections adequate contact pressure shall be ensured by means of two bolt connection with plain and spring washers and locknuts. The protruding bolts of different phases/ poles shall be staggered and shall not see each other directly. Bimetallic connectors shall be furnished for connections between dissimilar metals. Alternatively the joints surfaces shall be silver plated.

6.02.04 Bus bars and connections shall be fully insulated for working voltage with adequate phases/ ground clearance. Insulating sleeves for bus bars and shrouds for joints shall be provided. Shrouds for bus bar joints and tapping points shall be two part click-fit type epoxy resin cast/ fiber glass moulded.

6.02.05 Minimum clearance of 25mm is required between phases/ poles for entire run of horizontal and vertical busbars and 19 mm between phase and earth irrespective of sleeve/ shroud provided for bus bars.

6.02.06 For all other components, the clearance between two live parts, a live part and earthed part, and isolating distance shall be at least 10 mm throughout.

6.02.07 Wherever it is not possible to maintain the above mentioned clearances, insulation shall be provided by means of barriers. All connections from busbars upto the fuses shall be fully shrouded to minimize risk of phase to phase and phase to earth faults.

6.02.08 Insulating shrouds for busbar joints shall be moulded type. SWGR/PCC/MCC/ DB with higher clearances shall be preferred considering dust laden environmental condition in which SWGR/PMCC/ MCC/ DB has to operate. Bus supports shall be flame retardant, track resistant non-hygroscopic type epoxy/ SMC/ DMC with high creepage surface. Separate supports shall be provided for each phase and neutral busbar

6.02.09 Cross section of busbar shall be uniform throughout the length of assembly. All buses and connections shall be supported and braced to withstand, the stresses due to maximum short-circuit current and also to take care of any thermal expansion.

6.02.10 Busbars shall be colour coded for easy identification and so located that the sequence R-Y-B shall be from left to right, top to bottom or front to rear, when viewed from the ground to SWGR/PCC/ MCC/ DB assembly.

6.02.11 The horizontal busbar chamber shall be separate and totally enclosed. Control/ space heater buses shall be of copper and shall be extended throughout the length of the switchboard. These buses shall be supported by non-hygroscopic material and segregated from main busbar. Busbar chamber provided for control and auxiliary buses shall be segregated from main busbar chamber.

6.02.12 Busbar chamber provided for vertical busbar shall be segregated from cable alley chamber and outgoing terminals.

6.02.13 Bolted disconnect links shall be provided for DBS for all incoming and outgoing feeders for isolation of neutral, if necessary.

6.02.14 One metal sheet shall be provided between two adjacent vertical sections running to the full height of switchgear except for horizontal bus bar chamber. However, each shipping section shall have metal sheets at both ends.

DBs shall be fixed type construction.

6.02.15 415V Non-segregated phase busduct :

a) The entire bus duct shall be designed for dust, vermin and weather proofconstruction. A suitable aluminium sheet flange-protection hood shall beprovided to cover all outdoor bus duct enclosure joints to facilitate additional protection against rain water ingress. All horizontal runs of bus duct shall have a suitable sloped enclosure top to prevent retention of water for both indoor and out door portion of bus ducts. Bus duct enclosure shall have a degree of protection of IP-55.

b) The material of the conductor shall be aluminium. The bus bars shall be rated in accordance with the service conditions and the rated continuous and short time current ratings.

c) All steel structures required for bus duct support shall be hot dip galvanised.

d) The temperature rise of the bus bars and joints when carrying ninety percent (90%) of the rated current along the full run shall not exceed 40°C over an ambient of 50°C. The maximum temperature rise during short circuit conditions shall not exceed 200°C.

6.03.00 MCC/SVB/DB MODULES

6.03.01 Draw out type control module shall have self- aligning, plug in power / control disconnects. All disconnects shall be silver-plated to ensure good contacts.

6.03.02 The design shall be such as to permit easy withdrawal / reinsertion of the unit guide rails to ensure correct alignment & all the power contacts meet accurately every time the module is inserted.

6.03.03 Various module sizes should be multiples of one basic unit to facilitate modifications at site. Suitable provision for this purpose should also be incorporated in the vertical busbars.

6.03.04 Control module shall house the control components for a circuit such as switch, fuse, contractors, relays, push buttons, lamps etc. as per requirement only the push button actuators, lens of indicating lamps, and transparent windows for meters shall be mounted on module door such that when the module is withdrawn the cubicle door shall be provided the specified degree of protection when the module door is closed. These modules shall be designed to withstand internal arc faults i.e. in the event of fault occurring in one module the arc should not spread to neighboring module and should not affect their functioning.

6.03.05 The equipment layout shall provide sufficient working space in between the components and subject to Owner's approval.

6.03.06 It shall be possible to carry out routine, maintenance checks or small changes in a module without physically taking the module away from switchboard.

6.03.07 Automatic safety shutters shall be provided to fully cover the female primary disconnects when the module is withdrawn. Under any circumstances it shall not be possible to access the vertical dropper accidentally and also suitable means shall be provided to avoid any phase short circuit in vertical droppers.

6.03.08 The module shall be dust & vermin proof even when module is completely withdrawn. Suitable means shall be provided to achieve this feature.

6.03.09 Draw out type control modules of same size and type shall be electrically and physically interchangeable.

6.03.10 Draw out control modules of PCC/MCC shall have the SERVICE, TEST & ISOLATED positions with positive indications and interlocking for each position. The doors of individual modules and the cable alley should open in opposite directions to facilitate clear view of the module when the operator is working on the cable terminals.

6.03.11 In service position, both power and control circuits shall be engaged. It shall not be possible to open the module door when the module is in service position.

6.03.12 In TEST position, the power circuits shall be disengaged but the control circuits shall be engaged. It shall be possible to close the module door when the module is in TEST position. Keeping the front access door of module in closed condition, the breker can be placed in ISOLATED, TEST or SERVICE position from outside.

6.03.13 In ISOLATED position, both power and control circuits shall be disengaged.

6.03.14 Motor feeders of 30KW and above shall be provided with Ammeters & 75 KW and above shall be provided with Ammeter with selector switch.

6.03.15 For entire plant except CHP, motors rated 90kW and above till 200kW shall be ACB controlled. In CHP motors rated 90kW and above till 160 kW shall be ACB controlled.For motors 90 KW and above numerical protection relays are envisaged.. All motor feeder modules shall also be provided with local/field/Remote selector switches on the module itself.

6.03.16 For selection of modules please refer Cl. 6.04.00 below.

6.04.00 Circuit Breakers

6.04.01 Breakers shall have anti-pumping feature.

6.04.02 Circuit breakers shall have minimum interrupting capacity equal to the listed fault level.

6.04.03 Circuit breaker shall be three poles for motors and four poles for incomer, bus coupler and outgoing feeder single throw, air break type with stored energy, trip free mechanism and shunt trip.

6.04.04 The circuit breaker shall have short circuit and overload microprocessor based relay. The relay shall have facility of wide range current settings. The over current relay shall have family of IDMT characteristics curves to arrive at full discrimination with down stream over current relays / fuses MCCBs etc. The short circuit protection shall have adjustable time delay settings. If discrimination is not achieved with the relay, suitable external relays shall be provided for over current & short circuit protection.

6.04.05 One potential free contact for remote annunciation for each over current short circuit and under voltage, circuit breaker tripping.

6.04.06 Circuit breakers shall be draw out type, having SERVICE, TEST & ISOLATED positions with positive indication for each position.

6.04.07 Circuit breakers of identical rating shall be physically and electrically interchangeable.

6.04.08 All circuit breakers shall be of motor wound spring charged mechanism and also shall have hand operated spring charged mechanism facility.

6.04.09 For motor wound mechanism, spring charging shall take place automatically after each breaker closing operation. One open-close/ open operation of the circuit breaker shall be possible after failure of power supply to the motor.

6.04.10 Mechanical safety interlock shall be provided to prevent the circuit breaker from being racked in or out of the service position when the breaker is closed.

6.04.11 Automatic safety shutters shall be provided to fully cover the female primary disconnects when the breaker is withdrawn.

6.04.12 Each breaker shall be provided with an closing and emergency manual trip, mechanical ON-OFF indicator, an operation counter and mechanism charge/ discharge indicator.

6.04.13 In addition to the auxiliary contacts required for normal breaker operation and indication, each breaker shall be provided with following for interlocking purpose:-

- Position/ cell switch with 4 NO + 4 NC contacts.
- Auxiliary switch, with 6 NO + 6 NC contacts, mounted on the stationary portion of the switchgear/ PMCC/ MCC and operated mechanically by a sliding lever from the breaker in SERVICE position.
- Alternatively. Electrically reset latching relay may be used for the purpose. The exact requirement of contacts of position/cells switch, limit switch, auxiliary switch and latching relay shall be decided by the contractor taking into account the scheme requirement spares.
- Spring charge limit switch shall be provided for breakers with motor wound sring charging mechanism. These limit switches for motor duty shall be provided with minimum 2 NO + 2 NC aux. contacts.
- Limit / auxiliary switches shall be convertible type that is suitable for changing N.O contact to N.C. and vice-versa.

6.04.14 Provision of mechanical closing of breaker only in 'Test' and 'Widrawn' position shall be made. Alternatively, mechanical closing facility should be normally inaccessible, accessibility rendered only after deliberate removal of shrouds. It shall be possible to close the door with breaker in test position.

6.04.15 Mechanical tripping shall be through red 'Trip' push button outside the panels for breakers, and through control switches for other circuits.

6.05.00 Switches

6.05.01 Switches shall be double/ tripple pole, air break, AC23 motor duty for motor feeders and AC22 heavy duty for other feeders. Motors duty switches shall be capable of safety making and breaking the locked rotor current of the associated motor circuit. Rotary switches shall be provided with dummy packet between the phases to ensure higher creepage distance.

6.05.02 The switch shall have quick-make, quick break mechanism operated by a suitable external handle, complete with position indicator. This handle shall have provision for padlocking in ON and OFF position.

6.05.03 The compartment door shall be interlocked mechanically with the switch such that the door cannot be opened unless the switch is in OFF position. Means shall be provided for releasing this interlock at any time.

6.05.04 Switches shall be capable of withstanding the let-through fault current of back-up fuses or circuit breakers.

6.05.05 If two switches are specified for any MCC/ DB incomer, these switches shall be mechanically/ key interlocked so as to ensure that only one switch can be closed at a time. If bus coupler switch is provided these shall be

mechanically/ key interlocked so as to ensure that only two switch can be closed at a time.

6.05.06 Incomers for MCCs and DBs rated below 250A shall be load break isolator.

6.06.00 Fuses

Fuses shall be HRC type with operation indicator, preferably link type, with a minimum interrupting capacity equal to the listed short circuit current.

Fuses shall be furnished complete with fuse bases and fittings of such design as to permit easy and safe replacement of fuse element. Visible indication shall be provided on blowing of the fuse.

Motor fuse characteristics and ratings shall be chosen to ride over starting period without blowing. The fuse on incoming feeder, if specified, shall be chosen to provide discrimination with motor/ feeder fuses.

Isolating switches shall be of AC23A catergory when used in motor circuit, and AC 22A category for other applications. Fuse switch combination shall be provided wherever possible.

6.07.00 A.C. Starter

6.07.01 Contactors

a) Motor starter contactors shall be of air break, electromagnetic type suitable for DOL starting of motor, and shall be utilization category AC-3 for ordinary and AC-4 for reversing starters. For conveyor motors, minimum rating of power contactors shall be 200% of the full load current of the motors. For other motors minimum rating of power contactors shall be 160% of full load current of motor. DC contactor shall be DC-3 utiliztion category.

b) Each contactor shall be provided with two (2) normally open and two (2) normally closed auxiliary contacts rated 10 A at 240V AC or 2A at 220V DC. The exact requirement of contacts shall be decided by the contractor taking into account the scheme requirements and spares.

c) Reversing contacts shall be electrically and mechanically interlocked.

d) Contactors associated with timer to achieve delayed dropout feature shall be provided for some essential auxiliaries. The timer used for this purpose shall be electronic type only.

e) Reacceleration system to be adopted for Boiler MCC, turbine MCC and Emergency MCC contactor operated motor feeder.

f) All the contactor, starters shall comply with the requirement of type-2 co-ordination as specified by IEC 60947-4-1.

6.07.02 Thermal overload

a) Thermal overload relays shall be three element, positive acting, ambient temperature compensated with adjustable settings. Single

Phasing Preventor shall be provided as an inbuilt feature of the thermal overload relay.

b) Relays shall be manual reset type with one changeover contact. Resetting of relays shall be possible with compartment door closed, with direct operated reset knob. Colour of resetting button shall be BLACK.

c) Relays may be direct acting or C.T. operated, depending on current rating, C.T.s shall be included in the scope of supply.

d) For all motors having long starting time, the relays shall be provided with saturable current transformer to avoid spurious tripping during starting of the motor. The current transformer will have linear characteristic upto approx. twice the setting current.

6.08.00 DC STARTER

a) DC starters shall be complete with switch fuse units, contactors, resistors, relays,meters, push buttons, lamps, etc.

b) Starters hsall be furnished in totally enclosed floor mounting, sheet steel cubicles complete with a hinged front access door. Minimum thickness of sheet steel shall be 2 mm.

c) The cubicle enclosure shall provide dust and humidity protection, the degree of protection being not less than IP 54.

d) The resistor enclosure shall be provided with ventilating louvers and wire mesh guard and shall have a degree of protection IP 23.

e) Cubicle space heater shall be provided to maintain internal temperature above dew point. Heater shall be furnished with SFU and thermostat control.

6.09.00 Control & Indication

6.09.01 The circuit breaker shall be wired up for local and remote operation. Each breaker cubicle shall be equipped with following:-

a. One (1) "STEST-LOCAL-REMOTE" selector switch stay put type with black pistol grip handle and key interlock for motor feeder breaker and one (1) "LOCAL REMOTE" selector switch stayput type with black pistol gird handle and key interlock for incoming and outgoing tie feeders.

b. Two (2) heavy duty, oil tight, push buttons for TRIP & CLOSE.

c. One (1) heavy duty, oil-tight, CLOSE-NEUTRAL-TRIP Switch

d. Indicating light on front of compartment:

GREEN	-	Breaker open
RED	-	Breaker closed
AMBER	-	Trip/Trip circuit trouble
BLUE	-	Breaker Spring charged
AMBER	-	Breaker, Auto trip

WHITE	-	Trip coil healthy
WHITE	-	Breaker in test position
YELLOW	-	Breaker in service position

e. Lamps shall be LED type with coloured dome. Lamps and lens shall be replaceable from the front. LED lamp shall be made in accordance with InP technology (Aluminuim Indium Gallium Phosphide technology). The body shall be made of poly carbonate unbreakable lens. LED shall be protected by inbuilt fuse with surge suppressor or leakage voltage glow protection. LED circuit shall be PCB mounted. Intensity shall be greater than 200 mcd. All push button lamp shall be as per LED indicating lamp.

f. One voltage operated earth fault relay (64) shall be provided across the neutral grounding resistor through voltage transformer for each PCC/MCC incomer fed from transformer directly. Relay shall have at least 2 nos. contacts; one shall be connected to shown earth fault lamp indication (window) on incomer panel and other for indication on operating console.

g. Two(2) incomers and bus coupler shall be so interlocked that no two incomers shall operate in parallel.

6.09.02 The control module shall be connected for local remote operation. Each control module shall be equipped with the following:

6.09.03 Required nos. of push buttons as per scheme drawing.

6.09.04 Each push button shall have two (2) normally open and two (2) normally closed contact rated 10A at 240V.

6.09.05 Push button shall be heavy duty, oil tight, push to actuate type with integral escutcheon plate marked with its function.

6.09.06 One (1) MCC-REMOTE-LOCAL selector switch having make before break feature shall be provided for unidirectional motor feeders.

6.09.07 Lamps shall be LED type with coloured lens. Lens and lamps shall be replaceable from the front.

6.09.08 For control supply, the contractor shall provide 415/240 on load control transformers with 100% standby arrangement.

6.09.09 DCDBs shall be provided with indication to monitor healthiness of the incoming DC supplies.

6.10.00 Current Transformer

6.10.01 Current Transformers shall be epoxy cast-resin type rated 10 VA. All secondary connections shall be brought out to terminal blocks where wye or delta connection will be made.

6.10.02 Motor feeders rated 30 kW to below 75 kW, shall be provided with CTs for metering. Motor feeders rated 75 kW and above, separate CTs shall be provided for metering and protections. SFU rated 100 A and above for outgoing feeder shall be provided with CT and ammeter.

6.10.03 Accuracy class of the current transformers shall be:-

a. Class PS for differential
b. Class 5P20 for other relaying
c. Class 1.0, ISF < 5 for metering other than MEAA
d. CTs for MEAA metering shall be as per Chapter-1

6.10.04 Separate wire shall be used for metering and protection as far as possible. Secondary wire terminals shall be made available accordingly.

6.10.05 Terminals with CT secondary shorting links for metering leads and TEST terminals block for C.T. secondary relay and KWH leads shall be provided.

6.10.06 VA Burden of CT's shall be adequate (15 VA minimum) for connection to remote metering system. Also additional terminal blocks etc. as may be required shall be provided in panels.

6.10.07 Feeder requiring remote metering and/or current monitoring shall be provided with current transducers with calibration for full scale reading. The output shall be 4-20 mA DC which shall correspond to the normal range.

6.10.08 CT secondary shall be rated 1 A for metering and protection.

6.11.00 Voltage Transformer

6.11.01 Three nos. single phase voltage transformer shall be provided in each incoming power supply circuit with voltmeter and selector switch. Additional three nos. voltage transformers shall be provided for each bus section voltmeter and its selector switch.

6.11.02 Voltage transformers shall be epoxy cast resin and shall have an accuracy class of 1.0. Voltage Transformers mounted on breaker carriage is not acceptable. Voltage rating for the Transformer shall be 1.2 continuous and 1.5 for 30 second.

6.11.03 Voltage transformer shall capable to withstand 200% of rated voltage continuously without change in its characteristics.

6.11.04 High voltage windings of voltage transformer shall be protected by current limiting fuses.

6.11.05 Low voltage fuses, sized to prevent overload shall be installed in all ungrounded secondary leads. Fuses shall be suitably located to permit easy replacement while the MCC is energised.

6.11.06 VTs for MEAA metering shall be as per Chapter-1

6.12.00 Control Transformers

6.12.01 For control supply control transformers of adequate rating (min. 5 KVA rating) with 100% standby shall be provided.

6.12.02 For motor space heating supply, the transformers of adequate rating (min. 2 KVA rating) with 100% standby shall be provided.

6.12.03 All the control transformers shall be placed in spacious compartments to have proper air circulation and keep lower temperature of transformer and its module.

6.12.04 All the control transformers shall be provided with selector switch, fuses, indicating lamps. Each control transformer shall feed to its control buses of respective bus section during normal operation. In case of failure of one of the control transformer, provision shall be made to tap the control supplies from other bus section control transformer by auto changeover using aux. relays contacts/switch. Bidder has to develop scheme accordingly. This logic shall be made applicable for space heating and winding heating control transformer also.

6.12.04 All control transformer shall conform to IS: 12021.

6.12.05 For unit Emergency Switchgear 2 Nos of control transformer shall be provided with auto change over scheme.

6.12.06 Control transformer shall have + 2.5% to + 5% tappings in steps of 2.5

6.13.00 RELAYS

a) The protective relays shall be static or numerical type. However, numerical type shall be preferred. All relays, auxiliary relays and devices shall be of reputed make and types proven for the application and shall be subject to purchaser approval. The relays and timers shall have appropriate setting ranges, accuracy, resetting ratio, transient over-reach and other characteristics to provide required sensitivity to the satisfaction of the owner.

b) Relays shall be suitable for efficient and reliable operation of the protection scheme. Necessary auxiliary relays, timers, trip relays, etc. required for complete scheme, interlocking, alarm, logging, etc. shall be provided. Control relay shall not trip the circuit breaker when relay is de-energized.

c) Relays shall be flush mounted on the front with connections at the rear shall be draw-out or plug-in type/ modular case with proper testing facilities. Provision shall be made for easy isolation of trip circuits for testing and maintenance.

d) Auxiliary relays shall be provided in the trip circuits of protections located outside the board, such as buchholz relay, temperature indicators, fire protection, etc.

e) Control circuits shall operate at suitable voltage of 110V AC or 220V DC. Necessary control supply transformers having primary and secondary fuses shall be provided for each MCC, 2x100% per section. However the breakers shall operate on 220V DC. The auxiliary bus bars for control supply shall be segregated from main bus bars. The control supplies shall be monitored.

f) Contractor shall fully co-ordinate overload and short circuit tripping of breaker with upstream and down stream breakers/ fuses/ MCCBs motor starters. Various equipments shall meet requirement of Type-II class of coordination as per IEC.

g) In case of remote controlled breaker panels, following shall be provided.

Each feeder shall have local/ remote selector switch. Closing from local shall be possible only in test position whereas closing from remote shall be possible in either service or test position. Tripping from local shall be possible only when local/ remote selector switch is in local position. Tripping from remote shall be possible when breaker is in service position or selector switch is in remote position.

h) Suitable self powered transducers as per IS : 12784 Part - I (if required) for feeding signals to panel mounted electrical meters (ammeters, voltmeters, VAR meters and watt meters etc.) and DCCMIS shall be provided. Alternatively, analog signals from numerical relays shall be directly used.

i) The motor feeders for essential auxiliaries shall have contactors with delayed drop-out feature adjustable up to three seconds.

6.13.01 General-B

(a) All protective relays shall be of numerical microprocessor based multifunctional type having communication facility for connection to DCS through PC via PLC console.
(b) All relays shall conform to the requirements of IS 3231 / IEC: 60255 standards.
(c) Vendor shall ensure availability of spare parts and maintenance support for the equipment for at least 15 years from the date of supply.
(d) Any foreign relay manufacturer through his Indian partner or subsidiary company in India shall provide application, testing, commissioning and other necessary support for minimum 15 years. They shall also maintain adequate inventory of each type of relay or spares to meet the requirement arising during project execution and plant operation

6.13.02 Technical Requirement

(a) Auxiliary Power Supply
Unless otherwise specified, relay shall be suitable to accept both AC / DC supplies with range 110V to 240 V with tolerance of $\pm$20%. The auxiliary power supply shall preferably be site selectable requiring no additional hardware.

(b) Basic Requirement and Constructional Requirement

(i) Relays shall be suitable for flush mounting on the front with connections from the rear. The enclosure shall be dust tight having degree of protection minimum as IP:5X.
(ii) Relay shall have draw out feature with plug in type PCB for easy replacement. In case of fixed type relay, the terminals shall be easily accessible for testing and commissioning.
(iii) Relay shall have self-diagnostic feature with indication of relay failure on rely front. However, while diagnostic circuit runs, it must not interfere in the main protective relay circuit and allow working of main protective circuit continuously. Relay faults (self-diagnostic) shall be communicated and annunciated to HMI.
(iv) Design of the relay shall be such that it must operate selectively and with proper discrimination. It must be immune to any kind of electromagnetic interference. Vendor to submit all related type test reports for the offered model along with the offer.

(c) Display & Indication

(i) All numerical relays shall have keypad / keys to allow relay settings from relay front. In addition, relay shall have front port for downloading / uploading of relay settings from the PC / Laptop. All hand-reset relays shall have reset button on the relay front. Relay to be self or hand reset shall be software selectable.
(ii) All relays shall have LED / LCD display for settings, status, faults and events. LCD display shall be backlit and temperature compensated up to 65^0C for contrast and legibility.
(iii) As a minimum, the relay shall have LED indicating lamps for fault trip, relay healthy / unhealthy and control supply on.
(iv) The relay shall have at least 6 programmable LEDs on relay front.

(d) Software Security
Relay shall be provided with password protection against unauthorized write access. However, viewing of metering data, setting and status and event data as read only parameters should be without password protection.

(e) Disturbance, Event Recording & data Storage
Status, disturbance data and events shall be stored in non-volatile memory or memory backed up by battery. It should be possible to store minimum 50 events with date and time stamp, last 5 fault records and last disturbance record. When auxiliary power fails, it should be possible to see the latest state of display when power is restored. Also, in case of power supply failure lock out status of the relay should be stored and kept in memory to allow the working of interlock logic properly on restoration of the supply.

(f) Trip Circuit Supervision & Lock out function

(i) Relay shall have built in lockout function. Lock out feature shall be self reset or hand reset and shall be software selectable.
(ii) For trip circuit supervision separate relay shall be provided.

(g) Input / Output Interface, Filters an galvanic Isolation.

(h) Relay shall have at least 4 No contacts each shall separately be programmable for either hand reset or self-reset. The contact rating shall be minimum 5A at 250V AC / DC.

(i) Relay shall be made immune to capacitance effect due to long length cables.
(ii) All IOs shall have galvanic isolation. Analog inputs shall be protected against switching surges,, harmonics etc.

(i) Serial Communication

(i) Relay shall have RS 485 or FO (Fiber Optic) port for serial c communication.
(ii) All relays should be able to communicate with DCS system. Data shall be available at the DCS on request.
(iii) Protocol adapted for communication to DCS should facilitate easy interface with world wide used open protocol like Modbus or IEC 13 protocols.

(iv) It shall be also possible for Relay Parameterization as well Downloading of Disturbance Records form PC provided in Unit & Engineering Workstations located in Switchgear Room of each unit i.e. Unit & Engineering workstations shall be provided each in four (4) Switchgear Rooms. Necessary software to be provided for this purpose. Communication protocol shall be selected from relay to PC to provide all information.

6.14.00 Protection

i) 415V AC and 220V DC Incomers

a) Time graded short circuit protection on incoming supply feeder circuit breakers to main switchgears (PCCs and MCCs)

b) Instantaneous over-current protection on all outgoing feeders

c) Under- voltage protection for 415V bus

d) Sensitive earth fault detectors shall be provided in DC system to annunciate earth faults

ii) 415 Volts motor feeders

1) Contactor controlled motor feeders (Motors below 90 kW)

i) Instantaneous short circuit protection on all phases through HRC cartridge type fuses rated for 80 kA rms (prospective breaking capacity at 415V).
ii) Thermal overload protection
iii) Single phasing protection for motors protected by fuses

2) Breaker controlled motors feeders (motors rated above 200 kW)
i) Instantaneous short circuit protection on all phases
ii) Overload protection on two phases
iii) Over load alarm on third phase
iv) Earth fault protection
v) Under voltage protection
vi) Unbalance (negative sequence)
vii) Hand reset lockout relay with a blue lamp for monitoring

6.15.00 Secondary wiring

6.15.01 The MCC/DB shall be fully wired at the factory to ensure proper functioning of control, protection, transfer and interlocking schemes.

6.15.02 Fuse and links shall be provided to permit individual circuit isolation from bus wires without disturbing other circuits. All spare contacts of relays, switches and other devices shall be wired upto terminal blocks.

6.15.03 Wiring shall be done with flexible, 650V grade, PVC insulated switchboard wires with stranded copper conductors of 2.5 sq.mm for current circuits and 1.5 sq.mm for voltage circuits and control circuits. Colour code shall be maintained por voltage and current circuits.

6.15.04 Each wire shall be identified, at both ends with permanent tubular type printed markers bearing wire numbers as per Contractor's wiring diagrams. Each wire shall be ferruled by plastic tube with indelible ink print at both ends having terminal block no., terminal nos., destination no, as per approved drawing.

6.15.05 Wire terminations shall be made with crimping type connectors with insulating sleeves. Wire shall not be spliced between terminals. Fork type lugs shall be provided for all control terminals. The lugs shall be suitable for 2.5 sq.mm stranded copper conductor. However, C.T. wiring shall be done by using circular type lugs.

6.15.06 For power wiring inside module copper cables are to be used.

6.15.07 Terminal blocks with loose wires shall be provided in each shipping section for inter panel wiring.

6.15.08 All control terminals shall be of 10 sq.mm size and shall be sliding type for draw out module and clip on type for fixed type module.

6.16.00 Terminal Blocks

6.16.01 Terminal blocks shall be 660V grade box-clamp type with marking strips, similar to ELMEX 10 sq.mm or equal. Terminals for C.T.secondary leads shall have provision for shorting or any other equivalent new technology terminal blocks after approval of owner.

6.16.02 Not more than two wires shall be connected to any terminal. Spare terminals equal in number to 20% active terminals shall be furnished.

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

6.16.04 Coloured terminal blocks for connection of power cables (R,Y,B phases) shall be provided.

6.16.05 Twisted pair 0.5sq.mm copper cable will be used for DCS/BMS/ATRS surface

6.17.00 Cable Termination

6.17.01 SWGR/PCC/MCC/DB shall be designed for cable entry from the bottom. Sufficient space shall be provided for ease of termination and connection.

6.17.02 All provisions and accessories shall be furnished for termination and connection of cables, including removable gland plates cable supports, crimp type tinned copper/aluminium lugs, double compression type brass glands with tapered washer (power cables only) and terminal blocks. Terminating of power cables shall be shrouded to avoid accidental touch. Suitable supporting clamps shall be provided for cables to eliminate stresses on terminals.

6.17.03 Twisted pair 0.5 sq mm copper cable shall be used for DCS/BMS/ATRS interface.

6.17.04 Gland plates shall be minimum 4 mm thick for single core cable and 3mm for muti core cable. The gland plate and supporting arrangement for I/C Power cables shall be such as to prevent flow of eddy current.

6.17.05 Gland plates shall be easily removable type. The gland plate shall be mounted at 40/50 mm above the bottom of base frame of switch board.

6.17.06 Cabling area above gland plate shall be free of any earth bus, neutral bus etc. so that the total gland plate area is usable for cabling and also do not obstruct removal of gland plate.

6.18.00 Busduct Connection

Busduct connections, wherever provided, shall be furnished alongwith transition panel if required. Busduct connections shall be generally from top.

All connecting bus work shall have the same continuous rating as associated SWGR/PCC/MCC bus and shall be fully braced for the specified short circuit current.

All provisions such as matching flange and other accessories shall be furnished for connection to busduct.

All the incomers from transformer shall be connected by Bus duct.

6.19.00 Ground Bus

i. A ground bus made of copper/GI rated to maximum fault current shall be extended to full length of the MCC/DB.
ii. The ground bus shall be provided with two-bolt drilling with G.S. bolts and nuts at each end to receive 50x6 mm G.S.flat.
iii. Each stationary unit shall be connected directly to the ground bus. The frame of each circuit breaker and V.T. unit shall be grounded through heavy multiple contacts at all times except when the primary disconnecting devices are separated by a safe distance.
iv. The frames of all other drawout modules shall be grounded through heavy multiple contacts at all times except when the power disconnects are separated by a safe distance.
v. Wherever the schematic diagrams indicate a definite ground at the SWGR/PCC/ MCC a single wire for each circuit thus grounded shall be run independently to the ground bus and connected thereto.
vi. C.T. and V.T. secondary neutral shall be earthed through removable links so that earth of one circuit maybe removed without disturbing others.
vii. Door earthing shall be done by using 2.5 sq.mm stranded flexible copper conductor PVC insulated (Green colour).

6.20.00 Name Plates

Name Plates of approved design shall be furnished at each cubicle/control compartment, at the top of each MCC/DB and at each instrument and device mounted on or inside the cubicle.

The material shall be lamicoid or approved equal 3 mm thick with white engraved letters on black background.

The name plate shall be held by self-tapping screws. Name plate size shall be minimum 40 X 150 mm of 0.5mm thick for instrument/devices & 75 x 450 mm of 1mm thick for panels. The size of lettering shall be minimum 5 mm for

module/feeder designation; however, component designation letter size shall be 6 mm.

Caution notice on suitable metal plate shall be affixed at the back of each vertical panel for single front construction.

Board labels and panel Nos. shall be provided both on front and rear at two locations each if board is more than 10 meters in length.

6.21.00 Space Heaters and Plug Sockets

Each vertical section shall be provided with thermostat controlled space heater and 5A, 3 pin plug socket.

In addition, motor feeders 30 KW and above shall be wired up for feeding the motor space heater through suitably rated starter auxiliary NC contact.

Cubicle heater, Motor heater, plug socket circuit shall have individual switch fuse units.

For valve / actuator provision of space heater supply shall be provided.

6.22.00 A.C./D.C. Power Supply

The following power supplies shall be arranged to each SWGR/PCC/ MCC:

a) For each SWGR/PCC/MCC 220V DC Double feeder power supply shall be arranged by contractor for breaker control.

b) For control module in SWGR/PCC/MCC, 240V power supply shall be arranged by the contractor.

c) 240V power supply for motor space heating/hand lamps shall be arranged by the contractor in MCC.

d) Each SWGR/PCC/MCC shall be provided with group control transformer with 100% standby and on load changeover facility.

Isolating switch fuse units / MCBs shall be provided at each SWGR/PCC/MCC/DB for the AC/DC supplies.

Bus wires of adequate capacity shall be provided to distribute the AC/DC supplies to different cubicles. Isolating switch fuse units / MCBs shall be provided at each cubicle for AC/DC supplies.

AC load shall be so distributed as to present a balanced loading on three phase supply system.

6.23.00 Control

It shall be possible to control the starter/ breaker from local, near the motor or switchgear and remote - from Central Control Room(CCR) through potential free contacts from DCS or Trip-N-Close control switches from remote electrical control panel. it should be possible to inhibit starting of a motor from any position by a lockable stop push button located near the motor. all motor starters shall enable direct on line(DOL) starting of motors.

Every circuit breaker controlled module will have one close auxiliary relay (car) and one open auxiliary relay(oar) to operate in conjunction with open/close commands from dcs or sms.

Facilities shall be provided to connect field permissive contacts for interlocking. Necessary time delays associated with the schemes should be incorporated. At least twenty (20) percent spare terminals shall be provided for external interlocking.

6.24.00 Tropical Protection

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

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

6.25.00 Painting for SWGR/PCC/MCC/DB

All surfaces shall be subject to tank pretreatment process to produce a smooth, clean surface free of scale, grease and rust.

The SWGR/PCC/ MCC/DB and all other components shall be powdered coated RAL 7032(Siemens grey).

Sufficient quantity of touch-up paint shall be furnished for application at site.

6.26.00 Accessories

The following accessories shall be furnished alongwith the SWGR/PCC/ MCC.

a. Breaker lifting and handling truck.
b. Device for slow opening and closing of breaker – one per breaker.
c. Breaker racking in /out handle – one per breaker.

6.27.00 Tests

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

6.27.01 **Routine Tests**

A) The tests for SWGR/PCC/MCC/DB shall include but not necessarily limited to the following:

a. Operation under simulated service condition to ensure accuracy of wiring, correctness of control scheme and proper functioning of the equipment.

b. All wiring and current carrying part shall be given appropriate high voltage test.

c. Primary current and voltage shall be applied to all instrument transformers.

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

6.27.02 **Type Tests:**

1. General:

a) All equipments to be supplied shall be of type tested design. The Contractor shall submit for owner's approval the reports of all the type tests as listed in this specification and carried out within last five years from the date of bid opening. These reports should be for the tests conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client.

b) In case the Contractor is not able to submit report of the type test(s) conducted within last five years from the date of bid opening, or in case the type test report(s) are not found to be meeting the specification requirements, the Contractor shall conduct all such tests under this contract at no additional cost either at third party lab or in presence of client/owner's representative and submit the reports for approval.

c) All acceptance and routine tests as per the specification and relevant standards shall be carried out. Charges for these shall be deemed to be included in the equipment price.

2. **LT Switchgear**

The following type test certificates on each type & rating of LT switchgear and MCC panel shall be submitted.

a) Short time withstand test.

b) Temperature rise test.

c) Class II- Protection co-ordination test for any three ratings of MCC module as selected by employer.

d) Test sequence -1 & combined test sequence on each rating of circuit breaker mounted inside the panel.

e) Degree of protection tests.

f) Type test certificates for Numerical relays.

6.28.00 TEST WITNESS

Test shall be performed in presence of Owner's/ representative if so desired by the owner. The contractor shall give at least thirty(30) days advance notice of the date when tests are to be carried out.

DATASHEET FOR 415V PCC/PMCC/MCC/DBs

Sr. No.	Item	Units	

1.0	**GENERAL**			
(a)	Type		Metal-clad, drawout (PCC/PMCC/MCC) Metal-clad, fixed (DB)	
(b)	Service		Indoor	
(c)	Enclosure		For ampere rating upto 1600 A- degree of protection of PCC/PMCC/MCC shall be IP-52 and above 1600 A the degree of protection will be IP-42.	
1.1	SYSTEM		AC	DC
(a)	Voltage	V	415V ±10%	220V ±10%
(b)	Phase		3-phase and neutral	-
(c)	Combined voltage and frequency variation		±10% (absolute sum)	-
(d)	System grounding		Solidly grounded	ungrounded
1.2	RATED CURRENT AT 50 degC AMBIENT			
(a)	Busbar		*By Bidder	
(b)	Circuit breaker		*By Bidder	
(c)	Switches		16A to 400 A	
1.3	SHORT CIRCUIT RATING		AC	DC
(a)	Interrupting	kA	50 kA	25* kA
(b)	Short Time for 1 second	kA	50 kA	25* kA
1.4	HV FOR 1 MINUTE (MIN.)	kV	2.5 kV	1.5* kV
(a)	Indicative only; the actual value will be decided by the Bidder, after substantiating the same by calculation.			
1.5	A.C./D.C POWER SUPPLY			
(a)	Control Voltage for Circuit breaker	V	220V DC±10%	
(b)	Control voltage for MCC modules	V	110V AC ±10% , 1 Ph, 50 Hz ±5%	
(c)	Service voltage	V	110V AC ±10% , 1 Ph, 50 Hz ±5%	
2.0	**CIRCUIT BREAKER**			
2.1	DUTY CYCLE		0-3'-CO-3'-CO	
2.2	BREAKING CURRENT			
(a)	A.C. symmetrical	kA	50kA	
2.3	MAKING CURRENT	kA	105kA Peak	
2.4	AUXILIARY VOLTAGE			
(a)	Closing	V	220V D.C. (85-110%)	
(b)	Tripping	V	220V D.C. (70-110%)	
(c)	Spring Charging	V	220V D.C. (85-110%)	
3.0	**CONTACTOR DUTY**		AC	DC
			Class 3- Category AC-3 for unidirectional/inching duty drives	Class 1- Category DC-2
4.0	**BUSBAR INSULATOR**		Epoxy/Eparchy	

MODULE SELECTION

I) OUTGOING FEEDER FOR A.C.

TYPE	FUSE RATING	MODULE SIZES
AF	32	200MM
BF	63A	200 MM
CF	100 A	300 MM
DF	200 A	400 MM
EF	400A	600 MM

II) **MOTOR FEEDER**

TYPE	**MOTOR RATING**	**MCCBRATING**	**CONTACTOR RATING**	**MODULE SIZE**
AU / AR	0-5.5 KW	32 A	16 A	400 MM
BU /BR	5.6-11 MW	32 A	32 A	400 MM
CU	11.1-29.9KW	63 A	63 A	600 MM
DU	30 -46 KW 37 – 45 kW	100 A 125 A	100 A 100 A	900 MM
EU	50 - 75 KW	200 A	160 A	900 MM
FU	75.1 -89.9 KW	200 A	185 A	900 MM

NOTE:

1. Fuse and thermal overload relay are to be co-ordinated with motor rating by the contractor

2. Module sizes are based on the minimum module width of 400 mm. Cable alley of 250 mm and panel depth 450 mm (single front)

3. For auxiliary building and for street lighting, bidder to provide necessary feeders in the MCC for MLDBs.

4. All rating shown are indicative only. Exact requirement will be decided by successful bidder based on proven design. Type II coordination shall be achieved during finalization of component rating.

CHAPTER 15B : 415V SWITCHGEARS, NON SEGREGATED PHASE BUSDUCT AND DC BOARDS

1.01.00 SCOPE

1.01.01 Each set of 415V non-segregated phase bus duct will originate from 415V Switchgear Incomer panel terminals and will terminate at transformer terminals. The bus duct run shall be complete with all bends, flexible, bellows and terminal adaptor boxes, interconnection hardware etc. as required.

1.01.02 All supporting steel structures, fasteners and necessary hardware for complete bus-duct installation.

1.01.03 One set of special tools and tackles.

1.01.04 Mandatory Spare parts.

1.01.05 Recommended spare parts for three (3) years operation

1.01.06 All relevant drawings, data and instruction manuals.

2.00.00 DESIGN CRITERIA

2.01.00 The 415V non-segregated phase bus duct will serve as interconnection between the 415V Indoor Switchgear and outdoor/Indoor transformer terminals. It is also used for trunking connection between two separate switchgear panels, wherever applicable.

2.02.00 The 415V non-segregated phase bus duct shall be installed indoor / outdoor in a hot, humid and tropical atmosphere.

2.03.00 The portion of bus duct at the transformer end will be subjected to vibration normally prevalent for this type of installation in a power generating station/industrial plants. Suitable means shall be provided to isolate the transformer vibration from rest of the bus structure/ bus duct.

2.04.00 The current carrying capacity of the bus duct shall take into account the service conditions, including skin effect, ambient temperature, bus insulation and exposure to sunlight.

2.05.00 For continuous operation at specified ratings, temperature rise of the bus duct and auxiliary equipment shall be limited to the permissible values indicated in the annexure of this specification.

2.06.00 Bus duct shall be capable of withstanding the mechanical forces and thermal stresses of the short-circuit currents listed in the annexure without any damage or deterioration of material.

2.07.00 Bus duct and supporting structures shall be designed & constructed so as to withstand without damage the horizontal/ vertical ground accelerations due to earthquake.

2.08.00 The bus ducts shall be self cooled and shall not be equipped with blower or any other type of forced ventilation.

3.00.00 SPECIFIC REQUIREMENTS

3.01.00 General

3.01.01 The 415V bus duct shall be non-segregated phase enclosure, natural air cooled type.

3.01.02 All parts and accessories shall have appropriate match mark and part numbers for easy identification and installation at site.

3.02.00 Enclosures

Phases shall be enclosed in a weather-proof, dust-tight enclosure without any barrier between phases. It shall preferably be rectangular in shape adequately rigid with stiffeners as required. Enclosure for indoor run shall be IP52 protected. Outdoor enclosure shall have IP 55 degree of protection.

The enclosure shall be made of sheet steel for rated continuous current up to and including 2000A at site condition. Above 2000A bus duct enclosure shall be made of Aluminum alloy. The thickness of enclosure material shall not be less than 3mm.

3.02.02 Circumferential neoprene rubber gaskets (joint less type) shall be provided for dust tight joints with adjacent enclosure section.

3.02.03 The bus enclosure shall have extended bellows or equivalent means to allow for temperature changes and vibrations. Flexible joints shall be provided in enclosures at all points where the bus duct terminates at equipment to withstand vibration, expansion/contraction and at suitable intervals in any straight run of the bus duct where expansion and contraction would otherwise result in stresses in the supporting structures.

3.02.04 Horizontal runs of bus duct shall have suitably sloped enclosure top to prevent retention of water for both indoor and outdoor portions of the bus duct.. For outdoor runs, the shipping sections shall be provided with flange protection hood to facilitate additional protection against rain water ingress through joints.

3.02.05 Suitable inspection openings shall be provided for access to support insulators, bus joints, transformer terminals, switch gear terminals etc. All inspection openings shall have reliable sealing arrangement with neoprene gaskets.

3.02.06 Filtered drains for drainage of condensate shall be provided at the lowest points and at such locations where accumulation of condensate can be expected.

3.02.07 Shipping length of the bus duct shall be not more than three (3) meters in length.

3.03.00 Bus Conductor

3.03.01 The bus conductor shall be of high conductivity electrolytic grade copper or aluminum alloy as indicated in the annexure, supported on fine glazed porcelain / cast resin / FRP insulators fixed to enclosure.

3.03.02 The bus conductor shall be designed for bolted connections throughout the run.

3.03.03 Flexible connections shall be provided between bus sections to allow for expansion and contraction of the conductor. Flexible connection shall also be provided at all equipment terminations.

3.03.04 All contact surfaces shall be silver plated to ensure an efficient and trouble-free connection. All connection hardware shall be non- magnetic and shall have high corrosion resistance.

3.03.05 Bus bars shall be color coded at regular intervals for easy identification. Markings on the bar shall be Red for R-phase, Yellow for Y-phase and Blue for B-phase.

3.03.06 All bolted joints shall be provided with high grade stainless steel nuts bolts, plain and belle-ville washers.

3.04.00 Insulators

3.04.01 Bus support insulators shall be bus post type, interchangeable, high creep, high strength, flame retardant, non hygroscopic, wet processed, fine glazed porcelain. Alternatively good quality cast resin / FRP insulators may be offered.

3.04.02 Insulator shall be mounted in such a way so as to permit easy removal or replacement without disassembly of the bus. The insulator mounting plate shall be designed for cantilever loading to withstand the short circuit. Support span shall be taken into consideration.

3.04.03 The conductor shall be fastened on the insulator through fixed and slip joints so as to allow conductor expansion or contraction without straining the insulator.

3.05.00 Connections & Terminations

3.05.01 All matching flanges, gaskets, fittings, hardware and supports required for termination of the bus duct at the switchgears, transformers and other equipment shall be furnished.

3.05.02 In this connection the contractor is required to co-ordinate through the Engineer with the suppliers of the 415V Switchgears, transformers with regard to connection details, mechanical and thermal stresses.

3.05.03 Flexible connections both for conductor and enclosure shall be furnished :

a. At all equipment termination to provide for misalignment upto 25 mm. (1") in all directions.

b. Between bus duct supported from building steel to prevent transmission of vibration.

3.05.04 The equipment terminal connections shall be readily accessible and shall provide sufficient air gap for safe isolation of equipment during testing.

3.05.05 If the material of bus conductor and that of the equipment terminal connectors are different then suitable bi-metallic connectors shall be furnished.

3.06.00 Grounding

3.06.01 A separately run Galvanized steel flat suitably clamped along the enclosure shall be used as the ground bus. All parts of the bus enclosure, supporting structures and equipment frames shall be bonded to above ground bus.

3.06.02 Ground pad shall be bolted type to accommodate 75x10 mm. Galvanized steel flats at two points at each end of termination, complete with suitable tapped holes, bolts and washers.

3.07.00 Supporting Structures

3.07.01 All supporting structures required for hanging and/or supporting the complete bus duct shall be furnished. These include all members, indoor/outdoor posts, bolts, shims, base plates, beams, hangers, brackets, bracings and hardware.

3.07.02 All buses shall be adequately supported and braced to successfully withstand normal operation, vibration, thermal expansion, short circuit forces and all specified design loads.

3.07.03 Support shall be designed to provide tolerance of ±12 mm. (1/2") in the horizontal and vertical directions.

3.07.04 All steel members shall be hot-dip galvanized after fabrication. All hardware shall be of high strength steel with weather resistant finish.

3.07.05 Concrete foundation, building steel, concrete, inserts/plates will be provided by Owner/Purchaser. The Contractor shall co-ordinate with the Owner/Purchaser for this purpose giving well in advance the details of his requirements so as to enable the Owner/Purchaser to arrange for the same in time.

3.08.00 Name Plate

3.08.01 Suitable name plate shall be furnished with each piece of equipment.

3.08.02 Materials for name plate shall be anodized aluminium, 3 mm thick, using white letters on black background.

3.09.00 Finish

3.09.01 Except for supporting steel structurals and hardwire which shall be galvanized, all equipment shall be finished with a undercoat of high quality primer followed by two coats of synthetic enamel paints unless otherwise stated.

3.09.02 The interior surface of the bus duct enclosure shall be treated with matt black paint to enable efficient heat dissipation. The shade of exterior surface finish for indoor and outdoor portion shall be as indicated in the Annexure.

3.09.03 Pretreatment consisting of de greasing, de rusting etc. shall be done on all fabricated parts before painting or galvanizing.

3.09.04 Paints shall be carefully selected to withstand heat and weather conditions. The paint shall not scale-off or crinkle or get removed by abrasion due to normal handling.

3.09.05 Sufficient quantities of all paints and preservatives required for touching up at sites shall be furnished.

4.00.00 TESTS

4.01.00 Routine Test

Bus Duct shall be subjected to the following minimum tests :

a. Visual inspection and verification of dimensions.
b. Dry power frequency voltage withstand for 1-minute.

4.02.00 Type Test

Certified copies of type test certificates (not less than five years old) for similar equipment supplied by the bidder shall be submitted otherwise type test shall be carried out by the bidder within the contracted price and delivery schedule. Type test certificate for the following test shall be furnished:

a. Impulse voltage withstand on a typical section of bus duct including one bend.

b. Heat run test on representative sections of 3 phase bus duct, including one bend and flexible joints.

c. Short circuit test on representative sections of 3 phase bus duct, including one bend. The sections having longest span between support insulators shall be chosen.

d. Degree of protection test (air and water) on a representative section of bus duct

4.03.00 All cubicles shall be completely wired up at the factory and subject to wiring check and power frequency withstand tests on control/secondary wiring.

4.04.00 Test Witness

Tests shall be performed in presence of Owner/Purchaser's representative if so desired. The Contractor shall give at least seven (7) days' advance notice of the date when the tests are to be carried out.

4.05.00 Test Certificates

4.05.01 Certified reports of all the tests carried out at the works shall be furnished in six (6) copies for approval of the Owner/Purchaser.

4.05.02 The equipment shall be dispatched from works only after receipt of Owner/Purchaser's written approval of the test reports.

4.05.03 Type test certificate on any equipment, if so desired by the Owner/Purchaser, shall be furnished. Otherwise the equipment shall have to be type tested, free of charge, to prove the design.

5.00.00 SPECIAL TOOLS & TACKLES

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

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

6.00.00 SPARES

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

6.02.00 The Bidder shall quote and supply mandatory spare parts as per the list. The final quantity shall be decided during placement of order.

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

7.00.00 DRAWINGS, DATA & MANUALS

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

7.02.00 To be Submitted with the Bid

7.02.01 General Arrangement Drawing - Plan and Sections.

7.02.02 Typical details of bus insulator assembly, conductor/enclosure connections rigid & flexible, etc.

7.02.03 Bill of Materials.

7.02.04 Technical leaflets/Write-ups on various pieces of equipment offered.

7.02.05 Type test reports on similar equipment. The type test certificates shall not be more than 5 years old.

7.03.00 To be Submitted for Approval and Distribution
(A) : 'Approval' Category
(R) : 'Reference' Category

7.03.01 Sizing of the busbars and calculation for temperature rise for bus conductor and enclosure (A).

7.03.02 Calculation for short circuit forces justifying the proposed arrangement (A).

7.03.03 Dimensional general arrangement drawings with cross-sections of Busduct layout

7.03.04 Detailed material list with parts number. (R)

7.03.05 Details of bus insulator assembly, rigid and flexible connections of both bus conductor and enclosure, grounding provision, equipment termination arrangement etc. (A)

7.03.06 Foundation Plan and loading.(A)

7.03.07 Supporting steel structure and calculations. (A)

7.03.08 Set up layout of the busduct for carrying out type test (A)

7.03.09 Instruction manual for Busduct.(R)

The manual shall clearly indicate method of installation, check ups and tests to be carried out before commissioning of the equipment. The manual shall also indicate detail procedure of field welding of conductor and enclosure

7.03.10 Any other relevant drawing or data necessary for satisfactory installation, operation and maintenance.

7.04.00 The drawings and document marked with (A) above are of 'Approval' category and are subject to review by Owner/Purchaser. Those marked (R) are for 'reference' category.

The Owner/Purchaser may also review the documents marked (R) if found necessary. The contractor shall note that the approval of drawings & documents by the Owner/Purchaser does not relieve him of his contractual obligation.

7.05.00 The bidder may note that the drawings, data and manuals listed herein are minimum requirement only. The bidder shall ensure that all other necessary write-up, curves, etc require to fully describe the equipment are to be submitted with the bid.

7.06.00 All drawings shall be prepared by using Auto CAD approved version and all documents shall be generated using MS Office. The paper copy of the drawings & document shall be submitted for approval & reference. All final drawings and documents shall be submitted in CD in Auto CAD (approved version) and MS office format as applicable for Owner/Purchaser's future reference.

DATASHEET FOR NON-SEGREGATED PHASE BUSDUCT

SR. NO.	**ITEM**	**UNITS**	
1.0	**GENERAL**		
1.1	Type		Non- segregated
1.2	Service		Indoor/Outdoor
1.3	Material enclosure		Sheet steel/Aluminium
1.4	Conductor		Aluminium/Aluminium alloy/copper
1.5	Thickness of enclosure	mm	2 mm for sheet steel 3 mm for aluminium (min)
2.0	**SYSTEM**		
2.1	Voltage	V	415V AC ± 10%
2.2	Phase		3 phase and neutral
2.3	Frequency	Hz	50 Hz ±5%
2.4	Combined voltage and frequency variation		± 10% (absolute sum)
3.0	Service voltage (for space heater)		240 V AC ±10%, 1-phase

4.0	Rated current at 50 degC ambient	V	To be decided by the Tenderers
5.0	Short time current rating		50
6.0	For one (1) second	kA	2.5 kV (rms)
7.0	One (1) minute power frequency withstand voltage (minimum) (over 50 degC ambient)	kV	
7.1	Bus conductor		
(a)	With silver Plated bolted joints	degC	55 degC
(b)	With Plain or Tin joints	degC	40 degC
7.2	Bus enclosure and structure	degC	30 degC
8.0	Busbar insulator		Epoxy/Eparchy
9.0	1 min. power freq. withstand voltage		2.5 kV
10.0	Max. short circuit withstand current		50kA for 1 second
11.0	Momentary dynamic current withstand		105kA (Peak)
12.0	Phase to Phase clearance	mm	25
13.0	Phase to Earth clearance	mm	20

CHAPTER 16 : LOCAL CONTROL BOARDS / PANELS, LOCAL, ISOLATING SWITCH UNIT AND LOCAL PUSH BUTTON STATIONS

1.00.00 SCOPE OF SUPPLY

1.01.00 The following equipment shall be furnished with all accessories:
(a) Complete set of Local control panels: as required.
(b) Local push button stations: as required.
(c) Local isolating switch fuse unit : As required.

1.02.00 Furnishing, mounting, and wiring of all equipments, devices and accessories.

1.03.00 Floor channel sill, vibration damping pad, and kick plates for all floor- mounted control boards/panels, complete with holding down bolts and nuts.

1.04.00 Mounting hardware for all control panels and local push button stations.

2.00.00 CODES AND STANDARDS

2.01.00 All equipment and materials shall be designed, manufactured and tested in accordance with the latest applicable Indian standards (IS) and IEC except where modified and/or supplemented by this specification.

2.02.00 Equipment and material conforming to any other standards, which ensure equal or better quality, may be accepted. In such case, copies of the English version of the standard adopted shall be submitted along with the bid.

2.03.00 The electrical installation shall meet the requirements of Indian electricity rules as amended upto date and relevant IS Code of Practice. In addition, other rules and regulations applicable to the work shall be followed.

3.00.00 DESIGN CRITERIA

3.01.00 Local push button stations (LPBS) will be used for controlling drives from local as required.

3.02.00 Local Isolating Switch (L.I.S) Units will be used for local isolation of power supply to various machines in the Workshop Building.

3.03.00 All equipment except L.I.S and LPB stations, will be located in a clean but hot, humid and tropical atmosphere. LPBS will be generally installed in a hot, humid, and tropical atmosphere, heavily polluted at places with fly ash and/or coal dust, and shall be suitable for outdoor service with degree of protection specified elsewhere in this specification.

3.04.00 All control panels and LPBS shall be liberally sized so as to provide spacious layout of equipment and devices with sufficient working space in between.

3.05.00 Adequate space/ terminals shall be kept in the boards/panels for installing additional equipment in future.

3.06.00 For continuous operation at specified ratings, temperature rise of the various components/equipment shall be limited to the permissible values stipulated in the relevant standards and/or this specification.

3.07.00 All equipment/components there of shall be capable of withstanding the mechanical forces and thermal stresses of the system short circuit current without any damage or deterioration of material.

3.08.00 Design, material selection, and workmanship shall be such as to present a neat appearance outside and inside with no welds, rivets, screws, or bolt heads apparent from the exterior surface of the boards/panels. All instrument cut-outs, mounting studs, and support brackets shall be accurately located.

4.00.00 SPECIFIC REQUIREMENTS

4.01.00 CONSTRUCTION

4.01.01 Local control panel

(a) Local Control Boards may consist of a number of vertical panels mounted side_by_side, in which case, they shall be bolted together to form a compact unit. Where two panels meet, the joints shall be smooth, close_fitting, and unobtrusive.

(b) The control panels shall be totally enclosed type, conforming to degree of protection IP-54 or better.

(c) Generally, the local control panels shall be free-standing, floor-mounted, dead-front assemblies.

(d) Floor- mounted control panels shall be assembled on channel/angle base plates with anti-vibration mountings and stainless steel kick plates.

(e) Control panels shall be of folded sheet steel construction, minimum 2 mm thick, and free from all surface defects.

The panels shall have sufficient structural reinforcement to ensure a plane surface, to limit vibration, and to provide rigidity during shipment and installation.

(f) All floor mounted panels shall have rear door.

(g) Doors shall have concealed type hinges and padlocking arrangement. Doors shall be grounded by flexible copper braid.

(h) All doors and removable covers shall be provided with neoprene rubber gaskets all round and latches sufficiently strong to hold them in alignment when closed.

(i) Working height of the panels shall be limited between 750 mm and 1800 mm above floor level.

(j) Local control panel shall be provided with two (2) nos. control transformer for control supply (1*100% standby)

4.02.00 Local Push Button Stations

(a) LPBS shall be furnished in sheet steel enclosure of dust and vermin proof, weatherproof, gasketted construction, suitable for outdoor use without canopy, and conforming to degree of protection. IP-55 or better.

(b) LPBS shall be suitable for column/structure/wall mounting and shall be complete with push-buttons, terminal blocks, anodized aluminium inscription plate, two(2) nos, earthing terminals, removable gland plate along with crimp type tinned copper lugs and compression type glands for cable/conduit entry from top and bottom. The earthing terminals shall be suitable for connection to one (1) No. 8 SWG G.I. wire.

(c) LPBS shall have one (1) stop lockable type push buttons.

(d) All push buttons shall have a minimum of two(2) Normally open and two normally closed electrically separate contacts, rated minimum 10A at operating voltage.

(e) Wiring shall be done by 1.5 sq mm. 1100V grade, PVC/XLPE insulated, stranded copper conductor, cable. Each wire shall be identified at both ends by ferrules with wire designation.

(f) Terminals shall have provision for connecting at least two(2) nos 2.5 sq. mm copper cable and shall be rated for carrying continuously minimum 10A at 240V A.C. and 2A at 220V DC.

4.03.00 Local Isolating Switch Units

a) L.I.S. Units shall be furnished in sheet steel enclosure of dust and vermin_proof, weather_proof, gasketted construction, suitable for outdoor use without canopy, and conforming to degree of protection IP_55 or better.

b) L.I.S. Units shall be suitable for column/structure/wall mounting and shall be complete with load_break switch, terminal blocks, anodized aluminum inscription plate, two (2) nos. earthing pads, removable gland plate along with crimp type tinned copper lugs and compression type glands for cable/conduit entry from top and bottom. The earthing pads shall be suitable for connection to 25 x 3 mm G.S. flat

c) Load_break switches shall be four_pole, air break, heavy-duty type. Duty class of load_break switches shall be AC_23 for motor feeders. Motor feeder switches shall be capable of safely breaking the locked rotor current of the associated motor circuit.

d) Terminals shall be clip_on type, 10 sq.mm. minimum.

4.04.00 EQUIPMENT MOUNTING

a) All equipment shall be so mounted that removal and replacement may be accomplished individually without interruption of services to others. No equipment shall be mounted on panel door.

b) All equipment mounted inside the panels shall be so located that their terminals and adjustments are readily accessible for inspection or maintenance.

c) For Local Control Boards/Panels control components such as push buttons, indicating lamps, selector switches, indicating meters etc. shall be flush mounted on the front face of the board/panel while switch fuses, supervision relays (AC/DC) etc. shall be mounted inside.

4.05.00 MIMIC DIAGRAM

a) Mimic diagram of electrical connections shall be furnished on the front face of all electrical control panels.

b) Mimic buses shall be at least 3mm thick and 10 mm in width, made of suitably treated metal strips or approved equivalent and colour coded to denote different voltages.

c) The mimic representation, colour and size of diagram are subject to the approval of the purchaser.

4.06.00 LIGHTING, SPACE HEATING AND RECEPTACLES

a) Each panel shall be provided with interior fluorescent tube with door switch, space heater with thermostat and 5A, 3-pin receptacle with plug. Third pin of the socket shall be effectively grounded through the metallic structure.

b) Tube, heater and receptacle circuits shall be suitable for available A.C. supply and furnished with individual ON-OFF switch.

c) The lamp shall be located at the ceiling and guarded with protective cage. Space heater shall be located near the floor so as not to pose any hazard to service personnel.

4.07.00 DC POWER SUPPLY

a) Necessary D.C. supplies as required for control and service shall be arranged by the contractor. Duplicate feeders shall be arranged for D.C. supply.

b) Fuse and link shall be provided for individual circuits for protection and also for isolation from bus wire without disturbing other circuits.

c) The fuse requirements in each panel shall be grouped in easily accessible fuse blocks or distribution panel. The grouping shall be done in a neat and orderly fashion.

d) Alarm relays with reverse flag shall be provided to annunciate failure of main incoming A.C. and D.C. power supplies and annunciation D.C. supply in each panel. Lamp indications shall be provided individually for main D.C. supply-1 fail, main D.C. supply-2 fail, and panel annunciation D.C. supply fail. A common A.C. electric bell shall be provided to give an audible alarm in case of failure of D.C. supply-1/D.C. supply-

2/annunciation D.C. supply in any panel. A common push-button shall also be provided for cancellation of lamp indications and audible alarm.

e) Separate circuits shall be provided for:
- Indication and alarm
- Tripping, and
- Control

f) For lighting, auxiliary supply and space heating A.C. supply shall be used. D.C supply shall be used for providing control supply to annunciator.

g) Bus wires of adequate capacity shall be provided to distribute the incoming supplies to different cubicles of a VDB. Isolating switch fuse units shall be provided at each cubicle for A.C/D.C supplies.

4.08.00 WIRING

a) All wire termination shall be made with insulated sleeve solderless crimping type tinned copper lugs. Wires shall not be tapped or spliced between terminals.

b) The panels shall be fully wired up at the factory to ensure proper functioning of control, protection and metering schemes.

c) All spare contacts of relays and switches shall be wired up to terminal blocks.

d) Wiring shall be done with flexible, heat resistant, 1100V grade, PVC insulated, switchboard wires with stranded copper conductor, 2.5 sq.mm for current, 1.5 sq mm for control circuits and voltage circuits.

e) Each wire shall be ferruled by plastic tube with indelliable ink print at both end having terminal block no. terminal numbers, destination number as per approved wiring drawing.

f) Colour codes shall be used for wiring as per latest revision of IS: 375.

4.09.00 TERMINAL BLOCK

a) Multiway terminal blocks complete with necessary binding screws and washers for wire connections and marking strip for circuit identification shall be furnished for terminating the panel wiring and outgoing cables.

b) Terminals shall be box-clamp type, 10 sq mm minimum. Terminals for C.T. secondary leads shall have provision of shorting and grounding.

c) Not more than two wires shall be connected to one terminal. If necessary, a number of terminals shall be jumpered together to provide wiring points.

d) Each terminal shall be identified with designation as per approved schematic. At least 20% of the total number of active terminals shall be furnished as spare in each panel.

e) The wiring and terminals shall be so arranged that individual wires of an external cable can be connected to consecutive terminals.

f) The terminal blocks shall be located to allow easy access and also to suit floor opening for cable entry.

g) The terminal blocks within the panels shall be mounted on vertical support brackets. The support brackets shall be tack welded to the interior sheet steel mounting plates of the cabinet. Support brackets shall not be welded directly to the walls of the enclosure. The terminal blocks shall be attached to the support brackets with round head machine screws.

h) Terminal blocks shall generally be mounted vertically with adequate spacing (not less than 100 mm) between adjacent rows.

i) The bottom of the terminal block shall be at least 200 mm above the incoming cable gland plate.

4.10.00 CABLE ENTRY

The control panels shall have provisions of cable entry from the bottom. Bottom plate shall be provided to make entry dust-tight.

4.11.00 GROUNDING

a) 50 x 6 mm G.S. ground bus shall be provided in each control panel extending along the entire length of the assembly.

b) The ground bus shall have two-bolt drilling with G.S. bolts and nuts at each end and shall be suitable for connection to 50 x 6 mm G.S. flat.

c) The ground bus shall be bolted to the panel structures and shall effectively ground the entire assembly. The cases of meters, relays and switching devices shall be grounded through the steel structure.

d) Whenever a circuit is grounded, a single wire from the circuit shall be run independently to the ground bus and connected to it.

4.12.00 PAINTING

Panels and Push-button stations shall be finished with two coats of Siemens RAL 7032. Panels and push-button stations shall be stoved after each spraying of finish paint. Painting process shall be of power coating.

Caution Notice plate shall be affixed at the back of each panel.

4.13.00 FUSES

Fuses shall be HRC, preferably link type, with a minimum interrupting capacity equal to the system short circuit current.

Fuses shall be furnished complete with fuse boxes and fittings of such design as to permit easy and safe replacement of fuse element. Visible indication shall be on blowing of the fuse.

4.14.00 CONTACTORS

a) Contactors shall be three pole, air break type, with non-bouncing silver/silver alloy contacts. Contactor duty shall be class 3 – category AC3 for unidirectional drives and AC4 for bi-directional and inching drives/class 1- category DC2.

b) Each contactor shall be provided with minimum two (2) NO and two (2) NC auxiliary contacts rated 10A at operating voltage. The exact requirement of contacts shall be decided by the Tenderers taking into account the scheme requirements and spares.

c) Contactor starters shall comply with the requirements of IS-8544 (Part 1) in respect of co-ordination of the characteristics of contactor, overload relay, and fuse. The type of co-ordination shall be Type-C as per IS-8544.

4.15.00 PUSH BUTTON

a) All push buttons shall be oil tight, heavy duty, push to actuate type, with coloured button and inscription plate marked with its function. The colour of "ON" and "OFF" push buttons shall be RED and GREEN respectively. RESET push buttons shall be coloured black.

b) Each push button shall have minimum 2 NO + 2NC contacts, rated 10A at 240V AC and 2A at 220V DC.

c) Push buttons shall be shrouded type except for emergency trip button, which shall be mushroom type for easy identification.

4.16.00 LAMPS

a) Lamps shall be LED type.

b) LED lamp shall be made in accordance with INP Technology (Aluminium Indium Gallium Phosphide Technology). The body shall be made of Poly Carbonate Unbreakable Lens. LED shall be protected by inbuilt fuse with surge suppressor or leakage voltage glow protection. LED circuit shall be PCB mounted. Intensity shall be greater than 200 mcd. All push button lamp shall be as per LED indicating lamp.

4.17.00 METERS

a) All indicating instruments shall be switchboard type, back connected, suitable for flush mounting, 96*96 mm with 240 deg scale, antiglare glass and accuracy class of $\pm$ 2% of the full scale. The dials shall be made of such material as to ensure freedom from warping, fading and discolouring during the lifetime of the instruments.

b) All indicating instruments shall be enclosed in dust-tight cases suitable for tropical use.

c) Meters shall have provision for zero- adjustment from front of the panel.

d) Meters shall be compensated for temperature errors and factory calibrated to read the primary quantities directly without using a multiplying factor.

e) D.C. ammeters, wherever required, shall be provided with external shunt if the current exceeds 5A. The rated voltage drop for the shunts shall be 75mV.

4.18.00 ANNUNCIATOR SYSTEM

a) Each control panel shall be provided with an annunciator window board. The annunciator boards shall be back connected and suitable for semi-flush mounting.

b) The annunciator system shall be solid-state type with optical isolation for input signals. The functional requirements shall be as per Annexure-C.

c) Each annunciator group shall be independent, complete with its own power supply, acknowledge-reset-test buttons and other necessary accessories.

d) Hooter for audible alarm shall be common for each control panel assembly.

e) Each annunciator group shall be provided with a common alarm relay for group alarm annunciation in remote control room. The common alarm relay will operate on actuation of any alarm point of the group.

f) The annunciator shall be non-integral type with hardware box mounted separately for easy access and maintenance.

g) Audible alarms with different tones shall be used for trip, non-trip and ring back functions.

h) The window size shall be such as to accommodate minimum three (3) lines of twelve(12) characters each. Each character shall be minimum 4.75 mm high.

i) The annunciator system shall be suitable for suitable for operation from both NO and NC type initiating contacts.

j) At least 10% spare channels and window facia shall be provided in each annunciator group.

4.19.00 FUNCTIONAL REQUIREMENTS OF ANNUNCIATOR

Type

The annunciation system shall be manually reset type with ring back facility, suitable for operation from 220V DC ungrounded supply.

Function

The sequence of operation shall be similar to ISA-2A with fast/slow blinking as detailed below:

(a)	Field	Visual	Audible	Ringback
(b)	Condition	Display	Alarm	Alarm

(c)	Normal	Off	Silent	Silent
(d)	Abnormal	Fast blinking	On	Silent
(e)	Acknowledge	Steady on	Silent	Silent
(f)	Return to normal	Slow blinking	Silent	On
(g)	Reset	Off	Silent	Silent
(h)	Normal before acknowledge	Slow blinking	On	On
(i)	Acknowledge	Steady on	Silent	On
(j)	Reset	Off	silent	Silent
(k)	test	Fast blinking	on	On

4.20.00 RELAYS

Auxiliary shall be furnished in fixed, dust-tight, casings and mounted inside the panel.

The relays shall have adequate numbers of contacts to suit scheme requirements. Besides, each relay shall have spares contacts for future use. Contacts shall be silver surfaced, bounce-free, and capable of repeated operation without deterioration.

4.21.00 AUXILIARY DEVICES

The contractor shall furnish, install, and wire-up all auxiliary devices such as timing/switching/lockout/auxiliary relays/auxiliary contactors, etc as required for the proper functioning of the approved schemes.

The contractor shall number the various types of relays and contactors as per the numbers appearing in the approved schematic/Wiring appearing in the approved Schematic/Wiring diagrams.

4.22.00 TESTS

All control boards/panels, L.I.S. Units and LPBS shall be completely assembled, wired, adjusted and tested at the factory prior to shipment to ensure accuracy of wiring, correctness of control scheme and proper functioning of all components.

4.22.01 ROUTINE TESTS

The tests shall include wiring continuity tests, high voltage tests, insulation measurement test both before and after high voltage test, and functional tests to ensure accuracy of wiring operation of the control/ protection/metering schemes and individual equipment. Detailed test report including procedure and drawing shall be furnished.

All switches, meters, relays and other devices shall be tested and calibrated in accordance with relevant IS standards.

Type test certificate on any equipment, if so desired by the Purchaser shall be furnished. Otherwise, the equipment shall have to be type tested, free of charge, to prove the design.

4.23.00 TEST WITNESS

Test shall be performed in presence of Owner/Purchaser's representative so desired by the Owner/Purchaser. The contractor shall give at least fifteen (15) days advance notice of the date when the tests are to be carried

CHAPTER 17 : AC & DC MOTORS

1.00 MOTORS

1.1 SCOPE

This specification is intended to cover design, manufacture, assembly and testing of AC Squirrel Cage Induction Motors for use in Thermal Power Plants and is supplement to the driven equipment specifications under which these motors are being procured for the project.

SITE CONDITIONS

Site conditions are covered in 'Project Data', contained in specification of the driven equipment.

1.2 Gases, Fumes & Dust Particles

1.2.01 General - Sulphur dioxide and/or trioxide fumes mildly present. Climate is tropical, conducive to fungus growth.

1.2.02 **Dust Particles**

1 Outdoor locations - Heavily dusty with abrasive dust and coal particles of size five (5) to hundred (100) microns present in atmosphere in large quantity.

2 Indoor Locations.

2.1 Coal conveyors - As for outdoor as per clause 1.02.02.1 above.

2.2 Other locations - Lightly dusty with abrasive dust and coal particles of size five (5) to twenty (20) microns present in atmosphere.

1.2.03 **Special Fumes**

1 Water treatment plant and acid cleaning room - Acid and alkali fuses present.

2 Fuel oil pumping areas & Hydrogen generation plant - Explosive fuses (flameproof motors required).

1.2.04 For the purpose of design of equipment/systems, an ambient temperature of 50 deg. Centigrade and relative humidity of 95% (at 40 deg C) shall be considered. The equipment shall operate in a highly polluted environment.

1.3 **LOCATION OF MOTOR** - As required

1.4 **SPECIFICATIONS & STANDARDS**.....Motors shall comply with the latest revisions of all relevant standards of BIS (IS-325, IS-900, IS-996, IS-1231, IS-1885, IS-2148, IS-2223, IS-2253, IS-2254, IS-2848, IS-3202, IS-4029, IS-4691, IS-4722, IS-4728, IS-4889, IS-6362, IS-7816, IS-8223, IS-8789 , IS: 12615, IS:3177 and IEC : 60034 3Φ Induction motor) except as modified herein or in driven equipment specification.

Motors conforming to BS or IEC Publications, which ensure equivalent quality shall also be acceptable.In case of any difference between IS Specification/International Standards (IEC; NEMA etc.), this motor specification prevails.

1.5 TYPE

1.5.1 AC Motors:

a) Squirrel cage induction motor suitable for direct-on-line starting.

b) Continuous duty LT motors upto 160 KW Output rating (at 50 deg. C ambient temperature), shall be **Efficiency class-IE2**, conforming to IS 12615, or IEC:60034-30.

c) Crane duty motors shall be slip ring/ squirrel cage Induction motor as per the requirement.

1.5.2 DC Motors Shunt wound.

1.6 **VOLTAGE (NOMINAL)**

1.6.1 **LV Motors**

For motors upto and including 200 KW - Four hundred fifteen (415) V.

1.6.2 **MV MOTORS**

For motors above 200kW upto and including 1500kW, Three point three (3.3) kV.

For CHP conveyors motor above 160 kW, 3.3 kV, AC supply is to be used. However all the motors on stacker reclaimer shall be on 415 V AC only.

1.6.3 **HV Motors**

For motors above 1500kW - eleven(11) KV

1.6.4 All motors are to be designed for system grounding described in "System Particulars" under site information of the Driven Equipment Specification.

1.7 **FREQUENCY (NOMINAL)** - fifty (50) Hertz

1.8 NUMBER OF PHASES - Three (3)

1.9 SPEED - As required by the driven equipment

1.10 TYPE OF STARTING :

Direct on-line (VFD/Soft-starter/star/delta starting in special cases)

1.11 DUTY

1.11.1 Continuous motor rating shall be arrived at considering 15% margin over the duty point input or 10% over the maximum demand of the driven equipment,

whichever is higher, considering highest system frequency and voltage variation. Crane motors shall be rated for S4 duty, 40% cyclic duration factor. If however, a higher margin is stipulated in the accompanying driven equipment specification, the higher stipulated margin shall prevail.

1.11.2 All HT motors shall have vibration pads for mounting vibration detectors.

1.11.3 All motors shall be designed to withstand hundred twenty (120) percent of rated speed without any mechanical damage for two (2) minutes.

1.11.4 Motors shall be designed to keep torsional and rotational natural frequencies of vibration of the motor and driven equipment atleast twenty five (25) percent above or below, preferably above the motor operating speed (to avoid resonance in vibration over the operating speed) range.

1.11.5 All LV motors rated 0.37kW and higher with S1 duty shall be compulsorily be of energy efficiency level IE 2 as per IS 12615:2011.

Motors rated above 37kW shall have efficiency higher than 0.92 and high power factor of atleast 0.88.

1.12 **SUPPLY VARIATIONS**

Motors shall be capable of running continuously at full load under following variations in power supply:

1.12.1 All equipments shall be suitable for rated frequency of 50 Hz with a variation of (+) 3% and (-)5%, voltage variation of (±) 6% for 11 kV & 3.3 kV and (±)10% for 415V and 10% (absolute sum) combined variation of voltage and frequency unless specifically brought out in the specification.

1.13 **ABNORMAL CONDITIONS CAPABILITY**

Motor shall have following capabilities as specified design ambient temperature:

1.13.1 The motors shall also be capable of running up again after voltage collapse to about 40% for approximate duration of 0.5 sec. Subsequent rise in voltage to 70% and further to 80% and 100%, the total duration not exceeding 20 sec.

1.13.2 Low Voltage Running :

Motor shall be capable of running satisfactorily at seventy five (75) percent nominal voltage for five (5) minutes.

1.13.3 Momentary Low Voltage Withstanding :

Motor, when running at full load, shall not stall when voltage drops down to seventy (70) percent nominal voltage for one (1) minute.

1.14 **STARTING CAPABILITY**

1.14.1 Low Voltage Starting :

Motor shall be capable of starting and accelerating to full speed at full load (including loaded equipment e.g. mills and conveyors etc) at eighty (80)

percent nominal voltage at motor terminals. Mill motors may be permitted to start with terminal voltage not below 90%.

1.14.2 Cold Motor Starting ..... Under specified voltage variations two (2) starts in quick succession and third start five (5) minutes thereafter, all with full load (including loaded equipment eg mills and conveyors etc) of driven equipment. No additional start will be made till lapse of further thirty (30) minutes.

1.14.3 Hot Motor Starting ..... Under specified voltage variations, one (1) immediate and two (2) fifteen (15) minutes interval starts all with full load (including loaded equipment e.g. mills and conveyors etc) of driven equipment. No additional start will be made till lapse of further thirty (30) minutes.

1.14.4 Motor shall also be suitable for three (3) equally spread starts per hour when the motor is under normal service condition.

1.14.5 Break-away Starting Current .....Breakaway starting current as percent of full load current for various motor ratings shall not exceed the values given below:

1.14.5.1 Motors above 1500 KW upto 4000kW ..... 600% without any positive tolerance except for ID Fan Motor.

1.14.5.2 Motors above 4000 KW ..... 450%. Not subject to any positive tolerance.

1.14.5.3 For D.C. Motors the starting current shall be limited to 2 times full load current.

1.14.5.3 **Starting voltage requirement**

a) All Motors (except Mill Motors)

- 80% of rated voltage for Motors upto 4000 kW
- 75% of rated voltage for Motors above 4000 kW

b) For Mill Motors:

- 85% of rated voltage for Motors above 1000 kW
- 90% of rated voltage for Motors below 1000 kW

Except AOP & JOP motors running on D.G emergency supply, starting voltage shall be 80%.

1.14.5.4 **Starting Time**

1.14.5.4.1 For motors with starting time upto 20 secs. at minimum permissible voltage during starting, the locked rotor withstand time under hot condition at highest voltage limit shall be at least 2.5 secs. more than starting time.

1.14.5.4.2 For motors with starting time more than 20 secs. and upto 45 secs. at minimum permissible voltage during starting, the locked rotor withstand time under hot condition at highest voltage limit shall be at least 5 secs. more than starting time.

1.14.5.4.3 For motors with starting time more than 45 secs. at minimum permissible voltage during starting, 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.

1.14.5.5 **Torque Requirements:-**

1.14.5.5.1 Accelerating torque at any speed with the lowest permissible starting voltage shall be at least 10%. Motor full load torque.

1.14.5.5.2 Pull out torque at rated voltage shall not be less than 205% of full load torque. It shall be 275% for crane duty Motors.

1.15 **SAFE STALL TIME**

1.15.1 To avoid problem in selecting standard protective relays without using speed switches, safe stall time under hot conditions (corresponding to 110% nominal voltage at motor terminals) shall be more than the accelerating time (corresponding to 80% nominal voltage at motor terminals) by the following minimum values :

1.15.1.01 Two (2) seconds, where accelerating time (at 80% nominal voltage) does not exceed 20 seconds.

1.15.1.02 Three (3) seconds, where accelerating time (at 80% nominal voltage) exceeds 20 seconds.

1.15.1.03 At no stage, speed switch shall be provided to achieve the above requirements mentioned under Clause No. 1.14.5.4

1.16 **CLASS OF INSULATION**

1.16.1 LV Motors ..... Class F.

1.16.2 MV & HV Motors ..... Class F

1.16.03 However temperature rise shall be restricted to limits corresponding to Class 'B' insulation for both HT & LT motors. The temperature under abnormal running conditions shall be limited to 5°C above class 'B' limits.

1.16.04 The value of the polarization index for motors above 200kW should not be less than 2 when determined according to IS: 7816.

1.17 **TEMPERATURE RISE UNDER NORMAL CONDITIONS**..... Temperature rise over specified design ambient temperature when motor is running with full load at nominal supply voltage & frequency shall not exceed the values given below:

S.No.	Specified Design Ambient Temperature	Thermometer Method	Resistance Method
1.17.01	50°C	60°C	70°C
1.17.02	45°C	65°C	75°C
1.17.03	40°C	70°C	80°C

1.18 **BUS TRANSFER WITHSTAND CAPABILITY**

Motors will be connected to an automatic bus transfer system and hence may be subjected to one hundred and fifty (150) percent of the nominal voltage during changeover of buses due to the vector difference between the residual voltage and incoming supply voltage and the duration of this condition may be one second. Motors shall be capable of withstanding the voltage and torque stresses developed under such conditions without damage. The manufacturer/ vendor shall indicate the special precautions taken to meet the above requirements and confirm.

1.18.01 That about 5000 bus transfers, in lifetime of motor, shall not puncture its insulation.

1.18.02 That motor shall be capable of withstanding heavy inrush transient current caused by such bus transfers without damage.

1.18.03 That the motor windings shall be adequately braced to satisfactorily withstand mechanical stresses under these conditions.

1.18.04 The motor and driven equipment shafts shall be adequately sized to satisfactorily withstand transient torques under these conditions.

1.19 **TYPE OF ENCLOSURE**

1.19.01 Outdoor Motors ..... IP 55 (Additional canopy to be provided by EPC contractor.

1.19.02 Indoor Motors ..... IP 55

1.19.03 IP-55 degree of protection shall be achieved without application of any compound, putty etc.

1.19.04 Motor located in hazardous area shall have flameproof enclosure conforming to IS: 2148 /Equiv. as detailed below:

a) Fuel Oil area : Group IIB
b) Hydrogen generation plant area : Group IIC (or Group-I, Div-II as per NEC or Class-1, Gr-B, Div-II as per NEMA/IEC60034).

1.20 **METHOD OF COOLING**

1.20.1 Method of cooling shall be IC 411 (TEFC), IC 511 (TETV) or IC 611 (CACA). However, motors rated 3000kW or above can be closed air circuit water cooled (CACW).

1.20.2 Large capacity motors not available with above types of cooling may be accepted with IC 81 W for IC 91 W (CACW) cooling subject to the approval of the Owner.

1.21 **TYPE OF MOUNTING** ..... As required for the driven equipment.

1.21 **MAXIMUM MECHANICAL VIBRATIONS**

1.21.01 Noise level for all the motors shall be limited to 85dB(A) except for BFP motor for which the maximum limit shall be 90dB(A). Vibration shall be limited within the limits

prescribed in IS: 12075 / IEC 60034-14. Motors shall withstand vibrations produced by driven equipment. HT motor bearing housings shall have flat surfaces, in both X and Y directions, suitable for mounting 80mmX80mm vibration pads.

1.21.02 Noise level

The noise level of motors shall not exceed 85 db (A) at 1m from operating motor measured in accordance with IS: 10265.

1.21.03 Motor body shall have two earthing points on opposite sides.

1.21.04 11 KV motors shall be offered with Separate Insulated Connector (Elastimould or Equivalent make) as per IEEE 386. The offered Elastimould terminations shall be provided with protective cover and trifurcating sleeves. Elastimould termination kit shall be suitable for fault level of 25 KA for 0.17 seconds.

1.21.05 3.3 KV motors shall be offered with dust tight phase separated double walled (metallic as well as insulated barrier) Terminal box. Suitable termination kit shall be provided for the offered Terminal box. The offered Terminal Box shall be suitable for fault level of 250 MVA for 0.12 sec. Removable gland plates of thickness 3 mm (hot/cold rolled sheet steel) or 4 mm (non magnetic material for single core cables) shall be provided.

1.21.06 The spacing between gland plate & centre of terminal stud shall be as per Table-I.

TABLE - I

DIMENSIONS OF TERMINAL BOXES FOR LV MOTORS

Motor MCR in KW	**Minimum distance between centre of stud and gland plate in mm**
UP to 3 KW	**As per manufacturer's practice.**
Above 3 KW - upto 7 KW	85
Above 7 KW - upto 13 KW	115
Above 13 KW - upto 24 KW	167
Above 24 KW - upto 37 KW	196
Above 37 KW - upto 55 KW	249
Above 55 KW - upto 90 KW	277
Above 90 KW - upto 125 KW	331

Above 125 KW-upto 200 KW 203

For HT motors the distance between gland plate and the terminal studs shall not be less than 500 mm.

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

1.21.08 For motors rated 1500 KW & above, neutral current transformers of PS class shall be provided on each phase in a separate neutral terminal box.

1.21.09 The ratio of locked rotor KVA at rated voltage to rated KW shall not exceed the following (without any further tolerance) except for BFP motor.

(a)	Below 110KW	:	10.0
(b)	From 110 KW & upto 200 KW	:	9.0
(c)	Above 200 KW & upto 1000KW	:	10.0
(d)	From 1001KW & upto 4000KW	:	9.0
(e)	Above 4000KW	:	6 to 6.5

1.22 **WINDING & INSULATION**

(a)	Type	:	Non-hygroscopic, oil resistant, flame resistant
(b)	Starting duty	:	Two hot starts in succession, with motor initially at normal running temperature.
(c)	11kV & 3.3 kV : AC motors		Thermal class 155 (F) insulation. The winding insulation process shall be total Vacuum Presure Impregnated i.e resin poor method. Thelightning Impulse& interturn insulation surge withstand level shall be as per IEC-60034 part-15
(d)	240VAC, 415V : AC & 220V DC motors		Thermal Class(B) or better

1.23 **DIRECTION OF ROTATION**

1.23.1 As needed by driven equipment.

1.23.2 The 3 phase motor shall, however, be suitable for operation in both directions of rotation. A plate showing direction of rotation as determined by the phase sequence on the terminals marking shall be screwed at non-driving end of the body of the motor.

1.23.3 If, in the case of HT motors, fan is suitable for only one direction of rotation, the fan shall be so designed that with the slight modification work, it can be made suitable for other direction of rotation also. No extra material shall be required for doing above modification work.

1.24 **BEARINGS**

1.24.1 General ..... Greased ball, roller and/or sleeve bearing shall be rated for minimum standard life of 20,000 hours taking bearing and driven equipment loads into account. Loss of grease shall be scarce and it shall not creep along shaft into motor housing.

Bearing shall be effectively sealed against dust ingress and shall be pressure grease gun lubricated.

If the bearings are oil lubricated, a drain plug shall be provided for draining residual oil and oil level gauge shall be provided to show precisely oil level required under standstill and running conditions.

Unless otherwise approved, bearing lubricating system shall be such that no external forced oil or water is necessary to maintain required oil supply to keep bearing temperature within design limits.

For MV & HV motors, the bearings shall be insulated wherever necessary to prevent damage to motor bearings from shaft current.

When pressure oiling is required for horizontal motors, bearings shall be sleeve type arranged for pressure oiling supplied from lubrication system of driven machine, with ring oiling for starting and emergency duty. Ring oiling system shall be adequate for starting and continuous operation of motor for at least half an hour, without pressure oiling system in operation. Oil sight flow gauges shall be provided to indicate oil flow through each bearing.

Lubricants shall be selected for prolonged storage and normal use of motors in tropical climate and shall contain corrosion and oxidation inhibitors. Greases shall have suitable bleeding characteristics to minimize setting. The selected lubricants shall be indigenously available.

Sleeve bearings for use with motors having flexible coupling with limited end play, shall have adequate axial end play to prevent transmission of thrust from driven equipment to motor bearings.

Bearings shall be of reputed make subject to the approval of the Owner/Consulting Engineer.

1.24.2 Large motors ..... Large motors shall preferably have spherically seated babitted, ring forced, feed lubricated, water-cooled bearings. If anti-friction bearings are provided, these shall be roller bearings rated for a minimum standard life of 30000 hours taking all bearing and driven equipment loads into account.

1.25 **SHAFT EXTENSION** ..... Key slotted bare shaft extension of required length with key on driving end.

1.26 **DRAIN HOLES** ..... Two (2) drain holes with plugs, one (1) on either end of motor at the bottom most point.

1.27 **LIFTING DEVICES** ..... Motors shall be provided with eyebolts, lugs or other means to facilitate safe lifting.

1.28 **DOWEL PINS**..... It shall be possible to drill holes vertically inclined through motor feet or mounting flange for installing dowel pins after assembling motor and driven equipment, before despatch (for completed driving + driven

equipment assembly) or at site after erection (for separate supplies of above equipment).

1.29 **CENTERING SPIGOT**..... Flange mounted motor shall have centering spigot to match driven equipment socket.

1.30 **EASE OF MAINTENANCE**..... Motor shall be so constructed that it can be de-assembled and reassembled with ease.

1.31 **NAMEPLATES**..... Motor shall have nameplate(s) showing diagram of connections, all particulars as per IS: 325 and following additional information:

In addition, an arrow block shall be screwed on to the body of motor on the non-driving end to indicate direction of rotation of motor.

1.31.1 Temperature rise under normal/abnormal conditions.

1.31.2 Type of bearing and recommended lubricants.

1.32 **FINISH**..... Motor shall have glossy, light grey finish No. 631 as per IS: 5 for withstanding site conditions as per Clause 1.00 above.

All sharp edges and scales shall be removed from the surface, which shall then be thoroughly degreased, de-rusted and given two (2) coats of primer and two (2) coats of finish paint. It is preferred that a phosphate coat is given to motor prior to application of primer coat. Motors for water treatment plant shall have Zinc Chromate base with acid resistant Epilex 4 paint.

1.33 **TERMINAL BOXES**

1.33.1 General .....Motors shall be provided with separate terminal boxes for main, space heaters, embedded temperature detectors, bearing temperature indicators and moisture detectors terminals. When it is not possible to provide LT motors with separate terminal box for space heater terminals, space heater terminals shall be adequately segregated from the main terminals in the single box. Terminal boxes shall be weatherproof and water-tight confirming to minimum IP-55 degree of protection with removable front cover for making connections. IP-55 degree of protection shall be achieved without application of compound. Space between and around terminals shall be adequate for easily connecting aluminium conductor cables. Terminal box arrangement shall be to the approval of the Owner /Consulting Engineer. All terminal boxes shall be suitable for proper termination of the type and tentative size of cables specified in Clause 1.34 below, however, exact size of cables shall be furnished by Owner during engineering stage.

The terminal boxes shall be complete with cable glands and termination accessories as required. Suitable non-magnetic material construction shall be adopted for terminal boxes where single core cables are to be terminated. All HT motors shall be provided with phase segregated terminal box.

Terminal bushings and clamps shall be non-absorbent, non- inflammable, insulated material for connecting with cable.

1.33.2 **Main Terminal Box**

1.33.2.1 LV Motors ..... Main terminal box shall be capable of being turned through 360 degrees in steps of 90 degrees.

1.33.2.2 MV & HV Motors ..... Motor shall be provided with two (2) terminal boxes for stator terminals. One (1) terminal box shall be for phase terminals while other one for forming star connection. These should be interchangeable to facilitate cable routing.

Neutral terminal box for HT motors rated above 1500 KW shall be suitable for mounting of three (3) Nos. wound/bar primary/ring type cast resin insulated current transformers for differential protection. These transformers shall be supplied and mounted in the motor terminal box. In addition to above, 3 Nos. of identical current transformers shall be supplied loose for mounting in the switchgear. Stator phase terminal box may either be phase segregated of standard terminal box suitable for both top and bottom entry of cables (i.e. they should be capable of being turned through 180 Degrees). The terminal box shall be designed for termination of XLPE cables using heat shrinkable or push on type terminating Kit. Terminal leading shall be stud type or leading wire type.

1.33.2.3 Cable End Boxes.....Terminal Boxes shall be provided with cable end boxes having cable lugs and cable glands for cables of sizes as specified in Clause 1.34 below.

Cable box shall be suitable for glanding the cables; and shall have adequate space between cable glands terminating studs to allow suitable bends of cable inside the cable box for all 3 phases of relevant cable sizes specified.

1.33.2.4 The terminal boxes shall be capable of withstanding at the terminals the system fault level (as indicated below) without rupture for a duration of atleast 0.25 seconds.

Min. fault level for MV Motors - 40 KA

Min. fault level for LV & HV Motors - 50 KA

1.33.2.5 **PHASE TO PHASE/ PHASE TO EARTH AIR CLEARANCE:**

NOTE: Minimum inter-phase and phase-earth air clearances for LT motors with lugs installed shall be as follows:

Motor MCR in KW	Clearance
UP to 110 KW	10mm
Above 110 KW and upto 150 KW	12.5mm
Above 150 KW	19mm

1.33.2.6 Terminal Accessories.....Each terminal end shall be furnished with bimetallic washers, spring washers, nuts and crimp type aluminium (preferably tinned) lugs suitable for cables of sizes as specified in Clause 1.34 below.

1.34 **TYPE AND SIZE OF CABLES**

1.34.1 **Space Heaters**

1.34.1.1 For LV Motors: Two point five (2.5) mm^2, two (2) core copper conductor PVC insulated, armoured and FRLS PVC sheathed heavy duty 650/1100 V grade cable to IS: 1554 (Part-I).

1.34.1.2 For MV & HV Motors: Six (6) mm^2 two core aluminium conductor PVC insulated armoured and FRLS PVC sheathed heavy duty 650/1100V grade cable to IS: 1554 (Part-I).

1.34.2 For Embedded Temperature Detectors two sets of six (6) Twisted triad 0.5 mm^2 ATC copper conductor armoured, shielded cable, 650/1100 V Grade IS: 1554 (Part-I). For bearing temperature, RTDS, two (2) sets of four (4) twisted triad 0.5 mm^2, ATC copper conductor armoured shielded 650/1100 V Grade, IS: 1554 (Part-I).

1.34.3 Bearing Temperature Indicators - For each indicator, 0.5 mm^2 six (6) tarnished triad ATC copper conductor, PVC insulated, shielded armoured and FRLS PVC sheathed heavy duty 650/1100 V grade cable as per IS: 1554 Part-I. Two (2) cables one (1) for each bearing temperature indicator.

1.34.4 For Moisture Detectors.....As for space heaters as per Clause 33.01.01 above.

1.34.5 **For Main Terminals**

LT Motors

1. Three (3) core cables ……Stranded aluminium conductor, XLPE insulated, colour coded, laid up, PVC sheathed, GI wire / strip armoured, FRLS PVC jacketed overall, 650 / 1100V grade, heavy-duty cables as per IS: 1554 (Part-I).

2. Single core cables ……Stranded aluminium conductor, XLPE insulated, hard drawn aluminium wire/ strip armoured FRLS PVC jacketed overall, 650 / 1100V grade, heavy duty cable as per IS: 1554 (Part-I).

HT Motors

1. Three (3) core cables …… stranded aluminium conductor, XLPE insulated, screened colour coded, laid up, PVC sheathed, GI wire/strip armoured FRLS PVC jacketed overall, 6.6 KV / 11 KV grade, heavy duty cables as per requirement for unearthed system as per IS: 7098 (Part-II).

The size and no. of cable to be intimated to the successful bidder during detailed engineering and the contrcator shall provide terminal box, cable gland and lugs suitable for the same.

Cable size may be increased in some cases because of large number of cables in under-ground ducts or because of vaoltage drop consideration. The supplier shall supply with terminal box and cable accessories suitable for higher size of cable at no extra cost.

1.35 **EARTHING**

1.35.01 General..... Two (2) grounding terminals one (1) on either side at the bottom suitable for connecting mild steel/GI flat/GI wire grounding conductor, size of grounding conductor shall be decided during detailed engineering.

1.35.02 LV Motors.....At each earthing point, two (2) drilled and tapped holes with hexagonal head bolts, plain washers, spring washers and tinned lugs (for motors upto 5.5 KW) for size of conductor specified shall be provided.

1.35.03 MV & HV Motors.....Non-corrodible metallic grounding pad shall be welded or brazed at each earthing point. The size of grounding pad shall be 75x65x25 mm. Grounding pad shall have 40 mm apart two (2) drilled and tapped holes with hexagonal head bolts, plain washers and spring washers for size of conductor specified. In addition, one suitable earthing terminal shall be provided inside the stator phase terminal box for earthing metallic shield of XLPE cables.

1.36 **EMBEDDED TEMPERATURE DETECTORS**.....HT motor shall be provided with six (6) Nos. duplex resistance temperature detectors (RTDs) embedded in stator winding at locations where high temperatures are expected. In addition one (1) duplex type RTD shall be provided in each bearing. The RTDs shall be 3 wire duplex platinum resistance type having a value of 100 ohms at 0 Deg.C

1.37 **BEARINGS TEMPERATURE INDICATORS**..... HT motors shall be provided with dial type two (2) bearing temperature indicators and will have two (2) sets of contacts, each set having 2 NO + 2 NC contacts rated for 5A at 240V AC and 0.5A at 220V DC. One set will be set to operate at lower value to give alarm and other set at a higher value to trip the motor.

1.38 **SPACE HEATERS**.....Valve / Damper actuator motors; and Motors above 30 KW shall be provided with one (1) or two (2) space heaters suitable for 240V, 50 Hertz single phase AC supply and of adequate capacity to maintain motor internal temperature above dew point to prevent moisture condensation or deterioration of insulation during shut down. Heaters shall be mounted inside the motor in accessible locations so that their removal and replacement is simple. Motors upto 30 kW shall have stator windings suitable for connections to 24V, 50 Hz AC supply for space heating.

Motors upto 30 kW shall have stator windings suitable for connection to 24V, 50 Hz ac supply for space heating

The terminals of space heaters shall be brought out to a separate totally enclosed dust proof and weatherproof terminal box.

1.39 **HOT AIR TEMPERATURE DETECTOR**

If the motor is of CACA or CACW enclosure, a thermometer with alarm contracts in hot air circuit shall be provided.

1.40 **WATER FLOW INDICATOR**

If the motor is of CACW enclosure a provision shall be made for visual indication of water flow and flow switch shall also be provided with alarm contacts. Thermometers shall be provided in water inlet and outlet circuits.

1.41 **MOISTURE DETECTORS**.....Motors with type of cooling 1C 81W or 1C 91 W shall be provided with moisture detectors for raising alarm in the event of water tube failure.

1.42 **BED PLATE**.....Whenever motor is supplied with driven equipment the Supplier shall ensure that bed plate suits both motor and driven equipment and is adequately braced to keep vibration and misalignment within allowable limits to the approval of driven equipment and motor manufacturers.

1.43 **OTHER ACCESSORIES**..... Motor shall be supplied with all accessories and parts other than those, specified above which are necessary and/or useful for efficient operation.

1.44 **TYPE TEST**

1.44.01 **HT MOTORS**

a) The contractor shall carry out the type tests as listed in this specification on the equipment to be supplied under this contract. The bidder shall indicate the charges for each of these type tests separately. The type tests charges shall be paid only for the test(s) actually conducted successfully under this contract.

b) The type tests shall be carried out in presence of the Purchaser's representative, for which minimum 15 days notice shall be given by the contractor. The contractor shall obtain the Purchaser's approval for the type test procedure before conducting the type test. The type test procedure shall clearly specify the test set–up, instruments to be used, procedure acceptance norms, recording of different parameters, interval of recording, precautions to be taken etc. for the type test(s) to be carried out.

c) In case the contractor has conducted such specified type test(s) within last five years as on the date of bid opening, he may submit during detailed engineering the type test reports to the Purchaser's for waival of conductance of such test(s). These reports should be for the tests conducted on the equipment similar to those proposed to be supplied under this contract and test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client. The Purchaser's reserves the right to waive conducting of any or all the specified type test(s) under this contract. In case type tests are waived, the type test charges shall not be payable to the contractor.

d) Further the Contractor shall only submit the reports of the type tests as listed in "LIST OF TESTS FOR WHICH REPORTS HAVE TO BE SUBMITTED" and carried out within last five years from the date of bid opening. These reports should be for the test conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client. However if the contractor is not able to submit report of the type test(s) conducted within last five years from the date of bid opening, or in the case of type test report(s) are not found to be meeting the specification requirements, the contractor shall conduct all such tests under this contract at no additional cost to the Purchaser's either at third party lab or in presence of client representative and submit the reports for approval.

e) **LIST OF TYPE TESTS TO BE CONDUCTED**

The following type tests shall be conducted on each type and rating of HT motor

i) No load saturation and loss curves upto approximately 115% of rated voltage

ii) Measurement of noise at no load.

iii) Momentary excess torque test (subject to test bed constraint).

iv) Full load test(subject to test bed constraint)

v) Temperature rise test at rated conditions. During heat run test, bearing temp., winding temp., coolant flow and its temp. shall also be measured. In case the temperature rise test is carried at load other than rated load, specific approval for the test method and procedure is required to be obtained. Wherever ETD's are provided, the temperature shall be measured by ETD's also for the record purpose.

f) **LIST OF TESTS FOR WHICH REPORTS HAVE TO BE SUBMITTED**

The following type test reports shall be submitted for each type and rating of HT motor

i) Degree of protection test for the enclosure followed by IR, HV and no load run test.

ii) Terminal box-fault level withstand test for each type of terminal box of HT motors only.

iii) Lightning Impulse withstand test on the sample coil shall be as per clause no. 4.3 IEC-60034, part-15

iv) Surge-withstand test on interturn insulation shall be as per clause no. 4.2 of IEC 60034, part-15

1.44.02 **LT Motors**

a) LT Motors supplied shall be of type tested design. During detailed engineering, the contractor shall submit for Purchaser's approval the reports of all the type tests as listed in this specification and carried out within last five years from the date of bid opening. These reports should be for the test conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client.

b) However if the contractor is not able to submit report of the type test(s) conducted within last five years from the date of bid opening, or in the case of type test report(s) are not found to be meeting the specification requirements, the Purchaser's shall conduct all such tests under this contract at no additional cost to the Purchaser either at third party lab or in presence of client representative and submit the reports for approval.

1.44.03 **LIST OF TESTS FOR WHICH REPORTS HAVE TO BE SUBMITTED**

The following type test reports shall be submitted for each type and rating of LT motor of above 50 KW only

i) Measurement of resistance of windings of stator and wound rotor.
ii) No load test at rated voltage to determine input current power and speed.
iii) Open circuit voltage ratio of wound rotor motors (in case of Slip ring motors)
iv) Full load test to determine efficiency power factor and slip .
v) Temperature rise test.
vi) Momentary excess torque test.
vii) High voltage test.
viii) Test for vibration severity of motor.
ix) Test for noise levels of motor(Shall be limited as per clause no 1.21.01 of this section)
x) Test for degree of protection and
xi) Over speed test.
xii) Type test reports for motors located in fuel oil area having flame proof enclosures as per IS 2148 / IEC 60079-1

1.44.04 All acceptance and routine tests as per the specification and relevant standards shall be carried out. Charges for these shall be deemed to be included in the equipment price.

1.45 **INFORMATION WITH PROPOSAL**

1.45.1 AC Motor Data Sheet.

1.45.2 Dimension Drawing/Foundation load details of motor and driven equipment.
1.45.03 Manufacturer's catalogue showing constructional details.

1.46.00 **INFORMATION ON AWARD OF CONTRACT**.....Within six (6) weeks from the date of award of the Contract, following shall be furnished:

1.46.01 Motor Data Sheet.

1.46.02 Certified binding dimension drawing of motor complete with all accessories and fittings specifically showing terminal boxes, terminal spacing and sizes, earthing connections and sizes thereof, mounting details, lifting lugs, final foundation loads and dimensions with tolerances of centering spigot (where needed), shaft extension and key.

1.46.03 Following characteristics curves:

1.46.03.01 Torque-speed curves for motor at eighty (80), hundred (100) and hundred ten (110) percent rated voltage as well as torque-speed curve for driven equipment.

1.46.03.02 Current-speed curves at eight (80), hundred (100) and hundred ten (110) percent rated voltage

1.46.03.03 Current-time curves at eighty (80), hundred (100) and hundred ten (110) percent rated voltage.

1.46.03.04 Thermal withstand curves for hot and cold at eighty (80), hundred (100) and hundred ten (110) percent rated voltage.

1.46.03.05 Efficiency, power factor, current and speed versus power output curves.

1.46.03.06 Speed-time curves at eight (80), hundred (100) and hundred ten (110) percent rated voltage.

1.46.03.07 Negative phase sequence current withstand characteristics.

1.47 COMMISIONING CHECK LIST (HT MOTORS)

A PRELIMINARY CHECKS

Check the following:

1. Check the name plate details according to specification. Discrepancies, if any, to be satisfactorily resolved.

2. Check tightness of all bolts, clamps and connecting terminals.

3. Check body earthing

4. Check whether bearing lubrication is adequate

5. Check clearance inside terminal box

6. Checking stator (motor air gap) Check – Grease lubrication (for ball or roller bearing) is adequate if the motor was in storage for very long period replace the grease, by fresh grease after flushing the bearing clean. Excess grease in the bearing (housing … is overheat of bearings) Check 0 the free rotation of the rotor in decoupled condition. Check the air gap between stator and rotor at four positions 90o apart at driving and non-driving end. Compare the recorded values with factory results. For slip ring motors : with starting resistances.

   a) Check the variation of resistance
   b) Check brush lifting and slip ring short.

B COMMISSIONING CHECKS

1. Meggar tests of motor winding and cables
2. Continuity check of motor windings control and power cables
3. Measure resistance of motor winding (in case of large motors)
4. Control and interlocks should be checked
5. Motor protection relay to be calibrated
6. Phase sequence and direction of rotation
7. Other than DOL scheme to be checked example trafo starts
9. Measure starting current starting timer and no load current
10. On load operations starting and running currents (observed vibrations, temperatures of bearings and body)
11. On load operation, starting and running currents (observed vibrations, temperatures of bearings and body)
12. In case of forced water cooling of start or check winding temperatures as ready by built in RTDs.
13. Water level (start up cooling) low to be checked for limit switch operation.

1.48 COMMISIONING CHECK LIST (LT MOTORS)

A PRELIMINARY CHECKS

Check the following:

1. Check the name plate details according to specification. Discrepancies, if any, to be satisfactorily resolved.
2. Check tightness of all bolts, clamps and connecting terminals.
3. Check body earthing
4. Check whether bearing lubrication is adequate
5. Check clearance inside terminal box

B COMMISSIONING CHECKS

1. Meggar tests of motor winding and cables
2. Continuity check of motor windings control and power cables
3. Over load and short circuit relay tests and settings
4. Control and interlocks should be checked
5. Phase sequence and direction of rotation
6. Operation of timer in case of star delta starting
7. Measure starting current starting timer and no load current
8. On load operations starting and running currents

1.49 DC MOTOR SPECIFICATION

DC Motor will be of continuous duty type totally enclosed fan cooled (TEFC) having IP-54 degree of protection suitable for 220 V DC supply. DC motor will be shunt wound type having high torque characteristic suitable for Bi-directional rotation at rated speed and output. The general constructional features and details of DC motor will be in line with details/ particulars stipulated in the specification for AC squirrel cage induction motors.

Contractor will furnish the data in respect of DC motors.

DATASHEET

	Auxiliary power supply	
1.1	**HV supply**	
	11kV, 3Φ, 3W, 50 Hz non effectively earthed	Motors rated above 1500 kW
	Fault level	50 kA for 1 second
1.2	**MV supply**	
	3.3kV, 3Φ, 3W, 50 Hz non effectively earthed	Motors above 200kW upto and including 1500kW
	Fault level	40 kA for 1 second
1.3	**LV supply**	
	415V, 3Φ, 3W, 50 Hz effectively earthed	Motors below and including 200kW
	Fault level	50kA for 1 second
	110V, 1Φ, 2W, 50 Hz effectively earthed	Lighting, space heating, AC control and protective devices
1.4	**DC supply**	
	220V,2W, unearthed	DC alarm, control and protective devices.
	Fault level	25 kA for 1 second
2	Range of variation	As indicated in the specification
2.1	AC supply	
	voltage	------
	Frequency	------
	Combined voltage & frequency	--------
2.2	DC supply	198 to 240 V
Note: During starting of largest motor, the voltage may drop to 80% of the rated voltage for a period of 60 seconds. All electrical equipment while running shall successfully ride over such period without affecting system performance.		

CHAPTER 18 : ACTUATORS

1.00.00 ELECTRICAL ACTUATORS WITH INTEGRAL STARTERS

1.01.00 SCOPE

This Specification covers the general requirements of Electric Motor Actuators for valves, dampers and gates.

All electric motor actuators shall be furnished in accordance with this general specification and the accompanying driven equipment specification.

1.02.00 CODES STANDARDS

All the equipment specified herein shall comply with the requirements of the latest issue of the relevant National & International standards.

The design and materials used for the components shall also comply with the relevant National & International standards.

As a minimum requirement, the following standards shall be complied with :

Electric motor operated actuators:IS 9334

Degrees of protection provided by enclosures at low:IS 2147

voltage switch gear and control gear

Flame Proof enclosure at electrical apparatus: IS 2148

Specification for three phase induction motors: IS 325

AC contactor for voltages not exceeding 1000 V:IS 2959

Degree of protection provided by enclosures for : IS 4691

Rotating electrical machinery

Specification for rotating electrical machines: IS 4722

For other code refer Section D28.

1.03.00 SERVICE CONDITIONS

The actuator shall be integral type and suitable for operation in a hot, humid and tropical atmosphere, highly polluted at places with coal dust & fly ash and shall be suitable for an ambient temperature ranging from (-) 20 deg C to (+) 70 deg C.

Actuators for explosion-hazardous applications shall in addition be certified Flameproof for Zones 1 and 2 (Divisions 1 and 2 Group gases).

2.00.00 RATING

(a) Supply Voltage & frequency: 415V +/- 10%, 3 Phase, 3 Wire 50HZ +/-5%.

(b) Sizing:-

For Open/Close at rated speed against designed differential pressure at 90% of rated voltage.

For isolating service:- three successive open-close operations or 15 mins, whichever is higher. For regulating service 150 starts per hour or required cycles, whichever is higher.

2.01.00 PERFORMANCES

2.01.01 The actuator shall meet the following performance requirements:

2.01.02 Open and close the valve completely and make leak-tight valve closure, without jamming.

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

Operate the valve stem at standard stem speed and shall function against design differential pressure across the valve seat.

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

The entire mechanism shall withstand any shock resulting from closing with improper setting of limit switches or from lodging of foreign matter under the valve seat.

2.02.00 **SPECIFIC REQUIREMENT**

2.02.01 **<u>CONSTRUCTION</u>**

a) The actuator shall essentially comprise the drive motor, torque/ limit switches, gear train, clutch, hand wheel, position indicator and transmitter, . in built thermostat for overload protection,space heater and internal wiring.Actuator shall be integral type. Integral starters shall have facility to hook-up with plant DCS for positioning of limit and torque switches.

b) The actuator enclosure shall be totally enclosed, dust tight, weather proof (NEMA-6/IP-68) suitable for outdoor use without necessity of any canopy.

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

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

e) A lockable local/remote selector switch shall also be provided for selecting mode of operation.

f) Gear Train :

Metal (Fibre gears are not acceptable) self-locking to prevent drift under torque switch (where ever applicable) spring pressure when motor is de-energised.

g) Manual Wheel:

Shall disengage automatically during motor operation.

2.02.02 **MOTOR**

The squirrel cage induction motor shall be designed for full voltage direct-on-line start, with starting current limited to 6 times full-load current. The motor shall be capable of starting at 85% of rated voltage and running at 80% of rated voltage at rated torque and also at 85% of rated voltage at 33% excess rated torque for a period of 5 minutes each. The motors shall otherwise generally confirm with technical specification for motors mentioned elsewhere in this specification.

The actuators shall be sized so as to open or close valves/ dampers at rated speed enclosure shall not be more than 70 degree 'C' over ambient temp. of 70 deg.C as these are subjected to higher ambient conditions due to their vicinity to operate fluid on continuous load operation. The actuators shall be suitable for a relative humidity of 95%. Class of insulation shall be class-F and type of enclosure shall be IP-68.

The actuators shall be designed to be self locking upon loss of power. Motor shall be designed to close in 30 secs from full open position and shall have adequate capacity to open and close under full unbalanced design pressure.

The actuators shall be flange mounted to valve bonnets or with gearing and disengaging hand wheel for dampers.

2.02.03 **LIMIT SWITCHES**

Each motor actuator shall have Six (6) rotary drum position limit switches with two for open each with 2 NO + 2NC contacts and two for close each with 2 NO + 2 NC contacts positions, each with adjustable setting between fully open and fully closed positions. Each rotary drum limit switch shall have two (2) limit switches for intermediate open position each with 2 NO + 2 NC contacts. The limit switches shall have capacity of 5A at 240V AC or 0.5A at 220V DC.

Each motor actuator shall also have two (2) torque limit switches with four (4) normally opened and four (4) normally closed contacts each.

The torque switches shall have a minimum accuracy of 3% of set value. The torque switches shall be provided with calibrated knobs for setting desired torque and separate knobs shall be provided for open and close torque switches. The torque and position limit switches shall be housed in a separate enclosure with protection class as that of actuator.

The motor operators/actuators shall conform to AWWA specification and shall be capable of meeting 150 percent of unseating torque at specified voltage.

The motor actuators shall have 2 nos. potentiometric type transmitters of 100 ohm rating.

Torque switches shall function to stop the motor on closing. Upon actuation by the torque clutch it is restricted its attempt to open or close, thereby causing an overloading torque. Torque switches shall be non-self resetting type only (i.e.) once a particular direction torque switch operates, it will get resetted only when the equipment is operated in other direction.

All six (6) limit switches shall be changeover type and adjustable besides having the snap facility. All limit switches, contacts shall be wired up independently upto the terminal block.

2.02.04. **POSITION INDICATOR/TRANSMITTER**

a) Motor actuators shall be provided with clearly visible local position indicators mounted on the operator assembly itself. Suitable transducers shall be provided for remote indication of the position.

b) To be provided for 0 to 100% travel.

c) As required. Suitable for stabilized 4-20 mA signal, 2 wire inductive type, 24 volts DC operated.

2.02.05. **HAND WHEEL**

Hand wheel shall enable manual operation in case of power failure but it shall get automatically disengaged when once the motor starts functioning. The effort required to operate manually shall not exceed 18 Kg.

2.02.06 **SPACE HEATER**

Provision of space heater, if necessary, shall also be made with servomotor limit switch compartments. The space heaters shall be suitable for operation at 240V AC and its rating shall be indicated by the tenderer. Space heater circuit shall be complete with thermostat.

2.02.07 **TERMINAL BOX**

a) The terminals, terminal boards, terminal boxes, winding coils and associated equipments shall be suitable for connection to supply system having short circuit capacity specified in data sheet and clearance time determined by associated fuses. The terminal boxes shall be totally enclosed.

b) 650V grade for power cables.

2.02.08 **WIRING**

All wiring connections for various limit and torque switches, space heaters, position transmitters shall be brought out on separate terminal boards mounted on the valve, having liberal space for wiring and making connections to Purchaser's external circuits. Plug in type terminals shall be used suitable for analog/digital application. There shall be atleast 5 terminal spare to terminate spare cores of cable. Size of each control terminal shall be such that two (2) nos. lugged 2.5 sq.mm cable can be terminated on

each side. Power terminals shall be suitable for termination of 6 sq.mm lugged wire or as required depending on the motor capacity.

Motor terminal box and actuator terminal box shall be provided with cable glands to suit cable type and size.

Adequate earthing terminals preferably not less than 8 SWG GI wire shall be provided for suitable earthing system. Two earthing terminals shall be provided per motor, one No. on either side of the motor. The actuator shall include a diagnostic module, which will store and enable down load historical down load operation and torque data to permit analysis of actuator and valve in service performance. Data down load shall be carried out without removing any covers and all shall be available locally to the actuator or remotely via telecommunication data transfer. Diagnostic and configuration software shall be made for user PC system.

2.02.09 INTERFACES:

Open/Close command termination logic with position & torque Limit Switches, positioner circuit shall be suitably built in the PCB inside the actuator.

(a) For Binary Drive (both ON-OFF and INCHING type) :- Open/Close command & status thereof and disturbance monitoring signal (common contact for Overload, Thermostat, control supply failure, L/R selector switch at local & other protections operated) shall be provided.

Interface with the control system shall be through hardware signal only. Inter posing relays provided (with coil burden 2.5 VA) in the actuator shall be energized to initiate opening and closing, by 24V DC signal from the external control system.

(b) For Modulating Drive:- the command to actuator shall be in form of 4-20mA signal. The necessary positioning circuit and motor protection shall be provided

(c) Open/close command termination logic shall be suitably built inside actuator.

2.02.10 **DRAWING AND DATA AND MANUALS**

Data sheet for each of the actuator shall be furnished alongwith internal wiring diagram, suggested control schematic and limit switch contact development and manufacturer's catalogues.

2.02.11 **NAME PLATE**

Name plate shall be provided on the actuators with at least following data (a) Tag no. (b) Torque Rating (c) Full travel time.

2.02.12 **PAINTING**

The actuator shall be painted with epoxy based paint (the colour shall be indicated by the supplier). Paint shade shall be RAL 7032.

2.02.13 **PACKING**

The actuators shall be properly packed for transport by rail/ road/sea as applicable.

2.02.14 **OVERLOAD PROTECTION**

The actuator motor shall be provided with integral starter along with thermistor for overload protection.

2.02.15 **TESTS**

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

Following routine test shall be conducted as per IEC/IC standard. (a) Meggar Test, (b) Continuity test, (c) Operational test. Test certificates duly signed by inspecting agency shall be furnished.

The actuator shall be type tested as per IEC/National Standard, by international/national recognised test house. The test certificates issued by this house shall be furnished.

2.02.16 **TEST WITNESS**

Tests shall be performed in the presence of Owner/Purchaser's representative so desired by the Owner/ Purchaser. The contractor shall give at least fifteen (15) days advance notice of the date when the tests are to be carried out.

CHAPTER 19 : VARIABLE FREQUENCY DRIVE

1.00.00 CODES AND STANDARDS

DC reactor – IEC 60289
HT Circuit Breaker – IEC 60056
Motors – IS 60325 / IEC 60034 / IS 4722
Transformers – IS 2026
Bushings – IS 2099 / IEC 60137
Bushing CT – IEC 60185 / IS 2705
DRY Type Transformer – IS 11171
Harmonics & EM Compatibilty – IEEe: 519/IEC: 61000
Contactor/Switches/Fuses etc. – IEC: 60947, IS: 13947

2.00.00 TYPE

The Variable frequency drive (VFD) system shall be of a modern proven design for similar applications in power plants. The system shall be either Current Source Inverter (CSI) or Voltage Source Inverter (VSI) type with Twelve (12) pulse design for HCSD pumps (for AHP) & pipe conveyors (for External CHP) and six (6) pulse design for Rotary feeders(for AHP). Alternatively the contractor may offer technically superior and proven product subject to the approval of employer.

3.00.00 PERFORMANCE REQUIREMENTS

3.01.00 The system shall be energy efficient, designed as standard product and shall provide very high reliability, high power factor, low harmonic distortion and low vibration / wear/ noise.

3.02.00 The system shall be designed to deliver the motor input current and torque for the complete speed torque characteristics of the pump, with input supply variation of $\pm$10% and frequency variation of +3% & -5%. It shall be capable of withstanding the thermal and dynamic stresses and the transient mechanical torque, resulting from short circuit.

3.03.00 The drive system shall be designed to operate in one or more of the following operating modes as to suit characteristics of the driven equipment:

- Variable torque changing as a function of speed i.e. speed squared
- Constant torque over a specific speed range
- Constant power over a specific speed range where the torque decreases when speed increases

3.04.00 The drive controller shall be equipped with microprocessor based digital regulator with programmable functions. The power control regulator logic shall provide for an acceleration/deceleration current limit curve and shall be capable of field be separately programmable from 0.1 to 20 seconds.

3.05.00 Each channel and motor rating shall be rated to meet pump requirements. The system shall be designed for linear continuous speed control from 10% to 100% of pump rated speed and shall be of a modern proven design and fully compatible with excitation system offered.

3.06.00 The Total Harmonic Distortion (THD) of the voltage and current at inverter output shall be as per IEC 61800-4 and it shall be considered in the design of

the motor.

3.07.00 Harmonics at the supply side of the drive system at primary of the main input transformer shall be restricted within the maximum allowable levels of current and voltage distortion as per recommendations in the latest edition of IEEE-519.

3.08.00 The overload capacity of the controller shall be 150% of rated current of motor for one minute for constant torque applications, and 115% of rated current for one minute for variable torque application at rated voltage. If the motor load exceeds the limit, the drive shall automatically reduce the frequency and voltage to the motor to guard against overload. If the load demand exceeds the current limit for more than one (1) minute, the drive shall shut down to prevent overheating of the motor and damage to the drive.

3.09.00 During operation, the system shall be capable of developing sufficient torque under all load condition to respond to a 20% alteration in speed set point within a time limit up to 60 seconds.

3.10.00 The integrator action of the speed set point alteration shall be independently adjustable for both an upward and downward alteration. The minimum time interval between set point adjustments by the distributed control system shall be considered as 10 second.

3.11.00 The drive shall trip incase the speed exceeds 105% of the maximum operational speed or reduces to 95% of the minimum operational speed for more than 10 second.

3.12.00 Maximum noise level from the drive at 1meter distance, under rated load with all normal cooling fans operating shall not exceed 85dBA.

3.13.00 Variable frequency drive shall be arranged so that it can be operated in a circuit mode, disconnected from the motor for start up adjustment and troubleshooting/ maintenance.

3.14.00 Voltage at motor neutral terminal shall be maintained at ground potential for the total operating condition.

3.15.00 The drive system shall ensure the following:

- Harmful VFD induced harmonics which can create motor heating are eliminated.
- VFD induced torque pulsation are limited to maximum 1% (even at low speed) so there is minimal stress to the equipment.
- Motor is protected from dv/dt stresses.
- No appreciable increase in motor audible noise.

3.16.00 Electrical performance of the system shall comply to IEEE, IEC and equivalent international standard.

4.00.00 CONTROL REQUIREMENT

4.01.00 The system shall operate on constant V/f supply with required voltage boost capability in low frequency mode of operation.

4.02.00 Short time voltage dip up to 20% of nominal voltage (e.g. in case of a large motor start up connected to the same bus as VFD) shall not cause the control system to stop functioning and shall not trip the drive system.

4.03.00 The system shall also be equipped with a facility which will restart the system in case of voltage dip over 20% or power interrupter for less than 2 seconds, with recovery of the voltage to its normal value. The drive shall have the facility to block this feature, if required by operator. Upon restart the converter shall be capable of synchronizing onto a rotating motor and develop full acceleration torque within 10 seconds.

4.04.00 The power controller shall be controlled to always start the motor in the forward direction. Logic shall be provided to prevent the motor from being started in the reverse direction.

4.05.00 The drive motor shall be speed controlled corresponding to 4-20mA or 0-10V reference input signal. Unless otherwise specified, upon complete loss of the users speed reference signal, the drive shall automatically run at constant speed as at 8-100% of the last speed reference available prior to the loss of signal.

4.06.00 It shall be possible to vary the speed of the drive in either manual or auto mode. Auto/manual selection shall be from VFD panel unless otherwise specified.

- With the selector switch in "manual" mode, the operator shall be able to set the speed through keypad, mounted on front of the drive panel or from speed increase/decrease push buttons from the field. Motor operated potentiometer shall be provided as a speed set point device.

- With selector switch in "auto" mode, speed of the motor shall be controlled from a 4-20mA signal, from owner's PLC/DCS system. Necessary equipment like protocol converter as required for interfacing with PLC/DCS shall also be provided in the drive panel.

4.07.00 The required provision for the interface with remote PLC/DCS located at control room shall be either through hardwired connection (with potential free contacts and transducers as described elsewhere in this specification).

4.08.00 Drive system shall have provision for interface with upper level automation such as substation monitoring system or electrical control system.

4.09.00 The closed loop control feedback for the drive system having output transformer shall be tapped from the secondary side of the output transformer.

5.00.00 PANEL CONSTRUCTION

5.01.00 The panel shall include suitable semi conducting power devices (Diodes/IGBT) modules with protective devices, reactors (if required), filters (if required), control circuit, control accessories, indication and annunciation etc. The construction of the panel shall provide effective protection against electromagnetic emissions and shall meet design requirement of integrated standards.

5.02.00 Upstream breaker "ON/OFF/TRIP" indications and remote breaker closing and

trip push button shall be provided on the front door.

5.03.00 Safety Interlock shall be provided so that power cabinet can't be opened unless the up stream breaker is disconnected, safety-grounding switch is closed and DC link capacitor is discharged. Power source breaker can only be closed once the earthing switch is open and panel door is closed with lock defeat facility.

5.04.00 Duplicate control supply with automatic changeover shall be provided. Protection shall be provided against AC/DC transients, voltage surge etc. of power and control device.

5.05.00 The drive shall be housed in sheet steel panels fabricated with 2mm thick cold rolled sheet steel. The panel shall be suitable for indoor installation, if not otherwise specified. The panel shall be free standing with degree of enclosure protection as IP-41. The maximum operating height shall be 1800mm approximately.

5.06.00 Bolted un-drilled gland plate shall be provided at bottom. Clamp type terminals shall be used for connection of all wires up to 10mm2 and terminal for higher sizes shall be bolted type suitable for cable lugs. Minimum space for power cable termination shall be 600mm clear from bottom of the cable gland plate.

5.07.00 Bus bars shall be of electrolytic copper, color coded separately for AC and DC system. All the live parts shall be sleeved/shrouded to ensure complete safety to personnel intending to carry out routine inspection by opening the panel doors. All the equipment inside the panel and on the doors shall be provided with suitable nameplate.

5.08.00 All the switches, component and accessories which are essential for normal and emergency operation shall be mounted on the door and shall be operable externally. All the analog instruments, where provided, shall be switchboard type, back connected; 72x72mm.Scale shall have red mark indicating maximum permissible operating rating.

5.09.00 Each panel shall be provided with illuminating lamp/11W CFL with switch and fuse. 5/15A, 240V power socket with switch and fuse shall be provided. Each panel shall have space heater with switch fuse and variable setting thermostat.

5.10.00 Copper earth bus of min. 50x6 mm size shall be provided in the panel with provision for connection to purchaser's plant earth grid. All the non-metallic components /parts shall be connected to the main earth bus bar. Separate earth bus bar and stud for electronic control system as required shall be provided.

5.11.00 All the metal parts shall be treated so as to ensure efficient anti-corrosive protection. Hard wares shall be zinc passivated or electro galvanized. Panel enclosure and structure supports shall be thoroughly cleaned and degreased to remove mill scale and rust etc. External surface shall be painted Siemens grey (RAL - 7032) with two coats of synthetic enamel paint.

5.12.00 All panels shall be of same height so as to form a uniform line-up, to give good aesthetic appearance.

5.13.00 All the control wiring shall be enclosed in plastic/metal channel. Each wire shall be identified at both ends by self-sticking wire marker tapes of PVC ferrules. Power and control wiring inside the panel shall be done with BIS approved, PVC insulated, fire retardant, copper conductor wire. 1.5mm2 size wire shall normally be used provided the control fuse rating is 10 Amps or less and 2.5mm2 size for control fuse rating above 16A for electrical circuits and 0.7 mm2 for electronic circuits. All wires shall be ferruled and terminals shall be properly numbered, minimum 20% spare terminal shall be provided.

5.14.00 All electronic modules and components shall be accessible from front of panel only. Modular assemblies for both the system control electronic equipment and power electronic equipments shall be used.

5.15.00 All low voltage compartment and cabling shall be electrically and physically separated from the high voltage compartment.

5.16.00 DC link capacitor and pre charging and discharging circuit shall be preferably mounted in the rear of the panel.

5.17.00 Suitable removable type hooks shall be provided for lifting the panel.

5.18.00 Perspex type transparent insulating material shall be used for covering live compartments.

5.19.00 Drive keypad, operator control panel required for control, monitoring and measurements shall be supplied and installed outside the panel on the front door. It shall be accessible for operation without opening the front door and shall be non-removable type.

5.20.00 All the equipment shall be complete with cable glands, lugs etc. and cable glands shall be single or double compression type for indoor and outdoor equipment respectively.

6.00.00 COOLING

6.01.00 The drive panel shall be naturally cooled type as per manufacturer's standards. If unavoidable, forced type cooling system shall be provided. Cooling system shall include well-dimensioned panel, adequate cooling airflow path, module cooling fan and if necessary, panel-cooling fan shall be considered. Vendor shall ensure that the panel dimensions and the flow paths have been designed for continuous running at the specified ambient without overheating. For fan cooled drives, redundant ventilating fans (N+1) shall be provided.

6.02.00 Necessary starters shall be provided within the VFD panels for the ventilation fans, any other auxiliary motor etc. The system provided shall be interfaced with drive starting and shut down such that safety interlocks such as start permit from cooling system to drive and trip signal from cooling system to drive in case of cooling system failure etc., shall be incorporated in the overall sequence logic.

6.03.00 MCB for motor space heater, auxiliary power supply if required for local panel, drive panel space etc. shall be included and mounted in easy accessible location.

7.00.00 EQUIPMENT/COMPONENT SPECIFICATION

7.01.00 Motor

i. The motor shall be suitable for operation with a solid-state power supply consisting of an adjustable frequency inverter for speed control.
ii. The motor shall be suitable for the current waveforms produced by the power supply including the harmonics generated by the drive.
iii. The motor shall be designed to operate continuously at any speed over the range 10-100 % of rated speed.
iv. The permitted voltage variation should take into account the steady state voltage drop across the AC drive and all other system components upstream of the motor.
v. Motors required to be transferred to DOL, by-pass mode shall be rated for specified variations in system line voltage and frequency. Starting current of motor in DOL, bypass mode shall be limited to value in motor specifications.
vi. The motor shall be constructed to withstand torque pulsations resulting from harmonics generated by the solid-state power supply.
vii. The motor insulation shall be designed to accept the applied voltage waveform, within the V_p and dv/dt limits as per IEC-61800-4.
viii. The drive manufacturer shall be solely responsible for proper selection of the motor for the given load application and the output characteristics of the drive.
ix. Other details shall be as given in section of Electric motors.

7.02.00 Power Transformers

Indoor dry type. and shall be suitable for rating complying with system details. Other details as given in chapter for Dry Type Transformer.

7.03.00 Power Converter

i. The static power shall consist of a line side power converter for operation as a rectifier and a load side power converter for operation as a fully controlled inverter. Power converter shall be fast switching, most efficient and low loss type.
ii. Adequate short circuit and over voltage protection shall be provided for the converter and inverter system.
iii. All power converter devices shall include protective devices, snubber networks and dv/dt networks as required.
iv. The current rating of the converter's semi-conductor components shall not be less than 120% of the nominal current flowing through the elements at full load of the VFD through the whole speed range.
v. All power diodes shall be of silicon type with minimum V_{bo} rating as 2.5 times the rated operating voltage.
vi. The power converter circuit shall be designed so that motor can be powered at its full nameplate rating continuously without exceeding its rated temperature rise due to harmonic currents generated by the inverter operation.
vii. The conversion devices and associated heat sinks shall be assembled such that individual devices can be replaced without requiring the use of any special precautions/tools.
viii. The cooling system of the electronic components, if provided, shall be monitored and necessary alarms shall be provided to prevent any consequential damage to the power control devices.

ix. Offered system shall also take in account the distance between drive panel and motor and system shall include all material and accessories to make system suitable for a distance of 350m.

7.04.00 DC Link Reactor

i. Smoothing reactors for the DC link shall be designed to sufficiently decouple the rectifier and inverter portion of the converter and to limit fault currents in this circuit.
ii. Unless otherwise specified, the reactor shall be dry type, air cored, air-cooled and housed in separate enclosure in ventilated room.
iii. Reactor shall be suitable for withstanding earth fault continuously and for operation with the non-sinusoidal current wave shapes and DC components under all operational conditions of the system without exceeding its temperature limits.
iv. Noise level shall not exceed value specified in NEMA TR-1 standard.

7.05.00 Output Filter

VFD output current waveform should be inherently sinusoidal at all speeds, with harmonic limits as specified in this specification. Output filter shall be provided if required. Output filter capacitors shall be provided with discharge circuits to ensure that all residual stored charge is reduced to less than 50 V DC within 300 seconds after a loss of AC voltage. All capacitor shall be maintenance free and self-healing type.

The VFD system shall inherently protect motor from high voltage dv/dt stress, independent of cable length to motor. Output filter shall be an integral part of the VFD system and included within the VFD enclosure.

7.06.00 Bypass Feature

i. Bypass breaker / contactor-HRC fuse complete with protection, annunciation and metering shall be provided.
ii. All Variable frequency drives (VFD) having bypass feature shall have motor protection relay along with necessary control and metering etc. Switching scheme shall be such that in case of drive mal-operation, the motor could be taken on bypass control manually, while the drive could be attended by opening its isolation devices.
iii. Safety interlock between inverter and bypass breaker/contactor shall be provided such that closing of healthy device is inhibited in case of external fault.

7.07.00 CT/PT/Meters

As required for the system offered and shall be suitable for variable frequency operation.

7.08.00 Local Motor Control Station

i. The local motor control station is to be installed in the field near the motor. Components and accessories that are required in the local motor control station may be mounted on the local field mounted panel envisaged for the driven equipment.

ii. Meters in the local control station shall be suitable for 4-20mA transducer outputs and shall be calibrated for the actual motor current. Further, the drives with bypass facility, the meters shall be capable of reading bypass full load and starting currents, as well as the drive current.

7.09.00 Protection, Metering, Control, Annunciation & Indication

i. The system vendor shall provide all the necessary system control, protection; alarm equipment and metering for the entire drive system and its auxiliary equipment.
ii. Automatic sequence control shall include start-up of cooling system, auxiliary system of the motor, interlock checking, automatic start and run-up of drive, planned and emergency shutdown. The same shall be processed through microprocessor-based system.

7.10.00 Operator Control Panel

i. Each drive shall be equipped with a front mounted operator control panel consisting of a backlit alphanumeric display and a keypad with keys for parameterization and adjusting parameter which shall be limited to Start/Stop, Local/Remote, Auto/Manual, Increase/Decrease, menu navigation and protection and measurement parameter selection, etc.

ii. All parameter names, fault messages, warnings and other information shall be displayed in complete English words or standard English abbreviations to allow the user to understand what is being displayed without the use of a manual or cross-reference table. This shall also be used for the modification of all electrical values, configuration parameters, drive menu parameters, application and activity function access, faults, local control, adjustment storage, self test and diagnostics. Keypad shall be operable with password for changing the protection setting, safety interlock etc. However the parameters such as measurements, setting, and mode of drive etc. shall be allowed to be viewed without any password.

iii. Operator console shall have facility / port to connect external hardware such as Lap-Top etc. Console shall have facility for upload and download of all parameter settings from one drive to another identical drive for start up and operation.

iv. Drive system control also have facility to receive tripping signal from up stream breaker for tripping and also provision for closing upstream breaker after all required process parameters are achieved.

v. User-friendly software for operation and fault diagnostic shall be loaded in the drive system panel before commissioning.

8.00.00 PANEL PROTECTIVE FEATURES

The system offered shall incorporate adequate features, properly coordinated for the drive control and for motor but not limited to the following:

i. Incoming line surge protection.
ii. Under / Over voltage protection.
iii. Phase loss, phase reversal protection.
iv. Programmable Over current Protection and under load protection.

v. Inverter fault.
vi. Over frequency operation.
vii. Ventilation loss.
viii. Over temperature of equipment.
ix. Over speed of motor.
x. Specific motor protection, including motor winding, bearing temperatures, over current, overload, negative phase sequence, locked rotor and earth fault protections etc.
xi. System earth fault protection.
xii. Over and under frequency, rotor earth fault, field failure protection for synchronous motor.
xiii. Additional protection for drive system.

9.00.00 CONTROL

The following controls shall be provided as a part of the operators control panel or through separate switches:

i. Start/stop
ii. Speed control (Raise/lower)
iii. Auto/Manual/Test mode
iv. Local/Remote
v. Emergency Stop
vi. Start/stop for by pass starter (where specified)
vii. Trip-Remote Breaker
viii. Sequential switching of filters

10.00.00 INDICATORS

Indications as required for normal operation and for easy maintenance, which shall be provided but limited to the following indications:

i. Motor running
ii. Motor stopped
iii. VFD system fault
iv. AC mains ON
v. Motor over speed.
vi. Rectifier output ON
vii. Motor zero speed
viii. Rectifier breaker trip.

Above indications may be provided as a part of the operator control panel, i.e., door mounted keypad or through hardwired indicating lamps/LEDs.

Potential free contacts of first five items shall be wired separately for remote indications in PLC/DCS system.

11.00.00 METERING

Digital display of the following parameters shall be as a part of the Operator Control Panel, selected by the operator.

i. Input AC Voltage
ii. Input AC frequency
iii. Input AC current
iv. Output voltage

v. Output current VFD/Bypass
vi. Output frequency
vii. Motor thermal state
viii. Drive thermal state
ix. Motor speed
x. Motor energy meter
xi. DC link voltage
xii. Hour run

Necessary transducer shall be provided with 4-20mA output for indicating motor speed and motor current in PLC/DCS unless otherwise specified for other parameters.

12.00.00 AUDIO VISUAL ANNUNCIATION

i. The system shall incorporate audio-visual annunciations for protection, for various fault conditions, for the Drive motor, Supply cables, DC Reactor and the Converter, output transformer etc.

ii. Alarms shall also be included for the failure of various auxiliaries together with identifications of the failing unit, loss of cooling system, various protections devices provided for converter transformer etc.

iii. Audio-visual window annunciations shall be provided on the front of the panel. All annunciations as required for normal and satisfactorily operation of the drive system shall be included as per vendor standards. These annunciations can be part of operator console panel or separately mounted type.

iv. Vendor shall include audio-visual alarm as required for normal operations and maintenance of the system but not limited to the following:

1. Rectifier fuse failure
2. Main AC failure
3. Inverter fuse failure
4. Inverter overload
5. Inverter high temperature
6. Cooling system failure
7. Motor failed to start
8. Transformer failure
9. Battery monitoring healthiness
10. Communication and measurement system unhealthy
11. Motor temperature high
12. Harmonic filters monitoring

Common potential free contacts shall be provided for above annunciations and these shall be wired up to terminal block for owner's use for remote alarm and monitoring.

13.00.00 FAULT DIAGNOSTIC

Fault diagnostic shall be built into the system to supervise the operation and failure of the system. The information regarding failure of any of the system including shut down of the system shall be available for a period of minimum 4 days (96 hours) after a shut down even though no supply would be available to the system. The system may be totally de-energized for maintenance or

otherwise. It shall be possible to retrieve the record of events prior to tripping of the system or de-energization. Auxiliary supply to the system components or to the electronics (firmware) for the diagnostics / display shall be taken care by the manufacturer for this purpose.

14.00.00 EXTERNAL POWER SUPPLY FOR AUXILIARY & CONTROL CIRCUIT

Auxiliary power supply for devices external to VFD module, space heater supply for Motor, VFD panel space heater, auxiliary power supply for transformers, cubicle 11W CFL lamps etc. shall operate on 240 volts single phase AC provided by purchaser.

All control circuit shall operate at maximum voltage of 240V AC.

Vendor shall include supply of all control transformers, protective devices, required accessories etc. and any other control supply voltage as required for the system shall be derived from the power supply made available by other.

15.00.00 MAINTENANCE FEATURES

The controller design shall incorporate the following maintenance features:

- Modular construction
- All components shall be easily accessible

Standard diagnostics to aid maintenance personnel. These shall include LED or alphanumeric displays, test or measurement points.

16.00.00 PAINTING

i. All metal surfaces shall be thoroughly cleaned and de-greased to remove mill scale, rust, grease and dirt. Fabricated structures shall be pickled and then rinsed to remove any trace of acid. The under-surface shall be prepared by applying a coat of phosphate paint and a coat of yellow zinc chromate primer. The under-surface shall be made free from all imperfections before undertaking the finishing coat.

ii. After preparation of the under surface, the panel shall be provided with epoxy based powder coating. Panel finish shall be free from imperfections like pinholes, orange peels, runoff painted.

iii. All unpainted steel parts shall be zinc passivated, cadmium plated or suitably treated to prevent rust and corrosion. If these parts are moving elements, then these shall be greased.

iv. Final paint shade shall be Siemens grey (RAL - 7032).

17.00.00 INSPECTION, TESTING AND ACCEPTANCE

i. During fabrication, the drive shall be subject to inspection by owner, or by an agency authorized by the owner, to assess the progress of work, as well as to ascertain that only quality raw material is used. The manufacturer shall furnish all necessary information concerning the supply to owner's inspectors.

ii. All tests shall be carried out at the manufacturer's works under his care and expense. The tests shall be witnessed by an inspector of the owner or

an agency authorized by the owner. Prior notice of minimum of 4 weeks shall be given to the inspector for witnessing the test.

iii. The routine test shall be conducted on all the drive system. However type test shall be performed on one system of each rating and type unless otherwise agreed between purchaser and manufacturer. For the purpose of testing, drive system shall include input/output transformer (where applicable), switchgears, converter, filters etc.

iv. All routine and type tests shall be conducted on the drive system as follows:

I. Routine tests:

1. Visual Inspection
   It involves checking of various equipments/components fault diagnostic unit, wiring, terminals, earthing ratings, etc, in line with the approved drawings and visual inspection shall not be limited to the following:
   - Dimensions and door layout according to approved layout drawing
   - Degree of protection of cubicles
   - Simulation facility of control signals for testing purposes
   - Memory function of fault diagnostics
   - Voltage/current rating power semiconductor elements
   - Cable termination size and number of terminals, cable supporting, etc
   - Accessibility of components
   - External signals and indication/alarm signals on converter
   - Earthing of cubicles and cubicle doors
2. Insulation Test
3. Light Load and functional test
4. Load characteristics test
5. Load duty test
6. Checking of auxiliary devices
7. Checking the properties of the control equipment
8. Checking the protective devices
9. Checking of control and functional requirements
10. High voltage test
11. Shaft current/ bearing insulation
12. Automatic restar/re acceleration

II. Type Tests

1. Allowable full load current versus speed
2. Efficiency
3. Temperature rise
4. EM immunity
5. EM emission
6. Current sharing
7. Voltage division
8. Line side current distortion content
9. Power factor
10. Audible noise
11. Torque pulsation
12. Motor vibration
13. Dynamic performance

14. Current limit and current loop test
15. Speed loop test capability to ride through voltages less than 80%
16. Test capability to restart the system and resynchronize converter onto running motor after a voltage interruption.

Type test certificate from independent testing agency for similar equipment can be accepted for 4,5,6,10,11,12.

CHAPTER 23 : LT POWER CABLES

1.00.00 SCOPE OF SUPPLY

The LT Power cables shall be supplied, installed and commissioned in accordance with the following specification.

Other cables including special cables if any which are necessary as per proven engineering practice for satisfactory & trouble free operation of the entire cable system of the power plant shall also be within the scope of supply. These shall include all such cables for electrical integral with mechanical equipment systems and subsystems.

2.00.00 CODES & STANDARDS

All standards, specifications and codes of practice referred to herein shall be the latest editions including all applicable official amendments and revisions as on date of opening of bid. In case of conflict between this specification and those (IS: codes, standards, etc.) referred to herein, the former shall prevail. All the cables shall conform to the requirements of the following standards and codes:

IS:1554 (Part-I)	PVC insulated (heavy duty) electric cables for working voltage up to and including 1100 V.
IS : 3961	Recommended current ratings for cables
IS : 3975	Low carbon galvanized steel wires, formed wires and tapes for armouring of cables.
IS : 4905	Methods for random sampling.
IS : 5831	PVC insulation and sheath of electrical cables.
IS:7098 (Part - I)	Cross linked polyethylene insulated PVC sheathed cables for working voltages up to and including 1100V.
IS : 8130	Conductors for insulated electrical cables and flexible cords.
IS : 10418	Specification for drums for electric cables.
IS : 10810	Methods of tests for cables.
ASTM-D -2843	Standard test method for density of smoke from the burning or decomposition of plastics.
ASTM-D-2863	Standard method for measuring the minimum oxygen concentration to support candle like combustion of plastics.
IEC-754 (Part-I)	Test on gases evolved during combustion of electric cables.
IEEE-383	Standard for type test of Class IE Electric Cables.
IEC -60332	Tests on Electric cables under fire conditions. Part-3 : Tests on bunched wires or cables (catagory -B)
SS-4241475 classF3	Swedish Chimney test
NES-715-1	Temperature index

3.00.00 DESIGN CRITERIA

3.01.00 The cables will be used for connection of power circuits of the system. Actual cable sizes will be selected by the Contractor. Number of different sizes selected will be kept to a minimum for optimization.

3.02.00 Cables shall be generally laid on ladder type cable trays or drawn, through rigid Steel pipe conduits. For interplant connection cables shall be routed along overhead cable bridge.

3.03.00 For continuous operation at specified rating, maximum conductor temperature shall be limited to the permissible value as per relevant standard and/or this specification whichever is more stringent.

3.04.00 The insulation and sheath materials shall be resistant to oil, acid and alkali and shall be tough enough to withstand mechanical stresses during handling.

3.05.00 Armouring shall be single round wire of galvanized steel for multicore cables and aluminum for single core cable for power. For Fire survival power cable, Single core cables to be used in A.C. system, the armouring over inner sheath shall consist of single layer of round copper wire, for multi-core cables to be used in A.C. system and single/two core cables in D.C. System, the armouring over inner sheath shall consist of single layer of round galvanized steel wire.

3.06.00 The inner and outer sheath shall have flame retardant low smoke (FRLSH) characteristics or fire survival characteristics as the case may be, and shall meet the requirements of additional tests specified for the purpose.

3.07.00 Core identification for multicore cable shall be provided by colour coding.

3.08.00 Cables shall be so designed and manufactured that no damage occurs during handling, transit, storage, installation under any operative conditions which they may be subjected to.

3.09.00 Minimum value of volume resistivity for XLPE insulation shall be 1.0x1014 ohms-cm at 27 deg C and 1.0x1012 ohms-cm at 90 deg C.

3.10.00 Maximum continuous operating temperature shall be 90 deg C under normal operation and 250 deg C under short circuit condition. The cable cores shall be laid up with fillers between the cores wherever necessary. It shall not stick to insulation and inner sheath. All the cables, other than single core unarmoured cables, shall have distinct extruded PVC inner sheath of black colour as per IS: 5831.

4.00.00 SPECIFIC REQUIREMENTS / CONSTRUCTIONAL REQUIREMENTS

4.01.00 1.1KV Aluminium Conductor Power Cables

1100 volt, 90 Deg.C rating, heavy duty power cables with stranded aluminium conductor, extruded XLPE insulation, extruded HRPVC,FR-LSH inner sheath, aluminium round wire armour for single core cables and galvanized steel strip /wire armour for three (3) core cables, and extruded HRPVC, FR-LSH overall sheath.

Cables shall be manufactured in conformity to IS-7098 part 1 - 1988, amended up to date and bearing ISI mark.

4.01.01 Conductor

Aluminium conductor used in power cables shall have tensile strength of more than 100N/sq.mm. Conductors shall be stranded.

4.01.02 **Insulation**

Cross linked polyethylene (XLPE) of natural colour, extruded over screened conductor. This shall be conforming to IS: 7098 Part-1 (1988).

4.01.03 **Inner Sheath**

The laid up insulated cores of twin and multicore power cables shall be provided with an inner sheath of extruded HRPVC, FRLSH compound conforming to Type ST2 of IS:5831. Single core power cables need not be provided with any inner sheath.

4.01.04 **Armour**

For single core armoured cables, armouring shall be of aluminium wires/formed wires.

For multicore armoured cables, armouring shall be of galvanised steel as follows:

Calculated nominal dia of cable under armour	**Size and Type of armour**
Upto 13mm	1.4mm dia GS wire.
Above 13 & upto 25mm	0.8mm thick GS formed wire/1.6mm dia GS wire.
Above 25 & upto 40mm	0.8mm thick GS formed wire/2.0mm dia GS wire.
Above 40 & upto 55mm	1.4mm thick GS formed wire/2.5mm dia GS wire.
Above 55 & upto 70mm	1.4mm thick GS formed wire/3.15mm dia GS wire.
Above 70mm	1.4mm thick GS formed wire/4.0mm dia GS wire.

The aluminium used for armouring shall be of H4 grade as per IS:8130 with maximum resistivity of 0.028264 ohm mm^2 per metre at 20 deg C. The sizes of aluminium armouring shall be same as indicated above for galvanized steel.

The gap between armour wires / formed wires shall not exceed one armour wire/ formed wire space and there shall be no cross over / over-riding of armour wires / formed wires. The minimum area of coverage of armouring shall be 90%. The breaking load of armour joint shall not be less than 95% of that of armour wire / formed wire. Zinc rich paint shall be applied on armour joint surface of GS wires / formed wires.

4.01.05 **Overall Sheath**

Outer sheath shall be of PVC a per IS:5831 & black in colour. In addition to meeting all the requirments of Indian standards referred to, outer sheath of all the cables shall have the following properties.

(a) Oxygen index of min. 29 (as per IS 10810 Part-58).

(b) Acid gas emission of max. 20% (as per IEC-754-1).

(c) Smoke density rating shall not be more than 60% (as per ASTMD-2843).

4.02.00 **1.1KV Grade Copper Conductor Fire Survival Power Cables**

1100 volt grade,90 Deg.C rating, Power cables with stranded Copper conductor, heat resistance elastomeric insulation generally conforming to Type IE-2 of IS:6380-1984, extruded Halogen free or very low Halogen elastomeric inner sheath, generally conforming to Type SE-3 of IS-6380-1984 , round wire/strip armour and extruded outer sheath of elastomeric material generally conforming to Type SE-3 of IS:6380-1984.

The cables shall be generally manufactured in conformity to IS-9968 Part-1/1988.

The cables shall be rated for 3 hours fire rating.

4.02.01 **Conductor**

Conductor shall be of stranded construction, consisting of high conductivity annealed plain copper wires conforming to Class-II of IS 8130.
A suitable heat barrier tape, preferably glass mica tape shall be provided over the conductor.

4.02.02 **Insulation**

Cores of the cable shall be identified by colouring of insulation. Following colour scheme shall be adopted.

1 core - Red, Black, Yellow or Blue

2 core - Red & Black

3 core - Red, Yellow & Blue

4 core - Red, Yellow, Blue & Black

4.02.03 **Laying up of cores (For multi core cables only)**

The core shall be suitably identified in accordance with IS: 9968 (Part-I).

The suitable fire retardant material fillers shall be used for filling in the interstices.

Two layers of plain glass fiber binder tape shall be applied over the laid up cores.

4.02.04 Inner Sheath

An inner sheath of extruded special low smoke and very low halogen content (acid gas generation shall be less than 2% by weight) elastomeric (HOFR) compound of black colour conforming to Type SE-3 of IS-6380/1984, amended up to date, shall be provided over the laid up cores. This shall be provided even for single core cables after providing two layers of plain glass fiber tape over the insulation.

4.02.05 **Armour**

For Single core cables to be used in A.C system, the armouring over inner sheath shall consist of single layer of round copper wire.

For multi-core cables to be used in A.C. system and single/two core cables in D.C. System, the armouring over inner sheath shall consist of single layer of round galvanized steel wire.

4.02.06 **Outer Sheath**

The extruded outer sheath shall be of special low smoke and very low Halogen content (Acid gas generation shall be less than 2% by weight) elastomeric HOFR compound comprising of synthetic rubber and shall generally conform to the type SE-3 of IS: 6380 latest revision.

Minimum value of 'Tensile Strength' and 'Percentage elongation rate rupture' shall be 8 Newton/Sq. mm and 250% respectively.

The colour of outer sheath shall be black or any other colour agreed mutually between Owner and Supplier.

4.03.00 **Flexible Trailing Cables**

4.03.01 1100 V Grade flexible trailing cable shall be tinned copper of Class – 5 of IS – 8130, heat resistant electrometric compound based on EPR insulation, inner sheath of heat resistant electrometric compound PCP sheath, nylon cord reinforcement and heat resistant, oil resistant and flame retardant heavy duty electrometric compound FRLS CSP outer sheath.

5.00.00 CABLE SELECTION & SIZING

5.01.00 LT Power cables shall be sized based on the considerations mentioned in chapter 1.

5.02.00 Derating Factors

Derating factors for various conditions of installations including the following shall be considered while selecting the cable sizes:

a) Variation in ambient temperature for cables laid in air

b) Grouping of cables

c) Variation in ground temperature and soil resistivity for buried cables.

5.03.00 Cable lengths shall be considered in such a way that straight through cable joints are avoided.

6.00.00 GENERAL REQUIREMENTS

6.01.00 Drum Length & tolerance

6.01.01 Cable shall be supplied in wooden drums. The standard single length of each drum shall be minimum 500 metres for large size of cable minimum 1000 metre for smaller size of cables.

6.01.02 1.1KV Copper Fire Survival Power cables shall be supplied in wooden drums. Each drum shall be minimum 500 metres single length of cable.

Allowable tolerance on individual drum length is (+)5%.

6.02.00 Non-standard length

Bidder will be required to obtain Owner's approval before packing the non standard length of cables on drums. Non-standard lengths shall not be less than half of the standard packing length in any case.

6.03.00 Cable identification

Cable identification shall be provided by embossing on every meter on the outer sheath the following:

a) UPRVUNL
b) Manufacturer's name or trademark
c) Voltage grade
d) Year of manufacture
e) Type of insulation and sheath, e.g. XLPE /HRPVC FRLS,IE2/SE3 F.S. as applicable.
f) No. of core and size of cables.
g) Sequential length marking at an interval of 1m through out the length of the cable.
h) ISI mark
i) Type of improved fire performance, e.g. FR/FR-LSH/FS.

7.00.00 PACKING

7.01.00 Cables shall be supplied in non-returnable drums. The drums shall be of heavy construction as per relevant IS. All wooden parts shall be manufactured from seasoned wood. All ferrous parts used shall be treated with suitable rust preventive finish or coating to avoid rusting during transit or storage. Wooden drums shall be treated by immersing in copper nitrate solution

7.02.00 Cable shall be wound and packed on drums in such a manner that it will be properly sealed and firmly secured to the drum. The ends of each length shall be sealed before shipment. Heat shrinkable cable seals shall be used for this purpose

7.03.00 A label shall be securely attached to each end of the reel indicating the length, type, voltage grade, conductor size and number of core of the cable. A tag containing the same information shall be attached to the leading end of the cable inside. An arrow and necessary instructions shall be marked on the

drum indicating the direction in which it should be rolled. Drum numbers are to be indicated on cable drums

7.04.00 The cable drums should carry the following details in printed form (non returnable):

a) UPRVUNL & Manufacturer's name or trade make
b) Type of cable & voltage grade
c) Year of manufacture
d) Type of insulation / sheath e.g. XLPE /HRPVC FRLS,IE2/SE3 F.S. as applicable.
e) No. of core and size of cables
f) Cable code
g) Length of cable on drum
h) Direction of rotation, by arrow
i) Approx. gross mass.
j) ISI mark
i) IS/IEC number

8.00.00 TESTING PROCEDURE

8.01.00 TESTS DURING MANUFACTURE:-

During the manufacture of cables, manufacturer's standard tests shall be performed and record / test report shall be made available to purchaser's representative during inspection / testing.

8.02.00 TYPE ROUTINE & ACCEPTANCE TESTS:-

After completion of manufacture of cables, type, routine and acceptance tests shall be performed strictly as per relevant IS & other applicable standards amended upto date.

Routine tests shall be carried out on 100% drums.

8.03.00 TYPE TESTS :-

8.03.01 The type test as per applicable standards and as given below shall be conducted on one drum selected on random basis out of every 10 drums or less of each type and size of cable. Size shall mean area of cross section in sq.mm read in conjunction with the number of cores. Type shall mean type of insulation, sheath, volt grade FRLS/FS etc. In case, facilities of any of the type tests are not available at the works of the supplier, then such type tests shall be carried out by the supplier at independent recognized Govt. approved laboratory at the cost of supplier.

1. Tensile test (for aluminium) as per IS:8130

2. Wrapping test (for aluminium) as per IS:8130

Note:- In the case of compacted circular & shaped conductors these tests shall be carried out before compacting/shaping for ensuring use of H2 grade aluminium.

3. Conductor Resistance test as per IS:8130.

4. Test for armour wire/strip as per IS:3975

5) Test for thickness of XLPE Insulation and HRPVC,FR-LSH sheath :-

Requirements and methods of tests for the thickness of insulation, inner sheath and outer sheath shall be as per IS: 7098 (Part-2).

6) Tensile strength and elongation test for insulation & sheath :-

This test shall be carried out as per IS:7098 Part-2 for XLPE cable.

7) Ageing test for insulation and sheath:-

The method of test shall be as per the relevant IS standard. The period of test shall be 168 hours (7 days). At the end of the ageing period, the tensile strength and elongation test shall be carried out as per Sr.No.(6) above. The value obtained must not differ from the corresponding values obtained before ageing by more than + or - 25% in case of XLPE compound.

8) Loss of mass test for HRPVC, FR-LSH sheath :-

This test shall be carried out as per IS 583/1984 012 IEC 540 & IEC 502, on cables of all voltage grades. The maximum permissible loss of mass is 2 mg/sq.cm for PVC.

9) Shrinkage test for XLPE insulation & HRPVC FR-LSH sheath:-

This shall be carried out as per IS:5831 – 1984 for sheathed and as per IS 7098 (Part 2) 1985 for XLPE insulation.

10) Hot deformation test for HRPVC,FR-LSH sheath :-

This shall be carried out as per IS:5831 / 1984.

11) Cold Impact test for HRPVC,FR-LSH sheath :-

This shall be carried out as per IS:5831.

12) Heat shock test for HRPVC,FR-LSH sheath :-

This test shall be carried out as per IS 5831 / 1984 and IEC 540 and IEC 502 & sheath shall pass the requirements of this test.

13) Thermal stability test for HRPVC,FR-LSH sheath :-

This test shall be carried out on cables as per IS 5831 / 1984 and IEC 540 and cables shall pass the minimum requirements of 80 minutes for sheath.

14) Hot set test for XLPE Insulation :-

This test shall be carried out as per IS:7098 Part-1 and Part-2 and cable shall pass the requirements given therein.

15) Test for bleeding and blooming of Pigments for HRPVC,FR-LSH Sheath :-

This shall be carried out as per IS:5831 / 1984.

16) Fire Resistance Test

This test is compulsory and shall comply with the relevant clause of applicable IS.

17) Partial Discharge Test for XLPE Cables :-

The partial discharge test for XLPE insulation shall be carried out as per IS:7098 (Part-II).

18) Bending Test for XLPE Cables :-

The test method and test requirement shall be as per IS:7098 (Part-II). On completion of this test, the sample shall be subjected to partial discharge measurement and comply with the requirements given in above sub-clause 17.

19) Insulation Resistance / Volume resistivity -

As per IS 7098 Part-2 / 1985.

20) Dielectric Power Factor Test

As per IS 7098 Part-2 / 1985.

21) Heating cycle test for XLPE Cables :-

This test shall be as per IS:7098 (Part-II)

22) High Voltage Test

This test shall be performed as per the relevant Indian Standard 7098 Part 2 / 1985.

23) Test for Rodent & Termite Repulsion Property of Sheath :-

A few chipping of the PVC compound is slowly ignited on a porcelain dish or cubicle in a muffle furnace at about 60 degree C. The resulting ignited ash is boiled with a little ammonium acetate solution (10%). Place a drop of aqueous sodium sulphide solution on a thick filter paper and allow to soak. Touch the spot with a drop of above extract. A black spot indicates the presence of lead, the anti-termite and rodent compound.

24) Impulse Withstand Test

As per IS – 7098 (2) (amended upto date).

25) Water Absorption Test

As per IS 7098 Part-2 / 1985.

8.03.02 The normal sequence of the electrical tests shall be as per Clause 16.1.1 of IEC-502/1978 and / or as per IS 7098 Part – 2 / 1985 . All the tests listed herein shall be applied successively to the same sample.

8.03.03 The inner and outer sheath of the XLPE insulated cable shall be subjected to all the tests applicable for PVC sheath as per IS 5831 / 1984.

8.04.00 SPECIAL TESTS ON HRPVC 'FR-LSH' MATERIAL

All the sizes of XLPE power cables of the 'FRLS' HRPVC sheathed type shall pass following special test requirements. Inner sheath wherever applicable shall also be of the 'FR-LSH' type 'HRPVC' to meet these special tests.

i) Oxygen/Temperature Index test on sheath material :-

This test shall be carried out as per American National Std. A STM-D-2863/77.

The minimum oxygen index shall be 29 at room temperature.

For determination of the temp.index, the oxygen index test shall be carried out at different temperature upto 250°C. However, the test shall be carried out by extra-polation method beyond temperature at which the material of sheath may start deformation. The minimum temp. index (i.e. the temperature at which the oxygen index is minimum 21) shall be 250°C generally as per BICC Hand Book Chapter-6.

ii) Acid gas emission test on sheath material :-

This test shall be carried out as per IEC Std. 754-1. The maximum acid gas emission shall be less than 20 by weight.

iii) Smoke density test on sheath material :-

This test shall be carried out as per American National Standard ASTM-D-2843/1977 and also as per UITP method (3M cube test on finished cable sample). The ASTM test method is compulsory. For passing this test, the requirement of light transmission shall be minimum 40% after the test.

iv) Flammability test on finished cable sample :-

This test shall be carried out as per the following method :

Swedish Std.SS:424-14-75 Class-F3. This test known as Swedish Chimney test is compulsory.

IEEE std. 383-1974 – This test known as the vertical tray flame propagation test shall be conducted if insisted by purchaser.

IEC Std: 332-1. – The cable should meet the requirement of all the above standards.

9.00.00 ROUTINE TESTS :

The following tests shall be carried out as Routine tests on each and every drum length of cable, as per IS 7098 (Part 2) / 1985.

- High Voltage Test
- Conductor Resistance Test
- Partial discharge test (for screened cables) – on full drum length.

10.00.00 ACCEPTANCE TEST :

The following test shall be carried out as Acceptance Test in the presence of UPRVUNL Inspecting Engineer on samples taken from the delivery lot. One drum out of every 10 number of drums or less shall be selected at random sampling basis in each lot for the Acceptance Tests which shall be carried out at manufacturer's/supplier's cost.

1. High Voltage Test
2. Conductor Resistance Test
3. Tensile / wrapping test.
4. Partial discharge test (In screened cables).
5. Insulation Resistance/Volume resistivity test
6. Measurement of thickness of insulation and sheath and other dimensions
7. Tensile strength & elongation at break for insulation & sheath.
8. Hot set test on XLPE insulation
9. Flammability test as per Swedish standard SS:424-15-75 Class-F-3 (Swedish Chimney test)
10. Acid gas generation test as per IEC-754-1.
11. Smoke density test as per ASTM-D-2843/1977
12. Oxygen index test as per ASTM-D 2863/1977
13. Temp. index test as per ASTM-2863/77

11.00.00 TEST WITNESS

Tests shall be performed in presence of Owner/Owner's representative. The Contractor shall give atleast fifteen (15) days advance notice of the date on which the tests are to be carried out.

12.00.00 TEST CERTIFICATES

Certified reports of all the tests carried out at the works shall be furnished for approval of the Owner/Purchaser.

Test reports shall be completed with all details and shall also contain IS/IEC specified limit values, wherever applicable, to facilitate review.

The cables shall be dispatched from works only after receipt of Owner/ Purchaser's written approval of the test reports.

13.00.00 SITE TESTS

The contractor shall carry out the following commissioning tests and checks after installation at site. In addition the contractor shall carry out all other checks and tests as recommended by the manufacturers.

1. Check for physical damage

2. Ensure that gland plates of single core power cables are of non-magnetic material.

3. Bimetallic lugs are used when connections are made between different materials (i.e. Copper & Aluminum)

4. Meggar test between each case and armour 1 sheath.

5. Continuity check

6. Check connections.

7. Armour of single core cables should be earthed at one end only for multi core cables they are earthed at both ends.

8. Check for provision of correct cable tags, core ferrules, and tightness of connections.

CHAPTER 24 : LT CONTROL CABLES

1.00.00 SCOPE OF SUPPLY

The cables shall be supplied, installed and commissioned in accordance with the following specification.

2.00.00 CODES & STANDARDS

All standards, specifications and codes of practice referred to herein shall be the latest editions including all applicable official amendments and revisions as on date of opening of bid. In case of conflict between this specification and those (IS: codes, standards, etc.) referred to herein, the former shall prevail. All the cables shall conform to the requirements of the following standards and codes:

IS:1554 (Part-I)	PVC insulated (heavy duty) electric cables for working voltage up to and including 1100 V.
IS:3961	Recommended current ratings for cables.
IS:8130	Conductors for insulated electric cables and flexible cords.
IS:5831	PVC insulation and sheath of electric cables.
IS:2982	Copper conductor in insulated cables and cords.
IS:3975	Mild steel wires, strips and tapes for armouring cables
IS:5609	Specification for low frequency wirers and cables with PVC insulation and PVC Sheath.
IS:6380	Spec. of elastomeric insulation of sheath of electric cables.
IS:434(I and II)	Specification for rubber insulation cables
IEC:540	The methods for insulations and sheaths of electric cables and cords (elastomeric and thermoplastic compounds).
IEC:230	Impulse tests on cables and their accessories.
IEC:287	Calculations of the continuous current rating of cables(100% load factor).
IEC:288	Nominal cross-sectional area and composition of conductor of insulated cables.
NEMA-WC-5	Thermoplastic insulated wires and cables for transmission and distribution of electrical energy.
IEEE:383	Standard for type test for class IE electric cables, filled splices and connections for nuclear power generation stations.
IEC: 332-1	Test on electric cables under fire conditions.

ASTM-D-2843	Standard test method for density of smoke from burning/decomposition of plastics
ASTM-D-2863	Test for determination of Oxygen Index.
IEC-754-I	Test method for acid gas generation.
IEC-331	Fire resisting characteristics of electric cables.
SVENSK Standard	SS- 4241475 Class F3

3.00.00 DESIGN CRITERIA

3.01.00 The cables will be used for connecting control circuits.

3.02.00 Cables shall be generally laid on overhead cable trays/cable trays in cable trenches or drawn through rigid Steel pipe conduits. For interplant connection cables routed along overhead cable bridge.

3.03.00 Perforated type cable trays to be used for control cables. Only in cable risers ladder type cable trays can be used for control cables.

3.04.00 For continuous operation at specified rating, maximum conductor temperature shall be limited to the permissible value as per relevant standard and/or this specification whichever is more stringent.

3.05.00 The insulation and sheath materials shall be resistant to oil acid and alkali and shall be tough enough to withstand mechanical stresses during handling.

3.06.00 The inner and outer sheath shall have flame retardant low smoke (FRLSH) characteristics or fire survival characteristics as the case may be, and shall meet the requirements of additional tests specified for the purpose.

3.07.00 The cables shall be designed and manufactured in accordance with the best engineering practice and shall be such as has been proven to be suited for the intended purpose.

3.08.00 Minimum value of volume resistivity for PVC insulation shall be 3.5×10^{14} ohms-cm at 27°C room temp. and 3.5×10^{11} ohms-cm at 85°C.

For fire survival control cable, the armouring over inner sheath shall consist of single layer of wire/round galvanized steel wire as per IS 975 amended upto date.

4.00.00 SPECIFIC REQUIREMENTS / CONSTRUCTIONAL REQUIREMENTS

4.01.00 1100 V Copper Conductor HRPVC FRLS Control Cables

1100 Volt grade, 85 deg C rating, control cables with stranded copper conductors, HRPVC Insulation, extruded HRPVC, FRLS Inner sheath, round wire/strip armour as specified elsewhere in the specification and extruded HRPVC, FRLS overall sheath. The cables shall be suitable for use in 1100V non-effectively earthed system. Control cable shall generally conform to IS 1554 latest and have ISI mark. Armour shall be GS.

4.01.01 **Conductor**

Conductor shall be stranded, high conductivity annealed, plain (untinned) copper conductor having 7 strands for 0.67 sq.mm control cables. Conductor shall be generally conforming to Class-II of IS 8130.

4.01.02 **Insulation**

The conductors shall be insulated with HRPVC compound conforming generally to type-C of IS:5831/1984 amended up to date ,except for the following special properties / parameters, necessary at normal operation and at 85^0c maximum permissible conductor temperature. The maximum value of volume resistivity of insulation shall be $3.5x10^{14}$ ohms-cm at 27^oC and $3.5x10^{11}$ ohms-cm at 85 ^oC.

4.01.03 **Inner Sheath**

The laid up insulated cores of twin and multicore control cables shall be provided with an inner sheath of extruded HRPVC, FRLSH compound conforming to Type ST2 of IS:5831/1984 amended up to date.

4.01.04 **Armouring**

For cables up to and inclusive 7 cores, galvanized round steel wire armour shall be provided. However, for control cables above 7 cores, galvanized steel strip armour shall be provided.

The armouring wire/strip shall generally conforming to IS: 3975 amended up to date.

For multicore armoured cables, the armouring shall be of galvanised steel as follows:

Calculated nominal dia of cable under armour	**Size and Type of armour**
Upto 13mm	1.4mm dia GS wire.
Above 13 & upto 25mm	0.8mm thick GS formed wire/1.6mm dia GS wire.
Above 25 & upto 40mm	0.8mm thick GS formed wire/2.0mm dia GS wire.
Above 40 & upto 55mm	1.4mm thick GS formed wire/2.5mm dia GS wire.
Above 55 & upto 70mm	1.4mm thick GS formed wire/3.15mm dia GS wire.
Above 70mm	1.4mm thick GS formed wire/4.0mm dia GS wire.

4.01.05 **Overall Sheath**

A tough overall sheath of extruded HRPVC, FRLSH Compound conforming to type ST2 of IS: 5831/1984 shall be provided over armour. The colour of outer sheath shall be black or any other natural colour (with prior approval of the owner).

4.02.00 **1100 V Copper Conductor Fire Survival Control Cables**

4.02.01 **Conductor**

Conductor shall be of stranded construction, consisting of high conductivity annealed tinned copper conductors conforming to IS 8130/1984 amended up to date.

A suitable heat barrier tape, preferably glass mica tape shall be provided over the conductor.

4.02.02 **Insulation**

The conductor insulation shall consist of heat resisting elastomeric material EPR (Ethylene Propylene rubber) and shall conform to Type IE-2 of IS:6380/1984 amended up to date.

4.02.03. **Laying Up Of Cores (For Multi Core Cables Only)**

The core shall be suitably identified in accordance with IS: 9968 (Part-I).

The suitable fire retardant material fillers shall be used for filling in the interstices.

Two layers of plain glass fiber binder tape shall be applied over the laid up cores.

4.02.04. **Inner Sheath**

An inner sheath of extruded special low smoke and very low halogen content (acid gas generation shall be less than 2% by weight) elastomeric (HOFR) compound of black colour or any other natural colour with prior approval from Owner conforming to Type SE-3 of IS-6380/1984, amended up to date, shall be provided over the laid up cores.

4.02.05. **Armour**

The armouring over inner sheath shall consist of single layer of wire/round galvanized steel wire as per IS 3975 amended up to date.

4.02.06. **Outer Sheath**

The outer sheath shall be of special low smoke and very low Halogen content (Acid gas generation shall be less than 2% by weight) elastomeric HOFR compound comprising of synthetic rubber and shall generally conform to the type SE-3 of IS:6380 latest revision.

The colour of outer sheath shall be black or any other natural colour agreed mutually between Owner.

5.00.00 GENERAL REQUIREMENTS

5.01.00 Drum Length & Tolerance

The cable shall be supplied in wooden drums. Each drum shall be minimum 500 meters single length of cable. For above cable drums, allowable tolerance on individual drum length is +/- 5%.

1.1KV Copper Fire Survival control cables shall be supplied in wooden drums. Each drum shall be minimum 500 metres single length of cable. Allowable tolerance on individual drum length is ±5%.

5.02.00 Non-standard length

Bidder will be required to obtain Owner's approval before packing the non standard length of cables on drums. Non-standard lengths shall not be less than half of the standard packing length in any case.

5.03.00 Cable identification

Cable identification shall be provided by embossing on every meter on the outer sheath the following:

a) UPRVUNL
b) Manufacturer's name or trademark
c) Voltage grade
d) Year of manufacture
e) Type of insulation and sheath, e.g. HR85 for HR PVC/ FRLS, IE2/SE3/FS as applicable.
f) No. of core and size of cables.
g) Sequential length marking at an interval of 1m through out the length of the cable.
h) ISI mark

Reference standard
Type of improved fire performance eg. FR/FR-LSH-FS

6.00.00 PACKING

6.01.00 Cables shall be supplied in non-returnable drums. The drums shall be of heavy construction as per relevant IS. All wooden parts shall be manufactured from seasoned wood. All ferrous parts used shall be treated with suitable rust preventive finish or coating to avoid rusting during transit or storage.

6.02.00 Cable shall be wound and packed on drums in such a manner that it will be properly sealed and firmly secured to the drum. The ends of each length shall be sealed before shipment.

6.03.00 A label shall be securely attached to each end of the reel indicating the length, type, voltage grade, conductor size and number of core of the cable. A tag containing the same information shall be attached to the leading end of the cable inside. An arrow and necessary instructions shall be marked on the drum indicating the direction in which it should be rolled. Drum numbers shall be indicated on cable drums.

6.04.00 The cable drums should carry the following details in printed form (non returnable):

a) UPRVUNL & Manufacturer's name or trade make
b) Type of cable & voltage grade
c) Year of manufacture
d) Type of insulation / sheath e.g. HR85 for HRPVC/ FRLS, IE2/SE3/FS. as applicable.
e) No. of core and size of cables.

f) Cable code.
g) Single length of cable on drum
h) Direction of rotation, by arrow
i) Approx. gross mass.
j) ISI mark.

7.00.00 Testing Procedure

7.01.00 **1100 V Copper Conductor HR PVC FRLS Control Cables**

7.01.01 **TYPE TESTS**

The type test as per applicable standards as given below shall be conducted on one drum selected on random basis out of every 10 drums or less of each type and size of cable (In presence of UPRVUNL representative). In case, facilities of any of the type tests are not available at the works of the supplier, then such type tests shall be carried out by the supplier at independent recognized Govt. approved laboratory at the cost of supplier.

1) Tensile test (for Aluminium) as per IS:8130

2) Wrapping test(for Aluminium) as per IS:8130

3) Persulphate test (on tinned copper wire) as per IS: 8130.

4) Test for armour wire/strip as per IS:3975

5) Test For Thickness Of Insulation And Sheath

Requirements and methods of tests for the thickness of insulation, inner sheath and outer sheath shall be as per IS: 1554 (Part-I) and IS: 5831/1984.

6) Tensile Strength And Elongation Test For Insulation & Sheath

This test shall be carried out as per IS: 5831 for PVC cable.

7) **Ageing Test For Insulation And Sheath**

This test shall be carried out as per IS: 5831/1984.

8) **Loss Of Mass Test For HRPVC,FRISH Sheath**

This test shall be carried out as per IS: 5831/1984.

9) **Shrinkage Test For Xlpe Insulation & HRPVC,FRISH Sheath**

This test shall be carried out as per IS: 5831/1984.

10) **Hot Deformation Test For HRPVC,FRISH & Sheath**

This shall be carried out as per IS: 5831 / 1984.

i) Cold Bend Test For HRPVC Insulation

This test shall be carried out as per IS: 5831/1984.

12) **Cold Impact Test For HRPVC,FRISH Sheath**

This test shall be carried out as per IS: 5831/1984.

13) **Heat Shock Test For HRPVC Insulation , FRISH Sheath**

This test shall be carried out as per IS: 5831/1984 and IEC-540 and IEC-502 and PVC Insulation & sheath shall pass the requirements of this test.

14) **Thermal Stability Test For HRPVC Insulation ,FRISH Sheath**

This test shall be carried out on cable of all voltage grades as per IS 5831 / 1984 and IEC 540 and cables shall pass the minimum requirements of 100 minutes for insulation and 80 minutes for sheath.

15) **Test For Bleeding And Blooming Of Pigments For HRPVC,FRLSH Sheath**

This shall be carried out as per IS: 5831 / 1984.

16) **Fire Resistance Test**

This test is compulsory for all cables and shall comply with the relevant clause of applicable IS.

17) **Measurement of Insulation Resistance (Volume Resistivity) For HRPVC Cables**

This shall be carried out as per IS: 5831 / 1984 but the values of volume resistivity of HRPVC insulated cables shall be not less than the values given below:

Min. Vol. Resistivity at 27^0C temp. ……3.5 x 10^{14} ohm-cm.

Min. Vol. Resistivity at 85^0C temp. ……3.5 x 10^{11} ohm-cm.

18) High Voltage Test

This test shall be performed as per the relevant Indian Standard 1554.

19) Test For Rodent & Termite Repulsion Property Of Sheath

"A few chipping of the PVC compound is slowly ignited on a porcelain dish or cubicle in a muffle furnace at about 60 degree C. The resulting ignited ash is boiled with a little ammonium acetate solution (10%). Place a drop of aqueous sodium sulphide solution on a thick filter paper and allow to soak. Touch the spot with a drop of above extract. A black spot indicates the presence of lead, the anti-termite and rodent compound."

Or any other chemical method for detecting the presence of lead.

7.01.02 The normal sequence of the electrical tests shall be as per clauses 16.1.1 of IEC-502/1978. All the tests listed herein shall be applied successively to the same sample.

7.01.03 **Special Tests On HRPVC 'FRLSH' Material**

All the sizes of 1.1 KV Grade HRPVC insulated, HRPVC Control cables of the FRLSH sheathed type shall pass these special test requirements. Inner sheath wherever applicable shall also be of the 'FRLSH' type 'HRPVC' to meet these special tests.

i) **Oxygen/Temperature Index Test On Sheath Material**

This test shall be carried out as per American National Std. ASTM-D-2863/77.The minimum oxygen index shall be 29 at room temperature.

For determination of the temp index, the oxygen index test shall be carried out at different temperature upto 250°C. However, the test shall be carried out by extrapolation method beyond temperature at which the material of sheath may start deformation. The minimum temp. index (i.e. the temperature at which the oxygen index is minimum 21) shall be 250°C generally as per BICC Hand Book Chapter-6.

ii) **Acid Gas Emission Test On Sheath Material**

This test shall be carried out as per IEC Std. 754-1. The maximum acid gas emission shall be less than 20% by weight.

iii) **Smoke Density Test On Sheath Material**

This test shall be carried out as per American National Standard ASTM-D-2843/1977 and also as per UITP method (3M cube test on finished cable sample). **The ASTM test method is compulsory.** For passing this test, the requirement of light transmission shall be minimum 40% after the test (Corresponding to 60 % smoke density).

iv) **Flammability Test On Finished Cable Sample**

This test shall be carried out as per the following method :

Swedish Std.SS:424-14-75 Class-F3. (This test known as Swedish Chimney test is compulsory).

IEEE std. 383-1974 – This test known as the vertical tray flame propagation test shall be conducted if insisted by purchaser.

IEC Std: 332-1. – The cable should meet the requirement of all the above standards.

7.01.04 **Routine Tests**

The following tests shall be carried out as Routine tests on each and every drum length of cable, as per IS: 1554 / IS: 8130/1984.

- High Voltage Test.
- Conductor Resistance Test.

7.01.05 **Acceptance Test**

The following test shall be carried out as Acceptance Test in the presence of Owner's Inspecting Engineer on samples taken from the delivery lot. One drum out of every 10 number of drums or less shall be selected at random sampling basis for the Acceptance Tests.

1. Tensile / wrapping test.
2. High Voltage Test.
3. Conductor Resistance Test
4. Insulation Resistance/Volume resistivity test.
5. Measurement of thickness of insulation and sheath and other dimensions.
6. Tensile strength & elongation at break for insulation & sheath.
7. Flammability test as per Swedish standard SS: 424-15-75 Class-F-3 (Swedish Chimney test).
8. Acid gas generation test as per IEC-754-1.
9. Smoke density test as per ASTM-D-2843/1977.
10. Oxygen index test as per ASTM-D 2863/1977.
11. Temp. index test as per ASTM-2863/77

7.02.00 **1100 V Copper Conductor Fire Survival Control Cables**

7.02.01 **<u>Type Tests</u>**

The type test as per applicable standards as given below shall be conducted on one drum selected on random basis out of every 10 drums or less of each type and size of cable (In presence of UPRVUNL representative). In case, facilities of any of the type tests are not available at the works of the supplier, then such type tests shall be carried out by the supplier at independent recognized Govt. approved laboratory at the cost of supplier.

S No.	Name of Tests	Governing Standard	Special Requirements as per Purchaser's Specification
1	Annealing test (for copper)	IS:8130/1984	--
2	Persulphate test (for tinned copper)	IS:8130/1984	--
3	Conductor Resistance test	IS:8130/1984	--
4	Test for armour wires	IS:8130/1984	--
5	Test for measurement of DC Resistance of armour	---	--
6	Test for Thickness of insulation and sheath and other dimensions	IS:9968(i)	--
7	Tensile strength & elongation at break for insulation	IS:6380/1984	--
8	Tensile strength and elongation for sheath	IS:6380/1984	--
9	Ageing test for insulation		
	Air over	IS:6380/1984	--
	Air-Bomb		
	O_2 – bomb	IS:6380/1984	--
10	Oil Resistance Test for sheath	IS:6380/1984	--
11	Water absorption test for Insulation (Elect.)	IS:6380/1984	--
12	Hot set test for insulation	IS:6380/1984	--

S No.	Name of Tests	Governing Standard	Special Requirements as per Purchaser's Specification
13	Measurement of Insulation Resistance constant (K-valve)	IS:6380/1984	--
14	High Voltage Test		
	i) Water immersion test	IS:9968(I)	--
	ii) Spark Test		
15	Oxygen index test on inner & outer sheath material	ASTM-D-2863/77	MIN-29
16	Temp. index test on inner & outer sheath material	ATM-D-2863/77 IEC-331	Min 350°C
17	Acid gas emission test on inner & outer sheath material	IEC-754-1	Acid gas generation shall be less than 2% by weight.
18	Smoke density test on inner & outer sheath	ASTMD—2843/77 IEC-331	Max. smoke density in percentage light absorption shall not exceed 20%.
19	Flammability test on finished cable sample as per following method	IS:8130/1984	--
	i) 3 Hour Fire Survival test	IEC-331	--
	ii) Swedish Chimney Test	SS-424-14-75 75 9 (Class F3)	---
	iii) Vertical tray flame propagation test	IEEE383/74	---
	iv) Single Vertical cable fire Resistance Test	IEC-332-1	--

7.02.02 **Routine Tests**

The following test shall be carried out as Routine Tests on each and every delivery length of cable.

1. High Voltage Test - IS: 9968 (I)
2. Conductor Resistance test - IS: 8130/1984

7.02.03 **Acceptance Tests**

Following tests shall be carried out as acceptance tests in the presence of Owner's Inspecting Engineer on samples taken from the delivery lot. One drum out of every 10 drums or less shall be selected on random sampling basis.

1. Annealing Test - IS 9968 (I)
2. High Voltage test - IS 9968 (I)
   (Water immersion Test)
3. Conductor resistance test - IS8130/1984
4. Insulation Resistance Test - IS6380/1984
- Measurements of thickness of Insulation and sheath and other dimensions - IS:9968(I)
6. Tensile strength & elongation at - IS 6380/1984

Break for sheath

7. Tensile strength and elongation at break of sheath - IS 6380/1984 --As per GTP
8. Oxygen index test on inner & outer Sheath material at room temperature - ASTM-D-2863/77 Min. 29

9. Temp. index test on inner & outer degC ASTM-D-2863/77 Min 350

sheath material
IEC-331

10. Acid gas emission test on inner & generation IEC-754-1 Acid gas

outer sheath material shall be less than 2%

11. Smoke density test on inner & outer density sheath material ASTM-D-2863/77 Max smoke in percentage light

Absorption shall not exceed 20%.

- Flammability test on finished cable

Sample as per following method

i) 3 Hour fire Survival Test IEC –331
ii) Swedish Chimney Test SS-424-14-75
Class-F3)

9.00.00 SITE TESTS

The contractor shall carry out the following commissioning tests and checks after installation at site. In addition the contractor shall carry out all other checks and tests as recommended by the manufacturers.

1. Check for physical damage

2. Bimetallic lugs are used when connections are made between different materials (i.e. Copper & Aluminum)

3. Continuity check

4. Check connections.

5. Check for provision of correct cable tags, core ferrules, and tightness of connections.

CHAPTER 25 : FIRE SEALING

1.01.00 In order to prevent fire propagation through cable penetrations, after laying, dressing & clamping of cables, all the openings shall be properly sealed by using Fire Stop Mortar Seal and Fire Retardant Cable Coating Compound. The Fire Stop Mortar Seal / Fire Retardant Cable Coating Compound shall generally confirm to the specification given subsequently in this section. Further, the cable runs both before and after the fire seal shall be suitably sprayed with anti-fire propagation liquid.

1.02.00 **CODES AND STANDARDS**

The Fire Stop Mortar Seal and Fire Retardant Cable Coating Compound in compliance with the latest applicable Indian Standards (IS) shall be modified and/or supplemented by this specification and other related standards listed as follows:

Fire Stop Mortar Seal	Fire Retardant Cable Coating Compound
UL - 1479	IEEE -383
ASTME 814	IEC-331
BS 476	IEC-332
BS 12458	Modified Swedish Chimney Test

2.00.00 TECHNICAL SPECIFICATION FOR FIRE STOP MORTAR SEAL

Brief Description	:	Fire Seal shall be dry cement with other chemical ingredients capable of controlled swelling, non-shrinking, homogeneous and smoke / gas-tight fire seal for cable and pipe penetration.
Composition	:	It shall consist of inorganic binders, filters and light weight aggregates with special additives and agents.
Colour	:	Preferably – Grey colour
Bulk Density	:	Approx. 550 gm./liter (Minimum)
Toxicity	:	It shall be Non-toxic.
Combustibility	:	It shall be Non-combustible
pH value	:	7-11(at working consistency)
Storage temperature	:	+ 5 deg.C to 50 deg.C in dry conditions.
Shelf life	:	Minimum Two years, in original unopened packing stored in a dry place.
Packaging	:	Shall be packed in Moisture/Air tight container containing not more than 50 Kg. fire seal compound.

Compressive Strength	:	Approx. 0.6 N per sq mm (min).
Yield	:	1kg. Dry Mortar yields approx. 1.5 liters mixture of wet mortar
Fire Resistance	:	Fire Seal shall provide 3 Hrs. Fire Resistance.
Expansion	:	Approx. 3% by volume at 20 Deg. C
Recommended Uses	:	Recommended for both wall openings and floor cut-outs and fire barrier in cable trenches
Approval	:	The bidder should submit type test & routine test report certified by CBRI Roorkee / CPRI, for tests conducted within last 5 years from the date of opening of bid, as per IS 12458-1988, UL 1479 or BS 476 part 20 conducted for organization like NPCIL, UPRVUNL and BHEL.
Experience	:	The application should have been done successfully preferably in Power Stations

The penetration system shall have life expectancy of 40 Years

Asbestos shall not be used in the construction of fire penetration seal system

The penetration materials shall have no shrinkage or cracking after the setting for the complete life of the power plant.

The penetration materials shall have no reaction with cable sheath/ galvanising/painting of structural steel.

The penetration system shall be physically, chemically, thermally stable and shall be mechanically secure to the masonry/concrete/structural members. The system shall be mechanically robust and capable of giving satisfactory performance under vibrations encountered in power stations.

The penetration system shall be completely gas and smoke tight.

3.00.00 TECHNICAL SPECIFICATION OF FIRE RETARDANT COATING COMPOUND

Brief Description	:	Fire retardant cable coating compound shall be a ready to mix and easily brushable one.
Composition	:	Fire retardant coating compound shall be water based, solvent free coating comprising of thermoplastic resins, certain flame retardant chemicals and other inorganic incombustible fibers, filters and pigments. Fire retardant should not contain asbestos fibers.
Colour	:	Preferably – Off White colour
Density	:	1.25 to 1.35 gm per cc.

Solid contents	:	70 to 75% by weight
pH value	:	7 - 11
Odour	:	It shall be odourless
Toxicity	:	It shall be Non-toxic.
Combustibility	:	It shall be Non-combustible
Storage temp.	:	Max 50 Deg.C, must be protected from freezing
Shelf life	:	Shall be min. 2 years, in original unopened packing stored in dry place
Coating thickness	:	Recommended min 2.0 mm.
Packing	:	Shall be packed in Sealed-moisture/air tight container containing max. 50kg fire retardant compound
Thinning	:	Shall be only by water
Drying time	:	8 hrs. touch dry.
Ref. standard	:	IEEE-383, IEC-331,332, Modified Swedish chimney test
Fire resistance	:	Fire retardant coating shall provide minimum 30 minutes fire resistance
Limited oxygen index (LOI)	:	Greater than 60
Approval	:	The bidder should submit type test & routine test report certified by CBRI Roorki / CPRI, for tests conducted within last 5 years from the date of opening of bid as per IEEE 383 or modified Swedish Chimney test conducted for organization like NPCIL, UPRVUNL and BHEL.
Experience	:	The application should have been done successfully preferably in Power Station

4.00.00 FIRE RETARDANT COATING COMPOUND – SPECIAL FEATURES

Alkali Resistance	:	A Fire Retardant coated cable shall not show any effect on application of 10% soap solution for half an hour and 2% Na_2Co_3 solution for an additional half an hour.
Ampacity	:	On application of Fire Retardant coating, there shall be no effect on the current capacity of the cable.

Flexibility : Fire Retardant Coated HRPVC Cable may be bent 20 times cable diameter without cracking or peeling off.

Surface finish : Rough

Hydrocarbon Solubility : Shall have no effect.

Mineral Oil Resistance: Shall be highly Resistance to immersion in mineral oil for 48 hours at room temp. There shall be no physical and chemical changes.

Antirodent : Dry film of Fire Retardant shall be antirodent

Effect of Atmospheric humidity. Conditions : Shall be Highly Resistant to moisture and

Acid Resistance : No effect on application of 2% Conc. Sulphuric Acid on fire Retardant coated cable.

Salt Water Resistance: A Fire Retardant coated cable will not show any effect when dipped in salt water for 16 days.

Water Resistance : A fire Retardant coated cable will not show any effect when dipped in water at 40°C for 10 days.

5.00.00 GENERAL PRACTICE FOR APPLICATION / INSTALLATION SCHEME FOR FIRE STOP MORTAR SEAL & FIRE RETARDANT CABLE COATING COMPOUND.

1. Fire Barriers using Fire Stop Mortar Seal shall be installed at following locations. The thickness of Fire Barrier shall be such as to achieve 3 hr fire rating.

Control Room / Cable Vaults and in plant area.

- Panel bases in control room shall be sealed.
- All wall openings and floor openings in control room / cable vaults shall be sealed.
- All cable entry openings from trenches or overhead cable trays racks shall be sealed.

Trenches

- Barriers shall be installed inside the trenches at every intersection or Tee joints and bends at every 2 meters from center line of cable rack inside the trench.
- Barriers shall be installed at every 15 meters in straight runs of trenches.
- Fire Protective Coating shall be applied at following locations. The average thickness of the coating shall be 2 mm.

Control Room / Cable Vaults and in plant area.

- All vertical cables coming out below the panels shall be coated to a full length of vertical drop from bottom of panel plus 1.5 to 2.5 metres. Horizontal run after the bend.
- All vertical cable runs anywhere in the area are to be coated full.
- All horizontal cable runs to be coated for a length of 1.5 metres at an interval of every 2 to 3 metres. At bends / intersections and Tee joints, coating should be done 2 metres from center line of cable tray on each side.

Trenches

- All vertical cables coming down into the trenches from the equipment are to be coated full.
- At the intersection / joints / bends in the trenches all cables to be coated 2 mtrs from center line of the cable tray rack.
- All horizontal cable runs to be coated for a length of 3 mtrs in the center of every 15 mtrs i. e. at the center of two fire stop mortar seal barriers and in the same proportion if the distance is less than 15 mtrs and more than 6 mtrs.

NOTE : The above instructions are general and the application shall be carried out as per suitability to individual site condition to achieve maximum fire protection.

6.00.00 TYPE TESTS

The type tests to be carried out in presence of Owner's representative, as per latest applicable standards for Fire Stop Mortar Seal and Fire Retardant Cable Coating Compound for floor and wall opening / fire stop system for bottom of electrical switchgear / MCC / panel base are as under:

- Fire rating test.
- Hose Stream test.
- Accelerated aging test.
- Fire rating test on the MORTAR seal system built out of accelerated aged components followed by hose stream test.
- Temp. rise test for cable in the fire stop.
- Water absorption test followed by fire rating test.
- Flame Resistance test for fire retardant coating material./Modified Swedish Chimney Test.
- Anti-rodent test.
- Vibration test followed by fire rating test

6.01.00 TEST PROCEDURE FOR MODIFIED SWEDISH CHIMNEY TEST FOR CABLES COATED WITH FIRE RETARDANT CABLE COATING COMPOUND

The test determines the fire retardance and flame propagation properties for insulated cables under fire conditions under natural air draft.

6.01.01 TEST EQUIPMENT

The test equipment consists of a vertical steel tube (Chimney) fabricated from steel / GI sheet having nominal thickness 22 gauge (0.8 mm +/- 1.0 mm). The typical dimensions of chimney are:

- Internal Diameter – 125 +/- 5 mm
- Total Height of chimney – 800 mm

6.01.02 There are six rectangular openings for ventilation along vertical axis on the face of a circular chimney. The size of the opening is 60 mm vertically x 15 mm wide. The openings are equidistant from each other and separated by approx. 60 mm along the vertical axis.

6.01.02 A lid of steel of same diameter as that of the chimney and same steel sheet as that used for the chimney is fabricated with an arrangement for fixing the lid on the top of the chimney in such a way that it is possible to vary the gap between the lid and the chimney from 10 to 30 mm.

6.01.03 At the upper end of the chimney there is a suspension metal tie rod of approx. 10 mm dia. And 200 mm long to facilitate positioning of cable. The lower end of the cable specimen coated with fire retardant cable coating compound is tied to the chimney using a metal wire of max. 1mm dia so as to avoid deflection of the test specimen away from the centre of the fire source and centre of the chimney during the test.

6.01.04 LIMITATIONS

A single core cable having overall diameter up to 10 mm and multicore cable having overall diameter not exceeding 35 mm can be used.

6.01.05 FLAME SOURCE

One LPG Bunsen Burner capable of giving spreading vertical flame which can achieve required chimney calibration and operable by regular LPG supply cylinder.

6.01.06 BURNING TIME

The burning time for exposing the coated cable to fire in the chimney is determined using the following formula:

$T = K + D/5$

where,

T = Exposure time in minutes
K = 1 for cable with conductor cross sectional area less than 2.5 sq. mm.
= 2 for cable with conductor cross sectional area more than 2.5 sq. mm.
D = Overall diameter of the cable test specimen in mm

6.01.07 CALIBRATION

The calibration of the test equipment is done by adjusting –

- The distance between chimney and lid
- The gas flow rate to the burner

The temperature at the 6th window from the bottom of the chimney should be 250 +/- 5 deg. C at the end of 3 minutes from the time of positioning the burner under the chimney without test specimen.

6.01.08 TEST PROCEDURE

After calibration of the chimney, the position of the top lid of the chimney and the gas flow to the burner is kept unchanged.

The burner is removed and chimney is cooled to ambient temperature.

The test specimen of cable coated with fire retardant cable coating compound as per specification requirements is placed inside the chimney in such a way that the lower end of the specimen is 50 mm below the bottom end of the chimney. The top end of the specimen is flush to the top end of the chimney. The specimen is tied using metal rod at the top and metal wire at the bottom. The test specimen is exposed to the flame by placing the burner under the chimney for the exposure time determined by the formula above.

Three test specimen for each batch are exposed to the fire in the chimney one by one as per above procedure. Every specimen is allowed to cool and the damage to cable insulation is then measured from top of the specimen cable.

6.01.09 RESULT

The visible damage to the test specimen cable insulation shall not be more than 550 mm from the bottom exposed end of the specimen.

CHAPTER 26 : CABLING SYSTEM

1.00.00 SCOPE OF WORK

The scope of work covers supply, erection, testing and commissioning of complete electrical system including cabling,fire stop mortar seal, fire retardant cable coating system etc. the scope shall broadly cover, but not be limited to:

(a) Main power house building.

(b) Boiler area, ESP.

(c) Transformer yard.

(d) All auxiliary buildings (including electrical rooms of respective buildings) and structures as per details in the General electrical specification/ plot plan/ &related drawings.

(e) Coal handling plant.

(f) Ash handling plant including ash dyke

(g) Raw water system

(h) Fuel oil unloading & transfer system.

(i) Aux. power transformers

(j) Pipe cum cable rack.

(k) All electrical equipment as described in different sections.

(l) As built drawing for all above systems on completion of project.

The scope of work shall also include all civil and structural works necessary for successful installation, commissioning & commercial operation of all electrical equipment to be erected under this specification.

2.00.00 SCOPE OF SUPPLY

2.01.00 The equipments and materials within the scope of supply shall include but not limited to :-

i. Power & control cabling works (including that of special cables):

ii. Galvanized steel pre-fabricated cable trays, coupler plates, nuts, bolts & washers, reducers, covers, wall brackets, hanger clamps, straight run, elbows, bends, cable trays supporting structures etc.

iii. Supply and installation (including laying & termination) of control cables, special cables, instrumentation cables for all equipments and systems.

iv. Supply and installation (including laying & termination) of all power cables (HV and LV) of all power cables (HV and LV) for all equipments and systems.

v. Cable routing has to be planned such that it shall not cross the steam lines, oil lines.

vi. Fire Sealing Arrangement: All cable entries into the panel (HV & MV & LV SWGR panels) should be provided with fire sealing arrangements.

vii. Cable/cable tray openings in walls and floors or through pipe sleeves from one area to another or from one elevation to another within the unit shall be seated by a fire proof sealing system (FPSS). The FPSS shall effectively prevent the spread of fire from the flaming to non-flaming side of a fire.

viii. Galvanized steel rigid/ flexible conduits and accessories, ferrules, lugs, glands, terminal blocks, galvanized sheet steel junction boxes, cable fixing clamps, nuts & bolts etc as required.

ix. All necessary erection materials, consumables and sundry items including arc welding rods to complete the installation for satisfactory and trouble free operation.

x. Any item of works or erection materials which have not been specifically mentioned but are necessary to complete the work involved shall be deemed to be included in the scope of this specification and shall be furnished by the contractor without any extra charge to the purchaser.

3.00.00 CODES AND STANDARDS

All standards, specifications and codes of practice referred to herein shall be the latest editions including all applicable official amendments and revisions as on date of opening of bid. In case of conflict between this specification and those (IS codes, standards, etc.) referred to herein, the former shall prevail. All work shall be carried out as per the following standards/ codes as applicable.

IS:513	Cold rolled low carbon steel sheets and strips.
IS:1079	Hot Rolled carbon steel sheet & strips
IS:1239	Mild steel tubes, tubular and other wrought steel fittings
IS:1255	Code of practice for installation and maintenance of power cables upto and including 33 KV rating
IS:1367 Part-13	Technical supply conditions for threaded Steel fasteners. (Hot dip galvanized coatings on threaded fasteners).
IS:2147	Degree of protection provided by enclosures for low voltage switchgear and control gear
IS:9537	Conduits for electrical installation.
IS:9595	Metal – arc welding of carbon and carbon manganese steels - recommendations.
IS:13573	Joints and terminations for polymeric cables for working voltages from 3.3kv up to and including 33kv performance requirements and type tests.
IS:802	Code of practice for the use of Structural Steel in Overhead Transmission Line Towers.

IS:2309	Code o practice for the protection of building and allied structures against lighting.
IS:2629	Recommended practice for hot dip galvanising of iron & steel.
IS:2633	Method for testing uniformity of coating on zinc coated articles.
IS:6745	Method for determination of mass of zinc-coating on zinc coated iron & steel articles.
IS:8308	Compression type tubular in-line connectors for aluminium conductors of insulated class.
IS:8309	Compression type tubular terminal ends for aluminium conductors of inslated cables.
BS:476	Fire tests on building materials and structures
DIN 46267 (Part-II)	Non tension proof compression joints for Aluminium conductors.
DIN 46329	Cable lugs for compression connections, ring type ,for Aluminium conductors
VDE 0278	Tests on cable terminations and straight through joints
BS:6121	Specification for mechanical Cable glands for elastomers and plastic insulated cables.
	Indian Electricity Act.
	Indian Electricity Rules.

Equipment complying with other internationally accepted standards such as IEC, BS, DIN, USA, VDE etc. will also be considered if they ensure performance and constructional features equivalent or superior to standards listed above. In such a case, the Contractor shall clearly indicate the standard(s) adopted, furnish a copy in English of the latest revision of the standards along with copies of all official amendments and revisions in force as on date of opening of bid and shall clearly bring out the salient features for comparison.

4.00.00 DESIGN AND CONSTRUCTIONAL FEATURES

4.00.01 Inter Plant Cabling

4.01.00

Interplant cable routing will be on overhead cable trays on pipe cum cable trestle or only cable trestle except where approved by purchaser/consultant.

Major routes in boiler area to individual boiler drives, fly ash conveying compressor building, ESP building, CW pump house, Raw water pump house, DM plant, Filter water pump house, Clarified water pump house, Fly ash silo fluidizing blower house etc will be on overhead Cable trays either supported from available structures or on pipe cum cable trestle or on only cable trestle. Only in specific areas as will be approved by purchaser/consultant where number of cables are too small compared to the route length like Intake pump house & Ash dyke, cables may be directly buried underground with marker.

Overhead trestle will be provided to the extent possible. Cable route shall be provided in such a manner that movement of crane does not get restricted and also the cables are to be routed at a safe distance from hot pipes. Generally the bottom of steel supporting structure shall be at 6.5m above the grade level. Where rail/road crossing is involved the same shall be minimum at 8m above the grade level.

Individual shallow trench shall be routed from switchyard equipment to main switchyard trench which will be routed up to Switchyard control room. Interconnecting cables from Power House to Switchyard control room shall be routed through RCC trenches. From trenches to the switchyard equipments, all power and control cables shall be laid through PVC conduit.

Space for accommodating additional trays, which may come in future shall be provided in present cable route. Some trays may be required for use by the purchaser, which will be finalized during detail engineering stage. The successful bidder shall provide such trays without any extra cost to purchaser.

For Power supply to Raw Water Intake Pump house, Cable from powerhouse will run on overhead Cable trays up to Plant boundary. After that it will be buried cable that will follow the intake pipeline corridor.

For Power supply from Power House to Main CHP Substation Building and from Main CHP Substation Building to Crusher House & Pump House, Cable will run on overhead Cable trestles. Further, Cable shall be routed through the conveyor gallery / TPs / Crusher House by separate supporting structures and trench in the pump house.

4.02.00 Trenches

4.02.01 PCC flooring of built up trenches shall be sloped for effective drainage with sump pits and sump pumps.

4.02.02

4.02.03 All field switches for equipments corresponding to a stream located within a radius of 4-5 m shall be wired out to a field junction box and from field junction box to control panel/Input – Output cabinet by screened instrumentation cables.

4.02.04 For CHP following shall also be applicable:

a) All cable routes shall be overhead along the route of the conveyor gallery by separate supporting structures and cables shall be laid in vertical trays. The bottom of the steel shall be such that the existing facilities, movement of trucks/human beings etc. does not get affected. The cable trestle shall have a minimum 600 mm clear walk way and shall have maintenance platforms as required. The bottom of the steel supporting structure shall be generally at 6.5 M above the grade level except for rail/road crossings where it shall be at 8.0 M above grade level. However in bunker area the bottom of the cable trestle shall be 10 to 14 M depending on boiler/bunker layout.

b) Cable trenches shall be provided only in Switchgear/MCC rooms.

c) Cables shall not be routed through the conveyor galleries except for the equipment located in the conveyor galleries for a particular conveyor i.e. protection switches, receptacles etc.

d) Cables for Pull cord switches and belt sway switches shall be taken in cable trays. The trailing cables of the mobile machines shall also be laid in cable trays.

e) Two separate cable routes one on each side shall be provided for each boiler unit.cables for one set of auxiliaries such as ID,FD & PA fans & half of the coal mils shall be routed in one route & for through other set of auxiliaries through other route.

Cable trays in Boiler & ESP area shall be supported from the Boiler & ESP structure.The same shal be co-ordinated wih SG/ESP contractors

Cable trays in these areas shall be in vertical formation to avoid dust accumulation. No cable trenches shall be provided in Boiler/ESP area.

Contractor shall provide two independent routes for cables between ESP control room & ESP. Contractor shall provide the cable trays along with its supporting structure arrangement on the trestle.

f) **Turbine Hall Area:**

Two separate cable routes shall be provided for cable routing of working & standby drives or different sets/groups say 50% capacity) of auxiliaries.

g) **OffSite Area:**

In offsite area pumphouses, overhead cable tray arrangement shall be perferably followed.

h) **Cable Vault:**

Cable gallery (over ground) to be provided below each electrical control/switchgear room .

Cable vault of not less than 3 mts clear height from bottom of beam shall be provided.

Clear access passage of at least 750 mm wide & 2.0 Mts clear height shall be provided at entrances & along cable ways.Wherever the passage is through cable routes clear height shall not be less than 1.5 Mts.

Cable vaults shall be provided with adequate drainage facility for drainage of fire water.

Each cable vault should have two doors.

Exit signs shall be provided near doors for personnel escape in case of emergency.

5.00.00 EQUIPMENT DESCRIPTION

5.01.00 Cable trays, Fittings & Accessories

5.01.01 Cable trays shall be ladder/perforated type as specified complete with matching fittings (like brackets, elbows, bends, reducers, tees, crosses, etc.), accessories (like side coupler plates, etc.) and hardware (like bolts, nuts,

washers, G.I. strap, hook etc.) as required. Cable tray shall be ladder type for power & control cables and perforated for instrumentation cables.

5.01.02 These shall be either prefabricated hot dip galvanized sheet steel trays or site fabricated angle iron trays free from flaws such as laminations, rolling marks, pitting etc. These (including hardware) shall be hot dip galvanized as per relevant IS.

5.01.03 Cable trays shall have standard width of 600 mm, however trays with 450mm, 300mm and 150mm may be used in places considering the requirement and space constraint. and standard lengths of 2.5 metre. Minimum thickness of mild steel sheets used for fabrication of cable trays and fittings shall be 2 mm. The thickness of side coupler plates shall be minimum 3 mm.

5.01.04 Cable troughs shall be required for branching out few cables from main cable route. These shall be U-shaped, fabricated of mild steel sheets of minimum thickness 2 mm and shall be hot dip galvanized as per relevant IS. Troughs shall be standard width of 50 mm & 75 mm with depth of 25 mm.

5.01.05 Prefabricated hot dip galvanized sheet steel cable trays shall be used for maximum support span of maximum 1.25M for horizontally and 1.0M for vertically unless design is approved for larger span. Cable trays shall be suitable for a cable weight of 100 kg/meter running length of tray. Minimum thickness of sheet steel/galvanizing shall be 2mm/86 microns respectively. The amount of zinc deposit shall not be less than 610 gm per square meter.

In areas, where acid/alkalie ingration is likely to occur, glass reinforced plstic trays with fire retardant corrosion resistance properties shall be used.

5.01.06 Cable trays fabricated from standard rolled sections shall be 50x50x6/75x75x6 sections for runners for supporting spans limited to 2000 mm/more than 2000 mm respectively. Cross support shall be 32x6 mm / 50x6 flat for widths up to 500mm/more than 500mm respectively.

5.01.07 Separate coloured paint strips shall be applied for identification of different type of trays depending upon types of usage/applications/area as below:

High/ medium voltage cables: red strips, 2 inch width each, numbers
11kv/3.3kv equally spaced at 5 metres interval
1.1kv power cables : yellow strips ------- do -------
1.1kv control cables : blue strips ------- do -------
Instrumentation cables : green strips ------- do -------

5.02.00 Support System for Cable Trays

5.02.01 Cable tray support system shall be pre-fabricated similar or equivalent to "Unistrut make".

5.02.02 Support system for cable trays shall essentially comprise of the two components i.e. main support channel and cantilever arms. The main support channel shall be of two types: (i) C1:- having provision of supporting cable trays on one side and (ii) C2:-having provision of supporting cable trays on both sides. The support system shall be the type described hereunder:

a. Cable supporting steel work for cable racks/cables shall comprise of various channel sections, cantilever arms, various brackets, clamps, floor

plates, all hardware such as lock washers, hexagon nuts, hexagon head bolt, support hooks, stud nuts, hexagon head screw, channel nut, channel nut with springs, fixing studs, etc.

b. The system shall be designed such that it allows easy assembly at site by using bolting. All cable supporting steel work, hardware's fittings and accessories shall be prefabricated factory galvanised.
c. The main support and cantilever arms shall be fixed at site using necessary brackets, clamps, fittings, bolts, nuts and other hardware etc. to form various arrangements required to support the cable trays. Welding of the components shall not be allowed. However, welding of the bracket (to which the main support channel is bolted) to the overhead beams, structural steel, insert plates or reinforcement bars will be permitted. Any cutting or welding of the galvanized surface shall be brushed and red lead primer, oil primer & aluminium paint shall be applied.
d. All steel components, accessories, fittings and hardware shall be hot dip galvanized after completing welding, cutting, drilling and other machining operation.
e. The main support channel and cantilever arms shall be fabricated out of minimum 2.5 thick rolled steel sheets conforming to IS.
f. Cantilever arms of 300 mm, 600 mm and 750 mm in length are required. The arm portion shall be suitable for assembling the complete arm assembly on to component constructed of standard channel section. The back plate shall allow sufficient clearance for fixing bolt to be tightened with tray in position.
g. Cable trays in areas subjected to excessive coal dust or mechanical damage shall have hot dip galvanized sheet steel metal trays cover installed on front tray in vertical run and inverted 'V' type on upper tray in horizontal run with consideration for ventilation.

5.02.03 The size of structural steel members or thickness of sheet steel of main support channel and cantilever arms and other accessories as indicated above are indicative only. Nevertheless, the support system shall be designed by the contractor to fully meet the requirements of type tests as specified. In case the system fails in the tests, the components design modification shall be done by the Contractor without any additional cost. The contractor shall submit the detailed drawings of the system offered by him along with the bid.

5.03.00 Pipes, Fittings & Accessories

5.03.01 Pipes offered shall be complete with fittings and accessories (like tees, elbows, bends, check nuts, bushings, reducers, enlargers, coupling caps, nipples etc.) The size of the pipe shall be selected on the basis of maximum 40% fill criteria

5.03.02 GI Pipes shall be of medium duty as per IS: 1239.

5.03.03 The contractor shall provide and install all conduits, mild steel pipes, flexible conduits, rigid PVC pipes, etc. complete with accessories like tees, bends, adopters, locknuts, pull boxes, conduit plugs, caps, etc as required for the cabling work. Conduits shall be furnished in standard length of 5 metres, threaded at both ends.

5.03.04 Conduits diameter upto and including 25mm size shall be of 16 SWG and conduits above 25 mm diameter shall be of 14 SWG. Minimum diameter of conduits shall be 20 mm.

5.03.05 Conduits shall be made of hot-dip galvanized steel with an organic corrosion resistant ID coating. In chemical handling areas, battery room, etc., the exterior surface shall be further coated with chromate and polymer for better resistance to corrosion. Conduits, fittings & accessories shall have ISI mark.

5.03.06 For sizes above 63 mm, hot dip galvanized - both on inside and outside - steel pipes with necessary fittings & accessories shall be provided and installed by the contractor. The pipes and fittings shall be of heavy duty class with relevant ISI mark.

5.03.07 Flexible conduits complying to relevant IS and made with bright, cold_rolled, annealed and electro_galvanized mild steel strips shall be used between embedded conduits/pipes and the motor terminals. It shall also be used between fixed conduit and any equipment with vibration or equipment requiring regular removal.

5.03.08 Duct banks shall be High Density PE pipes encased in PCC (10% spare of each size, subject to minimum one) with suitable water-proof manholes.

5.04.00 Junction Boxes

5.04.01 Junction Boxes shall comprise of a case with hinged door constructed from cold rolled sheet steel of minimum thickness 2mm. Top of the boxes shall be arranged to slope towards rear of the box. Gland plate shall be 3 mm thick sheet steel with neoprene/synthetic rubber gaskets. All junction boxes shall be of adequate strength and rigidity, hot dip galvanised as per relevant IS, and suitable for mounting on wall, columns, structures etc. The boxes shall include brackets, bolts, nuts, screws M8 earthing stud etc. required for installation.

5.04.02 **Glass Fibre Reinforced Junction Boxes (for outdoor use)**

No. of Ways: 12/24/36/48 with 20% spares terminals.

5.04.03 Junction boxes shall be Glass Fibre Reinforced with saturated polyester conforming to standards like DIN 16911 type 803/16913 type 834, 5 self extinguishing in accordance with ASTM D635/UL 94 VO.

Junction boxes for use in outdoor or damp locations shall be sturdy construction. Temperature resistance shall be between – 10 to 100°C. Impact resistance shall be greater than 7 Nm, (EN 50014). Protective insulation shall be in line with VDE 0100, dielectric strength shall be greater than 10 KV/mm, halogen free toxicity, the enclosure and door cover shall be painted and electro statically power coated (preferably in RAL 7032). Earth connection (studs size shall be M 6) shall be provided on the cover as well as door.

5.04.04 Doors

With integrated viewing window of 3mm resistant plexi glass or equivalent. The doors shall be industrial heavy duty hinges. The doors shall be easily but firmly lockable with quick release fastener.

5.04.05 Protection Class

Protection Category shall be IP 66 to EN 60529. There shall be guaranteed perfect seal to meet Protection class IP 66 providing arrangement like highly elastic foamed in special type seal like polyurethane/chloroprene. The sealing

rubber shall not have aging effect and shall retain its sealing characteristics for more than 20 years. Contractor shall indicate this in data sheet. The rubber seal should be pasted at its place with pasting technology for like more than 20 years (double sealing arrangement is preferred).

5.04.06 **Mounting clamps and accessories**

Junction boxes shall be suitable for mounting on walls, columns and structure. Brackets, bolts, nuts, screws, glands and lugs required for erection shall be of brass. The accessories like mounting plates etc. of steel shall be powder coated. The support rails for terminal box shall be zinc coated.

5.04.07 General

- JBs shall have small canopy at the top.
- There shall be rainwater collection arrangement from top and side of the outer ages to ensure that any leakage into the junction box shall be avoided and it shall fall outside.
- Cable entry shall be from bottom side only.
- Ensure gland plate sealing perfect. It shall be of the same quality and arrangement as that of door to cover arrangement.

5.04.08 **Steel Junction Boxes (for indoor use)**

5.04.09 No. of Ways

12/24/36/48 with 20% spares terminals.

5.04.10 Junction boxes shall be designed in accordance with NEC, article 370, paragraph 18,19 & 20 or equivalent standards.

5.04.11 Enclosure

Junction boxes for use in outdoor or damp locations shall be sturdy steel construction. The enclosure and door cover shall be surface finished clean, degreased, phosphated, deep coated primed (preferably in RAL 7044) and electro-statically powder coated (preferably in RAL 7032). Earth connection (studs size shall be M6) shall be provided on the cover as well as door. The sheath steel thickness shall be more than 2 mm.

5.04.12 Doors
The doors shall be hinged and lockable. The doors shall have industrial heavy duty hinges. The doors shall be easily but firmly lockable with quick release fastener.

5.04.13 Protection Class

Protection Category shall be IP 66 to EN60529/1091 complies with NEMA 4. There shall be guaranteed perfect seal to meet Protection class IP 66 providing sealing arrangement like highly elastic foamed in special type seal like polyurethane. There shall be an arrangement like multifold protection channel for additional stability and prevention of ingress of dust and water when the enclosure is open.

The sealing rubber shall not have aging effect and shall retain its sealing characteristics for more than 20 years. Contractor shall indicate this in data

sheet. The rubber seal should be pasted at its place with pasting technology for like more than 20 years (double sealing arrangement is preferred).

5.04.14 Mounting clamps and accessories

The mounting clamps and accessories shall be suitable for mounting on walls, columns and structure. Brackets, bolts, nuts, screws, glands and lugs required for erection shall be of brass.

5.04.15 General

- JBs shall have small canopy at the top.
- There shall be rainwater collection arrangement from top and side of the outer ages to ensure that any leakage in to the junction box shall be avoided and it shall fall outside.
- Cable entry shall be from bottom side only.
- Ensure gland plate sealing perfect. It shall be of the same quality and arrangement as that of door to cover arrangement.

5.04.16 Junction boxes shall be provided with two nos. earthing terminals (externally available) suitable for connection of 8 SWG G.I. wire. Knockouts shall be provided at bottom and both sides. These shall be provided by fixing plates in order to make them detachable type with suitable neoprene gaskets. Bottom and side plates for cable/conduit connection shall be provided. All unused holes shall be sealed with suitable grommets.

5.04.17 Junction boxes shall be provided with external designation label. The label inscriptions shall be informed to the Contractor by the Owner. Junction boxes shall be provided with danger sign in case of 415V circuit.

5.04.18 Junction boxes shall be of two types, viz. One suitable for control cabling and the other suitable for power cabling.

Junction boxes for control cabling shall have 24 way/ 48 way terminal blocks suitable for up to 2.5 sq.mm. Cu. Cable. However, for instrumentation junction boxes there shall be 24/48 ways suitable for terminating cable of 0.5 sq.mm. Cu. Cable.

5.04.19 Junction boxes for power circuit cabling shall be suitable for 1 no. 3 core 16 sq.mm. Al. Incoming cable and 1 no. 3 core 2.5 sq.mm Cu. Outgoing cable.

5.05.00 Terminal blocks

Terminal blocks shall be 650 volts grade, rated for 10 Amps and in one piece, rigid, Bakelite moulded, with disconnecting /shorting link. It shall be complete with insulating barriers, Klip-on-type terminals and identification strips, terminal studs, washers, nuts, look nuts, marking strips etc.
Marking on terminal strip shall correspond to the terminal numbering on wiring diagrams. It shall be Elmex type CSLT-1 with insulating material of Melamine conforming to ESI Standard 12.1 or equivalent. Cage clamp type terminal block suitable for terminating 2 wires of 2.5 sq mm. on both sides arranged to facilitate easy termination shall be provided.

5.06.00 Terminations & Straight through Joints

5.06.01 Termination and jointing kits for 11/3.3 kV grade XLPE insulated cables shall be of proven design and make which have already been extensively used and type tested. Termination kits and jointing kits shall be pre-moulded type, taped type or heat shrinkable type. 11/3.3 kV grade joints and terminations shall be type tested as per IS: 13573. Critical components used in cable accessories shall be of tested and proven quality as per relevant product specification/ESI specification. Kit contents shall be supplied from the same source as were used for type testing. The kit shall be complete with the aluminium solder less crimping type cable lugs & ferrule as per DIN standard.

5.06.02 Straight through joint and termination shall be capable of withstanding the fault level for 11 kV and 3.3 kV systems.

5.06.03 1.1 KV grade straight through joints shall be of proven design.

5.07.00 Cable glands

5.07.01 Cable glands shall conform to BS: 6121 and be of robust construction capable of clamping cable and cable armour (for armoured cables) firmly without injury to insulation. Cable glands shall be made of heavy duty brass machine finished and nickel chrome plated. Thickness of plating shall not be less than 10 micron. All washers and hardware shall also be made of brass with nickel chrome plating Rubber components shall be of neoprene and of tested quality. Necessary cable dimensions shall be furnished to the successful contractor.

5.07.02 Cable glands shall be single compression for indoor use, double compression type for outdoor use. Glands for classified hazardous areas shall be double compression type flameproof and weather proof duly certified by CMRS and approved by CCE.Cable glands shall match with the sizes of different HT/LT/Control cables.

5.08.00 Cable lugs/ferrules

5.08.01 The cables lugs shall be conforming to IS: 8309.

5.08.02 Machine ferruling shall be adopted.

5.08.03 Cable lugs for power cables shall be Aluminium solder less crimping type suitable for aluminium compacted conductor cables.

5.08.04 The cable lugs for control/instrumentation/ telephone cables shall be provided with insulating sleeve and shall suit the type of terminals provided on the equipments.
Cable lugs shall be suitable for termination of different cross-sections of control/ instrumentation /telephone cables and shall be of following types.

i) Copper tubular terminal end for solder less crimping to copper conductors.
ii) Cable lugs for control cable termination shall be insulated type. These lugs shall be flat type/ring type/U type to suit the terminals provided in the pan
iii) Pin type lugs shall not used.
iv) Aluminium tubular terminal ends for solder less crimping of to Aluminium conductor.

Solder less crimping of terminals shall be done by using corrosion inhibiting compound. The cable lugs shall suit the type of terminals provided on the equipment. Lugs for control/instrumentation cables shall be PVC insulated/sleeved type.

5.09.00 Cable Clamps & Straps

5.09.01 The cable clamps required to clamp multicore cables on vertical run shall be made up of Aluminium strip of 25x3 mm size. For clamping the multicore cables, self-locking, de-interlocking type nylon clamps/straps shall be used. The clamps/straps shall have sufficient strength and shall not get affected by direct exposure to sun rays and outdoor environment.

5.09.02 Trefoil clamps for single core cables shall be pressure die cast aluminum or fibre glass or nylon and shall include necessary fixing accessories like G.I. nuts, bolts, washers, etc. Trefoil clamps shall have adequate mechanical strength to withstand the forces generated by the system short circuit current of 105 KA peak.

5.10.00 Galvanizing

5.10.01 Galvanizing of steel components and accessories shall conform to IS: 2629 & IS: 2633. Additionally galvanizing shall be uniform, clean smooth, continuous and free from acid spots

5.10.02 The amount of zinc deposit over threaded portion of bolts, nuts, screws and washers shall be as per IS: 1367. The removal of extra zinc on threaded portion of components shall be carefully done to ensure that the threads shall have the required zinc coating on them as specified.

5.11.00 Welding

5.11.01 The welding shall be carried out in accordance with IS: 9595. All welding procedures and welders qualification shall also be followed strictly in line with IS: 9595.

6.00.00 CONSUMABLES AND HARDWARE

i. The contractor shall furnish all erection matreials, hardware and consumables required to complete the installation.

ii. The materials shall include but not limited to the following:

iii. Consumables: Welding rods & gas, oil and grease, cleaning fluids, paints, electrical tape, soldering matreials etc.

iv. Hardware: Bolts, nuts, washers, screws, brackets, supports, clamps, hangers, saddles, cleats, sills, shims etc.

v. Supply of cement, sand, stone etc. required for the execution of the contract shall be the responsibility of the Contractor.

7.00.00 METHODS AND WORKMANSHIP

i. All work shall be installed in a first class, neat workmanlike manner by mechanics/electricians skilled in the trade involved.

ii. The erection work shall be supervised by competent supervisors holding relevant supervisory license from the government.

iii. All details on installtion shall be electrically and mechanically correct.

iv. The installation shall be carried out in such a manner as to preserve access to other equipment installed.

8.00.00 INSTALLATION

8.00.01 Cable tray and Support System Installation

08.01.01 Cables shall run in cable trays mounted horizontally or vertically on cable tray support system which in turn shall be supported from floor, ceiling, overhead structures, trestles, pipe racks, trenches or other building structures. All cable trays shall be in vertical configuration in boiler, CHP, AHP & ESP areas.

8.01.02 Horizontally running cable trays shall be clamped by bolting to cantilever arms and vertically running cable trays shall be bolted to main support channel by suitable bracket/clamps on both top and bottom side rails at an interval of 1500 mm. For vertical cable risers/shafts cable trays shall be supported at an interval of 1000 mm. Fixing of cable trays to cantilever arms or main support channel by welding shall not be accepted. Cable tray installation shall generally be carried out as per relevant Standard. The cantilever arms shall be positioned on the main support channel with a minimum vertical spacing of 300 mm unless otherwise indicated in the relevant approved tray layout drawings.

8.01.03 All cable way sections shall have identification, designations as per approved cable way layout as and painted/stenciled at each end of cable way and where there is a branch connection to another cable way. Minimum height of letter shall be not less than 75 mm. For long lengths of trays, the identification shall be painted at every 10 meter. Risers shall additionally be painted/ stenciled with identification numbers at every floor.

8.01.04 In certain cases it may be necessary to site fabricate portions of trays, supports and other non standard bends where the normal prefabricated trays, supports and accessories may not be suitable. In such cases the Contractor shall fabricate at site suitable sections of trays, supports and accessories to make the installation complete for the specific purpose after obtaining owner's prior approval, which shall be neat in appearance and shall match with the prefabricated sections in the dimensions. They shall be applied with one coat of red lead primer, one coat of oil primer followed by two finishing coats of aluminium paint.

9.00.00 Conduits/Pipes/Ducts Installation

9.01.00 The Contractor shall be fully responsible for properly embedding conduit pipe sleeves wherever necessary for cabling work. All openings in the floor/roof/wall / cable tunnel/cable trenches made for conduit installation shall be sealed and made water proof by the Contractor.

9.02.00 GI pull wire of adequate size shall be laid in all conduits before installation. Metallic conduit runs at termination shall have two lock nuts wherever required for junction boxes etc.

9.03.00 Conduit runs/sleeves shall be provided with PVC bushings having round edge at each end. All conduits/pipes shall have their ends closed by caps until cables are pulled. After cables are pulled, the ends of conduits/pipes shall be sealed with Glass wool/Cement Mortar/Putty to prevent entrance of moisture and foreign material.

9.04.00 Cable routing between lined cable trench and equipment/motors shall be taken through GI pipe sleeves of adequate size. Pipe sleeves shall be laid at an angle of maximum 150 to the trench wall. In case of larger dia cables i.e. 50mm and above, adequately sized pipe with larger bend radius shall be provided for ease of drawing of cable or for replacement. In places where it is not possible, a smaller trench may be provided if approved by Site Engineer.

9.05.00 Exposed conduit/pipe shall be adequately supported by racks, clamps, straps or by other approved means. Conduits /pipe support shall be installed square and true to line and grade with an average spacing between the supports as given below, unless specified otherwise

Conduit /pipe size (dia).	**Spacing**
Up to 40 mm	1 M
50 mm	2.0 M
65-85 mm	2.5 M
100 mm	3.0 M

9.06.00 In areas like WTP, chemical handling, battery room etc. exterior surface of the conduits shall be further coated with chromate or polymer for better resistance to corrosion.

9.07.00 All G.I. pipes shall be laid as per approved layout drawings and site requirements. Before fabrication of various profiles of pipe by hydraulically operated bending machine (which is to be arranged by the contractor), all the burrs from the pipes shall be removed. The bends formed shall be smooth. GI Pipes with bends shall be buried in oil/concrete in such way that that the bends shall be totally concealed. For GI pipes shall be undertaken well before paving is completed and necessary co-ordination with paving agency shall be the responsibility of Electrical Contractor. The open ends of pipes shall be suitably plugged with G.I. plugs after they are laid in final position. G.I. plugs shall be supplied by the contractor at no extra cost.

10.00.00 Junction Boxes Installation

10.01.00 Junction boxes shall be mounted at a height of 1200mm above floor level or as specified in the approved drawings or as decided by Owner and shall be adequately supported/mounted on masonry wall by means of anchor fasteners/ expandable bolts or shall be mounted on an angle, plate or other structural supports fixed to floor, wall, ceiling or equipment foundations.

11.00.00 Cable Laying and Installation

11.01.00 Cable network shall include power, control, lighting, communication and fire alarm system cables, which shall be laid in trenches, cables trays/conduits as detailed in the approved drawings and cable schedules. Erection of cable trays

and aligning and leveling as required shall be the responsibility of the contractor.

11.02.00 Cable installation shall be carried out as per IS: 1255 and other applicable standards. Cable drums shall be unloaded, handled and stored in an approved manner on hard and well drained surface so that they may not sink. In no case shall be drum be stored flat i.e. with flange horizontal. Rolling of drums shall be avoided as far as possible. For short distances, the drums may be rolled provided they are rolled slowly and in proper direction as marked on the drum. In absence of any indication, the drums may be rolled in the same direction as it was rolled during taking up the cables. For unreeling the cable, the drum shall be mounted on suitable jacks or on cable wheels and shall be rolled slowly so that cable comes out over the drum and not from below. All possible care shall be taken during unreeling and laying to avoid damage due to twist, kink or sharp bends. Cable ends shall be provided with sealed plastic caps to prevent damage and ingress of moisture.

11.03.00a. In outdoor areas, buried cables, wherever called for, shall be laid and covered with sand/riddled earth and protected from damage by bricks at sides and precast slab at top.

b. When buried cables cross road/railway track, additional protection shall be provided in the form of hume / galvanised iron pipes/RCC box culvert.

11.04.00 For coal handling plant the cables shall not be routed along conveyor galleries. The cables shall be routed on independent cable trestles.

11.05.00 All tray levels shall be checked after erection and marked in as built drawings. Cable routing given on the layout drawings shall be checked in the field to avoid interference with structures, heat sources, drains, piping, air-conditioning duct etc. and minor adjustments shall be done to suit the field conditions wherever deemed necessary. All tray runs shall be installed parallel to the trench/building walls and floors except otherwise noted in the approved drawings. The contractor shall have to secure rack/tray supports by welding to those inserts, suitable embedded steel inserts shall be provided. Outdoor trays shall be installed by welding on the steel/concrete structure with inserts by the contractor. As far as practicable, cable trays shall be supported from one side only in order to facilitate installation and maintenance of cables from the other side.

11.06.00 While laying cable, ground rollers shall be used at every 2 metre interval to avoid cable touching ground. The cables shall be pushed over the rollers by a gang of people positioned in between the rollers. Cables shall not be pulled from the end without having intermediate pushing arrangements. Pulling tension shall not exceed the values recommended by cable manufacturer. Selection of cable drums for each run shall be so planned so as to avoid using straight through joints. Care should be taken while laying the cables so as to avoid damage to cables.

11.07.00 All temporary ends of cables must be protected against dirt and moisture to prevent damage to the insulation. For this purpose, ends of all cables shall be tapped with an approved PVC or rubber insulating tape. Use of friction type or other fabric type tape is not permitted.

11.08.00 Cables installed above grade shall be run in trays, exposed on walls, ceilings or structures and shall be run parallel or at right angles to beams, walls columns. Cables shall be so routed that they will not be subjected to heat from adjacent hot piping or vessels.

12.00.00 Laying of cables in cable trays

12.01.00 Cables shall be laid on cable trays strictly in line with cable schedule furnished. Where specific cable layouts are not shown on approved drawings, contractor shall route these as directed by the Owner.

12.02.00 Power and control cables shall be laid on separate tiers. The laying of different voltage grade cables shall be on different tiers according to the voltage grade of the cables. In horizontal tray stacks, H.V. cables shall be laid on topmost tier and cables of subsequent lower voltage grades on lower tiers of trays. Single core cable in trefoil formation shall be laid with a distance of four times the diameter of cable between trefoil center lines and clamped at every two metre. All multicore cables shall be laid in touching formation. LT power cables above 95 sq.mm size shall be laid in single layer touching formation in trays while cables upto & including 95 sq.mm shall be laid in maximum of 2 layers. Control and Instrumentation cables can be laid upto a maximum of three layers in each tray.

12.02.00 All communication cables (telephone, P.A. System) RTD Cables shall run on instrument trays/ducts/trenches. Wherever these are not available, cables shall be taken in a separate trench/trays with a minimum clearance of 600mm away from electrical trench/trays as per the direction of Site Engineer and Communication cables shall cross power cables at right angles

12.03.00 Power and control cables shall be secured fixed to trays/support with self locking type nylon cable straps with de-interlocking facilities. For horizontal trays arrangements, multicore power cables and control cables shall be secured at every five meter interval. For vertical tray arrangement, individual multicore power cables and control cables shall be secured at every one meter by nylon cable strap. After completion of cable laying work in the particular vertical tray, all the control cables shall be binded to trays/supports by aluminium strips at every five meter interval and at every bend.

12.04.00 Bending radii for cables shall be as per manufacturer's recommendations and IS: 1255.

12.05.00 Individual cables or small groups which run along structures/walls etc will be clamped by means of 16 SWG GI saddles on 25x6mm saddle bars. The cost of saddle and saddle bars shall be deemed to have been included in the installation of cables. Alternatively small group of cables can be taken through 100mm slotted channel/ISMC 100.They shall be rightly supported on structural steel and masonry, individual or in groups as required, if drilling of steel must be drilled where the minimum weakening of the structure will result.

12.06.00 Cables shall be supported so as to prevent unsightly sagging. In general distance between supports shall be approximately 300mm for cables upto 25mm diameter and maximum 500mm for cables larger than 25mm dia and

cables laid in vertical run of cable trays shall be clamped at an interval of 900mm.

12.07.00 Where cables cross roads/rail tracks, the cables shall be laid in Hume pipe/PVC pipe. At road crossing and other places where cables enter pipe sleeves adequate bed of sand shall be given so that the cables do not slack and get damaged by pipe ends.the hume pipes shall be laid at a depth of minimum 1000mm such that cables are not damaged.

12.08.00 Power and Control Cables, as far as possible, shall be laid in complete, uncut lengths from one termination to the other. Straight through joints in power cable shall be allowed only in nearest of rare situation only after approval of owner.

12.09.00 Joints for less than 250 Meters run of cable shall not be permitted.

12.10.00 In each cable run some extra length shall be kept at suitable point to enable one LV/two HV straight through joints to made, should the cable develop fault at a later stage. Control cable termination inside equipment enclosure shall have sufficient lengths so that shifting of termination in terminal blocks can be done without requiring any splicing.

12.11.00 Wherever few cables are branching out from main trunk route troughs shall be used.

12.12.00 Cables shall be neatly arranged in the trays in such a manner so that criss-crossing is avoided and final take off to the motor/switchgear is facilitated. Arrangement of cables within the trays shall be the responsibility of the contractor.

12.13.00 The contractor shall ascertain the exact requirement of cable for a particular feeder by measuring at site and avoiding interference with structure, foundation, pipelines or any other works. Before the start of cable laying, cable drum schedule shall be prepared by electrical contractor and get that approved by site engineer to minimize/avoid straight through joints. The actual number of straight through joints required shall be worked out by the contractor. During the erection period the contractor shall furnish a monthly report on cable position in an approved proforma so as to keep the owner appraised of the position.

12.14.00 The installation work shall be carried out in a neat workman like manner & areas of work shall be cleaned of all scraps, water, etc. after the completion of work in each area every day. Contractor shall replace RCC/Steel trench covers after the Installation work in that particular area is completed or when further work is not likely to be taken up for some time.

12.15.00 Electrical cable trays exposed to hazardous process fluid shall be covered with detachable G.I. covers. The covers shall be suitable to resist wind forces.

For cables laid above ground in cable racks, asbestos sheeting of 3mm thickness shall be provided below the bottom cable tray to protect the cables from fire.

12.16.00 Supporting steel shall be painted before laying of cables. The painting shall be done with one coat of red lead paint and two coats of approved bituminous aluminium paint unless otherwise specified.

12.17.00 Separation

Sufficient spacing not less than 300mm shall be provided between different tiers of trays and maintained to permit adequate access for installation and maintenance of cables.

At least 300mm clearance shall be provided between :
- HV power & LV power cables,
- LV power & LV control/instrumentation cables,

12.19.00 Segregation
Segregation means physical isolation to prevent fire jumping.

Cables from two different services viz. supply from Station Board and Unit Board shall be segregated.

Interplant cables of station auxiliaries and unit critical drives shall be segregated in such a way that not more than half of the drives are lost in case of single incident of fire. Power and control cables for AC drives and corresponding emergency AC or DC drives shall be laid in segregated routes. Cable routes for one set of auxiliaries of same unit shall be segregated from the other set.

For Coal Handling Plant all the cables of one stream shall be segregated from the cables of the other stream and shall run on either side of the trestle.

13.00.00 Cable fire sealing

13.01.00 Cable/cable tray openings in walls and floors or through pipe sleeves from one area to another or from one elevation to another within the unit shall be seated by a fire proof sealing system (FPSS). The FPSS shall effectively prevent the spread of fire from the flaming to non-flaming side of a fire.

13.02.00 Wherever the cables/cable trays pass through walls/floors, fire proof cable penetration seals rated for one-twenty (120) minutes shall be provided. This shall be by suitable block system using individual blocks with suitable framework or by silicon RTV foaming system. In case foaming system is offered, damming board, if used, shall not be considered for fire rating criteria. Any of the system offered shall be of proven type as per BS: 476 (Part-20) or equivalent standard.

13.03.00 In order to prevent fire propagation through cable penetrations, after laying, dressing & clamping of cables, all the openings shall be properly sealed by using Fire Stop Mortar Seal and Fire Retardant Cable coating compound. Also the cable runs both before and after the fire scale shall be suitably sprayed with anti-fire propagation liquid.

14.00.00 Cable laying in trenches

14.01.00 RCC cable trenches with removable covers will be provided by the contractor. Cables shall be laid in 3 or 4 tires in these trenches. Concrete cable trenches shall be filled with sand where specified to avoid accumulation of hazardous gases. RCC covers of trenches in process area shall be effectively sealed to avoid ingress of chemicals etc. Removal of concrete covers for purposes of

cable laying and reinstating them in their proper positions after the cables are laid shall be done by the contractor at no extra cost.

14.02.00 For cable trays are laid in trench in more than two tiers a space of minimum 600 mm shall be available for maintenance. In case two or more tiers of cable trays are running parallel along both sides of trench walls there shall be space of minimum 600 mm between them.

14.03.00 Cables shall be handled carefully during installation to prevent mechanical injury to the cables. Ends of cable leaving trenches shall be coiled and provided with a protective pipe or cover tilt such times the final termination to the equipment is completed.

14.04.00 Prior to laying of cables inside both indoor and outdoor trenches, the contractor shall properly clean inside of those trenches.

14.05.00 When cables are laid in multiple tiers, spacing between individual tiers shall be as approved by Site Engineer. Space between individual tiers shall be filled and compacted with soil and sand.

14.06.00 As each row of cables is laid in place and before covering with sand every cable shall be given on insulation test in the presence of Site Engineer. Any cable, which proves defective, shall be replaced before the next groups of cables are laid.

14.07.00 All wall openings/pipe sleeves shall be effectively sealed after installation of cables to avoid seepage of water inside building/lined trench.

14.08.00 Where cables rise from trenches to motor, control station, lighting panels etc., they shall be taken in G.I. Pipes for mechanical protection up to a minimum of 150mm above grade.

14.09.00 Cable ends shall be carefully pulled through the conduit, to prevent damage to these cables. Where required, approved cable lubricant shall be used for this purpose. Where cable enters conduit the cable should be bent in large radius. Radius shall not be less than the recommended bending radius of the cables specified by the manufacturer.

Following guide of the pipe fill shall be used for sizing the pipe size:

a) 1 cable in pipe - 53% full
b) 2 cables in pipe - 51% full
c) 3 or more cables - 43% full
d) Multiple cables - 40% full

After the cables are installed and all testing is complete, conduit ends above grade shall be plugged with a suitable weatherproof plastic compound/'PUTTI' for sealing purpose. Alternatively G.I. Lids or PVC bushes shall be employed for sealing purposes. The cost for the same shall be deemed to have been included in the installation of G.I. pipe and no separate payment shall be allowed.

14.10.00 Where cables pass through foundation walls or other underground structures, the necessary ducts or openings will be provided in advance for the same. However, should it become necessary to cut holes in existing foundations or

structures, the electrical contractor shall determine their location and obtain approval of the Site Engineer before cutting is done.

15.00.00 CABLE IDENTIFICATION

15.01.00 Cable tags shall be provided on all cables at each end (just before entering the equipment enclosure), on both sides of a wall or floor crossing, on each duct/conduit entry & exit, and at every 20 meters in cable tray/trench runs. Cable tags shall also be provided inside the switchgear, motor control centers, control and relay panels etc. where a number of cables enter together through a gland plate. Cable tag shall be of rectangular shape for power cables and control cables. Cable tag shall be of 2 mm thick aluminum with number punched on it and securely attached to the cable by not less than two turns of 20 SWG GI wire conforming to IS:280. Alternatively, the Contractor may also provide cable tags made of nylon, cable marking ties of 'TY-CAB' or equivalent type with cable number heat stamped on the cable tags.

15.02.00 For laying of underground cable (applicable for Raw Water Intake Switchgear & Ash dyke) shall be provided with identity tags of Stain less steel securely fastened every 30 M of its underground length with at least one tag at each end before the cable enters the ground. In unpaved areas cable trenches shall be identified by means of markers. These posts shall be placed at location of changes in the direction of cables and at intervals of not more than 30 M for straight run and at cable joint locations with additional inscription `Cable Joint'. For buried cables the marker shall project 150mm above ground.

15.03.00 Drum number of each cable from which it is taken shall be recorded against the cable number in the cable schedule.

16.00.00 CABLE TERMINATIONS & CONNECTIONS

16.01.00 The termination and connection of cables shall be done strictly in accordance with cable termination kit manufacturer'' instructions, drawings and/or as directed by Site Engineer. Cable jointer shall be qualified to carryout satisfactory cable jointing/termination. Contractor shall furnish for review documentary evidence/experience reports of the jointers to be deployed at site.

16.02.00 Work shall include all clamps, fittings etc. and clamping, fitting, fixing, plumbing, soldering, drilling, cutting, taping, preparation of cable end, crimping of lug, insulated sleeving over control cable lugs, heat shrinking (where applicable), connecting to cable terminal, shorting and grounding as required to complete the job to the satisfaction of the Site Engineer.

16.03.00 Responsibility of proper termination shall lie on the contractor. Guarantee for termination shall also have to be given by the contractor.

16.04.00 The equipment will be generally provided with undrilled gland plates for cables/conduit entry. The Contractor shall be responsible for punching of gland plates, painting and touching up. Holes shall not be made by gas cutting. The holes shall be true in shape. All cable entry points shall be sealed and made vermin and dust proof. Unused openings shall be effectively sealed by 2mm thick aluminium sheets.

16.05.00 Contractor shall drill holes for fixing glands wherever necessary at no extra cost. Gland plate shall be of non-magnetic material/aluminium sheet in case of single core cables. If the cable end box or terminal chamber provided on the equipment is found unsuitable and requires major modifications the same shall be carried out by the contractor at the discretion of the Engineer- in-Charge.

16.06.00 Control cable cores entering control panel/switchgear/MCC/miscellaneous panels shall be neatly bunched, clamped and tied with self locking type nylon cable ties with de interlocking facility to keep them in position.

16.07.00 The panels where a larger number of cables are to be terminated and cable identification may be difficult, each core ferrule shall include the complete cable number. The ferrules shall be indelible interlocking type and shall fit tightly on cores. Spare cores shall have similarly ferrules with a suffix letter 'S' alongwith cable numbers and coiled up after end sealing.

16.08.00 All cable terminations shall be appropriately tightened to ensure secure and reliable connections.

16.09.00 It is the responsibility of the Contractor to terminate the cables at motor terminals in correct phase sequence to ensure the proper direction of rotation.

16.10.00 All cables upto 1.1KV grade shall be terminated at the equipments by means of compression type cable glands. They shall have a screwed nipple with conduit electrical threads and check nut.

16.11.00 All cable entries shall be through bottom only and top entry terminations are made only after getting approval of Site Engineer.

16.12.00 Power cables, wherever colour coding is not available, shall be identified with red, yellow and blue PVC tapes. Where copper to aluminium connections is made, necessary bimetallic washers shall be used. For trip circuit identification additional red ferrules shall be used only in the particular cores of control cables at the termination points in the Switchgear/Control panels and Control Switches.

16.13.00 In case of control cables all cores shall be identified at both ends by their terminal numbers by means of PVC ferrules. Wire numbers shall be as per schematic/ wiring/ inter-connection diagram. Contractors shall have the samples of PVC markers approved before starting the work. All unused spare cores of control cables shall be neatly bunched and ferruled with cable tag at both ends. Control cables shall be neatly bunched and served with PVC perforated tape to keep it in position at the terminal block.

16.14.00 Where threaded cable gland is screwed into threaded opening of different size, suitable brass threaded reducing bushing shall be used provided.

16.15.00 The cable shall be taken through glands inside the panels or any other electrical equipment such as motors. The individual cores shall then be dressed and taken along the cable ways (if provided) or shall be fixed to the panels with polyethylene straps. Only control cables of single strand and lighting cables may be directly terminated on to the terminals.

In case of termination of cables at the bottom of a panel over a cable trench having no access from the bottom, close fit hole should be drilled in the bottom plate for all the cables in one line, and then bottom plate should be split in two parts along the centre line of holes. After installation of bottom plate and cables it should be sealed with cold setting compound. Cables shall be clamped over the open armouring to connect it to earth bus.

16.16.00 Cable leads shall be terminated at the equipment terminals by means of crimped type solder less connectors.

Crimping shall be done by hand crimping/hydraulically-operated tool and conducting jelly shall be applied on the conductor.

Insulation of the leads should be removed immediately before the crimping. Conductor surface shall be cleaned and shall not be left open.

16.17.00 Termination and connection shall be carried out in such a manner as to avoid strain on the terminals.

16.18.00 All cable entry points shall be properly sealed and made dust and vermin proof. Unusual opening, if any, shall be effectively closed. Sealing work shall be carried out with approved sealing compound having fire withstand capability for at least one-twenty (120) minutes.

17.00.00 Cable accessories for H.V. Systems

17.01.00 The H.V. cables terminations/joints shall be done by skilled and experienced jointers duly approved by the Site Engineer.

17.02.00 The termination and straight through joint kits for use on high voltage system shall be suitable for the type of cables offered by the contractor or the type of cables issued by owner for installation. The materials required for termination and straight through joints shall be supplied in kit form. The kit shall include all insulating and sealing materials apart from conductor fittings and consumable items. An installation instruction shall be included in each kid.

17.03.00 The termination kits shall be suitable for termination of the cables to an indoor switchgear or to a weatherproof cable box of an outdoor mounted transformer/motor. The termination kits shall preferably be as of the following types.

a. 'PUSH ON' type for LV cables.
b. Heat-shrinkable sleeve type for LV & HV cables.

However, termination kits for HV cables shall be of Heat Shrinkable type of makes with specific approval of owner.

For outdoor installations, weather shields/sealing ends and any other accessories required shall also form part of the kit.

17.04.00 The straight through jointing kits shall be suitable for underground buried installation with uncontrolled backfill and possibility of flooding by water. The jointing kit shall be one of the following types.

a. 'TAPEX' of M-seal make or equivalent for LV cables
b. Heat-shrinkable sleeve type for LV & HV cables.

However, termination kits for HV cables shall be of Heat Shrinkable type of makes with specific approval of owner.

For outdoor installations, weather shields/sealing ends and any other accessories required shall also form part of the kit.

18.00.00 EXCAVATION AND BACK FILLING

18.01.00 The contractor shall perform all excavations and backfilling as required for buried cable and ground connections.

18.02.00 Excavation shall be performed up to the required depth. Such sheeting and shoring shall be done as may be necessary for protection of the work.

18.03.00 The contractor shall make use of his own arrangement for pumping out any water that may be accumulated in the excavation.

18.04.00 All excavation shall be backfilled to the original level with good consolidation.

19.00.00 CLEANING UP OF WORK SITE

19.01.00 The Contractor shall, from time to time, remove all rubbish resulating from execution of his work.No materilas shall be stored or placed on passage or drive ways.

19.02.00 Upon completion of work, the contractor shall remove all rubbish, tools, scaffoldings, temporary structures and surplus materials etc. to leave the premises clean and fit for use.

20.00.00 QUALITY ASSURANCE PROGRAMME

20.01.00 Contractor shall furnish detailed Quality Assurance Programme and Quality Plans for all materials and accessories to be supplied and installed under the scope of the specification as per General Technical Conditions of technical specification. The Quality Plans shall include all tests/ checks as per relevant National/International Standards and the requirements of this specification including tests listed in this section.

21.00.00 TESTS

21.01.01 Type tests on Cable Trays support system

A) Test 1A:
On main support channel type-C2 for cantilever arms fixed on one side only. A 3.5 metre length of main support channel shall be fixed vertically at each end to a rigid structure as per appropriate fixing arrangement. Eight (8) nos. 750 mm cantilever arms shall be fixed to the main channel and each arm shall be loaded over the outboard 600 mm with a uniform working load of 100 kg. Subsequently a point load of 100 kg shall be applied on arm 2. A uniform proof load on all the arms equal to twice the working load shall be then be applied. Deflections shall be measured at the following load intervals and other necessary points:

i) Working load

ii) Working load + point load
iii) Off load
iv) Proof load + point load
v) Off load

The deflection measured at working loads shall not exceed 16 mm. The permanent deflection after removing the combination of working load and point load shall not exceed 10 mm at the arm tips and 6 mm on the channel. No collapse of the structure shall occur with a combination of proof load and point load applied.

B) Test 1B:

Test 1A shall be repeated with Eight Cantilever arms uniformly loaded and with the same point load on arm 2

Test 2: On Main support channel type -C2 for cantilever arms fixed on both sides

a)Test 2A: A 3.5 m length of main support channel C2 for cantilever arms fixing on both sides shall be fixed at each end to rigid structure as per appropriate fixing arrangement. Six (6), 750 mm cantilever arms shall be attached to each sides and each arm uniformly loaded to a working load of 100 kg over the out board 600 mm. A point load of 100 kg shall than be applied to arm 2, followed by a uniform proof load of twice the working load on all the arms; deflection shall be measured at the following load intervals and other necessary points.

i) Working load
ii) Working load + Point load
iii) Off load
iv) Proof load + Point load
v) Off load

The deflection measured at working loads shall not exceed 16mm. The permanent deflection after removing the combination of working load and point load shall not exceed 10 mm at the arm tips and 6 mm on the channel. No collapse of the structure shall occur with a combination of proof load and point load applied

b) Test 2B: The test 2 A shall be repeated with the assembly but with an asymmetrical load on the C2 column and point load applied to arm 8. The 100 kg and 200 kg uniformly distributed loads shall be applied to the upper three arms on one side and the lower three arms on the opposite side.

Test 3:

A length of main support channel section shall be fixed to steel structure/floor and have loads applied as detailed below and other important points not mentioned herein.

a) **Test 3A :** A length of steel structure shall be rigidly supported. It should be fitted on a metre length of channel section using beam clamps welded/bolted. A point load of 1200 kg shall be applied to the centre point via two brackets. No distortion or pulling of the components shall take place.

b) **Test 3B:** With the components assembled as in Test 3A, two perpendicular point loads of 600 kg shall be simultaneously applied at positions 150 mm either side of the centre line, no distortion or pulling of the components shall take place.

c) **Test 3C:** With the components assembled as in Test 3A, a perpendicular point load shall be applied at a point 150 mm on one side of the centre line.
The load shall be gradually increased to the maximum value that can be applied without causing distortion or pulling of the components. This value shall be recorded.

Test 4 Channel nut slip characteristics (what ever applicable)

Tests 4A1, 4A2, 4A3:
A length of channel C1 section 200 mm long shall have fitted bracket with the two bolts fixing.

With loads applied at the appropriate position nut slip shall be determined with bolt torque of 30 NM, 50 NM and 65 NM No fewer than three measurements shall be made or each torque setting.

A minimum loading of 720 kg shall be obtained before nut slip with bolt torque of 65 NM.

Tests 4B1, 4B2, 4B3:

The length of channel C1 section 200 mm long shall have fitted bracket with the one bolt fixing. With loads applied at the appropriate position, nut slip shall be determined with bolt torques of 30 NM, 50 NM and 65 NM. No fewer than three measurements shall be made for each torque setting.
A minimum loading of 350 kg shall be obtained before nut slip with a bolt torque of 65 NM

Test 5 Weld Integrity Test
After deflection test as per test 1A, 1B, 2, 3 & 4 weld integrity shall be checked by magnetic particle inspection to detect sub-surface cracks developed, if any.

Cable termination kit and straight through joints should have been tested as per IS: 13573 for 3.3kV and 11kV class.

Fire proof Cable Penetration system should have been tested for the following tests:
a) Accelerated Ageing test
b) Water absorption test
c) Fire rating test
d) Hose Stream test
e) Vibration test followed by fire rating test

21.02.00 Routine/ Acceptance Tests

Following routine/acceptance tests shall be carried out on all the equipments, devices & materials supplied:

22.00.00 Galvanizing Tests

The quality of galvanizing shall be inspected visually and shall be smooth, continuous, and free from flux stains.

i) Uniformity of coating – The coating of any article shall withstand four 1 minute dips in standard copper sulphate solution without the formation of an adherent red spot of metallic copper upon the basic metal.

ii) The quality of cadmium/zinc plating on items with screw threads shall be inspected visually and shall be free from visible defects such as unplanted areas, blisters and modules.

iii) In addition, the plating thickness shall be determined microscopically/chemically or electronically.

23.00.00 Welding

The quality of welding shall be visually inspected, particular attention being paid to the following points.

1) The welded joints shall be continuous along its length on both sides and of uniform width and thickness. It should be free from blow holes.

2). The weld metal shall be properly fused with the parent metal without undercutting.

3) The outside surface of the weld shall be clean. All slag shall have been removed. All welding shall be regularly checked for cracking using magnetic particle inspection or their equivalent technique.

1. Physical and dimensional checks for all items.
2. All conduits/pipes, etc. shall be routine/acceptance tested as per relevant standards.
3. All acceptance and routine tests on cable glands as for BS: 6121. Additionally Proof torque test shall be carried out as acceptance on each body group of cable glands.
4. Deflection test cable trays.
5. All acceptance and routine tests on Junction boxes.
6. Following tests shall also be carried out on each type of equipments, devices and materials/items supplied:
   i) Physical and Dimensional checks
   ii) Check/measurement of thickness for Nickel chrome plating for cable glands and tinning for cable lugs.
   iii) Check chemical composition of brass parts for cable glands.
   iv) Hardness check on gaskets.
   v) Test for uniformity of galvanization.

24.00.00 Cable trays / supports and accessories

1) Check for proper galvanizing/painting and identification number of the cable trays/supports and accessories.
2) Check for continuity of cable trays over the entire route.
3) Check that all sharp corners, burrs, and waste materials have been removed from the trays supports.
4) Check for earth continuity and earth connection of cable trays.

CHAPTER 27 : ILLUMINATION SYSTEM

1.00.00 SCOPE OF WORK

1.01.00 This scope of work shall cover the design, manufacture, assembly, testing at manufacturer's works, supply & delivery, properly packed for transport F.O.R. site of POWER PLANT INDOOR AND OUTDOOR LIGHTING SYSTEM, complete with all materials and accessories for efficient and trouble-free operation.

1.02.00 The scope of work shall include complete installation, testing, commissioning and putting into successful commercial operation of the Lighting System of Power House, Mill building, Transformer Yard and all areas covered under power plant EPC package. This includes the supply of all labor, tools, implements and supplies.

1.03.00 The major areas to be illuminated under the scope of this package are listed in Annexure-4. The areas listed are however indicative only for the purpose of guidance to the bidder and is subject to change during detail engineering after finalization of plant layouts.

2.00.00 SCOPE OF SUPPLY

2.01.00 The equipment and materials within the scope of supply shall include but not limited to:

i. Lighting transformer.

ii. Lighting fixtures with lamps and accessories and LED type fixtures for main roads, secondary roads, secondary roads & perimeter compound lighting.

iii. Lighting panels/boards: Main lighting distribution boards, emergency lighting distribution boards, emergency DC lighting panels, lighting panels, street lighting panels etc. All panels shall be provided with Energy Saving System.

iv. Street lighting poles, flood lighting towers and high masts.

v. Ceiling fans, pedestal fans, receptacles, switches, switchboards, portable emergency lighting unit, portable 24V supply module including handset maintenance equipment etc.

vi. Cables, wires, splicing/termination kits/connection accessories.

vii. Conduit and accessories, junction and pull boxes, terminal blocks.

viii. Grounding materials and connections.

ix. All fittings, supports, brackets, anchors, clamps and connections.

x. Steel for field fabrication of supports and brackets.

xi. Datasheet and technical leaflets on each of equipments / devices.

3.00.00 SCOPE OF SERVICE

i. Carrying out of detail engineering including detail design calculations, preparation of lighting layouts showing location of fixtures, cable wires and conduit, preparation of cable schedule, and other related drawings as detailed in subsequent clauses and also consider the Energy Saving System.

ii. Furnishing of all labour (skilled and unskilled), supervisory personnel, erection tools and tackles, testing equipment, implements, supplies, consumables & hardware and transport for timely and efficient execution of the contract work.

iii. Preparation of **AS-BUILT** drawings showing field modifications, if any.

4.00.00 CODES AND STANDARDS

4.01.00 The design, manufacture and testing of equipment shall be carried out as per the latest Indian/International Standards, Indian Electricity Rules, Relevant Code of Practices and requirements of Govt. of Uttar Pradesh

4.02.00 All standards and codes of practice referred to herein shall be the latest edition including all applicable official amendments & revisions as on date of bid opening. In case of conflict between this specification and those (IS codes, standards etc.) referred to herein, the former shall prevail. All work shall be carried out as per the following standards & codes.

4.03.00 Lighting Fixtures and Accessories

IS: 1913 General and safety requirements for luminairies.

IS: 2148 Flame proof enclosures of electrical apparatus.

4.04.00 Lighting Panels, Switch-boxes, Receptacles and Junction Boxes

IS:2147 Degree of protection provided by enclosures for low-voltage switchgear and control gear.

4.05.00 Electrical Installation Practices & Miscellaneous

IS: 1944 Code of practice for lighting of public thorough fare

IS: 3646 Code of practice for interior illumination.

IS: 5572 Classification of Hazardous areas (other than Mines) having flammable gases and Vapours for electrical installation

IS: 6665 Code of practice for industrial lighting.
National Electrical Code
Indian Electricity Rules.
Indian Electricity Act

5.00.00 DESIGN CRITERIA

5.01.00 The system provides lighting and electric power supply to all plant areas covering both BTG and BOP. In addition, it also provides lighting to selected areas during plant emergency conditions.

5.02.00 The system will be installed in an adverse industrial environment. Equipment in some areas will be subject to vibration, coal-dust and oil / water vapours as prevalent in a thermal power generating plant.

5.03.00 The design shall be such as to provide minimum lighting levels & lighting fixtures for different areas as per Annexure.

The systems shall be suitable for operation on available power supply having characteristics as given in Annexure.

All fittings of control room/office shall be energy efficient type.

6.00.00 SYSTEM CONCEPT

The lighting system shall comprise of following sub-systems:-

6.01.00 Normal A.C. Lighting

This will be provided by A.C. lighting fixtures distributed throughout the plant. These lights will be ON as long as the A.C. supply is available.

A.C. lighting fixtures will be fed from respective area lighting panels, which in turn will be connected to main lighting distribution board. The main lighting distribution boards will be fed through respective unit ratio lighting transformer, which forms a part of the MLDB. Normal A.C. supply thus made available by the MLDB is 415V-3ph-4W-50HZ effectively grounded. Both the MLDB and the lighting panels shall be provided with at least 20% spare outlets.

6.02.00 Normal cum Emergency A.C. Lighting

Emergency A.C. lighting will be provided in selected areas of the powerhouse, boiler area, boiler galleries, in some selected areas close to the power house, Control room, DG set control room switchgear room etc. for general visibility, safe movements and operation of important auxiliaries.

The emergency LDBs (ELDB) are similar to the MLDB except that lighting transformers in this case are fed from station A.C. Emergency bus having D.G. System backup. Thus power for A.C. emergency lighting is 415V-3ph-4W, 50HZ, effectively grounded.

The lighting fixtures connected to this system will be available whenever normal supply is available in the plant and also when DG set supplies power to 415V A.C emergency bus.

At least 25% of the fixtures shall be fed from AC emergency source.

6.03.00 Emergency D.C. Lighting

During station emergency involving total AC failure, incandescent lamp A.C/ DC lighting fixtures shall be provided for movement of personnel in important areas/buildings at strategic locations in critical operating areas and emergency exits. Emergency DC lighting will be catered by DC emergency lighting distribution (DCELDB) boards. These DCELDBs will feed the DC emergency lighting fixtures directly and through a numbers of DC emergency lighting panels (DCELP) located suitably in respective areas.

The DC Emergency Lighting Distribution Boards will be fed from two power sources, namely –

i. Main Lighting Distribution Board (MLDB)

ii. 220V DC distribution boards (DCDB)

These lights will be ON all the time - normally from A.C supply, but on its failure from D.C. supply through automatic switching.

Lighted Exit signs shall be provided and installed in the control room, switchgear room, relay room, maintenance areas.

Underground conveyor tunnels & buildings (ex- Switchgear room and control room etc) located in other distant areas like coal handling, Ash handling plants, WT plants, Water system plants etc., the fixtures shall be 'Instalite' type which is permanently connected to normal supply charging a battery. These will switch "ON" automatically when AC power supply goes "OFF". Further, in underground areas flameproof fixtures shall be provided.

6.04.00 Remote Emergency Lighting

This will be provided in isolated building/area/mobile equipments viz. Stacker-Reclaimer where D.C. supply is not available by self-contained battery/ automatic charger/inverter/flood light units. These portable emergency light units will be energised automatically on loss of normal A.C. supply.

6.05.00 Street/Area Lighting

Time switch and photocell will be used for controlling streetlights with provision for manual override and also have the provision of latest Energy Saving Systems.

Same arrangement will also be used for controlling boiler gallery, ESP area , turbine floor (high bay), coal yard and railway marshalling yard lighting.

6.06.00 Receptacles

To cater to welding and other low voltage power requirement of the plant 63A TPN welding socket fed separate Weldimg receptacle distribution board shall be provided. For other services 15A, 3 pin socket shall be provided.

7.00.00 Not Used

8.00.00 RATING & REQUIREMENT

8.01.00 The lighting system will be supplied from 415 V/415 V ± 5%, indoor, dry type lighting transformers. Rating of each transformer shall be decided to limit the fault level within 9kA.

8.02.00 All equipment and accessories shall be designed for continuous operation under site conditions without exceeding permissible temperature rise as stipulated in relevant standards.

8.03.00 Switch, miniature circuit breakers (MCB), MCCB, bus bars shall be fully rated for short circuit level at the point of application. MCB shall have back-up HRC fuse if its rating is less than the available short circuit current.

8.04.00 All equipment and accessories shall have proper enclosure to suit the site conditions. Hazardous areas shall have flame-proof enclosure.

8.05.00 All wiring from lighting panels to fixtures and receptacles shall be carried out by PVC wires in G.I. Conduits.

8.06.00 Heavy duty XLPE FRLS cables will be used only for connections :

i. From main lighting distribution boards to area lighting panels.

ii. From street/area lighting panel to street light poles/towers.From 415V MCCs to receptacles of 63A and above.

iii. From Emergency Main Lighting Distribution Board (ACEMLDB) to Emergency Lighting Panels (ELP).

iv. From DC Emergency Lighting Distribution Board (DCELDB) to DC Lighting Panels (DCLP).

v. From 415V PMCC /ACDB to receptacles of 63A and above.

8.07.00 Suitable number of Flood Lighting Towers / Lighting Masts with adequate HPSV Flood Light will be provided for crushed coal pile, entire railway marshalling yard and other necessary outdoor areas.

8.08.00 Lighting of all main streets, approach roads to various buildings shall be included.

8.09.00 Each lighting panel shall be provided with adequate number of outgoing miniature circuit breaker for controlling fixtures. 5A, 3Pin sockets shall be fed from the lighting panel through separate circuits.

8.10.00 All A.C. Normal and Emergency A.C. lighting shall be provided with Energy Saving System.

9.00.00 METHOD OF CALCULATION

9.01.00 Standard Lumen method shall be adopted for interior & exterior lighting in order to determine the number of lighting fixtures for obtaining the desired average level of illumination.

9.02.00 The coefficient of utilization shall be considered to take care of Lumen loss due to:

a. Effect of room dimensions

b. Absorption of light in luminaries

c. Absorption of light at various room surfaces in ceiling, wall etc.

d. Floor cavity, ceiling cavity

e. Mounting height

9.03.00 Additionally, a maintenance factor shall also be considered to account for the fall of illumination due to ageing, pollution like dust deposit etc.

Maintenance factors to be considered for various areas shall be as follows :

Area	**Maintenance factor**
Air conditioned offices/control rooms with false ceiling	0.75
Switchgear/MCC Rooms in TG Building/Service Building	0.65
Other indoor areas	0.6
Boiler area and other areas prone to chemical/dust pollution	0.55

9.04.00 **Utilisation Factor**

- Dusty area such as conveyor galleries/tunnels, TPs/ Crusher House etc. = 50% ceiling, 30% wall, 10% floor.
- Clear areas such as switchgear room / control room etc. = 70% ceiling, 50% wall, 10% floor.
- Working plain = a) At conveyor walkway level. B) At building floor level.

9.05.00 Voltage drop at the fixture from the MLDB bus shall not exceed 3%.

9.06.00 Circuit loading of each lighting panel shall be done in such a way that almost balanced loading in all the phases i.e. R, Y and B is achieved.

9.07.00 At least two sub circuits shall be used for illumination of a particular area.

9.08.00 Sub circuit loading of each lighting panel shall be restricted to 2000W or 12 Nos. fixtures which ever is lower.

The working plane shall be considered at 0.85 m from the floor level.

The value of the ratio of spacing (S) to mounting height (H) shall be commensurate with the type of fittings selected, uniformity of illumination. The suspension height for suspended fixtures shall not exceed 1 meter.

10.00.00 **SPECIFIC REQUIREMENTS - SUPPLY**

EQUIPMENT AND MATERIAL

10.01.00 Equipment and material shall comply with description, rating, type and size as detailed in this Specification, drawings, Datasheet and Annexures.

10.02.00 Equipment and materials furnished shall be complete and operative in all details.

10.03.00 All accessories, control devices, internal wiring, fittings, supports, hangers, anchor bolts etc. which form part of the equipment or which are necessary for safe and satisfactory installation and operation of the equipment shall be furnished.

10.04.00 All parts shall be made accurately to standard gauges so as to facilitate replacement and repair. All corresponding parts of similar equipment shall be interchangeable.

10.05.00 Lighting Transformers

10.05.01 Lighting transformers shall be dry type, indoor type dusty vermin proof having 415 V/433 V ± 2 x 2.5% with off load tap-changer on primary side. The vector-group shall be Dyn11. (The secondary side shall be solidly grounded through an additional neutral bushing exclusively used for grounding.). Rating of each lighting transformer shall be selected to cater to the maximum connected lighting. The casing of the transformer shall be grounded at least at two (2) points.

10.05.02 If necessary, apart from the main lighting transformers, separate small additional lighting transformers may be used at distance lighting points.

10.06.00 Lighting Fixtures

10.06.01 Lighting fixtures shall be designed for minimum glare. The surface finish shall be smooth, unobtrusive and scratch resistant.

10.06.02 Reflector shall be of sheet steel or aluminium, minimum 20 SWG thick, securely fixed by fastening device of captive type.

10.06.03 Fixture shall be suitable for 20 mm conduit entry and 16 SWG G.I. earth-wire connections. Fixture shall also be suitable for case coupling entry wherever required.

10.06.04 High bay fixtures shall have provision for vibration damper to ensure rated lamp life.

10.06.05 Fixture shall be furnished complete with lamps and integrally/non-integrally or separately mounted control gear & accessories or applicable for different types of fixtures. These shall include holders, ballast, capacitor, starter, igniters (separate type) etc.

10.06.06 Fixtures shall be fully wired up to respective terminal blocks, suitable for loop in and loop one connection of PVC wires of following sizes:-

b) Lighting fixture : 2.5 Sq.mm Copper

c) Flood Light fixture : 2x2.5 Sq.mm Copper

10.07.01 Lamps

10.07.01 General lighting service (GLS) lamps shall be with clear glass and screwed caps. However, it is preferred to replace GLS lamp by CFL or other energy efficient lamps.

10.07.02 All fluorescent lamp shall be bi-pin rotary type and cool daylight.Lamp holder shall be spring loaded, low contact resistance type and shall have resistance to wear and tear.

10.07.03 Mercury/Sodium vapour lamp shall be colour corrected type with screwed cap.

10.07.04 Lamps shall be suitable for use in position and capable of withstanding small vibrations. Restrictions and special features, if any, shall be clearly indicated in the bid.

10.07.05 CFL and T5 fluorescent tube with electronic ballast or tri phosphorous tube.

10.07.06 Latest energy saving LED type lighting fixture/ lamps suitable for street light and other non critical areas.

10.08.01 Ballast/Electronic Ballast

10.08.01 Ballasts shall be heavy duty, low loss, polyster-filled type with copper winding.

10.08.02 Ballast for Mercury/Sodium vapour lamp shall be provided with suitable tappings to set the voltage within range specified.

10.08.03 Ballasts shall be free from hum. Ballasts which produce humming sound shall be replaced without any implication by the Contractor.

10.08.04 In multi-lamp fixture, each lamp shall be provided with individual ballast.

10.08.05 Ballast windings shall have maximum operating temperature of 120 Deg.C without rated temperature rise marking.

10.08.06 Ballast for Control Room Area shall be heavy duty, low loss, high-grade silicon steel stampings, vacuum impregnated polyester resin filled with copper winding.

Ballast for other area shall be electronic type, flicker free pre heat lamp start type having power consumption less than 3-watts per ballast, power factor less than 0.98 and THD less than 10%. Ballast shall operate at operating frequency of more than 40 kHz. Power consumption of ballast for 36W Fluorescent Tube shall be less than 9.5W.

Electronic Ballast shall be suitable for 220V DC and also 240V AC.

Electronic Ballast shall be of such design that minimum 25% reduction in energy consumption at constant luminous flux compared with conventional gear.

Electronic Ballast shall provide constant light independent of mains voltage fluctuation.

10.09.01 Lighting Panel/Distribution Boards

10.09.01 Lighting Distribution Boards/panels shall be metal-enclosed, cabinet type, fabricated, fully drawout type from CRCA sheet steel minimum 2.5 mm thick for load bearing members and 2.0mm for non-load bearing members, suitable for either wall/column mounting on brackets or floor mounting on channel sills. The panel shall be provided with lifting hooks. The LPs will be connected to LDB only.

10.09.02 Indoor Lighting Distribution Boards & Lighting Panels shall be dust and vermin-proof, IP-54 or better. Outdoor panels shall be weather-proof with canopy, IPW-55 or better. The cubicle housing transformer shall be minimum IP-42.

10.09.03 Lighting Distribution Boards and Lighting Panels shall be so constructed as to permit free access to the terminal connections and easy replacement of parts. Front access doors shall have padlocking arrangements. The LDB shall be fixed on a bottom channel 75mm.

10.09.04 Lighting Distribution Boards shall have provision of cable entry from bottom and, panels shall have provision of cable entry from top and bottom, as required, with removable gland plates. Necessary double compression type brass cable glands, tinned copper/Aluminium cable lugs are to be furnished.

10.09.05 Two ground pads with M10 G.I. bolts and nuts shall be provided on each Lighting Distribution Board and Lighting Panel for connection to ground conductor.

10.09.06 Each Lighting Distribution Board shall be complete with designation and caution notice plates fixed on front cover and a directory plate fixed on inside of the front cover. This directory Plate shall contain details of the Lighting Panels being fed from the Distribution Board including their designation, location, loading etc.

Each Lighting Panel shall be complete with designation and caution notice plates fixed on front cover and a circuit directory plate fixed on inside of the front cover. Circuit directory plate shall contain details of the points to be controlled by each circuit including the location of the point controlled, rating of the protective units and loading of each circuit. The plates shall be of anodized aluminium with inscriptions indelibly etched on it.

10.09.07 Bus bar shall be electrolytic grade hard drawn aluminium, colour coded for easy identification and designed for a maximum temperature of 85°C. Minimum size shall be 25 x 6 mm. The current density of Aluminium bus bar should not be below 0.8 Amp/Sq.mm. The bus bar shall be provided with heat-shrunk/cold-shrunk PVC sleeve.

10.09.08 Board / Panel shall be fitted with phase barriers such that it is not readily possible for personnel to touch the phase busbars. Insulation barriers shall preferably be fitted around the circuit breakers such that only the surface and the toggle of the circuit breaker is available on the front.

10.09.09 Incoming and outgoing circuits shall be terminated in suitable terminal blocks.

10.09.10 In lighting and receptacle panel 3-phase and 1-phase MCB should not be mixed.

10.09.11 In high bays, walkway shall be provided for maintaining light fittings. At other

places suitable ladder / platform / approach shall be provided for maintaining / replacement of light fittings.

10.10.00 **Board/Panel Equipment**

10.10.01 Each board shall consist of one dry type transformer housed in the different cubicles one (1) V.T operated voltmeter with selector switch, one (1) C.T operated ammeter selector switch, VTs, CTs, three (3) nos. phase energized indication lamps backed up by fuses and incoming triple pole MCCB. Proper discrimination between outgoing MCCB of lighting distribution board and downstream MCCB of lighting panel shall be ensured.

10.10.02 Each lighting panel shall have an incoming triple pole MCCB with neutral link and a number of outgoing miniature circuit breakers (MCB).

10.10.03 Board/Panel access door shall be interlocked with incoming MCCB such that the door can be opened only when the switch is in OFF position. Means shall be provided to defeat this interlock.

10.10.04 All MCCB shall be single throw, air break and heavy duty type having quick-make quick-break contacts. Fuses shall be HRC link type.

Contactors shall be air-break electromagnetic type. Push buttons shall be push to actuate type.

10.10.05 MCB shall be suitable for manual closing and opening and also automatic trip on overload and short circuit.

10.10.06 Time switch in street lighting panels shall be photocell type with automatic voltage stabilizer and necessary electronic unit with provision for sensitivity adjustment depending on external light intensity. When the exterior illumination level shall fall below a preset value for a considerable period of time (adjustable 30 sec. to 180 secs.) the electronic unit shall generate signal for the output relay to pick-up and potential-free contact of the same shall be used for control of contactor for lighting system. Sustained normal illumination level being restored (adjustable 30 sec. to 180 sec.) the lights shall switch off.

10.10.07 Voltmeter / Ammeter shall be of accuracy class 2.0 or better as per IS:1248 Voltmeter / Ammeter selector switch shall be of reputed make.

10.11.00 Receptacles

10.11.01 Receptacles shall be heavy duty, complete with individual plug and switch.

10.11.02 The conduit box of the receptacle shall be provided with earthing screws with washer and nuts welded on the surface for grounding with 16 SWG G.I. wire. Arrangement shall be provided inside the conduit box for grounding of third pin.

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10.11.03 Shrouded type plug shall be provided with corresponding matching arrangement at sockets to prevent accidental contact with finger during plug insertion.

10.11.04 Receptacles shall be of following types:

1. Type RA-6A, 240V, 2 pole, 3 pin type with third pin grounded, suitable for flush mounting in MCC Room, office areas, control rooms, store rooms, cabins etc. The switch shall be of piano-key type, also flush mounted and decorative non-industrial type.

2. Type RB-16A, 240V, 2 pole, 3 pin Industrial type with third pin grounded, metal clad with gasket having 19mm conduit entry and a metallic screwed cover tied to it with a metallic chain and suitable for installation in clean/dusty areas. The receptacles located in switchgear rooms, MCC rooms and control room shall have IP-42 degree of protection and those located in other dusty areas shall have IP-62 degree of protection. These receptacles shall be located at an interval of 50M along length of conveyor gallery/tunnel starting from one end and both sides of Track Hopper. Minimum one (1) no shall be provided in all equipment floor, feeder floor, boiler drum level, TPs Crusher House, Control Room, Pump House, Transformer Room and at suitable location in all other areas as required. In fuel oil area receptacles will be of flameproof type.

3. Type RC-63A, 415V, 3 phase, 4 pin Industrial type interlocked plug and switch with earthing contact. Other requirements shall be same as Type RB. Interlocking shall be so selected that the switch can be put to `ON' position only when all the four (4) pins of the plug are housed with complete alignment. In `OFF' position of the switch the socket outlet shall be completely dead and outgoing terminals isolated. Welding receptacles shall be connected with each other in loop-in loop-out connection to the extent of 3 Nos., located at an interval of 50 M. along the length of conveyor gallery/tunnel starting from one end and both sides of Track Hopper. and minimum one (1) no. shall be provided in all equipment floor, T.Ps, crusher house, wagon tippler, pump house, Cable spreader room, transformer room, boiler platform etc. Separate distribution board shall be used to feed these welding receptacles coming in TG building and boiler areas. At least one (1) no. shall also be provided in each offsite building, which will be fed from 415V MCC. In hazardous areas these receptacle shall be located in MCC rooms.

10.12.00 **Fans & Regulators**

10.12.01 The fan shall have three well balanced blades. And shall be reasonably free from noise. Pedestal fans shall also be provided as per Owner’s requirement.

10.12.02 Fan motor shall be totally enclosed type with copper winding & class E insulation.

10.12.03 Regulator shall have minimum five steps. Electronic regulator with smooth control is preferred.

10.13.00 **Switch & Switch Board**

10.13.01 All switch boards/boxes shall be of bent steel construction, fabricated of 14 SWG M.S. sheet with 6 mm thick Bakelite cover with brass fixing screws.

10.13.02 Switch boards/boxes located in control room and office areas shall be flush mounted type on brick wall with only the switch knob projecting outside.

10.13.03 Switch boards / boxes shall have conduit knock outs on the sides. Adequate

provision shall be made for ventilation of these boxes.

10.13.04 Flush type receptacles where provided shall be so located that only the plug projects outside.

10.13.05 Switches shall have quick-make and quick-break mechanism operated by a suitable external handle complete with position indicator.

10.14.00 **Lighting Poles/Towers**

10.14.01 **Street Light Poles**

i. Street light poles shall be swaged and welded steel pole, complete with fixing brackets, weather-proof junction box and all other accessories.

ii. The pole shall be coated with bituminous preservative paint on inside as well as embedded outside surface. Exposed surface shall be coated with two coats of metal primer (comprising of red oxide and zinc chromate in synthetic medium).

10.14.02 **Flood Light Tower**

13 Flood light tower shall be a lattice structure with maintenance platform and approach ladder. All structural members and hardware shall be hot-dip galvanized.

14 Structures shall be designed for an additional load of 1500kg for maintenance crew. Deflection under maximum wind pressure shall not exceed 1 in 360. Structural design shall be as per IS-800 and subject to Owner's approval.

10.14.03 **Lighting High Masts**

Applicable standards

IS-875 (Part-III) 1987	-	Code and practice for design loads for Structures.
BSEN 10025/DIN 17100	-	Grade of M.S. Plates.
BS-5135/AWS	-	Welding
BS.ISO 1461	-	Galvanizing
TR. No. 7200 of ILE	-	UK Specification for Mast and foundation.

Structure

Lighting High Mast shall be of continuously tapered polygonal cross section, at least 20 sided, hot dip galvanized and presenting a good and pleasuring appearance and shall be based on proven In-Tension design confirming to the standards referred to above, to give an assured performance, and reliable service. The structure shall be suitable for wind loading as per IS-875 Part-III, 1987. The masts dimensions shall be as per standards.

The Mast shall be of 30M height with lantern carriage to enable raising/lowering for ease of maintenance, including the Head Frame,

Double Drum Winch, continuous stainless steel wire rope, in built power tool, luminaries, suitable aviation warning light, lightning along with necessary power cables within the mast. The mast shall be delivered only in three sections & shall be joined together by slip stressed fit method at site. No site welding or bolted joints shall be done on the mast.

High mast shall be complete with feeder pillar panel for power distribution to lighting fixtures and winch motor. Feeder pillar panel shall be outdoor type stand mounting with dust and vermin proof, IP 55 and constructed of 14 swg sheet steel.

10.15.00 **Maintenance Equipment**

10.15.01 The Contractor shall supply one (1) no. of wheel mounted adjustable aluminium ladder for the maintenance of street lights.

10.15.02 For the maintenance of lighting fixtures within the power house, the contractor shall also supply two (4) nos. free standing adjustable aluminium ladder, adjustable from 5m. to 10m.

10.15.03 . For the maintenance of lighting fixtures within the CHP area, the Bidder shall supply two (2) nos. free standing adjustable aluminium ladder, adjustable from 5m. to 10m.

10.16.00 **Special Requirement**

10.16.01 All outdoor illumination fixtures, unless it is fed from photocell/time switch controlled lighting panel, has to be provided with outdoor type local switches.

10.16.02 In all the air filtration units and air handling units, one marine type lamp (of 100 Watt approx.) shall be supplied the wiring and fixing of the same has to be done by the contractor.

10.17.00 **Conduits and Accessories**

10.17.01 Conduits shall be rigid steel, hot-dip galvanised, furnished in standard length of 3 metres, threaded at both ends.

10.17.02 Conduits upto and including 25 mm shall be of 16 SWG and conduits above 25 mm shall be of 14 SWG. Minimum size of conduits shall be 20 mm.

10.17.03 Each piece of conduit shall be straight, free from blister and other defects and covered with capped bushings at both ends.

10.17.04 Flexible conduits shall be made with bright, cold rolled annealed and electro-galvanized mild steel strips and coated with PVC.

10.17.05 Conduit Wiring for Chimney

a) Complete C.I. conduits, PVC insulated wires, G.I. grounding conductor, weather proof outdoor junction box and all accessories viz. supports, clamps, junction boxes, etc. to make the installation complete in all respects. Conduit wiring shall be from the lighting fixtures to the junction box located at the bottom of the chimney.

b) All the obstruction lights shall be uniformly distributed over three single phase circuits. Conduit wiring for lighting installation shall be done with PVC cables drawn through the G.I. conduit of proper size. The GI conduits shall be terminated to a fuse box mounted on the chimney shell, at an accessible height from the ground. The cables shall be 1100/650 V Grade, 1/c, 10mm^2, PVC insulated and sheathed Stranded Aluminium conductor. The conduits shall be clamped at interval not greater than 600 mm. by means of approved type of saddles, clamps, etc. securely fixed on the shell/ladder. PVC bush shall be used at either end of the conduit. The minimum size of conduit to be used for the installations shall be 65mm. Pull boxes, at intervals of not more than 10 meters, inspection bends, etc. are to be provided at suitable locations to facilitate laying of wires. 8 SWG G.I. wire shall be run along the conduit for grounding purpose. All conduit accessories and junction boxes shall be hot-dip galvanized and of approved type. Wiring shall be done as per the relevant IS specification.

10.18.00 **Junction Box**

10.18.01 Junction boxes shall be of 16 SWG sheet steel hot-dip galvanized, dust and damp proof, generally conforming to IP-66.

10.18.02 Junction boxes shall be complete with gasketed inspection cover, conduit knock out/threaded hub and terminal blocks.

10.18.03 Junction boxes for outdoor use shall weatherproof IPW-66 and those for hazardous location shall be flame-proof type suitable for a particular zone / gas group in compliance with IS: 2148 / IS: 13346 and shall have certification from CIMFR, Dhanbad.

10.18.04 Junction boxes shall have following indelible markings :

- Circuit nos. on top
- Circuit nos. with ferrules (inside) as per drawing
- DANGER sign in case of 415V circuit

10.18.05 Junction Box for Chimney

The junction box at the chimney bottom shall be weather proof and suitable for flue laden atmosphere and provided with suitable terminal blocks and conduit knockouts for incoming cables and outgoing conduits. Double compression type cable gland shall be used for incoming cables.

10.19.00 **Lighting Cables & Wires**

10.19.01 Lighting Cable shall be heavy duty, 1100 Volt grade, multi-core stranded aluminium conductor,XLPE insulated, extruded PVC inner sheath, single round G.I. wire armoured and overall PVC sheathed with FRLSH conforming to IS 1554.

10.19.02 Lighting wires shall be 1100 Volt grade, PVC insulated, stranded conductor, single core cable conforming to IS 694,colour coded as below :

RED for R-Phase BLACK for Neutral

YELLOW for Y-Phase WHITE for +'Ve D.C.

BLUE for B-Phase GREY for -'Ve D.C.

10.19.03 Wire size shall be as follows :

For point wiring beyond lighting panel i.e. from lighting Panel to junction box (main run)	:	10 Sq.mm. Aluminium. Stranded conductor
From Junction box to lighting fixture	:	2.5 Sq.mm. Copper. Stranded conductor.
Receptacle	:	4 Sq.mm. Copper

10.20.00 **Terminals**

10.20.01 Multi way terminal blocks of approved type, complete with screws, nuts, washers and marking strips shall be furnished for connection of incoming/outgoing wires.

10.20.02 Each terminal shall be suitable for connection upto 2 nos. 10 Sq.mm stranded aluminium conductors without any damage to the conductor or looseness of connectors.

10.21.00 **Portable Emergency Lighting Unit**

The portable emergency lighting unit shall be complete with storage battery (rechargable), inverter, automatic charger, twin 6W fluorescent tube lamp and test switch. Contractor shall furnish make, type and catalogue.

10.22.00 **24V Supply Module**

10.22.01 Each 24V A.C. supply module shall have one(1) no. air-cooled two winding, 500VA, 1-phase, 50HZ, 240/24V transformer with 6A (240V side) and 16A (24V side) HRC fuse in primary and secondary side and necessary 240V and 24V terminals for incoming and outgoing connections. The 240V terminals of 24V AC supply module shall be fed from respective lighting panels. A group of 6A, 24V AC receptacles located near Boiler access doors and condenser area shall be wired upt from 24V side of each 24V A.C supply module.

The 24V A.C. supply modules shall be sheet steel enclosed with louvers and shall be suitable for outdoor use. The 24V A.C. supply modules shall be suitable for wall/steel structure/column mounting. Switches shall be mounted at the front on sheet steel enclosure.

10.22.02 Portable 24 V AC Supply modules having sheet steel enclosure with louvers as per above shall be supplied at entry and exit point of all room/ building.24V halogen automobile lamp with reflector alongwith 1100 V twin core PVC sheathed 2.5 mm^2 stranded copper wire of 20 M length as handset.

10.23.00 **Indication Lamp**

Lamps shall be clustered of LED type. LED lamp shall be made in accordance with InP Technology (Aluminium Indium Gallium Phosphide Technology). The

body shall be made of Poly Carbonate Unbreakable Lens. LED shall be protected by inbuilt fuse with surge suppressor or leakage voltage glow protection. LED circuit shall be PCB mounted. Intensity shall be greater than 200 mcd. All Push Button lamps shall be as per LED indicating lamp.

10.24.00 **Contactors**

10.24.01 Contactors shall be three pole, air break type, with non_bouncing silver/silver alloy contacts. Contactor duty shall be class III _ category AC3 for unidirectional drives and AC4 for bi_directional and inching drives/class I _ category DC2.

10.24.02 Each contactor shall be provided with minimum two (2) N/O and two (2) N/C auxiliary contacts rated 10 A at operating voltage. The exact requirement of contacts shall be decided by the Vendors taking into account the scheme requirements and spares.

10.24.03 Contactor starters shall comply with the requirements of IS_8544 (Part _ 1) in respect of co_ordination of the characteristics of contactor, overload relay, and fuse. The type of co_ordination shall be Type _ C as per IS_8544.

10.25.00 Remote Stop Push Button Station (RPB)

10.25.01 Remote Push button shall be utlised for manual ON/OFF for group of lights is approved selected zone. RPB's shall be metal enclosed, fabricated from CRCA sheet steel minimum 2 mm thick and shall be provided with a STOP Push Button only wired up to terminal block. RPB's shall be suitable for wall / column mounting on brackets. RPB shall be dust & vermin proof, IP-54 or better. In case of outdoor it shall have IPW 65 with additional weatherproof protection RPB shall have provision of cable entry both from top & bottom, as required with removable gland plates, minimum 2 mm thick.

10.25.02 Push button shall be heavy duty, oiltight, push to actuate type with integral escutcheon plate marked with its function.

10.25.03 Each push button shall have one (1) normally open and one (1) normally closed contacts rated 10 A at 240V.

10.26.00 **Nameplate**

Nameplates shall be furnished for identification of devices and circuits. All switches, controls and indications shall be permanently and legibly marked in English as to their functions.

All lighting fixtures, receptacles, fans, junction boxes etc. shall be properly marked up indelibly with corresponding circuit numbers.

10.27.00 **Samples**

Owner reserves the right to call for samples if considered necessary and the same shall be submitted by the Bidder free and without any obligation.

10.28.00 **Energy Saving System**

Panels

The energy saving system panel shall consists of loss less reactance coils with voltage tapping, contactor to select the tap, Micro-processor based TIMER along with real time clock for activating the contactor at a pre-set time. The unit shall be programmable so that at a pre-set time contactor on the lower voltage tap can be selected and reduced voltage can be applied across the circuit. It shall also be possible to modify the setting at site, if required.

The capacity of panels shall be 25/30 kVA or more as required. This system shall be incorporated in normal AC panels and Emergency AC panels.

Lamps

CFL and T5 fluorescent tube with electronic ballast or tri-phosphorous tube.

11.00.00 **SPECIFIC REQUIREMENTS-SERVICES**

11.01.00 **Consumables and Hardware**

11.01.01 The Contractor shall furnish all erection materials, hardware and consumables required for the completed installation.

11.01.02 The materials shall include but not limited to the following:-

a.	Consumables	:	Welding rods & gas, oil and grease, cleaning fluids, paints, electrical tape, soldering materials etc.
b.	Hardware	:	Bolts, nuts, washers, screws, brackets, supports, clamps, hangers, saddles, cleats, sills, shims etc.
c.	Materials	:	Junction boxes, terminal blocks, connectors, ferrules, lugs, brass glands, rigid/flexible conduits, cables, ground wires etc.

11.01.03 Supply of cement, sand, stone etc. required for the execution of the contract shall be the responsibility of the Contractor.

12.00.00 **ERECTION TOOLS & TACKLES**

12.01.00 The Contractor shall provide all tools, tackle, implements, scaffoldings, ladders, etc. which are required for handling and erection of the equipment and materials.

Installation work shall be carried out in accordance with good engineering practices and also manufacturer's instructions/ recommendations where the same are available.

Equipment shall be installed in a neat workmanlike manner so that it is level, plumb, square and properly aligned and oriented

12.02.00 **Street Lighting Poles**

Erection of Street Lighting poles together with all its accessories including civil foundation work, installing lighting fixture, wiring and cabling work are included within scope of contractor.

12.03.00 **Flood Lighting Tower**

12.03.01 Erection of Flood Lighting Towers including civil foundation work shall be done by Contractor.

12.03.02 Contractor shall also mount assembled fixtures, outdoor & lockable type isolating switch cubicle install necessary cabling and wiring make connections.

Floodlights shall be mounted on steel base facing the tentaive direction shown on the drawing. Fixing holes shall be provided with slot to turn the fixture about 5° on both sides. Bolts shall be finally tightened with spring washer.

The contractor shall supply and intall the steel base for fixing the flood light on the flood light towers.

Terminal connections to the floodlight shall be made through PVC coated flexible metallic conduits.

12.04.00 Receptacles

Receptacles shall be installed at locations shown in the approved drawings.

12.05.00 MLDB, EMLDB, DCELDB and Lighting Panel

MLDB, EMLDB, DCELDB and Lighting Panels shall be erected at the locations indicated in approved drawings.

12.06.00 **Lighting High Masts**

Erection of Lighting Masts together with all its accessories including civil foundation work, installing lighting fixture, wiring and cabling work are included within scope of contractor.

12. 07.00 **Lighting Fixtures**

12. 07.01 Continuous rows of fluorescent tubes shall be mounted on a continuous M.S. angle for each row of lights.

12. 07.02 In turbine hall, fixtures shall be mounted to maintain sufficient clearance from the overhead travelling crane trolley.

12. 07.03 In boiler galleries, mounting height of fixtures shall be about 2500 mm from platforms except shown otherwise.

12. 07.04 Bracket for fixture mounting shall be fabricated at site from 40 mm conduits with a reducing socket to suit the fixtures and clamped on to the handrails. The fixing shall be strong enough to withstand vibration and high wind velocity.

If a roof over platform is available, the fixture can be pendant mounted.

12.07.05 Fixtures shall be mounted on sub_station structures with suitable clamps. No cutting or drilling of sub_station structures is permitted. It is preferable to provide separate structures in Switchyard and Substation.

12. 07.06 The fixtures ahter erection shall be marked up indelibly with corresponding circuit number for easy identification of lamp circuit.

12. 08.00 **Wiring**

12. 08.01 Wiring shall be generally carried out by PVC wires in conduits. All wires in a conduit shall be drawn simultaneously. No subsequent drawing is permissible.

12. 08.02 Wire shall not be pulled through more than two equivalent 90° bends in a single conduit run.

12. 08.03 Wiring shall be spliced only at junction boxes with approved type connections or terminal strips. Maximum two wires can be connected to each way of the terminal block. Splicing of only one phase shall be done in a junction box.

12. 08.04 For lighting fixtures, connection shall be teed off through suitable round conduit or junction box, so that the connection can be attended without taking down the fixture.

12. 08.05 For vertical run of wires in conduit, wires shall be suitably supported by means of wooden/hard rubber plugs at each pull/ junction box.

12. 08.06 A.C. and D.C. circuits shall not be run in the same conduit and junction boxes. Circuits fed from different transformers shall be run through different conduits and Junction boxes.

12. 08.07 Receptacle circuits shall be kept separate and distinct from lighting and fan circuits.

12. 08.08 Separate neutral wire shall be provided for each circuit. Wiring throughout the installation shall be such that there is no break in the neutral wire in form of switch or fuse.

13.00.00 **CONDUIT SYSTEM**

13.00.01 In case of unarmoured cable, all conduits shall originate from the respective lighting panel and terminate in lighting fixtures, receptacles etc.

13.00.02 Exposed conduits shall be run in straight lines parallel to building columns, beams and walls as far as practicable. Unnecessary bends and crossings shall be avoided to present a neat appearance.

13.00.03 Conduit supports shall be provided at an interval of 750 mm for horizontal runs and 1000 mm for vertical runs.

13.00.04 Conduits shall be clamped on to approved type space plates or brackets by saddle or U-bolt. The spacer plates or brackets in turn, shall be fixed to the building by welding and to concrete or brick work by grouting as shown on drawing.

13.00.05 Wooden plug inserted in the masonry or concrete for conduit support is not acceptable.

13.00.06 Embedded conduits shall be securely fixed in position to preclude any movement. In fixing embedded conduit, if welding or brazing is used, extreme care should be taken to avoid any injury to the inner surface of the conduit.

13.00.07 Spacing of embedded conduits shall be such as to permit flow of concrete between them and in no case shall be less than 40 mm.

13.00.08 Where conduits are run on cable trays they shall be clamped to supporting steel at an interval of 600 mm.

13.00.09 For directly embedding in soil, the conduits shall be coated with an asphalt base compound. Concrete pier or anchor shall be provided where necessary to support the conduit rigidly and to hold it in place.

13.00.10 Conduits shall be installed in such a way as to ensure against trouble from trapped condensation.

13.00.11 Running threads shall be avoided as far as practicable. Where it is unavoidable, check nuts shall be used.

13.00.12 Conduits shall be kept, wherever possible, at least 300 mm away from hot pipes, heating device etc. when it is evident that such proximity may impair the service life of cables.

13.00.13 Slip joints shall be provided when conduits cross structural expansion joints or where long run of exposed conduits are installed, so that temperature change will cause no distortion due to expansion or contraction of conduit run.

13.0014 For long run, junction/pull boxes shall be provided at suitable intervals to facilitate wiring.

13.00.15 Conduits shall be securely fastened to junction box or cabinets, each with a locknut and insulated bushing inside the box and locknut outside.

13.00.16. Conduit lengths shall be joined by screwed couplers. Couplers shall be clearly cut.

13.00.17 Conduit joints and connections shall be made thoroughly water tight and rust proof by application of a thread compound which will not insulate the joints.

13.00.18. White lead is suitable for application on embedded conduit and red lead for exposed conduit.

13.00.19. The battery Room installation shall be made with acid fume proof conduits.

13.00.20 Field bends shall have a minimum radius of four (4) times the conduit diameter. All bends shall be free of kinks, indentations or flattened surfaces. Heat shall not be applied in making any conduit bend.

13.00.21 The entire metallic conduit system, whether embedded or exposed, shall be electrically continuous and thoroughly grounded.

13.00.22 Lighting fixture shall not be suspended directly from junction box in the main conduit run.

13.00.23 Conduits and fittings shall be properly protected during construction period against mechanical injury. Conduits ends shall be plugged or capped to prevent entry of foreign material.

13.00.24 After installation the conduits shall be thoroughly cleaned by compressed air before pulling in the wire.

13.00.25 In control rooms and office areas provided with false ceiling conduct run shall be concealed type, embedded in the walls.

14.00.00 **Cabling**

14.00.01 In outdoor areas, main runs from lighting panels shall be by means of XLPE cables, directly buried in ground or laid in trenches for the underground portion and through conduit for the above ground portion.

14.00.02 Buried cables shall be laid and covered with sand/riddled earth, and protected from damage by bricks at sides and precast concrete stab at top. Buried cables shall have cable markers at 50M interval and projecting 150 mm above ground. At cable bends and joints markers shall be provided.

14.00.03 When burried cables cross road/railway track, additional protection to be provided in form of G.I. pipe.

15.00.00 **Grounding**

15.00.01 All lighting panels, junction boxes, receptacles, fixtures, conduit etc. shall be grounded in compliance with the provision of I.E. Rules.

15.00.02 Ground connections shall be made from nearest available ground grid. All connections to ground grid shall be done by arc welding.

15.00.03 Panels/Boards shall be directly connected to ground grid by two nos. 35 x 6 mm G.S. flats. (for panels/two nos. 50x6 mm G.S. flats (for distribution boards).

15.00.04 All junction boxes, receptacles, lighting fixtures etc. shall be grounded with 8 SWG G.S. wire.

15.00.05 Each street lighting Pole shall be grounded at two points by two nos. 50x6 mm G.S flat risers from two (2) nos. earthing spike 40 mm dia & 3m long directly driven into ground at a depth of 1m from ground level. The junction box at each lighting pole is grounded at two (2) points from two (2) nos. earthing terminals by 16 SWG GS wire. One 16 SWG G.S wire shall be taken upto the junction box from lighting fixtures and connected to grounding point.

15.00.06 Two (2) nos. earthing spike 3m long & 40 mm dia directly driven into ground at a depth of 1m from ground level shall be provided for each flood lighting tower.

The sheet steel cubicle housing the power supply Isolator at base of flood lighting tower shall be connected at two (2) points from these earthing risers by 16 SWG G.S. wire - The flood lighting fixtures shall be grounded by one (1) 16 SWG G.S wire running through the lighting conduct upto the distribution box.

Two (2) nos. separate spike of 3m long & 40 mm dia directly driven into ground at a depth of one (1)m from ground level shall be provided for connection of the lighting must on top of flood lighting tower through two (2) nos. 50x6 mm G.S. flat down conductor.

A continuous ground conductor of 12 SWG G.S. wire shall be run all along each conduit run and bonded to it every 600 mm by not less than two turns of the same size of wire. This conductor shall be connected to each panel ground bus.

16.00.00 **Foundation & Civil Works**

16.00.01 Equipment foundations panel foundations and all other civil work will be provided by the Contractor.

16.00.02 Concrete trenches, cable trays and other civil work will be provided by the Contractor. The Contractor can make use of those trenches, cable trays etc. for conduit installation.

17.00.00 **Excavation and Back Filling**

17.00.01 The Contractor shall perform all excavation and backfilling as required for buried cable and ground connections.

17.00.02 Excavation shall be performed upto the required depth. Such sheeting and shorting shall be done as may be necessary for protection of the work.

17.00.03 The Contractor shall make use his own arrangements for pumping out any water that may be accumulated in the excavation.

17.00.04 All excavation shall be backfilled to the original level with good consolidation.

18.00.00 **Steel Fabrication**

18.00.01 All supports, hangers & brackets shall be fabricated by the Contractor. Necessary steel shall be supplied by the Contractor.

18.00.02 Steel for fabrication shall be straightened and cleaned of rust and grease. All fabrication shall be free of sharp edge.

18.00.03 Every effort shall be made to minimize the wastage of steel as far as practicable during fabrication. The wastage in no case shall exceed 3% of the total quantity of steel fabricated.

19.00.00 **Painting**

19.00.01 Street light poles shall be given two coats of aluminium paints after installation.

19.00.02 All steel fabrication shall be given two coats of red-oxide primer followed by two coats of Siemens gray (RAL-7032).

19.00.03 All equipment shall be given touch-up paint as required after installation.

20.00.00 **Cleaning up of Work Site**

20.00.01 The Contractor shall, from time to time, remove all rubbish resulting from execution of his work. No materials shall be stored or placed on passage or drive ways.

20.00.02 Upon completion of work, the Contractor shall remove all rubbish, tools, scaffoldings, temporary structures and surplus materials etc. to leave the premises clean and fit for use.

21.00.00 **Inspection & Testing**

21.00.01 On completion of erection works, the Contractor shall request the Engineer for inspection and tests with minimum fourteen (14) days advance notice.

21.00.02 The Engineer shall arrange for joint inspection of the installation for completeness and correctness of the work. Any defect pointed out during such inspection shall be promptly rectified by the Contractor.

21.00.03 The installation shall be then tested and commissioned in presence of the Engineer and put on trial run for stipulated contract period.

21.00.04 All rectification, repair or adjustment work found necessary during inspection, testing, commissioning and trial run shall be carried out by the Contractor without any extra cost.

22.00.00 **TESTS**

22.01.00 **Shop Tests**

22.01.01 All equipment shall be completely assembled, wired, adjusted and routine tested as per relevant Indian Standards at manufacturer's works and in the presence of Owner's representatives.

22.01.02 Tests on Control gear / Lighting Distribution Boards / Lighting Panels shall include:

a) Wiring continuity tests.

b) High voltage and insulation tests.

c) Operational tests.

22.01.03 The tests on lighting fixtures shall include:

a) All routine tests as per relevant I.S.

b) Rain-proof test for outdoor type luminaries and respective control gearbox as type test.

c) Temperature rise test on ballast/choke as type test. Dust proof test as type test.

22.02.00 **Site Tests**

22.02.01 Contractor shall thoroughly test and meggar all cables, wires and equipment to prove the same are free from ground and short circuit.

22.02.02 If any ground or short circuit is found, the fault shall be rectified or the cable and/or equipment replaced.

22.02.03 All equipment shall be demonstrated to operate in accordance with the requirements of this specification.

22.02.04 Illumination in different areas are as per designed lux level generally confirming with Indian Standards. The lux level shall be verified by photometer at site location.

Test Certificates:

Certified copies of all tests carried out at works and at site shall be furnished in requisite no. of copies for approval of the Owner.

The equipment shall be dispatached from works only after receipt of Owner's written approval of shop test reports.

Type test certificates on any equipment, if so desired by the owner, shall be furnished. Otherwise the equipment shall have to be type tested, free of charge, to prove the design.

	Yard/Railway line		light, high/medium beam flood light	HPSV
6.0	**GENERAL**			
6.1	Switchyard	50	Flood Light	1X250/400W MH
6.2	Corridors, walkways, staircase, etc.	100	Industrial type with vitreous enamel reflectors/channel mounted box type	Energy Efficient FTL
6.3	Lockers, toilets, wash rooms, etc		Channel mounted box type	Energy Efficient FTL
6.4	Building periphery lighting		Industrial well glass with integral mounted control gear/industrial bulk head with integral mounted control gear/ flood light fittings	70 W HPSV lamp / 400 W HPSV lamp
6.5	Office Rooms	300	Decorative recessed type FTL	Energy Efficient FTL
7.0	**DC LIGHT FITTINGS**			
7.1	Control room	-	Decorative recessed type with cylindrical reflector	1x100 W incandescent lamp
7.2	Other areas	-	Industrial bulk head or industrial well glass with reflector	1x100 W incandescent lamp

NOTE:

a) Energy efficient type FTL-T5 tube light fittings shall be used.

b) N/E AC lighting and DC lighting shall be identified with suitable colour code.

c) CONTRACTOR may change the type of fixture to be used in different area against indicated above, provided minimum illumination level as indicated above is maintained. Lighting shall appear aesthetically good. CONTRACTOR shall measure the lux levels in the above areas (measured at the working plane) using suitable devices/meters as per relevant standards to prove the specified values.

(d) For chimney / Cooling Tower, aviation warning lights as per AAAI's recommendation shall be provided.

1 Medium intensity light should be used alone or in combination of low intensity lights where height is greater than 45 m. High intensity light should be used for heights more than 150 m as required to conform to the standard of Civil Aviation Department, directorate of air route and aerodromes, Government of India, DGCA, ICAO or any other statutory body and also to conform to IS: 4998 and as per the drawing. Each aviation warning light shall be of neon type having two lamps. Only one (1) lamp in a given fitting would be ON at a time and if the lamp fails, its failure would initiate an alarm and the next lamp in that particular fitting would be switched on automatically. Necessary control panel for control and annunciation shall be supplied. The control scheme of the control panel shall be to the approved of OWNER/Consultant

2. One (1) photo controller along with suitable controller arrangement to be supplied by the bidder to switch ON and OFF the aviation warning light automatically based on the intensity of natural light during day/night. The

aviation warning lights on each of the external platform and three (3) nos. of flood lights (250 W HPSV) at all external platform levels shall be connected to three different phases.

3 The warning lights shall be adequately secured to the chimney against the wind forces. The low intensity shall be of fixed red colour, medium intensity shall be flashing red and high intensity shall be of flashing white. In no case the intensity shall be less than 100 candles of light. Blinker rate of Aviation warning lights shall be as per Aviation standards.

4 The top light or lights shall be so arranged as to mark the point or edge of the obstruction-marking surface. The lights shall be placed between 1.5 meter and 3 meter below the top. The number and arrangements of lights at each level or platform be such that the obstruction is indicated from every angle in azimuths.

5 The lights shall be displayed on the points at each platform of the chimney so as to indicate the general definition and extent of the obstruction.

6 The aviation lighting distribution board shall have facility to receive two (2) incoming feeders, one (1) from the main DB of the chimney and the other from the emergency source of the power plant with auto changeover facility.

7 Temporary aviation lights with infrared bulbs shall be installed at each of the levels as instructed by OWNER as the construction work progresses and also above the top most point of the obstruction as construction progresses. These lights need to be installed only after the level of obstruction is greater than 45 meter above grade level. The lights shall continue to exist till permanent arrangement to provide such lights are completed.

ANNEXURE-II

LIGHTING & LIGHTING TRANSFORMER

Sr. No.	ITEM	Unit	
1.0	**AUXILIARY POWER SUPPLY**		
1.1	**SYSTEM VOLTAGE**		
	Lighting equipment and accessories shall be designed for satifactory operation from the following power supply sources.		
1.1.1	A.C Supply		415 Volt, 3 phase, 50hz, 3 wire effectively grounded system Fault level 50kA rms symmetrical
1.1.2	DC Supply		Fault level 25kA symmetrical 220V, 2wire, ungrounded system.
1.2	**PERMISSIBLE VARIATION**		
	Equipment and accessories shall be suitable for operation over the entire range of voltage/frequency variations as listed below:		
1.2.1	A.C Supply		Voltage ±10% Frequency ±5% Combined voltage and frequency 10% (absolute sum)
1.2.2	D.C Supply		Voltage 198 to 242 Volt
3.0	**LIGHITNG TRANSFORMER**		
3.1	Type		Cast Resin Dry type, non-encapsulated VPI with nomex insulation
3.2	KVA rating		100kVA (Min.)
3.3	Voltage rating		415 V/433 V
3.4	Cooling		AN
3.5	P.U. Impedance		*0.04 ±10%
3.6	Voltage control		Off load tap switch/link with change of ±5% in step of 2.5% tapping full capacity
3.7	Vector Group		Dyn11
3.8	Class of Insulation		F (155 Deg.C)
3.9	Maximum Temperature rise over 50 Deg C. ambient in winding by resistance		90 Deg.C
3.10	Neutral		Solidly grounded

Notes:

The secondary neutral of the transformer shall be brought out for getting a grounded four (4) wire supply. Each transformer shall be routine tested and one transformer shall be type tested in accordance with relevant standard.

The transformer shall be liable for rejection if the tolerance on the quoted values of losses, impedance, temperature rise, etc. exceeds the specified values of relevant standard.

The transformer shall be mounted inside sheet steel enclosure which shall be an integral part of Lighting Distribution Board.

Typical Transformer rating of 100kVA and impedance is indicated in Annexure. However rating of transformer required shall be worked out by the bidder. Calculations for the same shall be submitted with bid.

Each lighting fixture shall be furnished complete with associated lamp, holder and control gear fully wired up. Control should include copper ballast, copper choke, capacitor starter, electronic- igniter (separate type). Fuse connector block etc.

For well glass fittings for HPSV lamps higher wattage (250/400 W) floodlight luminaire, the control gear will be separate/ non integral type whereas for high bay, streetlight and mini flood light fixture, the control gear shall be integral type.

Make, type & catalogue no. of lighting fixtures are indicated herein with the intent to elaborate the physical appearance/ constructional features only pertaining to the particular type of fixture.

The supply also includes associated junction boxes, brackets supports, hangers and wires wherever applicable.

ANNEXURE -III

FITTINGS AND ACCESSORIESOF LIGHTING TRANSFORMER

Each transformer shall be equipped with fittings and accessories as listed below :

1. 150 mm dia. winding temperature indicator with maximum reading pointer and electrically separate sets of contacts for trip and alarm.

2. Handling and lifting lugs both for enclosure and core-coil assembly.

3. Jacking pad for core-coil assembly.

4. Inspection cover for cable and box.

5. Door handle operated safety limit switch with 1NO + 1NC contact.

6. Ground bus.

7. IP-55 junction box.

8. Rating and terminal marking plates.

Note : All indication, alarm, trip contacts provided shall be rated for 0.5A at 220 V D.C. and 5A at 240 V A.C.

(oo) Administration building
(pp) Check post
(qq) Secondary gate
(rr) Ash gate
(ss) CW treatment building.
(tt) Loco shed
(uu) Peripheral road inside boundary wall
(vv) Security office
(ww) Any other as per plot plan & relevant drawings.

Note: Aviation obstruction lights shall be provided on tall installations as per regulation.

CHAPTER 29 : EARTHING & LIGHTNING PROTECTION

1.00.00 SCOPE OF SUPPLY

1.01.00 The scope of supply shall include but not be limited to the followings:

1.01.01 Timely procurement and transportation to site, unloading, storing at site in properly packed condition of all materials and miscellaneous items required to complete the erection work under this specification.

1.01.01 These materials and miscellaneous items shall include but not be limited to the following:

(a) Mild steel rods, galvanized steel flats, galvanized steel rods, lead coated copper tube suitably brazed with galvanized steel Bend ring galvanized steel wires etc. required for grounding and lightning protection system shall be supplied in standard lengths.

(b) Any item of works or erection materials which have not been specifically mentioned but are necessary to complete the work involved shall be deemed to be included in the scope of this specification and shall be furnished by the contractor without any extra charge to the purchaser.

1.01.02 **Main ground mat**

Ground mat (grid) shall be provided in power block (BTG) area, switchyard (400 kV), transformer yards & below all HT & LT switchgears as per details given in following sections. Laying of underground conductors and arc welding of the conductors at each crossing and straight run (lap joint) shall be provided. The conductors at the periphery of the mat shall be 1 no. 40 mm (min) diameter M.S. rod. Suitable pigtails shall be provided and shown in the layout drawing for connection with other plant/ground grids, stack, other grounding systems in power plant area etc.

1.01.03 **Grounding Electrode**

Fabrication and driving into ground 40 mm (min) diameter 3000 mm long M.S. rod and connecting them to the grounding mat by arc welding. 100 N.B. CI pipes for system Neutral earthing.

1.01.04 **Column Grounding**

(i) Concrete columns

Erection of 1 no. 40 mm (min) dia. M.S. rod from grounding mat to all concrete columns including necessary fixing, welding of one end of the rod with ground mat and the other end with the column above ground by welding with a short GS flat to edge angles.

(ii) Steel columns

Erection and connection of 1 no. 40 mm (min) diameter M.S. rod from grounding mat to all steel columns including necessary fixing welding with ground mat and the other end with the column above ground with a short GS flat.

1.01.05 **Risers**

Erection and connection of all risers from underground mat to above ground levels where the ends will be left free for connecting to the equipment. Each riser will be 1 No. 40 mm (min) dia. M.S. rod and minimum 300 mm above grade level/concrete floor level.

All other ancillary works in connection with the items of work described above which are not specifically mentioned but are necessary to complete the work, shall be under the scope of this specification.

1.01.06 **Perimeter Grounding:**

Perimeter grounding shall be provided for all areas of outdoor plant & buildings & interconnection between each outdoor plant & buildings ground subgrid and power block (BTG) ground grid shall be done at atleast four points. Each outdoor plant & buildings subgrid shall also be interconnected with each other at atleast 4 points by EPC vendor.

Earth electrode shall be provided at each corner of the perimeter grounding system. The ground resistance of perimeter grounding system shall be less than 0.5Ω.

Note: Minimum size of the MS rod used for the earth mat, riser and grounding electrode shall be 40 mm dia.

1.02.00 All materials and accessories to be supplied by the Bidder shall be brand new ones of reputed make.

1.03.00 Material for electronics earthing system (electronics earth electrode, earthing bus and single core copper cable from earth pit to electronic earthing bus) shall be of hard drawn copper wire as per equipment vendor suppliers requirement.

1.04.00 Connection from electronic earth bus to individual equipment shall be with minimum 6 sq mm copper cable or equipment supplier recommendation whichever is higher.

1.05.00 Necessary drawings, data sheets and Technical leaflets on each piece of material.

2.00.00 EARTHING REQUIREMENTS

Other Requirements of Earthing System:

Standard/Code	IEEE 80, IS 3043
Earthing System	
Life expectancy	40 Years
System Fault Level	As per system requirement (B0)

Soil resistivity	Actual as per site conditions.
Min. Steel corrosion	0.12mm/year
Depth of burial of main earth Conductor	1000mm below grade level;where it crosses trenches, pipes, ducts, tunnels, rail tracks, etc., it shall be at least 300mm below them.
Conductor joints	By electric arc welding, with resistance of joint not more than that of the conductor.

Welds to be treated with red lead for rust protection and then coated with bitumen compound for corrosion protection.

Surface resistivity	- Gravel	3000 ohm-meter
	- Concrete	1000 ohm-meter

3.00.00 ERECTION SCHEDULE

3.01.00 The entire erection work shall be carried out in a phased manner. A schedule of the work showing the sequence of erection shall be submitted by the Bidder for this purpose.

3.02.00 The erection schedule, as approved by the Owner's Engineer shall be strictly followed by the contractor. If, for any reason beyond the control of the Contractor, the work is held-up then the Contractor shall bring it to the notice of the Owner's Engineer without any delay.

4.00.00 DESIGN CRITERIA

4.01.00 GROUNDING SYSTEM

4.01.01 The power plant grounding system shall be symmetrical ground grid / symmetrical earth mat with equal spacing of grounding conductor designed incompliance with IEEE 80 and IEEE665 considering fault current of 50kA 1 sec and shall be subject to approval of owner after submission of manual design calculation with following parameters & clauses.

Soil resistivity - 100 Ohm-meter (for bidding purpose, final value will be decided during detail engineering after soil test).

Surface resistivity - 1000 Ohm-meter

Fault duration - 1sec

4.01.02 Earth resistance value shall be less than 0.5 ohm for earthing system.

4.01.03 The station grounding system shall be an interconnected network of MS conductor and MS ground rods. The system shall be provided to protect plant personnel and equipment from the hazards, which can occur during power system faults and lightning strikes.

4.01.04 Major items of equipment, such as generator, switchgear, transformer, motor, relay panels and control panels etc shall have integral ground buses or connection points which shall be connected to the station ground grid.

4.01.05 Electronic panels and equipment, where required, shall be grounded utilizing an insulated ground wire connected in accordance with the manufacturer's recommendations. Where practical, electronics ground loops shall be avoided. Where this is not practical, isolation transformers shall be furnished. All indoor and outdoor electrical equipment and associated non current carrying system, metal works, support structures, buildings columns, fence, neutrals, masts, arrestors, etc shall be connected to the plant ground system.

4.01.06 However, the surface resistivity shall be considered as 1000-ohm meter.

4.01.07 Instrumentation cable screens shall be single point bonded to the instrument earth network to minimize the effects of electrical interference.

4.01.08 For Signal/case/intrinsically safe signal, Earthing of control room instruments, separate earth pit not connected to main ground grid shall be used. Control cabinets shall be connected to this separate earth pit.

4.01.09 A Earthing conductor (steel wire armor) shall be routed parallel to all power conductors operating above 240 volts.

4.01.10 All ground wires installed in conduits shall be uninsulated.

4.01.11 Embedded earth bus conductor of 65 x 8 mm GS flat shall be laid at all the floor levels in all the building.

4.01.12 In addition mild steel ground pads at different locations i.e. on wall/floor/ceiling inside the buildings/tunnels/trenches shall be provided. These pads will be in turn connected to below ground level earth mat through galvanized steel flat or riser. Each ground pad shall have provision for connection of at least two 65 x 8mm GS flats.

4.01.13 Treated earth pit shall be provided for system earthing at locations where generator and transformer neutrals are grounded. Two pits shall be provided for each neutral.

4.01.14 Dedicated treated earth pit shall be provided for lightning protection system.

4.01.15 For every upper/lower floor grounding grid the distance between two adjacent risers originating from below the ground grounding grid shall not be greater than 10meters.

4.01.16 Clean earthing for instrumentation shall be provided with dedicated earthing system and separate treated earth pits below the main control room, feed water pump house in turbine house etc.

4.01.17 The necessary arrangement & system for watering of all the transformer neutral earth pits is to be provided.

4.01.18 Size of Conductors

4.01.18.1 Main Earting Conductors

The earthing conductor sizes shall be calculated as per the following formulae.

$$\frac{I}{S} = K \frac{1}{\sqrt{t}}$$

S= Cross-section area in sq.mm

I= Maximum A.C. RMS ground fault current amperes.

t= Operating time of the protective device to disconnect the faulty circuit, in sec.s

K= Factor depending on the earthing conductor, the insulation and other parts, and the initial and final temperature.

The factor "K" is determined by the formula

$$K = Qc \frac{(B+20)}{\rho 20} \ln \frac{(B+\theta f)}{(B+\theta i)}$$ ------

ρ20= Electrtical resistrivity of conductor material at 20 deg. C (ohm-mm)
Qc= Volumetric heat capacity of conductor material (J/deg. C cu.m)

B= Reciprocal of temperature co-efficient of resistivity at 0 deg. C for the conductor

θi = Initial temperature of conductor, (deg. C).
θf = Final temperature of conductor, (deg. C).

The maximum permissible temperature of conductors with welded joints may be up to the maximum permissible temperature (θf) o f the material, 500^0C (as per IS-3043) shall be the maximum permissible temperature for steel conductors with welded type conductor to conductor joints; the valu shall be 250^0C_ for steel conductors with bolted type conductor to conductor joints.

The calculated size shall be suitably (depending on the resistivity of soil) increased as per table below to account for the loss of material (steel) due to corrosion in soil.

RESISTIVITY OF SOIL ρ (OHM-METRE)	INCREASE IN THICKNESS/DIAMETER OF EARTHING CONDUCTOR (MM)
0< ρ<10	8.0
10< ρ<25	7.0
25< ρ<50	5.5
50< ρ<75	4.5
75< ρ<100	3.0
ρ<10	1.5

4.02.00 In order to meet the above objectives, symmetrical ground grid mesh will be provided as specified. Interconnection between switchyard ground grid and

power plant ground grid shall be done atleast four points and responsibility lies on power plant EPC vendor.

All electrical equipment, non current carrying metal parts, structures, building steel, lightning protection system, generator / transformer neutrals will be connected to this station ground grid.

The major aspects to be considered for grounding system design are given below:

4.02.01 Ground Grid Conductor

(a) Ground grid conductor of mild steel rod shall be used.

(b) The minimum conductor section is determined on the basis of ground fault current. This section is then increased by an allowance to account for the soil corrosion loss of 0.12 mm per year over the design life of 40 years.

4.02.02 Underground Grid

(a) The ground grid mesh is designed to keep the touch and step voltages within safe limits as per recommendation of IEEE 80 & IEEE 665 and Touch voltage and step voltage is to be calculated considering weight of person 50kg.

(b) The ground grid conductors will be buried in earth at a minimum depth of 1000 mm. The length of ground conductors below earth will be sufficient to ensure a ground resistance less than one (1) ohm.

(c) The ground grid conductor will be so laid as to provide short and direct connection to building steel and major electrical equipment.

(d) Ground rods shall be provided at the points where lightning protections are connected to the ground grid.

(e) All ground grid conductor connections will be welded type.

(f) For test pits, the Electrode will be 100 mm dia as per IS. Heavy duty C.I. pipe with perforations. Electrodes installed in test pits will have disconnecting facilities.

4.02.03 Above Ground Connections

(a) Galvanized steel flats shall be used for all connections above earth.

(b) Inside building, ground conductors 65x8 mm will be run for each floor supported on building steel and/or cable trays. These ground conductors in turn will be connected to the station ground grid through riser (riser raised for each alternate column or 10 meter distance between riser, whichever is higher) coming up along building columns / cable shafts.

(c) Two separate and distinct ground connections will be provided for each electrical equipment in compliance with I.E. Rules.

(d) All connections above ground will be welded type except connection to equipment/structures which shall be bolted type.

4.02.04 Equipment Ground Connection

Equipment ground connections will be sized to carry the available ground fault current. Considerations shall also be given to mechanical ruggedness of the connections and to limit the number of sizes.

The minimum ground conductor sizes for various equipment and structures are given in Cl.8.07.08

Entire erection of grounding work shall be carried out in such a way as to be capable of withstanding the intended services of carrying full short circuit level currents to ground mat without any damage/deformation.

5.00.00 LIGHTNING PROTECTION SYSTEM

5.01.00 Lighting protection system design shall be as per IS: 2309

The main purposes of lightning protection system are to:

a. Provide protection to structures from lightning strokes.

b. Provide a low resistance-conducting path to lightning discharge.

5.02.00 Lightning protection shall be provided for Power House building, Mill building & Transformer yard, switchyard, boiler, chimney etc.

5.03.00 Lightning protection shall be provided for structures/building higher than 55 meters in and/or where the calculated risk index exceeds 10-5.

5.04.00 For metal structures which are electrically continuous down to the ground level, no lightning protection is required except adequate grounding connections.

5.05.00 System Design

a. Air termination network with down conductors and earthing electrodes will be provided on the basis of IS Code of Practice.

b. The spacing between two horizontal air termination of 75X10 mm GS flat conductor on the roof of the installation shall not exceed 10 meters.

c. The vertical air terminal rods of 20mm dia shall be installed at the roof of buildings (including power house building), to protect these objects from lightning strokes.

d. Shielding angle for one vertical air termination shall be 45 degrees.

e. For more than one rod, shielding angle between the rods shall be taken as 60 Degrees.

f. Down conductors of 75x10 mm GS Flat for all installations except for conveyor gallery will run along the outer surfaces of the building and

shall have a test joint about 1500 mm above ground. It shall be 25x3 mm GS flat for conveyor gallery..

g. An earth electrode will be provided at the connection point of the down conductor with the station ground.

h. Galvanized steel rods and flats will be generally used for air termination and connections. All connections will be welded type.

i. An earth electrode of size 40 mm. diameter 3 metre long MS will be provided at the connection point of the down conductor with the station ground.

j. Risers (for Lightning protection) shall be of 1x40 (minimum) mm dia. MS rod from underground mat to minimum 300 mm above grade level/concrete floor level.

k. Shielding mast shall be provided at the top of steel columns cap plates of power house building.

l. All other ancillary items in connection with the work described above shall be furnished to complete the work irrespective of whether such items may have been specifically mentioned or not.

5.06.00 **CONSUMABLES AND HARDWARE**

5.06.01 The Contractor shall furnish all erection materials, hardware and consumables required to complete the installation.

The materials shall include but not be limited to the following :

Consumables : Welding rods & gas, oil and grease, cleaning fluids, paints, electrical tape, soldering materials etc.

Hardware : Bolts, nuts, washers, screws, brackets, supports, clamps, hangers, saddles, cleats, sills, shims etc.

6.00.00 **METHODS AND WORKMANSHIP**

6.01.00 All work shall be installed in a first class, neat workmanlike manner by mechanics/electricians skilled in the trade involved.

6.02.00 The erection work shall be supervised by competent supervisors holding relevant supervisory license from the Government.

6.03.00 All details on installation shall be electrically and mechanically correct.

6.04.00 The installation shall be carried out in such a manner as to preserve access to other equipment installed.

7.00.00 INSTALLATION

GROUNDING

7.01.00 The Contractor shall carryout the interconnection among various peripheral earthing grids/mats, steel structures, lightning protection system as well as

grounding of all electrical equipment, etc. The grounding work shall be carried out as per provisions of I.E. rules Indian standards and Erection grounding and lightning protection notes and details.

7.02.00 The grounding shall be done by conductors of sizes as laid down in grounding drawings and the same shall be connected to the risers of main ground mat.

7.03.00 For fabricated cable trays, a separate ground conductor (50x6 mm G.S. flat) shall run along the entire length of each route of cable tray being suitably clamped on the cable tray. Individual cable trays of each section shall be connected to above ground conductor through 50x6 mm G.S. flat to maintain continuity of ground path.

7.04.00 All ground conductor connections shall be made by electric arc welding/brazing unless otherwise specified. Ground connections shall be made from nearest available station ground grid risers.

7.05.00 All ground conductors shall be painted black for easy identification.

7.06.00 Equipment ground connections, after being checked and tested by the Engineer, shall be coated with anti-corrosive paint.

7.07.00 Whether specifically shown or not, all conduits, trays, cable armour and cable end box, electrical equipment such as motors, switchboards, panels, cabinets, junction boxes, lockout switches, fittings, fixtures, etc. shall be effectively grounded.

7.08.00 If there is no provision to ground the L.T. transformer neutral at transformer end, to make an effectively earthed 415V system the neutral bus of all 415V distribution boards shall be connected to ground grid at two different and distinct points.

7.09.00 The underground mat will be made of mild steel rods laid underground in length and breadth of the area at a depth shown in drawing but not less than 1000 mm below grade level. All crossings and straight run shall be arc welded for good electrical continuity. Ground conductors, when crossing underground trenches, directly laid underground pipe and equipment foundation, if any, shall be at least 300 mm below the bottom elevation of such trenches/pipes as shown in the relevant drawing.

7.10.00 The Contractor will plan and organise works to lay the grounding mat in the same sequence in which the building and equipment foundation is being done.

7.11.00 Ground Electrode

Ground electrodes will be 40 mm (min) dia and 3 metre long M.S. rod. These are to be fabricated and driven into the ground by the side of mat conductor. All connections to the conductors shall be done by are wilding process.

7.12.00 Risers

Risers are required for connecting the equipment and structures with the ground mat. These will be 1 No. 40 mm (min) dia M.S. rod. laid from ground mat to above ground level properly clamped or supported along the outer edge of the concrete foundation. Connection to the ground mat shall be done

by arc welding and the other end is to be kept free at least 300 mm above grade level/concrete floor level unless otherwise shown.

For every upper/lower floor the distance between two adjacent risers from the below the grounding grid shall not greater than 10meters.

7.13.00 **Column Grounding**

All columns are required to be grounded by 1 no. 40 mm(min) dia M.S. rod from ground mat. Laying, supporting along with foundation, connecting at ground mat are within the scope of this specification. At least 300 mm length of the above rods shall be left free above the grade level/concrete floor level for connection with columns.

7.14.00 PAINTING

The Contractor shall paint steel fabrications at site with two (2) coats of red oxide primer and two (2) coats of battleship grey (shade no. 632 of IS:5) synthetic enamel paint.

8.00.00 ERECTION OF EARHING AND LIGHTNING SYSTEM NOTES AND DETAILS

GROUNDING SYSTEM

8.01.00 MAIN GROUNDING MAT/GRID.

8.01.01 The main ground grid shall be buried in earth at a minimum depth of 1000 mm below finished grade level unless stated otherwise. The size of ground grid conductor shall be bare 40 mm (min) dia. mild steel rod.

8.01.02 A minimum earth coverage of 300 mm shall be provided between the ground grid conductor and the bottom of trenches, tunnels, underground pipes, foundations, railway tracks etc. The ground grid conductor shall be re-routed in case it fouls with equipment foundations.

8.01.03 In some cases, it may happen that the construction work of cable trench, foundation and laying of underground pipes are being taken up after the grounding mat has been laid. It may be required to cut a portion of grounding conductor to avoid fouling with cable trench, equipment foundations, underground pipes etc. In this case, the ground conductor shall be properly rerouted and rejoined/reconnected with the main grounding mat during the construction/laying of above underground objects and good electrical continuity of grounding conductor shall be ensured.

8.01.04 Grounding conductors crossing the road may have to be laid at greater depth to suit the site conditions.

8.01.05 Grounding conductor around the building shall be buried in earth at a minimum distance of 1200 mm from the outer boundary of the building.

8.02.00 **GROUNDING ELECTRODES**

8.02.01 The ground electrodes shall be Pipe Electrode, 100 NB, 3000 mm long heavy duty C.I. Pipe. These shall be fabricated and driven into the ground by the side of grounding mat conductors and connected to the ground mat conductors.

8.03.00 RISERS

8.03.01 All risers/pigtail from the ground grid shall be 40 mm (min) dia mild steel rod and shall be projected 300 mm above grade level/concrete floor level unless otherwise shown.

8.04.00 **EARTHING CONDUCTOR**

8.04.01 50x6 mm galvanised steel flats shall be run as main earthing conductors above ground along building columns, walls, steel structure, etc. for equipment and other structures earthing.

8.04.02 These earthing conductors shall be interconnected between them and to the main ground grid through risers/pigtail. The connection between earthing conductor and riser shall be made above ground.

8.04.03 Earthing conductors along their run on column, wall etc. will be supported by suitable welding/clamping at intervals set exceeding 750 mm.

8.04.04 Earthing conductors shall be embedded in concrete floor of the building without having direct contact with the reinforcement rods. Minimum concrete cover above earthing flat shall be 50 mm.

8.04.05 At the crossing of building walls, floors etc. the earthing conductor shall be passed through galvanised conduit sleeves. Both ends of the sleeve shall be sealed to prevent the passage of water through the sleeves.

8.05.00 **GROUNDING OF EQUIPMENT AND STRUCTURES**

8.05.01 All indoor and outdoor electrical equipment and associated non-current carrying metal works, supporting structures, building/ boiler columns, fence, system neutrals, lightning masts/arresters shall be connected to the plant ground system.

8.05.02 Two separate and distinct ground connections shall be provided for grounding electrical equipment frameworks in compliance with I.E. rules.

8.05.03 All Electrical equipment will be furnished with two (2) separate ground pads with tapped holes, bolts and spring washers. The connection between these ground pads and the grounding grid shall be made by short and direct earthing conductors free from kinks and splices.

8.05.04 Miscellaneous devices such as junction boxes, pull boxes, pushbutton stations, lockout switches, cable end boxes, lighting fixtures, receptacles, switches etc. shall be effectively grounded whether specifically shown or not.

8.05.06 The generator neutrals, transformer neutrals, earthing terminals of lightning arrestors, coupling capacitor shall be directly connected to Pipe Earth Electrode which in turn shall be connected to station grounding mat. Pipe Earth Electrode shall be 100 NB, 3000 mm long heavy duty C.I.Pipe.

Treated Earth Pits shall be provided for Generator & transformer neutral earthing.

8.05.07 Grounding mat comprising closely spaced conductors shall be provided below the operating handles of isolator and circuit breaker operating box located in outdoor high voltage substation. The operating handles shall be properly bonded with flexible conductors.

Metallic conduits and pipes shall not be used as earth continuity conductor.

8.05.08 Grounding mat comprising closely spaced conductors shall be provided below the operating handles of isolator and circuit breaker operating box located in outdoor high voltage substation. The operating handles shall be properly bonded with flexible conductors.

8.05.09 Metallic conduits and pipes shall not be used as earth continuity conductor.These shall be grounded at both ends.

8.05.10 The cable trays inside the cable trenches shall be grounded thru' one (1) no. 40 mm (min) dia M.S. Rod at an interval of ten (10) metres. One end of this rod is connected with riser from grounding mat and the other end which is projected inside the cable trench shall be connected with one (1) 50x6 mm G.S. flat which runs horizontally along the cable trench. This earthing conductor shall be securely attached to each tray section of cable tray/trays forming a solidly grounded tray system through 50x6 mm G.S. flats.

8.05.11 A continuous 50x6 mm G.S. flat earthing conductor shall run along the supporting structure of overhead cable trays/cable shafts.This earthing conductor shall be attached to each section of cable tray/trays through 50x6 mm G.S. flats.

8.05.12 Fence within the ground grid shall be bonded to the plant ground system at regular interval not exceeding ten (10) metres. Fence gate shall be separately grounded with flexible connection to permit movement. Earthing conductor shall be buried atleast 2000mm outside the fence of electrical installation.

8.05.13 The street lighting poles, junction boxes mounted on the poles etc. shall be connected to ground grid at minimum two points.

8.05.14 The steel columns, metallic stairs, hand-rail etc. of the building where electrical equipment are located shall be connected to the nearby groundmat by earthing conductor. Electrical continuity shall be ensured by bondingthe different sections of handrails and metallic stairs.

8.05.15 The railway tracks within plant area shall be bonded across fish plates and the rail tracks shall be connected to grounding grid at different locations.The rail tracks leaving the plant boundary shall be made electrically discontinuous from the rail tracks inside the plant area by providing suitable arrangements at fish plate joints.

8.05.16 The overhead crane rails shall be grounded at both ends. In addition all joints shall be bonded to provide electrical continuity.

8.05.17 The flexible earthing connection of jumpering wire shall be provided where flexible conduits are connected to rigid conduits to ensure continuity.

8.06.00 EARTHING OF CABLE

8.06.01 The metallic sheaths, screens and armour of cables shall be earthed at both switchgear/MCC/DB and equipment ends.

8.07.00 JOINTING AND CONNECTION

8.07.01 All ground conductor connections below ground level shall be done by electric arc welding with low hydrogen content electrode. The contact surfaces shall be thoroughly cleaned to provide good electrical continuity.

8.07.02 The bending of the large diameter ground conductor where necessary shall be done by gas heating.

8.07.03 The projected portion of riser/pigtail above ground shall be coated with two coats of bitumen paints (anti-corrosive paints) with a minimum thickness of 1 mm after connection.

8.07.04 The connections between the riser/pigtail and earthing conductors (galvanised steel flats) and between the earthing conductors above ground level shall be made by electric arc welding.

8.07.05 The portion of galvanised steel flats, which undergoes welding at site, shall be coated with two (2) coats of cold galvanising anti-corrosive paint after welding.

8.07.06 The earthing connections to equipment grounding pads/terminals and some removable structures shall be bolted type with GS bolts and nuts. The contact surfaces shall be thoroughly cleaned (to free from scale, paint, enamel, grease, rust) before connection to ensure good electrical contact.

8.07.07 Equipment/structures ground connections after properly checked and tested shall be coated with weather resistant paints/cold galvanising paints.

8.07.08 The sizes of earthing conductors for bvarious electrical equipments shall be as below:

	Equipment	**Earth condcutro buriedin earth 40 mm dia . MS Rod**	**Earth conductor above ground level & in built-up trenches**
a.	Main earth grid	40 mm dia MS rod	
b.	33kV/11kV/6.6kV/3.3 kV/ switchgear equipment and Transformers	--	75 x 10mm GS flat
c.	415 V PCC/PMCC/MCC/ Distribution boards	--	50 x 6mm GS flat
d.	LT Motors above 90 KW	--	50 x 6mm GS flat
	30 KW to 90 KW	--	35 x 6mm GS flat
	5KW to 30 KW	--	25 x 3mm GS flat

	Equipment	Earth condcutro buriedin earth 40 mm dia . MS Rod	Earth conductor above ground level & in built-up trenches
	Upto 5kW	--	8 SWG GI wire
	Fractional House power motor	--	8 SWG GI wire
e.	Control panel, local panel, lighting panel & control desk	--	35 x 6 mm GS flat
f.	Push button station / Junction Box	--	8 SWG GI wire
g.	Columns, structures, cable trays and bus ducts enclosures	--	50 x 6mm GS flat
h.	Crane, rails, rail tracks & other non-current carrying metal parts	--	25 x 6mm GS flat

8.08.00 LIGHTNING PROTECTION SYSTEM

8.09.00 AIR TERMINATIONS

8.09.01 The vertical air terminal rods shall be installed at the roof of buildings (including power house building), to protect these objects from lightning strokes.

8.09.02 The vertical air terminal shall be made of 20 mm dia. Galvanised steel rod. The projected length of the rod shall be as required to protect the object (on which the rod is fixed) from lightning stroke.

8.09.03 The air terminal rod shall be properly fixed on the top of the building/structure to withstand very high wind pressure. In case the air terminal rod is embedded at the top of roof of building, the portion embedded inside the concrete shall not touch the reinforcement bars and shall be duly insulated from them.

8.09.04 All the vertical air terminal rods shall be electrically connected together by means of horizontal conductors of size 50x6 mm galvanized steel flats.

8.09.05 The shielding angle for one vertical air termination shall be 45 degrees. For more than one rod, shielding angle between the rods shall be taken as 60 degrees.

8.09.06 For tall building and structures, early streamer emission (ESE) type air terminal system are preferred.

8.10.00 SHIELDING MASTS

8.10.01 The shielding mast for lightning protection shall be installed at the top of steel columns cap plates of power house main building.

8.10.02 The shielding mast shall be made of galvanized steel pipe and the height of the same shall be decided considering the zones to be protected.

8.10.03 Each shielding mast shall be connected to grounding grid by a down conductor 50x6 mm. Galvanized steel flat run along the building column. In addition all power house building columns joints shall be electrically bonded.

8.11.00 DOWN CONDUCTORS

8.11.01 The down conductors shall be 50x6 mm galvanised steel flats. The sizes of down conductors and horizontal conductor provided for lightning protection of conveyer gallery shall be 25 x 6 mm galvanised steel flats.One end of this shall be connected with air terminal rod/horizontal conductor at the top of roof/ structure and other end connected to the nearest 40 mm (min) dia. mild steel rod riser from ground electrode.

8.11.02 Each down conductor shall have an independent earth termination. In no case conductors of the lightning protection system shall be connected with the conductor of grounding system above ground level.

8.11.03 The connection between each down conductor and rod electrode (by means of 40 mm mild steel rod riser) shall be made via test link located at approximately 1500 mm above ground level.

8.11.04 The down conductor shall be laid straight and sharp bends shall be avoided as far as practicable. These shall be cleated on outside of the building wall and column/ structure at about 750 mm intervals unless stated otherwise in the drawing.

8.11.05 At all supports for down conductor along the column/wall of the buildings; chimney etc. the portion embedded inside the building concrete should not touch the reinforcement bars.

8.11.06 All exposed metallic parts of the buildings shall be bonded to the down conductors. Such parts shall include ladders, balconies, conduits etc.

8.11.07 The down conductors shall be protected at the ground level against mechanical injury by means of non-metallic pipes, viz. PVC pipes filled with bituminous compound.

8.12.00 **ELECTRODES (FOR LIGHTNING PROTECTION)**

8.12.01 The electrodes shall be 40 mm diameter 3000 mm long mild steel rod. These shall be driven into the ground.

8.12.02 All the electrodes shall be interconnected by means of one (1) 40 mm dia mild steel rod which will be laid under ground at a minimum depth of 1000 mm below finished grade level unless stated otherwise. This ground mats/electrode in turn shall be connected to main grounding grid.

8.13.00 RISER (FOR LIGHTNING PROTECTION)

8.13.01 All risers connected to grounding mat shall be 40 mm mild steel rods and shall be projected 300 mm above grade level unless stated otherwise.

8.14.00 JOINTING & CONNECTION

8.14.01 All ground conductor connections below ground level shall be done by electric are welding with low hydrogen content electrode.

8.14.02 The projected portion of riser above ground shall be coated with two (2) coats of bitumen paints (anti-corrosive paints) with a minimum thickness of 1 mm after connection.

8.14.03 The joints in the lightning conductors shall be kept to a minimum and there shall be no joint in the underground portions of conductors.

8.14.04 All the joints shall be done by arc welding process overlapping of the conductors at straight joints shall not be less than 150 mm. The contact surfaces shall be cleaned properly before jointing.

8.14.05 The portion of galvanised steel flats, which undergoes welding at site, shall be coated with two (2) coats of cold galvanising anti-corrosive paint after welding.

8.14.06 The bolted joint of the test link shall be covered with thick coating of bitumen paint after successful testing.

8.14.07 The air terminal rods and shielding mast shall be coated with weather resistant anti-corrosive paint (zinc chromate followed by two coats of aluminium paint).

8.14.08 The steel to copper connection shall be brazed type.

8.15.00 LIGHTNING PROTECTION OF OTHER AREAS.

8.15.01 The lightning protection of other areas shall be done by lightning masts on the top of steel towers. In addition, shield wires shall be used where required. The shield wire shall be strung across the top of the steel tower and/or power house structure.

8.15.02 The shield wire which shall be brought down up to bottom of steel tower shall be connected to the earthing conductor (75x10 mm galvanised steel flat) which in turn connected to the riser (from the main grounding mat/grid).

8.15.03 The lightning protection of inflammable liquid storage tanks wherever required, shall be provided with horizontal conductors strung between tall poles covering the entire zones or with air terminal rods mounted on top of poles/structure. These horizontal conductors/vertical air terminal rods shall be connected to rod electrodes, which in turn shall be connected to station ground mat.

8.15.04 All metallic equipments on roof and exposed steel works within the vicinity of 2000 mm from lightning protection conductors in air shall be bonded to conductors of lightning protection system.

8.16.00 THE SIZES AND MATERIALS OF EARTHING CONDUCTORS TO BE USED IN LIGHTNING PROTECTION SYSTEM ARE LISTED BELOW:

	DESCRIPTION	SIZE	MATERIAL
(a)	Vertical air termination	20 mm dia rod	Galvanized mild steel
(b)	Horizontal conductor	(i) 50*6 mm flat	Galvanized steel
(c)	Down conductors	(i) (i) 50*6 mm flat	-Do-
(d)	Riser from Electrode/grounding mat	40 mm(min) dia rod	Mild Steel
(e)	Electrode for lightning protection	40 mm dia (min)Rod 3000 mm long	-Do-

NOTE:

In addition to above, all materials as required such as G.I. pipes of appropriate length, diameter and thickness will be provided for lightning masts of Power House building.

9.00.00 GALVANISING

The galvanizing shall be uniform, clean, smooth, continuous and free from acid spots. Should the galvanizing of the samples be found defective, the entire batch of steel has to be regalvanised, at Contractor's cost. The amount of zinc deposit shall not be less than 610 grams per square meter of surface area and in addition, the thickness of the zinc deposit at any spot whatsoever shall not be less than 86 microns. The Owner reserves the right to measure the thickness of zinc deposit by Elkometer or any other instrument and reject any component which shows thickness of zinc at any location less than 86 microns.

10.00.00 EXCAVATION AND BACK FILLING

10.01.00 The Contractor shall perform all excavation and backfilling as required for buried cable and ground connections.

10.02.00 Excavation shall be performed up to the required depth. Such sheeting and shoring shall be done as may be necessary for protection of the work.

10.03.00 The Contractor shall make use of his own arrangements for pumping out any water that may be accumulated in the excavation.

10.04.00 All excavation shall be backfilled to the original level with good consolidation.

11.00.00 TESTS

11.01.01 All equipment to be supplied shall be of type tested design. During detail engineering, the contractor shall submit for Owner's approval the reports of all the type tests as listed in this specification and carried out within last ten years from the date of bid opening. These reports should be for the test conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client.

However if the contractor is not able to submit report of the type test(s) conducted within last ten years from the date of bid opening, or in the case of type test report(s) are not found to be meeting the specification requirements, the contractor shall conduct all such tests under this contract at no additional cost to the owner either at third party lab or in presence of client/owners representative and submit the reports for approval.

All acceptance and routine tests as per the specification and relevant standards shall be carried out. Charges for these shall be deemed to be included in the equipment price.

12.00.00 EARTHING AND LIGHTNING PROTECTION FOR CHIMNEY

12.01.00 Pointed vertical air terminal rods shall be provided at the top of the chimney shell. These shall be equally spaced at not more than 3 m interval around the outside circumference at the top of chimney. Air terminals shall consists of lead covered copper rods each not less than 20 mm in diameter and of height not less than 750 mm and securely anchored and braced with at least two lead covered copper alloy anchors spaced not more than 750 mm on centers. Air terminals shall be mechanically and electrically connected by the use of pressure type fittings to the chimney shell periphery and to a continuous circumferential conductor specified in clause 6.2. The installation work shall conform to IS: 2309/IEC. The ohmic resistance of the lightning conductor system complete with air termination, but without the earth connection, shall be fraction of an ohm.

12.02.00 The circumferential conductor shall be min 70 sq.mm lead covered, stranded, tinned copper conductor and the same shall be mounted at the top of the chimney shell. The circumferential conductor shall be suitably anchored to the top of the concrete shell.

12.03.00 The down conductors shall be of stranded tinned copper conductors of size min 70 sq.mm and shall run on opposite sides of the chimney. Down conductors shall be connected to the circumferential conductor at the top of the chimney and to the testing point at the chimney base as given in clause.

12.04.00 There shall be no intermediate splices in the down conductors the down conductors shall be cleated to the inner face of the concrete shell. The downconductors shall come outside the shell at the bottom through suitable pipesleeves to facilitate connection with the test link. The down conductors shallbe spaced at least 2000 mm away from the vertical conduit risers as well asthe staircase.

12.05.00 All vertical reinforcing bars at the top and at the bottom of the chimney shell shall be electrically connected to the nearest horizontal reinforcing rods and these rods shall in turn be connected to the copper down conductors. Where vertical reinforcing bars are spliced, each spliced bar shall be electrically connected to at least one horizontal reinforcing bar which in turn shall be electrically connected to each of the down conductors. These electrical connections with copper conductor shall be made by lashing with not less than five tightly wrapped turns of 6 sq. mm size solid soft drawn untinned copper wire.

12.05.00 All the metallic parts such as platform, railings, pull boxes, junction boxes etc. shall be grounded using GI wire of suitable size to the nearest GS flat.

12.06.00 Lightning protection and earthing required during the construction stage of the chimney shall also be provided by the Purchaser's.

12.07.00 During construction, temporary lightning protection should be maintained by connecting the concrete reinforcement to two permanent electrical grounding conductors. After the top lift of the chimney shell has been completed, temporary air terminals which may consist of reinforcing bars should be installed at the top to serve as temporary protection until the permanent air terminals are installed.

12.08.00 Chimney staircase/ladder shall be electrically connected to the down conductors both at top and bottom. For this, the two lower pairs of inserts supporting the staircase shall be adequately grounded by connecting to thecircumferential conductor connected to the down conductor. All intermediatebreaks in the staircase should be electrically bonded to maintain continuityfrom top to bottom.

12.09.00 Each down conductor shall be provided with a testing point at around 1000mm above ground level, but inaccessible to avoid interference. Test link shall be enclosed in 200 x 200 x 100 mm GI box fabricated hour 16SWG sheet steel.

12.10.00 All connections, clamps anchors, etc. of the lightning protection system shall be made of copper or suitable alloy fittings. All electrical connection, unless otherwise specified, shall be clamped or bolted by high pressure contact or by copper brazing of the metal to form a connection of adequate current carrying capacity and mechanical strength. Soldered connections will not be permitted.

12.11.00 Air terminals, connections, conductors, clamps, fixtures, anchors, etc. exposed within 8000 mm of the top of the chimney shall have a continuous covering of a sheath of commercially pure lead not less than 2.0 mm in thickness extruded and fused upon bare copper, the ends being covered by soldering. Where lead covering is specified, connection shall be made from copper to copper and after the joints have been made, they shall be again covered with solder or lead either by wiping or casting so that copper will not be exposed.

12.12.00 Make of all items used shall be of reputed and reliable make. These makes shall be subject to purchaser's approval.

CHAPTER 30 : ERECTION OF ELECTRICAL EQUIPMENTS

1.00.00 SCOPE OF WORK

1.01.00 The scope of work shall cover complete and efficient Erection, Testing and Commissioning and putting into successful commercial operation of all Outdoor and Indoor electrical equipment supplied under Power Plant EPC Package covering Power House Building, Transformer Yard & Mill Building, CW Pump House, Fuel Oil Pressuring Pump House, Plant Water System, Coal Handling, Ash Handling Plant, Chimney, IDCT, Air Compressor, Buildings & Areas & Interfacing etc as specified.

1.02.00 The scope of work shall also include all civil and structural works necessary for successful installation and commercial operation of all electrical equipment to be erected under this specification.

2.00.00 SCOPE OF SUPPLY

2.01.01 The work involves timely procurement and transportation to site in properly packed condition of all hardware, materials and miscellaneous items required to complete the erection job under this specification.

Miscellaneous steel structures, tray supports, hangers & brackets for cable trays, mounting of local panels, push button stations etc. shall be supplied. Any material or accessory, which may not have been specifically mentioned but which is usual and / or necessary shall be supplied.

2.01.02 All hardware, materials and accessories to be supplied by the Bidder shall be brand new ones of reputed make.

2.01.03 Spare Parts

2.01.04 All relevant drawings, data sheet and technical leaflets on each piece of devices.

2.02.00 SCOPE OF SERVICE

The work includes but is not limited to the followings:

2.02.01 Furnishing of all erection tools and tackles, testing equipment, implements, supplies, consumables and hardware for timely and efficient execution of the erection work. Hydraulic jacks or motorized jacks necessary for lifting of heavy equipment shall be provided by the contractor.

2.02.02 Transport vehicles necessary for efficient transportation of equipment from Owner's stores to site of erection and excess materials back to owner's stores.

2.02.03 Complete assembly, erection and connection, testing and commissioning, putting into successful and satisfactory commercial operations of the Outdoor and indoor Electrical Equipment and accessories listed below but not limited to:

(a) Power Plant System

(i) Generator Transformer
(ii) Unit Transformers & Unit Aux Transformers
(iii) Station Transformers & Station Aux Transformers
(iv) L.T. Transformers

(v) Lighting Transformers
(vi) Stringing and Connections
(vii) Neutral Grounding Resistor Cubicles
(viii) General Busduct and Auxiliary equipment
(ix) 3.3 kV & 11kV Busduct
(x) 415V Busduct
(xi) 11 kV Switchgear
(xii) 3.3kV Switchgear
(xiii) 415V Switchgears, Switchgear cum MCCs
(xiv) Motor Control Centres, A.C/ D.C. Distribution Boards, Main Lighting Distribution Boards and Miscellaneous items.
(xv) Battery and Battery chargers and DCDB.
(xvi) Electrical Control Panels, Relay Panels, Data logger Panels etc.
(xvii) Miscellaneous Local Panel
(xviii) Illumination system
(xix) 11 kV & 3.3 kV Power cable, 1.1 kV Power & Control Cables, FS Power and Control cables, special cables including cabling system.
(xx) Complete Switchyard
(xxi) All electrical equipment and systems integral with mechanical equipment, systems and sub-systems.
(xxii) DG set

2.02.04 The complete erection work shall be carried out in a phased manner. A schedule of the work showing the sequence of erection shall be submitted by the Bidder for this purpose.

2.02.05 The erection schedule, as approved by the Owner's Engineer shall be strictly followed by the contractor. If, for any reason beyond the control of the Contractor, the work is held-up then the Contractor shall bring it to the notice of the Owner's Engineer without any delay

2.02.06 All erection work of equipment shall be carried out in a neat and efficient way so as not to impaire their normal functioning in any way.

2.02.07 The pre-commissioning checks as well as commissioning of different equipment shall be carried out as per guidance of actual manufacturer's supervisor and or as per written instructions in Erection manuals. In case of any site related problem in commissioning activities, contractor shall seek advice of owner's engineers.

2.02.08 All erection work under this specificationshall be carried out strictly in accordance with the approved drawings.

2.02.09 In order to avoid concentration of stresses, all sharp edges of clamps, connectors etc. shall be rounded off.

2.03.00 METHOD AND WORKMANSHIP

2.03.01 All work shall be installed in a first class, neat workmanlike manner by mechanics / electricians skilled in the trade involved.

2.03.02 The erection work shall be supervised by competent supervisors holding relevant supervisory license from the Government.

2.03.03 All details on installation shall be electrically and mechanically correct.

2.03.04 The installation shall be carried out in such a manner as to preserve access to other equipment installation.

In order to avoid concentration of stresses, all sharp edges of clamps, connectors etc. shall be rounded off.

2.04.00 CONSUMABLES AND HARDWARE

2.04.01 The Contractor shall furnish all erection materials, hardware and consumables required for the completion of the installation

2.04.02 The materials shall include but not be limited to the following:

(a) Consumables : Welding rods & gas, oil and grease, cleaning fluids, paints, electrical tape, soldering materials etc.

(b) Hardware : :Bolts, nuts, washers, screws, brackets, supports, clamps, hangers, saddles, cleats, sills, shims etc.

(c) Materials : Junction boxes, terminal blocks, connectors, ferrules, lugs, brass glands, rigid/flexible conduits, cables, ground wires etc.

2.04.03 Supply of cement, sand, stone etc. required for the execution of the contract shall be the responsibility of the Contractor.

2.05.00 TESTING EQUIPMENT

2.05.01 The major testing equipment that ar required to be provided by the Contractor are listed below:

(a) Insulation Tester 10 kv Grade : (i) Power Operated Megger – 1 kV and (ii) hand Operated Megger - 1kv Grade

(b) Hand driven earth Resistance Meggar, range 0-1/3/30 Ohms

(c) high Potential testing Set – roller mounted type for LV, HV & EHV Equipment.

(d) Tong testers of suitable ranges

(e) Contact resistance measuring set of Micro-ohms

(f) Torque wrench of various sizes

(g) Multi-meters, test lamp, field telephone with buzzer set, spirit level, different gauges etc.

(h) Insulating oil testing set of range 0-60kV.

(i) Stream line filter for transformer

(j) Current Transformer for primary injection set

(k) Relay testing and checking bench

2.05.02 Other test equipment as required will be arranged by the contractor.

2.06.00 INSTALLATION – GENERAL

2.06.01 Installation work shall be carried out in accordance with good engineering practices and also manufacturer's instructions/ recommendations where the same are available.

2.06.02 Equipment shall be installed in a neat workmanlike manner so that it is level, plumb, square and properly aligned and oriented.

2.06.03 All erection work shall be carried out in strict compliance with manufacture's instructions and shall include all necessary adjustments, checks and measurements.

2.06.04 All internal wiring of the equipment which has been left incomplete because of shipping split or which requires minor modifications shall be carried out by the contractor.

2.06.05 The contractor shall record results of all erection tests and measurements. The contractor shall submit copies of those test results to the Owner for his reference and record.

2.06.06. High voltage test of transformer oil shall be carried out taking samples from individual transformer and also from each insulating oil drum. If the result of di-electric test is not to the satisfaction of the engineer, oil filtration, heat run and conditioning shall be carried out for the concerned transformer to improve the dielectric strength of oil and insulation to the acceptable value.

2.06.07 The storage and installation of transformer with all its accessories shll be carried out in strict compliance with manufacturer's instructions. Extreme care shall be taken to avoid ingress of moisture and foreign practicals into the transformer tank.

2.07.00 STEEL FABRICATION

2.07.01 All racks, supports, hangers and brackets wherever necessary shall be fabricated by the contractor.

2.07.02 Steel for fabrication shall be straightened and cleaned of rust and grease. All fabrication shall be free of sharp edges.

2.08.00 PAINTING

2.08.01 The Contractor shall paint all racks, supports and miscellaneous steel fabrication with two (2) coats of red oxide primer and two (2) coats of synthetic enamel paint of approved shade (say battle ship grey IS shade # 632)

2.09.00 FOUNDATION & CIVIL WORKS

2.09.01 Equipment foundations, equipment mounting structure foundation, panel foundations and other civil work will be provided by the Contractor.

2.09.02 The Contractor shall check these foundations before commencement of erection to ensure their suitability.

2.09.03 All final adjustment of foundation levels, chipping and dressing of foundation surfaces, setting and grouting of anchor bolts, sills, inserts and fastening devices shall be carried out by the contractor including minor modification of civil work as may be required for erection.

2.10.00 CLEANING UP OF WORK SITE

2.10.01 The Contractor shall, from time to time, remove all rubbish resulting from execution of his work. No materials shall be stored or placed on passage or drive ways.

2.10.02 Upon completion of work, the Contractor shall remove all rubbish, tools, scaffoldings, temporary structures and surplus materials etc. to leave the premises clean and fit for use.

3.00.00 TESTS

3.01.00 SITE TESTS

3.01.01 Contractor shall thoroughly test and megger all cables, wires and equipment to prove the same are free from ground and short circuit after erection and installation at site.

3.01.02 If any ground or short circuit is found the fault shall be rectified or the cable and / or equipment replaced.

3.01.03 AL equipment shall be demonstrated to operated in accordance with the requirements of this specification

3.01.04 All equipment shall be subject to High Potential test.

3.01.05 All protective relays shall be checked for correctness of operations.

3.01.06 All current transformers shall be subjected to Primary Injection test.

3.010.7 Generator Bus-duct Polarisation Index (P.I. value) shall be measured.

3.02.00 PRE-COMMISSIONING TESTS AT SITE

3.02.01 The installation of different type of equipment and accessory shall be tested by the contractor after completion of his erection work with an advance notice to the Engineer concerned so that he may witness the same also.

3.02.02 The test result of any installation or equipment or its parts, if considered unsatisfied to the Engineer, the concerned installation / equipment and its accessories shall be properly rectified and tested again to the satisfaction of the Engineer by the Contractor at his own cost.

3.02.03 The site tests to b carried out by the contractor on completion of installation / erection of equipment are broadly listed below for ready reference of contractor.

3.02.04 The major testing equipment which will be necessary for carrying out pre-commissioning tests at site are already listed in this specification.

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

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

NAME OF VENDOR					
			SEAL	REV.	
NAME	SIGNATURE	DATE			

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

LOAD TITLE	RATING (KW / A)		UNIT (U)/STN (S)	Nos.		VOLTAGE CODE*	FEEDER CODE**	EMER. LOAD (Y)	CONT.(C)/ INTT.(I)	STARTING TIME >5 SEC (Y)	LOCATION	BOARD NO.	CABLE		BLOCK CABLE DRG. No.	CONTROL CODE	REMARKS	LOAD No.
	NAME PLATE	MAX. CONT. DEMAND (MCR)		RUNNING	STANDBY								SIZE CODE	NOs				
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19

NOTES:
1. COLUMN 1 TO 12 & 18 SHALL BE FILLED BY THE REQUISITIONER (ORIGINATING AGENCY); REMAINING COLUMNS ARE TO BE FILLED UP BY PEM (ELECTRICAL)
2. ABBREVIATIONS : * VOLTAGE CODE (7):- (ac) A=11 KV, B=6.6 KV, C=3.3 KV, D=415 V, E=240 V (1 PH), F=110 V (cc): G=220 V, H=110 V, J=48 V, K=+24V, L=-24 V
: ** FEEDER CODE (8):- U=UNIDIRECTIONAL STARTER, B=BI-DIRECTIONAL STARTER, S=SUPPLY FEEDER, D=SUPPLY FEEDER (CONTACTER CONTROLLED)

भेल BHEL	LOAD DATA (ELECTRICAL)	JOB NO.	410	ORIGINATING AGENCY		PEM (ELECTRICAL)	
		PROJECT TITLE	1 X 660 MW PANKI TPS	NAME		DATA FILLED UP ON	
		SYSTEM / S	NDCT	SIGN.		DATA ENTERED ON	
		DEPTT. / SECTION	ELECTRICAL	SHEET 1 OF 1	REV. 00	DE'S SIGN. & DATE	

			CUSTOMER :			PROJECT TITLE :			SPECIFICATION NO. :			
		QUALITY PLAN	BIDDER/ VENDOR :			STANDARD QP NO. : PE-QP-999-509-E001, REV. 0			SPECIFICATION TITLE:			
		SHEET 1 OF 2	SYSTEM	EARTHING		ITEM : EARTHING & LIGHTNING PROTECTION MATERIALS			DOC. NO. :			
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS
									P	W	V	
1	2	3	4	5	6	7	8	9	10			11
1.0	**RAW MATERIAL**											
1.1	MILD STEEL (FLATS & RODS) AS PER SPECIFICATION	1.CHEMICAL & PHYSICAL PROPERTIES	MA	VERIFICATION, OF TC'S	100%	IS:2062	IS:2062	MILL TC	3	-	1/2	Refer note in Remark at Sl. No.3
		2.DIMENSIONS	MA	MEASUREMENT	100%	IS - 1730	IS - 1730	QC RECORD	3/2	-	-	
		3.SURFACE FINISH	MA	VISUAL	100%	IS : 1079	IS : 1079	QC RECORD	3/2	-	-	
1.2	ZINC	1.CHEM.COMP.	MA	CHEM.TEST	SAMPLE	IS - 209	IS - 209	QC RECORD	3/2	-	1/2	
2.0	**IN-PROCESS**											
2.1	CUTTING, DRILLING	1.DIMENSIONS	MA	MEASUREMENT	100%	APP. DATA SHEET/ APP. DRAWING	APP. DATA SHEET/ APP. DRAWING	QC RECORD	2	-	1	
		2.SURFACE FINISH	MA	VISUAL	100%	FREE FROM DEFECTS & SLAG	FREE FROM DEFECTS & SLAG	QC RECORD	2	-	1	
2.2	SURFACE PREPARATION	1.CLEANING PICKLING, RINSING, & FLUXING	MA	VISUAL	PERIODIC IN EACH SHIFT	IS:2629	IS:2629	QC RECORD	2	-	-	
		2.SURFACE QUALITY	MA	VISUAL	100%	IS:2629	IS:2629	QC RECORD	2	-	-	

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

LEGEND : 1 - BHEL/ CUSTOMER 2 - VENDOR 3 - SUB- VENDOR P - PERFORM W - WITNESS V - VERIFICATION

		QUALITY PLAN	CUSTOMER :			PROJECT TITLE :			SPECIFICATION NO. :			
			BIDDER/ VENDOR :			STANDARD QP NO. : PE-QP-999-509-E001 REV. 0			SPECIFICATION TITLE:			
		SHEET 2 OF 2	SYSTEM	EARTHING		ITEM : EARTHING & LIGHTNING PROTECTION MATERIALS			DOC. NO. :			
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS
									P	W	V	
1	2	3	4	5	6	7	8	9	10			11
2.3	GALVANISING	1.TEMPERATURE OF BATH	MA	TEMPERATURE INDICATOR	CONTINUOUS	IS - 2629	IS - 2629	QC RECORD	3/2	-	-	If vendor doesn't have his own galvanizing plant duly approved by BHEL PEM; then galvanizing shall be carried out at BHEL-PEM approved other galvanizing plants as per Annexure-2.
		2. DROSS	MA	VISUAL	PERIODIC	IS - 2629	IS - 2629	QC RECORD	3/2	-	-	
		3. RATE OF IMMERSION	MA	VISUAL/ MEASUREMENT	100%	IS - 2629/ MFRS PRACTICE	IS - 2629/ MFRS PRACTICE	QC RECORD	3/2	-	2	
		4.SURFACE QUALITY	MA	VISUAL	100%	IS - 2629	FREE FROM BURRS, ROUGHNESS, SLAG, FLUX, STAIN ETC.	QC RECORD	3/2	-	-	
3.0	**FINISHED ITEMS**	1. CHEMICAL	MA	CHEMICAL	1 No./LOT/SIZE	IS-2062	IS-2062	LAB TC	2	-	1	Note : Sample shall be selected by BHEL & testing shall be done at NABL/ govt. approved lab
		2.DIMENSIONS	MA	MEASUREMENT	IS 2500 (PART 1) LEVEL S-4	APP. DATA SHEET/ APP. DRAWING	APP. DATA SHEET/ APP. DRAWING	INSP. REPORT	2	1	-	
		3.SURFACE FINISH	MA	VISUAL	IS 2500 (PART 1) LEVEL S-4	FREE FROM BURRS, SLAG, ROUGHNESS, FLUX, STAIN, ETC.	FREE FROM BURRS, SLAG, ROUGHNESS, FLUX, STAIN, ETC.	INSP. REPORT	2	1	-	
		4.MASS OF ZINC COATING	MA	CHEM. TEST	IS - 4759	IS-6745 / APP. DATA SHEET	APP. DATA SHEET	INSP. REPORT	2	1	-	
		5.UNIFORMITY OF ZINC COATING	MA	CHEM. TEST	IS - 4759	IS-2633	IS-2633	INSP. REPORT	2	1	-	
		6.THICKNESS OF ZINC COATING	MA	ELCOMETER	IS - 4759	APP. DATA SHEET	APP. DATA SHEET	INSP. REPORT	2	1	-	
		6.ADHESION	MA	MECH.TEST	IS-4759	IS-2629	IS-2629	INSP. REPORT	2	1	-	

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

LEGEND : 1 - BHEL/ CUSTOMER 2 - VENDOR 3 - SUB- VENDOR P - PERFORM W - WITNESS V - VERIFICATION

			CUSTOMER :			PROJECT TITLE :			SPECIFICATION NO. :			
		QUALITY PLAN	BIDDER/ VENDOR :			STANDARD QP NO. : PE-QP-999-558-E001, REV.0			SPECIFICATION TITLE :			
		SHEET 1 OF 5	SYSTEM			ITEM :ILLUMINATION			DOC. NO. :			
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS
									P	W	V	
1	2	3	4	5	6	7	8	9	10			11
1.0	LUMINAIRES & LAMPS	1. ACCEPTANCE TEST										
		a) VISUAL	MA	VISUAL	IS 10322 (PART5 SEC1)	IS 10322 / APPD DRG./DATASHEET	IS 10322 / APPD DRG./DATASHEET	TEST CERT	3/2	1	-	AFTER SUCCESSFUL COMPLETION OF 1a, 1b & 1c FURTHER TESTING OF 1d) TO BE DONE BY PAPER INSERTION METHOD.
		b) IR (Dry)	CR	ELECTRICAL	IS 10322	-DO-	-DO-	-DO-	3/2	1	-	
		c) HIGH VOLTAGE	CR	ELECTRICAL	-DO-	-DO-	-DO-	-DO-	3/2	1	-	
		d) DUST PROOF	CR	ELECTRICAL	-DO-	-DO-	-DO-	-DO-	3/2	1	-	
		e) PHOTOMETRIC	CR	ELECTRICAL	-DO-	-DO-	-DO-	-DO-	3/2	1*	-	*: ONE NO. LUMINAIRE OF EACH TYPE TO BE WITNESSED BY BHEL. MAIN VENDOR TO WITNESS AS PER IS-10322.
		2. ROUTINE TEST										
		a) VISUAL	MA	VISUAL	100%	IS 10322 / APPD DRG./DATASHEET	IS 10322 / APPD DRG./DATASHEET	TEST CERT	3/2	-	1	
		b) IR (Dry)	CR	ELECTRICAL	-DO-	-DO-	-DO-	-DO-	3/2	-	1	
		c) HIGH VOLTAGE	CR	ELECTRICAL	-DO-	-DO-	-DO-	-DO-	3/2	-	1	
		3. TYPE TEST	MA	ELECTRICAL	ONE OF EACH TYPE	IS 10322. IEC-62384/ 61347 FOR LED	IS 10322. IEC-62384/ 61347 FOR LED	TEST REPORT	3/2	-	1**	**** Refer note 3 & 4**
2.0	LIGHTING PANELS AND LIGHTING DISTRIBUTION BOARDS/ FEEDER PILLAR	1.DIMENSIONS	MA	MEASUREMENT	10%	APPD DRG.	APPD DRG.	INSPT. REPORT	3	2,1	-	COMPONENTS TO BE OF APPROVED MAKE
		2.PAINT SHADE/ THICKNESS	MA	VISUAL/ MEASUREMENT	-DO-	APPD DRG./DATA SHEET	APPD DRG./DATA SHEET	INSPT. REPORT	3	2,1	-	
		3.DEGREE OF PROTECTION (INCLUDING EXPLOSION PROOF IF ANY)	MA	TESTS	1/ SIZE & RATING	APPD DRG./DATA SHEET RELEVANT IS	APPD DRG./DATA SHEET RELEVANT IS	TEST CERT	-	-	2,1	
		4.FUNCTIONAL TEST	MA	ELECT.	100%	APPD DRG./DATA SHEET	APPD DRG./DATA SHEET	INSPT. REPORT	3	2,1	-	
		5.HV/IR/HV	MA	ELECT	100%	2.5KV AC FOR 1 MINUTE	2.5KV AC FOR 1 MINUTE	INSPT. REPORT	3	2,1	-	

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

LEGEND : 1 - BHEL/ CUSTOMER 2 - VENDOR 3 - SUB- VENDOR P - PERFORM W - WITNESS V - VERIFICATION

QUALITY PLAN	CUSTOMER :	PROJECT TITLE :	SPECIFICATION NO. :
	BIDDER/ VENDOR :	STANDARD QP NO. : PE-QP-999-558-E001, REV.0	SPECIFICATION TITLE :
SHEET 2 OF 5	SYSTEM	ITEM :ILLUMINATION	DOC. NO. :

SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
		6. TYPE TEST	MA	ELECT	1/RATING	IS: 8623 (PART-1)/ IEC-439-1/ IS:60947/ APPD DATA SHEET	IS: 8623 (PART-1)/ IEC-439-1/ IS:60947/ APPD DATA SHEET	TEST REPORT	3/2	-	1**	**** Refer note 3 & 4**
3.0	LIGHTING TRANSFORMER	1. ROUTINE TEST										
		a) TYPE / RATING	CR	VISUAL	100%	IS 11171 / APPD DRG./DATA SHEET	IS 11171 / APPD DRG./DATA SHEET	INSPT. REPORT	3	2,1	-	
		b) WIND. RESISTANC	CR	TEST	100%	IS 11171 / APPD DRG./DATA SHEET	IS 11171 / APPD DRG./DATA SHEET	INSPT. REPORT	3	2,1	-	
		c) V. RATIO /VECTOR	CR	TEST	100%	IS 11171 / APPD DRG./DATA SHEET	IS 11171 / APPD DRG./DATA SHEET	INSPT. REPORT	3	2,1	-	
		d) Z VOLT/ Z SCKT	CR	TEST	100%	IS 11171 / APPD DRG./DATA SHEET	IS 11171 / APPD DRG./DATA SHEET	INSPT. REPORT	3	2,1	-	
		e) LOAD LOSS/ CURRENT	CR	TEST	100%	IS 11171 / APPD DRG./DATA SHEET	IS 11171 / APPD DRG./DATA SHEET	INSPT. REPORT	3	2,1	-	
		f) NO LOAD LOSS	CR	TEST	100%	IS 11171 / APPD DRG./DATA SHEET	IS 11171 / APPD DRG./DATA SHEET	INSPT. REPORT	3	2,1	-	
		g) SOURCE WITHSTAND	CR	TEST	100%	IS 11171 / APPD DRG./DATA SHEET	IS 11171 / APPD DRG./DATA SHEET	INSPT. REPORT	3	2,1	-	
		h) INDUCED O/V	CR	TEST	100%	IS 11171 / APPD DRG./DATA SHEET	IS 11171 / APPD DRG./DATA SHEET	INSPT. REPORT	3	2,1	-	
		2. TYPE TEST	MA	TEST	1/RATING	IS 11171 / APPD DRG./DATA SHEET	IS 11171 / APPD DRG./DATA SHEET	TEST REPORT	3/2	-	1**	**** Refer note 3 & 4**
4.0	CONDUITS	1.MATERIAL	MA	VISUAL,MECH, & CHEMICAL	APPD DATASHEET/ IS 9537	IS:9537	IS:9537	INSPT. REPORT	3	2	1	
		2.DIMENSIONS	MA	MEASUREMENT	APPD DATASHEET/ IS 9537	IS:9537	IS:9537	INSPT. REPORT	3	2	1	
		3. MECH. PROPERTIES a) BENDING TEST	CR	TEST	IS 9537-II	IS-9537	IS-9537	INSPT. REPORT	3	2,1	-	
		b) COMPRESSION	CR	TEST	IS 9537-II	IS-9537	IS-9537	INSPT. REPORT	3	2,1	-	FOR SAME MANUFACTURER, 1st LOT WILL BE WITNESSED BY BHEL, SUBSEQUENT LOT CAN BE CLEARED BASED ON TEST WITNESSED BY MAIN VENDOR.
		c) BEND	CR	TEST	BHEL APPPD DATASHEET/ IS 9537	APPPD DATASHEET/ IS 9537	APPPD DATASHEET/ IS 9537	INSPT. REPORT	3	2,1	-	
		4. GALVANISATION TEST a) ZINC COATING	CR	TEST	IS 9537-II	IS-2633	IS-2633	INSPT. REPORT	3	2,1	-	

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

LEGEND : 1 - BHEL/ CUSTOMER 2 - VENDOR 3 - SUB- VENDOR P - PERFORM W - WITNESS V - VERIFICATION

			CUSTOMER :			PROJECT TITLE :			SPECIFICATION NO. :			
		QUALITY PLAN	BIDDER/ VENDOR :			STANDARD QP NO. : PE-QP-999-558-E001, REV.0			SPECIFICATION TITLE :			
		SHEET 3 OF 5	SYSTEM			ITEM :ILLUMINATION			DOC. NO. :			
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS
									P	**W**	**V**	
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**			**11**
		b) MASS OF ZINC COAT.	CR	TEST	IS 9537-II	IS-6745/4759/ APPD DATASHEET	IS-6745/4759/ APPD DATASHEET	INSPT. REPORT	3	2,1	-	
		c) COATING THICKNESS	CR	TEST	IS 9537-II	IS-9537/ APPD DATASHEET	IS-9537/ APPD DATASHEET	INSPT. REPORT	3	2,1	-	BY ELCOMETER
		d) EPOXY THICKNESS	MA	VISUAL/PHYSICAL	IS 9537-II	50 MICRONS	50 MICRONS	INSPT. REPORT	3	2,1	-	
5.0	ELECTRIC POLES											
5.1	MATERIAL	1.CHEMICAL COMP.	MA	CHEM. ANALYSIS	IS 2713	IS-2713 IS:228 & IS:1608	IS-2713 IS:228 & IS:1608	-DO-	3/2	-	2,1	
		2.PHYSICAL PROP.	MA	PHY.TESTS	-DO-	-DO-	-DO-	-DO-	3/2	-	2,1	
5.2	FINAL INSPECTION	1.WORKMANSHIP AND FINISH	MA	VISUAL & MEAS	IS 2713	APPD DRG./ IS:2713	APPD DRG./ IS:2713	-DO-	3/2	2,1	-	FOR DEFLECTION & DROP TEST, TC VERIFICATION BY BHEL
		2.DIMENSIONS	MA	-DO-	-DO-	-DO-	-DO-	-DO-	3/2	2,1	-	
		3.WEIGHT	MA	-DO-	-DO-	-DO-	-DO-	-DO-	3/2	2,1	-	
		4.TESTS AS PER IS-2713	MA	-DO-	-DO-	IS-2713	IS-2713	-DO-	3/2	2,1	-	

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BIDDER'S/VENDORS COMPANY SEAL

LEGEND : 1 - BHEL/ CUSTOMER 2 - VENDOR 3 - SUB- VENDOR P - PERFORM W - WITNESS V - VERIFICATION

QUALITY PLAN	CUSTOMER :	PROJECT TITLE :	SPECIFICATION NO. :
	BIDDER/ VENDOR :	STANDARD QP NO. : PE-QP-999-558-E001, REV.0	SPECIFICATION TITLE :
SHEET 4 OF 5	SYSTEM	ITEM :ILLUMINATION	DOC. NO. :

SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
6.0	HIGH MAST											
6.1	High Mast Shaft	a) Dimensional conformity	MA	MEASURE	10% or Min. 2 Nos.	APPD DRG.	APPD DRG.	TEST CERTIFICATE	3	2,1	-	
		b) Galvanising	MA	MEASURE	-do-	DATASHEET	DATASHEET	-do-	3	2,1	-	BY ELCOMETER
6.2	Head Frame	a) Dimensional conformity	MA	MEASURE	-do-	APPD DRG/ DATASHEET	APPD DRG/ DATASHEET	-do-	3	2,1		
6.3	Lantern Carriage	a) Dimensional conformity	MA	MEASURE	-do-	-do-	-do-	-do-	3	2,1	-	
		b) Galvanising	MA	MEASURE	-do-	-do-	-do-	-do-	3	2,1	-	
6.4	Double drum Winch	a)Load Capacity	MA	MEASURE	-do-	-do-	-do-	-do-	3/2	2	1	Test certificate will be submitted by vendor
6.5	Stainless Steel Wire Ropes	a) Breaking Capacity	M	MEASURE	100%	-do-	-do-	-do-	3/2	2	1	Test certificate will be submitted by vendor
6.6	FEEDER PILLAR											Test for feeder pillar shall be as per S. No. 2
7.0	JUNCTION BOXES & RECEPTACLES	1.DIMENSIONS	MA	MEASUREMENT	100%	APPD DRG/ DATASHEET	APPD DRG/ DATASHEET	INSP. REPORT	3	-	2	COMPONENTS TO BE OF APPROVED MAKE
		2.PAINT SHADE/ THICKNESS	MA	VISUAL/MEAS.	10%	APPD DRG/ DATASHEET	APPD DRG/ DATASHEET	-DO-	3	-	2	
		3.HV/IR/HV	MA	ELECT.TESTS	100%	2KV AC FOR 1 MINUTE	2KV AC FOR 1 MINUTE	-DO-	3	-	2	
		4.DEGREE OF PROTECTION	MA	TEST	1/SIZE	IS:2147/ APPD DRG	IS:2147/ APPD DRG	TEST CERT.	3	-	2,1	
		5.SPECIAL TESTS IF ANY,EXPLOSION PROOF/FLAME PROOF	MA	TEST	1/SIZE	IS:2147/ APPD DRG	IS:2147/ APPD DRG	TEST CERT.	3	-	2,1	
		6. OPERATION CHECK	MA	TEST	10%	APPD DRG	APPD DRG	INSP. REPORT	3	-	2	
		7. MECHANICAL INTERLOCK	MA	TEST	10%	APPD DRG	APPD DRG	INSP. REPORT	3	-	2	

BHEL	PARTICULARS	BIDDER/VENDOR	
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	SIGNATURE		
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LEGEND : 1 - BHEL/ CUSTOMER 2 - VENDOR 3 - SUB- VENDOR P - PERFORM W - WITNESS V - VERIFICATION

QUALITY PLAN	CUSTOMER :	PROJECT TITLE :	SPECIFICATION NO. :
	BIDDER/ VENDOR :	STANDARD QP NO. : PE-QP-999-558-E001, REV.0	SPECIFICATION TITLE :
SHEET 5 OF 5	SYSTEM	ITEM :ILLUMINATION	DOC. NO. :

SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
8.0	PVC WIRES	1.SURFACE DEFECTS	MA	VISUAL	10%	IS:694 IS:1554	IS:694 IS:1554	INSPN. REPORT & TEST REPORT FROM MANUFACTURER	3	-	2,1	TO BE PROCURED FROM BIS APPROVED SOURCE
		2.DIMENSIONS	MA	MEASUREMENT	10%	-DO-	-DO-	-DO-	3	-	2,1	
		3.ACCEPTANCE TESTS	MA	-DO-	IS: 694	-DO-	-DO-	-DO-	3	-	2,1	
		4.ROUTINE TESTS	MA	-DO-	100%	-DO-	-DO-	-DO-	3	-	2,1	
		5.TYPE TESTS	CR	ELEC.TESTS	ONE/TYPE & SIZE	IS:694 IS:1554	IS:694 IS:1554	TEST CERT.	3	-	1**	**** Refer note 3 & 4**

NOTES:

1. IN CASE TYPE TEST CERTIFICATE FOR DEGREE OF PROTECTION/EXPLOSION PROOFNESS FROM INDEPENDENT LAB. IS NOT AVAILABLE, THE ITEM SHALL BE TESTED AT AN INDEPENDENT LAB.

2. ITEMS LIKE CEILING FANS, EMERGENCY LIGHTING UNIT, FLEXIBLE CONDUIT, EARTHING WIRE & FLATS, 24V SUPPLY MODULE, LADDERS, HUME PIPE, SWITCHBOXES, EXIT SIGNS, STRUCTURAL STEEL ETC. WILL BE CLEARED BASED ON COC (CERTIFICATE OF COMPLIANCE).

3. TYPE TEST CERTIFICATES TO BE FURNISHED FOR VERIFICATION BY BHEL ENGINEERING/CUSTOMER.

4. CONDUCTION OF TYPE TESTS TO BE DONE IF REQUIRED BY BHEL TECHNICAL SPECIFICATION & TEST CERTIFICATES FOR THE SAME TO BE FURNISHED FOR VERIFICATION BY BHEL ENGINEERING/CUSTOMER.

5. TYPE TEST REPORT DULY VERIFIED BY BHEL ENGINEERING/CUSTOMER SHALL BE SUBMITTED FOR VERIFICATION DURING INSPECTION.

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

LEGEND : 1 - BHEL/ CUSTOMER 2 - VENDOR 3 - SUB- VENDOR P - PERFORM W - WITNESS V - VERIFICATION

			CUSTOMER :			PROJECT TITLE :			SPECIFICATION NO. :			
		QUALITY PLAN	BIDDER/ VENDOR :			STANDARD QP NO. : PE-QP-999-507-E006, REV. 0			SPECIFICATION TITLE:			
		SHEET 1 OF2	SYSTEM CABLING			ITEM : CABLE TRAY SUPPORT MATERIAL (WELDED TYPE)			DOC. NO. :			
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS
									P	**W**	**V**	
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**			**11**
1.0	**RAW MATERIAL**											
1.1	MILD STEEL SECTIONS (CHANNEL & ANGLES) AS PER SPECIFICATION	1.CHEMICAL & PHY. PROPERTIES	MA	VERIFICATION OF TC'S	100%	IS -2062	IS -2062	MILL TC	3	-	1/2	Steel shall be procured from SAIL/TISCO/RINL/BHUSAN/JINDAL STEEL/JINDA ISPAT/ESSAR/LLOYD/ IISCO/ authorised SAIL Re Rollers.
		2.DIMENSIONS	MA	MEASUREMENT	100%	IS - 808/ IS - 1852	IS - 808/ IS - 1852	QC RECORD	3/2	-	-	
		3.SURFACE FINISH	MA	VISUAL	100%	IS:2062	IS:2062	QC RECORD	3/2	-	-	
1.2	ZINC	CHEM.COMP.	MA	CHEM. TEST	EACH HEAT	IS-209	IS-209	QC RECORD	3/2	-	1/2	
2.0	**IN-PROCESS**											
2.1	CUTTING	1.DIMENSIONS	MA	MEASUREMENT	100%	APP. DATA SHEET	APP. DATA SHEET	QC RECORD	2	-	1	
		2. WELDING QUALITY (IF APPLICABLE)	MA	VISUAL	100%	GOOD WELDING PRACTICE	FREE FROM DEFECTS & SLAG	QC RECORD	2	-	1	
		3.SURFACE FINISH	MA	VISUAL	100%	FREE FROM DEFECTS & SLAG	FREE FROM DEFECTS & SLAG	QC RECORD	2	-	1	
2.2	SURFACE PREPARATION	1.CLEANING, PICKLING, RINSING & FLUXING	MA	VISUAL	PERIODIC IN EACH SHIFT	IS:2629	IS:2629	QC RECORD	2	-	-	
		2. SURFACE QUALITY	MA	VISUAL	100%	IS-2629	IS-2629	QC RECORD	2	-	-	
2.3	GALVANISING	1.TEMPERATURE OF BATH	MA	TEMPERATURE INDICATOR	CONTINUOUS	IS-2629	IS-2629	QC RECORD	3/2	-	-	If vendor doesn't have his own galvanizing plant duly approved by BHEL PEM; then galvanizing shall be carried out at BHEL-PEM approved other galvanizing plants as per Annexure-2.

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

LEGEND : 1 - BHEL/ CUSTOMER 2 - VENDOR 3 - SUB- VENDOR P - PERFORM W - WITNESS V - VERIFICATION

		QUALITY PLAN	CUSTOMER :			PROJECT TITLE :			SPECIFICATION NO. :			
			BIDDER/ VENDOR :			STANDARD QP NO. : PE-QP-999-507-E006, REV. 0			SPECIFICATION TITLE:			
		SHEET 2 OF 2	SYSTEM CABLING			ITEM : CABLE TRAY SUPPORT MATERIAL (WELDED TYPE)			DOC. NO. :			
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS
									P	W	V	
1	2	3	4	5	6	7	8	9	10			11
		2. DROSS	MA	VISUAL	PERIODIC	IS - 2629	IS - 2629	QC RECORD	3/2	-	-	
		3. RATE OF IMMERSION	MA	VISUAL MEASUREMENT	100%	IS - 2629 / MFR'S PRACTICE	IS - 2629 / MFR'S PRACTICE	QC RECORD	3/2	-	2	
		4. SURFACE QUALITY	MA	VISUAL	100%	IS - 2629	FREE FROM BURRS ROUGHNESS, SLAG, FLUX, STAIN, ETC.	QC RECORD	3/2	-	-	
3.0	**FINISHED ITEMS**											
		1.DIMENSIONS	MA	MEASUREMENT	IS 2500 (PART 1) LEVEL S-4	APP. DATA SHEET	APP. DATA SHEET	INSP. REPORT	2	1	-	
		2. SURFACE FINISH	MA	VISUAL	IS 2500 (PART 1) LEVEL S-4	FREE FROM BURRS, SLAG, ROUGHNESS, FLUX, STAIN, ETC.	FREE FROM BURRS, SLAG, ROUGHNESS, FLUX, STAIN, ETC.	INSP. REPORT	2	1	-	
		3.MASS OF ZINC COATING	MA	CHEM. TEST	IS - 4759	IS-6745 / APP. DATA SHEET	APP. DATA SHEET	INSP. REPORT	2	1	-	
		4.UNIFORMITY OF ZINC COATING	MA	CHEM. TEST	IS - 4759	IS-2633	IS-2633	INSP. REPORT	2	1	-	
		5.THICKNESS OF ZINC COATING	MA	ELCOMETER	IS - 4759	APP. DATA SHEET	APP. DATA SHEET	INSP. REPORT	2	1	-	
		6.ADHESION	MA	MECH.TEST	IS-4759	IS-2629	IS-2629	INSP. REPORT	2	1	-	

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	SIGNATURE		
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LEGEND : 1 - BHEL/ CUSTOMER 2 - VENDOR 3 - SUB- VENDOR P - PERFORM W - WITNESS V - VERIFICATION

QUALITY PLAN	CUSTOMER :	PROJECT TITLE :	SPECIFICATION NO. :
	BIDDER/ VENDOR :	STANDARD QP NO. : PE-QP-999-507-E005, REV. 0	SPECIFICATION TITLE:
SHEET 1 OF 2	SYSTEM CABLING	ITEM : CABLE TRAYS & ACCESSORIES	DOC. NO. :

SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
1.0	RAW MATERIAL											
1.1	ROLLED SHEET	1.CHEM.& PHY. PROPERTIES	MA	VERIFICATION OF TC'S	100%	IS1079	IS1079	MILL TC	3/2	-	1/2	Steel shall be procured from SAIL/TISCO/RINL/BHUSAN/JINDAL STEEL/JINDAL ISPAT/ESSAR/LLOYD/ IISCO/ authorised SAIL Re Rollers.
		2.DIMENSIONS	MA	MEASUREMENT	100%	IS-1730/ APPD. DATA SHEET	IS-1730/ APPD. DATA SHEET	QC RECORD	3/2	-	-	
		3.SURFACE FINISH	MA	VISUAL	100%	IS-1079	IS-1079	QC RECORD	3/2	-	-	
1.2	ZINC	CHEM.COMP.	MA	CHEM TEST	EACH HEAT	IS-209	IS-209	QC RECORD	3/2	-	1/2	
2.0	IN-PROCESS											
2.1	FABRICATION	1.DIMENSIONS	MA	MEASUREMENT	100%	APPD.DRG.	APPD.DRG.	QC RECORD	2	-	1	
		2.WELDING QUALITY	MA	VISUAL	100%	GOOD WELDING PRACTICE	FREE FROM DEFECTS & SLAG	QC RECORD	2	-	1	Welding is to be done by qualified welders in accordance with ASME SEC. IX article III. WPS , PQR & WPQ to be reviewed during inspection.
		3.SURFACE FINISH	MA	VISUAL	100%	APPD.DRG.	APPD.DRG.	QC RECORD	2	-	1	
2.2	SURFACE PREPARATION	1.CLEANING PICKLING & RINSING & FLUXING	MA	VISUAL	PERIODIC IN EACH SHIFT	IS:2629	IS:2629	QC RECORD	2	-	-	
		2. SURFACE QUALITY	MA	VISUAL	100%	IS:2629	IS:2629	QC RECORD	2	-	-	

BHEL	PARTICULARS	BIDDER/VENDOR	
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LEGEND : 1 - BHEL/ CUSTOMER 2 - VENDOR 3 - SUB- VENDOR P - PERFORM W - WITNESS V - VERIFICATION

			CUSTOMER :			PROJECT TITLE :			SPECIFICATION NO. :			
		QUALITY PLAN	BIDDER/ VENDOR :			STANDARD QP NO. : PE-QP-999-507-E005, REV. 0			SPECIFICATION TITLE:			
		SHEET 2 OF 2	SYSTEM CABLING			ITEM : CABLE TRAYS & ACCESSORIES			DOC. NO. :			
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS
									P	W	V	
1	2	3	4	5	6	7	8	9	10			11
2.3	GALVANISING	1.TEMPERATURE OF ZINC BATH	MA	TEMPERATURE INDICATOR	CONTINUOUS	IS-2629	IS-2629	QC RECORD	2/3	-	-	If vendor doesn't have his own galvanizing plant duly approved by BHEL PEM; then galvanizing shall be carried out at BHEL-PEM approved other galvanizing plants as per Annexure-2.
		2.DROSS	MA	VISUAL	PERIODIC	IS 2629	IS 2629	QC RECORD	2/3	-	-	
		3.RATE OF IMMERSION	MA	VISUAL	100%	IS 2629/ MFR'S PRACTICE	IS2629/ MFR'S PRACTICE	QC RECORD	2/3	-	2	
		4.SURFACE QUALITY	MA	VISUAL	100%	IS 2629	FREE FROM BURRS ROUGHNESS, SLAG FLUX. STAIN. ETC.	QC RECORD	2/3	-	-	
3.0	FINISHED ITEMS											
3.1	(CABLE TRAY, ACCESSO-RIES & HARDWARES)	1.DIMENSIONS	MA	MEASUREMENT	IS-2500 (PART 1) LEVEL S-4	APPD. DRG	APPD. DRG	INSP.REPORT	2	1	-	Fasteners shall be of reputed make. Overall thickness of finished product shall not be less than the thickness of cable tray & accessories defined in technical datasheet.
		2,SURFACE FINISH	MA	VISUAL	IS-2500 (PART 1) LEVEL S-4	APPD. DRG	FREE FROM BURRS, SLAG, ROUGHNESS, FLUX. STAIN. ETC.	INSP.REPORT	2	1	-	Following shall be engraved/ punched on each standard length of cable tray at the center of both sides of runner:'PEM' (length of letter 90mm & height 30mm).
		3.RIGIDITY (FOR TRAYS)	MA	DEFLECTION TEST	2 No./ LOT/TYPE	APPD. DRG	APPD. DRG	INSP.REPORT	2	1	-	600MM wide cable tray to be testsed. Maximum deflection shall not exceed 7MM on mid span on uniform loading of 100KG/M.
		4.MASS OF ZINC COATING	MA	CHEM. TEST	IS-4759	IS-6745/ APPD. DATASHEET	APPD. DATASHEET	INSP.REPORT	2	1	-	
		5.UNIFORMITY OF ZINC COATING	MA	CHEM. TEST	IS-4759	IS-2633	IS-2633	INSP.REPORT	2	1	-	
		6.THICKNESS OF ZINC COATING	MA	ELCOMETER	IS-4759	APPD. DATASHEET	APPD. DATASHEET	INSP.REPORT	2	1	-	
		7.ADHESION	MA	MECH.TEST	IS-4759	IS-2629	IS-2629	INSP.REPORT	2	1	-	

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

LEGEND : 1 - BHEL/ CUSTOMER 2 - VENDOR 3 - SUB- VENDOR P - PERFORM W - WITNESS V - VERIFICATION

			CUSTOMEI TSPGCL			PROJECT TITLE	1 X 660 MW PANKI TPS		SPECIFICATION : NUMBER :			
		QUALITY PLAN	BIDDER/ VENDOR :			QUALITY PLAN NUMBER PED-506-00-Q-006, REV-01			SPECIFICATION TITLE			
		SHEET 1 OF 2	SYSTEM			ITEM AC ELECT. MOTORS BELOW 55KW (LV)			SECTION			VOLUME III
SL. NO.	COMPONENT/OPERATION	CHARACTERISTICS CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS
									P	**W**	**V**	
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**			**11**
1.0	ASSEMBLY	1.WORKMANSHIP	MA	VISUAL	100%	MANUF'S SPEC	MANUF'S SPEC	-DO-	2	-	-	
		2.DIMENSIONS	MA	-DO-	-DO-	MFG. DRG./ MFG. SPEC.	MFG. DRG./ MFG. SPEC.	-DO-	2	-	-	
		3.CORRECTNESS COMPLETENESS TERMINATIONS/ MARKING/COLOUR CODE	MA	VISUAL	100%	MFG.SPEC./ RELEVANT IS	MFG.SPEC. RELEVANT IS	-DO-	2	-	-	
2.0	PAINTING	1.SHADE	MA	VISUAL	SAMPLE	MANUFR'S SPEC/BHEL SPEC./RELEVANT STANDARD	BHEL SPEC. SAME AS COL.7	LOG BOOK	2	-	-	
3.0	TESTS	1.ROUTINE TEST INCLUDING SPECIAL TEST AS PER BHEL SPEC.	MA	-DO-	100%	IS-325/ BHEL SPEC./ DATA SHEET	SAME AS COL.7	TEST REPORT	2	1		NOTE -1 & NOTE-3
		2.OVERALL DIMENSIONS & ORIENTATION	MA	MEASUREMENT & VISUAL	100%	APPROVED DRG/DATA SHEET	APPROVED DRG/DATA SHEET & RELEVANT IS	INSPN. REPORT	2	1	-	NOTE -1 & NOTE-3
	BHEL		**PARTICULARS**		**BIDDER/VENDOR**							
			NAME									
			SIGNATURE									

		QUALITY PLAN	CUSTOMEI TSPGCL			PROJECT TITLE	1 X 800 MW KOTHAGUDEM TPS			SPECIFICATION : NUMBER :		
			BIDDER/ VENDOR :			QUALITY PLAN NUMBER PED-506-00-Q-006, REV-01				SPECIFICATION : TITLE :		
		SHEET 2 OF 2	SYSTEM			ITEM AC ELECT. MOTORS BELOW 55KW (LV)				SECTION		VOLUME III
SL. NO.	COMPONENT/OPERATION	CHARACTERISTICS CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	W	V	REMARKS
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**			**11**
		3.NAMEPLATE DETAILS	MA	VISUAL	100%	IS-325 & DATA SHEET	IS-325 & DATA SHEET	INSPN. REPORT	2	1	-	

NOTES:

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

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

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

Legends for Inspection agency

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

P. PERFORM
W. WITNESS
V. VERIFY

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