DELHI METRO RAIL CORPORATION LIMITED

DMRC ELECTRICAL STANDARDS & DESIGN WING (DESDW)

SPECIFICATION NO.
DMES-E/000/ DMRC-E-E&M-LIGHTING-17

SPECIFICATIONS FOR SUPPLY, INSTALLATION, TESTING & COMMISSIONING
Of Indoor Lighting System

Issued on:

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DELHI METRO RAIL CORPORATION LTD.
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Specifications For Supply, Installation, Testing & Commissioning of Indoor Lighting system

**Previous Record of specification**

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Specifications For Supply, Installation, Testing & Commissioning of Indoor Lighting System

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1.0 Detailed Description and Application in DMRC

The scope of work shall cover the supply, installation and testing, and commissioning of lighting system comprising light fittings (LED, fluorescent, metal halide, FL or SON type), chokes, control gear, lamps, fixing arrangement, fans (ceiling & exhaust), sockets etc. as specified.

2.0 STANDARDS

a. The following standards and rules shall be applicable

- IS 3646 (All 3 parts) Code of practice for interior Illumination
- IS 1913 - 1978 General and safety requirements for luminaires: Part 1 Tubular fluorescent lamps
- IS 1777 - 1978 Industrial luminaire with metal reflectors
- IS 374 – 1979 Electric ceiling type fans and regulators
- IS 10322 (All Parts) Specification for Luminaries
- LM-79 Performing measurement of LEDs
- Indian Electricity Act and Rules issued there under
- ECBC Code 2015 For conservation of energy

b. All codes and standards mean the latest. Where not specified otherwise the installation shall generally follow the Indian Standard Codes of Practice or the relevant British Standard Codes of Practice in the absence of Standard.

3.0 Requirement

3.1 GENERAL LUX LEVEL REQUIREMENT FOR STATION

a. The lux levels along with the lighting factors to be achieved in various areas of station buildings, both in normal and emergency conditions are indicated in the table below. Contractor shall verify and demonstrate the achieving of the light level as per the table.
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<table>
<thead>
<tr>
<th>APPLICATION</th>
<th>AVERAGE DESIGNED LUMINANCE (LUX)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passenger Area</td>
<td></td>
</tr>
<tr>
<td>Circulating and Parking Area</td>
<td>30 (Localised 50-100 as per design of utility)</td>
</tr>
<tr>
<td>Entrance/Exit/Passage/Mezzanine/Corridors/Concourse</td>
<td>200 (Localised 250 as per design)</td>
</tr>
<tr>
<td>Customer Care/Ticketing</td>
<td>200 (Localised 250)</td>
</tr>
<tr>
<td>Platform</td>
<td>200 (Localised 250 at PF edges)</td>
</tr>
<tr>
<td>Trainway, walk-ways and walking surfaces for emergency evacuation</td>
<td>10</td>
</tr>
<tr>
<td>Escalators, Lifts, stairs and landings</td>
<td>250</td>
</tr>
<tr>
<td>Toilets</td>
<td>200</td>
</tr>
<tr>
<td><strong>Operation rooms</strong></td>
<td></td>
</tr>
<tr>
<td>Tunnel</td>
<td>20</td>
</tr>
<tr>
<td>Metro Stabling Lines</td>
<td>20</td>
</tr>
<tr>
<td>Depots/Inspection bays/Repair Sections</td>
<td>200 (Localised Up to 500)</td>
</tr>
<tr>
<td>Station Control Room/OCC</td>
<td>250 (Localised 500)</td>
</tr>
<tr>
<td>Stabling Shed of Rakes</td>
<td>100</td>
</tr>
<tr>
<td>Underground Track Area and cable galleries</td>
<td>20</td>
</tr>
<tr>
<td>Stores Room</td>
<td>200</td>
</tr>
<tr>
<td><strong>Equipment Room</strong></td>
<td></td>
</tr>
<tr>
<td>ECS/TVF/Signalling and Telecommunication/UPS/Battery/ Pump/Chiller/Auxiliary Substation/TSS/DG Room/LT panel etc. (All plant room)</td>
<td>200 (localised 250)</td>
</tr>
<tr>
<td>Service Corridors</td>
<td>200</td>
</tr>
</tbody>
</table>
3.2 LIGHTING FIXTURES

a. All fixtures shall be complete with accessories and fixings necessary for installation whether so detailed under fixture description or not.

b. Fixture housing, frame or canopy shall provide a suitable cover for the fixture outlet box or Fixture opening.

c. Fixtures shall be installed at mounting heights as detailed on the drawings or instructed on site by the Employer's representative.

d. Fixtures and/or fixture outlet boxes shall be provided with hangers to adequately support the complete weight of the fixture tightly secured to a fixture stud in the outlet box. Extension pieces shall be installed where required to facilitate proper installation. Design of hangers and method of fastening other than shown on the drawings or herein specified shall be submitted to the Employer's representative for approval.

e. Pendant fixtures within the same room or area shall be installed plumb and at a uniform height from the finished floor. Adjustment of height shall be made during installation as per Employer's representative.

f. Flush mounted and recessed fixtures shall be installed so as to completely eliminate light leakage within the fixture and between the fixture and adjacent finished surface.

g. Fixture shall be completely wired and constructed to comply with the regulations and standards for Electric Lighting Fixtures, unless otherwise specified. Fixtures shall bear manufacturer's name and the factory inspection label unless otherwise approved.

h. Fixture with visible frames shall have concealed hinges and catches. Pendant fixtures and lampholders shall be provided with ball type aligners or similar approved means. Recessed fixtures shall be constructed so as to fit into an acoustic tile ceiling or plaster ceiling plaster rings/flanges shall be provided for plaster ceiling. Fixtures with hinged diffuser doors shall be provided with spring clips or other retaining device to prevent the diffuser from moving.

i. Detailed catalogue for all fixtures, or, if so required by the Employer's representative sample fixtures shall be submitted for approval to the Employer's representative before orders for the fixtures are placed. Shop drawings for non-standard fixture types shall be submitted for approval to the Employer's representative.
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j. Emergency lighting shall be supplied from UPS, designed to meet the requirements of illumination.

k. Recessed fixtures shall be constructed so that all components are replaceable without removing housing from the ceiling.

l. Lamp shall be supplied and installed in all lighting fixtures furnished under this contract. All lamps shall be rated for 230 volts. Lamps used for temporary lighting service shall not be used in the final lamping of fixtures units. Lamps shall be of wattage and type as shown on the drawings and schedule. Where not shown, the details shall be ascertained from the Employer's representative before procurement.

m. Lamps for permanent installation shall not be placed in the fixtures until so directed by the Employer's representative, and this shall be accomplished directly before the building portions are ready for occupation.

3.3 Fluorescent Fittings

a. Only single and/or two lamp HF Electronic ballast shall be used in any one fixture.

b. All fluorescent fixtures shall be provided with separate wiring channel with cover plate and an earth terminal. All screws shall be chromium plated brass screws. Lamp and starter holders shall be out of tough moulded plastic with spring loaded rotor type contactors rendered shock and vibration proof. Condensors shall be low loss paper impregnated hermetically sealed. Internal wiring shall be neatly clipped and where by passing the ballast, a suitable heat resistant barrier or sleeve shall be provided.

c. Surface mounted fixtures longer than two feet shall have one additional point of support besides the outlet box fixture stud when installed individually. Pendant individually mounted fixtures four feet long and smaller shall be provided with twin stem/conduit hangers. Stems shall have ball aligners or similar devices and provided for a minimum of 25-mm vertical adjustment. Stems shall be of appropriate length to suspend fixtures at required mounting height.

d. Lamps shall have bi-pin bases and a minimum guaranteed life of 17000 burning hours (3 years or 6 Years) and a lumen output of 2900. Lamp should have free replacement for one two years from the date of installation. The date of installation shall be from the date of handing over the work to DMRC. Lamp shall be T-5, high efficiency type.
e. Fluorescent tube mirrors optics luminaire as specified in BOQ with pre-anodized reflector and with/without clear Poly carbonate/clear acrylic cover-side hinged with IP-54/20 (and above) protection respectively. The luminaire, suitable for surface/recess mounting, shall consist of a housing of single piece channel with minimum spot welds, adequate glare control, light emitting angle of the order of 60-55 degree, ensuring maximum reduction in possibility of corrosion due to trapped moisture. It shall incorporate accessories such as heavy-duty electronic ballast, push fit type lamp holders, duly connected up to a terminal block. An earthing terminal shall be provided to enable connection of the earth wire to the metallic housing of the luminaire. Provision shall be made for the main connection directly at the back of the housing. A suitably designed pre-anodized reflector system as required for obtaining a high optical efficiency and to achieve a wide light distribution shall be incorporated in the luminaire. The fixing of the reflector assembly in the housing shall be done by means of stainless steel clips for ease of maintenance. The luminaire shall have a clear toughened glass/ or non-yellowing acrylic/poly-carbonate, UV stabilized cover Guaranteed for 5 years with gasket and suitable fixing arrangement as specified in BOQ and drawings. Long life efficient FL Tubes (similar to Trulite of M/s Philip) suitable for day light shall be provided. Recessed type fluorescent tube, Mirror Optic luminaire, incorporating all constructional features as indicated above shall be provided.

f. Where required to provide surface type luminaire in place of recess type or vice versa, the suitable luminaire as per the site conditions as approved by the engineer or Employer's representative shall be provided without additional cost on quoted rates of the above.

g. Industrial fluorescent luminaire (As applicable): The luminaire as specified in BOQ, suitable for surface mounting, shall comprise a stove-enamelled reflector, reflecting white from inside, fabricated from CRCA sheet, fitted to a base channel by means of a locking device be complete with capacitor, rotor, lock type lamp holders, electronic ballast pre-wired with PVC Insulated, PVC sheathed, multi-stranded, copper conductor with protection level of IP 55 or IP 65 as specified.

h. Industrial fluorescent luminaire (As applicable): The luminaire as specified in BOQ, suitable for surface mounting, shall comprise a stove-enamelled reflector, reflecting white from inside, fabricated from CRCA sheet, fitted to a base channel by means of a locking device be complete with capacitor, rotor, lock type lamp holders, electronic ballast pre-wired with PVC Insulated, PVC sheathed, multi-stranded, copper conductor with protection level of IP 55 or IP 65 as specified.

i. Box type 2X28 Watt fitting used for public utility areas as specified shall be surface mounting ceiling suitable. CRCA sheet steel, powder coated, opal acrylic
non-yellowing Guaranteed for 5 years cover with electronic ballast and suitable diffuser conform to at least IP-20.

3.4 Design Criteria:

a. A good design with a selection of lamp, and installation is necessary for the purpose of energy conservation, aesthetics and feeling of safety and security. Following are some of the essentials described below are to be taken care while lighting design.

3.4.1 Color Rendering Index:

a. Low-pressure sodium lighting has poor CRI whereas fluorescent lights range from about 50 for the basic types and up to about 90 for the best tri-phosphor type. Typical LEDs have about 80+ CRI, while some manufacturers claim higher CRI.

b. For public utility, the CRI level, in general, to be followed for circulation areas, plant room and passenger area are 20, 60 and 80. In view of this, Sodium Vapour lamps are provided only in circulating and parking area and all other utility area is provided with Flourescent Lamp (T5).

c. Compact Fluorescent or Metal halide having CRI of 80 and above.

3.4.2 Mounting arrangement and type of Luminaires:

a. Reflector luminaires are used for illumination of platform and concourse public area

b. Batten luminaires shall be used in escape stairs and corridors within ASS/ESR areas and stores rooms

c. Recessed modular luminaires shall be used in all operation/control rooms for glare control

d. Recessed modular luminaires with louver will be used in passenger subways and staff areas where false ceiling system are installed but glare control is not required.

e. Luminaires in riser ducts and staircases will generally be wall mounted under the structural soffit.

f. Where wall mounted luminaires are used, the mounting level is 2.5 meter to underside of fitting above the finished floor level unless otherwise specified. Page 12 of 19
f. Luminaries in ASS/ESR are suspended on conduits to approximately 3 meters above finished floor level and on 2.5 meter at wall. Final lighting layout shall match the plant equipment layout to illuminate the panel front, display boards, alleys etc.

g. The light fittings are to be so selected and mounted that it is easy to attend and replace the lamp, cleaning of reflector etc.

3.4.3 Ingress Protection

a. Ingress protection is to be governed as per IEC 60529. There are three levels of IP for standardized for application in elevated stations of DMRC as follows:

I. IP 65: External areas, high mast towers etc. Ingress protection assures dust tight with no ingress of dust, complete protection against dust and there shall be no harmful effect when water is projected by a nozzle (6.3 mm) against enclosure from any direction (protection against water jet).

II. IP 54: Platform and entry and exit point etc. Ingress of dust is not entirely prevented, but it must not enter in sufficient quantity to interfere with the satisfactory operation of the equipment. Water splashing against the enclosure from any direction shall have no harmful effect (protection against water splashing).

III. IP 20: ASS/ESR and any other area: Ingress protection is for objects of size more than 12.5 mm with no protection for water.

3.4.4 Light loss factor

a. The light loss factor shall be 0.9 for air conditioned area, 0.7 for non-air conditioned area and 0.6 for outdoor area. LED luminaries technology is evolving and light loss factor shall be reviewed as per the recommendations of the manufacturer.

3.4.5 Working Level

a. The working level shall be zero meters whenever referred for passenger area or floor level. It shall be 0.8 meter when referred to desk or staff working level.

3.4.6 Reflectance Factor

a. Reflectance factor of the floor is taken as 10% and that of ceiling and walls shall be 50% and 30% from front and back of the house respectively.
3.4.7 Dialux Software

a. Dialux software is to be used for working out Lux level diagram of the illuminated surface which gives average, minimum, maximum, uniformity ratio for the work plane, floor, ceiling and walls for the lamp and fittings of different manufacturers. Lumen output, wattage of lamps, Lumen power density total and per 100 lux etc. shall be worked out for each of the defined utility. Such a data is to be submitted in FDR to the engineer in charge for the correct assessment and selection of lamp for area wise applications.

3.4.8 Uniformity of distribution of Illumination

a. Uniformity Index (Emin/Eavg) shall be calculated with the use of Dialux software. The layout of the luminaires shall be decided to have the best level of uniformity Index. It is not considered to lay down any standard of uniformity index, but shall be finalized considering its need for the purpose of security, safety and aesthetic.

b. The locations for installation of the luminaires shall be finalized after the layout of the equipment, working table or layout for the staff is tentatively finalized and in such a manner to take the advantage of providing Emax at locations important for the utility.

3.4.9 Emergency Illumination

a. The following guidelines shall be followed while designing the system:

i. Passenger and staff working area: 25% or one third of the total lights distributed uniformly depending from situation to situation shall be connected to emergency source. DG source shall feed to UPS input also.

ii. B. Equipment Room: One for small or maximum depending on requirement of a bigger room shall be connected to emergency source of light.

iii. 6.9.2 Emergency light feeder wire shall run in a separate conduit. The emergency feeder conduit shall be marked at regular interval with a color band of red color for easy identification when required.

3.4.10 LUMINAIRES AND ACCESSORIES

a. The luminaires and accessories shall be as specified on drawings. However a brief description of various type of fittings and purpose is being given below:
<table>
<thead>
<tr>
<th>Type of Fixture</th>
<th>Description of Light Fixtures</th>
<th>Type of Lamp</th>
<th>Lamp Wattage</th>
<th>Area of Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Station</td>
<td>Energy Efficient and low Maintenance LED of 42W Power consumption with lumen output of 3275Lm</td>
<td>LED</td>
<td>42W</td>
<td>Paid/Unpaid Area, Public Corridor</td>
</tr>
<tr>
<td></td>
<td>- Surface mounting arrangement on wall or ceiling</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- High Efficiency Opal Diffuser</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Exturded Aluminium Housing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>Green Perform LED Batten 40W system Wattage having system efficacy &gt;90% with Conduit/Suspended/Surface type mounting.</td>
<td>LED</td>
<td>40W</td>
<td>Platform Edge Light</td>
</tr>
<tr>
<td>B</td>
<td>General purpose batten luminaries, surface mounting on wall or ceiling</td>
<td>T5 lamp</td>
<td>28W</td>
<td>Kiosk, PSB, DG Room, ASS Room, Mess Room, Security Room, Electrical UPS room, Pump Room</td>
</tr>
<tr>
<td>C</td>
<td>Energy Efficient and low Maintenance of 42W Power consumption with lumen output of 3000Lm</td>
<td>LED</td>
<td>38W</td>
<td>Staircase, Escalators from Ground to concourse, Concourse to</td>
</tr>
<tr>
<td>Type of Fixture</td>
<td>Description of Light Fixtures</td>
<td>Type of Lamp</td>
<td>Lamp Wattage</td>
<td>Area of Use</td>
</tr>
<tr>
<td>----------------</td>
<td>--------------------------------</td>
<td>--------------</td>
<td>--------------</td>
<td>------------------------------</td>
</tr>
<tr>
<td>E</td>
<td>Mirror optics, recess mounted</td>
<td>T5 lamp</td>
<td>28W</td>
<td>S&amp;T UPS,ALS,EFO, Property Development Area</td>
</tr>
<tr>
<td>F</td>
<td>Recessed circular down light</td>
<td>T5 lamp</td>
<td>18W</td>
<td>Toilets</td>
</tr>
<tr>
<td>G</td>
<td>Bulk Head with wire guard</td>
<td>CFL</td>
<td>9W</td>
<td>Shaft Room</td>
</tr>
<tr>
<td>H</td>
<td>Luminaire with aesthetically designed die cast aluminium housing pot optics reflector and toughened flat glass</td>
<td>Sodium vapour lamp</td>
<td>150W</td>
<td>Columns</td>
</tr>
<tr>
<td>I</td>
<td>Multipurpose Pole</td>
<td>LED</td>
<td>50W</td>
<td>Footpath, Ground Level</td>
</tr>
</tbody>
</table>
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<table>
<thead>
<tr>
<th>Type of Fixture</th>
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<th>Type of Lamp</th>
<th>Lamp Wattage</th>
<th>Area of Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>J</td>
<td>Recessed mounted Luminaries (in case of false ceiling)</td>
<td>LED</td>
<td>4 X 14W</td>
<td>SER, SCR, TOM</td>
</tr>
<tr>
<td>K</td>
<td>1 X 80W Wall, Ceiling and surface General Purpose Floodlight Luminaries</td>
<td>LED</td>
<td>80W</td>
<td>Terrace</td>
</tr>
<tr>
<td>L</td>
<td>1 X 210W Wall, Ceiling and surface General Purpose Floodlight Luminaries</td>
<td>LED</td>
<td>210W</td>
<td>Double Height Area</td>
</tr>
<tr>
<td>M</td>
<td>High Mast Light of 20Mtr./30Mtr. Height</td>
<td>Metal Halide Type</td>
<td>400W, 250W</td>
<td>Outdoor Lighting</td>
</tr>
</tbody>
</table>

#### 3.4.11 Incandescent fittings (As applicable)

- **a.** Incandescent fittings shall be of the type generally specified on the drawings. Contractor should have sample approved by Employer’s representative before procurement.

- **b.** Incandescent fixtures shall be equipped with porcelain, medium base, screw type sockets for lamps up to and including 200 watt and mogul screw type base for lamps 300 watt and over.

- **c.** Re-lamping the fixture shall be possible without having to remove the fixture from its place.

- **d.** Incandescent lamps shall be inside frosted or clear type as required by the Employer's representative.
3.4.12 ELECTRONIC BALLAST FOR FLUORESCENT LAMPS

a. Electronic ballasts shall be fitted with the fluorescent lamp luminaires. Ballast shall be completely enclosed inside sheet steel casing and shall have a corrosion resistant finish. Ballasts shall contain a thermosetting type compound not subject to softening or liquefying under any operating conditions or upon ballast failure. Compound shall not support combustion. All ballasts shall be of high power factor compensated to above 0.95 PF.

b. The ballast shall be designed to work satisfactorily at dry bulb temperature of 50°C and relative humidity up to 100% in a highly polluted metropolitan atmosphere. The equipment shall function continuously without any noise or hum. The installation is prone to vibration because of continuous train operation.

c. The ballast shall meet or exceed the IEC-60928 (1995-02), IEC 60929 (1990-12), IS13021 (Part 1&2) - 1991 and the latest standards.

d. Ballast shall comprise electrical and electronic components giving stabilized power output, surge suppression, radio frequency suppression and other protective devices for ensuring satisfactory performance and reliability of the ballast. It is inserted between the supply and one or more fluorescent lamps and serves mainly to limit the current of lamp(s) to the required value.

e. Following Ballasts shall be used in conjunction with fluorescent tubular lamps of following description:

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>1x28W (1200 mm long)</td>
</tr>
<tr>
<td>II</td>
<td>2x28W (1200 mm long)</td>
</tr>
<tr>
<td>III</td>
<td>4x14W (600 mm square)</td>
</tr>
</tbody>
</table>

f. All electronic ballasts shall be suitable for fluorescent lamp.

g. The ballast shall be suitable for operation with a supply voltage ranging from 170V to 270V. The power factor of the fluorescent lamp circuit with electronic ballast shall not be less than 0.95.

h. Total consumption of 28W fluorescent lamp along with electronic ballast should not exceed 32W at its rated input voltage of 230V AC while maintaining the illumination level at a minimum of 95% of the illumination measured by connecting the same fluorescent lamp with reference ballast at 230V AC.

i. The operation of the ballast shall be silent i.e. without any humming, noise or vibration.
j. The ballast shall conform to EN 55015, EN 55022 and EN 61000-3-2 to suppress RFI/EMI generation.

k. In the case of 2 x 28 W fluorescent fixtures, the Electronic Ballast / Digital Dimming HF Ballast shall have the feature that even if one out of two nos. 28W tube is not working, the other 26W tube shall keep on working.

3.5 SPECIFICATION FOR LED

3.5.1 Scope

a. This specification covers for supply of Light Emitting Diode (LED) lighting that shall be used as general lighting in DMRC.

b. The lumen maintenance of the LED fittings (of the system not chip) shall not be less than 70% after 5000 hrs. i.e. (L70; B10). It shall have a warranty of 5 years after delivery and warranty of the replaced item shall restart from the date of replacement.

c. The product should be latest state of art and compliant to relevant IEC 60598-1, 2, 3, IEC 62031 and IEC/PAS 62612 or their latest edition depending on the type of luminaire. In addition to the above luminaire shall adhere to relevant BIS standards IS 15985, 16101, 16102, 16103, 16104, 16105, 16106, 16107 (Part I & II) as per the application. The product shall be of proven design should possess type test certificate / performance certificate from the accredited laboratory. The product and its major components shall be state of art and of proven design.

3.5.2 Fixtures

a. The fixture shall be suitable to work under following ambient conditions.

b. Maximum ambient temperature of 45°C.

c. Atmosphere - The equipment shall be designed to work in coastal, humid, salt laden and corrosive atmosphere.

d. Housing, if not used as a heat sink shall be made of 0.5 mm thick CRCA sheet / Extruded Aluminium (2 mm) or pressure die cast (PDC-2 mm), conforming to relevant standards, polyester powder coated of at least 40 microns) and high U.V. & corrosion resistance.

e. Heat sink used should be extruded Aluminium or Pressure Die-Cast Aluminium having high conductivity preferably ADC 12 or LM 6.
f. Luminaries should be covered with suitable Glass or diffuser with High Transitivity.

g. Outdoor luminaire shall be with clear toughened glass or clear polycarbonate cover.

h. Lighting fixtures and accessories shall be designed for continuous trouble free operation under diverse atmospheric conditions without deterioration of materials. Degree of protection of enclosure shall be at least IP-65 for outdoor fixtures. However, down lighter and other internal fixture shall be provided with at least IP-20 protection.

i. The fixture should have a surge protection of 2 KV.

j. The fixture should conform to applicable IS 10322 / IEC 60598 (All parts & amendments) and should have the associated LM-79 report (for Electrical and photometric test methodology for LED lighting) from accredited lab. Test report shall be submitted along with relevant catalogues.

k. The fixture shall be surface suspended or recessed type depending on the application area.

l. Reflector (if) shall be a high quality aluminium reflector and shall have efficiency more than 85% to achieve a wide light distribution. The anodic film shall have a minimum thickness of 2.5 micron.

m. The fixture shall be provided with separate wiring channel with cover plate and earth terminal.

n. Provision shall be made for main connection directly at the back of housing.

3.5.3 LED Features

a. Approved makes are as per the approved list of makes. Manufacturer should have LM-80 report and projected life of the chip. Manufacturer has to submit the test report along with relevant documents.

b. High lumen efficacy LEDs suitable for the application along with following features shall be used:

1. LED Efficacy at the chip level shall > 120 lumen/watt (For High power LED)

   1. The efficiency of the LED at 85 Degree C junction temperatures shall be more than 85%.

   2. The system luminous efficacy of LED luminaire shall be as under:
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III. Efficacy > 60 lumen/Watt for low wattage luminaries (<45W); and

IV. Efficacy > 80 lumen/Watt for high wattage luminaries (>45W)

a. Adequate heat sink with proper thermal management shall be provided.

b. Minimum view angle of the LED shall not be less than 1200.

c. Power factor of complete fitting shall be more than 0.9

d. LED shall be surface mounted type duly soldered to PCB by Reflow system or COB type. The Solder used shall be ROHS compatible for environment friendliness.

e. Input frequency range shall be between 50Hz±3%

f. Colour rendering index CRI >=70 as specified in item description.

g. Correlated Colour Temperature shall be in the range of 3000 K - 6500 K as specified in item description.

h. It shall have an SDCM (standard deviation in colour maintenance) of < 5.

i. The LED efficiency shall be more than 85% at a junction temperature of 85°C.
  
  a. 12.4 LED driver and Control Circuit Specification :
  
  b. 12.4.1 LED driver shall have following features:

j. The LED driver shall be constant current type.

k. Input voltage range within 160 V (RMS) to 270 V (RMS) at 50 HZ.

l. The driver shall be able to withstand surge (EFT+ESD interference) of minimum 2 KV with a rise time of 20 nanoseconds.

m. Output voltage of the driver shall be designed to meet the power requirement of the system.

n. The driver shall have under voltage, over voltage, short circuit and earth fault protection.

o. Output over voltage protection of 125 V DC.

p. Output voltage ripple shall be within 3%.
q. It should have an option of dimming.

r. The driver shall have an efficiency ≥ 85%

s. Total Harmonic Distortion shall be.

t. For 0-50 W for shall be less than 25% (<25% for 0-50 W)

u. Above 50 W rating shall be less than 15%. (<15% for >50 W)

v. The Current waveform should meet EN 61000-3-2

w. LED Driver shall withstand voltage of 350V for 2 hours and restore normal working when normal voltage is applied

x. The driver should comply to CISPR 15 for limits and methods of measurement of Radio Disturbance characteristics

y. The equipment should comply to IEC 61547 for EMC immunity requirements

z. The control gear should be compliant to IEC 61347-2-13, IEC 62031 and IEC 62384.

aa. It shall have a power factor >.9

3.5.5 General

a. The lumen maintenance of the LED lightings shall not be less than 70% after 50,000 hours i.e. L70 (B50).

b. The supplier shall provide evidence that the LED chipset manufacturer has the patent right to produce the supplied LED chipset to avoid infringement of white LED patent.

c. Free warranty shall commence after delivery and end at 60 months after delivery. The warranty of replaced item shall re-start from date of attending defect / replaced. Test reports for various parameters i.e. Flux, power, efficacy, chromaticity, temperature, protection etc. issued by certified agency shall be furnished. Estimation on product's life and performance shall also be furnished.

d. DMRC reserves the right of testing of products for its conformity in accordance with above specifications.

4.0 ADDITIONAL REQUIREMENTS

4.1 PLUG-SOCKETS
Specifications for Supply, Installation, Testing & Commissioning of Indoor Lighting System

a. The 3-pin 6A/16A plug Universal socket shall be combination socket and switch and switch (on the live side) suitable for use with either 6A plug or 16A plug. The switches and sockets shall be enclosed type flush mounted switches of 230 volt ac grade. These shall be provided with approved poly carbonate modular cover plates, secured to the box with counter sunk screw. Where more than one switch occurs in same location, they shall be installed in gangs under one cover plate.

4.2. Time Switches

a. Spring reserve 24 hour dial time switches shall be suitable for operation on a 230 volt 50Hz ac supply and shall be driven by a self-starting synchronous motor with a spring reserve mechanism which will enable the clock to continue to function for a period of at least 30 hours after interruption of the supply. Separate motor and switch terminals shall be provided. Switch contacts shall be rated at 20 amperes.

b. Spring reserve - solar dial time switches shall be suitable for operation on a 230 volt 50Hz ac supply and shall be driven by a self-starting motor with a spring reserve mechanism which will enable the clock to continue to function for a period of at least 30 hours after interruption of the supply.

c. Separate motor and switch terminals shall be provided. Switch contacts shall be rated at 20 amperes.

d. The time switch shall be fitted with a 24-hour dial complete with one set of ON and OFF levers. A selective day omitting device shall also be provided. The time switch shall be provided with an "ON-OFF" by-pass switch to completely over-ride pre-set switching functions.

e. For safety reasons, where lighting switches occur in different phases they must be separated by a distance of not less than 2.0 m unless phase barrier type switches are used. This type of switch is only to be used when shown on the drawing or on the specific instruction of the Employer's representative.

f. Astronomical Timers: Astronomical Time switches are used to control events with respect to real time clock (RTC). The device should not use any sensor to detect the rise or set time of sun. Instead it should use Astronomical mathematics to calculate the rise/set time for given date. These calculations should be based on the entered Latitude/Longitude values or city selection with high level of accuracy in prediction.

4.3 Ceiling, Wall Fans & Exhaust fans
Specifications For Supply, Installation, Testing & Commissioning of Indoor Lighting system

a. Ceiling fans shall be energy efficient highest BEE rated of latest notification of 400mm/1200mm sweep conforming to IS: 374-1979 complete with fan suspension stem, canopies and regulators. 30-cm suspension stem shall be standard accessory and stems shall be heavy-duty steel tubes to IS: 1239-2004. The stem shall be painted with enameled paint. The fan shall have a junction box with MS hook of minimum size 150-mm diameter fixed in recess of ceiling and covered with sun-mica sheet of minimum 3-mm thickness.

b. The fan clamp shall be fabricated from new metal and shall be as close fitting as possible. The suspension rod shall be seamless steel tube. Mounted on a pre-embedded hook with hard rubber isolator. Regulators shall be step type mounted in the switch box. The box in all such cases shall be large enough to accommodate the regulator and switches. Air circulators of suitable size & sweep as specified, 1440 rpm, suitable for 230 V, 1-phase, Low noise level of 80-90dB or as stipulated in Indian Standards and approved shall be provided at suitable location.

c. Exhaust fan – The exhaust fan shall be of size 300/450-mm as specified and required and 900 rpm and shall conform to IS: 2312-1967 (as reaffirmed in 2005). The fans shall be robust, having double ball bearings and low noise.

5.0 Safety: Not Applicable

6.0 Energy Conservation:

a. 6.10.1 The energy conservation principles and directives shall be followed in right earnest. Selection of lamps, dimmer, sensors, and auto switch, the energy conservation features should be employed at the design stage with engineer incharge.

b. 6.10.2 The lighting norms in term of Lighting Power Density (Watt/m2) for different activities is given in ECBC code and reproduced below
Specifications For Supply, Installation, Testing & Commissioning of Indoor Lighting system

Table 7.1: Interior Lighting Power-Building Area Method (ECBC Table 7.1)

<table>
<thead>
<tr>
<th>Building Area Type</th>
<th>LPD (W/m²)</th>
<th>Building Area Type</th>
<th>LPD (W/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automotive Facility</td>
<td>9.7</td>
<td>Multifamily Residential</td>
<td>7.5</td>
</tr>
<tr>
<td>Convention Center</td>
<td>12.9</td>
<td>Museum</td>
<td>11.8</td>
</tr>
<tr>
<td>Dormitory/Hostel</td>
<td>10.8</td>
<td>Office</td>
<td>10.8</td>
</tr>
<tr>
<td>Eating/Bar/Lounge/Leisure</td>
<td>14.0</td>
<td>Parking Garage</td>
<td>3.2</td>
</tr>
<tr>
<td>Eating/Cafeteria/Rest Room</td>
<td>15.1</td>
<td>Performing Arts Theater</td>
<td>17.2</td>
</tr>
<tr>
<td>Dormitory</td>
<td>10.8</td>
<td>Police/Fire Station</td>
<td>10.8</td>
</tr>
<tr>
<td>Gymnasium</td>
<td>11.8</td>
<td>Post Office/Town Hall</td>
<td>11.8</td>
</tr>
<tr>
<td>Health care- Clinic</td>
<td>10.8</td>
<td>Religious Building</td>
<td>14.0</td>
</tr>
<tr>
<td>Hospital/Health Care</td>
<td>12.9</td>
<td>Retail/Mall</td>
<td>16.1</td>
</tr>
<tr>
<td>Hotel</td>
<td>10.8</td>
<td>School/University</td>
<td>12.9</td>
</tr>
<tr>
<td>Library</td>
<td>14.0</td>
<td>Sports-Arena</td>
<td>11.8</td>
</tr>
<tr>
<td>Manufacturing Facility</td>
<td>14.0</td>
<td>Transportation</td>
<td>10.8</td>
</tr>
<tr>
<td>Motel</td>
<td>10.8</td>
<td>Warehouse</td>
<td>8.6</td>
</tr>
<tr>
<td>Motion Picture Theater</td>
<td>13.9</td>
<td>Workshop</td>
<td>13.1</td>
</tr>
</tbody>
</table>

c. For transportation and offices, the defined value is 10.8. DMRC shall work to better the Lighting Power Density (LPD) norms as given in above table by at least 30% i.e. not more than 7.5.

d. 6.10.3 Following LPD standards are fixed based on the average achieved during very recent installation on an underground station, elevated station, depot etc.

<table>
<thead>
<tr>
<th>Area Lighting</th>
<th>Power Density</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elevated Station</td>
<td>7</td>
</tr>
</tbody>
</table>

6.1 Selection of Lamp

a. There is a continuous development in the design of lamp for improved energy conversion. The lamp parameters given below is for guidance only and it is necessary to check for the new developments and the current recommendations on the subject.

<table>
<thead>
<tr>
<th>Type of Lamp</th>
<th>Watts(W)</th>
<th>Lumen Output</th>
<th>Color Temperature(K)</th>
<th>Average Life More Than (hrs)</th>
<th>Color Rendering Index More than</th>
<th>Efficacy in Lumen/Watt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Linear</td>
<td>28</td>
<td>2900</td>
<td>65000/4000 K</td>
<td>20,000</td>
<td>85</td>
<td>105</td>
</tr>
</tbody>
</table>
Specifications For Supply, Installation, Testing & Commissioning of Indoor Lighting System

| Fluorescent Lamps T5 | Metal Halide | 70-150 | 5500-12000 | 4000 | 10,500 | 80 | 80 |
| High Pressure Sodium Vapour Lamp | 250 | 27000 | 2000 | 10,500 | 23 | 120 |
| Compact Fluorescent Lamps | 18 | 1200 | 4000 | 20000 | 80 | 65 |
| Light Emitting Diode (LED) | 5-35 | 400-3500 | 2800-4000 | 50000 | 85 | 100 |

b. Based on the trends as prevailing, the designing criteria for the selection of lamp is:
   i. Passenger area at Metro Station: LED/T5
   ii. Equipment Room: T5
   iii. Circulating Area: Sodium Vapor Lamp/LED

6.2 Luminaire

   a. Luminaire houses the lamp along with reflector, electro-magnetic/electronic choke, starter etc. with input terminals to connect with power source. The reflectors is to direct and distribute the lumen output towards the utility area in the most economical manner avoiding its loss and glare. Electro-magnetic choke consumes higher energy and a source of noise, therefore electronic choke is only used.

6.3 Dimmer

   a. Dimmers are used to reduce the lumen output of the lamp by controlling the input voltage. With reduced activity in circulating area, roads, inspection bays etc. the voltage applied to the system is reduced which in turn reduces the energy consumption and the lumen output.

6.4 Sensor
DMRC Electrical Standards & Design Wing

Specifications For Supply, Installation, Testing & Commissioning of Indoor Lighting system

a. Sensors used to detect the need of illumination and accordingly switching on and off of full or part of the illumination circuit. SCR, Toilets having illumination for most part of the day or night and not used extensively are most suited for this application.

6.5. Energy Management and Metering:

a. Energy metering for all major load centers accounting for at least 80-85% of the energy consumption shall be ensured. Lighting Management system consisting of segregation of circuits for emergency illumination, automatic or manual controls, dimmers etc.

7.0 Maintenance and Life: 10 Years

8.0 Material and Manufacturing: - Not Applicable

9.0. Testing

Prototype tests/routine tests as required shall be carried out by the contractor and witnessed by employer’s representative as stipulated in Special Conditions of contract.

10.0 Training: - Not Applicable