



STEEL AUTHORITY OF INDIA LIMITED
BHILAI STEEL PLANT

GENERAL SPECIFICATION
FOR
ELECTRICAL SYSTEM
(GS – 03)



MECON LIMITED
RANCHI - 834002

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GENERAL TECHNICAL SPECIFICATION



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10.0 ELECTRICAL

1.01 General

1.01.01 Standards

The design, manufacture, assembly and testing as well as performance (including safety, earthing and other essential provisions) of equipment and accessories covered under this specification shall, in general, comply with the latest issue of :

- Latest applicable Standards and Codes of Practices published by Indian Standards Institution (BIS).
- Latest IPSS (Interplant Standards for Steel Industry)
- Latest Indian Electricity Rules & statutory requirements of Central Govt. and State Govt.

In case, the tenderer is not in a position to comply fully with certain IS / IPSS specifications or in respect of certain items for which there are no IS / IPSS specifications, the tenderer may base his proposals on IEC recommendations or other reputed national or international standards subject to the approval of the Purchaser.

The components and materials used and the equipment supplied shall conform to high standards of design, engineering and workmanship and shall be suitable for efficient operation and reliable service in steel plant conditions .

All equipments supplied and all work done including system design and detailed engineering shall also comply with the statutory requirements of Govt. of India and the respective governments of state in which the plant is situated . The installation shall also confirm to Indian Electricity Act and Indian Electricity Rules.

In case of any contradiction between the data given in the Technical Specification (TS) and this General Technical specification (GTS), data given in the Technical specification (TS) shall prevail.

1.01.02 Climatic Conditions

1.01.02.01 Environmental condition

Sl.No	Environmental condition	Data
1.0	Maximum ambient temp.	50 deg. C
2.0	Maximum Humidity	100 % does not occur simultaneously with maximum temperature.
3.0	Height	Less than 1000 M.



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Sl.No	Environmental condition	Data
4.0	Environment	Dusty & Corrosive

1.01.02.02 Ambient conditions of shop units

Generally following maximum ambient temperature shall be considered in different units of the integrated steel plant .

Sl.No	Area	Data
A.	Coke Ovens & Byproduct Plant	
1.	Battery cellar	+ 55 Deg. C
2.	Battery Top	+ 60 Deg. C
3.	Coal Tower, Intermediate & End benches	+ 50 Deg. C
4.	Pusher Car & Loco	+ 50 Deg. C
5.	Guide Car & Charging Car	+ 60 Deg. C
B.	Blast furnace	
1.	Cast house	+ 60 Deg. C
2.	Furnace proper	+ 55 Deg. C
3.	Stock house	+ 50 Deg. C
4.	Pump house	+ 50 Deg. C
5.	Stove area	+ 55 Deg. C
6.	GCP area	+ 50 Deg. C
7.	Other areas	+ 50 Deg. C
C.	Steel Melting Shop	
1.	Converter Bay	+ 60 Deg. C
2.	Mixer Bay	+ 55 Deg. C
3.	Other areas	+ 55 Deg. C
D.	Continuous Casting Shop	
1.	Casting bay	+ 60 Deg. C
2.	Withdrawal , straightening and gas cutting areas	+ 55 Deg. C
3.	Other areas	+ 50 Deg. C
E.	Hot rolling mills	
1.	Generally	+ 55 Deg. C
2.	Finishing bays	+ 50 Deg. C
3.	Foundry	+ 55 Deg. C
4.	Auxiliary Shops	+ 50 Deg. C
F.	Other areas	+ 50 Deg. C
G.	Electrical rooms	
1.	HT/LT substation & MCC rooms (ventilated)	+ 45 Deg. C
2.	Cable basements / tunnels (ventilated)	+ 45 Deg. C
H.	Control Rooms	
1.	Control rooms – Air conditioned	+ 24 Deg. C

Equipment selection and de-rating shall generally be based on ambient temperature of 50 Deg.C. For specific areas and shops, the ambient temperature conditions indicated above shall be taken into consideration and equipment shall be suitably de-rated accordingly .



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The equipment offered should be suitable for smooth, efficient and trouble free service in the tropical humid climate prevailing at plant site and under the ambient temperature conditions indicated above for the different shops and areas. In hot areas of higher temperature conditions, the equipment shall be adequately protected against damage from radiant heat and hot air.

The equipment shall be designed to give efficient and reliable performance under heavy steel plant conditions and shall be such that the risks of accidental short-circuits due to animals, birds or vermins are avoided.

1.01.03 Standard Voltage levels:

In case the standard voltage levels to be adopted in the plant are specified in the Technical specification, it shall be followed. In absence of any details indicated in the Technical Specification, the following standard voltage levels shall be adopted.

SI.No	Description	Data
1	HT AC	11 KV / 6.6 KV , 3 phase, 50 Hz, unearthed neutral .
2.	LT AC	415V, 3 Phase, 50 Hz, 4 wire, solidly earthed
3.	AC control and signaling voltage	240V, AC \pm 10% obtained using suitable control transformers with auto changeover facility.
4.	DC supply voltage	220 Volts / 110 Volts
5.	DC control and signaling voltage	220 Volts / 110 Volts
6.	Control voltage for HT switchgear equipment	110 V DC from battery in HT S/S area. 220 V DC from battery in MSDS area.
7.	Special socket outlets for portable lamps	24V, single phase, 50 Hz, AC obtained through suitable transformers
8.	DC Electro-magnetic brakes	220V, DC, obtained through individual rectifiers
9.	Solenoid valves	24V DC, unearthed
10.	Machine tools lighting	24 V AC
11.	Sockets for Welding purposes	415V, 100A, 3 pin plus earth with plug interlocked switch
12.	Sockets for hand tools	240V, 15A, 2 pin plus earth with plug interlocked switch
13.	Illumination system	240 V AC for general application. 24 V AC for confined & semi confined area. (as per IPSS).
14.	PLC power supply	240 V AC, 50 Hz, obtained through UPS (for processor , RIO chassis ,



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Sl.No	Description	Data
		interrogation voltage and output voltage) 240 V AC , single phase from MCC (for aux. voltage)
15.	Monitoring and signaling in electronic installations, mimic panels	24V, DC (Through PLC output for PLC control boards / desks)
16.	PLC DI interrogation voltage	24 V DC
17.	PLC DO voltage	24 V DC

1.01.03.01 Symmetrical short circuit ratings:

The three phase symmetrical short-circuit ratings of the switchgear at the different voltage levels shall be as follows unless specifically indicated in the Technical specification:

Sl.No.	Description	Data
1.	11 kV switchgear	40 kA for 3 sec .
2.	6.6 kV switchgear	40 kA for 3 sec .
3.	415 V switchgear	50 kA for 1 sec.

1.01.03.02 Permissible variations:

The system / unit / plant / equipment shall be designed so as to be suitable for the following variations in voltage and frequency unless specifically indicated in the Technical specification:

Description	Voltage	Frequency
Permissible variations with rated performance, rated current and control effectiveness maintained	For LT system :- +10% & -15% For HT system :- +6% & -9%	Frequency variation for both HT & LT shall be + 4%, - 6%
Permissible variations With changes in rated Current / torque but without any undesirable effect on performance	+/- 10%	+/- 3%
Permissible variations for control and regulation equipment	+/- 15%	+6%, -6%



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Description	Voltage	Frequency
with rated performance and control quality maintained		
Permissible voltage dip at the HT and LT switch gear bus during starting of HT and LT motor	For LT system :- -15% For HT system :- - 10%	Frequency Variation for both HT & LT shall be considered as +4%, -6%.

1.01.04 Criteria for selection of voltage levels for motors & Power devices:

- AC squirrel cage induction motors of ratings up to 200 kW and slip ring motors up to 250 kW shall be fed at LT, 415V, 3 phase , 4 wire , 50 Hz with DOL.
- AC motors of ratings in excess of 200KW upto 1000 KW and beyond 1000 KW shall be connected to 6.6 KV U/E and 11 KV U/E power supply system respectively for DOL starting. The HT voltage level shall be as specified in the Technical specification.
- AC squirrel cage induction motors of ratings up to 200kW may be fed at LT, 415V, 3 phase 4 wire 50 Hz, with VFD where speed control is required.
- For motor rating more than 200 KW up to 1000 KW shall be provided with VFD where speed control is required , the rated voltage of the motor shall be 690 V .
- Soft starters with DOL bypass shall be provided for drives ratings ranging from 90 KW to 200 KW where full torque load starting and speed variation is not required

1.01.05 Design criteria & reliability conditions:

1.01.05.01 Power Distribution system

The power distribution system shall meet the following guide lines:

- Suitable numbers of 415V LT Substation (LTSS) shall be provided for feeding different Motor control centers and auxiliaries power distribution boards as required for the plant.
- The MCC / PDB / MLDB shall be fed from LTSS.
- Suitable numbers of 415V Motor control centers shall be provided for feeding power supply to motors of rating 90 KW and below.
- Field located Power supply panels (MCB DB / Local Starter Panels) shall be fed from MCC.
- Electronic relays with display (for motor rating of 37 KW and above) shall be considered in place of thermal overload relays as follows :
 - Electronic over load relay protection for motors below 15 KW for crane application and for reversible drives. Electronic over load relay / MPCB protection for motors below 15 KW for other application
 - EOCR for OC & EF , unbalance protection for motors rated 18.5 KW to 90 KW
 - Composite motor protection relay with OL , OC ,EF , unbalanced & locked rotor protection with digital display for motor rated 110 KW and above .
 - EOCR shall be used only for non intelligent feeders .
- Motor of rating above 90 kW shall be provided with independent Motor control Panel (MCP) which shall be fed directly from LTSS. Power devices like MCCB,



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Contactors, intelligent motor control relays / microprocessor based MPR (for non intelligent controllers) etc. shall be located in independent MCPs. Each MCP shall be located in MCC room by the side of the respective group MCC.

- VFD's shall be provided for process fans / pumps as per technological requirement
- A dedicated MCC with two incomers (one from PCC and other from DG set or any emergency power source) and bus coupler shall be provided for catering to all emergency loads of the shop/unit.
- MCCB, contactor and overload relay rating for the low voltage general purpose induction motors shall be selected as per type-2 coordination chart of selected manufacturer. However the minimum contactor rating shall be 32A.
- All the important drives (all 6.6 KV , 11 KV & 690 V motors) should be provided with suitable CBM systems such as vibration monitoring, current signature, temperature etc. Information from CBM systems to be interfaced to HMI system as well as plant-wide CBM system.

1.01.05.02 The capacities of the transformer shall be selected as per the following guidelines:

- MD of MCC, shall be calculated as per the guidelines given in clause no. 1.01.08 of the General Technical Specifications.
- Load factor of 0.9 shall be considered for motors being fed from 415V LTSS . The load factor shall be applied on the kW rating of motors. Only working motors shall be considered.
- Load of lighting transformer shall be considered as per the kVA rating of transformer.
- Where ACDB is provided along with the LTSS, then load of ventilation system with 0.9 load factor shall be considered.
- Diversity factor of 1.1 shall be used on the summation of MDs of various MCCs, motors, lighting transformers and ACDB.
- Spare capacity of 20% shall be provided for future use.
- Each LTSS shall be fed from two identically rated transformers.
- In case of outage of any transformer, the remaining transformer shall be loaded up to 80% of their rating.
- Transformer shall be selected from standard rating of 1000/2000 KVA only
- It shall be ensured that when all the loads are in operation and the largest motor is started, the voltage drop at the motor terminals shall not be more than 15%.

1.01.05.03 The rating of outgoing feeders of LTSS shall be selected from standard circuit breakers ratings of 800A, 1000A & 1600 A only considering the load requirement and derating factors due to ambient temperature as well as for the mounting of the component in the switch board. CTs shall be selected considering the actual loads.

1.01.05.04 11kV / 6.6 kV panel mounted load break switches with earthing switches of adequate rating shall be provided before feeding the transformer . Transformer pens shall also be provided with push button station for switching ON/OFF the corresponding 11kV / 6.6 kV upstream feeding circuit breaker.

In case of transformer of rating 5 MVA and above , following arrangement shall be followed:

- LBS (isolator) shall be provided in the transformer room, when transformer is fed from **remote** HT switchboard.
- Lockable type PB shall be provided in transformer room when transformer is fed from HT switchboard located in the **same building**.



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- 1.01.05.05** AC squirrel cage induction motors shall be used for drives requiring speed control. For all electrical machines wherever strip wound coils are used detail drawing is to be provided in soft copy.
Use of DC motors, AC slip ring motors shall be avoided to the extent possible.
Manufacturing drawing for parts – stator coils, slip ring, brush, brush holder in slipping motor's and drawings of parts of– armature coil, commutator, brush and brush holder in DC machine shall be provided in soft copy.
Sizes of conductors used in motors shall be preferred sizes as per IS.
Sufficient spares of parts of all electrical machines shall be provided..

1.01.06 Cabling

Tenderer shall note the following regarding cabling:-

Sl. No.	Requirement	Remarks
1.0	Inter shop cable routing	Through overhead cable galleries / structure or walkable cable tunnel.
2.0	Substation building	RCC cable basement of minimum 3.0 metres clear height .
3.0	MCC room	RCC cable trench / false floor at bottom of MCC
4.0	Illumination system cable laying in all units.	1. Unarmoured FRLS cables through MS black conduits in open area. 2. Armoured FRLS without conduit in covered area. 3. Unarmoured FRLS cables through concealed MS black conduits in buildings like control room, office building etc.

1.01.07

Motor starting and permissible voltage dips:

- Voltage dip on starting of the largest L.T. motor shall be limited to 15% of the nominal voltage at the motor terminals.
- Maximum allowable voltage drop in any feeder under steady state condition shall be maintained as follows :-
 - Total voltage drop during running : 6 %
 - LTSS to motor : 6 %
 - LTSS to MCC/PDB/MLDB if in same building : 2%
 - MCC to motor for above case : 4%
 - LTSS to MCC/PDB/MLDB if in different building : 3%
 - MCC to motor for above case : 3%

Voltage drop at the terminal of other equipment shall be as per the minimum voltage required for proper functioning of the equipment recommended by their manufacturers.



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1.01.08 Maximum Demand of MCC

Maximum demand (MD) of the MCC shall be calculated considering the following:

1. Working load of the MCC shall be calculated based on the motor kW rating.
2. The load factor shall be considered as follows:
 - For continuous drives – 0.9
 - For intermittent drives like sump pumps etc. – 0.6
 - For electrically actuated valves / dampers – 0.2
 - For maintenance loads like hoists, cranes etc. - 0.4
3. Welding and utility socket loads shall not be considered for calculation of maximum demand.
4. Load factor shall be applied on the kW rating of motor.
5. Diversity factor shall be considered as one.
6. Spare feeders shall also be considered for calculation of maximum demand as per guidelines indicated in SI. No.2
7. Load of power supply feeders shall be corresponding to the load being fed with 0.9 load factor.
8. Cyclic load shall be converted to continuous load and shall be used for MD without load factor. (e.g. 22kW motor at 40% duty factor will have continuous load as $22 \times \text{square root of } 0.4$)
9. 20% spare capacity shall be included in maximum demand for future use.

1.01.09 Incomer rating selection for MCC

1. All ACB I/C shall be intelligent type having standard protocol for communication
2. Incomer of the MCC shall be ACB / MCCB having fault level of 50 kA for 1 sec. MCCB shall be provided for ratings 630A and below. Standard ratings of ACB / MCCB shall be provided.
3. Continuous current rating of the incomer shall be corresponding to MD of the MCC.
4. In case of PMCC where MCC is directly fed from transformer, Continuous current rating of Incomer shall be equal to current rating of transformer.
5. In case ACB / MCCB is rated for 40 deg.C then continuous de-rated current in enclosure and for ambient temperature shall be more than MD / transformer current rating.
6. Main bus bar rating of MCC shall be equal to incomer rating.
7. Voltage rating of the breaker shall be equal to the incomer voltage of the system with rated tolerance (as mentioned in the relevant chapter).
8. Each MCC shall be provided with manual operated, draw out two nos.of incomers and one no. of bus coupler . Incomers and bus coupler shall be ACB / MCCB. ACB / MCCB shall be provided with overload, short circuit, earth fault and under voltage releases.
9. Each incomer and bus coupler shall be provided with indicating lamps for each phase for incoming supply and digital ammeter and voltmeter for measuring current in each phase and line to line voltages of MCC bus. ON, OFF and TRIP indicating lamps shall also be provided.
10. Incomer and bus coupler shall be mechanically interlocked in such a way that at any given time only two breakers can be closed. Electrical interlocks shall be provided as follows:



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- When both incomer ACBs / MCCBs are ON then bus coupler ACB / MCCB can not be switched ON.
- When incoming power to one of the incomer is not available then bus coupler can be switched ON manually.
- When incoming power to the incomer breaker is restored then incomer can be switched on manually and bus coupler will trip automatically.
- Bus coupler closing is not permitted if the incomer trips on fault.

1.01.10 Outgoing Feeder Selection for MCC

- 1 Motor feeders shall be provided with MCCB, contactor, electronic thermal overload relay (with indication lamp for motor rating 37 KW and above) and other auxiliary equipment like selector switch, indicating lamps, auxiliary contactors etc. as per requirement (for non intelligent MCC) .
- 2 Overload protection device shall be electronic overload relay as indicated in specification. In case electronic overload relay is provided then MCC module shall be provided with indicating lamps.
- 3 Motor control panel (MCP) for motor ratings above 90 KW shall be provided with motor protection numerical relay (for non intelligent MCC) as per specification. Other components same shall be same as motor feeders of MCC.
- 4 Power supply feeders shall be provided with MCCB and ammeter.
- 5 All PDB feeding non-critical loads shall be single fed system

1.01.11 Power Factor Compensation

In case power factor correction at LT level is specified in specification then APFC shall be provided in PMCC / LTPDB. The capacitor bank shall be so designed that the overall power factor of the system shall be 0.95.

1.01.12 Cable selection
.01 Incomers of MCC / PDB / MLDB

- Cable size for incomer of MCC & PDB shall be selected on the basis of current rating corresponding to MD and voltage drop.
- Cable size for incomer of MLDB shall be selected on the basis of current rating corresponding to lighting transformer and voltage drop.
- The standard size of the cable shall be 3.5 x 240sq.mm. of type AYY as per IS:1554 (A2XFaY for XLPE insulated cables as per IS : 7098 Part-1).
- For calculating the current rating of power cables de-rating factor of 0.65 shall be used.

.02 Motors

- Cable size for LT motors shall be selected on the basis of rated nameplate current and starting & running voltage drop as per specification.
- Cable size for HT motors shall be selected on the basis of rated nameplate current, starting & running voltage drop as per specification and short circuit capacity of the system. The cable size shall be calculated based on the breaker opening time of 0.35 seconds.
- Minimum size of cable for LT motors shall be 4x6sq.mm. of type AYY as per IS:1554 and maximum size of cable shall be 3.5 x 185 sq.mm. of type AYY as per



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IS:1554. In case copper conductor cables are used then the maximum & minimum size of cable shall be one size lower than as indicated above for aluminium cables.

- For motors rated up to 2.2 kW and actuators of motors of valves and dampers cable size of 4x2.5sq.mm. of type YRY as per IS:1554 shall be used.
- For calculating the current rating of power cables de-rating factor of 0.65 shall be used.

.03 Illumination System

- The minimum size of the cable for feeding power to SLDB or MCBDB having 32A incomer shall be 4x25sq.mm of type AYFY/AYY as per IS:1554.
- Cable size for MCBDB to light fittings shall be 2x2.5sq.mm. or 4x2.5sq.mm as per the configuration of fittings. The cable type shall be YRY/YY as per IS: 1554.
- In case of concealed wiring, single core, PVC insulated, stranded copper conductor wire of size 1.5sq.mm in MS conduit shall be used. For utility sockets, cable size shall be 4sq.mm.
- Laying of cables shall be decided as per details indicated in the specification.
- Energy efficient smart lighting fixtures and controls to be used for buildings.

.04 Automation System

- All control cables connecting I/Os from field to marshalling panel of PLC or remote I/O panel shall be of stranded copper conductor of type YRY as per IS: 1554 and of size 1.5 sq. mm. minimum for PLC I/O or as suitable.
- Communication bus shall be laid in GI pipe. The route for redundant communication bus shall be different.

.05 General

- Minimum size of the cables used in LT power circuits shall be 6sq.mm per core if with aluminium conductor or 4sq.mm per core if with copper conductor. Maximum cable size shall be 240sq.mm for incomers to MCCs, PCCs etc. The minimum cable size selected for applications in the power circuits of cranes and other moving mechanisms shall be 6sq.mm per core copper. All power cables shall be 3.5 / 4 cores.
- For power supply to moving mechanisms subject to vibrations, flexible copper cables preferably of single core should be used. In these cases, a separate core should be provided for earthing. For hoists with flexible / festoon cable system, power supply shall be through butyl rubber / EPR insulated PCP/CSP sheathed flexible cables. Cables used for circuits of tacho generators, brakes, solenoids, field windings and secondary windings of measuring transformers shall be copper conductor with cross-sectional area not less than 2.5sq.mm per core.
- For control circuits, PVC insulated and PVC sheathed multicore cables with copper conductors having a minimum cross-sectional area of 2.5sq.mm per core shall be used. The number of cores may be standardized as 3, 5, 7, 10, 14, 19, and 24.



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Each core of control cable with 7 core and above shall be numbered at every 1-meter interval.

- For signals like mA and mV, special screened/shielded cables shall be used.
- 20% spare cores shall be provided with minimum 1 spare core in multi-core control and signal cables.

1.01.13 Ventilation and Air Conditioning

The various electrical rooms of the plant shall be provided with ventilation and air conditioning facilities, as indicated below. Air dryer units to be provided wherever air is being used for purging / cleaning purposes .

.01 Substation building, MCC Rooms and Cable Cellar

All HT/LT substations, switch gear rooms and MCC rooms, cable basement/cellars which do not house any electronic equipment but contain only electrical equipment, shall be pressurized up to 2-3mm water column with cooled air washer system to maintain the room temperature at 45 deg.C irrespective of ambient temperature. Suitable capacity fan and pumps (1W+1S) shall be provided for each unit.

.02 Electrical rooms with electronic equipment / Central Control rooms

The electrical rooms housing electronic equipment like PLC , computers, Servers, Level –II systems, Remote I/Os, AC and DC variable speed drives , soft starters , UPS , electronic weighing panels , telephone exchange equipment etc. shall be installed in air-conditioned environment with pressurization to maintain the following conditions:

- Room temperature : Shall not be more than 35deg.
- Relative humidity : 50 to 60%
- Pressurization : 2-3 mm WC
- Temperature gradient : 2 Deg. C/h

For central control rooms standby air conditioners shall also be provided.

Separate room, as part of control room shall be provided with window AC units.

.03 Small local Control Rooms/pulpits

The small control rooms/pulpits shall be air-conditioned to maintain the following conditions:

- Room temperature : 24Deg. C
- Relative humidity : 50-60%
- Pressurization : 2-3 mm WC

.04 Cable tunnels



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- These shall be ventilated with fresh filtered air to maintain exit air temperature at 40deg.C.
- Cable tunnel ventilation shall be sectionalized to maximum length of 150 m.
- Temperature rise shall be limited to 3-5 deg.C above atmospheric dry bulb temperature subject to a maximum of 40deg.C at the exit of air from these premises.
- Partition door between basement and the cable tunnel shall be air tight and of fire retardant material.
- All cable tunnels shall be properly ventilated.

.05 General

- Necessary ducting with air diffuser shall be provided.
- Ventilation and air conditioning system shall be interlocked with fire detection system for safety.
- Airtight double door arrangement shall be provided for electrical rooms, control rooms and basement.

1.01.14 Variable Speed AC Drives.

1. Continuous current of AC drives shall be decided as indicated below:
 - For continuous duty drives (variable torque drives) like pumps fans etc. :- 115% of motor full load rated current.
 - For motion control drives and intermittent duty drives : 150% of motor full load current.
 - For constant torque drives and multi motor drives like moving machines, hoisting etc. :- 150% of the summation of rated motor current for multi motor drives and rated motor current for hoisting drives.
2. All AC drives shall be rated for 380 – 480V, three phase with voltage variation as specified.
3. Isolation transformer shall be provided for drive more than 75 KW and line reactor shall be provided for drive less than 75 KW in incoming (line) side .
4. For 4 quadrant operation applications active front end, low harmonics, regenerative AC drive shall be provided for main drives , process cranes and major auxiliary drives..
5. For crane applications in hot areas where ambient is more than 50 deg.C thyristor converters (ASTAT or SIMOTRAS) shall be used .
6. Current rating of AC drive as innumarated above shall be calculated after de-rating to specified ambient temperature.

1.01.15 Control Philosophy
.01 General

Adequate and appropriate automation systems shall be designed and engineered using state-of-art and field proven technology to facilitate monitoring, control and all other functions associated with operation of all the plant/shop units through user-friendly human-machine interfaces.

The Automation system shall be designed with geographical & functional distribution of hardware in a multi-level hierarchy, viz. Level-0, Level-1, level-2, level-3 etc, as

applicable, to meet specific plant requirements for monitoring, control, process visualization & optimization of all the plants/ shop units.

The automation system shall be structured in general, considering the following hierarchical levels:

➤ **Level - 0**

This level, also called field level, is functionally responsible for generation, transmission & conversion of signals for the process parameters compatible to the higher level equipment as well as signal based activation for the final control elements.

This level is realized based on the primary sensing elements, proximity switches, converters, microprocessor based intelligent systems and final control elements. The components of this level shall be grouped and distributed geographically around the plant as per main process equipment location.

➤ **Level-1**

This level, also called supervisory level, is functionally responsible for supervision of the individual process equipment & functions, monitoring, control, visualization and regulation of process parameters to the desired level based on the signals generated from the field level. This level is also responsible for processing of signals for generating compatible control commands to control the process parameters by activation of the final control elements.

This level is realized based on the controllers & systems, input & output systems, data base units, data communication, visualization system (HMI stations) and interface units for connectivity to the other levels of the automation system. In addition to routine PID functions, advanced process optimization functions comprising special control algorithms, mathematical computations etc. will be able to permit distribution of control and data acquisition functions throughout the entire plant.

➤ **Level-2**

This level is functionally responsible for the process control functions through the Level-1 automation system by process guidance & optimization and control of process parameters to the desired level of perfection based on the available signals from the supervisory level. This level is also called process control level and is responsible for generating set points / control commands to the Level-1 equipment based on the pre-loaded process specific mathematical models. This level is realized based on the process computer & its own data base units, input & output systems, data communication systems, visualization system (HMI stations) and interface units for connectivity to the other levels of the automation system. Level-2 automation system has been covered under a separate General Specification.

The Level-1 automation shall basically comprise:

- A Programmable Logic Controller (PLC) based automation system

.02 Modes of operation

The following modes of operation shall be provided, it shall be in line with changes suggested in respective TS.

A. Local

Local Control Station (LCS) shall be provided for all motor and actuator drives. LCS shall have required numbers of push buttons for operation of drive - In Local Mode, operation of single drive / equipment from LCS shall be provided. This mode of operation will generally be **for test and repair purposes**. To enable the testing of individual equipment all the interlocks shall be bypassed in this mode. However all critical equipment / drives shall be provided with hard-wired interlocking in MCC.

However for failsafe operation, potential free contact of Push Button from LCS and a potential free contact of field safety sensor shall be hard wired to MCC for safety reasons.

Drive can not be started from any place if the selector switch is in OFF position.

B. Remote

In Remote mode, the equipment can be started from control room only. This remote mode is further divided into following three modes:

- Operator mode
- Auto mode
- Computer mode (Level-2 system)

Once the remote mode of operation is selected then from HMI with help of key board / mouse / soft keys above three modes of operation can be selected.

Operator Mode

Under this mode it shall be possible to monitor & control the plant based on set points / commands given by operator through keyboard and the control, sequential operation of various mechanisms in the required sequence shall be executed by PLC with all interlocks. In this case all the changes / operations are operator initiated.

Auto Mode



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This is the **normal mode** of operation of the plant. In this mode, the desired values (set point) of the parameters of process control loop will be set via keyboard of the HMI and sequencing and logic functions will remain operative through the PLC as per application software.

There shall be a provision for group start of drives in individual section with the required interlocks, logic and sequencing between the individual drives.

Computer Mode

In this mode the entire plant will be controlled through level-2 system. All the required set points will be generated by level-2 computer as per the mathematical model calculations based on the inputs received from the field. In case of failure of the level – 2 system all the set points will be automatically shift to operator mode of operation.

1.01.16 Spares Philosophy

The spare philosophy for various equipment shall be as follows:

1. LTSS, MCC, PDB and MLDB shall be provided with 20% spare feeders or one of each type whichever is higher with minimum of two numbers *in each section*
2. LDB, MCBDB for lighting and MCB DB for utility sockets shall be provided with minimum 9 nos. of spare feeders.
3. DC MCB DB shall be provided with 8 nos. of spare feeders.
4. ACDB of UPS shall be provided with 40% spare feeders.
5. 20% spare terminals shall be provided in each module of MCC, MCP and each ACB panel.
6. 20% spare terminals shall be provided in all junction boxes, LCS and local control panels / local starters.
7. Control desk and control cabinet shall be provided with 30% spare terminals.
8. Marshalling panel of MCC and PLC shall be provided with 30% spare terminals.
9. Relay panels / relay modules shall have 20% spare relays of each type fully wired up to the terminal blocks.
10. 20% spare interposing relays fully wired up to the terminal blocks shall be provided in PLC panels.
11. 10% spare components of each type shall be provided in each control desk /control cabinet / signaling panel.
12. Spare I/O philosophy for PLC shall be as follows:
 - Min. of 20 % of I/O modules used (with at least one module of each type) for input and output shall be offered as spare for each programmable controller and the same shall be mounted and wired to the terminal block in the cubicle suitably.
 - No. of spare Channel per card shall be 20 %.
 - Provision shall be provided with empty slots for future expansion for 20% I/O modules.
 - Minimum 50 % spare memory capacity shall be available in the system for Purchaser's use after loading of application and system software.



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- 01 nos. of DI & DO card per PLC shall be provided as spare .

1.01.17 Uninterrupted Power Supply (UPS)

UPS shall meet the following requirements:

1. Hot standby dual redundant UPS system shall be provided. Each UPS shall be rated for full capacity and under normal condition one UPS shall be sharing the total load. In case of failure of any UPS second UPS shall take the full load.
2. Spare capacity of UPS shall be 60 %.
3. Load factor or diversity factor shall not be considered while calculating the load on UPS.
4. Two separate power supply from different sources shall be provided to UPS – one for UPS and the other for Bypass.
5. Bypass supply to equipment shall be through constant voltage transformer.
6. UPS and SMF batteries shall be located in air conditioned room.

1.01.18 Colour coding of equipment .

SL. No.	DESCRIPTION OF EQUIPMENT	COLOUR	PAINT SHADE NO. AS PER	
			IS 5 : 1991	EQUIVALENT RAL CODE
I. MOTORS				
1.	11 kV/6.6 kV motors	Traffic Grey A	631	7042
2.	415 V LT AC motors	Silver Grey	631	7030
II. MOUNTED ELECTRICS				
1.	Equipment installed on or along with motors viz. Tacho generators, brake etc.	Same as that of motor		
2.	Equipment installed on mechanism but separate from motor viz. Limit switches, pull chord switches, belt sway switches, speed switches, load cells, photo electric relays etc.	Traffic Grey A	631	7042
III. CONTROL GEAR				
1.	Drive panels, soft starter panels , UPS panels, PLC, Relay panels, MCC, PDB, MLDB, LDB, etc. including crane control panels	Light grey	631	7035
2.	Lighting distribution and power distribution board	Light grey	631	7035
3.	Fire fighting panel	Post office red	538	3002
4.	Local control box, Junction box	Light grey	631	7035
5.	Control desk	Light grey	631	7035
6.	Pulpit equipment	Light grey	631	7035
7.	Telecommunication panel	Smoke gray	692	7014
IV. MISCELLANEOUS EQUIPMENT				
1.	Junction boxes	Light gray	631	7035
2.	Conduit/pipe pull boxes	Light gray	631	7035
3.	Light fittings	Light gray	631	7035



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SL. No.	DESCRIPTION OF EQUIPMENT	COLOUR	PAINT SHADE NO. AS PER	
			IS 5 : 1991	EQUIVALENT RAL CODE
4.	415 V Welding sockets	Brilliant green	221	6010
5.	230 V Power sockets	Light orange	557	2000
6.	24 V transformer sockets, lamp sets etc.	Canary yellow	309	1016
7.	Earthing strip	Black		

1.01.19 Drawings and documents :-

All the electrical drawings shall be prepared on CAE (computer aided engineering) packages e.g. Si-Graph or any equivalent software package . The package shall have the facility to connect all the relevant drawings with ERP / SAP package .It must be OODB(Object Oriented Data Based) type.

The package shall have the facility to interface the most different systems in the plant establishment and operational process. It shall have the facility to accommodate the mechanical, civil, structural drawings also.

1.02 EQUIPMENTS

1.02.01 DRY TYPE TRANSFORMER

.1 Standards

Transformers shall comply with the following Indian Standards.

IS: 2026 (1977/1981) - Power Transformers
Parts (I, II, III & IV)

IS: 11171(1985)- Dry Type Transformers

IEC : 60726 - Dry Type Transformers

.2 Mechanical Design

.01 Transformer enclosure shall be welded/ bolted sheet steel construction, free standing, with suitable size of louvers backed with wire mesh. Base shall be suitably reinforced to prevent any distortion during lifting. Base channels shall be provided with flat wheels with pulling eyes and lifting hooks to facilitate handling.

.02 All fasteners and bolts etc. shall be galvanised or zinc passivated. All surfaces to be painted shall be thoroughly cleaned, made free from rust and given a primary coat of rust resisting paint followed by two finishing coats of approved shade. Paint shall be suitable to withstand specific climatic conditions.

.03 The transformer shall be provided with separate weatherproof HV/LV terminal boxes and disconnecting links on the side of transformer so as to facilitate withdrawal of transformer without disturbing the HT and LT cables connected to transformer.

.04 Tank shall be suitably designed to withstand harmonics available in the system as well as generated by the transformer.



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.3 ELECTRICAL DESIGN

- i) The transformer shall be cast resin dry type transformer, AN cooled suitable for indoor installation(in a covered room).
- ii) Generally as per IS 2026 – Part 1, 2 & 4 of 1977 and Part 3 of 1981.
- iii) 3 phase, core type, cast resin.
- iv) Rated output, voltage ratio, vector group shall be as specified in technical particulars for design.
- v) Rated frequency 50 Hz, $\pm 6\%$.
- vi) Insulation level shall be designed according to the voltages specified below.

Sl. No.	Description	11 kV System	6.6 kV System
1.	Nominal system voltage (kV)	11	6.6
2.	Max. system voltage (kV)	12	7.2
3.	One minute power frequency withstand voltage (kV)	35	28
4.	Peak impulse test withstand voltage (kV)	75	60

- vi) Transformers shall be capable of delivering rated current at an applied voltage up to 105% of rated voltage without exceeding the temperature limits.
- vii) Overload capacity of the transformer shall be as per IS 6600 - 1972 unless otherwise specified.
- viii) Shall be operable at its rated capacity at any voltage within $\pm 10\%$ of rated voltage of the particular tap.
- ix) Permissible maximum temperature at rated output and principal tap at the ambient temperature of 50 °C

Windings (by resistance method)	110 °C
Core and other adjacent parts of winding	110 °C
Core and other parts not adjacent of winding	Within safe limits of core and adjacent materials

- x) Transformers shall be designed to withstand the thermal and dynamic stresses due to short circuits at its terminals or symmetrical/ asymmetrical fault on any winding. Short circuit withstand capacity for the bolted fault at the terminals shall not be less than 5 second duration with respect to fault level specified.



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- xi) The maximum temperature at the end of the short circuit duration shall not be more than 250°C with the temperature prior to short circuit corresponding to maximum permissible overload.
- xii) Transformer shall be designed for minimum no-load and load losses within the economic limit.
- xiii) Designed for suppression of harmonics, especially 3rd and 5th.

01. MAGNETIC CIRCUIT

- i) Low loss CRGO silicon steel shall be used.
- ii) Laminations shall be annealed in a non-oxidizing atmosphere to relieve stresses and restore the original magnetic properties of CRGO sheets after the cutting and punching operations.
- iii) CRGO sheets shall be coated with insulation varnish compatible with the sealing liquid.
- iv) Insulation to withstand annealing temperature as high as 850 Deg. C and shall reduce eddy current to minimum.
- v) Ducts to be provided to ensure adequate cooling.
- vi) Core, framework and clamps arranged and tightened to securely hold laminations in order to prevent any settling or displacement in case of heavy shocks during transport, handling or short circuits.
- vii) Flux density under specified over voltage or frequency conditions shall be within the maximum permissible for the laminations. However it shall not exceed 1.6 tesla.
- viii) Transformers shall be designed to withstand 110% over fluxing corresponding to rated voltage.
- ix) Magnetising current shall be maximum 1% of the rated current.

02. WINDINGS

- i) Material shall be electrolytic grade copper.
- ii) Shall be subjected to shrinkage treatment.
- iii) Completed core and winding to be vacuum dried in full vacuum, impregnated immediately, then dried before casting in resin.
- iv) Shall be braced to withstand shocks due to rough handling and forces due to short circuit, switching or other transients.
- v) Permanent current carrying joints in winding and leads shall be brazed.
- vi) Coils shall be supported using dried and high-pressure compressed wedge type insulation spacers.
- vii) Insulating materials shall be compatible with transformer liquid under all service conditions.
- viii) Leads to the terminal board and bushings shall be rigidly supported.



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03. INSULATION

- i) Inter-turn and inter-coil insulation shall be designed such that di-electric stress is uniformly distributed throughout the windings under all operating conditions.
- ii) The winding shall be provided with class F insulation or better (as applicable to dry type transformer as per IS: 2026 part – II). However, temperature rise in winding and core shall be limited to class B insulation.

04. OFF CIRCUIT TAP SWITCH

- i) Bolted link type within enclosure, with easy accessibility.
- ii) Designed for sustained over current of at least 150% of the rated current of the winding
- iii) Capable of repeated operation and withstanding short circuit forces
- iv) Tap position configuration diagram shall be provided.
- v) Inspection/operation / or repair shall not require removal of transformer core from its enclosure.
- vi) Shall not occupy any intermediate position between clearly marked tap position.

05. TERMINATIONS

It shall be possible to withdraw the transformer easily after disconnecting the connections without disturbing the cable terminations. Cable termination box shall be bolted type and supported from bottom so that after withdrawing the transformer, it remains at its same position.

Winding shall be brought out and terminated on external /cable boxes as specified in the Technical Particulars.

- i) Cable termination
 - a) Air insulated cable end box suitable for the type and number of cables specified.
 - b) Air insulated disconnection chamber with inspection opening
 - c) Compression type brass cable glands with finned copper lugs of non soldering crimped type.
 - d) Bolted type gland plated (non magnetic material wherever specified).
 - e) Sealing kits with associated accessories like stress relieving , insulating type, bi-fercating boot, HT insulating tape etc.
- ii) Bus duct termination



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- a) When bus duct termination is specified, flanged throat shall be provided to suit the bus duct. Flange ends and inspection openings shall have weather proof gaskets.

06. Bushings

- i) Conforming to IS 3347 part-1,2 & 3 – 1979, Part 3&4-1988 and IS:2099-1986 for HT and IS 7421 for LT system.
- ii) Minimum rated current of line end bushings shall be 1.5 times rated current of the corresponding windings.
- iii) Clamps and fittings made of steel or malleable iron shall be hot dip galvanized.
- iv) Bushings rated 400 amps and above shall have non- magnetic clamps and fittings only.
- v) Bushing shall be solid porcelain type.
- vi) Neutral bushings shall be provided as required for earthing of neutral point. This shall be connected to brass/tinned copper bar and brought to outside the body through porcelain insulator.

.07 NEUTRAL CURRENT TRANSFORMERS

- i) Removable at site without opening transformer enclosure cover/active part.
- ii) Secondary leads shall be brought to a weatherproof terminal box and from there to the Marshalling box with 4 sq.mm copper armoured cable.

.08 WINDING TEMPERATURE INDICATOR

- i) Local winding temperature indicator (WTI) shall have a 150-mm diameter dial type indicator with a manual reset maximum reading pointer. There shall be two potential free contacts for alarm and trip signals. The settings for closing/opening of each contact shall be independently adjustable. Contact rating at DC11, 110V DC shall be minimum 5 Amps. The device shall be complete with lamp temperature sensing element, image coil, calibration device, aux. CTs etc. as required and shall be operated by RTD element.
- ii) Temperature indicator dials shall have linear gradations to clearly read atleast every 2°C. Accuracy shall be better than $\pm 1.5\%$.

.09 MARSHALLING BOX

- i) All outgoing connections from the transformer viz temperature indicators, level indicators CT secondaries, fault contacts for annunciation, etc. shall be wired to a Marshalling Box.
- ii) Degree of protection of enclosure shall be IP52 for indoor and IP55 for outdoor type respectively.



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.10 RATING PLATE

Each transformer shall be provided with a rating plate giving the details as per IS:2026 (Part-I). The marking shall be indelible and the rating plate shall be located on the front side. Exact value of transformer % impedance, as determined by tests shall be engraved on it and also on the final submission of name plate drawing.

.11 NOISE

Noise level shall be low and shall be within limit depending on the rating of the transformer as per IEEE-141.

.12 Earthing

- i) All metal parts of the transformer with the exception of individual core lamination core bolts and clamping plates shall be maintained of fixed by earthing.
- ii) Two nos. of tinned copper earthing terminals shall be provided.
- iii) One end of bushing CTs shall be earthed.

.13 List of Fittings and Accessories

- i) Off-circuit tap switch as specified.
- ii) Dial type winding temperature indicators operated by RTD elements.
- iii) Bushing CTs as specified.
- iv) Bi-directional rollers/flanged wheels with loading arrangement.
- v) Lifting lugs and jacking pads
- vi) Rating and diagram plates.
- vii) Earthing terminals.
- viii) Inspection cover
- ix) Identification plate
- x) Pockets for thermometer for winding temperature indicator.
- xi) HV, LV and Neutral bushings
- xii) Marshalling box.

.4 TESTS

The equipment shall be subjected to all the routine tests at the manufacturer works in accordance with latest version of IS2026 Part I and III or, the relevant IPSS (where specified), in presence of purchaser or his representative.

Test of all equipment shall be conducted as per latest BIS. Test shall also confirm to International Standards IEC/VDE/DIN/BS.

The tenderer shall submit type test certificates for similar equipment supplied by him elsewhere. In case type test certificates for similar equipment is not available, the same



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shall be conducted in presence of Purchaser or his representative if Purchaser so desires, without any financial implications to purchaser.

The transformer should pass the non-hygroscopic test according to DIN VDE-0532 and confirm to class E2 to prevent formation of moisture creepage path and resulting in failure of transformer.

The transformer should withstand the extreme load variation without any cracking of the casting. For this test certificate according to DIN VDE 0532 is to be furnished.

All the equipment shall be tested at site to know their condition and to prove suitability for required performance. The site tests and acceptance tests to be performed by manufacturer are detailed below.

The manufacturer shall be responsible for satisfactorily working of complete integrated system and guaranteed performance.

Acceptance tests to be conducted at site :

- i) Assembly inspection/ Painting check
- ii) Measurement of winding resistance
- iii) Measurement of voltage ratio and check of voltage vector relationship
- iv) Measurement of no-load current.
- v) Measurement of insulation resistance/ polarization index.
- vi) Certification for on-load/ off-load tap changer
- vii) Final documentation check

.5 DRAWINGS & DOCUMENTS

The suppliers shall supply the following drawings / documents and manuals.

- i) List of drawings
 - a) Overall General arrangement drawing
 - b) Rating and diagram plate
 - c) GA of Marshalling box
 - d) Wiring drawing of Marshalling box
 - e) H.V. cable box assembly
 - f) L.V. busduct assembly
 - g) QAP, Internal Test Certificates and Inspection Certificates
- ii) Instruction manuals for erection, testing and commissioning.
 - a) Instruction manual shall give step by step procedure for:
 - Erection, testing and commissioning
 - Operation
 - Maintenance and
 - Repair
 - b) Operation and Maintenance Manual



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- Recommended procedure for routine maintenance
- Tests for checking of proper functioning
- Diagnostic trouble shooting/ fault location charts
- c) Storage, conservation and re-commissioning Manual
- d) Safety Manual

Note : - Instruction manuals shall contain:

- a) Manufacturer's catalogues with ordering specification for all items
 - b) List of consumables with specifications, brand names and annual consumption figures
 - c) Procedure for ordering spares.
 - d) Drawings relevant for erection, operation, maintenance and repair of the equipments.
- iii) List of special tools and tackles

.6 TECHNICAL PARTICULARS

Sl. No.	Particulars	1000/ 2000 kVA
1.	Specification	IS 2026, Part I - 1977 Part II - 1977 Part III - 1981 Part IV - 1977 IS 11171 - 1985
2.	Type	Three phase, core type, cast resin dry type
3.	Duty	Indoor, installed in room
4.	Degree of Protection of Enclosure	IP42 for indoor and IP45 for outdoor.
5.	Voltage HV/LV	6.6 or 11 / 0.433 kV
6.	Frequency	50 Hz
7.	No. of phase	3
8.	Continuous rating	1000/2000 kVA
9.	Conductor	Copper
10.	Insulation class	Class F or better
11.	Cooling	AN
12.	Winding connection	Delta / Star
13.	Vector group	DYn 11



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Sl. No.	Particulars	1000/ 2000 kVA	
14.	Neutral grounding	Effectively earthed	
15.	System earthing	HV	Unearthed
		LV	Effectively earthed
16.	Percentage impedance	5% or 6.25% (as applicable)	
17.	Termination	HV	Cable end box suitable for termination of XLPE aluminium cables, with air insulated disconnecting chamber
		LV	Suitable for termination of Busduct with disconnecting chamber
18.	Temperature rise over 50°C ambient temp		
	a) In winding (measured by Resistance method)	80 °C	
	b) Core and other adjacent parts of winding	80 °C	
	c) Core and other parts not adjacent of windings	Within safe limit of core and adjacent materials.	
19.	Bushing mounted CT's		
	CT in LV Neutral bushing for standby E/F protection	Ratio : 500/5 A Class : 10P15	
20.	Off circuit tap changer	Bolted Link type	
	a) Range	±5%	
	b) Total tap positions	5	
	c) Taps above nominal voltage	2	
	d) Taps below nominal voltage	2	
	e) Voltage per step variation	2.5 %	
	f) Tap change controls	Manual	
21.	Impulse test withstand voltage	As per IS 2026, Part III – 1981	
22.	One minute dry and wet power frequency withstand voltage	- do -	
23.	Short circuit level on HV side	40 kA for 3 Seconds	
24.	Time duration to withstand 3 phase short circuit at secondary terminals, without any injury.	5 Secs.	
25.	Auxiliary supply voltage	240 V AC	
26.	Parallel operation	Suitable for parallel operation with transformers of similar ratings	
27.	Overload capacity	As per IS 6600 –1972	
28.	Paint & Paint shade	Epoxy based (Shade 632 as	

Sl. No.	Particulars	1000/ 2000 kVA
		per IS – 5)

1.02.02 VCB (Transformer Isolation)

1.02.02.01 6.6/ 11 kV CIRCUIT BREAKER (WITHOUT PROTECTION & METERING) PANEL

The 6.6/ 11kV circuit breaker panel shall be totally enclosed dust and vermin proof, sheet metal clad, floor mounted, free standing, indoor type and shall house circuit breakers, bus bars, control equipment, heat shrinkable cable termination, current transformers, potential transformers, instruments, relays, annunciation system and other accessories. This factory assembled HT circuit breaker panel shall be with fully draw out type breaker carriage, compartmentalised design with pressed sheet steel (thickness not less than 2.0 mm) and with IP-4X class of enclosure. All doors other than cable chamber shall be of hinged and lockable type with neoprene gaskets at all joints and the cable chamber shall be fixed with nuts and bolts. Additional wire mesh guards and gaskets shall be provided for cable chamber. Two separate earthing terminals shall be provided for HT panels. The HT panel shall be provided with metallic automatic safety shutters or those made of fibre glass of suitable insulation, which cover automatically the isolating contacts when circuit breaker is withdrawn from service position. Ventilation openings shall be provided where essential and shall have suitable screen protection.

Salient technical parameters to which the Circuit breaker panel shall conform are as follows:

Service voltage	6.6/ 11 kV +6%, -9%
System Frequency	50 Hz +4%, -6%
Degree of enclosure protection	IP 4X
Fault level in MVA	450/ 750MVA for 3 seconds
Type of CB	Sulpher hexa fluoride (SF6)/ Vacuum Circuit Breaker(VCB)
Rating	1250A
No. of poles	3



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No. of breaks/pole	1
Location	Indoor, floor mounted
Nominal current rating of bus bars	same as main bus bar rating of existing HT switchboard
Permissible temp. rise over ambient for switch board	45 °C
Operating Mode	Manual
Spring charging mechanism	Manual
Cable termination	Heat shrinkable termination kits
Connection of outgoing feeders	Cable

.1

General Features of 6.6/ 11kV Circuit Breakers

- 1) 6.6/ 11kV circuit breakers envisaged in the specification shall be designed to control and protect the power distribution system. The circuit breaker shall conform to IS:13118-1991 and IEC publication 56.
- 2) The circuit breaker shall be maintenance free and shall have adequate capacity, insulation and mechanical strength to withstand
 - a) In-rush magnetising currents of transformers
 - b) Starting currents of drives
 - c) Transient surges developed during various abnormal operating conditions
 - d) All electrodynamic stresses developed during abnormalities like faults in the system.
 - e) Frequent start/stop duty of the industrial load. Normally, 2 (two) quick succession cold starts and one restart from hot condition or 3 starts per hour shall be considered for design duty.
- 3) Circuit breakers shall have three operational positions, such as "Service" "Test" and "Draw-out" position. It will be possible to achieve all the above three positions with cassettes front door closed. Mechanical indicators for all three positions shall be provided. The circuit breakers shall carry a single break per pole which shall be identical with the other 2 pole chambers of the breaker. Simultaneous closing of the three poles



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of a breaker on a single closing command shall be ensured. All circuit breakers shall preferably be interchangeable.

- 4) The 6.6/ 11kV breaker shall be provided with electrical and mechanical trip free features and an emergency mechanical push to trip the breaker. All the features of the equipment shall ensure complete safety of the operation and shall be complete with approved safety devices to protect against potential hazards to operating personnel or to the equipment around. The design shall include all reasonable precautions and provisions for the safety.
- 5) All 6.6/ 11kV breakers shall be provided with at least 4 potential free Aux. contacts to be used by Employer for their interlocking/signaling purposes. Contact arrangement may be 2 NO + 2 NC and these shall be rated for 10 amp current duty on the control and auxiliary voltages (both AC & DC). Further, the following features shall be ensured in each 6.6/ 11kV breaker panel:
 - a) Control plugs provided shall be mounted in horizontal fashion.
 - b) Mini bus earthing with proper interlocks.
 - c) All supporting insulators shall have increased creepage distance as per IS and shall suit highly polluted atmosphere of steel industry.

.2

Bus Bars

- 1) The Power Bus Bars of 6.6/ 11kV breaker panel shall be made of high conductivity, electrolytic copper of purity 99.9% as per IS:613-1984 in rectangular sections.
- 2) Horizontal and vertical bus bar shall be designed manufactured and supported to withstand thermal and dynamic stress corresponding to rated short time and peak withstand current as specified above.
- 3) Bus bar arrangement shall be as per IS:5578-1985 & IS:11353-1995. Bus bar shall be sleeved with proper grade of insulating sleeves and of proper colour code for each phase. Care shall be taken to obviate corona formation at the joints and connections. All joints and connecting terminals shall be tinned.



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- 4) Bus bar shall be housed in a separate bus bar chamber with adequate air clearance and bushing. The insulators/ bushing shall be cast resin type to offer higher mechanical strength, during short circuit fault.
- 5) The clearance between bus bars shall be maintained as per standard. The bus bar chamber shall be provided with detachable side covers for regular maintenance and inspection and have provision of extension on both sides.

.3 Cable Chambers

The cable end termination chamber for each panel shall have adequate space for the termination of required number, type and size of cables and shall be provided with suitable bracings to support the weight of the cables without undue stress on the terminals. These chambers shall be complete with all accessories and shall form integral part of the cubicle and shall be freely accessible for cable connection.

.4 Earthing of 6.6/ 11kV Breaker panel

The following norms shall be adopted for earthing of HT breaker panel :

- 1) The 6.6/ 11kV outgoing cable shall be accessible to provide external earthing on opening the backside lower cover of the panel.
- 2) Continuous copper earth bus bar shall be provided. However, the cross section shall be checked to carry the peak short circuit and short time fault current of the system.
- 3) Earthing bus bar shall be positively connected/ welded with 6.6/ 11kV breaker panel, individual functional units and non current carrying metallic units.
- 4) Hinged door shall be earthed through stranded copper galvanized earthing braid.
- 5) For positive earthing of withdrawable units, silver plated copper strapping earthing contacts of "make before" / "break after" type shall be used ensuring earth continuity from "service" to "test" position of draw-out type breakers on both the sides.

1.02.03 415V Switchgear

1.02.03.01 General



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- The 415V switchboard shall comprise air circuit breakers & shall be metal clad, indoor type floor mounted (in fully drawout execution). Switchboard shall be in single tier execution for incomers & buscouplers & two tiers for outgoing feeders.
- Relative position of incomers shall be as per the equipment layout requirement.
- Sheet steel shall be CRCA of minimum 2.0 mm thickness.
- Circuit breaker shall be mounted on fully drawout truck with service, test and isolated positions and complete with following safety interlocks and safety shutters with padlock facility :
 - ⇒ It shall not be possible to move the truck in or out of cubicle when the breaker is closed.
 - ⇒ CB compartment door shall be mechanically interlocked so that it will not be possible to close the CB in plug position when the door is open.
 - ⇒ It shall not be possible to push the truck in close position if either of the safety shutter is not free and not in close position.
- The position of various control switches, push buttons, levers etc. requiring manual operation, shall be at a height not less than 450mm and shall not exceed 1850mm from the finished floor level.
- Name plate for each incoming bus coupler, and outgoing feeder at front and back, both on the fixed portion of the panel.
- All panels shall have space heater with switch and cubicle illumination lamp with door switch
- All breakers of similar rating shall be interchangeable.

1.02.03.02 Insulation Level

- Rated insulation voltage 1100 V
- One minute power frequency withstand voltage :
 - ⇒ 2.5 kV for power circuits
 - ⇒ 2 kV for control circuits
- Clearance in air (minimum) :
 - ⇒ Phase to phase - 25.4 mm
 - ⇒ Phase to earth - 19.0 mm

1.02.03.03 Short Circuit Strength

- Rated short time withstand current not less than the system short circuit level specified for 1 sec.
- Rated peak withstand current not less than 2.1 times the system short circuit level.

1.02.03.04 Busbars

- Busbars made of EC grade aluminium alloy equivalent to E91E WP as per IS 5082, 1981, size adequate for specified rated continuous and SC current.
- Jaw contact to be mounted on ACB and fixed contact to be mounted on the bus side (as per the manufacturer's standard).
- Three phase, neutral (with atleast 50% rating of main buses) and continuous earth bus. Bus bar shall be provided with proper grade & colour of heat shrinkable sleeve.
- Rating of horizontal buses shall be same as that of incomer circuit breakers and



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vertical run shall be same as that of outgoing breaker rating

- Temperature rise of bus bars shall not be more than 40 deg. C above an ambient of 50 deg. C.

1.02.03.05 Protection Requirements

- One auxiliary relay for each transformer incipient faults :
 - a) Buchholz - alarm (63X)
 - b) Oil temp. high alarm (490X)
 - c) Winding temperature high alarm (49 X)
 - d) Buchholz trip (63Y)
 - e) Oil temp. high - trip (490Y)
 - f) Winding temp. high trip (49Y)
- For the above faults, contacts to be made available for inter tripping primary side breaker also.
- All other protections as specified.

1.02.03.06 Construction Features (Mechanical Design)

- Sheet steel clad, floor mounted, free standing design, non-dust proof construction
 - ⇒ Extension bus links properly spaced for terminating single cables of size 120 sq. mm and above as well as for terminating multiple cables of all sizes.
 - ⇒ Where more than one cable have to be terminated per unit, the arrangement shall permit connection and disconnection of individual cables separately without disturbing other cables.
 - ⇒ Double, compression type brass cable glands and crimping type, tinned, heavy duty copper lugs suitable for the type, size and number of cables to be terminated, to be supplied with the switchboard for all LT power and control cables.
 - ⇒ The interior of the switchboard shall be finished with 'OFF WHITE' paint shade.
 - ⇒ **All the panels shall be of uniform depth.**
 - ⇒ All panels shall be supplied with base channels.
 - ⇒ The enclosure class shall be IP52 or better.

1.02.03.07 Relays

- Flush mounted
- Mechanically operated flag indicators with all relays capable of being reset without opening casing
- Shall withstand impulse voltage in accordance with IS/IEC recommendation.
- Test facility by plug from panel front.
- CT secondary shall be shorted on relay withdrawal.
- Diagram plate at the back of case to identify connections.
- The relay shall be microprocessor based numerical and communicable type.

1.02.03.08 Circuit Breaker

01. Electrical Features

- Air break triple pole (4 pole in case of DG power incomer) drawout type conforming to IS 13947.
- Identical tripping/closing coil rating shall be provided as per the supplier's standard.
- Rated continuous current as specified.
- Symmetrical breaking capacity and 1 second rating of the breaker not less than the system short circuit level specified.
- Making capacity 2.55 times breaking capacity.
- Performance category : P2



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- Auxiliary contacts : 6 NO + 6 NC minimum, convertible from NO to NC and vice versa at site.

Ratings :

Continuous	10 amps
AC 11	4 amps at 240 V
DC 11	0.5 amps at 110 V

02.

Operating Mechanism

- Manual or power operated mechanism as applicable
- Spring charged stored energy mechanism to ensure high speed closing and tripping independent of the operating forces.
- Anti pumping and trip free feature
- Emergency tripping by mechanically operated trip push button (shrouded to prevent accidental closing) acting directly on the trip bar.
- Closing operation of the breaker to charge the tripping spring, ready for tripping.
- Mechanical indication to show :
 - ⇒ Closing spring charged
 - ⇒ Breaker ON/OFF/TRIP
- Breaker to close only when spring fully charged
- Non-reset type operation counter
- For manually operated breakers.
 - ⇒ Independent manual charging of closing spring and closing by handle.
 - ⇒ Alternatively, closing by mechanical push button with spring previously charged by handle.
- For electrically operated breakers :
 - ⇒ Charging of closing spring by motor
 - ⇒ closing by closing coil
 - ⇒ spring charging motor and closing coil suitable for rated control voltage (240 AC unless otherwise specified).
 - ⇒ One opening and one closing operation without control supply.
 - ⇒ Provision also for manual closing with spring charging motor automatically decoupled as soon as charging handle is inserted.

03.

Drawout Features

- 3 distinct positions viz. service, test, and isolated with the door closed.
- Mechanical position indication and locking/latching facility for all 3 positions.
- Power connections - self aligning, plug-in type.
- Control connections - sliding or plug socket type, mechanically coded, to prevent wrong insertion, continuous rating 16 amps minimum.
- Automatic safety shutters to prevent accidental contact with live parts when the breaker is withdrawn.

04.

Safety Interlocks

- It shall not be possible to close the breaker in any intermediate position other than the 3 fixed positions.
- With the breaker closed, it shall not be possible to rack it in from any of the 3 position to another.
- Mechanical stopper to prevent accidental falling while withdrawing.
- It shall not be possible to rack in the breaker from isolated to 'test' position with the door open together with provision for defeat of this interlocking, however, it shall be possible to close the door only when the breaker is brought back to 'isolated' position.



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- It shall be possible to open the door only when
 - ⇒ breaker is OFF and
 - ⇒ is in 'Isolated' position.
- Remote closing of breaker is not permitted with door open.
- Insertion of breaker into 'Service' position shall not be possible if the shutters are not free.

05. Internal Control Wiring

- Control wiring by 1100V grade PVC insulated, single core copper conductor of minimum cross section 2.5 sq. mm
- Flexible wires, protected against mechanical damage for wiring to door-mounted devices.
- Wires identified at each end in accordance with schematic diagrams by interlocked type ferrules.
- Colour code for control wiring :

AC – black	Earth wire - Green
DC – light grey	Trip circuit - Red

- All connections external to a feeder, all the auxiliary contacts of the LT breaker, and all spare contacts of the relays shall be wired on to the terminal blocks.
- Interconnection between panels of adjacent shipping sections to be brought out to a separate terminal block, wires for interconnection properly labeled, looped and bunched inside the panel for connection at site.
- Not more than two connections shall be carried out on one terminal.

06 External Terminations

06.1 Control Terminations

- 650V grade multiway terminal blocks of non-tracking moulded plastic complete with insulated barriers, stud type terminals, washers, nuts and lock nuts and identification strips.
- Power and control terminals segregated.
- Control terminals of minimum rating 10 amps suitable to receive 2.5 sq. mm copper conductor.
- 20% spare terminals in each control terminal block.

06.2 Power Terminations

- Suitable for accepting cables/bus trunking as specified in the technical particulars.
- All spare contacts wired upto terminal block of the panels
 - a) Protective relays - withdrawable type
 - b) auxiliary, timer relays - fixed type

07.0 Microprocessor based releases

07.01 General

- The control unit shall be interchangeable on site for adaptation to changes in the installation.
- Sensors shall be non-magnetic or of the Rogosky type for accurate current measurements.
- The control unit shall measure the true RMS value of the current.
- The control unit shall comprise a thermal memory to store temperature-rise data in the event of repeated overloads or earth faults. It shall be possible to disable this function if necessary.



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07.02

Protection

- The control unit shall offer the following protection functions as standard:
 1. Long-time (LT) protection with an adjustable current setting and time delay;
 2. Short-time (ST) protection with an adjustable pick-up and time delay;
 3. Instantaneous (INST) protection with an adjustable pick-up and an OFF position.
 4. Earth-fault protection with an adjustable pick-up and time delay.
- **Current and time-delay settings shall be indicated in amperes and seconds respectively on a digital display. Acknowledgement that the setting change should translate to the trip threshold.**

07.03

Measurements

- An ammeter with a digital display shall indicate the true RMS values of the currents for each phase.
- An LCD Screen should continuously display the most heavily loaded phase apart from the load level on the three phases.
- A maximeter shall store in memory and display the maximum current value observed since the last reset. The data shall continue to be stored and displayed even after opening of the circuit breaker.
- The control unit shall measure voltages and calculate power and energy values.
- These values shall be displayable on the screen and updated every second. The minimum and maximum values shall be stored in memory.

07.04

Communication

- The circuit breaker shall be capable of communicating the following data through a bus:
 - Circuit-breaker status (open/closed, connected/disconnected/test, tripped on a fault, ready to close);
 - Control-unit settings, including protection setting parameters.
 - Tripping causes;
 - The measurements processed by the control unit: current, voltage, frequency & power(active & reactive).
- It shall be possible to remotely modify circuit-breaker settings:
 - Settings within the range defined by the switches on the front panel of the control unit;
 - Settings of the protection functions and the alarms.
 - It shall be possible to remotely control the circuit breaker of identified feeders only.(Viz. all incomers & buscouplers)
- Communications functions shall be independent of the control unit.

08.

Indicating Instruments(Analog Meters)

- Taut band type
- Size

Incomer and sectionalizer	144 sq. mm
Outgoing	96 sq. mm

- Flush mounting : in front of the cubicle
- Accuracy class - 1.0
- Ammeters shall be compatible with CTs of 5A secondary and read actual currents.
- For motor feeders ammeters shall have suppressed scale upto 6 times of full load current after 1.2 times of full load current and shall have red mark on full load



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value.

09. Protective Devices

All control circuits shall be individually fed by MCBs with built in thermal and magnetic releases. HRC fuses shall be provided for protection of spring charged motors of electrically operated breakers.

10. Contactors

Contactors shall break without damage 8 times rated current upto 100 amp rating and 6 times rated current for above 100 amp rating. Continuous current shall not exceed 2 amp and initial pick up shall be limited to 9 amp. Class of insulation shall be E or better. Drop out voltage shall be 45-65% of rated voltage and pick up shall be 85-110% contactor duty shall be AC3 unless otherwise specified in design parameters.

11. Annunciation Scheme

- Shall be static type.
- Hooter and bell shall be provided for trip & alarm indication respectively.
- Number of points shall be as per list.
- Shall have facilities for test, reset and accept.
- Shall consists of annunciation windows, relay blocks warning bell, emergency hooter, push buttons etc.
- All windows shall have two bunch LED in parallel.
- All accessories including actuator (if respective scheme is in Contractor's scope) shall be provided.
- Sequence of operation shall be as follows :

Description	Audio	Visual
On occurrence of fault	ON	Flashing
On accepting	OFF	Steady ON
On resetting (fault cleared)	OFF	OFF
On resetting (fault persists)	OFF	Steady ON

12. Control Supply

- Suitable arrangement for 240V AC reliable control supply of adequate rating shall be provided in each 415V switchboard.
- Two 240V AC feeders shall be provided in each board for control and annunciation purpose.
- Shunt trip shall be suitable for operation on 240V AC.
- Shall have supervision facility, alarm shall be provided for non availability of any one of the control supply.
- MCBs shall be provided on incoming sides of supplies.
- Control buses of two sections shall be connected through sectionalising switch.
- Indication lamps shall be connected to 240V AC supply.
- Isolation arrangement shall be provided on each panel to facilitate fault location and testing. Separate fuses shall be provided for spring charging motors, for indication lamps and for closing/tripping circuits of each cubicle.

13. Inter Tripping

- Provision shall be made for tripping of incomer LT breaker on tripping of upstream HT breaker.
- Provision for tripping of upstream HT breaker on fault tripping of LT incomer breaker shall also be provided.



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14. Indicating Lamps

- i) LED cluster type.
- ii) LEDs used shall be of the colour of the lamp.
- iii) Color shall be as follows:

ON	:	RED
OFF	:	GREEN
CIRCUIT HEALTHY	:	WHITE
FAULT/WARNING	:	AMBER
SPRING CHARGED	:	BLUE

15.

Control and Selector Switches

- Control switches for circuit breaker ON/OFF control 3 position spring return to neutral with lost motion device and pistol grip handle.
- Other control and selector switches - stay put type with wing type knobs.

16. Push Buttons

- Contact Rating :

Continuous	10 amps
AC 11	1.5 amps at 240V
DC 11	0.5 amps at 110 V DC, L/R - 40 ms

- Colour :

ON	RED
OFF	GREEN
ACCEPT	BLUE
RESET	BLACK
TEST	YELLOW

17. Protective Earthing

- Continuous earth bus of minimum size 50 x 6 mm copper or equivalent aluminium /galvanized steel section, designed to carry the peak short circuit and short time fault current as specified.
- Provided at the bottom extending throughout the length of the board, bolted/brazed to the frame work of each panel with an earthing terminal at each end, for terminating external earth conductor.
- Vertical earth bus for earthing individual functional units.
- All non-current carrying metal work (including metallic cases of instruments and other panel mounted components) effectively bonded to the earth bus.
- Hinged doors earthed through flexible earthing braid.
- Looping of earth connection, resulting in loss of earth connection to other devices, when the loop is broken, not permitted.
- Withdrawable units provided with self-aligning, spring loaded, silver plated copper scrapping earth contacts of make before/break after type ensuring earth continuity from service to the test position.

18. Breaker Handling Truck

- One for each switchboard, for withdrawing the breakers from the switchboard.
- Height of platform adjustable to suit the levels at which the breakers are mounted.
- Adequate mechanical strength for handling the largest breaker.
- Guide rails and stops.
- Incomer shall have analog meter (96 x96 mm) to measure line voltage/ bus voltage & current (New point)
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19. Auto Changeover Scheme

- Usually both the incomers shall be 'ON' with bus-coupler in the 'OFF' condition.
- In case of failure of one of the supply feeders (say by upstream fault), it will be sensed by the under-voltage relay which in turn will trip the incoming breaker after a pre-set time delay.
- Through the normally closed auxiliary contacts of the tripped incoming breakers, the bus-coupler breaker shall close provided the other section is "Healthy".
- The automatic transfer scheme shall be such that the automatic closing of the bus section can be done only once and in case the bus coupler breaker trips during auto changeover, no further auto closing shall be permitted. Auto changeover shall not take place if the incomer breaker trips on fault. The restoration of power shall be manual.
- The automatic transfer circuit shall be controlled through an auto manual changeover switch.

20. Technical Particulars

LT Switchboard	
Nominal system voltage	415 V
System earthing	Neutral solidly earthed
Short time rating	50 KA for 1 Sec.
Making capacity	105 kA
Control supply	240V AC
Configuration	As per IS
Colour code	R Y B
Busbar rating	4000 A
Enclosure	IP-4X or better
Circuit Breakers	
Symmetrical breaking current	50 kA
Making capacity	105 kA
Short time rating (for 1 second)	50 kA
Rating for incomers and buscouplers	4000A
Rating for outgoing	To be decided by the tenderer
Closing mechanism	
Incomer & bus sectionalizer	Motor operated spring charged stored energy type
Outgoing	Independent manual
Tripping mechanism	Shunt trip
Control supply	240 AC
No. of auxiliary contacts	6 NO + 6 NC for future use
Termination	
Incomer	Bus duct (top entry)
Outgoing	Armoured aluminium cables
Finish paint	Powder coated Brilliant green, shade 221 as per IS-5
Feeder Arrangement	
Incomer & buscoupler (Mounted in single tier arrangement)	Air circuit breakers



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Outgoings (Mounted in two tier arrangement)	Air circuit breakers
Feeder requirement	To be decided by the tenderer
Colour identification	LT switchboard colour identification shall be change from RYB to YGR

21. Schedule of Components

Sl. No.	Schedule of components equipment specification	Type of Feeder		
		B/C	Incomer	Out going ACB Feeder
1.	415V,50kA air circuit breaker with: - independent, motorized, spring charged mechanism, with electrical/manual ON/OFF control mechanism - shunt trip - ON/OFF indicator	1	1	-
2.	415V,50kA air circuit breaker with: - independent, manual, spring charged mechanism. -shunt trip - mechanical ON/OFF indicator	-	-	1
3.	Microprocessor based intelligent type direct acting O/C, S/C & E/F release with measurement control & data transfer facility.	1	1	-
4.	Microprocessor based direct acting O/C, S/C & E/F release with measurement & data transfer features without remote control facility.	-	-	1
5.	Control switch ON/OFF with spring return to neutral	1	1	1
6.	Multifunction meter	1	1	1
7.	Current transformer, class 1.0 for metering	3	3	3
8.	Microprocessor based motor protection relay	-	-	1(for motor feeders only)
9.	ON/OFF/Trip on Fault/Trip circuit healthy lamps	3	4	4
10.	Auxiliary relays flag indication for buchholz trip and alarm and oil temperature trip and alarm signals and winding temp. alarm and trip signals	-	6	-
11.	Auto changeover scheme with under voltage relay, check synchronization relay, PT etc.	Between incomers & bus couplers		
12.	Set of relays, contactors, timers, etc. for annunciation scheme	As per Requirement		
13.	Set of relays, contactors, timers for auto changeover scheme	As per Requirement		



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Sl. No.	Schedule of components equipment specification	Type of Feeder		
		B/C	Incomer	Out going ACB Feeder
14.	Impulse switch for tripping 6.6 kV or 11kV breaker	-	1	-
15.	Two position, two contacts stay put switch with pistol grip handle for closing permission of upstream 6.6 kV or 11kV breaker	-	1	-
16.	ON/OFF indication lamp for upstream breaker.	-	2	-
17.	Inter tripping push button to trip the upstream breaker	-	1	-
18.	Analog Voltmeter with selector switch	1	2	-
19.	Analog Ammeter	-	3	-

1.02.04 LT BUSDUCT

01. Electrical Design

- i) Electric power supply (Unless otherwise specified) 415V, 3 phase, 50 Hz system.
- ii) Insulation level
 - Rated Voltage : 415 V
 - Rated insulation voltage : 1100V
 - One minute power frequency voltage : 2.5 kV
 - Clearance in air (minimum)
 - Phase to phase (mm) : 25.4 mm
 - Phase to earth (mm) : 19.0 mm
 - Neutral grounding : Solidly grounded
- iii) Short circuit strength
 - Rated short time withstand current not less than the system short circuit level specified for 1 Sec duration.
 - Rated peak withstand current not less than 2.1 times the system short circuit level.
- iv) Rated current
 - Rated continuous current as specified while in enclosure and at specified ambient temperature with maximum temperature of bus bars limited to 90 deg. C
 - Neutral bus where specified with rating not less than half the rating of phase bus.

02. General Arrangement

- Rectangular, non-segregated phase, totally enclosed type.
- Comprising of following sections, as applicable, to make the installation complete and to match with the terminal equipment :
 - ⇒ Switchgear lead-in section with flexible hood.
 - ⇒ Straight section in standard length
 - ⇒ Matching section (length as required)
 - ⇒ Transformer lead-in section
 - ⇒ Corner sections (horizontal and vertical)
 - ⇒ Phase cross-over section, if required, to match phase sequence of boards.
- 240V AC space heater to be provided at suitable intervals and wired to external



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- terminal box with heat resistant cables.
- Silica gel breathers at appropriate locations.
- Horizontal bends to be avoided by positioning the switchboard incomers at appropriate place.

03. Construction Details

- Degree of protection for enclosure IP 52 or better for indoor installation, and IP55 for outdoor part.
- Enclosure material : Aluminum sheet, as specified of minimum thickness 2.0 mm for sheet steel & 2.5 mm for Aluminum.
- Enclosure construction rectangular welded construction.
- Maximum temperature of enclosure under rated operating conditions limited to 75 deg. C
- Bolted covers with gaskets for easy inspection and access to insulators and bus bar joints.
- Gasketed (Neoprene) connections between adjacent sections of metallic enclosure.
- Rubber bellows at each end to take care of vibrations.
- Provision for mounting on brackets.
- Seal off bushings shall be provided for busduct with indoor & outdoor part.
- The outdoor part shall be provided with sloping top.
- Seal off bushings shall be provided for busduct with indoor & outdoor part.
- Supply of painted MS supporting structures with necessary hardware shall be included in the scope of supply.
- Surface treatment.

Two coats of epoxy paint for outdoor and synthetic enamel paint for indoor application, preceded by de-rusting, cleaning chemically, degreasing, pickling in acid, cold rinsing, phosphating, passivating and spraying with two coats of zinc oxide primer.

- Shade of paint :
 - ⇒ Interior : Black
 - ⇒ Exterior : Light grey shade 631 of IS-5 (unless otherwise specified) for outdoor part
Shade 632 of IS-5(unless otherwise specified) for outdoor part.

04. Busbars and connections

- Material EC grade aluminium alloy equivalent to E91E WP conforming to IS 5082, 1981; or high conductivity electrolytic grade copper as per IS-613, 1984.
- Final operating temperature of both bus bars and joints under continuous operation in enclosure limited to 90 deg. C by thermometer method.
- Bus bar shall be as per IS-5082, IS-13947 & IS-5578..
- Phase identification by colour at ends and at regular intervals.
- Busbar joints of bolted type, with zinc bichromated high tensile steel bolts, nuts and spring washers. Bus-bar joint shall be chamfered as per the manufacturer's practice.
- Busbar surfaces to be tinned at joints and coated with oxide inhibiting grease prior to jointing.
- Copper busbar surface should be tinned.
- Flexible connections for termination on equipment.
- Expansion joints on straight runs with joints staggered in adjacent phases.
- Bimetallic joints for jointing between dissimilar metals.
- Busbar support insulators of non-hygroscopic material, having high impact and



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di-electric strength, with an anti-tracking contour.

05. Protective earthing

- Aluminium earth bus of size 50 x 10 mm running throughout the length of the busduct, positively connected to the body of the busduct.
- Provision at each end of busduct for terminating external earth conductor.

06. Technical particulars for Design

Sl. No.	Particulars	
1.	Application	Indoor
2.	Rated system voltage	415 V
3.	System earthing	Solidly earthed
4.	Rated continuous current as specified ambient conditions (in enclosure)	4000 A
5.	Rated short time withstand current (kA.rms) and its duration	50 kA for 1 Sec.
6.	Rated peak withstand current (peak)	105 kA
7.	Temp rise over ambient of 50 deg. C - Busbars - Enclosure	40 deg. C 25 deg.C
8.	Busbar material	Aluminium/ Copper
9.	Neutral bus	To be provided
10.	Earth bus material	Aluminium
11.	Earth bus size	2 nos. 50 x 10
12.	Supporting insulators	SMC/ FRP
13.	Busduct enclosure material	Aluminium
14.	Busduct enclosure material thickness	2.5 mm
15.	Busduct support structure	To be provided
16.	Overall (approximate) length of busduct (to be finalized, during detailing) including bends flanges etc.	8 m per set
17.	Type	Phase non-segregated type
18.	Maximum voltage at which busduct can operate	1100V
19.	One minute power frequency withstand voltage(kV)	2.5
20.	End connections	Copper flexibles
21.	Clearance: -Phase to phase -Phase to earth	25.4 mm. 19 mm.
22.	Accessories: -Space heater with thermostat -Silica gel breather -Busbar support structure	To be provided
23.	Enclosure Protection class	IP-52
24.	Paint-Shade -Interior -Exterior	Black Shade 631 of IS:5

1.02.05 Power Distribution Board (PDB)

- 415V, 3 phase, 4 wire, 50 kA (short time rating for 1 sec.) indoor type.



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- Board shall be single front, metal clad, front matched dust and vermin proof, fully compartmentalized and extensible on both sides, IP51 type enclosure.
- Degree of protection for enclosure IP 52 or better for indoor installation, and IP55 for outdoor part.
- Shall have base channel of size ISMC 75.
- Shall have isolated busbar chamber for main busbar at the top, running through out the length of the board. Chamber shall have removable cover.
- Cable alley shall have sufficient space for aluminium power cables and bottom cable chamber shall be left free completely isolated from the vertical busbars.
- Busbars shall have same cross section through out the length. Rating of the neutral busbar shall be 50% of the main busbar. Earth bus bar shall run in bottom chamber throughout the length of the panel.
- Shall have moulded case circuit breaker triple pole, air break type with independent manual quick make and quick break type. MCCB shall be capable of breaking rated current at .3 pf at rated voltage. MCCB shall withstand the fault current envisaged for 415V system.
- All feeders shall have ON/OFF lamps and 96 sq.mm size ammeter.
- Incomers of board and outgoing shall be MCCBs with E/F protection .

1.02.06 MOTORS & FIELD DEVICES

01. Low voltage squirrel cage induction motors :

Sl.No.	Parameters	Description
1.0	Standard	IPSS 1-03-001 / IS 325 / IEC 34 & IEC 72
2.0	Constructional Features	
(i)	Frame size & rating	As per IS 325
(ii)	Motor body	Grey iron casting as per IS:210-1978
(iii)	Motor Feet	Integrally cast with the stator
(iv)	Body Design	<ul style="list-style-type: none"> - Prevent breakage or other failures due to vibrations normally encountered in heavy industries . - Motors shall be of weather proof construction. - Designed to operate in the humid air stream - Drain plugs to be provided .
(v)	Protection for Motor & Bearing	IP - 55 (with canopy for motor if installed outdoor)
(vi)	Shaft ends & Extension	Cylindrical as per requirement Proper drilling and tapping shall be provided for mounting of tachos for speed feedback (if required) Crane motor in 225 and above frame sizes shall have tapered shaft (1:10) (New point)



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(vii)	Bearings	<ul style="list-style-type: none"> - For motor of rating upto 5 kW, ball bearings shall be used for both DE & NDE end. - For ratings above 5 kW the DE end shall be provided with roller bearing and NDE end shall be provided with ball bearing. - Bearings for motors shall be of C3 clearance . - Bearings shall be suitable for running of motor in either direction.
(viii)	Hazardous Area safety design	As per requirement
(ix)	Canopy	To be provided for all outdoor motors .
(x)	Greasing point	At DE & NDE sides .
(xi)	Paint shade	Light grey shade 631 as per IS:5 or RAL 7030 (grey).
(xii)	Direction of Rotation	For crane and mill duty motors : reversible For general purpose continuous duty motor : Bidirectional (New point)
3.0	Terminal box	
(i)	Location	Location on top preferably
(ii)	Suitability	<ul style="list-style-type: none"> - 4 Core Aluminium Cable - Extension shall be done to receive the aluminium cables to avoid cramping of the cables in the terminal box .
(iii)	Rotation	4 X 90 deg.
(iv)	Earthing stud	Inside Terminal Block
4.0	Cooling	<ul style="list-style-type: none"> - TEFC - Effective irrespective of direction of rotation
5.0	Quality of operation	
(i)	Vibration intensity	Shall be limited as per IS 12075-1986.
(ii)	Noise level	As per IS: 12065-1987
(iii)	Balancing	Motors shall be dynamically balanced with full key on the shaft- end and fan
6.0	Electrical design	
(i)	Power Supply	<ul style="list-style-type: none"> • 415 V +10 & - 15% • 50 Hz +/- 6% • 3-phase, 4-wire AC • 50 kA for 1 second, solidly earthed.
(ii)	Starting	DOL
(iii)	Min Voltage for Start & Run	85 % of rated voltage at terminal
(iv)	Starting Torque	>= 160 % Rated Torque
(v)	Breakdown or pullout torque	Minimum 275 % of the rated torque
(vi)	Starting current	<= 600% Rated current
(vii)	Duty	S1/or as specified in TS For crane duty S5 40% with 150 start/hour. For conveyor application S-3 and 6 starts / hr For continuous duty- efficiency class EFF-1.
(viii)	Starts/Hour permissible	3 equally spread or 2 in quick succession from cold or one hot start, under rated load condition..
(ix)	Max speed permissible	120% over speed for 2 minutes
(x)	Overload capacity	Capable of withstanding 60% Overload for 15 sec.
(xi)	Efficiency	All continuous duty motor (S1-100%) shall be of high



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		efficiency confirming to eff2 class as per IEEMA-19-2000 .
(xii)	Derating	Motor designed at 50 deg.C shall be derated suitably for mentioned ambient temperature .
(xiii)	Motor connections	Motor with frame size 90 shall be connected in star and of frame sizes more than 90 shall be connected in delta . For delta connected motors 6 leads shall be brought out .
(xiv)	Insulation	Class F
(xv)	Minimum temperature rise	Permissible Limited to class 'B' (120 deg absolute)
(xvi)	Torque Type	Normal / High / High slip type / Stall Torque type (as required for the specific application)
(xvii)	Space Heater	Out door motors above 45 kW Indoor Motor above 110 kW
(xviii)	No. of Poles	4 pole (unless specific drive requirement or economics call for other poles).
(xix)	Testing	As per approved QAP during engineering stage .
(xx)	Mounting	Normally horizontally foot mounting . Other type of mounting as per specific requirement .

02. Low voltage slip ring induction motors (Only for cranes and mill duty) :-

Sl.No.	Parameters	Description
1.0	Standard	IPSS:1-03-001-92, IPSS 1.03-004-93 , IS 325 , IEC 34 & IEC 72
2.0	Application	Slip ring induction motors shall be used only for drives of charging cranes . Slip ring motors shall be employed for intermittent duty drives requiring frequent switching operations and speed control and for heavy drive applications requiring high starting torque and meeting frequent overload conditions.
3.0	Constructional Features	
(i)	Frame size & rating	As per IS 325 Use of motors in frame sizes above 400 shall be avoided on cranes .
(ii)	Motor body	Grey iron casting as per IS:210-1978
(iii)	Motor Feet	Integrally cast with the stator
(iv)	Body Design	<ul style="list-style-type: none"> - Prevent breakage or other failures due to vibrations normally encountered in heavy industries . - Motors shall be of weather proof construction. - Designed to operate in the humid air stream - Drain plugs to be provided . - All motors to have continuously rated slip rings.



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(v)	Protection for Motor & Bearing	IP55 degree of protection as per IS : 4691.
(vi)	Shaft ends & Extension	<ul style="list-style-type: none">- Shall be of high grade steel .- Cylindrical as per requirement- Proper drilling and tapping shall be provided for mounting of tachos for speed feedback (if required) in non drive end or shaft shall be extended with different diameter and length . Tapered shafts for all crane drive motors shall be provided. Motors in 225 and above frame size shall have tapered shaft (1:10) . <ul style="list-style-type: none">- Provision of double identical shaft extension (cylindrical & taper) to be made (in case of requirement for a particular application) .
(vii)	Slip rings	<ul style="list-style-type: none">- All motors to have continuously rated slip rings.- Phosphor bronze or steel slip rings shall be provided .Cast iron slip- rings shall not be used .- Brush holders shall be in a complete assembly unit .- Slip ring unit shall have a cover with inspection window .- For higher range of motors, separate disc is provided between the slip ring and rotor windings to prevent carbon dust ingress into windings.
(viii)	Bearings	<ul style="list-style-type: none">- For motor of rating upto 5 kW, ball bearings shall be used for both DE & NDE end.- For ratings above 5 kW the DE end shall be provided with roller bearing and NDE end shall be provided with ball bearing.- Bearings for motors shall be of C3 clearance .- Bearings shall be suitable for running of motor in either direction.
(ix)	Hazardous Area safety design	As per requirement
(x)	Canopy	To be provided for all outdoor motors .
(xi)	Greasing point	At DE & NDE sides for online greasing facility without dismantling the motor.
(xii)	Paint shade	Light grey shade 631 as per IS:5 or RAL 7030 (grey).
4.0	Terminal box	
(i)	Location	On top preferably
(ii)	Suitability	<ul style="list-style-type: none">- 4 Core Aluminium Cable- Extension shall be done to receive the aluminium



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		cables to avoid cramping of the cables in the terminal box .
(iii)	Rotation	4 X 90 deg.
(iv)	Earthing stud	One earthing stud shall be provided in the terminal box and two terminals on mounting feet.
(v)	Stator and rotor connections	Separate and distinctly marked terminal box to be provided for stator and rotor connections.
(vi)	Protection class	IP 55 in all the cases .
(vii)	Cable glands	Suitable for double compression type cable glands .
5.0	Cooling	<ul style="list-style-type: none">- TEFC design only- Effective irrespective of direction of rotation- The cooling code of motor is IC 411 as per IS : 6362.
6.0	Quality of operation	
(i)	Vibration intensity	Shall be limited as per IS 12075-1986.
(ii)	Noise level	As per IS: 12065-1987
(iii)	Balancing	Motors shall be dynamically balanced with full key on the shaft- end and fan
7.0	Electrical design	
(i)	Power Supply	<ul style="list-style-type: none">• 415 V +10 & - 15%• 50 Hz +/- 6%• 3-phase, 4-wire AC,• 50 kA for 1 second, solidly earthed.
(ii)	Starting	DOL or thyristor converter (ASTAT or SIMOTRAS or equiv.) Soft starter feature through static voltage control/VVVF as per application
(iii)	Min Voltage for Start & Run	80 % of rated voltage at terminal
(iv)	Breakdown or pullout torque	Pull out torque of the intermittent duty motors to be not less than 300% of the rated torque at 40% duty factor.
(vi)	Starting current	<= 600% Rated current
(vii)	Duty	Duty cycle shall not be less than S4-40% , with a minimum of 150 starts per hour (600 starts / hour for charging cranes and other process cranes) . For conveyor application S-6 duty.
(viii)	Starts/Hour permissible	Mechanically and electrically shall be suitable for required number of switching / reversals or starts per hour.
(ix)	Max speed variation	250 % of rated synchronous speed at high accelerating rates and rapid reversals .
(x)	Max speed	250 % of rated speed or 2000 rpm whichever is less .
(xi)	Rated synchronous speed	Motors shall be of low synchronous speed for ease of dynamic balancing of hoist rotating unit . The motor speed preferably shall be as follows : Upto 37 KW :- 1000 rpm Above 37 KW upto 90 KW :- 750 rpm Above 90 KW :- 600 rpm
(xii)	Overload capacity	1.5 times the rated current for 2 minutes
(xiv)	Void	
(xvi)	Derating	Motor designed at 50 deg.C shall be derated suitably for mentioned ambient temperature .
(xvii)	Insulation	Class H



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(xviii)	Torque Type	Normal / High / High slip type / Stall Torque type (as required for the specific application)
(xix)	Space Heater	Out door motors above 45 kW Indoor Motor above 110 kW
(xx)	Over temperature detection and protection.	Slip ring motors for essential drives to be provided with Pt 100 resistance thermometers / thermocouples or thermistors .
(xxi)	No. of Poles	Not applicable
(xxii)	Testing	As per approved QAP during engineering stage .
(xxiii)	Mounting	Normally horizontally foot mounting . Other type of mounting as per specific requirement .
(xxiv)	Derating	Motors shall be derated considering all the factors <ul style="list-style-type: none"> - variation in voltage and frequency . - Ambient temperature - Thermal ability due to constant and variable losses of the motor - Type of load driven

03. Roller Table Motors (Torque motors)

1.0	Standard	IPSS 1-003-007-85
1.0	Duty & type	All travel mechanism shall have roller table duty motors .
2.0	Insulation class	Class H insulation . temperature rise limited to class F .
3.0	Maximum speed	All roller table duty motors shall have a maximum speed of 1000 RPM.
4.0	Cooling	Shall be TENV type only . IC 410 .
5.0	Temperature sensor	Roller table motor (Torque motor) shall have built in PTC thermistors .
6.0	Locked rotor withstand time	Ability to withstand locked rotor conditions for minimum 1 min. under hot conditions . The motors shall meet the process requirement also.
7.0	Control system	All the roller table motors shall be inverter duty in case of VFD control otherwise RDOL .

04. High voltage squirrel cage induction motors

Sl.No.	Parameters	Description
1.0	Standard	IPSS 1-03-018/IS 325
2.0	Constructional Features	
i).	Frame size & rating	As per IS 325
ii)	Stator Frame	Fabricated Steel / High grade cast Iron
iii)	Stator Core	Laminated sheets of high grade low loss silicon steel



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iv)	Motor body	Grey iron casting as per IS:210-1978
v)	Casing Feet	Integral with the motor frame
vi)	Body Design	Prevent breakage or other failures due to vibrations normally encountered in heavy industries
vii)	Protection for Motor & Bearing	IP – 55 as per IS 4691-1985.
viii)	Shaft	Forged Steel shaft
ix)	Bearings (below 1000kW)	Anti-friction Bearing with Regreasing facility & with grease quantity controllers
	Bearings (1000kW & above)	<ul style="list-style-type: none">- Pedestal type sleeve bearing with forced oil lubrication. (Arrangements to be incorporated to prevent lubricating oil from reaching the windings)- Bearing temperature, lubricating oil temperature and pressure to be measured and monitored .
x)	Vibration monitor	Shall be provided at the DE end of motor bearing
xi)	Pedestals insulation	Against circulating shaft currents
xii)	Hazardous Area safety design	NA / as specified
xiii)	Indication of direction of rotation	By Arrow blocks on non-driving end
xiv)	RTD & BTD (PT100 type)	<ul style="list-style-type: none">- All motors shall be provided with Bearing (DE & NDE) temperature detectors and 6 nos. stator winding temperature detectors, RTDs for monitoring alarm and trip conditions. RTD's shall be of PT100 type (duplex).- Analog input cards shall be provided in PLC for online monitoring of bearing (DE & NDE) and winding temperature of HT motors above 1000 KW .- For HT motors, temperature of each RTD (for winding / bearing) shall be wired to PLC system and limit value contacts for alarm and tripping shall be generated in the PLC along with the display of all parameters of the motor including the winding and bearing temperature.
xv)	Vibration monitoring	<ul style="list-style-type: none">- Vibration monitoring (online) shall be provided at the DE end of motor bearing for motors of ratings 1000 kW and above and it should be connected to PLC for online monitoring .
xvi)	Paint shade	<ul style="list-style-type: none">- Light grey , shade no. 631 as per IS 5
3.0	Terminal box	
i)	Protection	IP - 55
ii)	Type	Phase segregated
iii)	Location	As per requirement 1 no. each on opposite sides of motor.
iv)	Winding star point	<ul style="list-style-type: none">- Winding star point shall be kept outside in the motor for more than 200 KW HT motor and other



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		important HT motor . – In case no differential protection is required, star point of the winding may be formed inside the neutral terminal box to be provided on one side of the motor. The phase segregated terminal box shall be placed on other side of the motor.
v)	Suitability	– Termination of XLPE cables with heat shrinkable cable end seals. – Each terminal box to have two inlets to accommodate any parallel cables as required.
vi)	Reversible	To suit cable entry from Top / Bottom
vii)	Earthing stud	Inside TB for protective earth conductor termination
viii)	No. of terminal boxes	Separate for Space heaters, RTDs / BTDs , Vibration monitor etc
ix)	Fault withstand (Min.)	Rated Short circuit level of the system voltage for 0.25 sec
4.0	Cooling	TEFC / CACA / CACW CACW system shall be complete with temperature and pressure monitoring devices.
5.0	Quality of operation	
i)	Vibration intensity	Limited to 37.5 micron peak to peak.
ii)	Noise level	Continuous noise level should not exceed 85 db A at a distance of 1.0 m from the motor body as per IS: 12065-1987.
iii)	Balancing	Dynamically balanced with full key on shaft end and fan
6.0	Electrical design	
i).	Efficiency	High efficiency design of 96% at Full load
ii)	Starting	DOL
iii)	Min Voltage for Start & Run	80 % of rated voltage at terminal
iv)	Starting Torque	As specified in application
v)	Starting current	<= 600% Rated current
vi)	Duty	S1
vii)	Starts permissible	3 successive start from cold condition OR 2 successive start from hot condition.
viii)	Starts / hour	3 equally spread in normal Voltage, Frequency & Load
ix)	Max speed permissible	150 % rated for 2 minutes
x)	Differential protection	Required for 1000 kW & above
xi)	Insulation	Class F & confirming to IEC 34 - 15/1990
xii)	Insulation Material	Cast resin rich / VPI
xiii)	Minimum Permissible temperature rise	Limited to class 'B' (120 deg absolute)
xiv)	Space Heater	Required & automatically off during RUN
xv)	No. of Poles	4 (or as mentioned specifically)
xvi)	Locked rotor current withstand time	5 sec longer than starting time under rated load condition.
xvii)	Surge protection	As specified
xviii)	Operational design	Suitable to VCB Breaker
xix)	Motor winding and inter turn insulation, connections and	Shall be fully insulated using mica insulation. For such motors surge absorbers (with non-linear resistance)



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	leads:	shall be provided within 10 to 15 meters from the motor terminals to limit the over voltages. OR In case mica is not provided in motor insulation, both surge capacitors and surge absorbers (with non-linear resistance) shall be provided within 10 to 15 mtrs from the motor terminals to limit the over voltages and rate of rise of voltage.
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05. Synchronous Motors

2.0	Constructional Features	
i).	Frame size & rating	As per IS 325
ii)	Stator Frame	Fabricated Steel / High grade cast Iron
iii)	Stator Core	Laminated sheets of high grade low loss silicon steel
iv)	Motor body	Grey iron casting as per IS:210-1978
v)	Casing Feet	Integral with the motor frame
vi)	Body Design	Prevent breakage or other failures due to vibrations normally encountered in heavy industries
vii)	Protection for Motor & Bearing	IP – 55 as per IS 4691-1985.
viii)	Shaft	Forged Steel shaft
ix)	Bearings (below 1000kW)	Anti-friction Bearing with Regreasing facility & with grease quantity controllers
	Bearings (1000kW & above)	- Pedestal type sleeve bearing with forced oil lubrication. (Arrangements to be incorporated to prevent lubricating oil from reaching the windings) - Bearing temperature, lubricating oil temperature and pressure to be measured and monitored .
x)	Vibration monitor	Shall be provided at the DE end of motor bearing
xi)	Pedestals insulation	Against circulating shaft currents
xii)	Hazardous Area safety design	NA / as specified
xiii)	Indication of direction of rotation	By Arrow blocks on non-driving end
xiv)	RTD & BTD (PT100 type)	<ul style="list-style-type: none"> - All motors shall be provided with Bearing (DE & NDE) temperature detectors and 6 nos. stator winding temperature detectors, RTDs for monitoring alarm and trip conditions. RTD's shall be of PT100 type (duplex). - Analog input cards shall be provided in PLC for online monitoring of bearing (DE & NDE) and winding temperature of HT motors above 1000 KW . - For HT motors, temperature of each RTD (for winding / bearing) shall be wired to PLC system and limit value contacts for alarm and tripping shall be generated in the PLC along with the display of all parameters of the motor including the winding and bearing temperature.



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xv)	Vibration monitoring	– Vibration monitoring (online) shall be provided at the DE end of motor bearing for motors of ratings 1000 kW and above and it should be connected to PLC for online monitoring .
xvi)	Paint shade	– Light grey , shade no. 631 as per IS 5
3.0	Terminal box	
i)	Protection	IP - 55
ii)	Type	Phase segregated
iii)	Location	– RHS viewed from DE / On top – 01 nos. each on opposite sides of motor in case of Differential Protection (or not) / Neutral TB opposite to main TB
v)	Suitability	– Termination of XLPE cables with heat shrinkable cable end seals. – Each terminal box to have two inlets to accommodate any parallel cables as required.
vi)	Reversible	To suit cable entry from Top / Bottom
vii)	Earthing stud	Inside TB for protective earth conductor termination
viii)	No. of terminal boxes	Separate for Space heaters, RTDs / BTDs , Vibration monitor etc
ix)	Fault withstand (Min.)	Rated Short circuit level of the system voltage for 0.25 sec
4.0	Cooling	TEFC / CACA / CACW CACW system shall be complete with temperature and pressure monitoring devices.
5.0	Quality of operation	
i)	Vibration intensity	Limited to 37.5 micron peak to peak.
ii)	Noise level	Continuous noise level should not exceed 85 db A at a distance of 1.0 m from the motor body as per IS: 12065-1987.
iii)	Balancing	Dynamically balanced with full key on shaft end and fan
2.0	Design	Motors shall be of cylindrical design with brush less excitation system and automatic voltage and power factor regulation.
3.0	Power factor	0.9 or better.
4.0	Motor winding	Motor stator winding braced for full voltage starting. Squirrel cage type winding with short circuited rotor bars for producing starting torque and accelerating torque to bring the synchronous motor upto the speed All the three windings stator , rotor and exciter shall be VPI (Vacuum pressure impregnation) .
5.0	Bearings	Small frame size motors shall have endshield bearings and large motors shall have pedestral bearings .



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6.0	Cooling	All the three modes of cooling arrangement as per requirement <ul style="list-style-type: none">• Open air (for the areas where air is relatively clean e.g water supply pump houses)• Air to water (in closed cooling circuit)• Air to air cooling (ID fan etc.) . A shaft mounted fan or a separate fan to be provided for air circulation .
7.0	Excitation method	Brushless excitation system (Integral exciter and rotating rectifier assembly to eliminate the need for brushes and slip rings both on exciter and motor respectively) .
8.0	Automatic system power factor correction.	Motor field to have micro processor based thyristor controlled static excitation system (for automatic system power factor correction).
9.0	Motor synchronism protection	Field monitor relay to be provided for monitoring the power factor of the system which in turn trips the motor and the exciter field off if synchronism is not achieved within a specific length of time or if the motor pulls out of step .
10.0	Insulation class	Class F insulation for field windings as well as for stator with temperature rise limited to 70 deg. C (as measured by resistance method) over an ambient of 50 deg. C.
11.0	Locked rotor withstand time	Motors shall be capable of withstanding locked rotor current for atleast 5 second longer than starting time under rated load condition.
12.0	Starting method	DOL / Auto transformer starting method / Load commutated inverter (LCI)
13.0	Space Heater	Space heater to be provided.

06. LT Inverter Duty Motor

Sl.No	Parameters	Description
1.0	Type	- AC Squirrel cage induction motor. - Inverter Duty
2.0	Standard	- IPSS 1-03-001/ IS 325 - NEMA Standard MG1-1993 Part 31, or the latest revision in so far as it is applicable.
3.0	Constructional Features	
A	Frame size & rating	- As per IS 325



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		- 10:1 constant torque speed range motors may exceed frame standard by one frame rating.
B	Motor body	Grey iron casting as per IS:210-1978
C	Motor Feet	Integrally cast with the stator
D	Body Design	<ul style="list-style-type: none">- Prevent breakage or other failures due to vibrations normally encountered in heavy industries .- Motors shall be of weather proof construction.- Designed to operate in the humid air stream .
E	Protection for Motor & Bearing	IP - 55
F	Motor Shaft	Shall be provided with an external recessed slinger at the drive end of the motor to provide additional (minimum IP-54) protection from moisture and foreign material.
G	Shaft ends & Extension	<ul style="list-style-type: none">- Cylindrical as per requirement- Shaft shall be extended for encoder / tacho. mounting , accordingly suitable hole shall be drilled and tapped .
H	Internal Encoder	Motors with speed variation of 1000:1 at constant torque shall have internal builtin encoder for speed feedback
I	Bearing	<ul style="list-style-type: none">- Roller type bearing upto 5 kW .- Ball Bearing at NDE end for above 5 kW .- All motors shall have fully re-greasable, anti-friction bearings.- All motors shall have cast iron inner bearing caps.- Bearings shall be oversized .- All motors shall have a charged lubrication system to inhibit moisture condensation.- Standard motors shall have extended grease fittings on the opposite drive-end to facilitate re-lubrication. Grease ports shall be located on the periphery of the motor endshield.- Motor shall be fitted with a shaft slinger or V ring seal on the drive end for a minimum of IP-54 protection (to help protection of bearing from ingress of dust , dirt or fluids) .
J	Hazardous Area safety design	NA
4.0	Terminal box	
A	Location	RHS viewed from DE / On top
B	Suitability	- 4 Core Aluminium Cable



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		- The terminal box shall be oversize as compared to NEMA requirements .
C	Rotation	4 X 90 deg.
D	Earthing stud	Inside Terminal Block
E	Miscellaneous	- Shall be gasketed between the terminal box halves. - The conduit box shall be field convertible to cast iron. - External screws and bolts shall be grade five, hex heads and be plated to resist corrosion.
5.0	Cooling	- TEFC, Effective bi-directional - TENV (for roller table duty) - Motor with 1000:1 speed range and constant torque shall have external fan . - External fan motor shall be 3 phase , 415 V AC - Thermistors shall be provided in the windings.
6.0	Quality of operation	
A	Vibration intensity	- Shall be limited as per IS 12075-1986. - Shall not exceed .08 inches / second velocity.
B	Noise level	As per IS: 12065-1987
7.0	Electrical design	
A	Power Supply	415 V +10 & - 15% , 50 Hz +/- 6% , 4-wire AC, 50 kA for 1 second, solidly earthed.
B	Starting	Variable Frequency Drive
C	Service factor	- 1.0 for VFD power . - 1.15 for sine wave power .
D	Peak transient voltage	1600 V
E	Minimum rise time	0.1 microsecond
F	Starting Torque	200 % rated torque for 1 minute below base speed
G	Constant horsepower operation	1.5 times base speed .
H	Duty	Application dependent
I	Max speed permissible	150 % rated for 2 minutes
J	Derating for VFD	As per above mentioned standard
K	Insulation	Class H limited to class F .
L	Load Type	Constant Torque / Variable Torque (As per application)
M	Space Heater	- Out door motors above 45 kW - Indoor Motor above 110 kW
N	No. of Poles	4 / 6 / 8
8.0	Operating Characteristics	
A	Operation with variation in the	Motors shall operate successfully under running



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	voltage or the frequency	conditions at rated load with variation in the voltage or the frequency not exceeding the following conditions: <ul style="list-style-type: none">• +/-10% rated voltage at rated constant V/f ratio except for specific torque boost situations. Motors shall operate successfully under running conditions at rated load and V/f ratio when the voltage unbalance at the motor terminals does not exceed one percent.
B	Torques	Motors shall meet or exceed the minimum locked rotor (starting) and breakdown torques specified in NEMA Standard MG1 Part 12 for Design B for the rating specified when on sine wave power.
C	Operating speed range	<ul style="list-style-type: none">- Zero to base speed in case of VT.- 1000: 1 for CT (with blower cooling)- 10:1 , 6:1 , 4:1 for CT .
D	Locked rotor (starting) currents	Shall not exceed NEMA Design B values for the specified rating on 5:1 constant torque or less and variable torque motors. NEMA Design A values are allowed for 6:1 constant torque or higher value constant torque rated motors. Motors shall be capable of a 20 second stall at six times full load current without injurious heating to motor components.
E	Efficiency	<ul style="list-style-type: none">- Shall have a nameplate minimum and nominal full load efficiency for motors when tested in accordance with NEMA standard MG1 Part 12, IEEE Test Procedure 112 Method B, using accuracy improvement by segregated loss determination including stray load loss measurements.
9.0	Motor location	Outdoor / indoor installation .
1.0	Painting	For indoor motors : Total thickness of painting shall be 140 microns. For outdoor motors: Total thickness of painting shall be 240 microns.
11.0	Nameplate	<ul style="list-style-type: none">- Shall be of corrosion resistance stainless steel .- In addition to standard nameplate information following informations shall be included :<ul style="list-style-type: none">o Nominal efficiency .o Bearing identification numbers.



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		<ul style="list-style-type: none"> ○ Power factor. ○ Torque values with speed range and amps for that torque value. ○ Full Load Slip RPM. ○ Magnetizing amps ○ Encoder PPR and Voltage rating (if included).
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07. DC Electromagnetic brake

1.0	Standard	Metric
2.0	Voltage	220V DC
3.0	Application	Suitable for steel mill duty having long mechanical life.
4.0	Duty	Shunt brake for - Continuous duty - Intermittent duty Series brake for - One hour duty (mill duty) - Half hour duty (crane duty)
5.0	Mounting	Floor mounting, two shoes, self-aligning, quick acting with self-lubricating robust bearings.
6.0	Brake shoe lining	Lining of tough heat resistant material with countersunk fixing rivets to prevent rubbing against the brake wheel.
7.0	Shoe adjustment and indications	<ul style="list-style-type: none"> • Facility for brake torque adjustment • Lining wear indication
8.0	Coil	Insulation : Class F
9.0	Braking Torque rating	Minimum 150% of the motor FLT
10.0	Temperature limit for brake magnet and brake drum	Brake magnet : - The magnet shall not become heated , during operation , to a temperature exceeding 150 deg. C Brake drum : - The temperature of the drum during working of the brake shall not exceed 200 deg. C
11.0	Limit switch	Limit switches to be provided for contact feedback used for interlocking , indications etc.
12.0	Safety for fail safe operation	<ul style="list-style-type: none"> • Electrically released and spring applied for fail safe operation (gravity operated counterweight type are not acceptable)



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		<ul style="list-style-type: none">Manual / hand release shall be provided in case of power failure or other failure in the system .
13.0	Maintainability of brake coil	Brake coil connection brought to appropriate terminal box for ease in maintenance and terminals covered for protection against accidental touch.
14.0	Residual magnetic gap adjustment	To increase the residual magnetic gap for reducing brake application time anti magnetic shim shall be provided .
15.0	Brake panel	Necessary rectifier and brake forcing equipment shall be included for DC electro-magnet brakes used with AC system.
16.0	Installation of brake panel	DC electromagnetic brake panel shall be installed in MCC room

08. Field Switches

1.0	Enclosure protection	All field switches to have enclosure class IP-65 in covered area & IP-67 in open area.
2.0	Contacts	Minimum separate contacts 2NO & 2NC for interlocks and as required for process.(with external JB)

09. Power Resistance

1.0	Resistor design	To meet arduous heavy duty industrial and steel works application, unbreakable, rigid, resilient & rust less.
2.0	Material	Fechral edge wound
3.0	Duty rating	10 minutes rating of BS: 587 and conforming to IPSS No. 1-10-002-82 and addendum No 1 to IPSS (March 1985).
4.0	Construction	Every turn of every grid is fully supported so that adjacent turns and adjacent grids can neither vibrate nor distort so as to make mutual contact. The complete grid is spot welded to its neighbors thus eliminating slacken support due to heating and cooling and is mounted on mica insulated high tensile steel tie-rod and mica creepage washers. A tripping point is formed on each grid by a hole in the welded portion which is double thickness and absolutely flat. All grids shall have either zinc alloyed or cadmium plated surface for permanent weather proofing. Highest quality mica and porcelain insulated terminals are to be used



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		throughout. The thermal loading of the resistance box should be uniform.
5.0	Painting	All metal works for the housing shall be degreased, derusted and passivated before applying two coats of stove enamel.
6.0	Terminals	The terminals shall be easily accessible at the lower most stack.
7.0	Enclosure class	IP-30 or better for outdoor application and IP-11 for indoor application
8.0	Testing	Testing shall be carried in accordance to BS: 587.
9.0	Power resistors for crane control	Shall be of Fechral edge wound resistance boxes . The element design shall be either circular (Russian design) or elliptical (BHEL design) . Punched grid resistance boxes shall not be used for crane control .

1.02.07 Individual Drive Control Level

01. Variable Frequency Drive (VFD)

1.0	Basic design particulars	<ul style="list-style-type: none">- Digital control technology with vector control (with / without PG as per requirement) .- IGBT based with sine coded PWM control.- VFD shall communicate to basic automation system on system communication bus .- Suitable for variable torque or constant torque applications requiring harmonic control as defined by IEEE 519-1992.- The drive shall have an internal EMC filter capable of meeting the Second Environment levels for the EMC directive without the need for additional components.- Shall confirm to IEC 146 - International Electrical Code.- For 4 quadrant operational drives , active front end type VFD shall be provided .- Where speed control I desired for production and quality control VFD isto be provided .- Where speed control is not required sof t starter or motor intelligent controllers are to be provide.
2.0	Drive controller	<ul style="list-style-type: none">- Software configurable to either V/Hz (single or multi



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	technology	<p>motor) mode or Sensorless Dynamic Torque Vector mode (single motor).</p> <ul style="list-style-type: none">- Full, closed loop flux vector control shall be available for constant torque applications.- Operating the drive with motor disconnected.- Adjustable PWM carrier frequency within a range of 3 – 15 KHz.- Suitable for use on both CT & VT loads.- Multiple programmable stop modes including - Ramp, Coast, DC-Brake, Ramp-to-Hold and S-curve.- Multiple acceleration and deceleration rates.
3.0	Type of connection	<ul style="list-style-type: none">- Three full wave diode rectifiers supplied by phase shifted, three phase AC to provide a fixed DC voltage.- DC bus inductor on all ratings- DC link capacitors- Insulated Gate Bipolar Transistor (IGBT) power section, shall be rated for variable / constant torque applications. The power section shall use vector dispersal pulsewidth modulated (PWM) IGBT gate control algorithm and soft switching IGBT's to reduce motor terminal dv/dt and allow longer cable length from drive to motor without output filters.- The Main Control Board shall be the same for all ratings to optimize spare parts stocking and exchange- Common control connection for all ratings.
4.0	Overload capacity	<ul style="list-style-type: none">- 110% of the rated current for 1 minute , 30 seconds at 150% (with inverse characteristics proportional to time) for variable torque applications . Repetition interval shall not be less than 9 minutes- 150% of the rated current for 1 minute overload , 30 seconds at 200% (with inverse characteristics proportional to time) and 200% of rated current for 0.5 sec. for constant torque applications . Repetition interval shall not be less than 60 minutes .
5.0	Efficiency	More than 97% or better at full speed and full load.
6.0	Input power supply	<ul style="list-style-type: none">- 415 V AC +10% & -15%- 3 phase .- 50 Hz + / - 6 %- 4 wire neutral earthed system .
7.0	Voltage variation	<ul style="list-style-type: none">- Voltage variation of (+/-) 0.1 % with an input variation of +10% - 15%.



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		<ul style="list-style-type: none">- Steady state regulation of (+/-) 0.25% guaranteed against 100 to 200 % load disturbance and + 6% & -6% input supply frequency variation.- The drive should be designed to operate on an AC supply, which may contain line notching, and up to 10% harmonic distortion.
8.0	Environmental conditions	
8.1	Storage ambient temperature range	Upto to 70° C (-40° to 158°F).
8.2	Operating ambient temperature range without derating.	IP42 & above : 0° C to 50° C (0° to 122° F)
8.3	Relative humidity	Upto 100% non-condensing.
8.4	Operating elevation	Up to 1000 Meters (3,300ft) without derating.
8.5	Shock	15G peak for 11 ms duration
8.6	Vibrations	Suitable to withstand vibrations more than 0.5g.
9.0	Reference	
9.1	Input reference voltage	0 +/- 10 V DC / 0 – 10 V DC / 4 – 20 mA .
9.2	Reference signals	<p>The drive should be capable of the following speed reference signals</p> <ul style="list-style-type: none">• Digital MOP• Jog• HIM (Program/Control panel)• Analog Input signals• Preset Speeds• Communication module commands <p>All reference signals may have a trim signal applied to them for finer resolution and accuracy. Trim source and amount should be programmable.</p>
9.3	Loss of reference	<p>The drive should be capable of sensing the reference loss conditions .</p> <p>In the event of loss of an analog input reference signal, the drive should be user programmable to the following</p> <ul style="list-style-type: none">• Fault the drive• Alarm and maintain last reference• Alarm and go to preset speed• Alarm and go to minimum speed• Alarm and go to maximum speed• Alarm and maintain last output frequency <p>Signal loss detection should be available regardless of the function of the analog input.</p>
10.0	Output	
10.1	Output voltage	From 0 to rated motor voltage .
10.2	Output frequency	0.5 - 400 Hz.
10.3	Output Waveform	Sinusoidal



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10.4	Output frequency resolution	0.01 Hz.
11.0	Reflected wave	Maximum of 3.15 times the bus voltage or 1600V, whichever is less, up to cable lengths of 200 metres.
12.0	Starting torque	150 % / 0.3 Hz. (without PG) 150 % / 0 RPM (with PG)
13.0	Torque accuracy	+ / - 5 % .
14.0	Speed control accuracy	+ / - 0.02 % . IR compensation to be provided for drive without PG .
15.0	Ramp rate	- Linear acceleration and deceleration adjustable independently from 0 to 3600 seconds . - Provision of remotely selectable Accel / Decel settings should be accessible through digital inputs also.
16.0	Main power components in incoming AC side	- ACB / MCCB with 50 KA rating - Matching input isolation transformer / line reactor for harmonic and noise suppression . For input isolation transformer , the K factor shall be 4.0 or less. - AC line surge suppression network . - Input contactor .
17.0	Converter –Inverter Equipment	- Diode / Thyristor bridge for AC/DC. - DC link circuit with reactor/capacitor - IGBT bridge for Inverter for DC/AC. - Harmonic transformer . - Main PLC to take care of interlocking and sequencing etc. - Mimic panel (where drive is HT)
18.0	Load side components	- Filter network - Electronic over-load relay for each motor (with display). - Line contactors in output side (if required). - Output reactor / terminator (if required)
19.0	Terminal blocks	- Separate for control and power wiring. - Power terminal blocks to withstand a minimum of 90 °C and marked for both inputs and outputs . - Uniform color-coding to be followed for cabling, TB, etc.
20.0	By-pass Arrangement	By-pass arrangement shall be provided to operate the motor in case of failure of VFD.
21.0	Diode Bridge	Minimum ratings of Diode cells. - PIV rating : 2.5 times the peak value of line voltage - dv/dt rating : 200V/microsecond for voltage control and 1000V/ microsec. for inverter control. - di/dt rating : 100A / microsecond.
22.0	Input / Outputs	- Hard-Wired I/O



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		<ul style="list-style-type: none">• Hardwired I/O should be provided via separate I/O cards- Standard I/O Card• The “Standard I/O board should consist of both digital and analog I/O. It should be available in two versions; one for 115/240 VAC digital I/O and one for 24V AC/DC digital I/O.- Analog I/O• Differentially isolated $\pm 10V$ (bi-polar) / 20mA analog inputs .- Digital Outputs• Relay outputs – Minimum 04 nos.• Contact output ratings should be 240V AC / 24V DC, Maximum 2.0 Amp
23.0	Protective features	<p>AC line surge suppression network and overvoltage protection .</p> <ul style="list-style-type: none">- Under voltage in supply network- Phase sequence protection and monitoring- Single phase failure- Motor loss- Under voltage in DC bus- Over voltage in DC bus- Over speed protection in the event that the output frequency exceeds the maximum reference by a specified amount.- Over load- Earth fault- Instantaneous over current- Transformer fault ,If applicable- Cooling fan failure- Stall monitor for motor alarms- Controlled shut down, when properly fused, with no component failure in the event of an output phase to phase or phase to ground short circuit and annunciation of the fault condition.
24.0	Annunciations	<p>Following faults shall be annunciated in keypad of the drive / HMI .</p> <ul style="list-style-type: none">- AC line surge suppression network and overvoltage protection .- Under voltage in supply network- Phase sequence protection and monitoring- Under voltage in DC bus- Over voltage in DC bus- Over speed monitor- Over load- Earth fault



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		<ul style="list-style-type: none">- Instantaneous over current- Transformer fault ,If applicable- Cooling fan failure – Stall monitor for motor alarms- Motor fault (winding / bearing temperature, vibration) as applicable- Loss of frequency command- Shall be able to store at least 16 previous faults in memory on FIFO sequence . <p>In addition to annunciations in keypad , a separate annunciation window shall be provided on front door of the VFD panel .</p>
25.0	Meters	<ul style="list-style-type: none">- Output voltmeter and ammeter with selector switches.- Input volt meter and ammeter with selector switches .- Output frequency meter (digital type).- KW meter for drive ratings above 200 KW. <p>All digital display shall be programmable .</p>
26.0	Other features	
26.1	Bus Regulation	DC Bus regulation should be available to reduce the possibility of drive overvoltage trips due to regenerative conditions.
26.2	Load dependent current limit	Programmable current limit from .1 amps to 150% of drive rated amps. Current limit to be active for all drive states; accelerating, constant speed and decelerating.
26.3	Dynamic Braking	The drive shall have an internal, built in 7th IGBT for use as a dynamic braking chopper. This IGBT shall have enough capacity to handle greater than or equal to 100% regeneration power from the output, continuously. The drive shall also have a “drive mounted” dynamic braking resistor for low level braking applications and interactive software to protect the “internally” mounted resistor from abuse.
26.4	Fault Memory	16 nos. of faults to be stored on FIFO basis for fault analysis .
26.5	Ride Through	The control logic should be capable of "riding through" a power outage of at least 0.5 seconds in duration. The inverter section should be shut off after an 18% drop in bus voltage to conserve power for the drive logic.
27.0	Selector switches	<ul style="list-style-type: none">- Local / Remote .- Auto / Manual .- Main / Bypass . <p>All the selector switches shall be of 10 A rating .</p>
28.0	Pushbuttons	<ul style="list-style-type: none">- Trip reset .- Start.



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		<ul style="list-style-type: none">- Emergency stop.
29.0	Lamps	<ul style="list-style-type: none">- Drive ready .- Drive trip .- R , Y , B phase power ON .- Control supply ON . <p>All the lamps shall be of cluster LED type having low voltage glow protection..</p>
30.0	Regulation & control facilities	<ul style="list-style-type: none">- Reference speed setter- Ramp generator- Speed feed back- Current feed back- Flying start- Trigger module- Pulse transformers- Logic control module- Sequence module- PID control- Zero speed / over speed monitor as applicable- Momentary power loss restart .- Auto tuning .- Current limiter- Skip Frequency- Counter current / regenerative braking unit as applicable- Active electronic components used shall be of industrial grade hermetically sealed .- Output signals for fault alarm , frequency arrival , running signal .
32.0	Remote control facilities	<ul style="list-style-type: none">- Shall have transducer to monitor the outputs like motor speed at remote place / HMI .- Facility to accept speed reference from HMI / engineering station.
33.0	Auto / Manual Mode	<ul style="list-style-type: none">- The HIM should utilize the ALT function key to transfer the drive from Automatic mode to Manual mode and back.- When in Auto mode, the drive to receive its frequency command from the programmed source.- When in Manual mode, control of the frequency command to be transferred to the HIM speed control keys (or potentiometer).- The user should have the choice of preloading the HIM with the current "auto" frequency reference before transferring control to allow for smooth transitions without speed "jumps".



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34.0	Communication Bus	RS485 (ModBus, ProfiBus-DP, DeviceNet) bus Internally mounted interfaces shall be provided to connect to different buses .
35.0	Test points	Two electronic test point parameters should be available to examine data within the drive memory that is not available through other parameters.
36.0	Operator panel	Shall be mounted on the front door of the unit . IP 66 protection class . <ul style="list-style-type: none">- All adjustments to be made with the door closed.- Status and Power LEDs viewable through the cover- Status LEDs for communications status, including embedded DPI status, adapter health and communications network status, viewable through the cover .
37.0	Membrane keypad	<ul style="list-style-type: none">- The keypad shall be logically designed for two operating areas with required number of keys.- Local operator control like- local start /stop ,- jog forward / reverse .- Programming . Facility to run the drive without HIM shall be provided .
38.0	LCD display	<ul style="list-style-type: none">- Display shall be black lighted , enabling viewing in extremes of lighting conditions- Display shall be in alphanumeric (in English only)- 21 characters , 7 lines .- All the faults stored in memory shall be displayed by scrolling .
39.0	Construction features	<ul style="list-style-type: none">- Floor mounted, free standing- Dust and vermin proof- Sheet steel clad- Minimum 2.5 mm thick for panels.- Minimum 2.0 mm thick for doors and side covers.- Suitable to withstand vibrations to be encountered in steel plant application.- Cubicles with illumination lamps, door switches, space heaters and adequate sockets for soldering.- All control blocks plug-in-type with necessary test sockets.- Units shall be self contained and serviceable.
40.0	Enclosure and ventilation	<ul style="list-style-type: none">- Enclosure conforming to IP-42 or better with weather proof enclosures- Units shall be provided with cooling fans and louvers at the



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		bottom sides with filters. All louvers shall have fine mesh filter behind them. - Ventilation through individual ventilation ducts from bottom not acceptable. - For larger drives cooling fans of drives shall be powered from different power source .
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02. AC Line Reactor

1.0	No. of phases	03
2.0	Input power supply	- 415 V AC + 10% & -15% - 3 phase . - 50 Hz +/- 6 % . - 4 wire neutral earthed system .
3.0	Duty class	T2 as per IEEE-1973
4.0	Overload	- 125% for 2 hours - 200% for 10 seconds
5.0	Standard	IS: 5553 (Part-2)
6.0	Insulation class	Class H
7.0	Impedance	3% / 5% (As per system calculation)
8.0	Maximum temperature rise	95 Deg. C
9.0	Ambient temperature	50 deg. C
10.0	Location	Normally in the drive panel (In a separate enclosure in case of large size) .
11.0	Execution	IP 21
12.0	Termination	- Cables - All termination should be brought out on 6 or 10 mm thick fibre glass strip . - Terminal description should be engraved on termination strip
13.0	Cooling	AN
14.0	Winding Material	CRGO Si grade steel , Grade 51 or better
	Construction	Coils should be hot dipped and whole assembly should be dipped in varnish. Clamping stud should be insulated from lamination .
15.0	Rating	Inductance : As per calculation RMS current rating : As per calculation Inductance : AS per calculation
16.0	Characteristic	Reactors will be linear upto 200% of rated current .

03. Load Commutated Inverter (LCI)



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1.0	Standard	IEC 146-1-2	
2.0	Power System Input	3 Phase AC , +/- 10% of rated voltage	
3.0	Input voltage dip	30 % of rated voltage without tripping	
4.0	Frequency	50 Hz. , +/- 6%	
5.0	Operating environment	50 deg. C , with 95 % RH non condensing	
6.0	Type of motor to be controlled	Synchronous motor	
7.0	Efficiency	More than 99%	
8.0	Isolation transformer	<ul style="list-style-type: none"> - Indoor installation - Oil or dry type as per IEC 76-2 - Typical winding configuration : <ul style="list-style-type: none"> • 6 pulse LCI :- Delta-Wye • Pulse LCI :- Delta-Delta-Wye - Taps : 2x2.5% above and below nominal voltage . - Winding conductor : Copper - Insulation class : Class H (In case of dry type) 	
9.0	Bridge device	Thyristor	
10.0	Configuration		
(i)	Source bridge	AC fed 6 or 12 pulse SCR , regenerative with N+1 devices	
(ii)	Load bridge	6 or 12 pulse output configuration with with N+1 devices .	
11.0	Output speed control range	10 – 160% of rated speed .	
12.0	Overload	150% overload for 1 minute / every 10 minutes (for CT loads) 110% overload for 1 minute / every 10 minutes (for VT loads)	
13.0	Control	<ul style="list-style-type: none"> • Forced commutation below 10 % of rated speed . • Load commutated above 10 % of rated speed . • Torque regulated . • 4 quadrant speed control . • Volt / Frequency control • Field excitation control • Programmable acceleration / deceleration ramps 	
14.0	Control accuracy	Without tacho	With tacho
(i)	Speed regulation	0.1 %	0.005 %
(ii)	Max. starting torque	0.75 PU	2.0 PU
(iii)	Max. forward speed	1.0 PU	1.0 PU
(iv)	Max. reverse speed	0.5 PU	1.0 PU
(v)	Constant HP speed range	Base to top	Base to top
(vi)	Constant torque speed range	0.1 to base	1.5 Hz to base
15.0	Torque reversal principal	DC link voltage reversal by firing of anti parallel thyristors in the bridge . No contactor is to provided for the same .	
16.0	Protection	<ul style="list-style-type: none"> • Overcurrent • Overvoltage • Earthfault • Over temperature • Motor bearing and winding temperature measuring and protection 	
17.0	Cooling	<ul style="list-style-type: none"> • Water cooled with deionized water • Redundant cooling pump with automatic control 	



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18.0	Auxiliary power supply	415 V AC , 3 phase , 50 Hz.
19.0	Reliability	N+1 SCR redundancy (extra SCR in each bridge circuit) for full power output even in the event of a device failure .
21.0	Loudness	Less than 70 Db at 1 metre from enclosure
22.0	I/O	<ul style="list-style-type: none"> Standard I/O's as per manufacturer . In addition to standard I/O's , a dedicated PLC in the drive panel for sequencing and interlocking of all the hardware interlocks of the LCI .
23.0	Metering	<ul style="list-style-type: none"> Analog meters mounted on drive panels . For remote monitoring required transducers/ converters for transmission of signals in HMI .
24.0	Feedback devices	<ul style="list-style-type: none"> Encoder for position feedback Tacho for speed feedback
25.0	Communication bus	<ul style="list-style-type: none"> Profibus / Controlnet / Modbus compatibility. In case of making compatible with PLC communication bus , required hardware and software to be provided .
26.0	Cable entry	<ul style="list-style-type: none"> Top or bottom cable entry with no additional cubicle

1.02.08 INTELLIGENT TYPE MCC :-

A. General		
1.0	Type	Metal clad . Non drawout type
2.0	Construction	Modular construction . Fully compartmentalized with metal / insulating material partition.
3.0	Enclosure class	IP52 IP 54 for non intelligent MCC's installed in non airconditioned environment .
4.0	Type of execution	Single front.
5.0	Mounting	Floor mounting. Free standing with ISMC 75.
6.0	Installation	Indoor.
B. Constructional Features :-		
1.0	Sheet steel	
	Thickness	2.0 mm for load bearing members. 1.6 mm for non load bearing members.
	Material	CRCA
2.0	Cable entry	Incomer :- Bottom cable entry. Outgoing :- Bottom cable entry.
3.0	Design	<ul style="list-style-type: none"> Separate cable alley. Extendable at both ends. Rear access through removable rear hinged cover door



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		<p>on one side and screwed at other side .</p> <ul style="list-style-type: none">• All the components shall be accessible from front .• Motor controller shall be flush mounted on the respective door .• Interchangeable facility of same type of feeder modules• Each module to have covering at the bottom.• ACB cubicle door shall close when the ACB is in isolated position.
4.0	Interlocking & protection	Module door interlocked with main power isolating devices. Power circuit isolation device to have pad locking in the OFF position with door closed.
5.0	Operating height	Minimum :- 300mm Maximum :- 2000 mm.
6.0	Gland plate	Undrilled removable bottom gland plates (3 mm thick)
7.0	Miscellaneous	Neoprene rubber gasket shall be provided for all the doors , removable covers & between adjacent covers Lifting hooks for all the shipping sections Doors shall have concealed hinges .
8.0	Labelling	Clear legible identification labels (anodized aluminium with white letters engraved on black background) with letter sizes of :- 25-50 mm for MCC panel in front and back side of the panel . 5 mm for components and module name plates. Danger board on front and rear sides in English , Hindi .
9.0	Earthing	Two separate earthing terminals will be provided. Bolted joints with tooth spring washers for good earth continuity. Earth bus to run in all cable alley of the panel .
10.	Shipping length	To be limited to 2.4 M.
11.	Limiting dimensions	Width of MCC :- 800 mm Width of Module :- 500 mm Width of Cable alley :- 300 mm Height of module :- 400 mm (min) Depth of MCC :- 600 mm , maximum However depth of incoming ACB panel will be 1200 mm (minimum).
12.	Paint shade	Shade No. 631 as per IS-5:1992. or RAL 7035
13.	Panel space heater	In each panel with thermostat , MCB.
C. Busbars		
(i) Main horizontal & vertical busbars		



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1.0	Arrangement	Three phase & neutral.
2.0	Material	High conductivity electrolytic aluminium alloy conforming to grade E91E as per IS-5082 -1981.
3.0	Phase Busbar Rating	Shall be able to carry continuously the connected load (considering diversity factor) plus a 25% margin Max. current density shall be :- 1.0 A/sq.mm for Aluminium 1.5 A/sq.mm for Copper .
4.0	Neutral Busbar Rating	50 % of phase busbar rating
5.0	Short circuit rating	50 kA for 1 sec.
6.0	Busbar configuration	Red-yellow-blue from front to back or top to bottom or left to right as viewed from front.
7.0	Busbar insulation	Heat shrinkable PVC R,Y,B coloured sleeves for phases Black for neutral.
8.0	Busbar supporting insulators	Non-hygroscopic Flame retarded Track resistant High strength Sheet moulded compound or equivalent polyster fibre glass moulded type .
9.0	Max. temp. rise of bus	Not to exceed 40 deg. C. above ambient of 50 deg.C.
10.	Air clearance for bare busbar	Phase to phase :- 25.4 mm (minimum) Phase to earth :- 19.0 mm (minimum)
11.0	Joints and tap off points	Busbar joints and tap off points shall be shrouded and bolted (with cadmium coated bolts with plain and spring washers and locknuts). Bimetallic connectors for connection between dissimilar metals . Antioxide grease for all bus connections .
12.0	Neutral bus isolation	Through disconnecting link .
13.0	Vertical busbar	Rear side
(ii) Earth bus		
1.0	Material	GI.
2.0	Size	Minimum 50 x 6 mm with extension at both ends .
(iii) Control bus		
1.0	Material	Copper.



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2.0	Size	Minimum 25 x 3 mm .
(iv) Power supply bus for motor controller (from UPS)		
1.0	Voltage	240 V AC , 50 Hz.
1.0	Material	Copper.
2.0	Size	Minimum 25 x 3 mm .
D. Insulation level		
1.0	Rated insulation voltage	1100 V
2.0	Impulse withstand voltage	4 kV as per IS-13947 (Part I) 1993
3.0	One minute power frequency withstand voltage	2.5 kV for power circuit & 500 V for control circuit
E. Pollution Degree		
1.0	Pollution Degree	Pollution Degree 3 As per IS-13947 (Part-1) : 1993 ; unless otherwise stated
E Intelligent Controllers		
1.	Type	Modular type
2.	Wiring	Contacts from components (breakers , contactors ,) shall be hardwired to I/O terminal block of the controller. All the potential transformer PT's , protection CT's (phase CT and neutral CT) shall be hard wired directly to the controller or the controller module shall have builtin CT and PT for protection & metering purpose .
3.	Power supply	Separate power supply source (240 V AC) from UPS through MCB (for controller only). Separate power supply for (interrogation voltage) from MCC itself .
4.	Inputs and outputs	The controller shall have :- Minimum 12 digital and 4 analog inputs (For increasing the number of I/O's extended module can be added) . Minimum 4 relay outputs (240 V AC , 10 A).
5.	Functions in controller	Protection Control Metering Annunciations
9.	Fault memory	Faults to be stored in memory on FIFO sequence.
10.	LED indications	Controller healthy Controller fault



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		Controller power supply healthy
11.	Communication	Each motor controller (motor / feeder) unit shall communicate on the communication bus (Devicenet / Modbus / Profibus) with PLC directly or through Data concentrator / CN2DN converter or any equivalent module / converter . The communication protocol (bus) for intelligent MCC and package PLC shall be same for ease of communication .
12.	Communication Port	2 nos. RS 485 serial port
13.	Communication configuration	Trunk line configuration (with dual redundancy) in horizontal wireways. Dropline configuration (with dual redundancy) in vertical wireways . Each Data concentrator / CN2DN converter or equivalent module shall communicate with PLC on higher level communication bus e.g Controlnet / Profibus / Modbus etc .
14.	Communication speed	9.6 Kbps minimum (100 m distance)
15.	No. of nodes (without repeaters)	Minimum 32 nos.
16.	Control	From 16 character keypad and backlit LCD alphanumeric display provided on the controller. From HMI (located in control room). The keypad shall have the facility to start and stop the motor through a separate key (touch screen type) or separate PB's are to be provided for the same on the front door of the module .
17.	Software	All the configuration and monitoring shall be done through inbuilt software . All the required software required for operation and communication shall be provided with latest version available.
F. Feeder arrangement		
Incomers and Buscoupler		
1.0	Isolating Equipment	3 pole manual ACB 4 pole manual ACB (for DG source as second Incomer) Both the Incomers and Buscoupler shall be drawout type .
2.0	Quantity	Two incomer
3.0	Bus coupler	Required.
4.0	Interlocking	Required. Normally only one Incomer shall be ON . After incoming power failure of any Incomer or ACB trips , second Incomer shall be made ON manually .



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5.0	Interlocking type	Electrically . Mechanical (through castle key)
6.0	Indication Lamps	LED cluster type indicating lamps for :- MCCB / ACB ON/OFF/TRIP. Power ON R / Y / B . Lamps will be of M/S Binay optoelectronic make of 22.5 mm dia.in all cases . However model shall be freezed during detailed engineering .
7.0	Meters and selector switches	96 sq.mm size voltmeter with 7 position selector switches 96 sq.mm size ammeter with 4 position selector switches
8.0	Current transformer	3 numbers for protection . 3 numbers for metering . 1 number neutral CT . 1 number interposing CT (if required)
9.0	Potential transformer	1 number
10.0	Relays (mounted in each ACB)	Microprocessor based relay with O/L S/C E/F protections . The relays shall have communication facility with PLC on communication bus.
F. Outgoing feeder arrangements		
(i) Motor Starter feeders		
1.0	Circuit breaker	Three pole MCCB . Three pole ACB (for rating above 630 A) .
2.0	Power contactor	AC3/AC4 as per requirement. 3 pole. Minimum 32 A at AC-3 duty. Contactor coil rating for 240 V AC . 2NO + 2NC auxiliary contacts. Mechanically interlocked for reversible drives.
3.0	Auxiliary contactors	Required nos. as per scheme.
4.0	Control supply isolation device	MCB
5.0	Test PB	Inside module for testing of power contactor when the module incoming power breaker is OFF
6.0	Space heater power provision	For motor feeders of 45 KW and above :- Through separate MCB and interlock with main power contactor .
7.0	Ammeter in LCS	Interposing CT shall be provided in the feeder module for



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		motor rating 37 KW and above.
8.0	Thermal overload relay (for non intelligent MCC's)	Electronic type (with indication for motors of rating 37 KW and above)
9.0 Motor controller		
A.	Protections	Thermal overload Adjustable overload prealarm Earth fault Stalling Unbalance Short circuit Single phase prevention Under current Too many starts Under voltage Under voltage lockout Breaker or contactor failure alarm Trip failure alarm Over temperature Winding and bearing temperature (for motor of rating 160 KW and above).
B.	Display data	Voltage Frequency Power factors Power consumption , KW Thermal capacity Temperature Phase and average Amp. Earth fault current % motor load % unbalance Peak current during starting Starting time Pre trip values
C.	Fault / alarm history description	No. of trips No. of operations (Forward / reverse) Hours run Hours run last start Kilowatt hours Kilowatt peak demand Alarm / trip history (with date and time)



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		Alarm / trip description Reference start curve (in graphics) Start curve (in graphics) Time to trip / reset
(ii) Power supply feeders		
1.0	Circuit breaker	Three pole MCCB. Three pole ACB (for rating above 630 A) .
2.0	Indications	ON/OFF/TRIP indication lamp.
3.0	Earth fault protection required	Yes
G. Panel wiring		
1.0	Power / current transformer circuit	1.1kV grade single core , black colour PVC insulated , stranded copper conductor of minimum size 2.5 sq.mm. For feeder rating 100A and above all the power circuit shall be through rigid busbar .
2.0	Control and potential circuit	1.1kV grade single core Black colour PVC insulated Stranded copper conductor of minimum size 1.5 sq.mm.
3.0	Ferrules	Numbered plastic/ceramic ferrules. Self locking type.
4.0	Marking	Wiring will be properly marked as per relevant IS.
5.0	Spare contacts	All spare contacts of relays selector switches & contactors will be wired upto the terminal block. Each components shall have at least one potential free spare contacts.
6.0	Terminals	<ul style="list-style-type: none"> - Power & control terminals shall be segregated by insulating material like hylam/bakelite sheet. - Power terminals will be stud type. - Control terminals will be ELMEX type suitable for connecting two cores of 2.5 sq.mm wires. - Minimum 20 % spare terminals will be provided. - The minimum rating of control terminal shall be 10 Amps. - Color coded wires, TB's of different voltage rating to be provided . - Uniform color-coding to be followed for cabling, TB, etc.
7.0	Cable glands	Double compression cable glands for receiving external power and control cables
H. Control Supply		
1.0	Control transformer	1 nos. of 415V/240V control transformer of minimum 2.5 KVA in each section. Secondary unearthed.



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2.0	Input and output side isolation device	Input side :- MCCB Output side :- MCB
3.0	Control supply changeover system	Control supply auto and manual changeover through contactor logic and through selector switch respectively (Sel.sw. shall have a contact rating of 25 A at 240 V AC)

1.02.09 STAND ALONE STARTER

A. General :-		
1.0	Type	- Metal clad . - Non drawout type.
2.0	Construction	- Modular construction . - Fully compartmentalized with metal / insulating material partition.
3.0	Enclosure class	IP52.
4.0	Type of execution	Single front.
5.0	Mounting	- Floor mounting. - Free standing with ISMC 75.
6.0	Installation	Indoor.
B. Constructional Features :-		
1.0	Sheet steel	
	Thickness	- 2 mm for load bearing members. - 1.6 mm for non load bearing members.
	Material	CRCA
2.0	Cable entry	- Incomer :- Bottom cable entry. - Outgoing :- Bottom cable entry.
3.0	Design	- Rear access through removable rear hinged cover door. - All the components shall be accessible from front .
4.0	Interlocking & protection	- Module door interlocked with main power isolating devices. - Power circuit isolation device to have pad locking in the OFF position with door closed.
5.0	Operating height	- Minimum :- 300mm - Maximum :- 2000 mm.
6.0	Gland plate	Undrilled removable bottom gland plates (3 mm thick)
7.0	Miscellaneous	- Neoprene rubber gasket shall be provided for all the doors , removable covers & between adjacent covers . - Lifting hooks for the panel . - Doors shall have concealed hinges .
8.0	Labelling	Clear legible identification labels (anodized aluminium with white letters engraved on black background) with letter sizes of :- - 25-50 mm for panel . - 5 mm for components and module name plates. - Danger board on front and rear sides in English , Hindi and local language .
9.0	Earthing	- Two separate earthing terminals will be provided. - Bolted joints with tooth spring washers for good earth continuity.
10.0	Paint shade	Shade No. 631 as per IS-5:1992 equiv to RAL 7035 .



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11.0	Panel space heater	In each panel with thermostat , MCB .
C. Busbars		
1.0	Arrangement	Three phase & neutral.
2.0	Material	High conductivity electrolytic aluminium alloy confirming to grade E91E as per IS-5082 –1981 .
3.0	Phase Busbar Rating	<ul style="list-style-type: none"> - Shall be able to carry continuously the connected load (considering all derating factors) plus a 25% margin . - Max. current density shall be - 1.0 A/sq.mm for Aluminium - 1.5 A/sq.mm for Copper .
4.0	Neutral Busbar Rating	50 % of phase busbar rating
5.0	Short circuit rating	50 KA for 1 sec.
6.0	Busbar configuration	Red-yellow-blue from front to back or top to bottom or left to right as viewed from front.
7.0	Busbar insulation	Heat shrinkable PVC <ul style="list-style-type: none"> - R,Y,B coloured sleeves for phases - Black for neutral.
8.0	Busbar supporting insulators	<ul style="list-style-type: none"> - Non-hygroscopic - Flame retarded - Track resistant - High strength - Sheet moulded compound or equivalent polyester fibre glass moulded type .
9.0	Max. temp. rise of bus	Not to exceed 35 deg. C. above ambient of 50 deg.C.
10.0	Air clearance for bare busbar	Phase to phase :- 25.4 mm (minimum) Phase to earth :- 19.0 mm (minimum)
11.0	Joints and tap off points	<ul style="list-style-type: none"> - Busbar joints and tap off points shall be shrouded and bolted (with cadmium coated bolts with plain and spring washers and locknuts). - Bimetallic connectors for connection between dissimilar metals . - Antioxide grease for all bus connections .
12.0	Neutral bus isolation	Through disconnecting link .
13.0	Busbar access	Rear side
(ii) Earth bus		
1.0	Material	GI.
2.0	Size	Minimum 50 x 6 mm with extension at both ends .
(iii) Control bus		
1.0	Material	Copper.
2.0	Size	Minimum 25 x 3 mm .
D. Insulation level		
1.0	Rated insulation voltage	1100 V
2.0	Impulse withstand voltage	4 KV as per IS-13947 (Part I) 1993
3.0	One minute power frequency withstand voltage	2.5 KV for power circuit & 500 V for control circuit
E. Pollution Degree		



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1.0	Pollution Degree	Pollution Degree 3 as per IS-13947 (Part-1) : 1993 ; unless otherwise stated
F. Components		
1.0	Isolating Equipment	3 pole MCCB (upto 630A)
2.0	Indication Lamps	LED type indicating lamps for :- - MCCB ON/OFF/TRIP. - Power ON R / Y / B .
3.0	Meters and selector switches	- 96 sq.mm size voltmeter with 7 position selector switches - 96 sq.mm size ammeter with 4 position selector switches
4.0	Power contactor	- AC3 duty of rated capacity .
5.0	Intelligent motor controller	- As defined in clause no. 1.02.08 .
6.0	Motor protection relay (for non intelligent panel)	- Microprocessor based. - Suitable for 5A & 1A - Protections <ul style="list-style-type: none"> • Short circuit • Overload • Earth fault • Stalling protection • Undervoltage • Overspeed • No.of starts per hour (cold & hot) - Communication facility with PLC. - Memory for <ul style="list-style-type: none"> • Storing fault history & trending
7.0	Auxiliary contactors	- Shall be provided for logic operation and operating sequence . - Shall have minimum 2NO+2NC auxiliary contacts.
G. Panel Wiring		
1.0	Power / current transformer circuit	1.1Kv grade single core , black colour PVC insulated , stranded copper conductor of minimum size 2.5 sq.mm.
1.0	Power / current transformer circuit	1.1Kv grade single core , black colour PVC insulated , stranded copper conductor of minimum size 2.5 sq.mm.
2.0	Control and potential circuit	- 1.1Kv grade single core - Black colour PVC insulated - Stranded copper conductor of minimum size 1.5 sq.mm.
3.0	Ferrules	- Numbered plastic/ceramic ferrules. - Self locking type.
4.0	Marking	- Wiring will be properly marked as per relevant IS.
5.0	Spare contacts	- All spare contacts of relays selector switches & contactors will be wired upto the terminal block. - Each components shall have at least one potential free spare contacts.
6.0	Terminals	- Power & control terminals shall be segregated by insulating material like hylam / bakelite sheet. - Power terminals shall be stud type. - Control terminals shall be suitable for connecting two cores



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		<ul style="list-style-type: none"> of 2.5 sq.mm wires. - Minimum 20 % spare terminals shall be provided. - The minimum rating of control terminal shall be 10 Amps. - Color coded wires, TB's of different voltage rating to be provided . - Uniform color-coding to be followed for cabling, TB, etc.
7.0	Cable glands	Double compression cable glands for receiving external power and control cables
I. Control Supply		
1.0	Control transformer	1 nos. of 415V/240V control transformer of minimum 2.5 KVA Secondary unearthed.
2.0	Input and output side isolation device	Input side :- MCB Output side :- MCB

1.02.10 SOFT STARTER :-

A. Design Criteria:-		
1.0	Incoming supply voltage	415 V + 10 % & -15% , 50 Hz. +/- 6 % , 3 phase
2.0	Control Supply	240 V AC through control transformer. However there shall be provision of control supply of 110V/240 V AC through shorting links in control supply power terminal blocks .
3.0	Output	Full wave in line control
4.0	Device	IGCT/IGBT/ /Fast acting switching semi conductor device.
5.0	Acceleration	Stepless
6.0	Pump control	Starting :- 2 – 30 seconds Stopping :- 2 – 120 seconds
7.0	Adjustable current limit	500 % of In .
8.0	Adjustments	<ul style="list-style-type: none"> - Dwell time at current limit with ramp continuation after acceleration . - Acceleration time adjustable current limit - Minimum voltage adjustment - Voltage stability adjustment. - Initial torque ramp time adjustment . - Kick start
9.0	Overload tripping range	100 – 130 % (as per manufacturer's characteristic curve)
10.0	Overload capacity	Continuous :- 115 % 60 seconds :- 250 % 30 seconds :- 300 % 05 seconds :- 450%
11.0	Other features	- Shall have facility to run in energy saving mode during light load operation of the drive



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		<ul style="list-style-type: none">- Shall have bypass mode . Motor can run in bypass mode in DOL .- Soft starter mode or bypass mode can be selected through selector switch mounted on front side of the panel .- In auto mode soft starter shall start / stop after getting command from PLC.- Shall have the facility of kickstart .- Shall be able to communicate to PLC on dual redundant communication bus . Accordingly suitable cards / modules shall be mounted .
12.0	Protections	<ul style="list-style-type: none">- Short circuit- Overload .- Under voltage protection- Current monitoring in each phases- Transient voltage suppressor (MOV)- Heat sink overtemperature protection- Over temperature switches on each pole.- RC Snubber ckt.- Semiconductor fuse to be provided before the soft starter controller .- Single phase protection
13.0	LED Indications	<ul style="list-style-type: none">- Power ON (green)- RUN (amber)- Fault (red)- O/C trip (red)- Phase loss trip (red)- Auxiliary trip (red)
B. General :-		
1.0	Type	<ul style="list-style-type: none">- Metal clad .- Non drawout type.
2.0	Construction	<ul style="list-style-type: none">- Modular construction .- Fully compartmentalized with metal / insulating material partition.
3.0	Enclosure class	IP52.
4.0	Type of execution	Single front.
5.0	Mounting	<ul style="list-style-type: none">- Floor mounting.- Free standing with ISMC 75.
6.0	Installation	Indoor.
C. Constructional Features :-		
1.0	Sheet steel	



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	Thickness	<ul style="list-style-type: none">- 2 mm for load bearing members.- 1.6 mm for non load bearing members.
	Material	CRCA
2.0	Cable entry	<ul style="list-style-type: none">- Incomer :- Bottom cable entry.- Outgoing :- Bottom cable entry.
3.0	Design	<ul style="list-style-type: none">- Rear access through removable rear hinged cover door.- All the components shall be accessible from front
4.0	Interlocking & protection	<ul style="list-style-type: none">- Module door interlocked with main power isolating devices.- Power circuit isolation device to have pad locking in the OFF position with door closed.
5.0	Operating height	<ul style="list-style-type: none">- Minimum :- 300mm- Maximum :- 2000 mm.
6.0	Gland plate	Undrilled removable bottom gland plates (3 mm thick)
7.0	Miscellaneous	<ul style="list-style-type: none">- Neoprene rubber gasket shall be provided for all the doors , removable covers & between adjacent covers .- Lifting hooks for the panel .- Doors shall have concealed hinges .
8.0	Labelling	<ul style="list-style-type: none">- Clear legible identification labels (anodized aluminium with white letters engraved on black background) with letter sizes of :- 25-50 mm for panel .- 5 mm for components and module name plates.- Danger board on front and rear sides in English , Hindi and local language .
9.0	Earthing	<ul style="list-style-type: none">- Two separate earthing terminals will be provided.- Bolted joints with tooth spring washers for good earth continuity.
10.0	Paint shade	Shade No. 631 as per IS-5:1992./ RAL 7035
11.0	Panel space heater	In each panel with thermostat , fuse , switch.
D. Busbars		
1.0	Arrangement	Three phase & neutral.
2.0	Material	High conductivity electrolytic aluminium alloy confirming to grade E91E as per IS-5082 –1981.
3.0	Phase Busbar Rating	Shall be able to carry continuously the connected load (considering all derating factors) plus a 25% margin . Max. current density shall be



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		1.0 A/sq.mm for Aluminium 1.5 A/sq.mm for Copper .
4.0	Neutral Busbar Rating	50 % of phase busbar rating
5.0	Short circuit rating	50 KA for 1 sec.
6.0	Busbar configuration	Red-yellow-blue from front to back or top to bottom or left to right as viewed from front.
7.0	Busbar insulation	Heat shrinkable PVC R,Y,B coloured sleeves for phases Black for neutral.
8.0	Busbar supporting insulators	Non-hygroscopic Flame retarded Track resistant High strength Sheet moulded compound or equivalent polyester fibre glass moulded type .
9.0	Max. temp. rise of bus	Not to exceed 35 deg. C. above ambient of 50 deg.C.
10.0	Air clearance for bare busbar	Phase to phase :- 25.4 mm (minimum) Phase to earth :- 19.0 mm (minimum)
11.0	Joints and tap off points	Busbar joints and tap off points shall be shrouded and bolted (with cadmium coated bolts with plain and spring washers and locknuts). Bimetallic connectors for connection between dissimilar metals . Antioxide grease for all bus connections .
12.0	Neutral bus isolation	Through disconnecting link .
13.0	Busbar access	Rear side
(ii) Earth bus		
1.0	Material	GI.
2.0	Size	Minimum 50 x 6 mm with extension at both ends .
(iii) Control bus		
1.0	Material	Copper.
2.0	Size	Minimum 25 x 3 mm .
E. Insulation level		
1.0	Rated insulation voltage	1100 V
2.0	Impulse withstand voltage	4 Kv as per IS-13947 (Part I) 1993
3.0	One minute power frequency withstand voltage	2.5 Kv for power circuit & 500 V for control circuit
F. Pollution Degree		
1.0	Pollution Degree	Pollution Degree 3 as per IS-13947 (Part-1) : 1993 ;



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		unless otherwise stated
G. Components		
1.0	Isolating Equipment	3 pole manual ACB
2.0	Indication Lamps	LED type indicating lamps for :- ACB ON/OFF/TRIP. Incoming power R / Y / B . Auto / Remote / Local . Soft starter mode / bypass mode . Motor ON / OFF / TRIP.
3.0	Meters and selector switches	96 sq.mm size voltmeter with 7 position selector switches 96 sq.mm size ammeter with 4 position selector switches
4.0	Power contactor	AC3 duty of rated capacity .
5.0	Thermal overload relay	Electronic type CT operated Shall be connected in bypass mode .
6.0	Auxiliary contactors	Shall be provided for logic operation and operating sequence . Shall have minimum 2NO+2NC auxiliary contacts suitable for 5A DC .
7.0	Door mounted operating devices	Start / stop operating PB. Reset PB. Selector switches :- Auto / Remote / Local . Soft starter mode / bypass mode .
H. Panel Wiring		
1.0	Power / current transformer circuit	1.1Kv grade single core , black colour PVC insulated , stranded copper conductor of minimum size 2.5 sq.mm.
2.0	Control and potential circuit	1.1Kv grade single core Black colour PVC insulated Stranded copper conductor of minimum size 1.5 sq.mm.
3.0	Ferrules	Numbered plastic/ceramic ferrules. Self locking type.
4.0	Marking	Wiring will be properly marked as per relevant IS.
5.0	Spare contacts	All spare contacts of relays selector switches & contactors will be wired upto the terminal block. Each components shall have at least one potential



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		free spare contacts.
6.0	Terminals	Power & control terminals shall be segregated by insulating material like hylam / bakelite sheet. All control field wiring terminals shall be front access . Power terminals shall be stud type. Control terminals shall be suitable for connecting two cores of 2.5 sq.mm wires. Minimum 20 % spare terminals will be provided. The minimum rating of control terminal shall be 10 Amps. Color coded wires, TB's of different voltage rating to be provided . Uniform color-coding to be followed for cabling, TB, etc.
7.0	Cable glands	Double compression cable glands for receiving external power and control cables
I. Control Supply		
1.0	Control transformer	1 nos. of 415V/240 V control transformer of minimum 2.5 KVA . Secondary unearthed.
2.0	Input and output side isolation device	Input side :- MCCB Output side :- MCB

1.02.11 Specifications of major components

01. MOULDED CASE CIRCUIT BREAKER (MCCB)

1.0	Reference standard	IS : 13947 (Part-2) : 1993
2.0	Rated Current	As specified in SLD
3.0	MCCB for motor feeders	MCCBs for motor feeders shall be motor protection type conforming to type-2 co-ordination. (MCCB without overload not available. EOCC is being used)
4.0	Short circuit rating	50 kA (Minimum) (Ics =Icu).
5.0	Service Short circuit breaking capacity (Ics)	100% of rated ultimate short circuit breaking capacity (Icu)
6.0	Operating handle	Yes
7.0	Safety Door interlock	Door interlock



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		Padlocking in ON/OFF position
8.0	Withstand capability	Rated short time with-stand current (I _{cw}) will be 12 times maximum rated operational current for 1 sec.
9.0	Utilisation category	AC23B
10.0	Electrical features	<ul style="list-style-type: none">- S/C , O/C, E/F protection for power supply feeders & crane trolley line feeder MCCB's.- Features to minimise the let-through energy (I_{2t}) in the event of short circuit on load side.- Complete with continuous electronic / microprocessor based adjustable thermal and magnetic releases.- MCCB's for motor feeders shall be of motor duty class with magnetic trip only . Overload protection shall be through electronic overload relays .
11.0	Auxiliary contacts	1 NO + 1 NC Alarm contacts.
12.0	Miscellaneous	Can be used in load side or line side vice versa. Shunt trip coil .

02. AC CONTACTORS

1.0	Service	Indoor within steel cubicle for maximum system voltage, starting of motors and miscellaneous loads
2.0	Standard	Shall conform to IS / IPSS
3.0	No. poles	3 pole air break .
4.0	Operating type	Magnetic coil operated at 240 V AC. No economy resistors. Insulation for coils shall be class 'E' or better
5.0	Rating	32A (Minimum) , Rated for 125% of full load motor rated current for DOL motor feeders and 150% of motor rated current for RDOL motor feeders.
6.0	Interrupting capacity	Ten times the rated current for rated size upto 100A and eight times the rated current for larger sizes.
7.0	Duty	According to IEC 158-1 <ul style="list-style-type: none">- AC 1 duty :- Non inductive or slightly inductive loads .- AC 2 duty :- Slip ring motors : starting , plugging- AC 3 duty :- Squirrel cage motors : starting , switching off motors during running- AC4 duty :- Squirrel cage motors : Plugging , inching. Derated AC4 ratings shall be selected for inching and plugging operation of the drive (crane duty).



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8.0	Utilisation category	AC23A for unidirectional motors AC24A for bi-directional motors
9.0	Aux. contact requirement	- Minimum 4 NO +4 NC contacts with minimum rating of - 10A , 415 V. - 2A , 220 V for rated duty DC-11. - Shall have the facility of adding add-on contact blocks.
10.0	Closing (pick-up)	85% to 110%
11.0	Dropout	Will not be higher than 75% and lower than 40% of rated control supply voltage
12.0	Miscellaneous	For RDOL feeders the power contactors shall be mechanically interlocked.

03. Current transformers:

1.0	Type	Bar type primaries and 5A (max) secondary with thermal and dynamic ratings corresponding to the units with which they are used.
2.0	Accuracy class	- Measuring CT accuracy class 1.0. - Protective CT accuracy class 10 P 10.

04. Control transformers:

1.0	Type	Dry type , cast resin
2.0	Voltage	415V/240V
3.0	Primary taps	+2.5 % , +5 %

05. Indicating instruments:

1.0	Basic details	- Shall not damage by passage of fault current or existence of over voltage for the maximum permitted duration of fault conditions. - Ammeters for drives above 30 kW shall be CT operated. - Voltmeters protected by fuses placed as close to the busbar as possible. - Maximum reading 600% of IFL for motor feeders .
2.0	Mounting	Flush mounting, square dial with zero adjusting device for external operation .
3.0	Accuracy class	1.5
4.0	Size	- Size of voltmeter and ammeter for incomer 144 x 144 mm



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		for incoming feeders. - Size of ammeter for motor feeders 96 x 96 mm.
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06. Thermal Overload Relays .

1.0	Standard	IEC:292-1
2.0	Basic details	<ul style="list-style-type: none">- Electronic type (with indication for 37 KW motors and above)- Triple pole- Ambient temperature compensated .- Inverse time lag.- Hand reset type.- Bimetallic with adjustable setting and builtin single phase protection .- Reset PB shall be operable from outside .- Shall be able to withstand prospective short circuit current without damage or injurious heating till the motor protection MCCB clears the fault .- Auto tripping shall be indicated on MCC .
3.0	Contacts	1 NO + 1 NC contacts with minimum rating of <ul style="list-style-type: none">- 10A , 415 V for rated duty AC-11.- 2A , 220 V for rated duty DC-11.

07. Magnetic Overload Relays .

1.0	Standard	IEC:292-1
2.0	Basic details	<ul style="list-style-type: none">- Triple pole- Ambient temperature compensated .- Adjustable time lag feature or of instantaneous type.- Provided with a latch and hand reset feature or auto reset with flag indication .- Adjustable current setting and time delay calibrated between nominal current and twice nominal current rating
3.0	Contacts	1 NO + 1 NC contacts with minimum rating of <ul style="list-style-type: none">- 10A , 415 V for rated duty AC-11.- 2A , 220 V for rated duty DC-11.

08. Push Buttons

1.0	Standard	IEC 60947
2.0	Basic details	<ul style="list-style-type: none">- All push button switches including illuminated push buttons shall be of sturdy design- Un-shrouded actuator for "START" application, Mushroom



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		<p>actuator for "EMERGENCY STOP" application and key "STOP" application for "LOCK-OUT" application shall be provided.</p> <ul style="list-style-type: none"> - Mushroom actuator for Emergency Stop shall be latched type. - Press to latch in operated position and turn-to- release in unactuated position. - Double break parallel contact design or other suitable design feature enhancing contact reliability required in circuits with electronic interfaces involving low voltages and small currents shall be adopted.
3.0	Size	- 22.4 mm diameter
4.0	Contact rating	<ul style="list-style-type: none"> - Minimum 2 NO + 2NC contacts with following current ratings . <ul style="list-style-type: none"> • Continuous - 10 A • AC 11 - 1.5 amps at 240V • DC 11 - 0.5 amps at 110 V DC, L / R - 40 ms - All contact faces of contacts shall be of silver or silver alloy. - Facility of adding add on contact blocks to be provided
5.0	Colour	<ul style="list-style-type: none"> • Accept - Blue • Test - Yellow • Reset - Black
6.0	Protection class	<ul style="list-style-type: none"> - IP 66/ 67 - The P.B. switches shall be with higher contact reliability, electronics compatibility .

09. Indicating Lamps

1.0	Standard	IEC 60947
2.0	Type	- LED Cluster type
2.0	Basic details	- Sufficient number of lamp grips shall be provided for easy replacement of lamps.
3.0	Size	- 22.4 mm diameter
4.0	Voltage level	<ul style="list-style-type: none"> - Suitable for any of the following voltages as per the system requirement : <ul style="list-style-type: none"> • 415V AC / 240V AC / 110V AC / 24V DC / 220V DC - All indicating lamps shall be suitable for continuous operation at 90 to 100 percent of their rated voltage.
5.0	Colour	<ul style="list-style-type: none"> - For motor `ON`, valve/damper/gate `OPEN`, supply `ON`, breaker `CLOSE` : Red - For motor `OFF`, valve/damper/gate `CLOSE`, supply `OFF`, breaker `OPEN` : Green - Fault indication, over load, alarm condition, `SERVICE & TEST POSITION` : Amber



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		<p>indication.</p> <p>- General purpose indication, : White motor 'AUTO TRIP'.</p> <p>Other colours may be adopted depending upon particular application as approved by the Purchaser.</p>
6.0	Protection class	IP 66/ 67
7.0	Layout of indication lamps on boards / panels	<ul style="list-style-type: none"> • Indicating lamps shall be located just above the associated push-button / control switches. • Red lamps shall invariably be located to the right of green lamps. • In case a white lamp is also provided, it shall be placed between red and green lamps along the centre line of control switch/ push button pair. • Blue and Amber should normally be located above the Red and Green lamps. • When associated with push buttons, red lamps shall be directly above the green push button and green lamp shall be directly above the red push button.
8.0	Legend plates	Anodised aluminium

10. Miniature Circuit Breakers (MCB)

1.0	Type	Heat resistant plastic moulded type
2.0	Ref . Standard	IS: 8828 –1978
3.0	Protections	<p>MCB's shall be provided with</p> <ul style="list-style-type: none"> • quick break trip-free mechanism • direct acting thermal overload • short circuit trip elements.
4.0	Short circuit capacity	Not less than 9000A at 0.8pf
5.0	Mounting	<ul style="list-style-type: none"> • DIN Channel mounting . • Single phase MCBs mounted adjacent to each other and connected to different phases will be provided with adequate insulated phase barriers.
6.0	Current Rating	<ul style="list-style-type: none"> • The MCBs shall be selected from standard current ratings.(As per SLD) • Motor duty MCBs will be provided, if specified. • MCB shall be of C curve .

11. Selector Switches

1.0	Standard	IEC 60947
2.0	Basic details	<ul style="list-style-type: none"> - All control selector switches shall be of sturdy design . - Shall have modular construction with number of switching contacts for each position operated by a single shaft. - Inscription for each position shall be provided. - Stay-put or spring return arrangement shall be provided



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		<p>as per the circuit and control/operational requirement.</p> <ul style="list-style-type: none">- The contacts shall be designed for higher contact reliability and electronics compatibility involving low voltage and small value of currents.- The operating handle shall be robust and strong.- One number of potential free switching contact for each position shall be provided as spare.- Control switches for circuit breaker ON/OFF control 3 position spring return to neutral with lost motion device and pistol grip handle.- Other control and selector switches - stay put type with wing type knobs.
3.0	Contacts	<p>2 NO + 2 NC contacts with minimum rating of</p> <ul style="list-style-type: none">- All the selector switches shall be of 10 A rating- 25A for sturdy applications .- 1 NO & 1 NC contact / poles shall be potential free for PLC inputs .

1.02.12 LOCAL CONTROL STATIONS

1.0	Material	Sheet steel (CRCA) 2 mm thick
2.0	Mounting	Wall / structure mounted .
3.0	Enclosure class	IP-54 (for indoor installation) IP-55 with canopy (for outdoor installation)
4.0	Door opening	Hinged type front door opening .
5.0	Cable gland	Removable undrilled . To be provided on both top and bottom.
6.0	Internal wiring	2.5 mm , single core , stranded , black PVC insulated copper conductor .
7.0	No.of components like ON/OFF PB's , selector switches etc.	As per scheme requirement.
8.0	Contact details of components .	All the components like ON/OFF PB's , selector switches etc. shall have 2NO + 2NC contacts / poles of 10 A rating. 1 NO & 1 NC contact / poles shall be potential free for PLC inputs .
9.0	Stop push button details	Stop push button shall be :- RED in colour. Mushroom headed. Press to lock and turn to release type .
10.0	Start push button details	Start push button shall be GREEN in colour.



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		Shrouded type .
11.0	Lamp details (if any)	High density LED type .
12.0	Location of selector switches	Local / Remote selector switches shall be installed in the LCS
13.0	Terminal blocks	<ul style="list-style-type: none">- Shall be able to terminate wires of 2.5 sq.mm size .- Not more than two wires shall be terminated in a single terminal block .- Shall be mounted on D-channels .- 30 % spare terminals shall be provided .- Colour of TBs for different voltages shall be different.- Uniform color-coding to be followed for cabling, TB, etc.
14.0	Miscellaneous	LCS shall act as field junction box also for wiring termination from Limit switches, PCS, BSS and other field devices. Facility for termination of minimum 5 nos. 19X2.5 core shall be provided.
15.0	Provision of ammeter.	For motors of more than 45 KW ammeters along with 4 position selector switches shall be provided .
16.0	Earthing	Earthing studs shall be provided on two opposite sides . Internally the earthing studs shall be connected with the body through green colour PVC insulated copper flexible wire .
17.0	Paint	Shade no. 631 of IS : 5 - 1992.

1.02.13 CONTROL DESK

1.0	Material	<ul style="list-style-type: none">• Sheet steel (CRCA)• 2.5 mm thick
2.0	Mounting	<ul style="list-style-type: none">• Free standing• Floor mounting pedestal mounting or trunion mounting.
3.0	Enclosure class	<ul style="list-style-type: none">• IP-52 (for indoor installation)• IP-55 (for outdoor installation in bays)
4.0	Door opening	<ul style="list-style-type: none">• Hinged type front door opening .• Hinged top cover with latching facilities in open position
5.0	Cable gland	<ul style="list-style-type: none">• Removable undrilled .• To be provided in bottom.
6.0	Internal wiring	2.5 mm , single core , stranded , black PVC insulated copper conductor .
7.0	Angle of inclination	8 degrees
8.0	Components like ON/OFF PB's , selector switches etc.	<ul style="list-style-type: none">• Control switches, push buttons and indication devices mounted on top cover and wired upto terminal blocks using extra flexible appropriately insulated wires.• Numbers of components shall be as per scheme



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		requirement. <ul style="list-style-type: none">• Construction and switch layout to provide comfortable operation .
9.0	Lamp test PB	To be provided
10.0	Contact details of components .	<ul style="list-style-type: none">• All the components like ON/OFF PB's , selector switches etc. shall have 2NO + 2NC contacts / poles of 10 A rating.• 1 NO & 1 NC contact / poles shall be potential free for PLC inputs .
11.0	Emergency stop push button details	<ul style="list-style-type: none">• Emergency stop push button shall be installed on top right side of the control desk .• Emergency PB shall be :-<ul style="list-style-type: none">○ RED in colour.○ Mushroom headed.○ Press to lock and turn to release type .
12.0	Start push button details	<ul style="list-style-type: none">• GREEN in colour.• Shrouded type .
13.0	Lamp details	High density LED type .
14.0	Terminal blocks	<ul style="list-style-type: none">• Shall be able to terminate wires of 2.5 sq.mm size .• Not more than two wires shall be terminated in a single terminal block .• Shall be mounted on D-channels .• 30 % spare terminals shall be provided .• Colour of TB's for different voltages shall be different.• Uniform color-coding to be followed for cabling, TB, etc.
15.0	Spare switches	<ul style="list-style-type: none">• At least 02 nos. of each types of switches and indication lamps are to be provided as spare in each desk .• Two numbers of drilled holes are to be provided . The holes shall be plugged with rubber cap .
16.0	Earthing	Earthing studs shall be provided on two opposite sides . Internally the earthing studs shall be connected with the body through green colour PVC insulated copper flexible wire .
17.0	Paint	Shade no. 631 of IS : 5 – 1992 or RAL 7032

1.02.14. CONTROL SYSTEM CONCEPT AND PHILPSOPHY

- 01** The electrical control system shall be laid on distributed hierarchical concept with a great extent of decentralization of control functions so that individual system shall be autonomous in operation as far as possible.



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The system shall be sufficient to perform all the functions required of them & shall be designed to achieve high degree of accuracy of control functions.

Two hierarchical levels has been envisaged as indicated below :-

- Individual drive control level (Level-0)
- Functional group control level (Level-1)

02 Individual drive control level (Level-0)

This shall comprise of motors, field devices, HT/LT Switchgears, Intelligent MCC's, Local control stations, speed control equipment etc. which are to be connected to Level-1 System.

03 Functional group control level (Level-1)

It shall comprise of Programmable Logic Controllers (PLC). The PLC's shall be provided for control, interlocking and sequencing of different drives. This shall also include HMI, visualization, alarms logging, reporting, trend curves, controlling of set points, etc. for the plant units.

Necessary interface to Level-2/3 System shall be provided.

04. Drive Control Requirement

All process drives shall be generally be controlled from Central control room through Operator workstations / VDU's and keyboards. Use of Control desks / Control Cabinets shall be restricted to specific drives / emergency operation only.

All drives shall be provided with sel.switch for local operation / maintenance. LCB's shall be provided with start & stop PBs, Local / Remote Selector switch, any other devices / lamps for the operation of the equipment. Stop PB shall be lockable type with key to release.

For HT motors, ammeter shall be provided on LCB. Interposing CT of secondary 1A shall be provided with purchaser's switchgear at the middle phase for remote metering.

All pumps shall be provided with dry running protections.

For all motors, drive status (ON/OFF, open/close, forward/reverse) tripping due to O/L, earth fault, equipment fault, process faults etc. shall be displayed in VDUs.

Where speed control of process drives are envisaged, the speed indicator shall be provided in VDU.



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1.02.15. Automation System :-

01. General

A. Automation System Architecture		
1.0	System Architecture	- Client server architecture
2.0	Redundancy	<ul style="list-style-type: none">- Dual redundant CPU with hot standby mode (Application software based redundancy is not acceptable).- Dual redundant communication bus with dual communication cards / dual redundant interface module for the communication bus and each I/O chassis to be installed in each I/O rack / scanner units and synchronizing modules .- Two numbers of servers shall be provided with hot redundant mode .- Power supply redundancy .- Respective I/O rack shall act as a node to the I/O bus for interfacing with processor rack and shall not be interfaced through back plane extension between two or more I/O racks.
3.0	Speed of commn. interface at I/O level	Preferably 5 MBPS or better . Data loss shall not be more than 4 % .
4.0	Connecting ports	<ul style="list-style-type: none">- Cat.-5, UTP cable with provision for 2 nos. additional UTP ports .- Two ports for connection to Level-2 network shall be considered for the network.
5.0	Level-2 network communication bus	In place of industrial ethernet, any other deterministic network of 10 MBPS or better (Bus based on open protocols at minimum 4 OSI layers) may also be considered in which case, separate gateway interface with two UTP ports with TCP/IP protocol on Ethernet shall be provided for Level-2 network.
B. General		
1.0	Control Philosophy	<ul style="list-style-type: none">- All process data acquisition & monitoring functions, process control (PID), interlocking, logic & sequence controls of drive and various systems shall be performed by the PLC.- PLC's shall be connected to two different bus levels in the network . It shall communicate with RIO's , intelligent MCC's , VFD's , Soft starters, weigh panels etc. on Profibus / Modbus / Controlnet while with HMI's and HMI cum ES on high speed Ethernet bus through server . The Ethernet switch provided shall be manageable type .- The automation system shall cover all the sections of the entire plant .- A separate server shall be provided for MIS terminals to be located in welfare building of the individual shop through communication link switch .- Communication gateway shall be provided for communicating the system with plant network system of the plant .- For displaying the alarms and faults in the mobile handset



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		<p>of the authorized person a modem for GSM shall be provided in the network .</p> <ul style="list-style-type: none">- PLC installed in mobile equipments like stacker cum reclaimer etc. shall communicate with the main server through wireless communication . All the required hardware and software shall be provided for the same .
2.0	Data signals exchangeability with PLC	<ul style="list-style-type: none">- The PLC envisaged in this package shall exchange signals with RIO / Instrument panel / VFD / MCC's / Weigh Feeder Panels / dedicated position control system panels (if any) / Level 2 system computers / other PLCs of the plant.- However all the critical equipment / drives shall be provided with hardwire interlocking in addition to the interlocks through PLC .- The Tenderer shall include multi-vendor connectivity with all requisite hardware , communication interfaces & required software for exchange of signals with other PLCs of different make on high speed communication bus.- OPC server shall be provided for communication between the OEM PLC (of different make) and main system PLC .
3.0	Operational control mechanism	<ul style="list-style-type: none">- Provision of the visualisation of the system shall be through human-machine interface HMI , for the control and operation of the complete plant .- In addition to the normal workstations, at least two numbers of 42" or higher plasma/LCD display units and one overhead LCD projection system to be provided in each central control room.- Plasma/LCD display units along with AV switching unit to output AV signal from any machine in the control room
4.0	Operational facilities in HMI	<p>The Graphic interface to the operator shall have the following minimum features with user friendly navigation keys .</p> <ul style="list-style-type: none">• It shall be possible to display dynamic graphic of different section of plant on the TFT screen & large display system .• Graphic displays shall be field configurable only through engineering key-board with standard / user defined graphic symbols.• Different plant sections dynamics shall be displayed on different pages.• The graphic display on the HMI clients shall also include extensive process, system and equipment diagnostics in graphical form for troubleshooting. The PID and other such settings to be available on operator workstation for viewing and editing.• Graphic display shall be interactive type through which it shall be possible to control process. Following process control functions will be initiated via the HMI :-<ul style="list-style-type: none">- Operation mode (Auto / Remote / Manual) selection- Control mode (Auto / Semi-Auto / Local) selection .- Selection of drive and control loops- Set point selection.- It shall also be possible to send motor start / stop and shutdown, valve open / close command , control mode selection command from this display.



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		<ul style="list-style-type: none"> - It shall be possible to go from any graphic page to related graphic page or any group view or alarm summary in single keystroke using soft key function. - Process diagnostic system to provide status & fault signals of the process along with process error displays. - The details of graphic screens shall be finalised as required during detailed engineering and commissioning.
5.0	Operational menus in HMI	<ul style="list-style-type: none"> • Opening page with project description, name of supplier, name of consultant . • Sub-menus like command menu, report menu etc. • Command menu in the form of buttons for start and stop of each equipment / group of equipment . • Operation mode • Display of auto / local selection of each mechanism .
6.0	Reporting and data logging	<ul style="list-style-type: none"> • Summary of faults with description, date and time of occurrence . • Shift wise, daily, monthly, yearly hierarchical logging of report/faults/data with process values / production figures and other process data. However, same shall be finalised by the Purchaser during detailed engineering process. • Automatic log sheet – operation & maintenance – shift & day. • The system shall comprise of a standard library of control, logic and computational functions that are preprogrammed and stored in memory. During the system configuration, user shall be able to select the appropriate functional blocks from the library, link them together, set the various inputs and tune parameters associated with each block. • Real time recording of data for important equipment shall be provided (e.g high speed recorders etc.) • All logging in ORDBMS. Logging and reporting also to be provided batch-wise, campaign-wise, etc. Reporting to include analysis tools. • Historical data storage & trending. • Along with graphic generation, trending, and alarm generation, EVENT LOGGING also to be included. Event logging means data related to an event happening in the process or field. It will also include the user activities vis-à-vis operation through the automation system.
7.0	Mode of operation of the plant	<p>A Local Mode :-</p> <ul style="list-style-type: none"> • Operation of single drive / equipment • Start / Stop from LCS shall be done only for test and repair purposes . • To enable the testing of individual equipment all the interlocks which are not at all necessary shall be withdrawn in this mode . • However all personnel / equipment safety interlock are effective for safety reasons also in local mode . • LCS are provided for all motors , drives and



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		<p>actuators for valve operation as near as possible .</p> <p>B. Semi Auto :-</p> <ul style="list-style-type: none"> Under this mode it shall be possible to monitor & control the plant based on set points / commands given by operator through keyboard (for individual equipments or individual group for group control drives) and the control, sequential operation of various mechanisms in the required sequence shall be executed by PLC i.e.; in this case all the changes are operator initiated. <p>C. Auto Mode :-</p> <ul style="list-style-type: none"> This is the normal mode of operation of the plant . In this mode , the desired values (set point) of the parameters of process control loop will be set via keyboard of the HMI and sequencing and logic functions will remain operative through the PLC as per programme. There shall be a provision of group start of the individual sections . In the individual sections there shall be provision of interlocks , logic and sequencing between the individual drives
8.0	Screen display menu	<ul style="list-style-type: none"> Over view Group display Loop display Mimic display (dynamic) Alarm over view Alarm display Trend display (Dynamic display) Event displays(Dynamic display) Diagnostic & maintenance displays <p>However a dynamic mimic status pages shall be made available with security through web based portal for each respective packages . Location of the same shall be decided during detailed engineering (by BSP) .</p>
9.0	Process displays with dynamic variables graphic with process	<ul style="list-style-type: none"> Process status overview (On/Off status of process and plant) Operation status of Drives (Position and status of drives) Group display of Loops Control Loop display & Configuration of Control Loops Real time trending (Bar graph displays and / or numerical display) Historical trending. Historical trending for 7 days for 1 minute scan rate for all analog inputs Fault message indications Operational/ event message indication. Data and time synchronization on the complete HMI system shall be ensured .



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		<ul style="list-style-type: none">• High speed (1msec scan) recorder of 12 channels to be provided for real time recording of data for important equipment (at least 02 nos. for each packages) .
10.0	Process graphic display operation	<ul style="list-style-type: none">• Graphic Display will contain static and dynamic components. The dynamic components display the actual state of the plant section. Dynamic components will be actual binary states (e.g. drive “on”) or actual values . Values will be represented as bar charts and / or numerical.• Critical plant status will be highlighted by different colours or by blinking. Description in clear text will be provided to simplify Operator understanding.• Double clicking on any of the control valve in any of the menu / submenu pages shall invoke the corresponding PID loop display screen with real time trend. PID loop display screen shall show controller facia and displaying status and parameters of each controller. Each facia shall be able to display process value, set value and the manipulated variable. The remote manual functions and change of set points under auto mode shall be possible to be performed from these facias.• Graphics should also include very comprehensive diagnostics on process, plant, equipment, system etc., enabling the user to pinpoint exact reason of any problem faced.• In case of Cascade/ Ratio control, it shall show all the controllers facia with the facility of maximising one of them. PID parameters can be changed only after validation of software password.• Clicking on any mechanism like valve will invoke a small screen showing following (software lamps) indications for remote manual operation :<ul style="list-style-type: none">○ Local○ Remote○ Auto○ Open (Blinking with opening color during opening)○ Closed (Blinking with closing color during closing)○ O/L Tripped○ Torque switch actuated○ Control supply Healthy○ Valve Open Timer Time Out○ Valve Close Timer Time Out○ Local Stop• Clicking on any mechanism like fan / pumps will invoke a small screen showing following (software LED) indications for remote manual operation:<ul style="list-style-type: none">○ Local○ Remote○ Auto○ Run Feed-back○ Elect. Fault
11.0	Colour Codes	<ul style="list-style-type: none">• The display of the process will occur on full graphic color



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		<p>process terminals.</p> <ul style="list-style-type: none">• In Graphic display sheets color of the process line shall be as per the color code followed by the Purchaser.• However all fans / pumps color will be RED in ON condition, color will be GREEN in OFF condition and valves will be PINK (with blinking) in the intermediate position.• Client approved standard color-coding to be followed for graphics.• Uniform color-coding to be followed for cabling, TB, etc.
12.0	Trending	<p>In any menu/ sub menu page double clicking on any tag will invoke the trend menu of that particular tag. Based on the selection by the Operator either Historical or Real Time Trend menu will be displayed. Provision shall be there so that Operator can add trends by entering the tag nos. , for another 7 nos. of tags in the same page ,using the same time base for comparison purpose.</p> <p>The Automation system must support historical process information recording and retrieval. This historical information shall be available for use in logs, trends, etc, requested at any operator console. Recorded process information shall include:</p> <ul style="list-style-type: none">• Measured value• Alarm status• Setpoint or desired value• Output value• Control mode <p>A distributed approach to historical recording is preferred to a dedicated unit. For both logging and historical trending the operator/ engineer must be able to specify the points to be recorded, the frequency with which the data is to be collected and the time base. Historical data should support the following protocols:</p> <ul style="list-style-type: none">• OPC (Open Process Control)• OLE (Object Linking and Embedding)• ODBC (Open data base connectivity)• API (Application Programming Interface) <p>Sufficient online storage shall be included to accommodate the data base and alarm, event and historic data logs for monitoring 75% of analogue data for 24 hours at 10 sec. Trend rate.</p> <p>Display of trend shall have</p> <ul style="list-style-type: none">• Operator scalable X-axis from 60 seconds to 24 hours (for 24 hours history, trend shall be stored as 10 seconds scan for each variable)



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		<ul style="list-style-type: none">• Operator scalable X-axis from 8 hours to one month (for one month history, trend shall be stored as 10 minutes average value for each variable).• XY Plots also to be included. Storage frequency, maintenance, sizing, etc. to be done in consultation with client.• Current of all motors to be available on L-1 automation system for monitoring /trending etc for all process related drives.
13.0	Interlocking	<p>The interlock scheme shall be as per the technological requirement based on process flow diagram , P&I diagram and functional chart .</p> <ul style="list-style-type: none">• All emergency conditions like stop push button, emergency stop command, torque switches , level switches etc. shall be interlocked to the main power contactors of the drives.• Provision of providing interlocking of different equipment (which are controlled from different PLC) based on I/O exchange from that PLC .• Further the system shall be provided with pre-starting audio-visual alarm at equipment platform before starting of mobile equipments like conveyors , turret , tundish cars etc• Interfacing with subsystems : All outside auxiliaries and supporting units for process related system shall be interfaced. <p>However, all facilities to be provided in the central control room which shall be finalised during detailed engineering stage keeping in view the process / technological requirement.</p>
14.0	Alarms and alarm management	<ul style="list-style-type: none">• The use of multi-media system in HMI shall be envisaged for audio-visual signaling for faults & alarms.• There shall be dedicated key as a provision for acknowledging the faults. The usability of the operator interface shall be further enhanced with features such as sound cards, touch screen, track balls etc.• Alarm list / event list and operator action list and its logging for minimum one month .• Alarm Performance• Irrespective of Operator activity and choice of display, an alarm situation shall always have priority and shall be brought to the attention of the Operator, quickly and automatically.• The display containing the alarm shall be selected by a single keystroke action. Alarms should automatically



		<p>update in the event of an alarm operating i.e. it should not require operator intervention to update alarms either on process mimics or alarm summary format.</p> <ul style="list-style-type: none">• Alarm messages shall be time tagged to within 100 milliseconds (from detection at input card or receipt from data link) or less and are required to be displayed within two seconds of the field device operating. System resolution for the orderly detection of successive alarms shall enable those alarms to be displayed in order of occurrence, and/or priority.• In order to facilitate easy recognition of alarm status by operators, annunciator colours and audio tones shall be easily distinguishable. All alarms and trips shall be annunciated by a screen message and an audible alarm.• Critical process alarms shall come in the form of small size popup window on the HMI screen . Individual area wise alarm shall display in the corresponding HMI station.• The alarms and trips shall flash in a highlighted form (e.g. reverse video) until acknowledged. When acknowledged from any HMI, the flashing and audible tone shall stop on all HMIs. When an alarm returns to normal, flashing shall return to normal on all HMIs provided the alarm has been acknowledged.• Alarm Category Colours• The following colours shall be used for the process control system screen alarms, on a black or gray background:<ul style="list-style-type: none">• Fire & Gas : Red• ESD : Magenta• Fault alarm : White• Process alarm : Orange• These are proprietary colours and shall be confirmed during detailed engineering. The use of yellow colour (traditionally a gas alarm) and green colour (associated with normal conditions) shall be avoided for alarms.• Audible Alarm Category• There shall be audible differentiation between the fire and gas alarms (noise X), and process alarms and faults (noise Y and Z), where X, Y and Z noises have to be defined.• Analogue Alarms• All process variables and composed points shall have the possibility of being assigned at least two levels of high and two levels of low alarm values. All control loops shall have the possibility of being assigned high and low
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		<p>deviation alarm values. All alarms shall have a user-definable dead band. An alarm shall be provided when analogue signals are less than 3.8 mA or greater than 20.2 mA. Rate of change alarms and set point deviation alarms shall be provided.</p> <ul style="list-style-type: none">• Filtering based on plant, equipment, time-span etc. shall be possible• The system will be engineered such that it is anticipated that at least 4 levels of alarm priority will be used:<ul style="list-style-type: none">○ Low○ Medium○ High○ Critical• According to guidelines, which will be developed in detail engineering, the Alarm/ event logging facilities will be provided using Automation System based logging rather than printers.• Discrete Alarms<ul style="list-style-type: none">○ All discrete inputs shall have the possibility of being assigned a change of state alarm. Discrepancy alarm indicating failure of control action shall be provided.• Alarm Analysis<ul style="list-style-type: none">○ It shall be possible to inhibit alarms by point of priority when the initiating device is faulty or being maintained. While inhibited, the point must still be scanned and archived. The removal of the inhibit shall be logged. A summary display containing all inhibited points shall be provided on demand. Alarm inhibition shall be permitted from any of the work stations with level 3 or 4 access level only. Facilities shall be provided to mask out alarms from equipment (such as pumps) that is shutdown. These alarms shall be automatically or manually via keyboard, reinstated when the equipment is put back into service. Initiation and removal of inhibition shall be logged as an event and printed.• Alarm Display<ul style="list-style-type: none">○ Alarm displays shall take the form of a summary display of all points in alarm, and/or integrate the alarm message with associated item, group or overview data. Alarms shall be listed in order of occurrence, and for specific alarm displays the most recent alarm shall be shown at the top of the display. All alarms shall be identified by tag, description and the date and time of the occurrence, in hours, minutes and seconds. A banner type display
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		<p>showing a summary of alarms shall always be present at the top of the screen irrespective of main display.</p> <ul style="list-style-type: none"> • Alarm Grouping and Priority <ul style="list-style-type: none"> ○ Alarms from an area shall be capable of being grouped in one or more Alarm Groups. A minimum of 30 Alarm Groups shall be provided. At least four levels of alarm priority shall be available, with configurable presentation/ background colour. A global alarm acknowledge and reset facility shall be available. If unacknowledged, Alarm message stays on display until it is cleared. • Diagnostic Alarms <ul style="list-style-type: none"> ○ The Automation System shall have a comprehensive self-diagnostic alarm information shall identify the faulty device down to board level, with its location and provide a diagnostic code. Individual circuit boards shall be provided with LED indicators or equivalent, to positively identify a faulty board. The failure of any single item of equipment shall not generate erroneous alarms. • Alarm Handling Capacity <ul style="list-style-type: none"> ○ In addition to the alarms included in the point count, the Automation System shall be capable of handling alarms and status points received via any data link to which it is connected. • Alarm Flooding <ul style="list-style-type: none"> ○ The Tenderer shall outline his approach, to overcome the problem of alarm flooding.
15.0	Configuration	<ul style="list-style-type: none"> • For Instrumentation system a separate dedicated PLC shall be provided (as mentioned in TS) . • If the PLC is common for the process a separate dedicated remote I/O panel shall be provided for the instrumentation system .

02. Programmable Logic Controller (PLC)

General Features

1.00	Power supply system	
1.01	Power supply system	<p>PLC system shall have two independent Input supply voltage :-</p> <ul style="list-style-type: none"> - Two source of 240V AC single phase, 50 Hz from UPS for CPU and other required control modules , interrogation voltage and output voltage . - Two nos. of redundant power supply modules in each chassis with diode ORing . - One source of 240 V AC single phase, 50 Hz from MCC for



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		<p>auxiliary power supply e.g fans , panel lamps , power sockets etc.</p> <ul style="list-style-type: none"> - Both UPS power supply units shall have auto changeover facility as well as manual changeover facility through selector switch . - Redundant 24 V DC regulated power supply unit shall be provided for interrogation voltage and output voltage . - Separate power supply bus shall be provided for interrogation voltage supply for all inputs and output respectively (even if the input interrogation voltage and output voltage is same) - Power supply unit shall be provided with diode multipliers for input interrogation & output voltage for driving outputs (interposing relays, solenoid valves ,lamps etc.). - DP MCBs shall be provided for each rack of the PLC system . - 20 % spare DP MCB shall be provided in each panel .
1.02	Built-in power supply units	<ul style="list-style-type: none"> - Suitable for the power supply system as specified above. - Following power supply unit shall be provided for following units : <ul style="list-style-type: none"> • Redundant 24 V DC power supply units (with multiplying diodes for powering field instruments (2-wire transmitters). • Separate power supply modules, to be supplied by the Tenderer for each segment of Foundation Field bus system, shall be of Type 132: Non-I.S. power supply intended for feeding a non-I.S. barrier. Output voltage shall be 32 V DC maximum. Power supply module shall have in-built power conditioner. DP MCBs shall be provided for each segment of the Foundation Field bus system. - Redundant regulated power supply unit of proper rating shall be provided for special control module (if any required). <p>Following features shall be provided in the power supply unit mentioned above .</p> <ul style="list-style-type: none"> - Insulation level 2.5 KV for 1 minute. - Protection against surge protection & short circuit - Electronic over current protection with feedback feature. - Thermostat protection against over temperature . - Over voltage protection . - Fuse protection in the input and output circuit.
2.0	Central processor unit	<ul style="list-style-type: none"> - Modular and plug-in type - 32 bit microprocessor based - PLC shall be able to scan and execute all close loops (approx. 40 PID loops) in less than 100 milliseconds and scan digital inputs in 50 milliseconds simultaneously. - Execution time between 1 milliseconds to 3 milliseconds per 1K instruction or better. - Provision to latch desired outputs. - Provided with redundant hot standby CPU (with



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		<p>appropriate communication module).</p> <ul style="list-style-type: none">- The CPU system shall have facility of bumpless transfer in case of failure of one .- CPU shall have crystal clock generator .- Redundant CPUs to have extensive in-scan synchronization. Time synchronization from designated time server- Peer to peer communication through I/O channels shall be possible .- Backup system communication (redundant communication bus) shall be provided.- The processor shall have proper communication modules (for each CPU) for communicating with redundant processor , remote I/O modules and for communicating with other communication bus protocols like ethernet bus / profibus / modbus / controlnet / field foundation bus etc. (no proprietary bus, for any sort of communication including fieldbus, to be used.- The processor shall have in-built provision for software timers , counters , examining input conditions, compare, compute, logical, conversion from/ to BCD, bit manipulation, block memory manipulation, diagnostic, shift, sequencing, conditional jumping, subroutine instructions etc.- CPU shall be capable of handling PID functions including mathematical functions ,weighing and batching functions.- CPU shall be capable of handling 30 % additional (future) I/Os over and above 20 % spares (installed) I/Os indicated in basic configuration diagram. Maximum CPU loading shall be limited to 60 % for the intended applications.- The CPU shall have the facility of initializing a synchronizing pulse to the server periodically (Minimum once in a day).- CPU loading shall not exceed 60% .
3.0	Timers	The timers shall be OFF delay, ON delay ,retentive type timer with a range from few millisecond to few hours .Accuracy shall be +/- 0.1% of the set value .
4.0	Counters	The counters shall be of counter up and counter down type . It shall have the range from 0000-9999 .
5.0	Memory units	<ul style="list-style-type: none">- Modular and plug-in type- Word length 32 bit- Expandable in blocks of 4K Words- Minimum size 20MB .- EPROM/ RAM with battery power back-up- Back-up battery shall be as follows :-<ul style="list-style-type: none">• Rechargeable Ni-Cd batteries with necessary charging circuit / Lithium or any other internationally acceptable type.• Able to retain memory for a minimum of 1 year with no power applied to the controller.
6.0	Input Units	<ul style="list-style-type: none">- High density, modular, rack based (channel based I/O not acceptable) and plug-in type.- Insulation level of 1.5 KV



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			<ul style="list-style-type: none">- Input interrogation voltage 24 V DC.- Individual fuse for each unit shall be provided for protection against cable fault/earth fault .- For critical applications all inputs (analog, digital, others) to have individually isolated channels.
6.1	Digital Modules	Input	<p>Digital input units shall have the following features :-</p> <ul style="list-style-type: none">• 16 / 32 inputs per module.• Time delay of about 10 millisecond to filter out noise and contact bounce .• Optocoupler to galvanically isolate each input device from the decision making logic of the controller• LED status indication• BCD input units suitable for four digit input• Pulse inputs (Incremental encoder / digital tacho)• Absolute / incremental encoder inputs.• High speed counter type inputs• All the cards shall be compatible of receiving digital signals from field sensors and switches directly .• All the control modules / cards shall be lacqured .
6.2	Analog Modules	input	<p>Analog input units shall have the following features:</p> <ul style="list-style-type: none">• Shall be 8 channels, rack based & plug-in type..• Suitable for 4-20 mA / 0-10V DC / RTD / thermocouple / weighing signal inputs.• With necessary A/D converter having at least 12 / 14 bit resolution based on application.• Suitable for J/K/S type thermocouples & for PT100, 2- wire / 3 wire• Galvanically isolated differential inputs with insulation level of 1.5 kV.• For 4 – 20 mA analog inputs, fused TB with blowing fuse shall be provided.• Healthiness of every input shall be monitored & LED indication shall be provided.• Analog module shall have the facility to be configured in voltage or current mode and differential or single ended inputs mode .• Pulse/ frequency input module shall have range upto 50 kHz. For very high frequency applications, the range shall be upto 1 MHz.• All the cards shall be compatible of receiving analog signals from field sensors and switches directly . If not suitable converters shall be provided .
7.0	Output units		<ul style="list-style-type: none">- High density, modular, rack based (channel based I/O not acceptable) and plug-in type.- Insulation level of 1.5 KV- Individual fuse for each unit shall be provided for protection against cable fault/earth fault.- For critical applications all outputs (analog, digital, others) to have individually isolated channels.



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7.1	Digital Output modules	<p>Digital output units shall have the following features:</p> <ul style="list-style-type: none"> • 16 / 32 digital outputs per module . • High Density modular and plug-in type . • Isolated outputs with two separate terminals for each outputs . • Rated for 24 V DC • With insulation level of 1.5 KV • The output module shall be able to drive interposing relays (24V DC coil), solenoids, annunciation lamps, LEDs, Instrumentation control equipments etc. • Power devices like contactors etc. shall be actuated through interposing relays. The interposing relays shall be mounted in the same panel. Proper surge suppressor shall be mounted across the coil of the output relays. However as far as possible interposing relays to be avoided. • Any special requirement e.g position control to control field devices shall be met by using separate interface modules. <p>- BCD output units shall be as follows: -</p> <ul style="list-style-type: none"> • Suitable for four-digit output. • Rated to drive seven segment LED displays • With insulation level of 1.5 KV
7.2	Analog output modules	<p>Analog outputs shall have the following features:</p> <ul style="list-style-type: none"> • Shall be of 4 / 8 analog output channels . • Suitable for 4-20 mA / 0-10V DC / +/-10V DC outputs • With necessary D/A converters having 12 bit resolution • With insulation level of 1.5 KV • Each output shall be galvanically isolated.
8.0	Foundation Field Bus Interface modules (FIM)	<ul style="list-style-type: none"> • The Foundation Field bus interface modules (FIM) of the PLCs shall be chassis based modules. These modules shall completely integrate Foundation Field bus devices with the PLC controller & HMI software. These FIM modules shall deliver system wide integration of data access, control, connections, diagnostics and alarms with the PLC system. LED indication of power, error condition & status shall be provided in each FIM module. • PLC shall provide graphical support to the Field Bus Interface module to perform the functions of Link Active bus scheduler for a network. This will allow the system configuration engineer to see what's going on and shall provide complete flexibility to adjust schedules based upon the needs of the control scheme. PLC shall also support Back-up Link active scheduler. • All Foundation Field bus (FF) devices (to be procured under separate Instrumentation package) shall be



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		<p>registered with the Field bus Foundation at level ITK 4.0 or higher. Field bus interface modules & Field Bus Library manager shall be compatible with ITK 4.0 or higher version compliant devices. Tenderer shall also provide Field bus usage license. All FF devices provided shall be polarity insensitive. All FF cables shall be of Type A.</p> <ul style="list-style-type: none">• The PLC offered shall be certified for the Foundation Field bus Host Inter operability Support Testing (HIST) from Foundation Field bus organisation. HIST procedures provide a common methodology for assessing host inter-operability with registered devices.• PLC Software shall have the capability either to directly read Device description (DD), files from the Field bus devices and add these DDs/ Files to the library for Off-line & On-line configuration, or it shall perform this task through a separate software tool, Field bus library manager. It shall be possible for PLC based automation system to upload field device configuration changes implemented in the field. Once the configuration information is stored in the automation system, it shall be possible to download it to any other similar device, whether a new or replacement device.• In case of a new device added to a Foundation Field bus segment, its presence shall be immediately shown in that segment. Important information about the new device including tag name, address, model and revision shall be immediately available.• Downloading new software to Foundation Field bus devices shall be possible from the PLC. There shall be no need to physically change the firmware and to disconnect or remove devices for updating to the latest available revision. It shall be possible to simultaneously download the latest firmware to multiple field devices.• Each Foundation Field Bus interface module shall support minimum two segments.• The Terminators shall be impedance matching modules to be used at or near each end of a segment. There shall be two terminators per segment. The terminators prevent distortion and signal loss and shall be supplied as a pre- assembled, sealed module. Tenderer shall provide the Terminators as per the requirement.• The power for each Foundation Field bus segment shall be provided through a power conditioner to prevent the communication signal from being attenuated by the power supply & to eliminate cross talk between FF segments through a common power supply.• Power supply modules to be supplied by the Tenderer shall be of Type 132: Non-I.S. power supply intended for feeding a non-I.S. barrier. Output voltage shall be 32 V DC maximum.• For Field bus use, a power supply impedance matching network shall be provided. This shall be a resistive/ inductive network and built into the Field bus power
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		<p>supply module.</p> <ul style="list-style-type: none">• Connectors as coupling devices shall be employed to connect the wire medium to a field bus device or to another section of wire. Standard field bus connectors shall be used. Specification shall be as per annexure A of the ISA physical layer standard and annexure A of the IEC physical layer standard.• Couplers shall be the physical interface between segment and spur or segment and Field bus device. Field bus couplers shall be as specified in the IEC/ ISA physical layer standard and provide one or several points of connection to a field bus segment.• Grounding: The instrument signal conductors shall not be used as a ground. Instrument safety ground shall be made through a separate conductor outside of the signal cable. The conductor may be in the same cable as the instrument signal conductors and shield, but shall be located outside the shield within this cable. Field bus devices shall not connect either conductor of the twisted pair to ground at any point in the network. The Field bus signals are applied & preserved differentially throughout the network. Network cable shield shall be earthed/ grounded in one location only, at the field termination assembly (Host) end. At any field instrument, cable shield shall not be connected to the instrument earth/ ground or chassis. The cable shields from different networks shall not be attached together in a field junction box. This will create ground loop & noise onto the network.• Lightning/ Surge protection: Surge protection shall be provided for all field devices. The surge protection shall consist of low capacitance silicon avalanche diodes or spark gaps, wired for both normal & common mode protection and connected to the electrical safety ground grid. Surge suppressors shall be so selected that they shall not measurably attenuate the FF signal. To avoid any chance of short circuit, surge suppression devices shall be connected through a series fuse. <p>Foundation Field bus Network/ segment naming convention</p> <p>The following recommended network/ segment naming convention shall be followed:</p> <p># NN MM P</p> <ul style="list-style-type: none">• #: Indicates the plant/area number to which the segment shall be connected.• NN: Indicates the node number / controller name.• MM: Indicates model number/ card number.• P: Indicates segment or port number. <p>Loop & Instrument Naming convention :- Loop & Instrument naming convention shall be decided during detail engineering.</p>
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		Spur Naming convention :- All spurs shall be labeled with Instrument tag name.
9.0	Additional features	<ul style="list-style-type: none">- On-line replacement of any module shall be possible in such a way that the removal and addition of any module shall be possible without de-energizing the system. Further there shall not be any interruption in the system while replacing a faulty module except for the inputs / outputs which are being handled by the module.- Fully pre-programmed connection of field devices with input units through ordinary multi-core copper control cables of 1.5 sq. mm size (twisted pair) , upto a length of 500 m.- Communication with computer in distributed hierarchical control system and operator consoles / display units.- High speed communication among PLC and operator consoles/ display units shall be provided through dual redundant TCP/IP Ethernet using ethernet cards (no propriety cards) on HMI station .- Switch to disable all outputs of the controller during start-up / debugging .- All the automation equipment shall be user configurable to a fail-safe state to avoid dangerous situations in case of any failures caused by power failure, communication failure, etc.- Test sockets on input modules for input simulation- Facility to be provided to hook up engineering station at each location of I/O (preferably) .- Serial interface, RS232C and better shall be provided- Any special requirement to control field devices shall be met by using separate interface modules.- The PLC system shall be immune to the following: -<ul style="list-style-type: none">• Radio frequency interference• Electromagnetic interference (EMC compatible)• Power system spikes <p>The methods and standards followed for these features shall be furnished .</p> <ul style="list-style-type: none">- All network cabling to be structured and to be tested and certified.- Network teams from multiple switches to be employed for all the important machines (computers).
10.0	Mounted spares	<ul style="list-style-type: none">- Min of 20 % of I/O modules used (with at least one module of each type) for input and output shall be offered as spare for each programmable controller and the same shall be mounted and wired to the terminal block in the cubicle suitably.- No. of spare Channel per card shall be 20 %.- 20 % spare memory capacity shall be provided- Provision shall be provided with empty slots for future expansion for 20% I/O modules. Minimum 50 % spare memory capacity shall be built in the system after loading of application and system software.



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		<ul style="list-style-type: none">- 01 number each of DI+DO cards per each PLC shall be provided as spare . <p>Spare capacity of the spares mentioned above shall be applicable at the time of handing over of the plant .</p>
11.0	Self diagnostic features	<ul style="list-style-type: none">- Parity errors, cycle errors and under voltage- Failure in central processor unit, memory and power supply.- Indication of type of failure- Automatic turning OFF of all outputs or optionally holding of all outputs in their last state on failure detection.- Fault detection upto card level .- Communication failures – all types- Fuse failure indication for outputs
12.0	Monitoring functions	<ul style="list-style-type: none">- Monitoring of internal voltages- CPU Status monitoring- Memory status monitoring- I/O Status monitoring- Address monitoring- Bus & communication signal monitoring- Broken sensor detection- A milliammeter with selector switch shall be provided on panel front to monitor the earth leakage current.
13.0	Terminations	<ul style="list-style-type: none">- All inputs and output wired up to easily accessible terminal blocks rated for 660V- Screened cables for mA signals from Instrumentation I/O rack and other field sensors to terminal blocks of PLC.- Control cables for contact signals from Instrumentation I/O rack to terminal blocks of PLC.- Suitable for terminating up to 2.5 sq. mm. copper conductor industrial control cables.- Fuse terminals for all input & output signals (with LED indication).- Required test and maintenance equipment to be provided for maintenance and troubleshooting of FO and wireless communication.- Uniform color-coding to be followed for cabling, TB, etc.- As far as possible cross-ferruling to be used for all connections.
14.0	Earthing	<ul style="list-style-type: none">- Separate earthing bus for power / panel earthing and electronic earthing shall be provided. Minimum two numbers of electronic earth pits shall be provided for each set of PLC .- Electronic earthing bus shall be suitably insulated. Earthing requirements / earthing schemes for the equipment supplied shall be clearly indicated in appropriate drawings.
15.0	Constructional features	<ul style="list-style-type: none">- Unitised construction .- Floor mounted, free standing and indoor type.- Bottom cable entry through gland plate.- Sheet steel clad



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		<ul style="list-style-type: none">- Dust and vermin proof- Anti vibration pads to be provided to withstand vibrations as per application.- All modules plug-in type.- Panel illumination with door interlock limit switch.- Switch-socket outlet for maintenance.- Suitable fans & inlet air filters shall be provided at the bottom/ top of each panel for proper air circulation.- Empty slots of the racks shall be provided with dummy cards for protection against dust & damage.- Colour shade outside and inside shall be RAL 7035.- All panels shall be of Rittal make.
16.0	Enclosure	<ul style="list-style-type: none">- Conforming to IP-42 class in PLC room/control room.- Conforming to IP-54 class for remote I/O cubicles located in shops/ bays.- Programmable controllers, even if housed in air-conditioned enclosure, shall be suitable for normal industrial environment and ambient temperature upto 50°C.- Temperature while operating<ul style="list-style-type: none">• Lower limit : 0 degree C• Upper limit : 60 degree C- Temperature while not operating (storage)<ul style="list-style-type: none">• Lower limit : 20 degree C• Upper limit : 75 degree C- Relative humidity<ul style="list-style-type: none">• Daily average 80 to 90% (8 hrs.) and 65 to 90% (16 hrs.)• Maximum 98%, not occurring simultaneously with maximum temperature.
17.0	Data sheet to be furnished by the tenderer	<p>Tenderer shall submit the data sheet of the PLC system . The following informations shall be at least mentioned in the data sheet :</p> <ul style="list-style-type: none">• CPU processing speed• I/O handling capacity• CPU in built communication port• CPU programming memory capacity• Minimum scan time achievable• CPU self and diagnostic features .

03. Human Machine Interface (HMI) Work Station & Engineering Station



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1.0	Type	<ul style="list-style-type: none">- Shall be console type PC based colour graphic Work Station- Commercial grade latest available in the market.- Industrial grade latest available in the market (for installations in the plant bay e.g. on casting platform in MOP)- In addition to the normal workstations, at least two numbers of 42" or higher plasma/LCD display units and one overhead LCD projection system to be provided in each central control room.
2.0	Interfacing card / module required	Proper interfacing card / module with related communication protocol shall be installed in the programming unit so that it can communicate with the network (i.e PLC processor , server , HMI , printers) smoothly
3.0	Programming Facilities	<ul style="list-style-type: none">- Programming unit shall be suitable for developing programs in ladder diagram / block diagram / statement form / SFC.- Programming unit shall have facility for loading the program from CD & DVD .- The programming terminal shall be capable of developing multiple programs offline without connecting to the programmable controller. Upload and download of the program between PLC and program unit shall not require 'compile' before 'download' .- Engineering station shall have an integrated and development and configuration setup for all the drives , instruments , PLC/DCS , HMI etc.
4.0	System Configuration	<ul style="list-style-type: none">- Industrial grade PC with Pentium CPU- 19 " TFT color monitor with 0.28 mm dot pitch 1280 * 1024 resolution- Dual Ethernet interface with LAN accessories for all PC based operator station- 64 bit , 256 MB RAM, 80 GB Hard Disc drive & controller- Combo Drive, Graphics Accelerator Card with minimum 8 MB on board RAM, Keyboards, Track ball / Mouse, Tape / Data backup drive suitable for plugging in USB port.- The computers shall be provided with minimum 3 serial ports & one parallel port, ethernet interface with accessories.
5.0	Functions	<ul style="list-style-type: none">- Error detection and reporting.- Fail safe / broken sensor information and alarm and their reset .- Selection of highest / lowest signal from a group of accepted inputs and displaying the same- Linearisation and other arithmetic calculation. Provision shall be kept for pressure and temperature correction to be computed for flow measuring loops.- Built-in ambient temperature compensation for thermocouple inputs from field.- Trending real time and historical (Trending shall be



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		<p>provided for all analog inputs).</p> <ul style="list-style-type: none"> - Report generation and periodic logging. - Developing of graphic symbol library as per ISA – 5.1 and 5.3. in addition to standard industrial symbols. - Printing of alarm conditions with parameter identification. - Online editing of :- <ul style="list-style-type: none"> • Scan sequence • Identification number • Engineering units • High and low alarm limits • Alarm dead bands • Addition / Deletion signals • Removal / introduction of analog and digital points in scanning.
6.0	Miscellaneous	<ul style="list-style-type: none"> - Networking via Ethernet with Network diagnostic displays - Ability to add optional packages (e.g. for data analysis) - All the important drives should be provided with suitable CBM systems such as vibration monitoring, current signature, temperature etc. Information from CBM systems to be interfaced to HMI system as well as plant-wide CBM system. - All equipment to have extensive diagnostic capability. This information to be used for generation of relevant diagnostic information on working and problems in the system. - Extensive BOM covering all hardware, software, etc. should be provided.
7.0	Printer	Latest appropriate model of HP Laser Printer to get hard copy of the program dump / data logging / alarm logging / event logging / data trending etc.

04. Server :-

1.0	System Configuration	<ul style="list-style-type: none"> - Industrial grade . - Server grade Intel Xeon, Dual CPU (Resultant speed 3.06 GHz) - 4 MB Cache memory. - 512 MB RAM. - 2 X 72 Hot swap SCSI HDD (RAIR level-1 Disc mirroring) . - 1X1.44 MB FDD. - Combo drive - 2 Serial ports, 1 parallel port, 2 USB port (for all client as well server). - Graphic accelerator card with minimum 8 MB onboard RAM) - Dual Network interface. - 19" TFT colour monitor - Keyboard and Mouse. - Operating system Windows 2000/NT.
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2.0	Make	- Servers shall be of COMPAQ/ DELL/ IBM make.
3.0	HMI server	- HMI serves shall be redundant. Separate clustered/ redundant servers to be considered for data servicing. The server to be of latest & proven specification at the time of implementation.
4.0		- Only client-server, multi-tier system to be used. No standalone workstations apart from emergency workstations. Number of operator stations and emergency workstations to be finalized during engineering stage and should have at least two and one hot spare respectively

05. Software :-

1.0	System software (Windows Programming)	<p>The PLC programming software shall be latest, Windows based, menu driven and shall support the following minimum : -</p> <ul style="list-style-type: none">- Cyclic, Time Controlled, Interrupt controls.- Retentive / Non Retentive Timers, Bi- Directional counters, latches, etc.,- Internal Flag generated by the PLC.- All Boolean Logic Functions- Data Transfer, Block Transfer- Sub Routines- Arithmetic functions & formula Calculations- Communication functions with Remote I/O as well as Work stations- Closed loop PID control functions including nested and cascaded loops.- Output of PID controllers shall be 4-20 mA DC.- Control valve position (in 4 – 20 mA) shall be made available in PLC.- PID Controller shall have auto tuning facility- Totalisation of flow inputs.- Linearisation function blocks and other useful function libraries- Linearisation function block shall be such that a table of values (X against Y) can be entered in a menu driven manner and for any particular field input X, the value of Y can be calculated using the values of table by interpolation method. Maximum 30 point linearisation function block shall be considered. Below 30, point of linearisation shall be user selectable.- Built-in ambient temperature compensation for thermocouple inputs from field.- Broken sensor detection etc.- Simulation facility / software shall be supplied for programme testing without disturbing the working PLC .- Minimum no. of PID Control Loops: 40.- The complete PID blocks shall be transferred to HMI work station in place of split bits .- All computer shall have anti – virus software. <p>The Software shall be suitable for PC based Programming Unit .</p>
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2.0	Application Programme software	<ul style="list-style-type: none">- Shall be as per process control requirement.- The application programme software shall be written in Ladder logic / block diagrams / statement form.- Online programme editing facility shall be available.- Troubleshooting manual for all application software, system software, configuration, hardware, network, etc. to be provided, spelling out possible causes, checks and measures for corrective action.
3.0	HMI software	<ul style="list-style-type: none">- Window based, latest version (at the time of implementation) of HMI software.- HMI software package shall have the facility to perform multitasking, data acquisition, supervisory control, monitoring, control development and routine software.- HMI software shall also have the features for alarming, trending, data logging, production backup history, operator action list, creation of shift reports after every shift, online printing of events.- Number of graphic pages shall not be a limit.- HMI software shall have the facility of handling unlimited tags (Digital as well as analog).- HMI software shall be capable of curve fitting, co-relation & regression functions.- In the engineering workstation & servers, development version of HMI software & Foundation Field bus system software (licensed versions) shall be provided.- In the operator workstations, runtime version of HMI software & Foundation field bus system software (licensed versions) shall be provided.
4.0	Database Software	<ul style="list-style-type: none">- ORACLE & DEVELOPER 2000 / As required & supported by the system offered.- All logging (data, event, etc.) of HMI in ORDBMS.
5.0	Operating System	WINDOWS NT / 2000 (Service Pack – Latest at the time of supply)
6.0	Testing	<ul style="list-style-type: none">- All tests on software, hardware, network, communication, etc. shall be carried on the basis of a pre-agreed protocol clearly listing out steps involved in testing with its responsibility and minimum expected results as per specifications, engineering and other documents.- Purchasers' involvement in design of control philosophy development, application software and hardware combined, drawing up of software specifications, software development, off-line testing, etc. for both Level-I and Level-II system.- Provisions to be made for off-line testing of Level-I and Level-II systems prior to actual deployment.
7.0	Miscellaneous	All software required for design, development, testing, reporting-by-exception to be included. Troubleshooting, simulation, etc. should be supplied with requisite number of licenses.

06. Special tools and tackles for maintenance and troubleshooting :



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Test equipments, tools, software, etc. for all relevant hardware and/or software systems/subsystems shall be provided .

Special tools to include tools in sufficient number for tracing, location, testing, jointing, fault location & rectification, termination etc. for all cables including special cables (network and FO cables) in all major units of the expansion projects.

Tenderer shall indicate the list of special tools and tackles .

07. Documentation :

All drawings, designs, configurations, software, numbers, models etc. listed in TS and GTS are indicative and minimum only. Bidder may suggest a better and more comprehensive solution.

08. Standardization :

- Minimum make / type shall be considered to minimize inventory.
- All automation hardware, including that employed in various machines, analyzers etc., from single manufacturer. No more than two models to be used for systems with more than 24 I/Os. Both models to have same programming environment. All the hardware in individual systems should be from the same product series. All the automation hardware shall be interfaced to Ethernet network connecting the systems to HMI.

09. Training :

Training to be provided for at least the following levels:

- Hardware of Automation System (PLC) and its programming & troubleshooting.
- Training on Electro-Hydraulics – Servo, proportional, etc.
- HMI system – configuration, programming & troubleshooting.
- Client-server hardware, architecture, operating system, etc.
- Fieldbus communication – configuration, programming & troubleshooting.
- Networking & communication systems – Relevant toolkits, protocol analyzes, scopes, loggers, etc., for maintenance and troubleshooting, to be included.
- All the training to be conducted by OEM or its authorized training partner at a fully equipped training center with facilities where extensive hands-on exercises can be performed with system, identical to one under supply. Curriculum of each program to be finalized in consultation with client. Required number of trainees (minimum 15) to be covered through multiple programs on each topic. Most of the training to be conducted before use. (number of trainees shall be as per commercial contract)

10. Conference Room Gadgets :

All the shops shall have a conference room in the new welfare building . Following gadgets shall be provided in the conference room by the tenderer :-

- In conference room, ceiling mounted projector with automatic screen and good quality music system, also to be included. Projector and music system also to be interfaced thru AV switching unit to all the computers in the room.

1.02.16 Large Screen Display System :-

Large screen display screen system shall be provided in the control room of the plant . The display system shall have linear setup in the control room .

The display system shall consist of a matrix of rear projection modules for high overall resolution, a controller unit based on either MS-Windows or Linux , and optional wall management software. Rear projection modules shall have DLP (Digital Light Processing) technology .

The system shall have following features :-

- High resolution to show large applications with several video or RGB sources.
- The system shall not be susceptible to environmental factors like heat, humidity, or vibration, which can cause an image to degrade over time The system shall be zero hassle and minimal maintenance. All components are carefully chosen to provide high mean time between failure and minimal mean time to repair.
- The system shall have excellent module to module color uniformity.
- The system shall have high contrast image.
- Modular Design

The system shall be able to deliver a highly reliable and superior quality image display to the operator. The displays can be seamlessly integrated into any center. The modular concept shall also be applied within each module. System shall have separate fan- module, projection unit and illumination unit so that maintenance from the rear of the system is very easy. Filter and lamps can be replaced from the outside.

- Image optimization
- Builtin redundancy with hot standby configuration
- On screen menus

Size of the display system shall be 5m (length) x 3 m (width) . Distance from the screen to operator shall be minimum 5 metres . The cube configuration shall be considered based on the above size of the screen . The display unit shall have following features :

- Full viewing angle : 180 degrees .
- Half gain angle(Horz. / vertical) : 35 deg. / 35 deg.
- Seam size screen : less than 0.2 mm
- Aspect ratio : 4 : 3

Operating condition :

- Humidity : upto 90 % non condensing
- Temperature : upto 50 deg. C.
- Optical dimming with dynamic feedback : Yes
- Power supply :- 240 V AC , 50 Hz.
- EBU Colour triangle



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- Inputs : Shall have all options of multi input module: DVI-D, DVI-I, Multi Sync RGB input (VGA upto UXGA), Video Input (PAL, NTSC, SECAM)

Projection unit shall have : -

- Single chip DLP technology .
- High resolution
- High contrast .
- Ergonomic luminance
- Integrated optical dimmer

1.02.17. UNINTERRUPTED POWER SUPPLY

1.0 Basic particulars for design :-	
(i)	Input Voltage 415 V AC +10% & -15%, 3-Phase ,4 wire, grounded neutral system with a symmetrical fault level of 50 KA for 1 sec .
(ii)	Input Frequency 50 Hz. +/- 6%
(iii)	Output Voltage 240 V AC , 1-Phase / 415 V AC , 3-Phase
(iv)	Output Voltage tolerance +/- 1%
(v)	Output Frequency 50 Hz. +/- 0.1% Internal clock synchronism shall be provided .
(vi)	Output Voltage wave form Sine wave
(vii)	Harmonic Distortion Less than 3% for individual harmonics Less than 5% for total harmonics distortion
(viii)	Voltage Distortion Less than 3% for 100% linear loads Less than 5% for nonlinear loads
(ix)	Phase Displacement 120 deg. +/- 1deg. for balanced load 120 deg. +/- 3deg. for unbalanced load
(x)	Transient recovery Shall return to steady state condition in less than 100 msec . after a disturbance
(xi)	Maximum ambient 50 deg.C
2.0 Basic details	
(i)	Duty type True online continuous
(ii)	Reference standard Features and performance in line with IEEE 446
(iii)	Overload 125% of the rated output for 10 minutes 150% of the rated output for 30 sec
(iv)	Configuration With isolating transformer, rectifier, inverter unit and necessary DC batteries
(v)	Power device Inverter power circuit shall comprise of IGBT using PWM control technique
(vi)	Redundancy The system shall be of dual redundancy type in hot standby mode
(vii)	Static bypass Automatic static bypass and common DC battery bank . The load shall normally be fed from the inverter.



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		In addition to static bypass switch , a manual changeover switch (MCCB) of adequate rating shall be provided to supply the load directly (bypassing the rectifier/charger, inverter, and static transfer switch) from the mains instead of through the UPS system .
(viii)	Maintenance bypass	Maintenance bypass shall be provided in parallel to the static bypass line with an isolation device . The contacts of the isolation device shall be of "make before break' type .
(ix)	Battery bank	<ul style="list-style-type: none">• Sealed maintenance free (SMF) batteries shall be provided for the battery bank .• The batteries shall be housed in a separate battery cabinet located adjacent to the UPS panel.• The battery power pack shall include SMF battery housed in a separate cabinet . Battery cells shall be mounted on slide-out trays for ease of maintenance.• A battery disconnect circuit breaker with undervoltage release (UVR) shall be included for isolation of the battery pack from the UPS module.• The UPS shall automatically be disconnected from the battery by opening the breaker when the battery reaches the minimum discharge voltage level.• Casters and leveling feet shall also be provided with the battery power pack cabinet for ease of installation.• The battery bank shall be installed in separate panel beside the UPS panel in the airconditioned environment located in the control room itself .
(x)	Battery backup	Battery shall be suitable to maintain the power supply for at least 30 minutes (throughout the total duration) in the event of mains failure with rated capacity of the UPS at full load
(xi)	Battery management system	UPS shall have latest 'Battery Management System' to charge / discharge the entire battery automatically
(xii)	UPS management	UPS shall have latest 'UPS Management System' to load / unload the UPS automatically .
(xiii)	AC DB	Necessary distribution board for distribution of power from UPS output to individual consumers
(xiv)	Loading capability	UPS shall be capable of taking 100 % non linear loads
(xv)	Interchangeability of sub assemblies	The UPS shall be constructed of replaceable subassemblies. PCB's shall be plug-in type . Like assemblies and like components shall be interchangeable
(xvi)	Noise level	Maximum noise level shall be less than 60 dB at a distance of 1 m from the body of the UPS



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(xvii)	Efficiency	The efficiency values of UPS under 50% unbalanced load & 100 % linear loads shall be as near as possible to normal efficiency
(xviii)	Isolation transformer	The isolation transformer shall be of dry type and shall be provided on both input side , output side and static bypass side of the UPS
(xix)	Grounding	<ul style="list-style-type: none">• The AC output neutral shall be electrically isolated from the UPS chassis.• The UPS chassis shall have an equipment ground terminal. Provisions for local bonding shall be provided.• Component mounted doors shall be seperately earthed through 2.5 sq.mm PVC insulated green/green-yellow color flexible copper wire .
(xx)	Communication port	The UPS shall have inbuilt RS 485 port for display of online status of UPS on HMI .
3.0	Rectifier	<ul style="list-style-type: none">• Dual rectifier with each unit rated for supplying both inverter load and battery charger load in different modes.• Rectifier unit shall consist of minimum six pulse bridge connection .• Active front end rectifier set to reduce the harmonic distortion .• With necessary smoothing reactor and filters• Automatic boost and float charging control.• Equalizing mode for compensating the charge lost by the battery after a discharge automatic changeover from equalizing mode to float mode and vice-versa .
4.0	Protective features	<ul style="list-style-type: none">• Maximum current limiting .• Automatic reduction of current limit in the event of cooling fan failure .• Boost charging and float charging current limiting• Surge suppressor in output side of the UPS .
5.0	Inverter	<ul style="list-style-type: none">• With input circuit consisting of battery contactor, battery filter and smoothing reactor .• DC/AC converter for voltage control .• Inverter proper and control electronics .• Series reactor and parallel filter .• Output transformer
6.0	Protection	<ul style="list-style-type: none">• Abnormal output voltage (over voltage & under voltage) .• Abnormal link voltage .• Over current on output .• Over current on input or commutating failure .• Low battery voltage .• High transformer temperature .• Auxiliary supply failure .• Fan failure• Logic failure• Clock failure



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		<ul style="list-style-type: none">• Fast acting HRC fuse for inverter circuit and control circuit• Reverse power protection for parallel inverters .
7.0	Static by-pass switch	<ul style="list-style-type: none">• Static switch automatically switches the load to the reserve power supply for the mains whenever there is failure in inverter supply to the load .• Fast acting inverter contactor shall connect the inverter output to the load.• High speed fuses shall be provided for protecting the thyristor against accidental overload.
8.0	Indicating meters to be provided on the ACDB panel	<ul style="list-style-type: none">• Input voltmeter with selector switches .• Input ammeter with selector switches• DC voltmeter with selector switches• Centre zero type DC ammeter for measurement of charging/discharging current from the battery . <p>Digital type meters shall be provided for the following :</p> <ul style="list-style-type: none">• AC output voltmeter with selector switch• Separate frequency meter to see Input and Output frequency .• AC output ammeter with selector switch• AC voltmeter with selector switch for bypass circuit .• AC ammeter with selector switch for bypass circuit .• Frequency meter for bypass circuit .
9.0	MIMIC on UPS panels	<ul style="list-style-type: none">• MIMIC of the system power flow diagram as single-line diagram of the UPS shall be provided on UPS panels front door with long-life LED's integrated within the single line diagram to indicate the operating status of different components/sections of the UPS.
10.0	Display and Operating system	<ul style="list-style-type: none">• The UPS shall be provided with a microprocessor based keypad and display unit mounted on UPS panels front door for operating and viewing the UPS status for convenient and reliable user operation .• The monitoring functions such as metering, status and alarms shall be displayed on an alphanumeric LCD display. <p>Additional features of the monitoring system shall include:</p> <ul style="list-style-type: none">• Menu-driven display with text format• Real time clock (time and date)• Alarm history with time and date stamp (minimum upto 16 faults in memory with FIFO sequence)• Battery back-up memory / condenser charged back up memory .



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11	Metering	<p>The following parameters shall be displayed:</p> <ul style="list-style-type: none">• Input AC voltage line-to-line and line-to-neutral for each phase .• Input AC current for each phase• Input frequency• Battery voltage status• Battery charge/discharge current• Output AC voltage• Output AC current• Output frequency• Percent of rated load being supplied by the UPS• Battery time left during battery operation .
12	Alarm Messages	<ul style="list-style-type: none">• Input power out of tolerance• Input phase rotation incorrect• Incorrect input frequency• Charger in reduced current mode• Battery charger problem• Battery failed test• Low battery voltage warning or blown battery fuse• High battery voltage• DC bus overvoltage• Bypass frequency out of range• Load transferred to bypass• Excessive retransfers attempted• Static switch failure• UPS output not synchronized to input power• Input power single phased• Input voltage sensor failed• Inverter leg overcurrent in X-phase• Output undervoltage• Output overvoltage• Output overcurrent• System output overloaded• Load transferred to bypass due to overload• Fan failure• Overtemperature shutdown• An audible alarm shall be provided and activated by any of the above alarm conditions.
13	Status Messages	<ul style="list-style-type: none">• Normal operation• Load on maintenance bypass• Load on UPS• Load on static bypass• System shutdown• UPS on battery
14	Controls	<ul style="list-style-type: none">• UPS start-up / shutdown shall be done by push button / rotary control switch• Normal operation / bypass operations shall be done by a single rotary control switch.• An advisory display and menu-driven user prompts writeup sticker (pasted inside the



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		<p>panel door) shall be provided to guide the operator through system operation without the use of additional manuals.</p> <ul style="list-style-type: none">• Pushbuttons shall be provided to display the status of the UPS and to test and reset visual and audible alarms.
15.0	Constructional features	<p>The UPS system shall consist of a dedicated ACDB panel consisting of Incoming and Outgoing terminal blocks, MCCB's, power and auxiliary contactors, isolation transformers.</p>
(i)	Isolation devices	<ul style="list-style-type: none">• MCCB (upto 630A) in incoming side• TPN/SPN MCB (of adequate rating) in outgoing side.• Power circuit isolation device to have pad locking in the OFF position with the door closed
(ii)	Installation	<ul style="list-style-type: none">• Metal clad , indoor installation
(iii)	Mounting	<ul style="list-style-type: none">• Floor mounting with base channel of ISMC-75
(iv)	Enclosure protection	<ul style="list-style-type: none">• Totally enclosed dust and vermin proof.• IP - 42
(v)	UPS housing	<ul style="list-style-type: none">• Each UPS system shall be housed in a separate cubicle, complete with an individual front and back access door with concealed type hinges.• For UPS panel all the switches, indication lamps and meters shall be flush mounted on the respective compartment door.• For ACDB panel the input MCCB's and output MCB's shall be operated from outside the panel door .
(vi)	Back access	<ul style="list-style-type: none">• Each panel shall have a door on back side . All the doors shall have neoprene gasket .• Natural rubber gasket shall be provided between adjacent panel doors and removal covers .
(vii)	Lifting hooks	<ul style="list-style-type: none">• Lifting hooks for each panel shall be provided
(viii)	Designation plate for UPS	<p>Inscription plate for each panel :-</p> <ul style="list-style-type: none">• Name plate shall be provided at top centre of the UPS panel .• Name plates will be of Anodised Aluminium with white letters engraved on black background and in English language.• Letter height for UPS designation plate shall be in the range of 25-50 mm .• Individual components shall be identified with identification plate and shall match with the identification tags mentioned in the drawing .• Danger board shall be provided on front and rear side of the UPS both in Hindi , English languages.
(ix)	Thickness of sheet steel (CRCA)	<ul style="list-style-type: none">• Load bearing members : 2.0 mm• Non load bearing member : 1.6 mm



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(x)	Door earthing	<ul style="list-style-type: none">• Hinged door at front and back with flexible earthing connection .
(xi)	Cable entry	<ul style="list-style-type: none">• Incomer :- Bottom cable entry• Outgoing :- Bottom cable entry
(xii)	Gland plates	<ul style="list-style-type: none">• Undrilled removable bottom gland plates (3 mm thick)
(xiii)	Output power indication	<ul style="list-style-type: none">• Auxiliary contactors shall be provided in output side of the UPS for potential free contacts for indication of UPS and non UPS power supply at different location .• Proper transducers shall be provided for voltage and frequency indication at different locations .
(xiv)	Cooling of panels	<ul style="list-style-type: none">• Panels shall have fan installed vertically at top for forced air draft and louvers with screen protection in bottom .• Fans shall be powered from input supply of the UPS . Low velocity fans shall be used to minimize audible noise output .• The thermal design, along with all thermal and ambient sensors, shall be coordinated with the protective devices before excessive component or internal cabinet temperatures are exceeded.• The UPS shall be installed in air conditioned environment.
(xv)	Bolts , nuts & cable glands	<ul style="list-style-type: none">• All bolts and nuts for terminations shall be cadmium coated .• Double compression cable glands for receiving external power & control cables.• Compartment door interlocked with the isolating device for safety with provision for defeating it by authorised person
(xvi)	Indicating lamps	<ul style="list-style-type: none">• All indicating lamps shall be of LED cluster high density type.
(xvii)	Finish	<ul style="list-style-type: none">• Interior and exterior :- RAL 7035
(xviii)	Terminal block	<ul style="list-style-type: none">• Terminal block for incoming cable shall be located in back side and outgoing cables shall be in front side of the ACDB panel .• All incoming terminal blocks shall be fully insulated for the working voltage.• The terminal blocks shall be sleeved color coded Red , Yellow , Blue , Black for R,Y,B,N respectively using heat shrinkable PVC sleeve .• All outgoing terminal blocks shall be sleeved color coded Red and Black for line and phase respectively using heat shrinkable PVC sleeve .• Colour coding shall be provided for TB's and wires for different voltages level .• All the terminal blocks shall be shrouded .• Not more than two connections shall be made at one terminal.• Terminal blocks shall be suitable to connect



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		<p>two cores of minimum 2.5 sq.mm .</p> <ul style="list-style-type: none">• There shall be 20 % spare terminal blocks
(xix)	Minimum air clearance for bare busbars .	<ul style="list-style-type: none">• Phase to phase :- 25.4 mm• Phase to earth :- 19.0 mm
(xx)	Output power bus	<ul style="list-style-type: none">• The solid output power bus shall be of bare copper with a minimum rating of 100 A at 240 V AC (1 pair).
(xxi)	Earth bus	<ul style="list-style-type: none">• The main earth bus shall be of 50 x10 mm GI with extension at both ends of switchboard for connection to safety grounding network . Earth busbar shall run continuous throughout the UPS panel at bottom .
(xxii)	Panel internal wiring	<p>The panel internal wiring shall be carried out by 1100 V grade , single core , black color PVC insulated , stranded copper wire of following size</p> <ul style="list-style-type: none">• Current transformer circuit :- 4.0 sq.mm• Control and potential circuit :- 2.5 sq.mm• Identification of wire shall be numbered by plastic/ ceramic ferrules.• Ferrules shall be self locking type.
(xxiii)	Incoming Feeders	<ul style="list-style-type: none">• 3 pole MCCB.• Ammeter with 4-position selector switch (three phases & OFF)• Voltmeter with 4-position selector switch and fuses (three line-line & OFF)• Current transformers (for metering)• 3 nos. indicating LED type lamps (R, Y, B)• 3 nos. indicating LED type lamps (CB ON-Red , CB OFF- Green, CB TRIP - Amber)• Following protections are required for the MCCB controlled<ul style="list-style-type: none">▪ Incomers :-<ul style="list-style-type: none">- Overcurrent releases .- Short circuit .- Earth fault .
(xiv)	Outgoing Feeders	<ul style="list-style-type: none">• Each outgoing feeder shall have followings:-• Outgoing feeders shall have SPN MCB• MCB of 09 kA rating with Thermo-magnetic releases .
(xv)	Testing	<ul style="list-style-type: none">• All routine tests shall be as per IS-8623 (Part-II) 1993• Type test certificate shall be submitted.
(xiv)	Documentation	<ul style="list-style-type: none">• Operation & maintenance manual• Wiring diagram (internal panel showing individual components and flow of wires .



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1.02.18 Electronic Weighing System

This section covers electrics for belt weigh feeders, loss in weigh feeders, load cell based bunker level measuring system & belt weigh scales.

- 1.1 Microprocessor based Individual Weighing Controller (IWCs) with digital display and keyboards – for Belt weigh feeders/ Loss in weigh feeders
- 1.2 VFD drive for speed control of AC motors of belt weigh feeders with necessary switchgears, incoming choke, output reactors if required, protective devices, communication links with IWC, input/output for remote start/stop, interlocking, indication lamps, controls, metering, potential free contacts for remote status indication like ON/OFF/TRIP/ converter fault (to be wired to PLCs), motor protective devices at field etc. Technical features of VFD drive shall be as per General specification for electrical system(GS-03).
- 1.3 Individual Belt Weigh feeder panels housing IWC (Intelligent weighing controllers) controller & VFD drive, DOL starters for vibrating hoppers interlocked with belt weigh feeders.
- 1.4 Microprocessor based Bin weight measuring panels with digital display and keyboards with auto taring and auto calibration facility. Bin Measurement panels housing IWC controller (IWC Controllers for mote than one Bin can be combined in one panel.
- 1.5 Beltweigh scale panels (if any as per Mechanical scope) housing microprocessor based measuring indicator with digital display and keyboards with auto taring and auto calibration facility.
- 1.6 Provisions for Communication with PLC / DCS .

Belt Weight feeder IWC, Bin weigh measuring controller & Belt Weigh Scale IWC shall be able to communicate 100% with purchaser's PLC/DCS on the plant communication bus as selected (like Profibus DP) by Tenderer.
- 1.7 Load cells, techogenerators, field junction boxes, limit switches etc. for Belt weigh feeders, Bin level measuring systems, Belt weigh scales (if any).
- 1.8 Common local control station for Belt weigh feeders & Vibrating hoppers (as applicable) housing Local /Off/Auto selector switches, Start/stop push buttons, speed increase/decrease, TPH indicators etc.
- 1.9 Local Indicator panels for Bin weighing control & Belt weigh scales (if any)
- 1.10 LT AC motors for belt weigh feeders & vibrating hoppers.
- 1.11 Calibration weights for belt weigh feeders.
- 1.12 Supply of dummy load cells for various Bunkers (BLMS system)
- 1.13 Features for Belt slip detection in case of weigh feeders, like tail end tacho or other suitable measures shall be provided by Tenderer.



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2.1 DESIGN BASIS FOR BELT WEIGH FEEDER/LOSS IN WEIGH FEEDER

The weighing system shall be designed, manufactured, assembled and tested in accordance with relevant OIML/NTEP Standard . Equipment shall comply with statutory requirement of Weights & Measures Deptt. Govt. of Chhatisgarh and Govt. of India . The equipment shall be of proven designed, imported and reputed make.

The consistency of the feed rate shall be guaranteed within +/- 0.5% of the set value within the operating range of 10% to 100% of rated capacity.

The weighing control shall be totally automatic with close loop control. The feed rates of different materials shall be calculated by the computer and set points of Belt weigh feeder shall be set by the computer through PLC. In case of computer failure manual setting (remote manual) and operation of feeders shall be possible.

Load cell shall be globally reputed make, confirming to OIML/NTEP Standard and preferably digital type, side mounted and easily replaceable type.

Weighing system shall be mounted in the horizontal portion of the conveyor with multi idler/weigh carriage system.

Equipments shall be provided with anti sway, anti sagging and anti slip devices.

Auto zero track, annunciation and diagnostic facility shall be provided.

Surge, radiation, EMF & RF protection devices shall be provided.

Test weights for different range of calibration should be provided with each equipment.

Redundant electronics shall be provided.

Special tools & tackles shall be provided with the equipment. Such as HBM/Molen load cell calibrator – 2 nos., Portable think Pad based software programmer – 2 nos. Universal Source HP/Fluke – 2 nos. High precision Digital Multimeter minimum 4 ½ digit Philips/ HF/Fluke 2 nos. Professional Toolkit RS – 2 nos. Guard, Triple output DC Power supply make ISO Tech – 2 nos. WMD1 Multi Digital Power Unit with Soldering Station, make Weller – 2 nos. USB to 2xPS/2 Converter alongwith USB IrDA Infrared Adaptor – 2 nos.

Two years maintenance spares shall be included.

Compress air and high pressure water injection facilities to be provided for cleaning of weighing area.

Training on maintenance aspect is required for Inst. & Weighment personnel.

2.2 CONTROLLER PANELS OF BELT WEIGH FEEDERS/LOSS IN WEIGH FEEDER PANEL

The IWCs for control of Belt weigh feeders/ LIWs shall be microprocessor based having automatic weighing and calibration facilities. The system shall be complete with protection against overloading. Accuracy of Belt weigh feeders shall be +/-0.5% or better of preset feed rate.

It shall be possible to operate the Belt weigh feeders under the following modes:

Local - Volumetric
Local - Gravimetric
Remote - Gravimetric (remote manual/PLC automatic)

Under remote mode of operation, following control shall be possible.

Remote - From IWC panel
Remote- From HMI station at individual shop control room.



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Microprocessor shall be provided with each IWC as per standard design/ system requirement. IWC shall generate signal for material feed rate in t/hours. The IWC shall compare the actual feed rate with the set point feed rate and generate a suitable correction for the VVVF converter of belt drive. The signal shall change the belt speed and accordingly provide the desired feed rate. It will be complete with auto calibration, auto tare, auto belt slip/ drift monitoring facilities etc. The stored values after calibration shall not change due to power failure.

Belt Weigh feeder panel housing above IWC & VFD drive shall also be provided with following control equipment /facilities.

- Main incoming MPCB/MCCB (50kA) for incoming power supply
- Control transformer (415/110V) with MPCB (50kA) at primary, MCBs at secondary.
- MPCB, Power contactor (min. 25A), thermal overload relay, necessary auxiliary contactors, ON/OFF/TRIP indication lamps for each motor of bin vibrating hoppers.
- Necessary Power supply units, conversion equipment.
- DP MCBs for incoming UPS power supply and its distribution to all panels.
- Panel illumination lamps (fluorescent tubular).
- Start/stop push button, selector switches as required.
- Power ON indication.
- Power and control terminals.

The IWC shall have following features (minimum)

- Actual flow rate indicator.
- Set rate feed indicator.
- Totalised amount indicator.
- Belt load indicator.
- Belt speed indicator.
- Deviation indicator.
- Fault messages (separate lamps).
- Operational mode selector switch for gravimetric/volumetric/calibration/ Automatic and Constringency mode selection.
- Auto taring & calibration.
- Load cell/Tacho filter time
- No motion alarm set.
- Material starvation signal
- Load sensor break
- Material over/under load alarm
- Gravimetric / volumetric deviation alarm
- Proportional band, Integral time, Derivative time (for Gravimetric / volumetric mode) for PID.
- Tantalizer value
- Tare value
- Load electrical value
- Speed electrical value

Following displays and messages shall be possible for all the operating and calibrating functions:

- Set point.
- Normal/Maintenance/Calibration modes.
- Actual feed rate.
- Belt load (Platform load).
- Belt speed.



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- Totaliser value.
- Deviation error between set and actual feed rate.
- Service data such as measured value, controller output, control signal level etc.
- Event messages/fault messages.

The above shall be available on each IWC on digital display unit in central control room. Display and messages listed above shall also be made available on VDU of PLC/DCS.

Panel Construction features.

- Floor mounted, free standing.
- Dust and vermin proof.
- CRCA sheet steel clad.
- Minimum 2.0 mm thick for panels.
- Suitable to withstand vibrations to be encountered in steel plant applications.
- Cubicles with illumination lamps door switches, space heaters and adequate sockets for soldering.
- All control blocks plug-in-type with necessary test sockets.
- Units shall be self contained and serviceable.
- Power wiring-Min 2.5 sq.mm. Cu
- Control wiring – Min 1.5 sq.mm. Cu
- The panel door shall be provided with toughened glass in front of controllers for viewing of display units without opening the panel door. All control devices and indicators shall be mounted on the front. Two numbers earthing studs shall be provided with the panel for external earthing. All power, control, and signal terminals of different voltages shall be segregated. 20% spare terminals shall be provided in the panel.

3.1 BIN/WEIGH HOPPER LOAD CELLS AND LEVEL MEASURING SYSTEM:

Design Basis for Bin Level Measuring System

Equipment shall comply with statutory requirement of Weights & Measures Deptt. of Govt. of India. Load cell shall be of globally reputed make, confirming to OIML/NTEP Standard & preferably digital type. Load cell shall be easily replaceable type, provided with safety devices from impact load, vibration and lifting arrangement facility. Lightning & Surge protection devices shall be provided in load cells, JB's, electronics & main electrical power supply.

Load cells shall be of high precision strain gauge type, hermetically sealed, robust in design, shock proof and insensitive to overload, temperature, vibration, electrical noise etc. Enclosure class shall be IP 67 / IP 68 .

Load cell shall be provided with ambient temperature compensating device upto 55 deg. C. Provision shall be kept to neutralise the error caused due to application of transverse forces.

Max. Measurement error permitted is +/- 1%

Weighing system shall be auto zero & auto calibration facilities.

Test weight for calibration shall be provided.

The weighing system shall be hooked up with customer host computer and shall support remote monitoring on BSP's Existing Plant Wide Network.

3.2 CONTROL PANEL FOR BIN LEVEL MEASUREMENT (BLM)HOUSING IWC

Bin level measurement system shall be microprocessor based having automatic weighing, taring and necessary calibration facilities. The system shall be complete with protection against overloading. Accuracy of weighing +/-0.1% or better.



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The controller shall have digital display and keyboards, indication, alarm, annunciation etc. It will be complete with auto calibration, auto tare facilities etc. The stored values after calibration shall not change due to power failure.

The controller shall be complete with built in power supply unit, CPU, program memory, A/D & D/A converters, etc. The above will be of modular design using standard PCBs and connectors.

It should communicate actual weight/level, conditions for bin empty, level low, level high etc to Automation system.

One no. large display unit for outdoor display shall be provided.

Compress air and high pressure water injection facilities to be provided in weighing area.

4.1 BELT WEIGH SCALES

The IWPs for control of belt weigh scales shall be microprocessor based having automatic weighing and necessary calibration facilities. The system shall be complete with protection against overloading. Accuracy of belt weigh scale shall be $\pm 0.25\%$ or better of flow rate.

Microprocessor as per standard design/ system requirement shall be provided each IWC. Microprocessor shall multiply load cells and conveyor speed signal in digital form to generate signal for material conveying rate in T/Hours. It will be complete with auto calibration, auto tare etc. The stored values after calibration shall not change due to power failure.

The following displays and messages shall be available for all the operating and calibrating functions:

Conveying rate in TPH.

Belt load (Platform load)

Belt speed.

Totaliser value.

Service data such as measured value, controller output, control signal level etc.

Event messages/fault messages.

Auto taring & Error corrections.

The above shall be available on each IWC on digital display unit. Display and messages listed above will be made available on VDU of in central control room.

Panel Constructional feature

Shall be same as for Weigh feeder panels.

5.0 DIGITAL TECHGENERATORS

It will be of robust construction and designed to give guaranteed accuracy of feed rate. It shall generate consistent output pulses of positive or negative polarity as applicable by accepting shaft rotation. The output pulses shall be suitable for feeding into high impedance electronic circuit/instrument for digital measurement and control. The enclosure class shall be IP 67. It will be provided with ambient temperature compensating device.

Arrangement of mounting of techogenerators and its coupling with AC motor shall be decided considering ease of maintenance.

6.0 LOCAL CONTROL BOX (LCB) FOR BELT WEIGH FEEDERS/LOSS IN WEIGH FEEDER & LOCAL INDICATION BOXES FOR BLMS & BELT WEIGHERS.

Each belt weigh feeder/Loss in weigh feeder shall be supplied with a local box with following features.

- Sheet steel (2.0mm thick) construction.
- Wall/ structure mounted type.
- Hinged door, dead front type.
- Enclosure class IP-55.
- To be painted as per standard procedure agreed.
- Internal wiring with 1.5 sq.mm copper conductor.
- The box shall be wall/structure mounted type and be complete with cable glands and lugs.

The LCB shall be provided with the following :

- Local – Off – Remote selector switch.
- Start/Stop push buttons
- Emergency stop push button (press to lock turn to release type)
- Increase/decrease PB for speed setting
- Feed rate actual (TPH meter – digital type).
- Start/stop push button for bin vibrator
- Indication lamps.
- Any other device required for satisfactory operation of BWFs to be decided during detailed engineering.

Each local indication box for BLMS/Weigh Scales shall have digital indication of Bunker level/feed rate.

7.0 LOAD CELLS

- Load cell shall be imported reputed make as per OIML / NTEP standards with surge protection.
- Compression type suitable for weigh hoppers and material presence detectors on charging conveyor.
- Enclosure class IP 67 / IP68
- Hermetically sealed, stainless steel precision strain gauge / digital type.
- Maximum usable load: 200%
- Destruction load: >500%
- 300% over load capacity.
- Suitable for maximum 70°C.
- Temperature compensation range: - 40°C to 70°C
- Capacity of the Load cell for BLMS system shall be as per details given under mechanical part. However, final rating of load cells shall have safety margin of minimum 150% of the rating calculated.
- Load cell accuracy 0.04%
- Combined error: $\pm 0.03\%$
- Excitation: 10 to 50 V dc
- Zero balance: $\pm 1\%$ of R.O.
- Insulation resistance: >5000M Ω
- Complete with excitation source, transmitter, amplifier, junction boxes, special cables, etc.

1.02.19 CABLES :

1. HT Cables
 - (i) 11 kV (UE) XLPE cables



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Sl.No.	Parameter	Description
1.0	Voltage Grade	11 kV (UE)
2.0	Duty type	Heavy duty
3.0	No. of cores	3 cores
4.0	Reference standard	IS:8130 – 1984 IS:5831 – 1984 IS:3975 -1988 IS:1554, part - 1, 1988 IS:3961 (Part-II) - 1967. IS:7098 Part-I & II IEC-60502
5.0	Conductor type	Compact circular stranded (rm/V) aluminum conductor, with conductor screening of extruded semi conducting material . Conductor construction class-2 as per IS 8130-1984.
6.0	Insulation type	XLPE insulated and insulation provided with shielding of extruded semi conducting compound over individual core followed by lapped semi conducting material and copper tape (non magnetic) metallic screen , cores stranded together with a holding tape provided with a common covering of extruded inner sheath of type ST2 compound . Thickness of the insulation shall be 5.5 mm for size 3x185 sq.mm as per table-2 IS 7098 (part-II) 1985.
7.0	Armour	Galvanized steel wire armoured . For multi core cables , armoring shall be applied over the inner sheath by flat steel wires strips(formed wire). Round steel wire armoring can also be offered. For single core armoured cables non-magnetic armour consisting of hard drawn flat or round aluminium wires shall be provided.
8.0	Outer sheath	Overall PVC outer sheath of type ST-2 compound as per IS 5831/1984. Outer sheath should be applied with extrusion only cables to be ISI marked. Thickness of the outer sheath shall not be less than 3.6 mm for size 3x185 sq.mm as per table –5 of IS:7098)part-II)/1985 & IS:10462 (part-I)/1983). The sheath shall be black in colour . Suitable chemicals shall be added into the PVC compound of the outer sheath to protect the cable against rodent and termite attack.
9.0	Miscellaneous	Copper screen shall be suitable to carry 1 KA E/F current for one second.
10.0	Temp. rise on continuous load	90 deg.C
11.0	Oxygen index of outer sheath material for XLPE Cable	Shall not be less than 29 at 27 ± 2 deg. C.
12.0	Temperature index	Not below 250°C.
13.0	Max. conductor withstand temperature during short circuit.	250°C

(i) 6.6 kV (UE) XLPE cables



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Sl.No.	Parameter	Description
1.0	Voltage Grade	6.6 kV (UE).
2.0	Duty type	Heavy duty
3.0	No. of cores	3 cores
4.0	Reference standard	IS:8130 – 1984 IS:5831 – 1984 IS:3975 -1988 IS:1554, part - 1, 1988 IS:3961 (Part-II) - 1967. IS:7098 Part-I & II IEC-60502
5.0	Conductor type	Compact circular stranded (rm/V) aluminum conductor, with conductor screening of extruded semi conducting material . Conductor construction class-2 as per IS 8130-1984.
6.0	Insulation type	XLPE insulated and insulation provided with shielding of extruded semi conducting compound over individual core followed by lapped semi conducting material and copper tape (non magnetic) metallic screen , cores stranded together with a holding tape provided with a common covering of extruded inner sheath of type ST2 compound . Thickness of the insulation shall be 5.5 mm for size 3x185 sq.mm as per table-2 IS 7098 (part-II) 1985.
7.0	Armour	Galvanized steel wire armoured . For multi core cables , armouring shall be applied over the inner sheath by flat steel wires strips(formed wire) . Round steel wire armouring can also be offered. For single core armoured cables non-magnetic armour consisting of hard drawn flat or round aluminium wires shall be provided.
8.0	Outer sheath	Overall PVC outer sheath of type ST-2 compound as per IS 5831/1984. Outer sheath should be applied with extrusion only cables to be ISI marked. Thickness of the outer sheath shall not be less than 3.6 mm for size 3x185 sq.mm as per table –5 of IS:7098)part-II)/1985 & IS:10462 (part-I)/1983). The sheath shall be black in colour . Suitable chemicals shall be added into the PVC compound of the outer sheath to protect the cable against rodent and termite attack.
9.0	Miscellaneous	Copper screen shall be suitable to carry 1 KA E/F current for one second.
10.0	Temp. rise on continuous load	90 deg.C
11.0	Oxygen index of outer sheath material for XLPE Cable	Shall not be less than 29 at 27 ± 2 deg. C.
12.0	Temperature index	Not below 250°C.
13.0	Max. conductor withstand temperature during short circuit.	250°C

2. LT CABLES



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(i) 1.1 kV Power Cable

Sl.No.	Parameter	Description
1.0	Voltage Grade	1.1 kV grade
2.0	Duty type	Heavy duty
3.0	No. of cores	<ul style="list-style-type: none">- 3.5 / 4 core cables shall be used for motor feeders.- For other consumers or for power supply to other panel 4 core (upto conductor size of 50 sq.mm) or 3.5 core (for conductor size beyond 50 sq.mm) cables shall be used.
4.0	Reference standard	IS:8130 – 1984 IS:5831 – 1984 IS:3975 -1988 IS:1554, part - 1, 1988 IS:3961 (Part-II) - 1967. IS:7098 Part-I & II IEC-60502
5.0	Conductor type	<ul style="list-style-type: none">- Plain aluminium conductor.- All power cables of size 10 sq.mm and above shall have standard sector shaped (sm) or compact circular stranded (rm/V) or circular stranded (rm) aluminum conductors as applicable.- The conductors will be H2 or H4 grade.- The solid conductor shall be class - 1 and the stranded conductor will be class - 2.- The conductors shall be solid for conductor of nominal area upto and including 6 sq. mm. and stranded beyond 6 sq. mm. Conductors of nominal area less than 25 sq. mm. shall be circular or shaped. Cables with reduced neutral conductor shall have sizes as per Table 1 of IS 1554 (Part-1) -1988.
6.0	Insulation type	<ul style="list-style-type: none">- XLPE insulation- The insulation compound shall be conforming to IS:7098 (Part I) - 1988.
7.0	Inner sheath	<ul style="list-style-type: none">- For armoured / unarmoured cables a tough inner sheath of heat resisting PVC compound (wrapped / extruded as per size) ,Type ST2 as per IS 5831 .- Black in colour .
8.0	Armour	<ul style="list-style-type: none">- Galvanised steel wire armour shall be used for 3Cx10 sq.mm / 4Cx6 sq.mm cable.- Galvanised flat steel wires (strips) armour shall be used for bigger size cables.- Single core armoured cables are provided with non-magnetic armour consisting of hard drawn flat or round aluminium wires.
9.0	Outer sheath	<ul style="list-style-type: none">- For armoured / unarmoured cables a tough outer sheath of heat resisting PVC compound (Type ST2 as per IS 5831) .- Black in colour .
10.0	Miscellaneous	<ul style="list-style-type: none">- Minimum cross - sectional area of the power cable shall be 6 sq.mm in case of aluminium conductor and 2.5 sq.mm in case of copper conductor.



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		- Power cables shall be selected from core sizes of 6, 10, 16, 25, 50, 70, 120, 150, 240 & 300 sq.mm (Aluminium conductor).
11.0	Temp. rise	Shall be limited to 90 deg.C.
12.0	Core identification	- Cable identification will be provided by embossing on the outer sheath the following: <ul style="list-style-type: none">• Manufacturer's name & trade mark• Voltage grade• Year of manufacture• Type of insulation - R,Y,B for phases . - Black for neutral (fourth core)

(ii) **1.1 KV Grade Control Cable :-**

Sl.No.	Parameter	Description
1.0	Voltage Grade	1.1 kV grade
2.0	Duty type	Heavy duty
3.0	No. of cores	As per requirement .
4.0	Reference standard	IS:8130 – 1984 IS:5831 – 1984 IS:3975 -1988 IS:1554, part - 1, 1988 IS:3961 (Part-II) - 1967. IS:7098 Part-I & II IEC-60502
5.0	Cross sectional area	Shall be 1.5 / 2.5 sq.mm. (as per TS)
6.0	Conductor type	Solid annealed circular stranded copper conductor.
7.0	Insulation type	XLPE insulated
8.0	Inner and outer sheath	- Type ST-2 PVC shall be used for inner sheath . - Type ST-2 PVC shall be used for outer sheath . - Both inner and outer sheath shall be extruded type upto 7 core and after 7 core inner sheath shall be wrapped ..
9.0	Armour	- Galvanised steel wire armour shall be used for cables upto 14 cores . - For cables having larger number of cores galvanised formed wire (steel strip) shall be used.
10.0	Spare Cores	- 3, 5 and 7 cores cables shall have at least one spare core, cables with 10 core and above shall have at least 2 spare cores.
11.0	Miscellaneous	- The Tenderer shall furnish necessary calculations to show that the selected cable satisfy the criteria including for voltage drop. - Cables for temperature detectors shall be screened type of required technical parameters with core size not less 1.5 sq.mm.
12.0	Core identification	- Cable identification will be provided by embossing on the outer sheath the following: <ul style="list-style-type: none">• Manufacturer's name & trade mark• Voltage grade• Year of manufacture• Type of insulation - Cores of the cables upto 5 cores shall be identified by



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		<p>colouring of insulation.</p> <ul style="list-style-type: none">- For cables having more than 5 cores, core identification shall be done by numbering insulation of core sequentially.- All the numbers shall be of same colour, which shall contrast with the colour of insulation.- Numbers shall be written in figures and words both- The numerals shall be legible and indelible.- The numbers shall be repeated at regular intervals along the core, consecutive numbers being inverted in relation to each other.- When number is a single numeral a dash shall be blacked underneath.- If the number consists of two numerals, these shall be disposed one below the other and a dash placed below the lower numeral.- The spacing between consecutive numbers shall not exceed 100 mm.
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(iii) **1.1 KV Grade Screened /Special Cable :-**

Sl.No.	Parameter	Description
1.0	Voltage Grade	1.1 kV grade
2.0	Duty type	Heavy duty
3.0	No. of cores	As per requirement .
4.0	Cross sectional area	Shall be 1.5 sq.mm.
5.0	Conductor type	<ul style="list-style-type: none">- Solid annealed circular stranded copper conductor.- For twisted pair cables , the conductors shall be of stranded tinned copper having proper flexibility to provide limpness and extended flex-life as required for these small diameter cables.
6.0	Insulation type	<ul style="list-style-type: none">- PVC insulated, Type A- Type ST-1 PVC shall be used for inner sheath.- Both inner and outer sheath shall be extruded type.- Outer sheath made of PCP (Chloroprene rubber), abrasion resistant, oil resistant and flame retardant conforming to IS:434 –1964 (Part - I), as amended upto date.
7.0	Screen	<ul style="list-style-type: none">- Tinned annealed copper mesh over metallised tape , in a close woven braid .
8.0	Shielding	<ul style="list-style-type: none">- Special aluminium foil to provide 100% shield coverage for optimum protection against radiated interference and ingress of audio and radio frequencies.- It shall have shorting fold for metal to metal contact and isolation fold to prevent adjacent shields from shorting to one another, so as to improve the voltage breakdown characteristics. The drain wire shall be of stranded tinned copper wire of 0.518 sq. mm. (20 AWG) cross-section.
9.0	Spare Cores	<ul style="list-style-type: none">- 20% spare cores but not less than 2 spares shall be provided in all the multi core cables .
10.0	Reference standard	As per relevant IS with latest amendments



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11.0	Miscellaneous	<ul style="list-style-type: none">- The Tenderer shall furnish necessary calculations to show that the selected cable satisfy the criteria including for voltage drop.- Cables for temperature detectors shall be screened type of required technical parameters with core size not less 1.5 sq.mm.- The special twisted paired cables shall be of the type to provide balanced signal transmission and shall have good noise immunity.
12.0	Core identification	<ul style="list-style-type: none">- Cable identification will be provided by embossing on the outer sheath the following:<ul style="list-style-type: none">• Manufacturer's name & trade mark• Voltage grade• Year of manufacture• Type of insulation- Cores of the cables upto 5 cores shall be identified by colouring of insulation.- For cables having more than 5 cores, core identification shall be done by numbering insulation of core sequentially.- All the numbers shall be of same colour, which shall contrast with the colour of insulation.- Numbers shall be written in figures and words both- The numerals shall be legible and indelible.- The numbers shall be repeated at regular intervals along the core, consecutive numbers being inverted in relation to each other.- When number is a single numeral a dash shall be blacked underneath.- If the number consists of two numerals, these shall be disposed one below the other and a dash placed below the lower numeral.- The spacing between consecutive numbers shall not exceed 100 mm.

(iv) Heat resistant cable

Sl.No.	Parameter	Description
1.0	Voltage Grade	1.1 kV grade confirming to IS: 9968 (Part-II)- 1988
2.0	Reference standard	IS: 6380
3.0	Duty type	Heavy duty
4.0	No. of cores	Single or multicore as per requirement
5.0	Cross sectional area	As per requirement .
6.0	Conductor type	Annealed tinned copper conductor
8.0	Insulation type	Silicone rubber insulation
9.0	Shielding	Asbestos or glass braid and lacquered protection
11.0	Outer sheath	Flame retarded Oil resistant
12.0	Miscellaneous	As per requirement for working at higher temperature, nickel coating shall be done .
13.0	Armouring	GI strip armoured as per requirement (as specified in



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	respective TS)
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(v) Trailing cable

Sl.No.	Parameter	Description
1.0	Voltage Grade	1.1 kV grade confirming to IS: 9968 (Part-II)- 1988
2.0	Reference standard	IS: 9968 IS: 8130 IS: 6380
3.0	Duty type	Heavy duty
4.0	No. of cores	Single or multicore as per requirement
5.0	Cross sectional area	As per requirement .
6.0	Conductor type	Highly flexible stranded tinned annealed high conductivity copper conductor
8.0	Insulation type	EPR (Ethylene-propylene Rubber) For higher temperature zone, silicone rubber (trailing duty)
9.0	Shielding	Each individual core protected and covered and overall
11.0	Sheath	Poly-chloroprene rubber or chlorosulphorated polyethelene cable shall be conform to IS: 9968 (Pt-I) - 1988. Flame retarded (for higher temperature area) Oil resistant
12.0	Miscellaneous	Shall have one additional core for earthing .
13.0	Armouring	GI wire armoured as per requirement and size (as specified in respective TS)

(vi) Flame Retardant Low Smoke (FRLS) Cables

Sl.No.	Parameter	Description
1.0	Voltage Grade	1.1 kV grade
2.0	Reference standard	Category AF as per IS : 10810 ASTM-D 2863 (Critical Oxygen Index) ASTM-D 2863 (Temperature Index) ASTM-D 2843 (Smoke density) IEC 754-1 (Acid gas generation) IEEE-383 (Flammability test on group of cables) Swedish chimney test SS 424175, class F3. (Flammability test) IEC 332-1 (Flammability test) IEC 332-3 (Flammability test) IS 5831 (Fire resistant test)
3.0	Duty type	Heavy duty
4.0	No. of cores	Single or multicore as per requirement
5.0	Cross sectional area	As per requirement .
6.0	Conductor type	Annealed tinned copper conductor
8.0	Insulation type	XLPE insulation
11.0	Sheath	Specially designed with thermoplastic or thermosetting materials , superior resistance to ignition and flame propagation with smoke emission and toxicity or corrosive characteristics Flame retarded Oil resistant
12.0	Armouring	GI wire / strip armoured as per requirement and size (as specified in respective TS)
13.0	Test values	Critical Oxygen Index : Minimum 29

		Temperature Index : Minimum 250 deg. C Smoke density : Minimum average light transmission of 40% Acid gas generation : HCl gas released 20% maximum Flammability test on group of cables : As per standards mentioned Flammability test : As per standards mentioned Fire resistant test : As per standards mentioned
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01.02.20 EOT Cranes

01. Trolley lines and power supply arrangements for cranes (DSL System)

Power to all the bays shall be fed from crane LTSS through PDB's installed in respective bays . Number of panels shall be decided as per requirement (to be indicated by the tenderer . Isolator (MCCB) for each feeding section will be provided in each bay .

All the PDB's shall have 02 incomers and 01 buscoupler . Normally both the incomers will be charged and buscoupler will be OFF . In case of power failure or any fault power will be fed from either of the incomers . Incomers , buscoupler and busbars shall be designed to take care of entire load of the cranes .

Crane trolley lines feeding cranes in major production units shall be sectionalized with two separate feeding points. Two fully rated MCCB / ACB shall be provided for each incomer feed point to crane DSL. Sectionalizer shall be provided between the two incoming ACBs with necessary padlocking arrangement.

Isolator (MCCB) panels shall be provided for the repair section for maintenance by the tenderer .

In case of circuit breaker rating more than 630A , ACB's shall be provided . All the ACB's shall be installed in a PDB which shall in turn be installed in the bay / shop floor . In case of circuit breaker rating is 630A or less , than the MCCB (as isolator) with earth fault protection and magnetic over current release shall be mounted in the respective column of the feeding bay in a separate enclosure at manheight level .

Signal lamps shall be provided just below the trolley lines at 60m intervals as well as at the beginning and end of each section/repair section to indicate whether the trolley lines are energized or not.

Insulation air gap between two sections of a sectionalised trolley line shall be minimum 50 mm for voltage levels upto 500V, but in no case should be greater than the length of the current collector on the crane.

Maintenance Bay

When two or more cranes are fed from the same trolley line, maintenance bays (repair sections) shall be provided with sectionalizing isolator so that repair or maintenance of any crane can be carried out without disturbing the operation of the other cranes. Necessary DSL arrangement for repair section shall be provided by Tenderer.

Isolator panels shall be provided for each repair section for maintenance. Dead zones shall



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be provided with isolator arrangements to prevent collision between cranes and momentary paralleling to two incomer supplies. Incomer ACB's shall be provided with earth fault protection and magnetic over current release. The DB,s shall be located suitably on the shop floor.

For end zones, minimum length of maintenance bay shall be 2 m plus the crane width. For middle zone, the length of hospital bay shall be 4 m plus the width of crane.

Repair section shall be provided with red lamp steady/flashing fixtures at four corners. These fixtures shall be located at crane gantry with manual ON/OFF provision.

Boarding or access platform shall be arranged within the limits of each repair section for approach to be crane.

02. Trolley power conductors

The Power conductors or down shop lead (DSL) shall have 4 conductors, 3 phase, 4 trolley line system (3 power + 1 earth) .

Trolley power conductors shall be of mild steel angel sections / rails .

For cranes/hoists upto 10 t capacity, the DSL shall have 50 x 50-x 6 mm MS angle. For cranes above 10t upto 100 t, the DSL shall have 75 x 75 x 6-mm MS angles. For cranes above 100 t, the DSL shall have to maintain rail size of 75 lb.

Expansion and section gaps shall be provided in rails at every 30m. The gaps shall be cut at an angle of 30 degree to the rail and shall be 50mm wide. The gaps shall be provided with flexible joints. The conductors shall be supported at 3000 mm intervals by insulators mounted on brackets welded to crane girders.

Looping cables shall be used in parallel with the conductor rails and aluminium equalising strips shall be provided, wherever necessary, for limiting the voltage drops. However, aluminium equalising strips shall not be used in the hot areas like slag / liquid steel / slab / slab yard etc. In such areas, copper cable looping shall be used.

In order to provide electrical continuity across the expansion joints the power conductors on both sides of the joints shall connected by stranded aluminum conductor jumper, fitted with steel Aluminum strap and lugs suitable for the steel angle sections .

The power supply feeder and trolley line conductors/looping cables shall be selected so as to limit the voltage drop to within 15% of the rated voltage at the crane motor terminals for the short time peak current corresponding to the starting of the largest capacity motor and the maximum continuous operating current of the rest on the system. Expansion and section gaps shall be provided in rails at every 30m. The gaps shall be cut at an angle of 30 degree to the rail and shall be 50mm wide. The gaps shall be provided with flexible joints.

The section shall be straight, unbranded and smooth on the running surface. Joints between lengths of angles shall be welded and all welds shall be finished flush with parent metal. The conductors shall be painted with anticorrosive paint, except for contact surface. Parallel aluminum buses shall be provided as specified. The jointing of standard

lengths shall be made by 100% but welding and top surface finished smooth by grinding to get free movement of the current collectors.

03. Insulators and trolley line holders

The insulators used for the manufacture of trolley line holders shall be preferably steatite, tufnol or porcelain insulation material having substantial mechanical strength specifically against blows and vibrations. They shall be capable of withstanding the impact and shocks resulting from operation of the machine. The creepage distance of the insulators shall not be less than 80 mm.

The insulators used in the LT/AC system shall have the following minimum flashover value and mechanical strength :

Dry flashover voltage	:	25 kV
Wet flashover voltage	:	12 kV
Ultimate mechanical strength	:	1000 kg.

The trolley line holders shall generally conform to the design shown in the drawing to be furnished to the successful Tenderer. All sharp edges shall be ground smooth. The porcelain insulators shall be manufactured and tested as per IS: 1445 –1997

04. Supporting brackets

The trolley line conductors shall be mounted on holders. The holders shall be bolted on to brackets which in turn shall be welded on to crane girder at stiffeners at regular intervals. In normal run, intermediate type of brackets shall be used, but when sectionalizing gaps or expansion joints are provided, sectionalizing type of brackets shall be provided.

05. Steel to Aluminium straps

These are meant for connecting parallel aluminium bus, at expansion joints, power supply cables from load break switch. They shall be complete with MS cadmium coated bolt nuts, spring washers, lugs etc.

06. Signal lamp assembly

Signal lamp assembly shall be industrial, heavy duty dust tight and water proof in construction suitable for indoor or outdoor locations. The units shall comprise three lamps for three phase with red glass lens and reflectors. The lamp shall be provided with dropper resistance connected in series with the lamp and the resistance shall be rated for continuous inclusion in the circuit. Alternatively, a built-in transformer may be provided to suit the lamp voltage.

07. Aluminium parallel bus

These buses shall be of E.C. grade aluminium. They shall be free from any deformity in profiles.

08 Current Collectors

2 nos. current collector shall be provided per trolley line each rated for 100% of total rating . The collector shoe will be of heavy duty design and chamfered at both ends, each rated



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for 100% of total crane rating. Double collectors on each earth trolley line shall be provided and these shall be different from those on power trolley line. Collector shall be multi hinged for self – aligning. Collector will be designed in such a way that load is transmitted not on the insulators but on the insulator stud to avoid damage to insulators.

09. Power distribution on crane

One adequately rated isolator (MCCB/ACB) with locking facility shall be provided immediately after current collectors on incoming line on the crane. The isolator shall be capable of carrying current of two largest motors.

Power from the isolator shall be taken to the air circuit breaker to be provided in operator's cabin. In case of pendant operated cranes, this circuit breaker shall be located in protective panel located at bridge platform.

The breaker shall be provided with under voltage, over load and short circuit releases. The breaker shall also be with earth fault protection . The breaker can be closed only when :

- All master controller handles are in neutral position.
- None of the stator or directional contactors are in closed positions.
- Emergency corner switches not operated.
- Door/Gate switch are not actuated and gravity limit switch for hoist motion not operated. Power for lighting and magnet circuits shall be tapped from the incoming side of isolators near current collectors.

10. Power supply for CT. motion

Flexible trailing cable systems mounted on retracting support system shall be used. The system shall consist of insulated multi-conductor or several single conductor cable with permanent termination on the bridge and on the trolley. The flexible trailing cables shall have ample length and shall be supported by means of properly designed movable clamps. These clamps shall be fitted with rollers and shall run freely on a guide rail allowing relative movement of bridge and trolley without undue stress or wear on the suspended cable. Provision later stage in case of necessity. The flexible cable shall be butyl rubber or EPR insulated CSP sheathed type.

For rotating trolley cranes, power supply shall be through festoon cable arrangement slipping or cable basket. Cable reeling drum or cable basket shall be used for power supply to the magnet from the trolley. Two spare turns of cable provided on cable reeling drum. The cable reeling drum shall be directly driven by hoist mechanism, a clutch shall also be provided to disconnect the drum from hoist mechanism.

Flexible cables system mounted on latest PVC linked chain system in normal area & metallic chain systems in hot area. (New point)

11. Meters

Ammeter and voltmeter with selector switches shall be provided on the incoming line in operator's cabin.

Ammeter and voltmeter shall be provided on DC side for Electromagnets.



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12. Control features

All controls shall be fully magnetic, operated through master controllers. All travel motions shall be provided with plain rotor resistance control with plugging. For long travel drives, the electrical control shall be grouped for the individual pair of motors separately in case of four motor drive and each pair of motors shall be able to drive the crane at reduced acceleration and speed. As an anti-skewing measure, out of a pair of motors for LT., if one drive motor trips, the other drive motor shall also be switched off. For pendant control, plugging shall be avoided for travel motion.

Brakes shall not be used for speed control.

Synchronization of separate drives where required shall be done with the used of solid state thyristor control.

For all hoist motions, except where creep speed is required, plain rotor resistance control shall be provided on all master controller notches in the hoisting direction. The rotor resistance shall be cut out gradually when moving from lower to higher notches such that current peak of 2 times the rated current is not exceeded. In the lowering direction of the motion, controlled lowering shall be provided using one/ two plugging notches, one single phasing notch and one/ two super synchronous power lowering notches. For obtaining creep speed, conventional methods like planetary gear system, DC. injection (where requirement calls for creep speed in lowering direction only) etc. may be offered.

Hoist control circuit shall also be provided with anti-drop feature i.e., whenever the master controller is brought back to zero position from higher notches in both directions, the motor shall automatically be connected to hoisting direction for some time (time adjustable through timers) to avoid the downward drift of the load. Brakes shall be clamped in zero position of the master controller.

13. External control of auxiliary hoist and CT of LRS Crane

Tenderer shall supply one no. of Ground Control Post in Pedestal for installation in PCM control room. The control post shall have following facilities:

- a) Control on PB- This shall transfer the control of CT and auxiliary hoist from cabin , master controller to ground control post and will not allow LT motion from cabin.
- b) For CT and aux. Hoist 4 push buttons each (total 8 PBs) shall be provided on ground control post for following application:
- c) 10% speed of hoist & lower
- d) 30% speed of hoist & lower
- e) 10% speed of CT forward & reverse
- f) 30% speed of CT forward & reverse

The control post shall be connected to the main control of cabin on crane through hear resistance flexible cable with copper conductor arrangement and plug and socket system. The socket shall be fixed to the cabin. The no. of pins for socket, no. of additional aux. Contactor, no. of cores for flexible cable to achieve the above control shall be decided by the Tenderer during detail engineering and shall be included in the scope of supply of Tenderer.



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Further, Tenderer shall quote radio control system to achieve the above control requirement as an optional feature. Cost for the radio control option shall be indicated separately.

14. Thyristor control drives

Thyristor control shall be provided for all the cranes operating in areas where ambient temperature is more than 50 deg. C . Control shall be achieved through master controllers for each direction. Rated and creep speeds are to be provided in each direction i.e., hoisting and lowering. Creep speed shall be 10% or lower as per operational requirements of rated speed.

The thyristor regulator shall be fully controlled and suitable for four quadrant operation.

Speed control of the slipping motor shall be achieved through regulation of stator voltage with resistance in the rotor circuit, if necessary. The reversal of direction shall be through magnetic contactors which shall open and close at zero current.

The continuous rating of the thyristor converter shall **be at least 2.0 times the motor rated current at the mechanical KW** and the converter shall be designed and rated for load requirement taking care of peak currents during acceleration, normal operation and regeneration conditions. The dv/dt and di/dt rating of the thyristors shall be suitably selected.

The repetitive PIV rating of semi conductor devices shall not be less than 2.5 times the peak of normal system voltage. Thyristor bridges shall include R.C. snubber circuits across the thyristor, high speed semi-conductor fuses with micro-switches for monitoring of failure. Closed loop regulation suitable for the system with various feed back such as speed, current etc. shall be provided. Speed feed back shall be through tacho-generator of permanent magnet type mounted on the non-driving end of the motor shaft. The regulation shall include ramp generators, potentiometers for various setting, various regulators, signal conditioners, logic command module sequence, module, trigger module, zero and over speed monitor, torque less protection module etc. as per the requirements. The control and regulation equipment shall be able to maintain their rated performance and control quality even under conditions of variation of +10% and - 15% in voltage and +5% in frequency. A zero current sensing device shall be incorporated. The reversing of stator contactor shall be done at zero current. Braking down to zero speed shall be electrical with mechanical brake setting only at zero speed. Protective features like anti-drop etc. shall be incorporated to prevent load setting. The circuitry shall also provide for the protection against failure of motor torque such that the mechanical brake sets in such cases. All other features of conventional crane controls shall also be built into the scheme. The following shall also be provided on the A.C. side.

- Surge suppressor
- Over current protection
- Overload protection
- Single phase protection
- Phase sequence protection
- Ammeter and voltmeter with selector switches
- Isolating switches

Control and auxiliary supply shall be provided with separate transformer and under voltage protection.



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The test shall be performed as per IEC : 146.

Details of the system offered shall be furnished along with necessary single line diagrams and block diagrams.

All the control modules shall be grouped in a sheet steel enclosure. The control module cards shall be made of epoxy glaze and suitable for plugging into the racks. The cards shall be locked into the rack, which carries a sealing bar and assists locking of the cards thereby cutting down on the wear of the printed circuit connector contacts which can be subjected to high rate or vibration and further avoid the disconnection of cards from the connector. The thyristor panel shall be suitably mounted so that little vibrations are reflected to the components and connection.

The cables for the thyristor controller and associated equipment shall be laid and clamped separately on the crane.

15. VFD control drives

VFD control shall be provided for cranes operating in areas where operating temperature is 50 deg. C . Control shall be achieved through master controllers for each direction. Rated and creep speeds are to be provided in each direction i.e., hoisting and lowering. Creep speed shall be 10% or lower as per operational requirements of rated speed.

The VFD shall be fully controlled and suitable for four quadrant operation (active front end type) . Other details of VFD shall be as per respective clause for VFD in the GTS.

16. Panels

There will be separate panels for each motion in addition to the protective panels and resistance panels.

All panels shall be of free-standing floor-mounting construction, suitable to withstand vibrations encountered on crane. Hinged doors shall be provided for closed type panels. Panels shall be front wired. Front wired live points of bottom most equipment shall be mounted at least 350 mm above the bottom cover of the panel. Panel shall be fabricated from 2.0 mm thick steel sheet.

Power and control terminals shall be segregated. 10% spare terminals shall be provided in each panel.

Equipment in the panel shall be so mounted that their removal or replacement from the front is easy.

Separate control panel for each motion shall be provided.

Panels shall be of closed type when mounted on bridge platform.

The panels shall be mounted along the girder facing the hand railing. Sufficient clearances shall be provided between the panels. A minimum clearance shall be provided in front of the panels for walkway and approach as per I.E. Rules. The panels shall be supported in the back from the girder to avoid vibrations. Open type panels may be used for installation

inside the box girders. In this case, adequate lighting and ventilation shall be provided for the room.

17. Switchgears

Each mechanism motor shall be provided with MCCB, contactors on stator and rotor sides, Electronic over load relays and suitably rated rotor resistances. In case of thyristor controlled drive, each mechanism motor shall be provided with breaker / switches, transformer, thyristor, rotor resistances, contactors on stator and rotor side etc. Each motor shall be fitted with a tacho-generator for speed feed back. The speed range shall be 0-160% of rated speed.

MCB shall be provided in the control circuit of each motion.

Each brake circuit shall be provided with a suitable contactor.

Rating of contactor selected for any mechanism shall be at least 50% higher than the respective motor full load current for the mechanism at 40% duty cycle. The minimum rating of the contactor used shall be 32A and the life of each contactor shall not be less than 10,000 hrs. of operation.

Reversible directional contactors shall be inter locked both mechanically and electrically.

18. Motors

Heavy duty reversible crane service, totally enclosed fan cooled, foot mounted, wound rotor motor conforming to latest edition of IS:325-1996 shall be used for various drives. Class of insulation shall be F/F (Stator/Rotor) with temperature rise limited to that for 'B' Pullout torque to the not less than 225% and 275% of full load torque corresponding to 40% CDF for class 1 & 2 and class 3 & 4 duty cranes respectively.

The main motor shall have following speed ranges :

a) Class M3 & M5 duty cranes :

Main & auxiliary hoist	:	750 rpm
Long & cross travel	:	1000 rpm

b) Class M7 & M8 duty cranes :

Main & auxiliary hoist	:	600 rpm
Long & cross travel	:	750 - 1000 rpm

All motors shall have the terminal box at top. Frame sizes shall conform to IEC Standards.

Horizontal foot mounted and with tapered shaft extension.

While selecting the motor rating following shall also be taken into consideration :

- Duty type S4 & S5
- Cyclic duty factor
- Number of switchings per hours



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- Type of controls used
- Inertia of the motor and mechanism
- Ambient correction factor
- Service factor
- Derating for thyristor control
- Wind pressure

Maximum permissible operating speed shall be 250% of synchronous speed or 2000 rpm whichever is less. Over load capacity 150% of full load current for 2 minutes without damage or permanent deformation.

19. Brakes

Brakes shall be D.C. electromagnetic type , confirming to AISE standard. The brake coils shall be made of copper and of insulation class 'F'.

Brakes shall be designed to fail safe whenever the current is interrupted either intentionally or by failure of the main supply.

Brake circuit forcing shall be provided for D.C. brakes. D.C brake circuit shall be switched off on D.C. circuit for quick operation of brake.

A separate set of parking brake for L.T. motion shall be provided for each out door crane. Power supply for these brakes shall be obtained from protective panel.

20. Limit switches

Roller lever operated, resetting limit switches shall be provided for all travel motions. For each hoist motion, a rotary cam type over hoist and over lower, self resetting limit switch shall be provided. This limit switch shall have independently adjustable cams for hoisting and lowering motion. The cams shall have adjustability such that end limit can be set to within 100 mm of the hoisting or lowering motion. In addition to this, a back up ultimate limit switch of series/ shunt gravity type shall be provided to prevent over hoist. The later shall be of manual reset type. In case of cranes handling hot metal, the gravity limit switch shall preferably be of series type. Provision shall be made to bridge the gravity type limit switch contact by push button/ switch or any other means to lower the load. An indication shall be provided to the operator whenever this limit switch has operated. Suitable limit switch shall be provided for slack rope, gate/door opening, slew mechanism, grab closing/ opening etc. wherever necessary. Protection class of the limit switch shall be minimum IP 65 .

21. Anti- Collision Devices

In cranes where two or more cranes are operating in the same bay(at same or different level) all cranes shall be provided with suitable Anti- collision system. Anti-collision device shall be **electronic type**.

A sound signal shall be provided to the crane operator when they are at certain safe distance apart (distance to be adjusted as a function of speed at site) and crane shall stop. After few seconds, it shall be possible to run the cranes towards each other (or only one crane can move towards the other) till buffers of the cranes meet by providing "by pass" in the operators cabin.

Anti-collision shall also be provided on trolley for twin trolley cranes along with suitable by pass arrangement.



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22. Resistances

Air cooled, robust, heavy duty, corrosion resistant fechral edge wound resistance. Resistance shall be in single phase execution. In a particular box the rating of resistances shall be the same. Resistance shall have vibration proof only.

Rated for 10 minutes duty. Continuous duty rating of resistances shall be provided in case of hoist motions controlled by thyristor converters.

Maximum temperature (absolute temperature) of resistor elements shall be limited to 335 deg C at desired duty. Suitable tapping points shall be provided.

Resistance boxes shall be mounted in racks that permit independent removal of any selected box.

23. Master controller

Cam type master controller with joy stick type lever shall be used.

Separate master controllers for hoist ,LT & CT shall be provided.

Duel master controller operated with single handle shall not be used.

Master controller for each motion controls shall have four/ five notches in each direction. Master controller for electro- shall have three positions i.e Lift- Off-Drop. It shall have spring return from drop position to Off position.

24. Lighting, socket outlets, bells etc.

Lighting shall be provided in operator's cabin, stair cases, platforms and working areas.

Minimum 4 nos. 400 watts high pressure sodium vapour flood lights equally spaced (under crane girders) about the crane span shall be provided along with shock absorbing and anti-swing suspension arrangements. More numbers of fittings shall be provided if required for cranes with longer span and/or longer height of lift.

Fluorescent lamps with necessary fittings shall be used for operator's cabin, staircases, platforms etc.

Adequate number of hand lamp socket outlets (2 Pin, 10A, 24V) and power socket outlets (3 Pin, 20A, 240V) shall be provided along with switches socket & switch shall be interlocked suitably. A hand lamp(160W SLS lamp with enclosed type battery and wire guard) along with sufficient length (15m) of cable with a plug shall also be provided for each crane.

An alarm bell shall be provided on each crane.

25. Electromagnets

All magnets shall be suitable for steel plant application and shall be welded construction.

Magnets shall be rated for 230 V DC and suitable transformer – rectifier units shall be provided for feeding them. Rectifiers shall also be suitable protected by suitable protective device.

Magnets shall be class ‘H’ insulated, at least 50% rated, copper conductor would and shall have surge suppressor box and separate in terminal box for termination of cable. Magnets for production cranes handling hot products shall be 75% rated. Surge suppressor shall be compact , non-linear resistor silicon carbide thyrector, variator or metrosil type.

Each magnet shall be provided with suitable plug socket unit.

One earth terminal on magnet to be connected to spare core in magnet cable.

Wherever specified, a set of batteries, a battery charger, one annunciation system and other accessories shall also be provided along with magnet so that the magnet can hold the full load for atleast **half an hour** in case of power failure.

25. Equipment in operator’s cabin or on pendant unit

a) In case of pendant controlled crane following shall be included on the pendant unit :

Push button for	:	Hoist slow, hoist fast, lower slow, lower fast, left cross traverse, right cross traverse, forward long travel, backward long travel, emergency stop conditions.
Switch for	:	Lights and bells
Lamps for	:	Power ‘ON’ indication and emergency corner switch operation.

b) In case of cabin operated cranes :

The operator’s cabin shall contain the following :

- Master controllers for all the motions and magnet (wherever applicable).
- Emergency stop push button.
- Foot switch for alarm or bell.
- Switches for all lighting equipment on crane.
- Switches for air conditioner, exhaust fan and for cabin fan.
- A fire extinguisher.
- Insulating mat and operator’s chair.
- Cabin light.

Annunciation panel with indication lamps for power ‘ON’ control ‘ON’ emergency corner switch operated, ammeter and voltmeter with selector switches.

c) In case of master controller operated cranes :-

In this case there should be the facility of controlling the crane from the control pulpit .

All the control facility available in case of operating from the operator's cabin is duplicated in the control pulpit through the cable .



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d) Radio remote control :-

In this mode of control system, all the 3 motions

- Hoist .
 - Cross travel.
 - Long travel.
- can be controlled .

The system shall have capability to provide range of 1.5 times the long travel distance of the crane .

In the case of signal failure, all motion shall come to a safe stop.

The system shall have facility of controlling speed in two steps :-

- (i) Slow speed on the first step of the breaker contact / pushbutton of the radio remote control representing the first or second notch of the master controller.
- (ii) Full speed on the second step of the breaker contact / pushbutton of the radio remote control representing the final notch of the master controller.

Transmitter :-

Transmitter shall have following features :-

- Constructed with sophisticated microprocessor technology and surface mounted electronics .
- Transmission type :- FM FSK
- Transmission speed :- 9.6 Kbps .
- Built in self test for all functions .
- Transmitter shall consist of switching breaker , dial switch and push buttons .
- Switching breaker shall be non locking to zero position or maintained function .
- Indications :-
 - Operation status
 - Battery status
 - Indicators that display information from crane .
- PIN -code (Personal Identification Number)
- Internal antenna .
- Rechargeable battery .
- Battery 7.2 V NiCd
- Operating time :- About 8 hours .
- Different operating frequencies (minimum 16 nos.)
- Two hand upstart.
- Stop push button .
- Operating conditions :- Areas having large temperature variations , dusty , more vibrations , oil and humidity .
- Operating temperature range :- Min. 10 deg.C to Max. 60 deg.C
- Protection class : IP - 54.
- Casing material : Polycarbonate / ABS plastic .

Receiver :-



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- Receiver shall have following features :-
- Upto 20 functions exclusive safety relays (for transmitting preset reference values to VFD in the crane).
 - 2 safety relays (for control of main contactor)
 - Power supply suitable for 240 V AC ,6 A.
 - Minimum 16 different operating frequencies.
 - Two redundant microprocessors for monitoring each others .
 - Cyclically redundancy check check for high security of transmitted radio messages .
 - Frequency scanning in the receiver .
 - Memories last 10 users .
 - Interlocking of the relays .
 - Momentary or latched relay functions .
 - Two hand up start (to avoid unintentional start).
 - Protection class : IP - 65.
 - Casing material : Aluminium profile for fast mounting on DIN rail .
 - Operating temperature range :- Min. 10 deg.C to Max. 60 deg.C

26. Enclosure Class

- a) For indoor operations
- Resistance boxes : IP : 11
 - Motors : IP : 55
 - All other electric equipment : IP : 54
- b) For outdoor operations
- Resistance boxes : IP : 33 with canopy
 - Motors & panel : IP : 55 with canopy
 - All other electrical equipment : IP : 65 with canopy

27. Cables

Power cable suitable for 3 Phase, 4 wire, AC power supply system.

All cables shall have stranded copper conductors. Control wiring shall be with 2.5 mm² copper; minimum size of power cable shall be 6.0 mm². Fixed wiring on cranes shall be carried out with PVC insulated. PVC sheathed armoured cable or EPR insulated CSP sheathed cable or better.

All flexible cables (i.e. cables for magnet, trolley, feed, pendant unit etc.) shall have copper conductor, EPR insulation and CSP sheathing or better.

All cable shall be suitably de-rated for grouping and higher ambient temperature.

All cables shall be of 1100 Volts grade.

All accessories like cable glands, clamps, pipes, wire and terminal marks etc. shall also be provided.

Cable laying and terminations shall be such that the chances of cables getting damaged is remote.

Cable sizes shall be selected considering motor rated current.



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In all passages and on trolley the cable shall be laid in trays and shall be covered by similar trays and properly clamped & fixed.

01 LT Power Cable

1.1 kV, heavy duty power cable, 4/3.5 core with stranded sector shaped (sm) or with compact circular stranded (rm/V) or circular stranded (rm) Copper conductors as applicable, PVC insulated suitable for 70°C operation as per IS:5831-1984, core stranded together provided with a common covering of PVC inner sheath, galvanized round steel wire armoured and PVC outer sheathed, multi core conforming to IS:1554 (Part-I – 1988) Type TWY.

02 Control Cables

1.1 kV, circular stranded (rm), annealed copper conductor, PVC insulated suitable for 70°C operation, as per IS:5831-1984, cores stranded together provided with a common covering of PVC inner sheath, galvanized round steel wire armoured and PVC outer sheathed, multi-core similar to IS:1554- (Part-I)-1988, Type YWY.

03 Flexible Trailing Cable

1.1 kV grade, heavy duty type with tinned annealed high conductivity flexible copper conductors, ethylene propylene (EPR) insulated and chlorosulphorated polyethylene (CSP) sheathed conforming to IS:8130-1984, IS:6380-1984 and IS:9968 (Part-I)-1988.

28. Earthing

A ring earthing system shall be provided on the crane. Each and every electrical equipment shall be connected to this earthing at least at two points. However the electronic circuit insulated earth wire shall run in panel and terminate at main earth connection only at one point. The earthing shall be connected to the fourth trolley line in DSL system through 2 nos of current collector. Additionally current collectors shall also be provided on crane rails for earthing on crane . All these collectors shall be connected to earthing ring.

An earth core shall be provided in trolley feed cable and the magnet. The cable reeling drum shall have a separate slipping for earthing purpose.

It shall conform to general specification for earthing.

Rubber mattings shall be provided in front of the protective and control panels.

All bonds between earth conductors and crane parts shall be welded if possible, or rivetted and soldered. Where screwed bonds are made, care shall be taken that there is satisfactory contact surface and nuts shall be locked to prevent their loosening. Earth connections to equipment shall be made by means of multi strand flexible conductor to adequate section.

The earth ring on the crane/ machine shall be connected to the plant earthing system through to gantry rails. Each end of each gantry rail shall be bonded to the plant earthing system.

In addition, intermediate earthing bond shall also be provided on the rails at every 60 m in case of longer tracks.



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Flexible copper bonds shall be provided across any gap in the running gantry rail.

For mobile equipment with flexible cables, one separate copper conductor of adequate size shall be provided for earthing.

29. Crane weighing system :

Electronic weighing system including calibration equipments, cables, load cells and panel mounted associated electronics (microprocessor based) with communication capability with PLC on bus.

Cranes & hoist (as per scope of supply) including their complete electrics & control (as given in relevant chapter) including power supply, power conductor lines (DSL) , Load break isolators (to be located in bay) & cables .

Crane weighing system to be connected to ground station by Radio link module. Necessary hardware & software including cables for above as well as communication of ground station with main automation network of shop automation system to be considered.

Other details of crane weighing system :

1. The Weighing system shall be designed, manufactured, assembled & tested in accordance with relevant OIML / NTEP standards.
2. Load cell shall be of globally reputed make, confirming to OIML/NTEP Standard & preferably digital type. Load cell shall be easily replaceable type, provided with safely devices from impact load, vibration, heat & dust.
3. Weighing system shall be auto zero & auto calibration facilities.
4. Redundant electronics shall be provided.
5. Test weight for calibration shall be provided.
6. Two nos. large display unit shall be provided.
7. The requirement of the system are:
 - i) The Weighing system will be sufficient to measure, display and telemeter the loading material weight, meet all operating requirement and necessary safety provision including alarms for abnormal conditions. Design should support better tolerances in the mechanical system.
 - ii) The equipment selected for the purpose will be suitable for a continuous and reliable functioning in environment generally prevailing in steel plant area. Signal transmission will be through radio communication. The frequency used shall be in license free bands as per prevailing standards in India.
 - iii) The designed will include all necessary precautions and provision for the safety of operating and maintenance personnel and equipment.
 - iv) Accuracy of the system will not be less than $\pm 0.5\%$ of FSD.
 - v) The Crane Weigh unit will be able to tolerate sudden shock loads caused by the lifting and traveling of crane,. Weigh unit will be suitable for continuous loading for long durations. Electronics will be resistant to vibration prevalent in cranes.
 - vi) Weight signal shall not be affected by the height at which load is weighed.
 - vii) The Weighing system shall have protection against strong magnetic field, electrical surge, RF interference and heat & dust.
 - viii) Data updation on real time basis in the central computer.
8. The scope of work includes Supply, Erection, Testing and commissioning of Crane Weighing systems as per following:
 - i) Crane Weighing units complete with top & bottom crane mounting accessories, weighing electronics, wireless communication interface, anti heat shielding for the equipment, protection against EMI, batteries and chargers, one standby battery for



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- each weigh unit, power supply unit etc. the Amp. Hour of the battery shall be adequate enough for minimum one month working.
- ii) Hand held unit based on radio frequency signal with toggling facility for current and cumulative weight display complete and charger, long range antenna (as per site requirement), wireless communication interface, provision for entering product and customer details. This unit will have calibration facility with password protection.
 - iii) Wireless Transreceiver at PC end (with IP65 enclosure), power cable, antenna (if required as per site condition)
 - iv) Commercial grade PCs.
 - v) The required tools and testing instruments for normal maintenance and operation of the equipment.
 - vi) The weighing system shall have real time connectivity to the plant MES / ERP through plant wide network.
 - vii) Supply of following tools and testing equipments:
 - a) Digital Multimeter 4 ½ digit- 2 nos. (make: Philips / HP / Fluke)
 - b) Portable Think pad based software programmer (make: HP / IBM / SONY) - 1 no.
 - c) Universal calibrator (make: HP / Fluke)-1 no.
 - d) Professional tool kit (make: RS / Philips)
 - viii) Integration of subunits.
 - ix) Supply of complete data, design calculations, technical literature and documents, erection / maintenance and operation manuals, erection drawings, Quality Assurance Plan (QAP) and as built drawings.
 - x) Supply of special tools and tackles, commissioning spares.
 - xi) Component level training to maintenance staff of BSP at the tender's works.
 - xii) Earthing.
 - xiii) Stamping and verification at the manufacturer's works by the tender as required under Weights and Measures Act.
 - xiv) Suitable safety devices for the protection of the weighing and processing system against impact loading.

1.02.21 Erection Specification

1.02.21.01 Guidelines for design of system and engineering the layout of electrical equipment.

001 General

The tenderer shall prepare the layout drawings for civil assignment and civil drawings for construction of the substation buildings and civil buildings for other electrical premises taking into consideration the requirement listed below. In case of total turnkey contract the civil aspects mentioned in following specification shall be adhered to while planning / executing civil work.

002 Electrical premises

- All electrical premises shall have adequate space to accommodate the electrical equipment from the point of view of operation and maintenance, and conform to IE Rules & Regulations.



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- The clearance between the ceiling of the electrical room and top of the tallest equipment shall not be less than 1m, 2m where the equipment are to be maintained from top and additional height of lifting tackle wherever required.
- Lifting/handling facilities shall be provided. Rolling shutters shall be provided to facilitate transportation of the equipment into and out of the electrical room, MCC rooms.
- Electrical room located on the top floors shall have erection openings and landings.
- All electrical rooms shall have cable basement/cable galleries /cable trenches as per equipment layout in the electrical rooms . The clear height of the basement/cable gallery walkways shall be minimum of 2.2 m for cable tunnels and 3 m for basement/galleries.
- The wall of the basement shall have water proofing and draining facilities below ground level.
- All electrical rooms shall be constructed with heatproof material at the roof if it is exposed to sunlight .
- Cable basement/galleries shall be provided with suitable lighting/ventilation facilities.
- 24V AC sockets fed from dry type L.V. transformers shall be provided for hand lamp connection throughout the premises including basement and cable tunnels.
- Airtight double door arrangement shall be provided for electrical rooms and basement. The stairs to the basement shall be from inside the electrical room.
- Welding power socket outlets shall be provided within basement at intervals of 60m with minimum of one, where basement is less than 60m long.
- Electrical room and cable galleries/basement shall be considered fire hazardous.
- Roofs of the electrical premises shall be fully watertight and moisture proof.
- Erection openings with removable cover plates shall be provided on the floor of the electrical rooms connecting the basement/cable gallery.

003 Control rooms/pulpits

- Location of control posts shall be decided taking care of clear visibility.
- All control rooms shall be air-conditioned and temperature shall be 24 deg. C.
- Air lock rooms shall be provided for all the control room / pulpits .
- Inner walls shall be sound proof.
- Granite flooring shall be provided.
- Window glass shall be toughened, heat resistant and of greenish tint, hinged glass to be opened from inside.
- Double glass panels, wherever required, shall be provided to make the control post heatproof.
- Suitable wire mesh shall be provided for the glass windows for protection against mechanical damage wherever required.



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004 Cable tunnels

Standard cable tunnel size:

- Full tunnel : 2200 mm (W) x 2200 mm (clear height)
- Half tunnel : 1500 mm (W) x 2200 mm (clear height)
- Partition door between basement and the cable tunnel shall be air tight and of fire retardant material. Cable tunnel shall be provided with fire / smoke detectors as per norms.
- Gradient of the floor at transition from one elevation to another shall not exceed 15 deg. Gradient shall be in the form of ramp.
- Floor gradient towards the water collecting pit shall not be less than 0.3%.
- Plate inserts (200 x 100 x 6 mm) at an interval of 1500 mm shall be provided on the wall along the length of the tunnel. Three rows of inserts shall be provided at suitable intervals along the height.
- Plate inserts shall be provided at an interval of 1.5 m under the ceiling for lighting fixture.
- Entries to the cable tunnel shall be provided generally at 70 m interval along the length of the tunnel inside the shop or at least 2 entries in case of small tunnels .
- Tunnel walls shall be waterproof design.
- For interplant cable tunnels, long tunnel shall be split into compartment not exceeding 150 m with fire proof partition doors.
- All cable tunnels shall be properly ventilated.
- Atleast two evacuation exits should be provided in each of the cable gallery and cable tunnel. The distance between any point and exit should not be more than 35m. The distance from dead end of cable gallery/cable tunnel to the exit should not be more than 25m.
- All the cable tunnels and cable galleries shall be provided with sump pumps for pumping out seepage water. Sump pumps shall be provided with high level/low level switches for automatic operation.

005 Cable shafts

- Cable shafts shall be of either civil or structural design as per requirement.
- Landing platform shall be provided at every 5 m of height.
- Suitable cat ladders shall be provided in the cable shaft.
- Suitable ventilation/lighting facilities shall be provided for the cable shafts.

006 Clearances inside the electrical rooms

Sl.No.	Clearance	Min. Distance
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		(in mm)
1.0	Back clearance	1250
2.0	Front to front clearance between drawout / semi-drawout panel boards	2500
3.0	Between two panel boards installed in a row	1000
4.0	Between front of the panel to the wall of the room	2000
5.0	Between the wall and end of the switchgear / MCC	1000
6.0	Back to back clearance	1500
7.0	Back to front clearance	2000
8.0	Between the bottom of the ventilation duct and top of the electrical equipment	As per statutory requirement and regulation

- Resistance boxes shall be floor mounted and shall be placed on the floor near the respective MCC.
- Disposition of control desk, mimic boards, instrumentation panels shall be properly located for visibility and operational convenience.
- Profile & dimension and painting of control desk / mimic panels shall be same as for control room for aesthetic design
- In any other case, the layout shall confirm to provide clearances as per Indian Elect. Rules.

007 Transformer rooms

All mineral oil filled transformers shall have oil soak pit around it. These soak pits in turn shall be connected to a common catch pit for collection of oil. The capacity of catch pit shall be equal to 1.2 times of the oil content of the biggest transformer.

In case oil filled transformers are located inside the shop, the catch pit shall be outside the shop connected to soak pits by pipes. Also the transformer room shall be enclosed on three sides. Access side may have steel framed gate with expanded metal jali doors with wicket door provision.

All mineral oil filled transformer shall be separated from switchgear/electrical rooms with partition wall. All transformers and heavy equipment shall have adequate transportation and lifting facilities.

There shall be minimum 1m clearance all around the transformer. The ceiling height of the rooms shall be 1.5 m above the conservator. The minimum dimension of transformer room shall be 6mx6mx5.0m(H).

1.02.21.02 Guide-line for erection of Electrical equipment and accessories

001 General

All the electrical equipment shall be installed with proper care and as per layout drawings. Minor modifications required at site shall be made by the contractor with



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approval of purchaser representative/Consultant for installation of the equipment. Care shall be taken for proper handling of equipment and undue vibrations shall be avoided particularly in case of sensitive (instrument mounted on panels) equipment.

The contractor shall have valid electrical contractor's license valid for State Govt. and as well supervisory licence. He shall have in his employment sufficient number of electricians and supervisors holding valid licenses for HV and LV installations. It will be the responsibility of the Contractor to get the installation cleared and relevant drgs. Certified / approved by Electrical Inspectors , Factory inspectors, Insurance agencies and other statutory authorities. The Govt. fees and necessary commercial aspects will be taken care by the Contractor.

002 Rotating machines

The erection work of motors shall include checking of all motors before installation including thorough cleaning and checking of bearings, replacement / rectification of defective items, greasing of bearing, if required, making minor modifications in its mounting arrangement, wherever required, assembling and its mounting on the motor base plate or on mechanical equipment, as the case may be, including levelling and alignment, checking insulation resistance and improving the same, if necessary, checking of internal connections etc.

All work associated with revisioning of motor shall also be included such as uncoupling and removing of motor from mechanical equipment, disassembling, cleaning, checking of insulation resistance and improving the same, if necessary, regreasing and replacing defective items/bearings on foundation, wherever required, reassembling, placing, levelling, aligning and fixing of coupling of the revisioned motor with mechanical equipment.

The contractor shall check different parts and assemble the motor at site in correct sequence wherever the motors are delivered in a dismantled state i.e. base frame, bearing pedestals, armature, field frame etc. in separate packages.

Erection, alignment and securing shall be done under expert technical supervision. Straight edges, feeler gauges, dial gauges etc shall be used for aligning purpose.

The height of the shaft of the motors shall correspond to the machine to be driven, if discrepancies are encountered these shall be compensated by inserting machined metal shim plates under the supports of the motor.

The motors mounted on the movable base frames / base plates shall be connected via intermediate terminal boxes with flexible cables.

After the complete installation of the motors, all bolts and bolted joints of the mechanical and electrical equipment shall be checked to ensure that they are done up



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tightly by torque wrench. A further check shall be made to ensure that the armature can be easily rotated.

The insulation resistances of the coils and connecting leads within the machine shall be checked against earth by a suitable megger. Insulation resistance if found less, the machine shall be dried to achieve the desired value.

Space heaters of main drive motor required to be installed in motor foundation pits shall be suitably and firmly mounted.

For handling the machine with the crane, the slings, lifting cables etc. shall not be secured around the shaft. However, the armature of disassembled machines may be lifted or supported by the shaft.

The machine shall be lifted or lowered without shocks or quick jerks to avoid any damage.

Handling facilities of the motors shall be provided at places where direct crane approach is not possible .

The system components delivered in separate packages like tank, gear pumps, filters, pressure switches, thermometer, flow regulators, centrifuge etc. shall be assembled at site and installed as per supplier's drawings. The supply and return pipelines along with their supporting structures from the lubrication system to the motor bearing shall be laid/erected by the contractor as per the relevant pipeline routing drawings. Meters and gauges shall be fixed and wired.

003 Sheet metal enclosed panels, open control panels, control desks and boxes

The base frames of all panels, desks, posts etc., shall be welded to structures or to the civil inserts provided on the floor/walls. Fabrication of supports/frames, wherever required, shall be done by the contractor.

The shipping section shall be placed in position before removing the protective covering to eliminate scratch/damage. The shipping section shall be moved by using rollers under the shipping skids wherever lifting cranes are not available. The contractor shall do the assembly at site as per manufacturer's general arrangement drawings and installation instruction. While assembling a complete board comprising several unit type cubicles, the board as a whole shall be aligned. The panels shall be properly leveled prior to grouting the holding down bolts or welding the panels to the inserts. All interconnection of busbars and wiring between the panels shall be done as per manufacturer's instructions and drawings. Welding work on the panels shall only be carried out after consultation with the purchaser. Damage to the paint due to welding shall be rectified by the contractor.

After mechanical installation of the board is completed, loose instruments shall be installed, wherever required, and wires shall be connected to the instrument. The



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wiring of intermediate terminal strips between two panels, wherever disconnected for transport, shall also be connected.

Each post shall be mounted at the place of installation in such a way that the operator has both the plant and the post before him.

The installation of control posts / boxes on mechanical equipment must be approved by the purchaser.

In cases where the control posts / boxes are separately mounted near the equipment, the contractor shall manufacture a structural support for the same before mounting the control posts/box.

004 Static converters

The installation shall be carried out as per manufacturers' instructions & equipment layout drawings.

The preservative grease from the metallic parts shall be removed by petrol and with clean markin cloth. Grease from copper parts shall be removed with ethanol and wiped with clean dry markin cloth.

The base frame of panels shall be welded to the civil inserts.

The panels supplied in separate shipping units shall be assembled at site as per manufacturer's drawings / instructions. The unit installation shall be started with the main converter. All the cabinets shall be aligned in a perfectly straight row and each of them exactly leveled. All inter-connections shall be done as per manufacturer's drawings/instructions.

005 Transformers and reactors

The transformer and its accessories and mountings like radiators, conservator, thermometers, silicagel breathers, marshalling box, rollers etc., delivered at site in separate packages, shall be assembled at site after cleaning by the contractor in proper sequence as per manufacturer's drawings.

Jacks shall never be placed under valves or cooling tubes.

Suitable stopper shall be provided both in front as well as rear of transformer to keep the transformer stationary in its position. For the front wheels such stoppers shall be screwed on the rails.

The oil conservator and the pipes shall be erected as shown in the manufacturer's drawings. All radiator tubes shall be cleaned before installation.

Before the transformer is filled/topped with oil, oil samples shall be checked by the contractor from each container. The oil shall possess the dielectric strength as per relevant IS/CEA. Oil shall be filled upto the mark shown.

The contractor shall also test the oil from each transformer to determine its suitability for use. If required, the contractor shall carry out drying and filtering operations as per



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IS code of practice to ensure that moisture is completely removed and the oil is free from impurities. This may be carried out by using oil filtering equipment to be provided by the contractor having vacuum as well as heating arrangement. Only after the dielectric strength of oil and other parameters are checked and approved, the external connections shall be made to the transformers.

The dial thermometers shall be screwed to the thermometer pockets after removal of the blind plugs.

All necessary cabling shall be connected before charging of the transformer. This will include signaling cables upto marshalling box and from marshalling box to meters, if not already done, as well as inter cabling between surge suppressor cubicle and transformer secondary.

Any modifications to HT and LT terminal box to accommodate the number of cables to be terminated shall be carried out by the contractor.

Naked light and flame shall never be used near the transformer.

Reactor shall be suitably shielded to avoid magnetic interference to electronic circuit.

006 Battery installation

All batteries shall be installed in a separate room. It shall have a water tap and adequate ventilation facilities for acid/alkali fume extraction. Battery for UPS (SMF type) shall be panel mounted located by the side of UPS.

Rooms having battery installation shall have acid resistant floors.

Walls will have acid resistant tiles on the side walls upto 1.5m height .

007 Busbar

Busbar installation shall be commenced from the middle section and the buses shall be fastened without tightening the bolts. The buses shall lie freely on the insulators without warping and if necessary, suitable packing shall be provided at the insulators.

Final tightening of the bolts shall be done after the complete laying of buses. Approved means shall be used for tightening of the bolts.

Bimetallic strips/ washers shall be used wherever aluminium busbars or aluminium cables are terminated on copper busbars.

008 Crane Trolley Lines

While sectionalising, one middle safety section shall be arranged slightly in excess of the crane braking distance so that it can act as a buffer and prevent the danger of crane collector bridging the isolator gap and leading to accidents on other section under repair or maintenance.

Boarding or access platform shall be arranged within the limits of each repair section for approach to the crane.

In the middle of the run between two expansion joints and at sectionalising gaps, the rails shall be rigidly fastened/supported.

009 Resistance boxes

The resistance boxes shall be installed on frames to be welded to civil inserts already provided.

010 Cables Installations

Interplant cabling shall be done in cable tunnel. Overhead cable bridges / concrete cable channels can be considered in case of lesser number of cables. Cables laid overhead using separate structural cable bridge with suitable walkway of minimum 800mm wide for laying of cables. Cables of small in numbers and cables for drives/field switches inside shop units shall be laid along the structures and columns of the shop / buildings. Cables may run partly in walkable cable tunnels or underground trenches and/or surface ducts in the shops and partly along the structures and columns of the buildings.

In case of space constraints/restrictions, cable shall be laid in walkable cable tunnels. Where the number of cables to be laid calls for walkable tunnels and cable shafts, same shall be provided. Underground walkable cable tunnels shall have hydro sealing to prevent water seepage.

For multi-layer installation, overhead cable bridge/walkable cable tunnels shall be used depending upon the number of cables to be laid.

Laying of cables directly in underground or in trenches shall be avoided. However, it may allowed in special case with permission from site in charge. In such case, cable shall be laid in one layer only, more than one layer is not permissible.

Cables in trenches shall be laid on 8 cm of riddled sand and covered with 8 cm of riddled sand. RCC slabs shall be provided for covering these trenches. The maximum trench depth shall normally be 1.5 m and thickness of top cover of 75 mm. If the trench is to cross railway tracks/roads or any load bearing area the cables shall be taken through suitable GI conduits/pipes/ducts.

For crossing the road / rail track, cables shall be laid in concrete cable ducts, heavy duty GI pipes . 25% spare conduits / pipes / duct openings shall be provided.

Installation of cables directly buried in ground shall generally conform to the requirements given in IS: 1255 –1983.

011.1 Laying in tunnels/surface ducts/on structures

Cable racks for cable trays shall be fixed at a maximum interval of 1.5 m.

Cables leaving the ground/floor shall be protected upto 2-m height by conduits/metallic guards.



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Ladder type cable racks and trays shall be provided to lay cables in tunnels/shafts/cable basements. Cables shall be laid in separate racks according to the voltage / application classification. Fireproof partitions such as asbestos sheets shall be provided between trays carrying LT & HT power cables, control and screened cables , communication cables , instrumentation cables & telecommunication cables. The cables shall be laid from top to bottom in order of HT on top rack followed by LT cables and other cables on lower racks.

All communication cables shall be laid through separate conduits to be installed in different routes with suitable separation from the other electrical cables .

Conduits carrying special cables shall be painted, coded, marked as per plant norms.

All necessary frame works and fixings for the support of cables and accessories shall be supplied.

Cables shall be suitably protected against heat, and mechanical damages.

Cables at fire partition wall crossings shall be painted with heat resistant paint 2 m on either side of wall.

011.2 Structures for cable laying

Power cables shall be laid on ladder type cable trays. Ladder type cable trays shall be selected from sizes 300 mm, 450 mm & 600 mm and shall be fabricated from 50x50x6 mm MS angles for longitudinal members and 25x5 mm flats for cross members placed at an interval of 250 mm along the length of cable tray. Control cables shall be laid on perforated trays.

Supporting vertical racks and horizontal hooks shall be of 50x50x6 mm MS angles. Cable racks and hooks shall be of welded construction.

To avoid damage during cable laying, cable structures shall have no scales, abrasive or rough surfaces or cutting edges.

The over head cable bridge structure shall be designed considering future cable laying and shall have 30% spare space for installation of future cable trays.

Walkway of minimum 800mm wide shall be provided for laying of cables.

Two numbers additional cable trays and 20% extra space on each cable tray for future use shall be provided as far as possible .

Cable shall be fixed to racks or trays or cleats as required for proper support, accessibility and neatness of installation. Hanging of cables racks over panels shall not be permitted rather no cable shall be laid/pass over any electrical equipment e.g. transformer, switchboards etc. Cable tags shall be provided at a regular interval of 30M. For cable run shorter than 30M one cable tag shall be provided in the middle. These tags shall be in addition to end cable tags. The cable tags shall be marked with cable number, size and voltage grade. Middle tag shall be indicated with destination. The end tag shall be with second terminal point.



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Cables shall be clamped rigidly at an interval of not more than 1000 mm in horizontal, and 500 mm in vertical & inclined run and at bends.

In the cable basement/cable galleries, cable structures shall be properly arranged giving sufficient clearance for movement of personnel from one part of the basement/gallery to the other. It shall also be possible to escape easily in case of fire. Cable passing through water/scale pit/acid fume etc. shall be laid in PVC pipe with PVC junction boxes and pull boxes etc. Where cable racks or trays cannot be erected or the number of cables on the route does not justify their use, cables shall be cleated direct to walls or structural steel work.

Perforated trays shall only be used where necessary for the support of a number of small cables. Each tray shall be firmly supported at suitable intervals and shall carry the weight of its cables without sagging. Trays shall be painted and where the surfaces or edges are cut or otherwise impaired during erection, they shall be made good by coating with aluminium paint.

Small cables may be bunched together under one saddle provided that in any bunch all cables have sheaths of the same material. The number of cables shall not exceed four wide and two deep.

Not more than one cable shall be drawn into one conduit unless otherwise agreed. After the cable has been drawn in, the conduit shall be sealed by an approved means.

After complete installation of racks and trays etc. it shall be painted with a primer of red oxide(zinc chromate)and a top coat of finishing paint as approved.

Fire protection barrier as approved by purchaser shall be provided between HT cables on racks laid on top and LT cables on racks below the HT cable rack.

All cables shall be tested for proper insulation before start of laying work.

Cables shall be laid in conduits, racks/trays, cable tunnels/trenches, along with structures or buildings, as per cable routing drawing and cable list.

Suitable adjustment shall be made in cable routes, if required at site, with a view to avoid any interference with any part of building, structures, equipment, utilities and services with the approval of the purchaser.

While laying cables, care shall be taken that kinks, twists or mechanical damage do not occur to the cable.

All bends in cables shall be made with due consideration to the minimum permissible bending radius of the cables.



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Loops shall not be allowed to be formed during the laying of the cables. When being pulled, the cable shall not be allowed to drag drawing along the ground or over a second cable already laid. Special care shall be taken while pulling through an opening where other cables have already been laid. Only approved cable pulling devices shall be used.

No joints shall normally be made at any intermediate point in through run of cables unless the length of the run is more than the standard drum length. In such cases where jointing is unavoidable, the same shall be made inside proper bases having plastic moulds and shall have moulded epoxy resin construction. Provision shall be made for earthing continuity at the joint. Cable splicing and jointing shall be done in accordance with the relevant IS, code of practice and manufacturer's instructions. Insulation resistance of cables shall be checked before cable jointing.

Adequate length of cables shall be pulled inside the switch boards, control panels, control desks, etc. so as to permit neat termination.

All cables shall be neatly dressed without interlocking or cross overs. While laying the cable vertically, these shall be clamped at suitable intervals. Horizontal runs shall be rigidly secured to trays on racks/hangers in all the places where the direction of the route changes as well as at cable terminations or joints. The clamps shall not be done up so tight that the insulation is damaged or deformed.

Cable markers shall be provided on either side of road crossing at each turning and at 30 m intervals at straight runs for underground cables.

Where cables are required to cross roads, surface drains and water, oil, gas or other pipe lines, they shall be taken through reinforced spun concrete or steel pipes.

Entry of cables from underground to the buildings or trenches shall be through pipe sleeves. After laying of cables, the sleeves shall be sealed with bitumen or epoxy compound with sand matting and cement plaster to make them fully water tight.

Special consideration shall be given for protection of cables against chemical and mechanical damage.

All cable entry openings in the equipment shall be sealed and made vermin proof. All cable openings in walls and floors shall be sealed after laying of cables by a weak mixture of asbestos and cement mortar.

All cables shall be provided with identification tags indicating the cable number in accordance with cable lists. Tags shall be fixed at both ends of the cable and at 15 m spacing for straight runs as well as on both sides wherever cables are crossing walls/floors. The tags shall be of aluminium/PVC with numbers punched/painted on them and securely attached to the cables by non-corrosive wires. The shape of tags



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shall be round, triangular and rectangular for control, medium voltage and high voltage cables respectively.

Glanding shall be done for direct entry of both power and control cables into the panels by the contractor. Compression type brass or aluminium alloy cable glands shall be used.

The cables shall be terminated in accordance with relevant connection diagram. Termination and clamping shall be carried out in such a manner as to avoid strain on the terminals.

All power cable terminations shall be by means of crimping type cable lugs. For flexible conductors, soldered termination shall be adopted. In case of aluminium power cables termination on copper bus bars, suitable aluminium copper bimetallic washers shall be used. Corrosion inhibiting grease shall be used for aluminium cable terminations. All 1.5 sq.mm screened cable/ 2.5 sq.mm control cable termination shall be made by crimping using pin / fork type (as decided during engineering stage) insulated copper lugs. The 1.5 / 2.5 sq.mm copper lugs shall be supplied by the contractor.

Suitable numbered and coloured letter interlocking type ferrules shall be provided for end termination of power and control cables. Cross ferruling shall be used for control termination as far as possible

Control cable entering switch boards, control panels, control desks etc. shall be neatly bunched and strapped with PVC perforated straps and suitably supported to keep it in position at the terminal blocks. All spare cores of each cable shall be segregated, marked spare, neatly dressed and suitably tapped at both ends.

When the cores of two or more multicore cables take a common route in side equipment, cores of each cable shall be separately bound and the separate bundles neatly bound together.

Individual cores of control cables shall have plastic interlocked type coloured ferrules with engraved numbers at both ends of the circuit for identification.

The contractor shall be responsible for correct phasing of motor power connections and shall interchange connections at the motor terminals box, if necessary, during each motor is test run.

The trays shall be earthed and rendered electrically continuous by welding the trays to the grounding strip at not less than two places from both sides of the tray.

011.3 Cable Joint/termination accessories

The cable accessories shall include end termination kits, straight through joints and also any special tool and tackles and accessories required for making the joints/terminations.



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The straight through joint/termination arrangement shall be complete with all fittings and consumables. The joint shall have electrical and mechanical withstand capability, same as that of the associated cable. For all cables, a minimum extra length of 2 metres will be left before jointing.

The termination kit shall be of heat shrinkable type only.

The termination kits/straight through joints shall have the following features:

- Electrical stress control to be provided at the cable insulation shield terminus.
- An external leakage insulation to be provided between the cable conductors and ground.
- Adequate protection to be provided at the end of the cables against the entrance of the moisture and, provision to maintain the constant pressure in the cable.

012 Exposed conduits

Exposed conduits shall be laid along walls, floors, ceilings, on steel supports etc. as per working drawings/site requirements in consultation with the supervisory personnel. The conduits shall be neatly run and evenly spaced.

Fixing of conduits to the supports on wall, column, structure shall not be done by welding. Exposed conduits shall be adequately supported by racks, clamps, straps etc.

Jointing of conduits shall be done only in straight portion and not in bend portion.

The contractor shall have available at site bending facilities for conduits as well as dies for threading conduits of diameters and threads corresponding to the standards. The threaded ends of conduits shall be painted with anticorrosive paint. The outer ends shall be smoothed free of burrs and sharp edges. Bushings shall be fitted at both ends of conduits.

Flexible metallic conduits shall be used for termination of connections to motors and other electrical equipment like pressure switches etc. which need to be disconnected at periodic intervals.

All conduits shall be effectively connected to the earth terminal of the equipment where it terminates.

Both ends of conduits shall be suitably earthed. Earthing continuity to be maintained by means of flexible wire wherever two conduits are joined with sockets.

Approved conduit bending machines to be arranged by the contractor shall be used for bending conduits at site. The radius of any conduit bend shall be as per standards for cabling. Bends shall be free from cracks, crimps or other damage to the pipe or its coating.

1.02.22 Earthing and lightning protection

01 Earthing

Entire system shall be earthed in accordance with the provisions of the relevant IEC recommendations/ IS code of practice IS 3043-1987 and Indian Electricity Rules, so that the values of the step and contact potentials in case of faults are kept within safe permissible limits.



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Parts of all electrical equipment and machinery not intended to be alive shall have two separate and distinct earth connections each to conform to the stipulation of the Indian Electricity Rules and apparatus rated 240 V and below may have single earth connections.

All shops and buildings as well as the electrical sub-stations and electrical rooms shall be provided with a ring main earthing system each. Individual ring main earthing systems shall again be interconnected as a network.

The ring earthing system around each building shall be laid at a distance of approximately 1.5 m from the building and at a depth of approximately 0.8m. The ring shall be bonded at intervals to the building steel structures, reinforcement of building columns and also to pipes, wherever they are crossing. The earth ring shall further be connected at intervals to deep earthing electrodes to achieve a combined earth resistance of less than one ohm.

For the purpose of dimensioning the earthing lines/conductors, the duration of the earth fault current shall be taken as 0.3 seconds.

For different floors in a building, localized ground mats shall be formed and connected to the ground earthing ring through vertical risers. The earthing mat shall be common to both power and lighting installations.

For protective earthing separate conductor shall be used for flow of earth fault current as elaborated below.

The LV side neutrals of the Power distribution transformers shall each be connected to two separate earthing electrodes. They shall also be connected with the neutral bus of the corresponding switchgear and the switchgear neutral bus shall be connected to the earthing ring at two different and distinct points. The fourth core or armour of cables and all conduits for cables shall also be connected to the earthing mains. A continuous earth strip shall be run in each side of cable tunnel and in cable ducts and trenches.

The power supply cables (LT) from the sub-station and the distribution cables to individual motors shall have 4/3.5 cores.

LT power supply cables shall have four cores and the fourth core shall have cross-sectional area of 50% of the other cores generally. The fourth core of the main supply lines shall be connected to the solidly earthed neutral bar in the substation switchgear as well as at the earth bars in MCC/distribution boards.

Separate electronic earthing system shall be provided for all electronic equipment like PLC"s, weighing panel, computer etc.



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Earthing scheme to be finalized before basic engineering, in consultation with the client and approval of OEM.

02 Conductor sizes for ground connections:

For equipment ground connections, the minimum conductor sizes used should be as follows:

02.1 High voltage systems :-

75 x 5 mm GI flat :

- Main earthing rings
- Main LT switch-boards
- Transformers
- Earthing leads to earth electrodes.

02.2 LT system where the voltage does not exceed 650V normally :

6 Sq.mm Stranded GI wire :

- Motors and starters upto and including 2.2kW, Light fitting, JB's, etc.
- Instruments and miscellaneous small items protected by fuses of ratings not exceeding 15A.

16 Sq. mm Stranded wire :

- Motors and starters above 3.7 kW and upto and including 15 kW.

25 x 3 mm GI flat :

- Motors and starters above 15 kW, and upto and including 45 kW
- Control desks, cabinets, LCB, Welding socket outlet, Isolators, LDB's.

50 x 6 mm GI flat :

- Motors and starters over 45 kW and HT motors
- MCC, PDB, MLDB.
- Main earthing ring for MCC room, in shop units/plant buildings
- Bonds to crane gantries
- Cable trays all around
- LT Switchboards and other equipment protected by circuit breakers.

03 Earthing electrodes:

The earthing electrodes shall be of GI pipes 50 mm dia and about 4 mm thickness in one piece provided with water holes and other filling devices. Earthing system for



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computers and microprocessor based equipment/ PCs shall be distinct and separate from the power and lighting equipment earthing system.

Earthing of electrical equipment on cranes and travelling machines:

Every electrical equipment shall have double earthing.

A ring earthing system shall be provided within the crane/machine to which every electrical equipment shall be connected at least at two places.

The earth ring on the crane/machine shall be connected to the plant earthing system through the gantry rails. Two sets of earth collector brushes shall be provided on each side of crane/machine to connect its earth ring to the gantry rails.

Each end of each gantry rail shall be bonded to the plant earthing system.

In addition, intermediate earthing bond shall also be provided on the rails at every 60 m in case of longer tracks.

Flexible copper bonds shall be provided across any gap in the running gantry rails.

For mobile equipment with flexible cables, one separate copper conductor of adequate size shall be provided for earthing.

04 Lightning protection

All buildings and plant structures vulnerable to lightning strokes owing to their height or exposed situation shall be protected against atmospheric flash-overs and lightning strokes in such a manner as to eliminate any danger to the personnel employed therein. Stipulations of IS : 2309 - 1969 shall be followed.

A 'Faraday Cage' made of hot galvanised strip steel connected to all buried pipes and steel structures crossing this cage ring shall be laid around each main building or plant unit as earthing device. This shall be separate from the electrical equipment earthing ring main.

All lightning arrestor earth leads of the buildings and plant units shall be connected to this cage ring.

Air termination network should cover all salient points of the structure. All metallic chimneys, ducts and the like above the roof of the structure shall be bonded to and form part of the air termination network. Vertical air termination points shall project at least 30 cm above the object on which it is fixed.

Down conductors shall follow the most direct path possible between air termination and earth termination avoiding sharp bends. Down conductor shall have a testing point adjacent to the earth electrode. Each conductor shall have an independent earth termination. All earth terminations shall be interconnected.

Earthing electrodes and grid for lightning protection will be distinct separate from the earthing system for earthing of electrical equipment and at no place will be connected to other earthing system.

Earthing connection to equipment subject to movement, vibration and shocks, shall be through flexible stranded conductors.



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The termination of strips to the equipment shall be done by bolting and the wires shall be terminated by compression lugs. Jointing of strips shall be done by welding for proper continuity. All contact surfaces shall be thoroughly cleaned of dust and oil and after jointing, the joints shall be given bitumen paint.

Earthing conductors laid directly in ground, shall be coated with one coat of bituminised paints, be wrapped with one layer of bitumaetic tape laid on half lapped and shall have a final coat of bituminised paint to prevent corrosion.

Earthing conductors run on walls/floors/cable and equipment structures etc. shall be supported at suitable intervals and painted with black oxide paint.

All joints in the branch connections except at earthing electrode shall be welded and painted black.

At road /rail crossings earthing strips shall be laid through conduits /concrete ducts. Special earthing shall be provided for all electronic equipment as per manufacturer's recommendations / practice.

1.02.23 Repair network

01 General

A repair network shall be laid to cover all the units/buildings of main technological plant for providing power to maintenance tools, tackles and telfhers.

Welding switch socket outlets shall be provided at every 60m distance in conveyer galleries and atleast one at every working platform of junction houses. The number of welding socket outlets for main technological plant units shall be decided based on requirement, approach etc. Generally the socket outlets shall be provided in such a manner so that using 30m flexible cable with welding set, total plant area can be covered. Upto three switch socket outlets can be looped per feeder circuit. Sheet metal clad switch units shall be provided for feeding power to telfhers.

02 Switch socket outlets

- 415V, 100 A, 3 pole load break switch
- 3 phase and one earth pin socket
- Switch socket interlocked so as to prevent insertion or withdrawal of plug when switch is "ON".
- Facilities for terminating two cables of 3.5 x 70 sq. mm aluminium cables.
- All the switch socket outlet shall be fed from PDB directly .

03 Cables

- Outgoing feeders to switch sockets 3.5 x 70 sq. -mm for 100A sockets,

- Outgoing to telphers as per requirement.

1.02.24 Ventilation and Air-Conditioning of Electrical Premises/Control Rooms

01 General

The control rooms shall be provided with air conditioning system. For central control rooms of standby air conditioners shall also be provided.

Rooms for shift in-charge and office in-charges shall be provided with package AC units.

Separate room, as part of control room shall be provided to house AC units.

The ventilation and air-conditioning system supplied shall be complete with all necessary central air-conditioning plants (modern microcomputer based), packaged air-conditioners (micro-computer based), fresh air filters, fan units, supply and return air ducts, monitoring and regulating equipment and electrical power supply equipment to complete the job complete in all respects.

Necessary safety interlocks shall be provided to stop the fans/AC system in case of fire and to prevent spread of fire.

Window / package Air conditioners: Energy savers with temperature sensors / Time switches for switching ON/OFF of compressor motors.

The equipment shall meet the requirement listed in equipment specification under part-I.

02 Switchgear rooms, MCC rooms, Cable cellar

All HT/LT substations, switchgear rooms and MCC rooms, cable basement/cellars which do not house any electronic equipment but contain only electrical equipment, shall be pressurised with cooled washed air to maintain the room temperature within 45 deg.C irrespective of outer temperature . This shall match with the duty conditions of electrical equipment in the rooms. Where a large number of electrical equipment are involved, adiabatically cooled air washer system shall be provided to maintain room temperature at 40deg.C. Suitable capacity fan and pumps (1W+1S) shall be provided for each unit. Necessary ducts shall be supplied by tenderer.

03 Electrical rooms with electronic equipment

The electrical rooms housing electronic equipment, Remote I/Os, electronic weighing panels including telephone exchange equipment shall be air-conditioned with pressurisation to maintain the following conditions:



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- Room temperature : 30 Deg.C
- Relative humidity : Not more than 50 %
- Pressurisation : 2-3 mm WC

04 Central Control rooms, Rooms for PLC, Servers, Computers and Level-1/2 automation system equipment.

These rooms shall be air-conditioned with pressurisation to maintain the following conditions:

- Room temperature : 21 to 24Deg. C
- Relative humidity : 50 to 60%
- Pressurisation : 2-3 mm WC
- Temperature gradient: 2 Deg. C/h

05 Small local Control Rooms/pulpits

The control rooms/pulpits shall be air-conditioned to maintain the following conditions:

- Room temperature : 24Deg. C
- Relative humidity : 50-60%
- Pressurisation : 2-3 mm WC

06 Cable tunnels and basements

These shall be ventilated with fresh filtered air to maintain temperature of air at exit so as not to exceed 45 deg.C and pressurised - ventilation of cable basements and tunnels shall not be combined with other premises.

Cable tunnel ventilation shall be sectionalised to maximum length of 150m.

Temperature rise shall be limited to 3-5 deg. C above atmospheric dry bulb temperature subject to a maximum of 45 deg.C at the exit of air from these premises.

Ventilation and air conditioning system shall be interlocked with fire detection system for safety.

1.02.25 Testing

Test of all equipment shall be conducted as per latest ISS/ IPSS applicable. Tests shall also confirm to International Standards IEC/VDE/DIN/BS (in case corresponding test are not mentioned in ISS/ IPSS).



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All routine test shall be carried out at manufacturer's works in the presence of purchaser or his representative.

The tenderer shall submit type test certificates for similar equipment supplied by him elsewhere. In case type test certificates for similar equipment are not available, the same shall be conducted in the presence of purchaser or his representative if purchaser so desires, without any financial implications to the purchaser.

All the equipment shall be tested at site to know its condition and to prove suitability for required performance. The site tests and acceptance tests to be performed by Contractor are detailed below.

The Contractor shall be responsible for satisfactory working of the complete system in an integrated manner and its guaranteed performance.

1.02.25.01 Type & Routine

.01 Transformers

A. Routine Tests

- viii) Assembly inspection/ Painting check
- ix) Measurement of winding resistance
- x) Measurement of voltage ratio and check of voltage vector relationship
- xi) Measurement of impedance voltage (Principal tapping), short circuit impedance and load loss.
- xii) Measurement of no-load and current.
- vi) Measurement of insulation resistance/ polarizatation index.
- xiii) Dielectric test:
 - a) Induced over voltage withstand test
 - b) Applied voltage withstand test
(H.V. power frequency test)
- xiv) Certification for off-load tap changer
- xv) Final documentation check

B. Type Tests

- i) Temperature rise test
- ii) Measurement of acoustic sound level
- iii) Lightning impulse withstand test (if test certificates are not available)
- iv) Short circuit test
- v) Measurement of commutating reactance and determination of inductive voltage drops (for thyristor converter transformer only).

.02 Busduct

A. Routine Tests

- i) One min. power freq. withstand voltage



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- ii) Measurement of insulation resistance
- iii) Measurement of resistance and reactance of busbars

B. Type Tests

- i) Heat run test
- ii) Short time rating test (thermal & dynamic)
- iii) Impulse withstand test
- iv) Tests for degree of protection for enclosures

.03 Power Control Centre and LT switchgear

A. Routine Tests

- i) Assembly inspection/ Painting check
- ii) Measurement of insulation resistance
- iii) Dielectric test for assembled unit
- iv) Functional test including automatic bus transfer scheme
- v) Tests of ACBs including operation test, calibration of releases, measurements of contact resistances.
- vi) Polarity tests for CTs.
- vii) Final documentation check

B. Type Tests

- i) Temperature rise test for main and vertical bus-bars.
- ii) Short-circuit test for main and vertical bus-bars.
- iii) Enclosure class, degree of protection
- iv) Dielectric test including protective circuit.

.04 Load Break Isolator

A. Routine Tests

- i) Assembly inspection/ surface treatment check
- ii) Power frequency voltage withstand dry test on the main circuit.
- iii) Voltage withstand test on auxiliary and control circuits.
- iv) Check of the main circuit
- v) Mechanical operating test
- vi) Insulation resistance measurement
- vii) Contact resistance
- viii) High voltage test
- ix) Final documentation check

B. Type Tests

- i) Type test for typical isolator and/ or earthing switches



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- ii) Temp. rise test of contact

.05 Current Transformer and voltage transformer

A. Routine Tests

- i) Assembly inspection
- ii) Power-frequency tests on primary windings
- iii) Power-frequency tests on secondary windings
- iv) Over-voltage inter-turn tests
- v) Dielectric test
- vi) Ratio & polarity test
- vii) Measurement of ratio error & phase angle error
- viii) VI characteristics
- ix) PT winding resistance
- x) Final documentation check

B. Type Tests

- i) Short-time current test
- ii) Temperature rise test

.06 Final Test of Materials of Grounding and lightning system

- i) Visual check
- ii) Dimensional check
- iii) Accessories fitting check
- iv) Mechanical and electrical test (where applicable)
- v) Final documentation check

07 CABLES

1. Shop Tests

- a) The cables shall be subject to shop tests in accordance with relevant standards to prove the design and general qualities of the cables as below:-
 - b) Routine test on each drum of cables
- 2. Acceptance tests on drum chosen at random for acceptance of the lot
 - a) High Voltage withstand test for HT cable (Hi Pot test)
 - b) Type tests certificates on each type of cable, inclusive of measurement of armour D.C. resistance of power cables will be furnished by Contractor

B. PACKING

- 1. Cables will suit barrel diameter and securely clamped/fixed. The barrels must be sufficiently strong to withstand mechanical shocks and shall effectively protect against transit.



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2. Both ends of cable will be metal capped to prevent moisture ingress. Ends shall be kept inside the cable drum in a manner so that these are accessible for testing.
3. Cable drum identification/markings will be as follows:
 - a) Makers name
 - b) Consignee's full address
 - c) Type size and length of cables
 - d) Net and gross weights
 - e) Any other marking for shipping
 - f) Drum Markings

C. Drum Lengths

1. LT Cables will be delivered at site preferably on standard drums each containing 500 m or 1000 m cables, Where total quantity of a particular cable is less than 500 m, the entire length will be supplied in one drum.
2. For 90% cable drum of each item of cable permissible tolerance is in length + 5% For 10% balance cable drums, Contractor shall ensure that each 500 m capacity drum contains at least 250m and each 1000m capacity drum contains at least 500m cable lengths. Overall tolerance for each item of cable is + 1% of total length.

08. Motors :-

A. Routine Tests

The following are the routine tests carried out on each and every motor :

- 1.0 Measurement of resistance.
- 2.0 Insulation resistance test .
- 3.0 Motors are tested at 1/3 times the rated voltage for checking the ability of the motor to run upto full speed , when switched in either direction .
- 4.0 No load test .
- 5.0 High voltage test .

B. Type Tests

- 1 Measurement of rotor resistance .
- 2 No load test
- 3 Locked rotor test .
- 4 Full load reading of voltage, current , power input and slip.
- 5 Temperature rise test.
- 6 Momentary overload test .
- 7 Insulation resistance test .
- 8 High voltage test .
- 9 Polarisation index test (for HT motors)



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09 SITE TESTS AND CHECKS

001 General

All the equipment will be tested at site to know their condition and to prove suitability for required performance.

The test indicated in following pages will be conducted after installation. All tools, accessories and required instruments will have to be arranged by contractor. Any other test that is considered necessary by the manufacturer of the equipment, Contractor or mentioned in commissioning manual has to be conducted at site.

In addition to tests on individual equipment some tests / checks are to be conducted / observed from overall system point of view. Such checks are highlighted under miscellaneous tests but these will not be limited to as indicated and will be finalised with consultation of client before charging of the system.

The Contractor will be responsible for satisfactory working of complete integrated system and guaranteed performance.

All checks and tests will be conducted in the presence of Client's representative and test results will be submitted in six copies to Client and one copy to Electrical Inspector.

Test results will be filled in proper proforma.

After clearance from Electrical Inspector, system / equipment will be charged in step by step method.

Based on the test results clear cut observation will be indicated by testing engineer with regard to suitability for charging of the equipment or reasons for not charging are to be brought by the Contractor.

002 Trial Run Test

After the successful test of each equipment as per standard test procedure, the entire control system will be put on trial run test on actual site conditions and operation of the system.

003 Acceptance Test

The acceptance test on the system will be carried out by the contractor as per mutually agreed test procedures to establish satisfactorily functioning of the system as a whole and each equipment as part of the system.

004 Site Tests

The tests to be carried out on the equipment at pre-commissioning stage will include following but not limited to the following:

Transformer

- 1 IR test on each winding to ground and between winding and check for polarization index.
- 2 Turns ratio test on each tap
- 3 Polarity and vector group test
- 4 Measurement of winding resistance for windings by Kelvin bridge.
- 5 Heating and drying and checking with heating and cooling curve.



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6. Checking of earthing wrt transformer tank (flexible from top cover to tank) other parts, neutrals and tank to electrodes of LAs (for LAs located near transformer)..
7. Testing of Buchholtz relay for alarm and trip conditions
8. For bushing CTs, tests applicable will be as for current transformers.
9. Calibration and setting of oil/winding temperature indicators, level gauge
10. Check insulators for cracks.
11. Checking for oil leakage and arresting of leakages (if required)
12. Checking of operation of all valves.
13. Checking of open operation of all valves (except drain and filter set)
14. Filtration of oil by using line filter and heater set
15. BDV test on Oil samples from top & bottom
16. Checking of Oil for acidity, water content and tan delta as per IS 335.
17. Measurement of magnetising current and no load loss.
18. Checking of silica gel breather.
19. Checking of noise level at no load and at full load.
20. Checking of air circulation conditions for indoor transformers.
21. Conducting magnetic balance test.
22. Checking of other points given in manufacturer's commissioning manuals.
23. IR, wiring and operational tests on all control devices in control cabinet, oil level indicator winding and oil temp. indicators, oil pump, cooling fan etc.

HT ISOLATOR

1. IR test before & after HV test
2. HV test
3. Operational test
4. Checking of interlocking with earth switch
5. Checking of operation of earth switch
6. Checking of tightness of earth connection
7. Check for continuity of aux contacts



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8. Check working of shunt trip (if applicable)
9. Checking of CTs, PTs (if applicable) as per the details given in HT board.
10. Contact resistance/ millivolt drop test

LT SWITCHBOARD

1. IR test
2. HV test with 2.5 kV megger
3. Functional test for all feeders
4. Testing and calibration of all meters
5. Checking and calibration of overload relays and protective relays by primary injection method.
6. Check operation of contactors from local and remote points.
7. Checking of interlocking between incomers/ bus couplers and other feeders
8. Test of prove interchangeability of similar parts.
9. Test to prove correct operation of breakers at minimum and maximum specified control voltages.
10. Checking operation of RC circuit (if there) for tripping of circuit breaker after disappearance of control voltage.
11. Checking of earthing connection for neutral-earth bus, cable armour, location of E/F CT etc. as per the scheme.
12. Checking of tests, service and drawout position of all the breakers and operations of mechanical flag indicator and electrical indication lamps.
13. Checking the functioning of various electrical schemes like auto change over, signaling etc.
14. Contact pressure test

BUS DUCTS

1. IR measurement before and after HV test.
2. HV test.
3. Checking tightness of bolts with torque wrench.
4. Checking for phase sequence marking.
5. Check for clearances between phase to phase and phase to earth.
6. Check for minor damages and cracks in supporting insulators and bushings after cleaning.
7. Checking of busbar cracks and rectification of same.



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8. Checking for inspection openings and accessibility for replacement of insulator etc.
9. Check tightness of earthing connections on enclosure.
10. Checking of silicagel breather (if there).
11. Checking of working of space heater.
12. Hot air blowing to remove moisture if required.

Cables

1. Visual check
- .2 Checking of continuity and IR values for all the cables before and after HV test.
- .3 HV test and measurement of leakage current after termination of cable kits (for HT cables).
- .4 Checking of earth continuity for armour and fourth core (if applicable)
- .5 Check for mechanical protection of cables.
- .6 Check for identification (tag number system) distance placement of cable marker, cable joint etc. as per the cable layout drawing.
- .7 Check earthing of cable structures.
- .8 Check safe head room in tunnel and basement area.
- .9 Check clearance from ventilation duct and light fittings for cable structures.
- .10 Check proper fixing of cable structures.
- .11 Check for proper drainage and removal of water (if any).

Lightning Protection

- .1 Check continuity of all the earth strips / shield wire.
- .2 Check tightness of all connections.
- .3 Measure earth resistance of each electrode and combined system.

Earthing

- .1 Check tightness of all earth connections.
- .2 Check earthing of all metallic equipments, cable trays, busbar supporting structures, building column (if steel) all elect equipments, pipe lines etc. as per the drawing / specification
- .3 Measurement of earth resistance for each electrode.
- .4 Measurement of total earth resistance.



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.5 Measurement of earth loop resistance for E/F path of biggest LT drive.

Miscellaneous

- .1 Checking of continuity of the system.
- .2 Checking of phase sequence from overhead line consumer end.
- .3 Checking safe accessibility of all operating points
- .4 Check availability of emergency lighting
- .5 Check availability of control aux. supply.
- .6 Ensure availability of first aid box, fire fighting equipments, earth discharge rods, rubber mats, rubber glove.
- .7 Check oil drainage system for transformer oil
- .8 Check filling of gravels in transformer pits.
- .9 Check for safe movement of operators control room / switchgear etc., wrt proper illumination, escape light uncovered openings provision of hand railings in stairs etc.
- .10 Check proper covering of cable channels.
- .11 Placement of shock treatment chart, danger boards provision of boards indicating 'Man on work' 'Do not switch ON' 'Do not switch OFF'. 'EARTHED' etc.
- .12 Provision of route map at gallery entry points for indication of escape.
- .14 Check proper dressing of cables, mechanical protection of cables, placement of cable markers.
- .15 Check sealing of all cable openings including conduits opening with fire resistance material.
- .16 Check sealing of all openings at bottom of electrical panels.

APPENDIX

TABLE - I

SELECTION OF POWER COMPONENTS & WIRING FOR CONTINUOUS DUTY CAGE MOTOR DRIVES

Rating of MCCB / MPCB as required shall be selected based on type-2 protection.

Motor rating at S1 duty (kW)	Minimum rating of MCCB in Amps (AC23)	Minimum rating of Power contactor Amps (AC3)	Minimum size of Cu wire / flat in sq. mm for internal power connection	Minimum size of Power cable (Al.) termination in sq.mm.



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Up to 3.7 (DOL)	32	32	4	4x2.5 Cu.
Up to 3.7 (RDOL)	32	32	4	4X2.5 Cu.
5.5	32	32	4	4X6
7.5	63	32	4	4X6
11	63	45	6	4X10
15	63	45	10	4X16
18.5	63	70	16	4X35
22	125	70	16	4X35
30	125	110	35	3.5X50
37	125	110	35	3.5X50
45	250	170	50	3.5X95
55	250	170	70	3.5X120
75	250	250	95	3.5X185
90	250	250	30X5 Flat	2(3.5X120)
110	400	400	30x5 Flat	2(3.5x120)
125/132	400	400	30x5 Flat	2(3.5x120)
160	400	630	40x5	2(3.5x185)
180/200	630	630	30x10	3(3.5x185)

1.02.27 ILLUMINATION

1.0 General

The lighting system inside and outside plant units are designed based on the desired illumination levels recommended by IS and the practices followed in industries, architectural arrangement, building dimensions including mounting height, environmental considerations, ease of maintenance and reliability of the lighting distribution network.

- 2.0 The illumination system shall be designed as per IS:3646-1992. The level of illumination, type of fittings, maintenance factor to be considered is as given below:

Area	Type of Light Fittings	Lux level	MF
Control rooms	Louvered recessed type 2x40W & 4x20W fluorescent fittings	300	0.75
Electrical rooms having PDB, MCC, VFD panels, PLC	Industrial corrosion proof fluorescent lamp fittings for 2x36W fluorescent lamps Philips type TKC 22/236 or equivalent	200	0.7
Staircases of plant buildings	- do -	70	0.6
Staircases (steel) of plant	Industrial well-glass integral type luminaire	70	0.6



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complex and cable tunnels / cellars	suitable for 70W HPSV lamps, similar to Philips type SDL-23/70 or equivalent		
Pump house	- do -	200	0.6
Flood lighting	Weather proof flood light fittings for 1x400W HPSV lamps Philips type H/SVF12 or equivalent	70	0.5
Pipeline tunnel	Industrial fittings for 24V, 2x50W halogen lamps "Sigma" make deck lights or eqvt.		
Casting Bay	High bay HPSV industrial incandescent (1000 W) equivalent to HDK /SDK of PHILLIPS make	200	
Conveyor Houses / conveyor gantries / junction houses	Fluorescent / incandescent industrial type fitting equivalent to TPW / NXC of PHILLIPS make	70 to 100	
Aviation obstruction	Aviation obstruction light fittings, flame retardant type consisting of multi ultra high intensity 60 mscp LED module, without flashing module, steady in red colour, having omni directional capability and shall be suitable to deliver maximum light output in the zone between 70° above and 10° below the horizontal with a maximum of condition at 20° above the module.		

a) Standard wattage of lamps shall be

1. FTL

36 W high luminous lamps.

2. HPMV

250 and 400 W

3. HPSV

70, 150, 250 and 400 W

4. Incandescent

60, 100 W (Use of Incandescent lamps shall be avoided)

b) Compact fluorescent lamps are to be used for offices and corridors.

c) All switches and sockets used in office buildings shall be of flush type

d) For street lighting, necessary control gear shall be provided for reduced voltage running during off peak traffic for energy conservation.

Illumination: Electronic ballast having third harmonic distortion less than 6 % and total harmonic distortion less than 12 % with high luminous tube lights are to be used. Time switches, reduced voltage controllers, group solar lighting sections for remote areas shall be provided wherever feasible. Lighting Fixtures and Accessories shall be energy efficient

3.0 Area Lighting :-

Classification	Type of road	Av. Lux level	Type of illumination	MF
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Group - A1	Important traffic road carrying fast traffic	30	Cut off / semi cut off	0.6
Group - A2	Main road carrying mixed traffic	15	Cut off / semi cut off	0.6
Group - B1	Secondary road with considerable traffic	8	Cut off / semi cut off or non cut off	0.6
Group - B2	Secondary road with light traffic	4	Cut off / semi cut off or non cut off	0.6

MF : Maintenance factor

The light fittings shall be complete with all accessories like electronic ballast, reflector etc. External area lighting including street/road lighting / tower lights shall be fed from MLDB through separate SLDB located at suitable places. Automatic switching ON/OFF of these circuits shall be done through timers. Flood light towers shall be fed through 415/240V, 3 phase, 4 wire circuit with individual fittings distributed at 240V, single phase, with control and protection located at bottom of each tower. Rewireable fuse in a sheet steel box shall be provided near each fitting to facilitate removal of lamp in off position.

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.

B. Power distribution

- 1.0 The distribution of lighting power supply for the individual areas shall be done at 415V, 3 phase, 4 wire bus system through Main Lighting Distribution Boards (MLDB) for the area. **The MLDB shall be fed through a lighting transformer** . The outgoing feeders of the MLDB shall feed the required numbers of Sub Lighting Distribution Boards (SLDB) for lighting. Each SLDB shall receive power at 415V AC, 3 phase, 4 wire and distribute it into 240V, 1 phase circuits for connection to the lighting fixtures and 240V receptacles. The SLDB shall be located in the rooms, bays etc. covering the respective zone. The SLDB shall be located in the electrical rooms in the respective area.

2.0 Emergency lighting

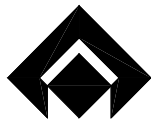
In case of indoor illumination, separate lighting circuit shall be provided as emergency lighting circuit. Emergency lighting circuit shall be through emergency MCC/PDBs so that in case of failure of power in lighting DBs circuit, these lights can continue to glow. 20% lights shall be connected to this circuit. Balance lights shall be connected through lighting circuit.

Portable Emergency lighting including built-in battery, battery charger & lamps shall be provided in strategic areas like control rooms, staircases, entry of cable tunnels/basements, escape routes, etc. for safety.

3.0 Maintenance lighting

For maintenance lighting, power supply shall be fed from 240/26.5V small capacity step-down transformers to the 24V socket outlets.

4.0 Outdoor lighting



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Flood lights for area lighting shall be mounted on towers/poles or building structures. Tower height shall be kept to an average of 22m.

Street/road lighting and boundary wall lighting shall be provided with HPSV/fluorescent lamp fittings mounted on poles of 9m to 11m height.

Neon aviation obstruction lights shall be provided on chimneys and other such tall installations as per regulation. M/S Binay or equivalent make aviation obstruction lights(LED type) shall be provided . For street lighting necessary control gear shall be provided for reduced voltage running during off peak traffic for energy conservation .

5.0 Power factor improvement

Power factor of all the light fittings shall be improved so that it is not less than 0.90. Power factor shall be improved by providing capacitor banks with discharge resistor in the light distribution or by providing capacitors with individual fittings.

C. SPECIFICATIONS :-

A. EQUIPMENTS AND COMPONENTS

1 Lighting Transformer

Sl.No.	Parameter	Description
1.0	Type	Dry Type
2.0	Power Rating	As per load calculation
3.0	Primary Voltage	415 V
4.0	Secondary Voltage	415 V
5.0	Connection	Star - Star

2.0 Main Lighting Distribution Board (MLDB)

A. General		
1.0	Type	- Metal clad . - Non drawout type.
2.0	Construction	- Modular construction . - Fully compartmentalized with metal / insulating material partition.
3.0	Enclosure class	IP52
4.0	Type of execution	Single front.
5.0	Mounting	- Floor mounting. - Free standing with ISMC 75.
6.0	Installation	Indoor.
B. Constructional Features :-		
1.0	Sheet steel	
	Thickness	- 2 mm for load bearing members. - 1.6 mm for non load bearing members.
	Material	CRCA
2.0	Cable entry	- Incomer :- Bottom cable entry. - Outgoing :- Bottom cable entry.
3.0	Design	- Separate bus alley and cable alley on opposite side of the outgoing modules .



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		<ul style="list-style-type: none">- All the components shall be accessible from front .- Each module to have covering at the bottom.
4.0	Interlocking & protection	<ul style="list-style-type: none">- Module door interlocked with main power isolating devices.- Power circuit isolation device to have pad locking in the OFF position with door closed.
5.0	Operating height	<ul style="list-style-type: none">- Minimum :- 300mm- Maximum :- 1800 mm.
6.0	Gland plate	Undrilled removable bottom gland plates (3 mm thick)
7.0	Miscellaneous	<ul style="list-style-type: none">- Neoprene rubber gasket shall be provided for all the doors , removable covers & between adjacent covers .- Lifting hooks for the panel .- Doors shall have concealed hinges .
8.0	Labelling	Clear legible identification labels (anodized aluminium with white letters engraved on black background) with letter sizes of :- <ul style="list-style-type: none">- 25-50 mm for MLDB panel- 5 mm for components and module name plates.- Danger board on front and rear sides in English , Hindi and local language .
9.0	Earthing	<ul style="list-style-type: none">- Two separate earthing terminals will be provided.- Bolted joints with tooth spring washers for good earth continuity.- Earth bus to run in all cable alley of the panel .
10.0	Shipping length	To be limited to 2.4 M.
11.0	Limiting dimensions	<ul style="list-style-type: none">- Width of MLDB :- 2400 mm- Depth of MLDB :- 500 mm- Width of Cable alley :- 300 mm- Width of Bus alley :- 300 mm- Height of module :- 400 mm (min)
12.0	Paint shade	Shade No. 631 as per IS-5:1992.
C. Busbars		
(i) Main horizontal & vertical busbars		
1.0	Arrangement	Three phase & neutral.
2.0	Material	High conductivity electrolytic aluminium alloy conforming to grade E91E as per IS-5082 –1981.
3.0	Phase Busbar Rating	<ul style="list-style-type: none">- Shall be able to carry continuously the connected load (considering all derating factors) plus a 25% margin .- Max. current density shall be- 1.0 A/sq.mm for Aluminium- 1.5 A/sq.mm for Copper .
4.0	Neutral Busbar Rating	50 % of phase busbar rating
5.0	Short circuit rating	50 KA for 1 sec.
6.0	Busbar configuration	Red-yellow-blue from front to back or top to bottom or left to right as viewed from front.
7.0	Busbar insulation	Heat shrinkable PVC <ul style="list-style-type: none">- R,Y,B coloured sleeves for phases- Black for neutral.
8.0	Busbar supporting insulators	<ul style="list-style-type: none">- Non-hygroscopic- Flame retarded



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		<ul style="list-style-type: none"> - Track resistant - High strength - Sheet moulded compound or equivalent polyster fibre glass moulded type .
9.0	Max. temp. rise of bus	Not to exceed 35 deg. C. above ambient of 50 deg.C.
10.0	Air clearance for bare busbar	Phase to phase :- 25.4 mm (minimum) Phase to earth :- 19.0 mm (minimum)
11.0	Joints and tap off points	<ul style="list-style-type: none"> - Busbar joints and tap off points shall be shrouded and bolted (with cadmium coated bolts with plain and spring washers and locknuts). - Bimetallic connectors for connection between dissimilar metals . - Antioxide grease for all bus connections .
12.0	Neutral bus isolation	Through disconnecting link .
13.0	Vertical busbar	Rear side
(ii) Earth bus		
1.0	Material	GI.
2.0	Size	Minimum 50 x 6 mm with extension at both ends .
(iii) Control bus		
1.0	Material	Copper.
2.0	Size	Minimum 25 x 3 mm .
D. Insulation level		
1.0	Rated insulation voltage	1100 V
2.0	Impulse withstand voltage	4 KV as per IS-13947 (Part I) 1993
3.0	One minute power frequency withstand voltage	2.5 KV for power circuit & 500 V for control circuit
E. Pollution Degree		
1.0	Pollution Degree	Pollution Degree 3 as per IS-13947 (Part-1) : 1993 ; unless otherwise stated
F. Feeder arrangement		
Incomers		
1.0	Isolating Equipment	3 pole MCCB (for rating upto 630 A) (with E/F protection).
2.0	Quantity	Two incomer
3.0	Autochangeover	<ul style="list-style-type: none"> - Through contactor logic with suitable timer. - Normally only one Incomer shall be ON .
4.0	Indication Lamps	LED type indicating lamps for :- <ul style="list-style-type: none"> - MCCB ON/OFF/TRIP. - Power ON R / Y / B .
5.0	Meters and selector switches	<ul style="list-style-type: none"> - 144 sq.mm size voltmeter with 7 position selector switches - 144 sq.mm size ammeter with 4 position selector switches
6.0	Current transformer	3 numbers for metering .
Outgoing feeder arrangements		
1.0	Circuit breaker	Three pole MCCB .
2.0	Indications	ON/OFF/TRIP indication lamp.
3.0	Protection	All the equipment inside the boards shall be covered in front with a 3 mm thick bakelite sheet. Only the operating knobs of the equipment shall be projected outside the bakelite sheet for safe operation.



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G. Panel wiring		
1.0	Power / current transformer circuit	1.1Kv grade single core , black colour PVC insulated , stranded copper conductor of minimum size 2.5 sq.mm.
2.0	Ferrules	- Numbered plastic/ceramic ferrules. - Self locking type.
3.0	Marking	- Wiring will be properly marked as per relevant IS.
4.0	Terminals	- Power & control terminals shall be segregated by insulating material like hylam / bakelite sheet. - Power terminals will be stud type. - Control terminals will be ELMEX type suitable for connecting two cores of 2.5 sq.mm wires. - Minimum 20 % spare terminals will be provided. - The minimum rating of control terminal shall be 10 Amps.
5.0	Cable glands	Double compression cable glands for receiving external power and control cables

3.0 SUB LIGHTING DISTRIBUTION BOARD (SLDB)

1.0	Type	- Metal clad - Shall be suitable for 415/240V, 3 phase and neutral.
2.0	Construction	- Totally enclosed. - Dust & vermin proof. - Welded back and sides .
3.0	Enclosure class	IP54 . IP 55 (with canopy) for outdoor installation .
4.0	Type of execution	Single front.
5.0	Mounting	Wall mounting .
6.0	Installation	Indoor / Outdoor (with canopy).

B. Constructional Features :-

1.0	Sheet steel CRCA	
	Thickness	2 mm .
2.0	Cable entry	- Incomer :- Bottom cable entry. - Outgoing :- Top / Bottom cable entry.
3.0	Design	- One Incomer and outgoings . - All the components shall be accessible from front . - Access to the operating handle of the incoming isolating switch shall be from the front of the cubicle without opening the front door. - Operating knobs of outgoing MCBs shall be accessible only after opening the front door of the cubicle. - Protective insulated cover plate (3 mm thick bakelite sheet) shall be provided inside the cubicle to shroud all the live parts .
4.0	Gland plate	Undrilled detachable gland plates (3 mm thick) shall be provided at the top and bottom with suitable gaskets for cable entry.
5.0	Miscellaneous	- Neoprene rubber gasket shall be provided for all the doors , removable covers & between adjacent covers . - Suitable locking devices.



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		- Doors shall have concealed hinges .
6.0	Labelling	Clear legible identification labels (anodized aluminium with white letters engraved on black background) with letter sizes of :- - 5 mm for components and module name plates. - Danger board on front and rear sides in English , Hindi and local language .
7.0	Earthing	Two separate earthing terminals will be provided.
8.0	Limiting dimensions	- Width of SLDB :- 800 mm - Depth of SLDB :- 300 mm - Height of SLDB :- 400 mm (min)
9.0	Paint shade	Shade No. 631 as per IS-5:1992.
C. Busbars		
1.0	Arrangement	Three phase & neutral.
2.0	Material	High conductivity electrolytic aluminium alloy confirming to grade E91E as per IS-5082 –1981.
3.0	Phase Busbar Rating	- Shall be able to carry continuously the connected load (considering all derating factors) plus a 25% margin . - Max. current density shall be - 1.0 A/sq.mm for Aluminium - 1.5 A/sq.mm for Copper .
4.0	Neutral Busbar Rating	50 % of phase busbar rating
5.0	Short circuit rating	50 KA for 1 sec.
6.0	Busbar configuration	Red-yellow-blue , black for neutral .
7.0	Busbar insulation	Heat shrinkable PVC - R,Y,B coloured sleeves for phases - Black for neutral.
8.0	Busbar supporting insulators	- Non-hygroscopic - Flame retarded - Track resistant - High strength - Sheet moulded compound or equivalent polyester fibre glass moulded type .
9.0	Air clearance for bare busbar	Phase to phase :- 25.4 mm (minimum) Phase to earth :- 19.0 mm (minimum)
F. Feeder arrangement		
Incomers		
1.0	Isolating Equipment	3 pole ELCB ELCB shall be of AC 23 duty category conforming to IS: 13947-1993 having fully shrouded contacts.
2.0	Quantity	One
3.0	Indication Lamps	LED type indicating lamps for :- - Power ON R / Y / B .
Outgoing feeder arrangements		
1.0	Circuit breaker	DP MCB
G. Panel wiring		
1.0	Power / current transformer circuit	1.1Kv grade single core , black colour PVC insulated , stranded copper conductor of minimum size 2.5 sq.mm.
2.0	Ferrules	- Numbered plastic/ceramic ferrules. - Self locking type.
3.0	Marking	- Wiring will be properly marked as per relevant IS.



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4.0	Terminals	<ul style="list-style-type: none"> - Power & control terminals shall be segregated by insulating material like hylam / bakelite sheet. - Terminals shall be ELMEX type suitable for connecting two cores of 2.5 sq.mm wires. - Minimum 20 % spare terminals will be provided. - The minimum rating of control terminal shall be 10 Amps.
5.0	Cable glands	Double compression cable glands for receiving cables .

4.0 Control Room Switchboard

1.0	Location	Control room for controlling the lighting fixtures
2.0	Type	Flush mounted type
3.0	Construction	Fabricated from 14 SWG MS sheet with 6mm thick bakelite cover Shall have conduct knockouts on the sides.
4.0	Switch mechanism	Quick make and quick break mechanism
5.0	Power source	The switchboards shall be fed from SLDB of respective area.

5.0 Transformer for 24V AC Sockets :-

1.0	Type	Dry type Step-down transformer Air-cooled
2.0	Rating	Minimum 2500VA
3.0	Primary / secondary voltage	240V /26.5 V AC , single-phase
4.0	Construction	The transformer shall be enclosed in industrial wall mounting stainless steel (2 mm thick) box having separate chambers for the transformer, incoming and outgoing MCB's.
5.0	Cable entry	Suitable knock-outs shall be provided at the top and bottom for cable entry through GI pipes.
6.0	No. of winding	Two winding
7.0	Protection	SPN MCB's on primary and secondary side incorporating overload and short circuit releases.
8.0	Utility	Power supply to 24V repair network
9.0	Location	On structural platforms

6.0 24 V AC SWITCH SOCKET OUTLET

1.0	Type	2 pole, 3 pin with third pin earthed industrial type receptacles
2.0	Rating	24 V AC , 5A,
3.0	Construction	Metal clad gasketed construction, weatherproof
4.0	Cable entry	Suitable for cable entry through 20mm dia. conduit.
5.0	Mounting	Wall / column mounting

7.0 240V SWITCH SOCKET OUTLET

1.0	Type	1 pole, 3 pin with third pin earthed industrial type receptacles . non-reversible, metal-clad, dust proof, industrial type suitable for horizontal insertion.
2.0	Rating	240 V AC , 15A,
3.0	Construction	Metal clad gasketed construction, weatherproof



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		All socket outlets will be supplied with heavy-duty type plug and cap with chain.
4.0	Isolation Switch	rotary type switch mounted flush in the socket outlet box. The isolating switches will be manually operated industrial type of category AC 22.
5.0	Protection	Operating handle of the rotary switch will be fixed in such a manner that it will not be possible either to insert or withdraw the plug without switching off the supply.
6.0	Cable entry	Suitable for cable entry through 20mm dia. conduit.
7.0	Mounting	Wall / column mounting
8.0	Inscription	Inscription plate will be provided indicating the voltage and current rating of the switch socket outlet.
9.0	Miscellaneous	In hazardous area, flame proof switch socket outlet will be provided.

8.0 Miniature Circuit Breakers

1.0	Type	Heat resistant plastic moulded type
2.0	Ref . Standard	IS: 8828 –1978
3.0	Protections	MCBs shall be provided with quick break trip-free mechanism and direct acting thermal overload and short circuit trip elements.
4.0	Short circuit capacity	Not less than 9000A at 0.8pf
5.0	Mounting	DIN Channel mounting . Single phase MCBs mounted adjacent to each other and connected to different phases will be provided with adequate insulated phase barriers.
6.0	Current Rating	The MCBs shall be selected from standard current ratings.(As per SLD) MCB shall confirm to curve C . Motor duty MCBs will be provided, if specified.

9.0 240 V SINGLE/ DOUBLE POLE SWITCHES

1.0	Application	The switches are intended for controlling lighting circuits
2.0	Type	Weather and dustproof and industrial type
3.0	Design	The rotary or toggle switches provided will be of sturdy design
4.0	Standard	As per IS : 6875 (Part-3) - 1980
5.0	Housing	The unit will be housed in cast iron or cast aluminium box having gasketed, screwed front cover plate, fixing lugs and suitable provision for terminating conduit/cable at the top, bottom or sides as specified.
6.0	Mounting	DIN Channel mounting . Single phase MCBs mounted adjacent to each other and connected to different phases will be provided with adequate insulated phase barriers.
7.0	Terminal suitability	Terminals suitable for aluminium conductor cables.

B. Cabling and Wiring

- 01 All wiring from SLDB to lighting fixtures and receptacles shall be carried out with 1100V / 650V grade PVC insulated and PVC sheathed unarmoured cable in MS / GI pipes. For each outgoing phase conductor from the MCB of SLDB, one no. neutral conductor shall be taken



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from the same SLDB and shall run along with the phase conductor throughout the length of the cable run upto the luminaires.

- 02 All lighting cables for the entire complex shall be PVC insulated with copper conductors .

C. Lighting Fixtures and Accessories

- 01 All the luminaires will be designed, manufactured and tested in accordance with the Indian Standards in so far as they are applicable. Lighting Fixtures and Accessories shall be energy efficient
- 02 All the luminaires will be industrial type. Specification for the various types of sodium vapour and fluorescent fittings mentioned in the schedule of quantities will be followed. All the lighting fixtures will be complete with all parts along with lamps/tubes, control gears and accessories for installation and efficient performance whether specifically mentioned in the specification or in the schedule of items or not.
- 03 Individual light fittings will be provided with suitable gland arrangements for 3x2.5 sq.mm armoured copper cable entry unless otherwise specified. Terminals of all fittings will be suitable for taking 3x2.5 sq.mm, copper conductor PVC insulated and PVC sheathed cable.
- 04 All fittings will be supplied with all interconnections made and fully wired upto the terminal block.
- 05 All live parts will be provided with suitable sleeves to prevent accidental contacts. The earthing terminal in the fitting will effectively earth the body of the entire luminaire.
- 06 Dust and vapour tight fittings will have the enclosures suitably designed to withstand the heating effect.
- 07 The fixing arrangement of various components and lamps will be in such a way that the maintenance and replacement jobs can be easily carried out.
- 08 All flameproof equipment will be provided with flameproof plugs.
- 09 Flame proof fittings and control gearboxes will be provided as per relevant IS in hazardous area.

D. ILLUMINATION FITTINGS

1.0 OUTDOOR LIGHTING FITTINGS.

All road lighting fittings will be mounted on steel tubular poles with single/ double or triple outreach brackets having sodium vapour lamps. The fittings will be cut-off / semi cut-off distribution and integral type.

For lighting of open areas self-supporting steel towers shall be provided with flood light fittings and sodium vapour lamps.

2.0 FLUORESCENT FITTINGS

2.01 DECORATIVE FLUORESCENT LIGHT FITTING

Decorative type fluorescent tube light fitting complete with stove enamelled mounting rail, polyester filled ballast, spring loaded rotor lamp holders, starter holder and starter, power factor correction condenser to improve the power factor to 0.95 and acrylic diffuser. Provision will be made for mounting the fitting end to end in continuous row and/or for mounting individually using high impact black polystyrene end plate. All the fluorescent tube lights fixtures shall have electronic ballast having third harmonic distortion less than 6% and total harmonic distortion less than 12 % .

2.02 INDUSTRIAL TYPE FLUORESCENT LIGHT FITTING



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The fitting will have channel and reflector made of CRCA sheet steel with white cover plate. Channel and reflector will be finished with light Grey stove enamelled outside and white stove enamelled inside. The fitting will be complete with all electrical accessories like polyester filled ballast, starter, spring loaded rotor lamp holders, starter holder, power factor improvement capacitor to improve the power factor upto 0.95 etc. All the fluorescent tube lights fixtures shall have electronic ballast having third harmonic distortion less than 6% and total harmonic distortion less than 12 % .

All types of fluorescent fittings will be suitable for mounting on wall/ceiling/conduit suspension.

2.02.1 WELL GLASS FITTINGS

Well glass lighting fitting will be fitted with sodium vapour or mercury vapour lamps. These fittings will be suitable for hanging by means of hangers, brackets, hooks etc. as required. All fittings will be integral type.

2.02.2 FLOOD LIGHT FITTING

- Sodium vapour flood light fittings are required for area lighting as specified in schedule of quantities.
- The Flood light fitting will be weatherproof and suitable for outdoor duty. The housing/enclosure will be of die cast Aluminium alloy and finished with hammertone Grey. The enclosure of the luminaries will be provided with a flat toughened glass in the front. Adequate gasketing will be provided with synthetic rubber for making the luminaries completely weatherproof. The fitting will be provided with facility to position the luminaries for effective lighting at the target area. The fitting will also be provided with graduated protractor to aid accurate aim and ensure a con-trolled light distribution.
- High quality polished Aluminium will be used in the reflector to ensure powerful light beams. The reflector will be anodised to enhance the longevity and contoured in multiple segments for optimum optical performance. The fitting will be provided with GES porcelain lamp holder. The control gear housing (separate control gear-non-integral type) will be housed with copper wound ballast, perfected improvement capacitor and terminal block. An electronic igniter will be provided in the luminaries.
- All the control gear components will be pre-wired in all respects and terminated to the terminal block for incoming cables. The fitting will be provided with earthing terminal and wiring will be done by multi-strand copper conductor. All the fasteners will be electroplated and passivated. The fitting will be suitable for twin/Single 400 watts HPSV lamps.

2.02.3 STREET LIGHT FITTING

- Street light fittings will be suitable for outdoor duty in weatherproof, single piece die cast Aluminium enclosure, finished with epoxy paint outside and stove enamelled inside. The fitting will be provided with GES porcelain lamp holder, and anodised Aluminium reflector with facility for obtaining cut off as well as semi-cut off light distribution. These will also be provided with high transparency clear acrylic cover with neoprene rubber gasket to make them absolutely dust and weather proof. Control gear compartment will be provided with detachable CRCA steel, pre-wired with ballast, capacitor, igniter and terminal blocks for incoming supply, Fittings will be provided with earthing terminals and wiring will be done with multi-strand copper conductor.
- All the fasteners will be electroplated/passivated and mounting arrangement will be suitable for direct mounting on poles having maximum 65 mm. OD with provision for holding the pipe in extended portion of control gear by means of clamps

2.02.4 FLAME PROOF FITTINGS



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Flame proof type fittings will be well glass type luminaries suitable for use with HPLN 250W (High pressure Mercury Vapour) lamp with separate control gear complete with copper ballast, power factor improvement capacitor, terminal block enabling loop-in-loop out connection. Both fittings & control gear will be of cast Aluminium alloy LM6 or cast iron stove enamel, Grey hammertone finish outside and white inside.

The control gear box and enclosure for fittings will have certification from CMRS, Dhanbad and will be suitable for gas groups IIA & IIB as per IS 2148-1981. The fittings will be designed as per IS 2206 (Part-I) -1987. The material for cable gland will be brass/stainless steel/aluminium alloy LM6 and will be double compression type suitable for indoor/outdoor use. These are must for every flameproof fittings and accessories.

2.02.5 CONTROL GEAR, LAMP & ACCESSORIES

- **Lamps**

Sodium vapour lamps will be suitable for universal burning position. The characteristics of the lamps will be in line with the relevant Indian Standards. The outer bulbs will be elliptical hear resistant type, evacuated to minimise heat losses and coated with light diffusion film for pleasing colour discharge. The lamp will be provided with corrosion resistant, nickel-plated screw base.

- **Ballast's**

All ballast's will be of proven design and capable of delivering long trouble free service. The ballast's will be made up of low loss silicon with steel lamination and will be wound with polyester-based super enamelled copper wire. The ballast will be polyester filled and able to dissipate the heat efficiently so as to keep the temperature rise well within the limits specified in the IS.6616-1972. The ballast will be provided with tapping at 200,220 and 240 volts and will be suitable for HPSV lamps.

- **Capacitors**

Capacitors will have element wound from layers of high purity Aluminium foils laid over the two faces of capacitor paper. The Aluminium cylindrical case containing the elements will be dried under high vacuum and impregnated before being sealed. The solder type lug terminals will be mounted over porcelain insulators at the sealed end and the capacitor will conform to IS: 1569. The value of capacitance will be chosen as to raise the power factor of burning lamps to above 90%.

- **Igniters and Starters.**

Igniters for HPSV lamps will be of proven design and capable of delivering long trouble free operations. The igniter and starters will be suitable for tropical condition and conform to IS: 2215-1968.

- **Lamp and Starter Holders**

Lamp and starter holders will have good spring contacts and of well tried out design. The spring contact will be such as to prevent disconnection due to vibration during cleaning. They will also have facility for easy removal.

3.0 Street Lighting Poles

Lighting poles will be fabricated from GI of specified section with joints swaged together when hot and bevelled on outside edges. A weatherproof sheet steel junction box will be provided at the bottom of the pole and contain fuse, neutral link, bolted type terminals, grounding stud etc. The bolted type terminals will be suitable for receiving 4 x 16 mm² AYFY cables with loop-in-loop out arrangement GI conduits will be embedded in the muff for incoming and outgoing cables.



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The street light poles of 9M height will be conforming to: 410-SP-29

The street light poles of 7M height will be conforming to : 410-SP-3

All erection consumables like bricks, sand, cement stone chips etc. for foundation of poles will be supplied & erected

4.0 High Mast Lighting Tower

4.01 Mast Proper

The mast will be 30 meter's high and designed in such a manner that it is capable of withstanding external forces exerted by wind pressure as per IS: 875 (Part 3)-1992 along with load of the lantern carriage assembly.

4.02 Mast Construction

The mast will be fabricated from special steel plates conforming to BS 4360 cut and folded to form number of polygonal sections, giving a continuous tapered profile for stability and aesthetics, Silicon content in steel should not exceed 03% for good quality galvanisation. Bottom section will be provided with plate welded to it for anchoring the mast to a reinforced concrete foundation block. To increase the strength, gussets will be provided.

The bottom section will be accommodate winch, electric drive etc. and for the safety of the same a vandal resistant and weather proof door will be provided with locking arrangement.

The fabricated and welded mast sections as detailed above will be hot dip galvanised with a minimum thickness of coating 90 microns conforming to IS 4759-1996, IS: 2629-1990 & IS: 2633-1992, both internally and externally.

After the delivery of the mast at site, these will be jointed by slip stressed fit method with necessary stressing equipment. No site welding or bolted joints will be accepted. Earthing terminal will be provided on the mast base and feeder pillar-box as per relevant ISS.

The mast will be provided with suitable aviation obstruction lamp.

4.03 Head Frame

The head frame designed to be a capping unit of the mast will be of welded steel construction, galvanized internally and externally after assembly.

The head frame assembly will accommodate specially designed LM 6 die-cast pulleys to accommodate the wire ropes and cable. Pulley construction will ensure that wire rope does not jump out of the grooves.

The suspension arrangement for lantern carriage will be with three ropes of stainless steel running on three on three pulleys for superior stability. There will be a separate pulley for running the electric supply cable.

The pulleys will run on stainless steel shaft/spindles and will be self lubricating type.

The whole head frame assembly will be covered and protected by steel canopy, hot dip galvanized internally and externally and secured to frame by stainless steel hardware.

4.04 Lantern Carriage

It will be of mild steel construction and hot dip galvanized internally and externally. The lantern carriage will be so designed and fabricated to hold designed number of flood light fittings and their control gearboxes, radically symmetrical. All junction boxes, Controlgear, fittings etc. mounted on the lantern carriage will be on non-corrodable material with class of protection IP 55.



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At the top docking position, combined guides and stops will ensure concentricity between the lantern carriage and the masthead. The stops will also help to ensure proper levelling and positioning of the lantern carriage at its top position. All the lower docking position, the lantern carriage will rest firmly at a maintainable height from the ground level with the help of stoppers for ease of maintenance.

During lowering/raising operation the design will ensure that there is no damage caused to the mast surface and any other parts installed.

4.05 Winch Assembly

The winch will be self sustaining and self lubricating type specially designed without the need of breaks, springs or clutches, and will consist of two drums fabricated from steel with machined grooves and mounted inside the mast at a convenient height from the base.

The wire rope will be wound on the drum with one end attached to the lantern carriage while the other end is clamped to the winch drum. The design will ensure no inter winding of the fitting ropes.

At least four turns of rope will remain on the drums when the lantern carriage is fully lowered.

4.06 Support Ropes

The support ropes will be of stainless steel and will be capable of safely handling the lantern carriage load.

4.07 Supply cables.

Power supply cables will be class B insulated with required number of cores provided with multi-pin heavy duty locking type male/female connectors at the end. Pulley assembly will accommodate extra cable for emergency supply.

Test load will be of 5-meter length 5-core 2.5-mm² copper conductor cable with multi-pin heavy duty locking type male/female connectors at the ends. Under no circumstances the test lead will travel through the mast.

4.08 Foundation

The design and construction of foundation for high mast lighting tower will be included in the scope of the contractor. The contractor will consider the following indicative data as design parameter for high mast. However the actual data will be indicated during tender scrutiny.

- a) Soil bearing capacity at 1-Metre depth :- As per data supplied by Purchaser (BSP)
- b) Wind speed :- As per data supplied by Purchaser (BSP)
- c) The Contractor will submit the design drawings for approval of MECON for high mast based on soil bearing capacity and wind speed. The Contractor will be responsible for safe & efficient erection of the mast.

4.09 Electric Drive & Fittings

The drive will be 3 phase, 415 volt, 50 Hz, class B insulated, flameproof type induction motor/geared motor with suitable torque limiter.

The motor will be mounted on MS hot dip galvanised plate inside the mast with a possibility of adjusting its position. The drive will be capable of taking the load of whole lantern carriage with luminaries, control gearboxes, aviation obstruction light mounted on it.

Manual handle will be supplied along with power tool for operating the winch manually in case of power failure. Reversible type starters for motor, contactors for lighting circuit, MCB isolator switch etc. will be provided in a flame proof & weatherproof enclosure.

4.10 Light Fittings

The light fittings will be of flood light type with twin 400-watt HPSV lamps. The quantity, mounting position/angle and optical characteristics will be decided on the basis of the following illumination requirement.

Minimum 30 lux illumination will be achieved at a horizontal distance of 30 meters from the bottom of the mast all around. Illumination level of 10 lux will be sufficient at plant boundary wall , parking area, Administrative Building, etc. Minimum of 3-5 lux is required to be achieved at a horizontal distance of 125 Metre from the bottom of the mast towards all area. Minimum 20 lux will be achieved in the areas adjoining at the perimeter of 40 meter (approx.) radius considering the mast base at the centre.

All lighting performances will be checked holding the lux meter in horizontal plane at ground level.