

**VOLUME-2**  
**PART- I**  
**Section-20**  
**Illumination System**

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## 20. Illumination System

### 20.1 Scope of Work

The intent of these specifications is to define and cover the scope of work under this section which includes the provision of labour, tools, plants, materials and performance of work necessary for the design, manufacture, quality assurance, quality control, shop assembly, shop testing, delivery at site, site storage and preservation, installation, commissioning, performance testing, acceptance testing, training of Purchaser's personnel, handing over to Purchaser and guarantee of Illumination system for Keyi Hydro Electric Project, Arunachal Pradesh as per the specifications hereunder, each complete with all auxiliaries, accessories, spare parts and warranting a trouble free safe operation of the installation.

It is not the intention to specify the minute details/smallest items to deliver a functional system or to define the standard manufacturing practice but to outline the performance, constructional, operational and guaranteed requirements. It is the responsibility of the contractor to ensure these requirements.

### 20.2 Scope of Supply

#### 20.2.1 Normal Lighting System

Normal lighting system shall include indoor and outdoor lighting of complete powerhouse, switchyard, barrage site & intake area, approach roads and other adjoining areas, comprising of following major components:

- Main Lighting board complete with cubicles, bus-bar system, moulded case circuit breakers, miniature circuit breakers, instrument transformers, instruments cabling and wiring and complete with all other accessories.
- Lighting distribution cabinets, Power distribution boards, sub-distribution boards and switchboards with TPN / SPN MCCBs / MCBs for incoming and outgoing illumination feeders
- Lighting equipment, including the lighting fittings, lighting fascia/panels, warning/direction sign boards,
- Convenience outlets 5/15/32 A
- Control points, including:
  - Pushbuttons or switches,
  - Dimmers, smart switches/sensors,
  - Indicator lights on the main control panel indicating on-off circuits.
- 132 kV switchyard lighting (Switchyard lighting fittings shall be mounted on Columns & Beams of Gantry structure)
- All cabling and wiring including conduits, racks, ducts, channels or any other media of cable runs and associated accessories / fixtures/ fasteners for normal lighting system.
- Powerhouse approach road (100m) and barrage/intake outdoor lighting by sodium vapour/halogen lamps on lighting poles.

### **20.2.2 Emergency lighting system**

Emergency lighting system shall comprise of:

- Emergency lighting boards, Inverter
- MCCB/MCB fitted distribution and sub-distribution boards
- Lighting equipment, including the lighting fittings,
- All cabling and wiring including conduits, racks, ducts, channels or any other media of cable runs and associated accessories / fixtures/ fasteners for emergency lighting system.

### **20.2.3 Convenience Outlets**

Power supply system for convenience outlets shall comprise of:

- The power outlet circuits and individual sockets of single phase 5A/15A (normal and UPS),
- Fixed wall mounted sockets of single-phase 15A,
- Fixed wall mounted sockets of three-phase 63A/100A,
- All cabling and wiring including conduits, racks, ducts, channels or any other media of cable runs and associated accessories / fixtures/ fasteners for power supply network for convenience outlets.

### **20.2.4 Services**

- Transportation and delivery to site including all logistics and proper site storage and preservation as per manufacturer's recommendation.
- Site installation and commissioning
- Field / touch-up painting including all painting materials
- Performance and field acceptance testing as per the relevant clause of this section and submission of report
- Training of Purchaser's personnel including operation and maintenance staff
- All the technical documentation including preparation and submission of O & M manuals

## **20.3 Specific Parameters and Layout Conditions**

### **20.3.1 Layout and General Arrangement**

The illumination system for powerhouse complex shall be supplied from the powerhouse illumination board, which shall be connected to station service board (SSB-A & SSB-B). Lighting and service power supply network for convenience outlets shall cover all areas of powerhouse. Major areas are listed below:

- Lighting in Powerhouse Complex
  - Machine Hall Floor including MIV pockets
  - Service Bay

- Control Room floor
- Battery room
- 11 kV switchgear room
- 415 V switchgear room
- WC
- Draft Tube Deck (outdoor)
- 132 kV Switchyard including powerhouse adjoining area/approach road

The entire lighting network of the powerhouse, switchyard & outdoor lighting around powerhouse shall be supplied from a lighting board located in powerhouse.

For barrage site lighting, separate lighting board shall be provided in barrage site switchgear room. Barrage site lighting board shall draw power for illumination from Barrage Auxiliary Board.

### **20.3.2 Design considerations**

#### **20.3.2.1 Normal lighting**

Normal lighting in each important functional area shall be divided in two or more circuits, each circuit providing specified lux level divided by number of circuits. Control points shall be arranged to facilitate group control at convenient locations. Smart switches / sensors shall be installed in facility areas to turn off or on the lights depending upon occupancy for the purpose of power saving.

Provisions shall be made to get glare free uniform intensity of light in the area.

Illumination for control room and other areas of strategic importance shall be supplemented through UPS/inverter for interruption free lighting. It shall be ensured that when normal lighting fails, at least 10% of the lighting fittings shall automatically switchover to inverter supply.

#### **20.3.2.2 Emergency AC lighting**

A separate emergency lighting system shall be supplied through emergency lighting board. Emergency lighting boards shall be fed from 110V DC distribution boards and after converting the same to 50 Hz AC supply, shall feed the strategically important areas. When normal supply is available, illumination supply to entire premises shall be through normal lighting board. On failure of Normal AC supply, emergency lighting board shall be automatically connected to inverter source and illumination fittings in designated circuits shall get supply from emergency lighting board.

The wire for illumination system and for convenience power outlets of switchyard shall be in the PVC conduits and for main lighting board shall be on cable trays.

The design and construction of normal illumination system and that of inverter based 110V DC system shall be adequately coordinated.

**20.3.2.3 Power supply for Convenience Outlets**

Power supply for convenience outlets shall also be taken from lighting cabinets fed from main lighting board.

Single phase and three phase power outlets covering all areas shall be provided for maintenance of power supply.

Some of Power outlet circuits (20%) for control room shall be supplied through inverter source on failure of normal supply.

**20.4 Rating and Functional Characteristics****20.4.1 Service voltages**

System	Description
Normal lighting system	Three-phase, four wire, 415/240V, 50Hz
Emergency lighting system through	Two wire, 110 V DC converted to 240 V, 50Hz AC
AC socket outlets single-phase	Single-phase, three pins, 240V, 50Hz
Power socket outlets three-phase	Three-phase, five pins, 415/240V, 50Hz

**20.4.2 Lux levels and quality of direct glare limitation**

The nominal illumination level for lighting, measured at the height of a worktable (0.8 m) shall have on average the following values:

Sl No.	Area/Location	Average Illumination Level(Lux)	Type of Fixture
1	Erection Bay,	200	250 W HPSV + 2X28 W FT
	Machine Hall	200	250 W HPSV + 2X28 W FT
2	Switchgear rooms/ areas etc.	200	2X36 W LED
3	Control room, Control Equipment room,	300	2X36 W LED
4	Battery room	100	2X36 W LED
5	Diesel Generating area	50	2X36 W FT or suitable fixture
6	Mechanical Workshop	300	2X28 W LED
7	Entrance, staircases,	100	2X28 W LED
8	Surface Switchyard yard area, Draft tube deck,	50-60	150/250/400 W HPSV flood light



9	Outdoor storage handling and unloading area	20	HPSV / flood light
10	Store	100	2X28 W LED
11	Electrical Workshop	300	2X28 W LED
12	Cooling Water Supply System Area	150	2X28 W FT
13	Office	300	2X36 W LED
14	Approach road/barrage outdoor lighting	100	2X28 W LED

## 20.5 Performance Guarantee

The illumination system along with all auxiliaries and accessories shall be capable of performing intended duties under specified conditions. The Contractor shall guarantee the reliability and performance of the individual equipment as well as of the complete system.

## 20.6 Design and Construction

### 20.6.1 Standards

The system and equipment shall be designed, built, tested and installed to the latest revisions of the following applicable standards. In the event of other standards being applicable they will be compared for specific requirement and specifically approved during detailed engineering for the purpose:

Standards	Description
IEC 60598	Luminaries
IEC 60309	Plugs, socket outlets and couplers for industrial requirements
IS 6665	Code of practice for industrial lighting
IS 10322	Specification for Luminaries
IS 3646	Code of practice for interior illumination
IS:2667	Fittings for rigid steel conduit for electrical wiring.
IS:3837	Accessories for rigid steel conduits for electrical wiring.

## **20.6.2 General Details**

The average illumination levels as required at various floors of the Powerhouse area and other locations are given in the specification.

The Contractor is required to design and submit the complete lighting scheme & layout drawing including the number of fittings required and same shall be subject to the approval of the Purchaser. The Contractor shall also submit for approval of the Purchaser the drawings showing quantity & layout of lighting fixtures, location of switch boards, power sockets ceiling fans, routing of the various conduits in each area/room to be illuminated as specified in the specification.

The tenderer shall quote price for the entire job of supply & erection/commissioning of illumination system covered under this specification as a LOT. The tenderer shall note that there may be minor changes of room sizes/areas etc. from the sizes as shown in the tender drawings at a later date. The contractor will have to complete the jobs with no extra cost to Owners for those minor changes if applicable. However, for any major changes or any extra areas to be covered for illumination which are not covered in this specification, the tenderer shall quote unit rate of supply & erection of each item & same shall be clearly furnished in the price bid.

All the lamps and fixtures shall be delivered to the project in their original cartons and shall be installed in the space provided just prior to completion of the project. Fixtures shall be complete with mounting plates, choke coils, starter, lampshade, discharge resistance, etc. These shall be of sturdy construction capable of withstanding surrounding temperatures, easy to maintain and inspect, and admit no dust or insects, as far as practicable. Full description of proposed type and characteristics as well as illustrated pamphlets or catalogues shall be furnished by the Contractor for approval of the Owner.

## **20.7 General description of Illumination Scheme**

### **20.7.1 Lighting system**

The complete lighting of the power plant shall be met through sectionalised main lighting board (MLB) to be located inside powerhouse. The main lighting board shall feed various lighting distribution cabinets (LDCs) which shall then feed various sub distribution boards (SDBs) to be located suitably near individual load centre. The scheme is described clearly in the tender drawing. In order to provide emergency lighting during normal AC failure, an AC Emergency lighting distribution board shall be provided which shall have outgoing feeders meant to provide functional lighting in control room/switchgear room machine hall floor, staircase, exit points and other vital location during black out. The emergency lighting board shall normally be supplied with single phase, 240V AC supply & the switchboards/lightings connected to emergency lighting board shall be switched on from AC source. Failure of AC supply will automatically trip the AC contractor & switch on inverter contactor. On restoration of normal AC, the inverter supply will automatically be tripped & normal AC supply to emergency lighting board will be automatically resumed. This automatic change over system shall be provided in the emergency lighting board.

In the event of failure of normal AC supply, emergency lighting shall be provided through inverter supply in control room, staircases & other vital locations.

### **20.7.2 Power socket/convenience outlet supply system**

Some of outgoing feeders on the SDB shall be utilised for feeding power socket distribution network. The outgoing feeders of SDB used for power socket supply shall comprise of MCB for one power socket outlet.

Sufficient number of receptacles with individual control switches would be provided in various areas of the power station. At least one number 15/5A receptacles would be provided in each room or enclosed area. In large areas, one 15/5A receptacle shall be provided at every 15 m distance.

15/5A power socket shall be installed 250mm above the floor level.

Sufficient nos. of 32A/100A industrial metal clad, 415V, 3-ph, neutral & earth plug and sockets shall be provided through power distribution board.

## **20.8 Guideline for design of lighting system**

### **20.8.1 Illumination level calculation guidelines**

#### **20.8.1.1 Indoor areas**

Working plane shall be assumed about 800 mm above the finished ground level.

Fluorescent/LED luminaries fixed underneath the ceiling or with pendant suspension shall be installed 2.75m above the finished floor level.

Maintenance factor shall be taken as 0.7.

Average illumination level shall be taken in the horizontal plane as specified.

#### **20.8.1.2 Outdoor areas**

Initial calculations shall be done by average illumination method with suitable coefficient of utilization which shall be cross checked / verified for correctness & uniformity with sample calculations by point by point method by the successful bidder.

Maintenance factor shall be taken as 0.7.

### **20.8.2 Lighting Distribution System design**

While designing the protection of the circuit supplying the mercury and sodium vapour lamps, it shall be ensured that the starting current shall not interrupt the circuits.

Distribution system shall be designed for voltage drop at the end point limited to 5%.

Distribution boards shall be located as near as possible to the centre of the load which they are intended to supply.

Each outgoing feeder of the lighting/power socket distribution board shall be loaded up to maximum 70 to 80% of the MCB rating.

The current rating of wires connected to the outgoing side of any MCB shall not be less than the MCB thermal rating. Similarly, cables connected to MCCBs shall have current rating not less than the thermal current rating of its MCCB.

As far as possible, load shall be balanced on three phases of the main lighting board.

Separate MCB from SDBs for sub-circuits shall be utilised for each group of luminaries. For 15/5A power socket circuit, separate MCB shall be utilised.

Lighting load on individual sub-circuit emanating from SDB shall be restricted to 2000W.

Provision for adequate spare feeders shall be kept on each SDB.

## **20.9 Specification of Equipment**

### **20.9.1 Inverter**

Quantity for Powerhouse: One (1)

Type: Digital type of latest design

Rating: input-110 V DC & output-240V AC

Capacity: 1 x 5 KVA

### **20.9.2 Main Lighting Board**

The main lighting board shall be fed from two incomers with their incomer breakers mechanically interlocked to avoid paralleling of supplies. The incomer feeder to main lighting board shall be fed from Unit-Station Auxiliary Board through. The MLB shall feed a number of lighting distribution cabinets (LDCs) and power distribution board.

Quantity: 1 (one)

Type: Free standing, floor mounted, modular design.

Fabrication material: MS sheet steel of thickness not less than 2.0mm.

Degree of protection: IP: 42 as per IS: 13947

Busbars: 3-phase & neutral busbars of 200 A continuous current rating with anti-tracking barriers on common insulator support. Neutral bus rating shall not be less than half of the phase bus. The busbars shall be housed in the lower chamber and the breakers in the upper chamber. Material of the busbars shall be high conductivity copper.

Operating devices: The MCCBs to be provided for the incoming & MCB to be provided for outgoing feeders, the incomer MCCB shall be accessible from the front door of each module by means of operating handles complete with pad locking facility. The rating of the MCCBs for incoming & outgoing feeders shall be suitably selected.

Earthing: Continuous GI earth bus shall be provided inside the MLB with two studs for external. Each draw-out module sheet metal and transformer neutral & body shall be connected to the earth bus by means of GI strip not less than 50X6mm.

The main lighting board (MLB) shall comprise of the followings:

- Two 415 V / 415 V, 75 kVA isolating transformers
- Two 100 A, 415V, 4-pole MCCBs interlocked with each other on incoming side.
- Suitable CTs on the incomers on all three phases for metering.
- One ammeter & selector switch for each incomer.
- One voltmeter & selector switch with MCB connected to busbars.
- 3-phase & neutral busbars of adequate rating.
- Adequate numbers of 415V, 4-pole MCB on outgoing circuits of suitable ratings.
- Neutral links & terminals for all outgoing circuits.
- Space heater with thermostats.
- Base frame, gland plates, terminal blocks, cable lugs, compression cable glands, name plate, circuit numbering, earthing lugs, locking arrangements with locks etc.
- Red & green lamps for ON/OFF indication for each MCB.

### **20.9.3 Lighting Distribution Cabinets**

Lighting distribution cabinet shall have adequately rated one 415V, 4-pole MCB on incomer side & sufficient nos. of 240V outgoing feeders controlled by 2-pole MCBs.

General requirement of LDC shall be similar to main lighting board.

Components:

- One adequately rated 415V, 4-pole MCB.
- Three phase & neutral aluminium busbars of suitable rating
- 2-pole MCB of adequate rating in each outgoing circuit.
- Neutral terminal strip for all outgoing neutral wires. Terminals shall be made of tinned copper.
- Cable lugs, compression cable glands, nameplate, circuit numbering, earthing lugs, locking arrangements etc.

#### **20.9.4 Power Distribution Board**

The power distribution board shall have adequately rated one 415 V, 4 pole MCCB on incomer side & sufficient nos. of 415 V / 240 V outgoing feeders controlled by 4 pole MCCBs/MCBs or 2 pole MCCBs / MCBs on outgoing feeder side.

#### **20.9.5 AC Emergency Lighting Board**

Emergency Lighting Board shall have one 63 A, 240V, 2-pole incoming MCB & sufficient nos. of 240V outgoing feeders controlled by 2-pole MCCBs.

The board shall have necessary change over contactors/relays/timers for automatic change over from normal AC supply to inverter supply & vice versa as described elsewhere in the specification.

General requirement of AC Emergency Lighting Board shall be similar to LDCs.

Components:

- One 63 A, 240V, 2-pole incoming MCB.
- Single phase & neutral aluminium busbars of suitable continuous current rating.
- 2-pole MCBs of adequate rating in each outgoing circuit.
- Neutral terminal strip for all outgoing wires.
- Cable lugs, compression cable glands, name plate, circuit numbering, earthing lugs, locking arrangements etc.

#### **20.9.6 AC Sub-distribution board/DC sub distribution board**

The following general description is applicable to AC-SDB & DC-SDB.

Enclosure-

The enclosure including the door shall be constructed of sheet steel of thickness not less than 2mm. The degree of protection for indoor board shall be IP: 42 & outdoor installation shall be IP: 55 with a canopy on the top.

Door & opening devices-

The door shall be suitably gasketed & fitted with a lever type handle. The operation shall be possible only after opening the door. An insulated/ hylem sheet shall cover the live parts inside for protection against live contact when door is open. Labels shall be fixed on the front door for incoming & outgoing feeders.

Mounting-

The indoor AC-SDBs & DC-SDBs shall be suitable for wall mounting. They shall be installed 750mm above the floor level. SDBs for outdoor installation shall be suitable for pedestal/steel structure mounting & same shall be kept 750mm from the finished ground level. All structural frame/concrete shall be in the scope of the contractor.

**Components-**

Each of the AC SDBs to be located on various floors as shown in the drawing shall comprise of the followings:

- One two pole incoming MCB.
- Single phase & neutral aluminium busbar with 16/32 A current rating.
- Four nos. of single pole MCBs of adequate rating (16A or higher) for circuits.
- Neutral terminal strip for all outgoing neutral wires.
- Cable lugs, compression cable glands, nameplate, circuit numbering, earthing lugs, locking arrangements etc.
- All wire shall be terminated with pin type lugs.

DC Sub-distribution boards:

- One incoming 110 V DC, 2-poles MCB as described in the specification.
- Thirteen nos. of DC, 2-pole MCBs for outgoing feeders as shown in the drawing.

**20.10 Paintings**

After fabrication of panels & boards, all surfaces shall be cleaned by sand, chemicals etc., scrapped and painted with primer coating and enamel coating. The colour of the finished paint shall be grey to shade no: 631 as per IS: 5

After installation, all the equipment provided shall be inspected for chipping off paint and touch up paint, wherever required, shall be done at site in a professional manner using spray gun.

**20.11 Fault level and Interrupting Capacity**

The equipment shall be designed for the following fault level & interrupting capacity.

Description Fault level Interrupting capacity

	<b>MCCBs</b>	<b>MCB</b>
MLB, LDC	20 KA	9 /10 kA
SDB	NA	9/ 10 KA at 240V

**20.12 Lighting of Outdoor Areas**

This shall be a part of normal AC lighting. For lighting of outside areas around lighting fixtures shall be mounted on the powerhouse wall. For switchyard cum transformer yard lighting, the lighting fixtures shall be mounted on the gantry structure/ lighting structures at a suitable height & angle to achieve uniform illumination of the yard. The brackets for wall mounting of the fixtures shall be included. The cable shall be laid properly in the conduits up to the individual lighting fixture.

For illumination of powerhouse adjoining areas i.e. three sides of P/H including tail race area, flood lights shall be mounted in the wall at a suitable height & angle.

The number of lighting fixtures as well as position & height from ground shall be so adjusted that illumination is free of sharp dark and light zones.

### **20.13 Mounting of lighting fixtures in indoor area**

Wherever false ceilings are provided the lighting fixtures shall be flush mounted with the false ceilings & supported by conduits at two ends of the fixtures. The conduits shall be fixed with the concrete slab by suitable means.

Rooms/area without false ceiling, the fixtures shall be mounted similar to above at a suitable height from the floor.

In the unloading/erection bay & machine hall, the lighting fixtures shall be mounted just above the EOT cranes on roof truss structures. The fixtures shall be so mounted that they can be rotated in both horizontal & vertical plane to achieve uniform illumination in the floor.

### **20.14 Lighting Fixtures**

All lighting fixtures & other accessories shall conform to the latest issue of relevant Indian Standards. These shall be of reputed make. These fixtures shall be of proven design which have been provided in industrial installations & performed satisfactorily. A certificate in this regard from earlier installations shall be furnished with the bid.

The components of lighting fixtures shall be as follows:

#### **Lamps-**

All fluorescent tubes connected to AC supply shall be rated at 240V. Incandescent lamps shall be rated at 240V. All incandescent lamps shall be single coiled gas filled depending on wattage. High pressure mercury & sodium vapour lamps shall be suitable for operation on 240V.

#### **Lamp holders-**

All 240V lamp holders with the exception of those for fluorescent lamp luminaries shall be of Edison Screw cap lamps. Goliath Edison screw lamp holders shall have a solid spring loaded centre pin & anti vibration springs. Lamp holders for fluorescent lamps shall be of bi-pin type made from polystyrene and designed to ensure that lamps cannot rotate when subjected to prolonged & severe vibration.

#### **Ballasts-**

Ballasts for fluorescent tubes shall be of rapid start type with a lagging power factor rated at 240V. The ballast shall comply with IS: 1534. Separate ballast shall be provided for each lamp in multi-tube luminaries. These shall be polyester filled and shall be copper wound.

#### **Starter-**

Starters for fluorescent lamps shall be of tropic proof construction with radio-interference suppression capacitor.



**Capacitors-**

Capacitor for fluorescent lamp and mercury vapour lamps shall be hermitically sealed aluminium housing. The capacitors shall be of adequate rating to correct the power factor of luminaries to 0.95 or better.

**Chokes for mercury/sodium vapour lamps-**

Chokes for mercury/sodium vapour lamps shall be metal clad epoxy encapsulated type.

**Brackets & supports-**

If required, brackets & supports shall be provided. These shall be hot dip galvanised after fabrication. The brackets shall either be bolted or welded to the structure. All suspensions for fluorescent, incandescent, mercury & sodium vapour lamps with integral chokes shall be suspended on 19mm/25mm conduit

**Identification of luminaries, outlets & switches-**

All luminaries, socket outlets shall be labelled with their respective distribution cabinet & circuit number. The identification shall be positioned so that it is visible.

**20.15 Component description****20.15.1 Moulded case circuit breakers (MCCB)**

All the 4-pole, 415V & 2-pole, 240V circuit breakers mounted in MLB, LDC & sub-distribution boards shall be of moulded case type suitable for removal from front without disturbing the electrical connections. MCCBs are of trip free type & shall be provided with adjustable thermal overload & instantaneous over current tripping devices with setting to suit full load current of individual circuit. MCCBs shall have hand reset & pad locking facility.

**20.15.2 Miniature Circuit Breakers (MCB)**

MCBs shall conform to latest issue of IS: 8828. It shall have a thermal element for protection and instantaneous magnetic element for protection against short circuit fault. These shall be so design that it is possible to inter change multi-pole & single pole MCBs without structural alteration to the SDBs.

**20.15.3 Light Switches/Switch Boards**

Piano type ON/OFF switches shall be used for group control of lights with GI switch boards. The switches shall be installed on 3mm hylem sheet with mat white sun mica finish. Wherever ceiling fans are provided, piano type switch for each fan point and space for regulator shall be provided on the switch board. The switch boards shall be installed at a height of 1200mm from floor level.

In WC & staircase, 2-way switches shall be provided, so that the lightings can be controlled from different locations.

#### **20.15.4 Conduit & accessories**

The contractor shall supply and install heavy duty black enamelled mild steel conduits, junction boxes, wire ways & fixings required to complete the job. All necessary hardware such as screws, bolts, hangers, clamps, locknuts, bushings, conduit pipes, tee drains & box drains, couplings, pulling irons, identification tags etc. shall be in the scope of the bidder.

Conduits shall be rigid, heavy duty in lengths of 5m approx. Each of the conduit length shall be threaded and sealed with protective caps.

Conduit sizes shall be 19mm, 25mm, 38mm etc depending on nos. of wires required to be drawn in the conduits keeping necessary voids as per standard.

All conduits for wiring shall be concealed type. All conduits in air-conditioned areas, where false ceiling is provided i.e. control room; conference room etc. may be run along the beams or column but shall be concealed in false ceiling.

Maximum permissible number of single core cables/wires that can be drawn into the conduits shall be as per IS: 732.

Entire metallic conduit system shall be electrically continuous & grounded.

Inspection Tees, inspection bends/junction boxes shall be used wherever required.

Conduit pipes shall be fixed by heavy gauge saddles, secured to suitable wooden/nylon plugs in an approved manner at an interval of not less than 1m.

#### **20.15.5 Cable/cable laying**

All the power cables shall be 1.1KV grade, heavy duty, PVC insulated, armoured PVC sheathed standard aluminium conductor.

Lighting cable up to main lighting boards shall be laid in general in cable trays as far as possible. Beyond main lighting boards, the cables shall be run in concealed conduits. In each cable run some extra length shall be kept at suitable points to enable one or two straight joints to be made at a later date if required. Wherever no outdoor cable trench is available, the cable may be directly buried in ground.

#### **20.15.6 Wiring**

All the wire shall be of 1.1KV grade, PVC insulated stranded copper conductor. Electrical wiring for lighting & power sockets emanating from the respective SDBs shall be carried out in surface mounted MS conduits/wire ways.

#### **20.15.7 Separation of phases & AC/DC system**

Wiring of each phase (RYB) along with its neutral wire shall be carried in separate conduit. Similarly, AC & DC wires shall not be clubbed into common conduits/wire ways. Also, power circuit for power socket outlets shall be kept separated & distinct from lighting sub-inspection.

Specification of wires:

	Description
Type	: PVC insulated, stranded as per IS: 694
Voltage grade	: 1.1KV
HV test	: 3 KV rms as per IS: 694
Conductor	: Copper as per IS: 8130
Minimum cross section	: 1.5 sq. mm for lighting circuits (group control) & 5A power sockets. : 2.5 sq. mm for 2 nos. of flood lights. : 4 sq. mm for 15/5A power socket outlets.

Current rating/conductor sizes:

The conductor sizes of wires shall be so selected as to limit the total voltage drop to 5% (subject to minimum sizes specified).

#### **20.15.8 Protection of wires**

In order to protect the wires from sustained overload the current rating of the wires shall not be less than the thermal current rating of its MCB.

##### **20.15.8.1 Colour coding**

PVC wires of different colours shall be used as follows:

##### **20.15.8.2 AC wiring**

R-phase: Red; Y- phase: Yellow; B- phase: Blue; Neutral: Black

##### **20.15.8.3 DC wiring**

Positive: Grey; Negative: White

#### **20.15.9 Lighting Control**

Indoor Fluorescent/incandescent lighting fixtures shall be group controlled by 5/6 A piano type switches mounted on switch boards. Maximum number of lighting fixtures to be controlled by a single switch shall be limited to 4 (four).

Indoor HPSV (150/250/400W) lightings & outdoor lightings shall be group controlled by suitable rating of MCB. Maximum 4 (four) nos. of lighting fixtures shall be controlled by a single MCB.

In lighting layout, the fixtures to be controlled by a single switch/MCB shall be selected alternatively to cover maximum area for illumination.

### 20.15.10 Earthing

Earthing terminals shall be provided with each lighting boards, MLB, LDC, SDB, lighting fixtures, luminaries, receptacles, pole junction boxes etc. and shall be earthed by connecting to the P/H ground mat as per IS: 3043. At remote area, where earthing risers are not available, the same shall be provided by means of earthing rods.

To achieve perfect electrical continuity, a GI ground wire (14 gauge) shall run all along the steel rigid conduits throughout the installation, all fixtures and conduits shall be effectively grounded at the end adjacent to the distribution boards from which they originate or otherwise at the commencement of the run by a ground conductor.

The earthing of each component shall be done as follows:

Main lighting board- GI strip of 50X6 mm size

Lighting distribution cabinet- GI strip of 25X3 mm size

All sub-distribution board-s GI wire of 8 SWG size

Earthing of poles, conduits & fixtures etc- GI wire of 14 SWG size

### 20.16 Testing and Inspection:

Main lighting boards, Lighting distribution cabinets, AC/DC sub-distribution boards, socket outlets/receptacles, lighting fittings, lamps, fuses, cables, switches, MCCBs, MCBs, contactors, relays, instruments, CT, PT etc. shall be subjected to routine tests in accordance with the requirements of the latest issue of relevant Indian Standards in presence of Purchaser or Purchaser's representatives. Before despatch of the materials, the test certificates shall be got approved from Purchaser.

The dry type lighting transformers & inverters shall also be routine tested as per relevant standards.

Each completely assembled MLB, LDC & SDBs shall be inspected & tested to ensure that all its protective, control and interlock systems work satisfactorily.

#### 20.16.1 Site Tests:

The following minimum site tests shall be conducted at site as per the approved site testing procedure to be furnished for approval during detailed engineering.

- Visual inspection after installation for proper erection, workmanship, neatness, earthing, levelling, conformity to GA drawings etc. approved by Owner.
- Insulation resistance tests.
- Functional test of each light/power circuit.
- Functional test of each normal & AC/DC emergency lighting system.
- Calibration test for instruments.
- Illumination level measurement for Indoor/Outdoor areas.
- Test on lighting transformer & inverter.

## **20.17 Drawings, Documents and Design Calculations**

### **20.17.1 Design memorandum**

The Contractor shall submit to Purchaser a design memorandum prepared in accordance with clause 1.2 of "Section 1-General Technical Specifications of the proposed equipment /system fulfilling the contract specification/requirement for approval prior to submission of drawings and documents. The design memorandum shall include the design philosophy, methodology, system description, input parameters for design, standards and codes, design & selection criteria, equipment data, material specification, major technical features, basic arrangement / layout etc.

### **20.17.2 Drawings and documents**

The Contractor shall submit all the drawings and documents in accordance with requirements stipulated in "Section 2 - Technical Documents" of "General Technical Specification (GTS)".

These drawings and documents shall include at least the following:

- Outline, general arrangement and layout plan for illumination system,
- Cable and conduit routing diagram,
- Wiring and termination drawings,
- Type of luminaries, fittings, power sockets, switches etc.,
- Drawings for distribution boards, control points etc.,
- Lighting mast, lighting fascia/panels details.
- Light distribution curve for each luminaire
- Catalogue of Illumination fitting

### **20.17.3 Design calculation**

The Contractor shall submit the design calculation in accordance with Clause 2.6 of "General Technical Specification (GTS)" covering at least the following, for review / acceptance.

- Calculations for the illumination levels of the different areas with respect to installation plan,
- Cable and conduit sizing.

## **20.18 Delivery, Installation and Commissioning**

The Contractor shall follow the requirements of Delivery, Installation and commissioning elaborated in clause 1.7 "Delivery, Installation and commissioning" of "Section 1 - General Technical Requirements."

## **20.19 Quality Assurance and Testing**

The bidder shall submit the quality assurance plan along with bid for approval of the purchaser. The Contractor shall follow the quality assurance and testing requirements as per quality assurance plan approved by the purchaser.

**20.20 Guaranteed and Technical Particulars**

Guaranteed and Technical Particulars as called for in Vol. VI shall be furnished along with the bid. Bids lacking in this may be considered unresponsive. Particulars subject to guarantees shall be clearly marked

**20.21 Completeness of Equipment**

All fittings and accessories of the Illumination system and associated auxiliary & ancillary equipment which may not have been specifically mentioned in these specifications but are usually necessary for completion of the above equipment, shall be deemed to be covered by the specification; and shall be indicated and furnished by the supplier without any charges to the purchaser.

**20.22 Deviation from Specifications**

While the purchaser does not bind himself to accept any deviation, due consideration will be given to any special devices or equipment put forward by the supplier with a view to increase the efficiency of the equipment and minimize the maintenance cost of the equipment as a whole.

Should the supplier wish to depart from these specifications, he shall submit a complete and itemized list of such deviations, together with full particulars of the reasons for the deviations in a separate schedule with special reference to clause and paragraph nos. of this specification. Unless this is done and the purchaser's concurrence in respect of such deviations is obtained in writing, the equipment offered shall be deemed to comply in every respect with these specifications.