

## SECTION-IX

### POWER HOUSE AUXILIARIES

Power house auxiliaries shall consist of the following systems :

1	415 Volts Switch Gear	- 1 Lot
2	3.3 Kv Switchgears	- 2 Sets
3	15 Tonne Eot Crane	- 1 No
4	Batteries, Charging Equipment and D.C. Board	- 1 Lot
5	Diesel Generating Set	- 1 No.
6	Power & Control Cables Including Cable Trays	- 1 Lot
7	Grounding / Earthing	- 1 Lot
8	Lightning Protection	- 1 Lot
9	Miscellaneous Equipment	
9.1	Transformer Oil Purifier	- 1 Lot
9.2	Fire Protection System for Power House	- 1 Lot
9.3	Water Level And Turbine Discharge Measurement	- 1 Lot
9.4	Air Conditioning Of Control Room	- 1 Lot
9.5	Ventilation System	- 1 Lot
9.6	Lighting System	- 1 Lot

#### 9.1 415 VOLTS SWITCH GEAR

##### 9.1.1 Scope Of Supply And Design Criteria

- i) These boards shall be of Indoor type suitable for hot, humid & tropical atmosphere. The cubicles shall be dust and vermin proof as per latest version of IS : 54 & IS : 2147 and shall be self standing. The construction shall be compartmentalized having doors with isolating switch handle of inter locking type. All the components shall be mounted on sheet steel and wired upto terminal block. Height of cubicles shall not be more than 1800 mm and easy extension on either side shall be possible. Sheet thickness shall be 14 SWG.
- ii) All the equipment and their component shall be suitable for 415V  $\pm$  10% (-20% for induction generator) voltage, 3 phase 4 wires, 50 Hz, grounded system. The fault level shall be worked out on the basis of total MVA of transformers & their reactance and generators MVA and their transient reactances. It shall not be less than 30 MVA. A.C. Control voltage shall be single phase 240 V  $\pm$  10% (- 20% for induction generators).
- iii) Draw out type of ACBs and MCCBs/MCBs shall be provided of adequate capacity for various distribution supplies as indicated in the drawing for single line diagram and as per actual site requirements.

##### 9.1.2 Bus Bar

Bus bar shall be suitable for short circuit & continuous current, and maximum temperature rise shall be 35°C above 40°C ambient. Bus bars shall be at the top of the cubicle in separate compartments. Vertical bus bars shall be isolated from control

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components by metallic barriers or insulating sleeves. Bus supports shall be arc resistant, non-tracking, low absorptions, moulded insulators, high impact strength & long creepage surface. It shall withstand short circuit stresses.

### **9.1.3 Protection And Metering**

The switchgear panels shall be equipped with adequate fuse, contactors, relays, lamps push buttons, wiring and terminal blocks as per approved drawing. Lamp, push buttons relays etc., shall be approachable from front out side. The electronic meter shall be provided on incoming panels from station transformer and diesel set.

### **9.1.4 Circuit Breaker**

It shall be Air break type, 3 pole, indoor, Metal clad, draw out type, mounted on welded sheet steel, fault level 250 MVA. It shall be complete with transfer trucks self-aligning primary & secondary disconnecting device. Main & arcing contacts shall be of forged copper, with brazed silver tungsten alloy. Provisions for emergency trip, mechanical ON-OFF indicators, operation Counter, Mech. charge discharge indicator, manual closing device, safety shutters for female primary contacts, racking switch with 3 contacts for test & 3 for service position, operation in Local & Remote mode etc., shall be made. It shall be motor operated and shall having spring charging mechanism, trip free with anti pumping arrangement auxiliary relays etc. It shall operate at 70% rated control voltage, 4 No. and 4 NC auxiliary contacts, shall be provided. It shall have thermal over load & instantaneous magnetic release arrangement.

### **9.1.5 Isolating Switch**

It shall be provided with triple pole/ double/ single pole air break, making capacity equal to current rating of fuse and with removable type neutral link. External handle with position indicator and door inter locking shall be provided.

### **9.1.6 Fuse**

These shall be HRC link type, minimum rupturing capacity of 30 MVA or more as per installed capacity at 415 volt, complete with fuse base, visible indication for blowing, possible to change with circuit alive etc. AC Rewire able fuses are not acceptable.

### **9.1.7 Ac Motor Starters With Thermal Overload Relays Single Phase Preventer**

It shall be triple pole solenoid operated, air break type, suitable for direct on line start of 15 KW Squirrel cage induction motor, Class - III Category AC 3f IS : 2959 duty. Its contactors should not drop upto 75% rated voltage, Control circuit shall be protected by HRC fuse and shall have provision of 3 elements ambient tempt., compensated bimetal thermal over load relay. It shall be manual reset type with Knob at the front. The T.O.L. relay shall be connected directly or through C.T., and shall have auxiliary contacts for interlocking & indication, Single-phase preventer shall operate on negative phase sequence current. It shall operate at any load, & its resetting shall be possible by Knob on front door.

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### 9.1.8 Moulded Case Circuit Breakers/MCB

The MCCBs/MCB as per single line diagram and actual site requirements with spares shall be provided on the panels for providing circuit controllers as per the load requirements. The load shall be assessed for each distribution circuit and according to the circuit controller capacity shall be decided.

### 9.1.9 Construction Of Protective Relays, Meter Auxiliary Relays CT, Etc.,

#### i) Relays

These shall be of standard make only & got approved. These shall be draw out type, flush, semi flush, mounted and shall operate at 70% to 110% rated voltage. Auxiliary relays may be plug in type also. All relays shall conform to IS : 3231 latest revision. Auxiliary relays & timing relays for each breaker shall be indicated. These shall operate in less than 15 milli seconds. Relays for automatic change over scheme, if any, shall be indicated. All relays and their contact shall be rated for 5 amp. C.T. secondary and 110 volt P.T. secondary. Relay contact shall be capable of breaking/making maximum current of its control circuit. All relays shall have two pairs of independent contacts. Indicating meters shall be moving iron type with squares, 90% scale (110 x 110 mm), accuracy class  $\pm 1.5\%$ , full scale 120% rated current flush mounting. Its zero adjuster shall be accessible from front. Integrating meters shall have current & pressure coil test blocks. The entire AC/DC ammeter, voltmeter shall conform to accuracy class - 1.5. Frequency meter shall be digital type and of accuracy class - 1. Instrument should not damage due to passing of fault current through primary winding of their respective C.T. Integrating meter shall be provided with reverse stop.

#### ii) Current Transformers

These shall be epoxy cast, dry type unit conforming to IS : 2705 latest revision. 415 V. C.T. shall be indoor type. C.T. shall withstand the thermal and magnetic stresses due to short circuits. These shall be suitable for metering & protection.

#### iii) Miscellaneous

Switchgear Panels shall have space heaters rated for 240 volt, control wiring by flexible heat resistant, PVC insulated, stranded copper conductor 2.5 mm<sup>2</sup>. Multi way terminal blocks with 20% spare terminals, power terminals with tinned copper crimping lugs, Ground bus through the panel for specified short circuits. current shall provide General Arrangement drawings, final wiring diagram with cable/ terminal numbers, leaflets of various accessories, test certificates of major equipment, short circuit & tempt. rise calculation of bus bars, list of spare parts of all major equipment for 5 years operation, past experience report etc. shall be submitted in due course.

### 9.1.10 L.T. Switchgear (AC, DC)

#### Technical Features/Requirements

All 415 VAC switchgear, motor control centres (MCCs), Unit boards, unit station/distribution boards (DBs), etc. shall be of metal enclosed, indoor, floor mounted

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and free standing type. The switchgear/MCCs shall be fully drawout type. However, distribution boards may be of fixed type construction.

The incomer and bus coupler breakers for switchgear shall be electrically operated with over current releases or relays. Paralleling of two supplies shall be avoided by interlocking, Auto-changeover scheme shall be provided for loss of supply to one section of bus. Provision for manual operation and changeover shall be included. Incomers for MCCs and DBs could be load break isolators.

For small motors switch-fuse contractor feeders shall be provided. The other outgoing feeders would be moulded case circuit breakers.

All frames and load bearing members shall be fabricated using mild steel structural sections or pressed and shaped cold rolled sheet steel of thickness not less than 3 mm. Frame shall be enclosed in cold rolled sheet steel of thickness not less than 1.6 mm. Doors and covers shall also be cold rolled sheet steel of thickness not less than 1.6mm. Stiffeners shall be provided wherever necessary. Removable gland plates of thickness 3mm (hot/cold rolled sheet steel) or 4 mm (non-magnetic material) shall be provided for all panels.

All switchboards/panels shall be of dust and vermin proof. All cut outs shall have synthetic rubber gaskets.

Where breaker/starter module front serves as compartment cover, suitable blanking covers, one for each size of panel per switchboard shall be supplied for use when carriage is withdrawn.

All switchboards, MCCs and DBs shall have following distinct vertical sections:

- a. Completely enclosed bus bar compartment for horizontal and vertical bus bars.
- b. Completely enclosed switchgear compartment, one for each breaker, motor starter or MCCBs.
- c. Compartment, alley or cable box for power and control cables. In case of cable box, they shall be segregated with complete shrouding for individual feeders at the rear for direct termination of cables. For breaker cable connections, a separately enclosed cable compartment shall also be acceptable. It should be possible to carryout maintenance on a feeder with adjacent feeders alive.
- d. Compartment for relays and other control devices associated with a circuit breaker, Wherever necessary shall be provided.

MCCs and DBs shall be divided into vertical sections. Each vertical section shall be provided with adequately sized cable alley covering entire height. In case cable alleys are not provided for DBs, segregated cable boxes with complete shrouding of individual feeders shall be provided at the rear for direct termination of cables in each individual feeder.

Busbars shall be of high conductivity aluminium alloy. Minimum air clearance in air between phases and phase-earth shall be 25mm. For all other components, the clearances shall be at least 10 mm. All connecting strips horizontal and vertical busbars, insulation shall be provided by sleeving or barriers. In case of DC DBs/fuse boards, the busbar

system shall be insulated or physically segregated with barriers to prevent interpole short circuit.

Bus bar insulators shall be of track-resistant, high strength, non-hygroscopic, non-combustible type and suitable to withstand stresses due to over-voltages and short circuit current. Insulators and barriers of inflammable material such as Hylam shall not be accepted.

Control circuits shall operate at suitable voltage of 48 V DC or 220 V AC. Necessary control supply transformers having primary and secondary fuses shall be provided for each MCC, 2x100% per section. The auxiliary busbars for control supply shall be segregated from main busbars. The control supplies shall be monitored.

Contractor shall fully coordinate overload and short circuit tripping of breakers with upstream and down stream breakers/fuses/MCCBs/motor starters. Various equipment shall meet requirement of Type-II class coordination as per IEC.

Suitable trolley arrangement shall be provided for breaker modules. Two trolleys per switchgear room shall be provided so that top most breaker module of all types, sizes and rating can be withdrawn on trolley and lowered for maintenance purpose.

All non-current carrying metal works of boards/panels shall be effectively bonded to earth bus of galvanised steel extending throughout the switchboard/MCC/DB. Positive earthing shall be maintained for all positions of chassis and breaker frame.

The circuit breakers shall be air break, three pole, spring charged, horizontal drawout type, suitable for manual and electrical operation, and shall have inherent fault making and breaking capacities. They shall have shunt trip coil. In case releases are offered, the same shall have contact for energisation of lockout relay. It shall have anti-pumping feature. All breakers shall have built in interlocks for equipment and personnel safety.

Mechanical tripping shall be through red 'Trip' push buttons outside the panel for breakers, and through switches for other circuits. Clear status indication for each circuit shall be provided through lamps, switch positions or other mechanical means. Provision of mechanical closing of breaker only in 'Test' and 'Withdrawn' position shall be made. Alternatively, mechanical closing facility should be normally inaccessible, accessibility rendered only after deliberate removal of shrouds.

Motor starter contactors shall be of air break, electromagnetic type as per IS:13947 Part-4, section-1 suitable for DOL starting of motors.

Fuses shall be HRC type with operating indicator. Isolating switches as per relevant standards shall be supplied. Fuse switch combination shall be provided wherever possible.

Isolating switches and MCCBs shall have door interlocks and padlocking facility. All switchgear, MCCBs, DBs, panels, modules, local starters and push buttons shall have prominent engraved identification plates.

Local push button stations shall have metal enclosure of die cast aluminium or rolled sheet of 1.6 mm thickness.

The temperature rise of the horizontal and vertical busbars and main bus link including all power drawout contacts when carrying 90% of the rated current along the full run shall in no case exceed 55 deg.C with silver plated joints and 40 deg.C with all other types of joints over an ambient of 50 deg.C.

#### 9.1.11 Routine & Type Tests

These shall be as per latest revision of relevant I.S. including short circuits., tempt, rise and high potential test. Routine tests shall be witnessed by Owners/Developers representative. Test certificates in 6 copies shall be furnished.

#### 9.1.12 Guaranteed And Technical Particulars

The guaranteed and Technical Particulars under this head shall be furnished in the tender document as per annexed Schedules

#### 9.1.13 Technical Requirements

Sr. No.	Description	L.T. Switchgear
1.0	<b>BUS BAR</b>	
1.01	Type	High Conductivity Aluminum
1.02	Rated Voltage	415 V + 10% (-) 20%
1.03	No. of Phases	3 phase, 4 wire
1.04	Frequency	50 Hz $\pm$ 5%
1.05	System Earthing	Effectively Earthed
1.06	Continuous current rating within the cubicle at 50°C ambient.	Suitable for scheme proposed.
1.07	Short time current rating for (1) Sec.	41.74 KA for 30 MVA at 415 volts or more for higher fault levels.
1.08	Temperature rise of bus bar joints under normal working conditions at rated current and at 50°C Ambient.	35°C
1.09	HV withstand test voltage for (1) minute.	2.5 KV rms.
1.10	Minimum clearances.	
	i) Phase to phase	30 mm
	ii) Phase to earth	30 mm
1.11	Insulation to Bus Bar.	PVC Sleeve/ heat shrinkable

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	Size of bus bar.	Pl. specify alongwith supporting calculation.
2.00	<b>BUS SUPPORT INSULATOR:</b>	
2.01	Type & Service.	Solid, Indoor
2.02	Material	Porcelain/ Cast resin
2.03	Voltage Class	650 V
2.04	HV withstand test for one (1) minute.	2.5 KV rms.
3.00	<b>CIRCUIT BREAKER:</b>	(With Thermal over load and Magnetic release.)
3.01	System	3 phase, 4 wire 50 Hz effectively earthed system.
3.02	Service	Indoor
3.03	Type	Moulded Core Circuit Breaker
3.04	Pole	3
3.05	Rated Service Voltage	415 + 10% (-) 20%
3.06	One (1) minute power frequency with stand voltage.	2.5 KV (rms)
3.07	Rated continuous current at 50°C and within the cubicle.	Suitable for scheme. Rated out put at 80% voltage
3.08	Short time current for one (1) Sec.	41.74 KA or more
3.09	Rated breaking capacity.	30.0 MVA at 415 V or more
3.10	Rated breaking current.	
	a) Symmetrical	41.74 KA or more
	b) Asymmetrical	As per relevant ISS
3.11	Rated making capacity	2.1 x 41.74 KA or more
3.12	Operating mechanism	Manual closing mechanism.
3.13	Tempt. rise above 50°C	As per relevant ISS
3.14	Operating duty	0-3 Mn-Co-3 Mn-Co
3.15	<b>AUXILIARY VOLTAGE:</b>	
	i) Closing	48V DC (85%-110%)
	ii) Tripping	484V DC (70%-110%)
	iii) Spring charging motor	240V AC + 10% (-) 20%
	iv) Space heater & lamp 240 VAC, 50 Hz	

3.16	Mounting	cubicle.
4.00	<b>CURRENT TRANSFORMER:</b>	Cast resin, easily accessible, IS:2705, test links.
4.01	System	3 phase, 4 wire, 50 Hz effectively earthed neutral.
4.02	Service	Indoor
4.03	Type	Bar primary
4.04	Rated voltage	415 + 10% (-) 20%
4.05	Quantity	As per the scheme requirement
4.06	Power frequency with stand voltage.	2.5 KV rms for 1 minute
4.07	Mounting	Inside switchgear in fixed portion.
4.08	Rated short time current for one (1) Sec.	41.74 KA or more
4.09	Current ratio and accuracy.	250/5 for protection, 2.0 for metering.
5.00	<b>MAGNETIC CONTACTOR (AC):</b>	
5.01	Service	Indoor, within cubicle for direct or line starting.
5.02	Poles	3 (single throw)
5.03	Rated voltage	415 + 10% V (-) 20%
5.04	Frequency	50 Hz + 5%
5.05	Continuous current rating	16/25/63/100/160/200/250 A or more
5.06	Power frequency test voltage	2.5 KV for one (1) minute
5.07	Short time current rating	To be co-ordinate with fuse protecting it.
5.08	Over load protection.	Thermal overload in 3 phases
5.09	Control circuit voltage	240 Volts, 1 phase, 50 Hz
5.10	Operation Indicator	Red, Green lamps for close, open indication
5.11	<b>AUXILIARY CONTACT:</b>	
	i) Normally closed	2 pair
	ii) Normally open	2 pair

**5.12 CONTACTOR COIL RATING:**

i)	Pick-up	(85%-110%) line voltage (75% or less) line voltage
ii)	Drop out	
5.13	Temperature rise limit for magnetic coil.	In compliance with IS:2959/1975, Table-5
5.14	Temperature rise limit for power circuit and other accessories.	In compliance with IS:2959/1975, Table-6
5.15	Duty class	Intermittent Class-3 IS:2959
5.16	Utilization category	AC-3

**9.2 3.3 KV SWITCHGEARS****9.2.1 SCOPE OF SUPPLY AND DESIGN CRITERIA**

Design, manufacturing, supply, erection, testing and commissioning of 3.3 kV switch gear panels comprising of 3.3 kV switchgear panels complete with air circuit breakers, HV bus of copper flat, connecting strips duly insulated, indicating instruments, controlling switches, CTs, PT& protecting relays etc.

**9.2.2 APPLICABLE STANDARDS:**

IS 13118, IEC 56, IEC 298

**9.2.3 TECHNICAL REQUIREMENTS OF BREAKERS**

SL. NO.	PARTICULARS	3.3 KV BREAKERS
1.	Name of manufacturer/ (Word equivalent not acceptable)	
2.	Manufacturers type designation	Air Circuit breaking type
3.	Rated Voltage	3.3 KV
4.	Maximum (continuous service rated voltage)	3.6 KV
5.	Short current rating: 1 second rms (kA) 3 second rms (kA)	12.5 KA
6.	Normal current rating: Under normal conditions Under site conditions	Amp. Amp.
7.	Maximum temperature rise ambient	
8.	Breaking capacity a) Symmetrical	12.5 KA

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SL. NO.	PARTICULARS	3.3 KV BREAKERS
	b) Symmetrical at rated service voltage c) Asymmetrical	250 MVA
9.	Making capacity	31.8 KA
10.	Total break time at 10% rated interrupting capacity	128 ms
	at rated interrupting capacity	94 ms
11.	Arcing time	Please specify
12.	Make time	81 ms
13.	Minimum re-closing time from the instant of trip coil energization	--
14.	Minimum dead time for 3 phase re-clasping	--
15.	Data on transient recovery voltage i) Amplitude factor ii) Natural frequency iii) Phase factor iv) R.R.R. volts in micro second	-- -- -- -- --
16.	Dry 1 minute power frequency withstand test voltage a) Between line terminal and ground objects: b) Between terminal with breaker contacts open	35 kV --
17.	1.2 / 50 full wave impulse withstand test voltage for the two cases given below: Between line terminal and grounded objects Between terminal with breaker contacts open	75 kVP 75 kVP
18.	Bushing of insulators Type of bushing Dry 1 min. power frequency withstand test voltage kV (rms) Dry flash over value kV (rms) Wet flash over value kV (rms) 1.2/50 impulse withstand kV (speak) Creepage Distance	Solid porcelain -- -- -- -- -- --
19.	Minimum clearance in air	

SL. NO.	PARTICULARS	3.3 KV BREAKERS
	Between phases	60 mm
	Live parts to earth	127 mm
	Live parts to ground level	--
20.	Number of poles of circuit breaker	3
21.	Number of breaks per phase	2
22.	Total length of break per phase	178 mm
23.	Type of main contacts	Road & Tulip
24.	Type of arcing contacts	-----
25.	Material of arcing contacts	Phosphor bronze
26.	Contacts silver plated or not	Yes
27.	Thickness of silver plating	20 micros
28.	Contact pressure	
29.	Number of auxiliary contacts provided	
	Those closed when breaker is closed	6
	Those open when breaker is closed	6
30.	Type of operating mechanism Opening Closing	Manual motor spring charging mechanism.
31.	Control circuit voltage	48 V DC
36.	Maximum over voltage on switching transformer on no load and the charging current	--
41.	Kilometric fault level (MVA)	250 MVA

#### 9.2.4. 3.3 kV Switchgear Panel

##### a) Codes And Standards

Switchgear & breaker IEC 298, IEC 56, IS:13118

##### b) Constructional Features

- (i) The switchgear shall be fully compartmentalised metal clad construction, comprising of floor mounted panel. The switchgear assembly shall be rodent and vermin proof.
- (ii) The circuit breaker shall be mounted on with draw able trucks, having distinct 'Service', 'Isolated' and 'Withdrawn' positions. Testing of breaker shall be possible in isolated position by keeping control plug connected.
- (iii) In panel design where breaker compartment does not have a door i.e. breaker truck front serves as a door, suitable blanking cover for each switchboard shall be supplied. Use of inflammable material such as Hylam as an Interpol barrier shall not be accepted.

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- (iv) The height of panels shall not exceed 2600 mm. Bushing or other sealing arrangement between breaker and bus bar/cable compartments shall be provided so that there is no air communication around isolating contacts in the safety shutter area with truck in service position. The horizontal bus bars, vertical droppers and connections to the fixed end of the isolating contacts shall be of high conductivity copper. Pressure relief device shall be provided in each high voltage compartment.
- (v) The over-voltage generated by switching of breaker/contactors under any duty condition shall not exceed 2.5 pu of nominal line to neutral voltage. Evaluation criteria shall be as per IEEE envelope. Suitable surge suppression device, if required, may be provided.
- (vi) Bus bar insulators shall be of track-resistant, high strength, non-hygroscopic, non-combustible type and suitable to withstand stresses due to over-voltages and short circuit current. The temperature rise of bus bars shall not exceed 55 deg. C for silver plated joints and 40 deg. C for other joints under any condition over an ambient of 50 deg.C.
- (vii) The internal earth bus shall be provided to withstand short circuit currents for one second. All enclosures shall be connected to this earth bus. Earthing arrangement for breaker/VT trucks shall be provided either through integral earth switch or through separate earthing truck. In case of latter arrangement, one set of different types of earthing trucks per switchboard shall be supplied. Suitable mechanical interlock shall be provided to prevent inadvertent earthing of any live part. Earthing switch shall have short time (1 second) current withstand capability equal to the breaker.
- (viii) All components shall be correctly rated. Use of two breakers in parallel shall not be acceptable.
- (ix) Panels should be suitable for top/bottom cable entry.
- (x) Each breaker panel shall have breaker control switch of spring return type and a local/remote selector switch of stay-put type. The panel shall also have 'ON', 'OFF', 'Spring charged' and 'Control supply healthy' indicating lamps. The lamps shall be filament type and low watt consumption with built-in resistors.
- (xi) The switchboard/panel shall have suitable arrangement to receive and distribute ac and dc supplies. Control dc supply shall be duplicated for each board. Each switchgear panel shall have thermostatically controlled space heater with switch, illumination and power plug point. All panels on front and back as well as inside shall have engraved nameplate giving circuit description and component identification.

### 9.3 15 TONNE EOT CRANE

#### 9.3.1 Scope Of Supply And Design Criteria

This specification covers the design, manufacture, testing at shop before dispatch, supply, delivery at site, erection, testing and commissioning at site of one number EOT crane. The crane is required to be installed in the Machine Hall of Power House. The project envisages installation of 1500 kW horizontal hydro generating units. The crane shall be equipped with a trolley having a hoist of 15 tones capacity capable of safely handling the generator or rotor with shaft, turbine, valve or any other assembly of the generating units and shall be complete with all motions of the crane and the hoist control gears, runway, rails, runway conductors with mounting brackets, collectors, insulator, M.S. angles etc. The powerhouse crane shall be supplied with spare parts, accessories, special tools etc., and such other items which are necessary to erect, operate and maintain a safe and reliable crane even though these are not specifically mentioned.

#### 9.3.2 Standards

Structural design of crane shall be done in accordance with IS 807 - 1976. The crane shall be designed as per IS 3177 - 1977 except as otherwise specified in these specifications. All equipments shall comply with the latest edition of the relevant Indian Standard specifications. Deviations, if any, from these specifications shall be clearly stated in the tender.

#### 9.3.3 Type And Capacity

The crane shall be electrically operated, indoor, overhead traveling type and shall be of Class I duty as per IS 807 - 1976. The crane shall be controlled from floor level by means of pendant push buttons.

A preliminary drawing of the Power House showing the layout of the generating units and the crane is attached. The requirements of the crane are given below. It may be pointed out that these requirements excepting those at Sr. Nos. ii), iii) & iv) are only approximate.

i)	Hoist rated capacity	}	15 Tones
ii)	Hoist normal speed		_____ 1 m/minute
iii)	Cross travel speed		_____ 2 m/minute
iv)	Long travel speed		_____ 4 m/minute
v)	Crane span		_____ meters (Approx.)
vi)	Runway length		_____ meters (Approx.)
vii)	Height of top of crane rail above generator floor	(as per civil details)	_____ m (Approx..)
viii)	Vertical travel of Hook		_____ meters

The contractor shall make his own assessment of the weight to be lifted, span and lengths of travel based on the equipment offered and layouts required. These parameters shall be clearly stated and the crane offered accordingly.

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### 9.3.4 Safeguards During Earthquake

The crane shall be designed to withstand seismic forces. Clamping necessary to contain the movement of the crane during earthquake shall be provided. The locking shall be designed to put it on and off easily.

### 9.3.5 Mechanical Equipment

#### i) Crane Bridge

The bridge shall consist of two girders supported on end trucks. The girders shall be designed to safely carry the full rated load without undue vertical or lateral deflection or vibrations. The design shall take into account all conditions of operations and tests at works and site as per IS : 3177 - 1977. The girders shall be of the box type construction reinforced by stiffening ribs. Suitable stops shall be welded near the end of each girder to engage bumpers on the trolley to prevent it from leaving the bridge.

Rails for the trolley shall be supported centrally on the girders and shall be held in place by rail clips. The clips shall be locked in position to prevent the rails from creeping.

#### ii) End Carriages (Trucks)

The end trucks shall be constructed of cast steel, structural steel sections or plates welded and shall be of box type with openings at each end for receiving the truck wheels. Each truck shall be fitted with double flanged rail wheels with roller bearings, running on suitable axles, wheel fracture props, buffer etc.

All trucks shall be provided with suitable track sweeps at each end of trucks so as to be effective in both directions of travel. Safety lugs shall be provided which shall extend below the top of rail on both sides to prevent the trucks from leaving the rails. Lugs shall be provided on the truck frames to permit a drop of not more than 25 mm in case of broken axle.

The end stops shall be provided and they shall contact the face of the end truck and not the wheels. The stops shall be attached at each end of runway rails.

Suitable jacking pads shall be provided for maintenance of wheels.

#### iii) The Wheels and Axles

The bridge shall be carried on sufficient number of wheels on each side. All wheels shall be double flanged with treads machined or ground to size and shall be of forged or rolled steel. The flanges shall be tapered to prevent derailment. The truck axles shall be made of forged carbon or alloy steel. The journal bores of all the truck wheels shall be drip proof and shall be provided with roller bearing with high pressure grease lubrication.

**iv) Bridge and Trolley Drive, Hoisting Machinery**

The bridge and cross travels of the crane shall be effected electrically through push buttons on pendant. The travels will be steady and free from vibration or rocking in any part of the structure while traveling under maximum load. There shall be no tendency for the crane structure to get out of line while traveling along the runway under any condition.

The trolley shall be equipped with a hoist. The hoist shall be driven by suitable motor and gears to obtain the required hoisting speed. The hoist shall be provided with brakes and retarding devices as stated elsewhere.

**v) Hook and Block**

The hook and block shall be arranged to lift without twisting and sidewise pull of load end and dead end rope. The hook shall be swiveled on antifriction thrust bearings of an approved type and shall have ample capacity for the maximum loads. The hook shall be made of annealed forged alloy or carbon steel or may be cut from rolled stock. The sheave pins shall be made of annealed carbon or alloy steel and shall have ample sheave bearing area. The bottom blocks shall be constructed so as to guard the hoisting ropes fully and prevent them leaving the sheaves under the conditions of operation.

**vi) Rope Drum, Sheaves and Rope**

The winding drum shall have machined grooves to receive the full hoisting rope without over-lapping and the drum shall be of such size that there will be not more than one layer of rope on the drum, when the rope is in fully wound position.

All rope sheaves shall be made of cast iron, cast steel or mild steel and shall be machine grooved to a depth of not less than 1.5 times the diameter of the rope.

The hoisting rope shall be flexible plough steel wire type with fiber core and internal lubricant. The factor of safety of hoisting rope shall not be less than 5 (five). The rope system shall be equalized and arrangements entailing reverse bends shall be avoided as far as possible.

**vii) Gears, Bearings and Lubrication**

All gears shall be machine cut and shall conform to relevant Indian Standards. Gearboxes shall be so designed that the gears which they enclose will be automatically lubricated. The gears shall be readily removable and the gearboxes shall be oil tight.

All bearings shall be of the roller, ball or sleeve type with removable and bronze linings preferably flanged at both ends. All bearings shall be designed so as to be replaceable easily. Bushings at ends of shaft shall be sealed properly to prevent dripping of lubricant.

Oil lubrication shall be provided for all gear trains, sleeve bearings on motor and bearings for truck wheels. Lubrication for all mechanically operating parts shall be by means of biodegradable oil and industrial button type fitting shall be used.

**viii) Walk-ways and Ladders**

Ladders, platforms, walkways, hand holds, foot holds etc., necessary to give safe access to bridge drive and trolley drive mechanisms and all other components of the crane, needing inspection, maintenance and repair shall be provided for. The walkways shall be of steel required plate extending to the entire length of the bridge.

**ix) Rails**

Two runway rails for the bridge travel will be furnished by the contractor for the full length of powerhouse. The trolley rails shall be of the same size as those used on runway. The stoppers at each end with sole plate clips for crane run to cover the full length of powerhouse shall also be supplied.

**x) Bumpers**

Rubber bumpers shall be attached to the bridge trucks and on the trolley. The bridge shall have four bumpers, one at each corner arranged to meet the crane stop squarely. The trolley shall have two bumpers on each side placed to meet the truck stops squarely at the end of track.

**xi) Slings**

The contractor shall deliver suitable wire rope slings in pairs having a safety factor of not less than five when lifting specified loads. Each sling shall have a ring at one end and a ring or hard eye at the other end with matching shackles.

**9.3.6 Electrical Equipment**

**i) General**

All equipment and wiring shall suit the requirements and shall be in accordance with the latest standards unless otherwise specifically stated in the specifications. Mats, railings, screens and other accessories which are external to the apparatus, but which may be required to meet these codes for installed equipment shall be furnished by the contractor.

The power supply will be 415 volts, three phase, 50 Hz. A circuit breaker with overload and short circuit magnetic releases shall be provided in the incoming power supply.

**ii) Electric Motor**

All electric motors shall be of ample capacity for the duties and speeds specified, and shall conform to IS : 325 - 1970. The motors shall also meet the requirements as specified in IS : 3177 - 1977. The rated capacity of the motors shall be such that their full load torque shall not be exceeded in giving the specified performance. The motors

shall be suitable for operation at 415 volts, 50 HZ, 3 phase, 4 wire supply system, with

- |      |                               |        |
|------|-------------------------------|--------|
| i)   | Voltage variation of          | + 10 % |
| ii)  | Frequency variation of        | + 3%   |
| iii) | Any combination of (i) & (ii) |        |

The synchronous speed of the motors shall not exceed 1000 rpm. The pull out torque of the motors shall not be less than 225 percent of full load torque of motors with rated voltage and frequency applied. Motors shall be provided with class 'F' insulation and rated on the basis that under the specific service conditions, the temperature rise will not exceed the limits specified in Table - 1 of IS : 325 - 1970. Protective gear for the motor shall be provided as per the requirements indicated in IS : 3177 - 1977.

The motors shall be subjected to type and routine tests as specified in IS : 325 - 1970 and the copies of the test reports shall be furnished by the tenderer.

### iii) **Controls**

Control of the hoist for raise and lower of the load shall be effected by a person standing at the floor of the power house by means of a pendant controller connected through a sufficient length of suitable cable.

Adequate length of the cable with control mechanism shall be supplied in addition. The motor controllers shall be of fully magnetic reversing type to provide gradual acceleration. They shall be designed so that it will be possible to limit the vertical movement of the hooks with full rated load and when starting from standstill to within 6 mm. Hoist motor controller shall have atleast two speed control points in each direction of operation. At lowering with full load, it shall be possible to achieve a continuous speed not more than 10% of rated full load hoisting speed. Controls for the bridge travel and trolley travel motors shall also be provided in the same pendant.

A push button for emergency stop shall be provided. The push button shall be so arranged as to immediately cut OFF the main supply and apply electro magnetic brake simultaneously, irrespective of controller position.

The control and lighting supply circuits shall be protected through circuit breakers and fuses of appropriate rating.

### iv) **Brakes for Hoist Motion**

Solenoid operated electro-magnetic brakes shall be provided for hoisting motor. The brake shall be applied immediately irrespective of controllers position, on operating an emergency stop push button. The electro-magnetic brake shall be complete with the rectifier equipment to obtain D.C. supply for the solenoid.

In addition to electro-magnetic brake, electro-hydraulic thruster brake shall also be provided.

**v) Limit Devices**

Limit switches of gear or cam type for 'UP' and 'DOWN' limits for the hook block shall be provided. Suitable limiting devices shall also be provided to limit the travel of the trolley at the ends of the crane girders.

**vi) Wiring, Conductors and Collectors**

All wiring shall be in metal conduit hot dip galvanized. All conductors for primary power and lighting shall be insulated for not less than 600 volts and shall have standard moisture resisting double braid coverings. The control and lighting conductors shall be of standard and suitable sizes in copper.

The main runway conductors shall be rigid type and shall consist of four lengths of hard drawn copper wire with end brackets, intermediate brackets and insulators etc., to suit the power house building. The trolley conductors shall be of the rigid type.

The collector shall be designed to reduce the sparking between collectors and conductors to the minimum and shall be readily renewable.

**vii) Lighting**

The permanent 240 volts lighting system on the crane shall consist of two 250 watts high bay lighting units to illuminate uniformly the area under the crane. Suitable convenience outlets shall also be provided.

**9.3.7 Cleaning And Shop Painting**

After being fabricated, all structural steel and unfinished surface of castings shall be cleaned thoroughly of all mill or foundry scale, rust, dirt, oil, grease and other foreign substances. All machine finished parts and surface including bolts and nuts shall be well coated with a suitable rust preventive compound. In addition, one coat of finishing paint of approved colour on all surfaces shall be applied over a coat of primer.

**9.3.8 Shop Assembly And Testing**

The crane shall be completely assembled and operated in the shop and load tested for adequacy of design and suitability for reliable safe and proper operation. The crane shall be tested at shop under full load and 25% overload on hoisting and cross travel motions. The parts of the crane shall be sent in as large units as practicable for field erection and handling, keeping in view the limitation of transport and handling.

**9.3.9 Inspection**

The Developer/ Owner and his authorized representatives shall have access to the manufacturer's works at all reasonable times for the purpose of witnessing the manufacture, inspection and testing of all components and/or complete crane.

### 9.3.10 Acceptance Tests

After the crane has been installed at site and placed in satisfactory operation, it will be tested by and at the expense of the Developer/ Owner to determine whether the requirement of these specifications have been fulfilled. All tests will be made under the supervision of the contractor or his representative. Complete set of tools and plant required for erection, testing and commissioning shall be arranged by the contractor at his own cost.

### 9.3.11 Spares

The tenderer shall give item wise prices for the spares. The tender shall list any other spare part that he recommends for 5 years operations of the crane.

### 9.3.12 Drawing And Data

- i) The tenderer shall submit with his tender detailed description, drawings, clearance diagrams, bridge wheel spacing and loading, photographs, catalogues covering the general construction and dimensions of the apparatus he proposes to furnish and electrical schematic diagram.
- ii) Three copies of instruction manuals for installation, operation and maintenance of the crane shall also be supplied.

### 9.3.13 Deviation From Specifications

All deviations from the specifications shall be listed separately in the absence of which it will be presumed that the provision of the specifications are complied with by the tenderer fully.

## 9.4 BATTERIES, CHARGING EQUIPMENT AND D.C. BOARD ETC.

### 9.4.1 GENERAL

9.4.1.1 This specification broadly covers manufacture, supply, installation and commissioning of (a) one set 48 / 110 volts, 300 AH capacity **NICKEL CADMIUM** batteries (b) one set of float and boost charger for quick and trickle charging of the batteries and for supplying 30 Amps continuous DC load and (C) one no. 48 volts D.C. distribution board.

9.4.1.2 The 48 / 110 volts 300 AH **NICKEL CADMIUM** high discharge type batteries shall be used for supplying power to essential services where instant availability and reliability of D.C. supply are most important such as:

Protection, control and indicating circuits.

D.C. emergency lighting of powerhouse.

Tripping and closing coils of 33 kV, 11 Kv, 3.3 kV and 415 volts switchgears.

Trip coils for controlling generator field circuit breakers, emergency solenoid of electro hydraulic governor cubicle and alarm annunciator etc.

9.4.1.3 The battery and charger shall meet following load requirement:

Continuous load for three hours	30 Amps
Emergency load for one hour	25 Amps
Intermittent load for 1/60 hour	55 Amps

**The above load requirement is tentative. The tenderer shall give actual load requirement based on specification of the equipments offered.**

9.4.1.4 The charging arrangement for main batteries shall comprise installation of one sets of float and boost battery charger. The boost charger should be capable of quick charging the battery in 10 hrs. from the fully discharged condition. The charger shall be connected to the batteries through D.C. distribution board, which shall have a charger load bus, load bus, emergency load bus contactors, MCCBs, and MCBs as shown in drawing No. E-127-4. By means of MCCBs, it shall be possible to connect any of the charger or Battery to the load bus. Under normal operating conditions, battery charger shall be connected to load bus, float charger shall be ON while boost charger shall be OFF, to keep the battery floating.

9.4.1.5 The float charger shall be capable to trickle charge the 300 AH batteries at 1.3 volt/cell, while supplying a permanent load of 30 Amps. Boost charger shall be capable of quick charging the batteries upto 1.7 volt/cell. The charger shall be provided with controls for adjusting the voltage between range of 48 volts to 70 volt, so as to make them suitable for trickle charge as well as boost charge duty. For distribution of 48 volts D.C. supply, a 48 volts D.C. distribution board shall be installed with two incoming circuits from chargers one circuits from batteries and 12 outgoing circuits. One outgoing circuits shall feed the emergency lighting board, through emergency lighting contactors. The emergency lighting contactor shall supervise the A.C. supply to normal lighting boards and shall switch on D.C. lighting in the event of A.C. failure.

#### **9.4.2 REQUIREMENT**

One no. 48 / 110 volts, 300 AH nickel cadmium batteries complete with stands, insulators, inter-row, inter-tier and inter-cell connectors.

One set of automatic voltage regulated, static type full wave battery charger for batteries complete with filters, rectifier, AVR, voltmeter (0-100 V DC), ammeter 0-100 Amps, moulded case circuit breaker, fuses etc.

One no. 48 / 110 volts D.C. distribution board equipped with:

One positive and one neutral charger load bus.

One positive and one neutral for load bus

One positive and one neutral for emergency load bus

One outgoing circuit controlled by MCCB from the charger load bus connecting load bus.

Three incoming circuits of moulded case circuit breaker type, two from battery charger and one from battery.

12 outgoing circuits of miniature circuit breaker type, one of which shall feed emergency lighting board through emergency lighting contactors and remaining to the other D.C. loads.

The D.C. distribution board shall be equipped with protective relays to give visible and audible alarms with buzzer silencing facility etc. under the following conditions:

- Over voltage at bus bar
- Under voltage at bus bar
- Battery ground (positive bus, negative bus)
- A.C. supply failure annunciation
- D.C. over load
- Earth leakage
- Float output D.C. fuse failure/MCCB trip
- Boost output D.C. fuse failure/MCCB trip
- Controller card defective
- Float charger failure
- Boost charger failure
- Alarm annunciation scheme for the above protections with "Alarm accept, reset and test push buttons."

- One No. 415V/230V A.C. emergency lighting contactor.
- Instrument for measuring
  - Voltage for 415V A.C. supply
  - D.C. output voltage of float and boost charger
  - D.C. output current of float and boost charger
  - Trickle charging current of battery and discharging current from battery

Four outgoing circuit of miniature circuit breaker type from emergency load bus.

An internal lamp with a door switch shall be provided. The distribution panel shall be physically matching with the charger panel in all respect and its construction will be similar to the charger cubicles.

### **9.4.3 TECHNICAL PARTICULARS**

#### **9.4.3.1 Battery**

Type	Nickel cadmium
Normal voltage of a single cell	1.2 volt
Capacity when discharging to 1.0 volts/cell at 10 hrs discharge rate	300 AH
Voltage under floating conditions	52 Volts
Voltage at the end of full discharge	45 Volts
No. of cells	40 Nos.
Types of cells (to comply IS:10918-1984)	Open type, single cell construction

The nickle cadmium batteries shall comply with IS 10918-1984 or its latest version.

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### **9.4.3.2 Connectors**

48 / 110 V battery cells shall be accommodated in double row single tier arrangement on wooden stands. Sufficient No. of inter-row, inter-tier and inter-cell connectors shall be provided.

### **9.4.3.3 Potassium Hydroxide**

It shall strictly comply with relevant ISS and shall be sufficient for one filling with 10% spare.

### **9.4.3.4 Water**

The distilled water shall be sufficient for one filling and charge-discharge-recharge operations with 10% spare. It shall conform to IS:1069-1964 (revised).

### **9.4.3.5 Stand**

The stand shall be constructed from seasoned teak wood and shall be robust enough to take the full load of batteries. The stand shall have bolted connections and should be supplied in pieces to facilitate entry in the battery room. The stands shall be coated with three coats of paints as per IS requirements.

### **9.4.3.6 Bolts & Nuts**

Bolts and nuts for connecting the cells shall be effectively lead coated to prevent corrosion.

## **9.4.4 Float & Boost Charger For 48 V Battery**

### **9.4.4.1 Type**

It shall be static type, full wave, suitable for boost charging and trickle charging to keep 40 cells battery floating under normal operating conditions while supplying permanent load upto 30 Amps.

Input	-	415 V, 50 c/s, 3 phase A.C.
Output	-	48 V to 70 V
Current	-	30 Amps permanent load

In the event of failure of float charger, boost charger should be capable to boost/trickle charge the batteries and also to supply 30 Amps. permanent load.

### **9.4.4.2 Regulation**

It shall be inherently voltage regulated static type with automatic regulation within plus and minus one percent from 10% of rated load to full load and shall have steep voltage drop beyond 110% full load.

Both the chargers will be housed in a sheet steel cubicle of angle iron structure with adequate ventilation for natural air cooling, suitable for floor mounting indoor operation and having door at the rear side with locking arrangement for easy access to all the components housed in side as detailed below. The height of the charger shall be such as to allow easy operation of all the switches and push buttons.

#### **9.4.5 48 / 110 Volts D.C. Distribution Board:**

##### **9.4.5.1D.C. Bus Bars:**

There shall be one charger load bus, one load bus and one emergency load bus. The charger load bus shall be rated for 200 Amp, 10kA short circuit withstand rating. Load bus bar shall be rated for 100 Amps, 10 kA short circuits withstand rating. The emergency load bus shall be rated for 50 Amps, 5 kA short circuits withstand rating. The charger load bus and load bus shall be connected through 100A MCCB.

##### **9.4.5.2Outgoing Circuits: (14 Nos.)**

- 3 No. feeder to 3 nos. UCBs .
- 1 No. feeder to control and relay panel.
- 1 No. feeder to L.T. Board.
- 1 No. feeder for 33 kV switchyard
- 3 Nos. feeders to Electronic governor panel
- 3 Nos. feeder to excitation panel
- Two Nos. feeders as spare.

One No. feeder for emergency lighting which will comprise of a emergency load bus and 4 Nos. outgoing emergency light circuits having 16 amps MCB in each circuit, each housed in D.C. panel itself. One main lighting feeder shall be connected to emergency load bus through emergency lighting contactors. The contactor will normally keep D.C. supply to the mini bus off, but in case A.C. fails it will automatically switch on the D.C. to emergency lighting.

**Note:** All above feeders except emergency load bus feeder will be connected through 32 amps MCB. Emergency load bus will be connected through 50 Amps MCCB.

9.4.5.3. One no emergency lighting contactor rated for 415/230 V. A.C. and provided with two sets of contacts controlling D.C. emergency contactor. The DC contactor rated for 48 Volt. controls D.C. emergency supply.

9.4.5.4 The board shall be complete with wiring, cable glands, cable lugs for termination of outgoing and incoming circuits, as shown in drawing. This drawing is tentative and tenderer is desired to submit his own drawing for approval of the purchaser.

#### **9.4.6 Instruments**

Following instruments may be installed on the charger:

1. AC voltmeter 0-500 V with RY, YB, BR selector switch
2. DC output-voltmeter for float charger
3. DC output-voltmeter for boost charger

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4. DC ammeter for float output
5. DC ammeter for boost output
6. DC ammeter (centre zero) to measure trickle charging current to battery as well as discharging current from the battery.

#### **9.4.7 Spares**

The technical particulars of the spares shall be identical to those of corresponding components. Tenderer will give list of spares required for five years.

#### **9.4.8 Tools**

##### **For 48 / 110 volt 300 AH Nickel Cadmium Battery**

Cell testing voltmeter	2 Nos.
Thermometers	2 Nos.
Hydrometers	2 Nos.
Alkaline mixing tank	1 No.
Alkaline resistant jugs, funnels, rubber apron, rubber gloves, rubber siphon and rubber syringes, spanners	2 Nos. each

#### **9.4.9 Design & Construction**

9.4.9.1 Wooden stands shall be of first class seasoned teakwood. These shall be mechanically strong and coated with three coats of KOH resistant paint.

9.4.9.2 Charger shall be floor-mounting type totally enclosed in steel cabinet with provision of cable entry from bottom. All the breaker controls and instruments shall be mounted in front of the panel and at a convenient height to facilitate ease of operation. It shall be provided with hinged doors at the rear side. The charger cabinet shall be painted with approved shade colour as per ISS Plastic paint in gloss finish shall be used.

9.4.9.3 DC distribution board shall be floor-mounting type. It shall be totally enclosed in steel cabinet with welded steel work inside so as to make it rugged and all fuses bus bars and switches except their operating handle shall be mounted inside. Bus bars shall be covered with coloured PVC tapes or epoxy insulated and shall be designed for the appropriate current rating. A common earthing shall be provided for the DC board. Cable glands shall be provided and mounted on the glands plate so as to facilitate easy termination of all the incoming and outgoing cables entering from the bottom. Front of the cabinet shall be hinged type. The cabinet shall be painted with approved shade colour.

#### **9.4.10 Tests**

Following tests shall be performed on each battery after installation at site. The tests shall be performed in accordance with IS:1651-1970 and the test results shall strictly conform to the provisions of the above said standard.

Visual inspection and dimensional check as per Para 10.4 of IS:1651-1970.

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Capacity test on complete batteries as per Para 10.5 of IS:1651-1970.  
 Test for retention of charger as per Para 10.7 of IS:1651-1970.  
 Potassium hydroxide supplied shall be tested in accordance with IS (revised).

### Tests of Chargers

Following tests shall be performed on each of the charger:  
 General inspection of circuits, associated components and checking of wire etc.  
 Capacity test on charger to verify temperature rise of various components.  
 Calibration test of indication instruments.  
 Performance test on voltage regulating equipment both on auto and manual condition.  
 Testing of overload and other protective devices.

### Tests on DC Distribution Board

General inspection of the board and associated components checking of working etc.  
 Calibration test of indicating instruments provided on the D.C. distribution board.  
 Test of insulation resistance.  
 Test of safety devices such as over voltage, under voltage and ground fault alarms and lighting contactors etc.

## 9.5 DIESEL GENERATING SET

Diesel generating set 60 kW, 415 V, 3 phase, 50c/s, manual/battery auto start directly coupled to an alternator fixed on a sturdy channels section steel base frame.

It should be complete with control panel, water pump, lubricating oil cooler, radiator or heat exchanger. It should have low noise level and low vibration level as per relevant IS. It should have superior combustion chamber design so as to give low fuel consumption and high efficiency. The set should be rated for 24 hours running. The set should shut down on high temperature, low fuel level and low lubricating oil level.

### Technical Particulars

1.	Make	From	reputed
	manufacturer.		
2.	Quantity	1 No.	
3.	Rating	60 kW	
4.	Phase	3 Phase 4 wires	
5.	Voltage	415 Volts	
6.	Frequency	50 c/s	
7.	Voltage variation from no load to full load	Not more than 3%	
8.	The set shall be complete with control panel water pump, lubricating oil cooler radiator etc.		
9.	Manual/Auto battery start		
10.	The set should shut down on high-temperature, low fuel level and low lubricating oil level.		

## **9.6 POWER & CONTROL CABLES INCLUDING CABLE TRAYS**

### **9.6.1 Scope**

The scope shall include supply, laying of power and control cable, cable trays, termination of cable etc., their testing and commissioning

#### **9.6.1 Power Cables**

The 3.3 kV XLPE power cables in full length (Without Intermediate Joints) shall be required to interconnect the 3.3 kV stator terminals to 3.3 kV switchgear located in the power house and to terminal cubicles. Continuous current carrying capacity may be taken as 400 Ampere with a fault level of 25 kA for 1 second. These are also required to connect:

- i. 3.3 kV Switchgear to one no. 3.3/0.415 kV, 250 kVA Station Service Transformer suitable for (50A, 25kA -1 sec.).
- ii. 3.3 kV Switch gear to 3.3 kV terminal of 3.3/33 kV Main Generator Transformers located in the switchyard suitable for 500A, 25 kA – 1sec.
- iii. 3.3 kV switchgear to 3.3/11 kV 630 kVA Transformer located in switchyard and suitable for 50- A current.
- iv. L.T. Power Cables

The 415 V AC and 48 / 110 V DC cables shall be required to interconnect the different auxiliary service boards and connect to various equipment to various distribution boards as required. 250 V DC flexible insulated oil restraint copper cable shall also be required to connect generator field with the excitation equipment. The insulation level of all these cables shall be 1.1 kV grade.

#### **9.6.1.2 Control, and Instrumentation Cables**

These shall include all cables required for the installation of the complete instrumentation, control, protection and metering systems in the power house, transformer sub-station, switchyard, diesel set and fore bay.

Special reference is made to:

- i. Control room with their control panels/control desks, metering, protection and automatic control cubicles.
- ii. The digital turbine governor electronic/mechanical cabinets, the static excitation equipment alongwith automatic voltage regulators.
- iii. Automatic and manual control of unit
- iv. Unit and station auxiliaries

#### **9.6.1.3 Cable Trays, Supporting Structures, Cables Terminals etc.**

The cable trays, supporting structures, cable terminating lugs and other accessories shall be required to interconnect various service boards and equipment to complete the system.

#### 9.6.1.4 Design Features

All cables shall be designed to cope with the short circuit conditions and voltage drop. Fusing capacity of power cables may be taken for fault duration of 200-ms. Maximum short circuit current for 3.3 kV system may be taken as 25 kA, for 415V power circuit as 18 kA.

For

PT & CT circuits, 4 mm<sup>2</sup> copper cables shall invariably be used. DC distribution shall also be on 6mm<sup>2</sup> copper cables. Size of aluminium power cable shall in no case be less than 10 mm<sup>2</sup>.

The cables shall be capable of satisfactory operation under a power supply system voltage variation of  $\pm 10\%$  and frequency variation of  $\pm 5\%$  and a combined frequency voltage variation of 10% (absolute sum). The cables shall have heat and moisture resistant properties. These shall be of type and design with proven record of power station installation.

All the accessories and special tools supplied and used by the contractor during the installation of cables shall be handed over to the Owner for future use after completion of work.

Broad assessment/quantities of different type of power and control cables, no. of cores, ratings, sizes, fault current withstand capability etc. shall be furnished with the bid.

Quantities of different sizes of cable trays, supporting structures, cable routes, cable schedules termination detail etc. shall also be furnished.

For the purpose of proper assessment of the requirement, the site may be visited on any working day with prior intimation.

#### 9.6.1.5 Power Cables 3.3 kV System Single & Multi-core Cables

3.3 kV power cables shall be heavy duty, stranded circular aluminium conductor, cross linked polyethylene (XLPE) insulated provided with conductor screening and insulation screening, laid up, extruded PVC inner-sheathed, armoured FRLS type conforming to IS 7098 (Part-III) / Relevant IEC and as specified in this specification. The conductor screening shall be by strippable extruded semi-conducting thermo setting material with a minimum thickness of 0.3 mm. as per IS. The insulation and screening shall be extruded, semi-conducting and with copper tape screening (with at least 0.075 mm thickness) about it.

#### 9.6.1.6 Power Cables 1100 Volts Grade

All LT power cables shall be of stranded Aluminium conductor except DC power cables, which shall be of stranded copper conductor. All control and instrumentation cables shall be of stranded 2.5 mm<sup>2</sup> copper conductors except cables for CTs & PTs which shall be 4 mm<sup>2</sup>.

#### Single Core Cables

These cables shall be at least 1100 volts grade, heavy duty, single core, stranded aluminium / **copper** conductor, HR-PVC insulated and PVC sheathed armoured FRLS type and shall conform to the same design and properties as cables conforming to IS: 1554 (Part I & II) / IEC. The outer sheath is of specially formulated PVC compound.

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## Multi-core Cables

The cable shall be at least 1100 volts grade, heavy duty multi-core, stranded aluminium/copper conductor, PVC insulated, colour coded, laid up, armoured inner sheathed with extruded PVC, 2/3.5 or multi-cores FRLS type, conforming to IS 1554 / relevant IEC. (Part I). The outer sheath is of specially formulated PVC compound.

## Control & Instrumentation Cables

The control & instrumentation cables shall be multi-core, colour coded, annealed high conductivity copper, single conductor, insulated with HR-PVC insulation, PVC sheathed, armoured FRLS type conforming to IS 1554 (Part I & II) / relevant IEC. The outer sheath is of specially formulated PVC compound,

All these cables shall have the following properties:

Oxygen index	Min. 29
Smoke density	Min. 40% light transmittance
Acid gas	Max. 20% by weight
Flame propagation	Shall meet IEC 332-1, IEEE 383 & SEN of 4241475 (Class F 3)

### 9.6.1.7 Performance Criteria and Guarantees

The power, control and instrumentation and other cables system shall be capable of performing all intended duties and it is the responsibility to supply the equipment as per guaranteed technical particulars.

## 9.6.2 DESIGN AND CONSTRUCTION

### 9.6.2.1 Conductor

The conductor shall be made from stranded annealed copper / aluminium to form compact conductor having a resistance within the limits specified in relevant IS /IEC. HR-PVC insulated cable of size 25mm<sup>2</sup> and above shall have sector shaped conductor.

### 9.6.2.2 Conductor Shield

The conductor having a semi-conducting screen shall ensure perfectly smooth profile and avoid stress concentration. The conductor screen shall be extruded in the same operation as the insulation. The semi-conducting polymer shall be cross-linked (for XLPE cables)

### 9.6.2.3 Insulation

The insulation of the cables shall be extruded type and shall be designed and manufactured for the specified system voltage. The manufacturing process shall ensure that insulation is free from voids.

The insulation shall withstand mechanical and thermal stresses under steady state and transient operating conditions. The extrusion method should give very smooth interface between semi-conducting screen and insulation. The insulation of the cable shall be of high standard quality.

#### **9.6.2.4 Insulation Shield**

In XLPE cables, to confine electrical field to the insulation a non-magnetic semi-conducting shield shall be put over the insulation. The insulation shield shall be extruded in the same operation as the conductor shield and the insulation by Triple extrusion process. The XLPE cable insulation shall be strippable. Metallic screening as given in this specification for the various control and power cables and special cables shall be provided.

#### **9.6.2.5 Sheath**

The sheath shall be suitable to withstand the site conditions and specified temperature conditions. It shall be of adequate thickness and applied by a continuous process to produce a sheath of consistent quality free from any defects. The sheath shall be extruded.

#### **9.6.2.6 Armour**

Hard drawn aluminium wire armouring /single galvanised steel tape/wire armouring shall be used for single core and multi-core cables respectively. The diameter of the aluminium wire shall be as per the table for the dimensions of the galvanised steel wire armour given in the relevant standard.

#### **9.6.2.7 Service and Outer Sheath**

Extruded PVC serving as specified shall be applied over armouring with suitable additives to prevent attack by rodents and termites. All servings must be given anti-termite treatment. The cable shall have suitable fillers laid up with the conductors, before the sheath is applied and the fillers shall be of substantially circular cross section. Fillers shall be suitable for operating temperature of the insulation and compatible with the insulation.

#### **9.6.2.8 Size & Length of Cables**

The number of cores and sizes of the cables required for various circuits shall be specified in the schedule of requirement by the contractor.

The cables covered by this specification shall be supplied in one length or in standard length as approved by the Owner.

#### **9.6.2.9 Colour Scheme and Identification**

To facilitate easy identification of phases a colour scheme of Red, yellow and Blue for phases and black for neutral shall be adopted for power cables. Multi-core control cables shall be colour coded for identification of cores as per IS: 1554 1976/ IEC.

All the cables shall carry manufacturer data in a permanent, legible manner at an interval of at least 3 meter run. The manufacturer's data shall include the name; cable size, voltage rating together with any other information.

#### **9.6.2.10 Termination Kit**

The termination kits required for 3.3 kV XLPE cables terminations shall be heat shrinkable type as per relevant IS / IEC.

The contractor shall supply all hardware consumables such as plumbing metal, sealing compound, tapes and other materials required for the making of these terminal connections of various sizes of cables.

#### **9.6.2.11 Cable Lugs**

The cable lugs shall be supplied as per cable schedule and these shall be made of copper tube electro tinned. The contractor shall supply longneck-crimping lugs for cables of size 400 mm<sup>2</sup> & above. The contractor shall ensure that no bimetallic action takes place, between the aluminium conductor of the cable and the cable-connecting lug by filling the lugs with suitable compound. The lugs shall be of standard quality conforming to relevant IEC / IS only.

#### **9.6.2.12 Cable Accessories**

The contractor shall supply all the required accessories that may be found necessary during actual execution of the job, within the quoted prices.

#### **9.6.2.13 Cable Glands**

The cable glands shall be double compression type and shall be made of brass duly electro tinned in order to avoid corrosion and oxidation of the surface. The nipple threads shall be in accordance with IS 1653 / IEC. Glands shall provide neat, tight, dust and vermin proof termination.

Gland shall be provided with rubber ring to hold the cables firmly when check-nut is slightly tightened. Gland shall be complete with suitable washers etc.

#### **9.6.2.14 Compression Type Terminals for Control Wiring**

These terminals are required for copper conductor of control wiring. They shall be crimped to the conductor while other end will provide flat surface for better connections. The connectors shall be made of copper electro tinned.

#### **9.6.2.15 Button Tape (Strap & Stud)**

This consists of perforated cable strapping with holes conveniently spaced for assembly and moulded studs. The strapping shall be made of NYLON Grade 220 or other elastic material to give proper performance. The studs shall be made of 'NYLON'.

#### **9.6.2.16 Self Adhesive Marker**

Self-adhesive marker in the form of strips of any one character, which can be easily peeled from the backing cards and can be applied on the cable, shall be supplied. The strips shall be water- proof duly marked with special formulated ink with specific thermo-setting adhesive to withstand high temperature.

Suitable plastic ring type ferrules marked with engraved indelible ink for control cables and sticker type ferrules for power cables shall be supplied. These shall be marked as per cable schedule such that each core of each cable can be identified easily.

#### **9.6.2.17 Aluminium Strip**

Aluminium strip of adequate size for making tags for labels shall be supplied.

Good quality PVC tapes, cotton tapes and any other accessories required for laying, termination, testing & commissioning shall be supplied conforming to relevant IS.

#### **9.6.3 Cable Trays & Support Structure**

Perforated cable trays made out of 14-gauge mild steel sheet shall be fabricated. The trays shall be provided with long shape slots of 20mm x 8mm size. The trays shall be of perforated plates for proper ventilation of the cables.

The cable trays shall be fully galvanized as per the relevant IS / IEC and the Owner reserves the right to test galvanizing as specified in the relevant IS / IEC in presence of its representative. The tack welded portion of trays and the contact surfaces shall be given a layer of epoxy paint or shall be treated with galvanized compound. The cable support shall be painted.

Detailed design of the cable trays & supports shall be got approved from the Owner before commencement of fabrication/assembly. The fixing of supports to the walls/ceiling/tunnel/column/ trench etc. is also covered in the scope of supply. The fixing arrangement shall be approved by the Owner. Embedment for the fixing of the supports shall be provided by the Owner.

#### **9.6.4 Fire Proofing**

Cables passing through different fire zones, shall be provided with fire-proof barriers with the same fire rating as the penetrated walls or partitions.

#### **9.6.5 Cable Junction Boxes**

Junction box shall be constructed of sheet steel of thickness not less than 2mm. The door shall be adequately strengthened to ensure rigidity and strength. Sheet steel and sections used in enclosures shall be cut neatly and finished free from burrs. Ample wiring space shall be provided at the sides, and back of the enclosure for incoming and outgoing circuits. Removable plates with gaskets shall be fitted at the top and bottom of the box to provide the entry for conduit or cable. The door shall be suitably gasketed and fitted with a lock type handle. The door shall be hung on hinges having brass bodies and stainless steel pins.

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Each cable junction box shall be provided with terminals of adequate rating on the terminal strip of suitable thickness. Disconnecting (sliding) type terminal blocks shall be provided, to facilitate testing & maintenance without disconnecting the cables.

Multi-block terminal board of 15 A, 500 V rating shall be provided to form assembly of number of terminal block. Assembly may be secured with only two screws on the surface. There shall be provision on the strips to add more terminal in case of further requirement.

#### **9.6.6 Packing**

All the cables shall be supplied on non-returnable wooden drums with adequate barrel diameter so as to avoid any damage to the cables and to withstand rough handling during transportation and storage.

Particulars of the drum on which the cables would be packed for transportation with a dimensioned drawing shall be submitted. Preferably not more than one length shall be wound on one drum. The supplier will be held responsible for any loss or damage caused by any defects in packing.

A layer of waterproof paper shall be applied to the surface of the drums and over the outer cable layer. A circular space of at least 40mm shall be left between the cable and the lagging. Each drum shall carry the name of the manufacturer, the name of the Owner his address, order number, item number, type, size length of cable, net and gross weight duly stencilled thereon.

#### **9.6.7 Quality Control And Assurance Requirements**

The supplier has to supply the cables and other accessories of best quality. The supplier has to maintain control and quality assurance during the manufacturing, installing, testing and commissioning of equipment. The quality assurance plan shall be submitted with the technical bid.

#### **9.6.8 Calculations**

The supplier is required to submit the calculation for selecting the cable size for connecting various boards/equipment. The cable schedule and termination diagram for all power, control & telephone cables shall be prepared by the contractor and submitted to Owner for approval.

#### **9.6.9 Workshop Test**

The cables shall be routine tested as per relevant IEC/IS at the works of supplier in presence of representative of the Owner. The Supplier is required to submit type test certificate and routine test reports of all the items.

Requirement of tests for power and control cables (IS 1554 / IEC).

**9.6.9.1 Type Tests:****i. Tests on conductor:**

- a. Annealing test (for Cu.)
- b. Tensile test (for Al.)
- c. Wrapping test (for Al.)
- d. Conductor resistance test.

**ii. Test for armouring wires/strips:-**

- a. Nominal thickness (for steel strip)
- b. Nominal diameter (for round wire)

**iii. Test for thickness of insulation and sheath.****iv. Physical test for insulation and outer sheath.**

- a. Tensile strength and elongation at break of insulation and sheath.
- b. Ageing in air oven.
- c. Shrinkage test
- d. Hot deformation
- e. Loss of mass in air oven.
- f. Heat shock test.
- g. Thermal stability.

**v. Insulation resistance test.****vi. High voltage test (water immersion test)****vii. High voltage test at room temperature.****9.6.9.2 Acceptance Tests:**

- i. Annealing test (for Cu.)
- ii. Tensile test (for Al.)
- iii. Wrapping test (for Al.)
- iv. Conductor resistance test.
- v. Test for thickness of insulation and sheath.
- vi. Tensile strength and elongation at break of insulation and sheath.
- vii. Insulation resistance test.
- viii. High voltage test at room temperature
- ix. Capacitance measurement test on 3.3 kV cables.

**9.6.9.3 Routine Tests**

- i. Conductor resistance test.
- ii. High voltage test at room temperature

**9.6.9.4 Optional Tests**

- i. Cold bend test
- ii. Cold impact test

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- iii. Armour resistance test

The following **FRLS tests** are to be conducted as per the referred standard.

#### **9.6.9.5 FRLS Tests**

- i. HCL gas evolution test (IEC - 754.1)
- ii. Oxygen Index (ASTM-D-2863)
- iii. Temperature Index (ASTM-D-2863)
- iv. Smoke density test (ASTM-D-2863)
- v. Flammability test (IEC-332.1)
- vi. Swedish Chimney test (SS-424 14 75)
- vii. Ladder Test (IEEE-383)
- viii. XLPE cables shall be tested as per IS 7098 / IEC.
- ix. The instrumentation and fibre-optic cables shall be routine tested as per relevant IEC/IS.

#### **9.6.10 Installation And Commissioning**

All installation and lying of cables and cable trays shall be done by skilled workers in a workmanlike manner. Sufficient spare cores in control cables shall be kept as spare cores in cable scheduling for future use. Before charging of cables all wiring/cable shall be checked as per cable schedule programme.

##### **i. Cable Routing**

For the main cable ways, a system of cable racks and trays as well as cable ducts and trenches shall be provided. The cable trays shall be provided for power and control cables. The cables which are buried underground shall be laid at depth of at least 1 metre and shall be protected by bricks on two sides and at the top.

The cables for emergency lighting, fire alarm systems, etc., shall run on separate trays.

All cables laid by the contractor shall be terminated at both ends. The contractor shall make all electrical connections strictly in accordance with the contractor's cable schedule approved by Owner and shall provide numbered ferrules at each connecting terminal in order to check connections without any difficulty. Terminal blocks have been provided in various panels/equipment for these terminations. One termination shall mean connecting both ends of one core of a cable to given terminal blocks. The cables shall be terminated by crimping lugs to the ends.

Jointing compound, 3.3 kV jointing kits, termination kits, button tape, PVC tape, cotton tapes etc. shall be supplied by contractor and used as part of consumable material. However joints shall be avoided as far as possible.

The cables shall be handled with care so as to avoid kinking and damage. Sufficient slack shall be allowed in each run of cable to permit contraction and expansion. Suitable loops between gland and terminating point shall also be provided.

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Contractor shall take proper care in the handling of cables against external damage of any kind. Necessary rollers etc. shall be used while pulling and laying of the cables. Owner shall have the right to stop the work in case of improper handling of the cables.

Cables shall be properly clamped at regular intervals with the help of non magnetic/moulded fiber glass strip clamps/PVC sleeved clamps, of suitable size. Contractor shall submit typical drawings along with tender giving proposed clamping arrangement and also give distance of clamping at bends and in regular run of cables.

**ii. Cable Markers and Cable Binding**

Suitable cable markers of aluminium with punch marks shall be provided and suitably tagged to the cable permanently so that cable could be easily identified.

**iii. Cable Binding/Strapping**

All control cables after glanding shall be neatly routed and binded with the help of cable straps and studs inside the panel. Complete routing in panel shall be such that it gives a neat appearance good workmanship.

For L.T. Power cables, suitable holding clamps will be provided in the panel if required.

The contractor shall also be responsible for sealing the spare holes and panel circuits with the help of suitable blanking plates or mutually agreed method.

The contractor shall do the cable glanding suitable for each cable size at both ends of termination of each cable.

**9.6.11 Field Tests**

Before commissioning of complete system all cabling system shall be checked as per cable schedule and complete report shall be prepared by contractor and shall be submitted.

Field test shall include:

Cabling checking

Continuity checking

Megger testing in accordance with the applicable codes and standards.

Resistance checking

Contractor shall be responsible for conducting tests as per IS / IEC before termination of the cables i.e. measuring insulation resistance of each core to earth and core to core, identification of cores, all tests before and after termination etc. Contractor shall be fully responsible for correct terminations and if at the time of commissioning some modifications/rectifications are required the same shall also be carried out by him. If any terminations/cable boxes etc. fail at the time of commissioning, Contractor shall be responsible to replace the same.

### 9.6.12 Spare Parts

The supplier shall supply spare parts as per General Technical Specification 3A. In addition the supplier shall submit a detailed proposal on recommended spares and consumables for five (5) years operation. This proposal shall be prepared under due consideration of the requirement of the General Technical Specification.

### 9.6.13 Tools

In addition to the tools listed in general technical specification the contractor shall provide one set of all necessary tools for erection, testing, commissioning, repair and maintenance as recommended by the manufacturer. A list of such tools shall be furnished with the bid.

## 9.7 GROUNDING / EARTHING

Earthing system shall be designed as per IS: 3043 and IEEE: 80. Earthing system network/earthmat shall be interconnected mesh of mild steel rods buried in ground in the plant. All off-site areas shall be interconnected together by minimum two parallel conductors. The contractor shall furnish the detailed design and calculations for Owner's approval. Contractor shall obtain all necessary statutory approvals for the system.

Soil resistivity data for by shall be measured by the Contractor for designing earthing system.

Enclosures of all electrical equipment as well as all cabinets/boxes/panels/etc. shall be earthed by two separate and distinct earth connections. Metallic pipes, conduits, cable tray section, etc. shall be bonded to ensure electrical continuity and earthed at regular intervals as well as at both ends. Metallic conduits, pipes, etc. shall not be used as earth continuity conductor. All hinged doors shall be earthed by flexible braids of adequate size.

All steel structures shall be duly earthed. Metallic sheaths and armour of all multicore cables shall also be earthed at both equipment and switchgear end.

Earthing conductor shall be buried at least 2000 mm outside the fence of electrical installations. Every alternate post of the fences and all gates shall be connected to earthing grid by one lead. Earthing conductor embedded in the concrete floor shall have at least 50 mm concrete cover.

Earthing connections with equipment earthing pads shall be bolted type with at least two bolts, and joint surfaces shall be galvanised. The connections shall be painted with anti-corrosive paint after testing and checking.

Neutral of power transformers shall be directly connected to two rod electrodes in treated earth pits, which in turn shall be connected to station earthing grid.

The earthing terminal of surge arresters and voltage transformers, and lightning protection, down conductors shall also be connected to station earthing grid through separate rod electrode.

The earthing resistance of the grounding system of the power house and the switchyard together shall not be more than 0.5 Ohms.

Other requirements for Earthing system

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- a. Standard/Code IEEE-80, IS: 2309
- b. Earthing system life expectancy 40 years
- c. System fault level 40 kA for one second
- d. Soil resistivity Contractor to measure at site at min. 20 locations approved by Owner.
- e. Min. steel corrosion rate 0.25 mm per year.
- f. Depth of burial of main earth conductor 600 mm below ground level; where it crosses conductor trenches, pipes, ducts tunnels, rail tracks, etc., it shall be at least 300 mm below them.
- g. Conductor joints By electric arc welding, with resistance of joint not less than that of the conductor. Welds to be treated with red lead for rust protection and then coated with bitumen compound for corrosion protection.
- h. The minimum conductor size for earthing system shall be as follows:

Equipment	Buried conductor	Conductor above ground & in trenches
Main station grid	40 mm dia MS rod	65x8 mm GS flat
Switchgear	--	65x8 mm GS flat
415 V distribution boards	--	50x6 mm GS flat
HT motors	--	50x6 mm GS flat
LT motors above 125 kW	--	50x6 mm GS flat
LT motors - 25 to 125 kW	--	25x6 mm GS flat
LT motors - 1 to 25 kW	--	25x3 mm GS flat
Fractional HP LT motors	--	8 SWG GS wire
Control panel & control desk	--	25x3 mm GS flat
Push button stn. & Junction box	--	8 SWG GS wire
Cable trays, cols. & structures	--	50x6 mm GS flat
	--	50x6 mm GS flat
Rails & other metal parts	--	25x6 mm GS flat
Equipment earthing for switchyard	--	76x8 mm GS flat and 50x6 mm GS flat

## 9.8 LIGHTNING PROTECTION

The lightning protection system shall be designed as per IS: 2309. It shall cover all buildings and structures in the plant, and switchyard areas. It shall comprise horizontal/vertical air terminations, down conductors, test links and earth connections to the station earthing grid. All conductors shall be of minimum 25x6 mm size and shall be of galvanised steel only.

The down conductors of lightning protection system shall have a test joint at about 1500 mm above ground level. Each down conductor shall be connected to a 40 mm dia, 3 m long mild steel earth electrode as well as station earthing grid.

The lightning protection system shall not be in direct contact with under ground metallic service ducts and cables, and shall not be connected above ground level to other earthing conductors. All joints in the down conductors shall be of welded type.

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Pulser system for lightning shall not be accepted.

Hazardous areas handling inflammable/explosive materials and associated storage areas shall be protected by a system of aerial earths as per IEEE: 142.

## **9.9 MISCELLANEOUS EQUIPMENT**

### **9.9.1 Transformer Oil Purifier**

One No oil purifier 250 liter per minute capacity machine complete in all respect for centrifuging transformer oil shall be supplied and commissioned for successful performance. The purifier shall be mounted on rubber pad wheels trolley and shall comprise of compressor systems, heater system, filter packs etc including all electrical switches, fuses, temperature controllers, indicating instruments and operating valves. This machine should be able to centrifuge the transformer oil as per relevant Indian standards.

### **9.9.2 Fire Protection Equipment / System For The Power House**

Fire fighting arrangements at the generator floor, control room, switchgear room etc. of the power house shall be provided. The equipment/system shall comprise fire/smoke detectors, portable fire extinguishers, fire buckets and hydrants as per the IS/relevant standards.

#### **i. Fire Detectors**

The following locations shall be provided with fire/smoke detectors which will be installed above the equipment / most suitable locations.

Generator floor  
Control room.  
L.T. and 3.3 kV switchgear area.  
Any other location deemed necessary.

These fire / smoke detectors shall initiate alarm and indication in the Fire Alarm Panel to be installed in the control room to identify the location of smoke/fire to enable corrective actions. The central alarm & annunciation panel shall also have a connection from the detectors.

#### **ii. Portable Fire Extinguishers**

Portable Fire Extinguishers of various types of requisite capacity shall be located at appropriate locations in the power house as below:

- |    |   |   |  |
|----|---|---|--|
| a. | Trolley mounted CO <sub>2</sub> type    | : | 2 cylinders on Generator floor               |
| b. | CO <sub>2</sub> type fire extinguishers | : | 2 Nos. for Control room                      |
| c. | Soda Acide type                         | : | 2 Nos. Near D.C. batteries                   |
| d. | Foam type extinguishers                 | : | 2 Nos. Near OPU                              |
| e. | Dry chemical type extinguishers         | : | 2 Nos. for Switchgear and Control room each  |
| f. | Carbon Tetra-Chloride type              | : | 5 Nos. for General electrical installations, |

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### iii. Fire Buckets

Two sets of fire buckets, each set comprising 6 buckets filled with sand, shall be provided on covered steel stand at various places in the powerhouse area.

### 9.9.3 Water Level And Turbine Discharge Measurement

Each of the 2 water turbines receive water from the forebay through 2 nos. penstocks each feeding to the respective turbine. The tenderer shall provide a system for measurement of water levels at forebay, & tailrace and measurement of discharge of each turbine. The prices of this system may be included in rates for turbines.

#### 9.9.3.1 Features

The equipment/system shall have following features:

- i. Use of suitable probes/transducers making use of multiple acoustic path as may be required for two decimal digital accuracy of level measurement in metres and three decimal digital accuracy of discharge measurement in cu m.
- ii. An ultrasonic level and flow meter.

#### 9.9.3.2 Location

- i. For forebay water level measurement, the transducers shall be located suitably on the upstream side of the trash racks in the forebay channel.
- ii. The water level is also to be measured after the intake gates for which transducers shall be installed at a suitable place in the reach immediately downstream of the intake gates for monitoring the trash rake cleaning/head loss measurement.
- iii. For discharge measurement, the transducers etc. shall be located suitably in the respective distributors of each generating unit.

### 9.9.4 Air Conditioning Of Control Room

Control room shall be provided with A.C. for which approval shall be taken from the purchaser by the contractor. Two numbers 1.5 tonne air conditioners may be sufficient for this purpose.

### 9.9.5 Ventilation System

Adequate and proper ventilation equipment/system shall be provided in the machine hall, control room, office room etc. as required as per approval to be taken from the purchaser. Three numbers 450 mm size exhaust fans may be installed in down stream wall of the power house.

## 9.9.6 Lighting System

### 9.9.6.1 Scope

These specification covers design, manufacture, supply, installation, testing and commissioning of the lighting system at the project. The scope covers lighting arrangement for powerhouse, switchyard, tailrace, forebay and other appurtenant works like bye pass approach road and trash rack etc.

### 9.9.6.2 Standards

IS: 3646	Illumination and glass index
IS: 694	Wires
IS: 732	Wiring installation conditions

### 9.9.6.3 General Requirements

A comprehensive illumination system shall be provided in the entire project i.e. all areas within the plant boundary. The system shall include lighting fixtures, distribution boards, lighting panels, junction boxes, lighting poles, receptacles, switchboards, cables and wires, conduits, poles and masts, etc. The system shall cover all interior and exterior lighting such as area lighting, yard lighting, street lighting, security lighting, etc.

### 9.9.6.4 Design Criterion

The illumination system shall be designed on basis of best engineering practice and shall ensure uniform, reliable, aesthetically pleasing, glare free illumination. The design shall prevent glare/luminous patch seen on VDU screens, when viewed from an angle.

Power supply shall be fed from 415/240 V normal ac power supply, station service board, and 48 V dc supply for emergency lighting. Lighting panels shall be located at different convenient locations for feeding various circuits. These panels shall be robust in construction with lockable arrangements and MCB for different circuits.

48V dc emergency lighting shall be provided in following areas:

- |    |   |                   |
|----|---|-------------------|
| a. | Machine hall  | 20 lux            |
| b. | Control room  | 100 lux           |
| c. | Exit points and stair cases   | One light fixture |
| d. | All other strategic locations for safe personnel movement during any emergency. |                   |

DC lighting shall come on automatically on failure of normal ac supply. These shall be switched off automatically after the normal ac supply is restored and luminaries have attained their full glow.

Lighting panels, fixtures, receptacles, poles, masts, distribution boards, switch boxes, conduits, junction boxes etc. shall be properly installed and earthed.

All outdoor fixtures shall be weather proof type. Fluorescent fixtures, installed in other than control room areas shall have electronic ballasts. For control rooms, the ballasts shall be copper wound inductive, heavy duty type, filled with thermo-setting insulating moisture repellent polyester.

All luminaries and their accessories and components shall be of the type readily replaceable by the available Indian makes. All fixtures and accessories shall be of reputed make and non-corrosive type. Acrylic covers/louvers shall be of non-yellowing type.

The constructional features of lighting distribution boards shall be similar to AC/DC distribution boards described elsewhere. Outgoing circuits shall be provided with MCBs of adequate ratings.

Wiring shall be by multi-stranded PVC insulated colour code cable laid in GI conduits. Wiring for lighting circuits of ac, and dc systems shall be run in separate conduits throughout. Minimum size of the wire shall not be less than 1.5 sq.mm copper or 4 sq.mm aluminium. Wire shall conform to IS: 694 and wiring installation shall be as per IS: 732.

Conduits shall be of heavy duty type, hot dip galvanised steel conforming to IS: 9537. In corrosive areas, conduits shall have additional suitable epoxy coating.

At least one 5/15A, 240 V universal socket outlet shall be provided in offices, stores, cabins, control room, switch gear room etc. 20A, 240 V ac industrial type receptacles shall be provided strategically in all other areas including switch gear room and control room. All these receptacles shall be 3 pin type and controlled with a switch. Suitable numbers of 63 A, 3 phase, 415 V ac industrial type receptacles with control switches shall be provided for the entire plant for welding and other purposes, particularly near all major equipment and at an average distance of 50 m.

Street lighting shall be with swaged tubular steel poles of swan new construction. The poles shall be coated with anti-corrosive treatment and paint.

Area lighting shall be with suitable lighting masts. Masts of adequate height shall have lattice structure with ladder, cage and top platform. Alternatively they shall have lantern carriage of raise/lower type with electrical winch provided inside the tubular mast.

All outdoor lighting systems shall be automatically controlled by synchronous timer or photocell. Arrangement shall be provided in the panel to bypass the timer/photocell for manual control.

#### 9.9.6.5 Illumination Levels And Type of Fixtures And Luminaries

Location	Average Illumination level (Lux)	Type of Fixture
Machine Hall	200	HPSV high/medium bay Industrial trough type fluorescent
Control room	300	Decorative mirror optics
Offices	300	type -Do-

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Switchyard, Forebay, intake weir etc.	10 (general) 50 (on equip.)	HPSV flood light, weather proof
Street lighting roads	20	HPSV street lights
Outdoor storage handling	20	HPSV flood light, weather proof.
Garage/Car parking	70	Industrial trough type fluorescent

**The lighting plan shall have to be got approved by the contractor from the Department.**

#### **9.9.6.6 A.C. & D.C. Sub-distribution Boards**

Sub distribution boards shall be attractive in design, mechanically strong, robust in construction and shall be totally enclosed in a mild steel cabinet of 3 mm. thickness. It shall have specified sets of MCCBs/MCBs and shall be vermin and dust proof complete with double door, lock and key arrangement. The doors shall be properly hinged. Cable entry shall be through suitable conduit pipe. The interior and exterior shall be painted with two coats of red oxide primer after 7 tank treatment and two coats of approved colour paint as per IS: with a minimum thickness of 60 microns. The sub distribution board shall be suitable to be mounted on concrete wall/columns or it may be mounted inside the wall so that its top surface is flush with the wall. Suitable fixing arrangement such as nuts, bolts, washer, anchors shall be provided at suitable places for its proper fixing.

The MCCBs/MCBs units shall be of reputed make only and shall be complete and fully comply with latest edition of IS:2516-1977, IEC 157-1983. The operating handle shall be properly insulated from the live portion of MCCBs/MCBs and shall always be easily accessible. The MCCBs/MCBs used for A.C. supply and D.C. supply shall be designed for a fault level of 10 KA for 1 second. These S.D.B.'s shall be suitable for voltage variations as per latest relevant I.S.S. Suitable earthing arrangement shall also be provided with sub distribution boards.

MCCBs/MCBs current rating and other details of various subdistribution board shall be as per actual requirement.

#### **9.9.6.7 3φ Wire Power Supply Points**

These power points shall consist of MCCBs suitable for 100 Amps. fixed in air tight vermin & water proof 2 mm. thick m.s. sheet enclosures complete with two Nos. suitable size cable glands and lock & key arrangement.

#### **9.9.6.8 Cables**

Cables shall be of reputed make and of High conductivity and stranded copper conductor, PVC insulated 1100 volt grade, conforming to ISS:1544 Part-I with FRLS properties shall be used with different colours i.e. red, yellow, blue, black, green suitable for light & power circuits.

### 9.9.6.9 Conduits

2 mm. thick m.s. conduits conforming to the relevant latest ISS shall be used where ever required.

### 9.9.6.10 Distribution Board & Junction Boxes

Only Piano type switches shall be provided on sunmica sheet fixed on suitable size m.s. box. Fuse unit duly covered with white bakalite sheet shall be provided on each board. Space for fan regulator should be provided on sunmica board wherever required. Multi pin Plug and Piano type switch with fuse unit shall be provided on sunmica board fixed on m.s. box for power points.

M.S junction box of 2 mm. thick sheet of suitable sizes with lock & key arrangement along with suitable size of Porcelain fuse kit-kat wherever required, shall be used.

**9.9.6.11** The requirement of various light fitting and other equipment is given below which is tentative and may be provided by the tenderer:

- 250 watts, 250 volt HPMV colour corrected fitting (high way luminiare)-6 Nos.+ 2 spare = 8 nos.
- 100 Amps. 415 V, triple pole MCCB power points – 4 Nos.
- 15 Amps. 250 V, multipin plug with-switch fuse power point - 6 Nos.+ 2 spare = 8 nos.
- 60 watts electric fans - 2 Nos. (Pedestral type)
- AC Sub distribution Board - 2 Nos.

Local distribution board - 6 Nos.

250 watts, 250 volt HPSV fitting for street lighting  
6 nos. + 2 spare = 8 nos.

- Exhaust fan 18" size 250 volts single phase - 6 Nos. (Machine hall)  
Exhaust fan 12" size 250 volts single phase - 4 Nos. (Battery room, LT room, Kitchen, toilet)

100 watts 48 volt D.C. incandescent lamp with decorative flush mounting type fitting-6 Nos. + 2 Nos. for switchyard + 4 spare = 12 nos.

2 x 40 watts 250 volt decorative recess/flush mounting type fluorescent tube fitting-12 Nos.+ 2 spare = 14 nos.

Air conditioner 1.5 tones 250 Volt single phase-2 Nos.

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(Wall split type).

#### **9.9.6.12 Wiring & Fixing**

- i. All the wiring and fixing shall be done in accordance with the provisions of Indian Electricity rule 1956 & as per latest relevant ISS modified up to date. The wiring shall be done with looping system in accordance with Indian Electricity rules & relevant ISS.
- ii. Number of wires/cables running in each conduit should not exceed the permissible numbers as per Indian Electricity Rule & latest relevant ISS. The other material used in wiring shall be of standard make manufactured in accordance with relevant ISS & duly approved by Engineer in charge at site.
- iii. As far as possible three phase wiring shall be done as per circuit diagram enclosed & load shall be equally distributed on all the three phase in such a way that when one or more phase is out of order, sufficient distributed light should be available at important installations such as control room, machine hall, battery, room.
- iv. False ceiling would be provided in control room as such concealed conduit wiring shall be done at these places as per site requirements. Surface conduit wiring shall be done at rest of the locations. Under ground wiring shall be done in existing trenches for street & park lighting and conduits shall be used wherever trenches are not provided.
- v. The layout of conduit should be such that any condensation or sweating inside the conduit is drained out. Suitable precaution shall be taken to prevent entry of insects inside the conduits.
- vi. Conduit pipes shall be joined by means of screwed couplers. The ends of conduits shall not have sharp edges.
- vii. In concealed wiring the use of bends, elbows shall be avoided as far as possible, and if their use becomes inevitable, the conduit pipes themselves may be bent with long radius, so that it may permit easy drawing of cables.
- viii. Mild steel junction boxes of 2 mm. thick sheet of suitable sizes with lock and key arrangement shall be provided & fixed at suitable location as per site requirements.
- ix. Wherever joint boxes are provided, all joints in conductor shall be made by means of approved mechanical connectors. In all type of wiring no bare or twisted joints shall be made.
- x. Suitable inspection boxes to the barest minimum requirement shall be provided to permit periodical inspection and to facilitate replacement of wires if necessary. These shall be mounted flush with the wall.
- xi. Conduits pipes shall be fixed by heavy gauge saddle screwed to suitable wood plugs or other approved plugs with screwed in an approved manner at an interval of not more than one meter.

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- xii. A.C. power, light & D.C. wiring shall be kept separate and distinct and layout of wiring shall be designed so as to give minimum bends & crossings. The wall shall be crossed through china clay tubes/m.s. conduits.
- xiii. A continuous 16 SWG G.I. earthwire shall be provided shall run with light, fan & power wiring. G.I. fish wire of 10 S.W.G. shall also be provided along with laying of recessed conduits. The joint in earth wire if proper brazing shall make any.
- xiv. All ceiling fans shall be wired to ceiling roses or to special connector boxes & suspended from hooks or shackles with insulators between hooks & suspension rods. There shall be no joint in suspension rod.
- xv. For power point wiring multipin plug, piano type switch fuse unit shall be provided on sunmica board fixed on M.S. box.
- xvi. All switches shall be placed in live conductor of the circuits.
- xvii. Suitable size G.I. pipe shall be provided for installation of light fittings at various points, which shall be hot, dipped galvanized with heavy zinc coating. All the bolts nuts & washers shall be galvanised.
- xviii. Hooks for ceiling fan shall be provided & got buried by the contractor wherever required.
- xix. Various S.D.B.'s & L.D.B.'s required for A.C. & D.C. lighting shall be properly fixed on the wall/columns flushed with the surface of wall as per requirements.
- xx. The contractor shall be required to lay the cables from station service board/battery room to various sub distribution boards in cable trenches/cable-racks. Fixing arrangement and its termination in station service board & S.D.B.'s shall be the responsibility of the contractor.

#### **9.9.6.13 Painting**

- i. The outer surface of conduit including all bends, unions, tees, junction boxes etc. forming part of conduit systems shall be adequately protected against rust when such system is exposed to weather by being painted with two coats of red oxide paint applied before they are fixed.
- ii. After installation of conduits & wiring all accessible surface of SDB's LDB's conduit pipe, junction boxes etc. shall be painted with two coats of enamel/aluminum paints of approved shade as required to match the finish of surrounding walls, trusses etc.

#### **9.9.6.14 Drawing**

After having completed the wiring, the contractor shall submit eight sets of wiring diagram to the purchaser indicating the position of main switches, various circuits, positions of points with their controlling switches along with one set of reproducible on tracing-cloth in ink. The circuits shall be clearly numbered in the same order as they have been actually been marked in the building.

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**9.9.6.15 Test**

On completion of installation the following tests shall be carried out:

- i. Insulation resistance test
- ii. Polarity test of switches
- ii. Earth continuity test

After completion of the work completion certificate shall be given by the contractor on the prescribed Performa