GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS

FUNCTIONAL REQUIREMENT SPECIFICATION

FOR

ENERGY EFFICIENT LED BASED LUMINAIRE UNIT FOR INDOOR LIGHTS TO BE USED IN INDIAN RAILWAY OFFICES AND BUILDINGS

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1.0 SCOPE

The scope of work includes design, development, manufacturing, testing, supply, installation and commissioning of energy efficient luminiar complete with all accessories, LED lamps with suitable current control driver circuit including mounting arrangement for recessed type & ceiling mounting arrangements. The luminiar shall be suitable for rugged service under the operational and environmental conditions encountered during service. The following types of luminaries are required to be provided:

1. Troffer Light (2 x 2 and 1X1 LED Fixture)
2. LED Down Lighter
3. LED Tube Light/ LED Line fitting
4. LED Bulb

Each type of luminarie shall be supplied with associated driver circuit compatible with LEDs in all respect as required including complete optics.

2.0 SERVICE CONDITIONS:

Indoor lights on pipe/Recess mounting type light unit complete with luminaries and mounting accessories shall be suitable for Office cabins, office complex ,Railway Buildings(indoor) of Indian Railways under the following environmental conditions :-

2.1 Environmental conditions

Maximum ambient air temperature	:	45° C
Minimum ambient air temperature	:	-5° C
Max. Relative humidity	:	100%
Atmosphere	:	Extremely dusty and desert weather and desert terrain in certain areas. The dust contents in air may reach as high values as 1.6 mg/m^3
Coastal area	:	The equipment shall be designed to work in coastal area in humid, salt laden and corrosive atmosphere.

The maximum value of the condition in the coastal area will be as follows:

Max. pH value	:	8.5
Sulphate	:	7 mg/liter
Max. concentration of chlorine	:	6 mg/liter
Max. Conductivity	:	130 siemens
Annual rainfall	:	Ranging between 1750 to 6250 mm with\thunder storm
Altitudes	:	Not exceeding 1200 m above sea level

3.0 REFERRED STANDARDS

IS: 513	Cold-rolled low carbon steel sheets and strips

IEC 60529	Classification of degree of protections provided by enclosures.
EN 55015, CISPR15	Limits and methods of measurement of radio disturbance characteristic of electrical lighting and similar equipment.
IEC 62031	LED modules for general lighting-Safety requirements
EN 61547	Equipment for general ighting purposes – EMC iimunity requiement.
EN 60929	Performance, AC supplied electronics ballast for tubular flourescent lamps perormance requirement.
IEC 60598-2-1	Fixed general purpose luminaries
IEC 60598-1	Luminaires - General requirement and tests
IEC 61000-3-2	Electro Magnetic compatibility (EMC) -Limits for Harmonic current emission –– (equipment input current ≤ 16 Amps. per phase.
IEC 60068-2-38	Environmental Testing :Test Z- AD: composite temperature/ humidity cyclic test
IEC 61347-2-13	Lamp control gear : particular requirements for DC or AC supplied electronic control gear for LED modules.
IS 10322	Specification for the luminaries
IS 4905	Method for random sampling
LM 79	LED luminair photometry measurement.
LM 80	Lumen Maintenance
IEC 62384	DC or AC supplied electronic control gear for LED modules-performance requirements
IEC/PAS 62612	Self-ballasted LED lamps for general lighting services- Performance requirements

4.0 CONSTRUCTION

a. All the luminiars shall be finalized based on the performance feedback. The detailed calculation for lux level as per clause no.5.8 with uniform distribution including the lux distribution curve /graph distribution shall be submitted in support of the dimensions selected and variation thereof. Housing, if not used as a heat sink shall be made of at least 0.8 mm thick sheet Steel conforming to IS: 513 (Grade O)/CRCA polyester powder coated of at least 60 microns) and high U.V. & corrosion resistance. Heat sink used should be aluminum extrusion having high conductivity preferably to grade 6061 alloy or better having thermal conductivity of at least 170-180 W/m.K or Aluminium die cast having high conductivity preferably ADC 12 or LM 24. Efforts shall be made to keep the overall outer dimensions as minimum as possible.

All luminaires shall be provided with toughened glass of min. 0.8 mm thickness of sufficient strength and high efficiency (90%) prismatic diffuser under the LED chamber to protect the LED and luminaries. And shall not show yellowness during luminarie life time.

1. Troffer Light (2 x 2 and 1X1 LED Fixture)
2. Down Lighter
3. Tube Light /Line fitting
4. LED Bulb

b. Suitable number of LED lamps shall be used in the luminiars. LED lamps of NICHIA/CREE/ OSRAM/ SEOUL/ PHILIPS LUMILEDS/AVAGO make shall be used for the purpose. The manufacturer shall submit the proof of procurement of LEDs from above OEMs at the time of testing.

c. Suitable reflector / lenses may also be provided to increase the illumination uniformity and distribution.

d. Supplier will be solely responsible for testing and performance of the luminaries after installation and shall also ensure the specified and uniform illumination and comfort level on the work desk/ floor.

e Design of the thermal management shall be done in such a way that it shall not affect the properties of the diffuser.

4.1 High power and high lumen efficient LEDs suitable for following features shall be used:

a. The efficiency of the LED lamps at 85 Deg C junction temperature shall be more than 85%.

b. The working life of the lamp at junction temperature of 85 Deg C at rated current shall be more than 50,000 working hours of accumulative operation and shall be suitable for continuous operation of 24 hours per day . These features shall be supported with datasheet.

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

d. Colour temperature of the proposed white colour LED shall be 5700k (nomonal CCT) and the color variation should be 5665 +/-365K (ANSI binning)

e. Minimum view angle of the LED shall not be less than 120^0**.**

f. The output of LED shall be more than 100 lumen per watt at minimal operating current and shall ensure guaranteed operation life of 50,000 burning hours with controlled junction temperature of 85^0 C.

g. Lumen maintenence report as per LM 80 guidelines shall be produced for the power LEDs used.

h. Power factor of complete fitting shall be more than 0.9 at full load 240V.

i. Thermal management shall be in such a way that LED soldering point temperature shall not go beyond 75 degree centigrade.

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

k. The LED luminaire shall be free of glare.

l. Color rendering index CRI >=75

4.2) LED DRIVER specification used for street light

a. Input voltage Range within 180Vrms to 270Vrms
b. Operating input voltage 240Vrms
c. No load power consumption ≤ 500mW
d. Output voltage 105VDC±3%
e. Output voltage ripple should be within 3%
f. Output over voltage protection 125VDC
g. Power factor 0.95

h. Full Load Efficiency ≥ 90%

i. THD ≤8 %

j. Hot swapping

k. Load regulation ±5%

l. Current waveform should meet EN 61000-3-2

m. Led Driver shall withstand, withstand voltage of 440V for 2 hours and restore normal working when normal voltage is applied

n. Maximum Temperature rise <= 30ºC @ 45ºC Tamb with safety margin of 10^{o}C

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

p. The equipment should comly to IEC 61547 for EMC immunity requirements

q. The controlgear should be compliant to IEC 61347-2-13, IEC 62031 and IEC 62384 as per the requirements

4.3 The equipment should be compliant to IEC 60598-1, IEC 62031and IEC/PAS 62612 depending on the type of luminaire.

5.0 TECHNICAL REQUIREMENTS

The driver of the luminiars should have

a) 2 x 2 Fixture- Shall have Short Circuit , Over Voltage, String Open protections.
b) 1 x 1 Fixture- Shall have Short Circuit , Over Voltage, String Open protections.
c) Down Lighters – Shall have Short Circuit , Over Voltage protections
d) Tube Light – Shall have Over Circuit , Over Voltage protections.

5.2 The electronic components used shall be as follows:-

a) IC (Integrated circuit) shall be of industrial grade or above.

b) Metallic film / Paper/Polyester Capacitor shall be rated for a temperature of at least 105ºC.

c) The resistors shall be preferably made of metal film of adequate rating. The actual loading versus rating shall be 3.

d) The junction temperature of the Switching devices such as transistors and MOSFETs etc. shall not exceed 125ºC (allowing thermal margin of 25 ºC).

e) The conformal coating used on PCBs must be cleared and transparent and shall not affect colour code of electronic components or the product code of the company.

The LED must be mounted on MCPCB, which should be made up of Metal core (Aluminum metal core) and should have the alumina coating with aerosol spray process of manufacturing to have the better heat conduction or dissipation.

MCPCB shall be made with OPA dielectric thickness of 0.1mm and Al 5052H34. MCPCB must comply with IPC-A-600G and IPC-6012A class 2. UL approved solder mask and silkscreen must be used.

f) The heat sink compound used should be of silicon with high thermal conductivity with 3W/mk.

g) The heavy components shall be properly fixed. The solder connection shall be with good finish.

h) The electronics covered for this equipment shall pass all the tests called for in the specification. The tenderer shall indicate the deviation or compliance otherwise the offer may

not be considered for evaluation.

i) The infrastructure for Quality Assurance facilities as called for in the specification shall be available for the manufacturing of this product. The compliance shall be indicated clearly in the tender itself.

5.3 The connecting wires used inside the luminiar, shall be low smoke halogen free, fire retardant PTFE cable and fuse protection shall be provided in input side.

5.4 Care shall be taken in the design that there is no water stagnation anywhere. The entire housing shall be dust and water proof having IP20 protection as per IEC 60529.

5.5 The control gear shall be designed in such a way so that temperature rise of MCPCB shall not be more than 20^0C with respect to ambient temperaturewhen measured half inch away from the component.

5.6 Luminiar shall be such that the glare from individual LED is restricted and shall not cause inconvenience to the people.

The Diffuser should be used in the luminiar to restrict the glare of LEDs. And should have no yellowness during the entire life of the luminaire.

5.7 All the material used in the luminiar shall be halogen free and fire retardant confirming to UL94 V.0
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5.8 **Illumination Level**: The fitting shall be so designed that the illumination level shall be evenly distributed and shall be free from glare. Illumination level of different types of luminiar shall be as below:

Sl. No.	Place to be illuminated	Vertical Distance of fittings from the floor level(Mtrs)	Average Illumination Level (Lux)	Colour Temp in ^oK
Indoor Light				
1.	Work areas like cabins and work stations	2.743	**250 at 1mtr above ground level**	5500 to 7000
2.	Corridors	2.743	**125 on the floor**	5500 to 7000

* Illuminance at center is assumed for single luminaire.

Note: 1. Variation in illumination level shall be ±2% is allowed in input voltage range from 180VAC to 270VAC.

2. The illumination shall not have infra-red and ultra-violet emission. The test certificate from the NABL approved laboratory shall be submitted.

5.9 The area and locations where LED indoor fittings are to be provided is given in Annexure “B”.

6.0 TESTS:

Tests are classified as:–

- Type test
- Acceptance test
- Routine rest.

6.2 Type Test

Type tests shall be carried out to prove confirmation with the requirement of specification and general quality/design features of the unit. In case of any change in Bill of Material or design of unit, complete type test shall be repeated.

If any sample fails in any of the type tests, two fresh samples shall be taken and tested. If any sample again fails in that test, the whole lot shall be rejected.

6.3 Acceptance Tests:

These tests are carried out by an inspecting authority at the supplier's premises on sample taken from a lot for the purpose of acceptance of a lot. Acceptance tests shall not be carried out from particular size from the lot on which type tests have already been conducted. Recommended sampling plan is given below.

6.3.1 Sample size and criteria for conformity

The luminaries shall be selected from the lot at random. In order to ensure randomness of selection, procedures given in IS 4905-1968 (Reaffirmed 2001) may be followed.

6.4 Routine Tests:

These tests shall be performed by the manufacturer on each complete unit of the same type and the results shall be submitted to the inspecting agency, prior to offering the lot for acceptance test. the firm shall maintain the records with traceability.

6.5 Test Scheme:

Sl. No.	Description of test	Clause no.	Type Test	Acceptance Test	Routine Test
1	Visual and Dimensional check	7 (i)	Y	Y	Y
2	Checking of documents of purchase of LED	7 (ii)	Y	Y	Y
3	Resistance to humidity	7 (iii)	Y	-	-
4	Insulation resistance test	7 (iv)	Y	Y	Y
5	HV test	7 (v)	Y	Y	Y
6	Over voltage protection	7 (vi)	Y	-	-
7	Surge protection	7 (vii)	Y	-	-
8	Reverse polarity	7 (viii)	Y	Y	Y
9	Temperature rise Test	7 (ix)	Y	-	-
10	Ra (Colour Rendering Index) measurement test	7 (x)	Y	-	-
11	Lux measurement	7 (xi)	Y	Y	Y
12	Fire retardant Test	7 (xii)	Y		
13	Test for IP65protection	7 (xiii)	Y	-	-
14	Environmental tests	7 (xv)	Y	-	-
15	Reliability Test	7 (xvi)	Y	-	-
16	Life Test	7 (xvii)	Y	-	-
17	Endurance Test	7 (xviii)	Y	-	-
18	EMI/EMC		Y	-	-

7.0 Method of Testing

ι) Visual and Dimensional Check:

The unit shall be checked visually for all dimensions as per approved design and drawing. General workmanship should be good; all the components properly secured and sharp edges shall be rounded off. Check the marking and quality of the workmanship visually. Check the rating and make of electronic / electrical items.

ιι) Checking of documents of purchase of LED

Check Document of purchase of LED lamps of approved sources viz. NICHIA/ OSRAM/ SEOUL/ PHILIPS LUMILEDS / LEDNIUM/AVAGO/CREE.

ιιι) Resistance to humidity test

This is carried out by suspending the painted panels in corrosion chamber maintained at 100% RH and temperature cycle of 42 to 48 deg. C for 7 days and examining it for any sign of deterioration and corrosion of metal surface.

ιϖ) Insulation resistance test

The insulation resistance of the unit between earth and current carrying parts shorted together shall not be less than 2 MΩ when measured with 500V megger.

v) HV test

Immediately after insulation resistance test, an AC voltage of 1.72 KV rms (1500 + 2 x rated voltage) of sine wave form of 50 Hz shall be applied for one minute between the live parts and frame. There shall not be any kind of break down, flashover or tripping of supply.

vi) Over voltage protection

The Luminaire shall withstand at 300V AC for two minutes.

vii) Surge protection

It shall withstand a surge of 1.5kV $\pm$ 3% for 50 microseconds $\pm$ 20 % at the input terminals for all types. (Tests shall comply with Clause 5.4 of latest IEC 60571-1).

viii) Reverse polarity

The Luminaire shall withstand polarity reversal. It shall be operated with reverse voltage for 5 minutes at maximum value of voltage range. At the end of this period, the supply shall be made correct polarity and Luminaire shall operate in a normal way.

ix) Temperature rise Test:

Temperature rise Test shall be conducted at 100VAC with full load. The temperature rise shall be recorded by temperature detectors mounted at the specified reference points on the body of semiconductors, capacitors and other components as agreed between purchaser and manufacturer. The maximum-recorded temperature under worst conditions shall be corrected to 55^0C and compared with maximum permissible temperature (for power devices at

junction). Under loading conditions as specified above, the corrected temperature of the power devices shall have a safety margin of minimum 10^0 C.

Temperature at junction shall not exceed 100 ^{0} C when corrected to 55^0 C. The Luminiar shall also be subjected for short time rating after continuous loading to ensure the temperature rise is within the permissible limit. The maximum temperature rise of the electronics devices on the PCBs shall be in limit for industrial grade components suitable for 85^0C environment. In case of exceeding limit, use of MIL-grade component shall be considered keeping RDSO informed.

x) Ra (Colour Rendering Index) measurement test

The lumen is the unit of luminous flux, which is equal to the flux emitted in a solid angle of one Steradian by a uniform point source of one candela.

The initial reading of the chromaticity co-ordinates x & y shall be within 5 SDCM (Standards Deviation for Colour matching) from the standardised rated value as per Annex. D of IEC 60081 - 1997.

The initial reading of the general colour-rendering index (Ra) shall not be less than the rated value decreased by 3.

The lumen maintenance of the lamp shall not be less than 80% of the initial lumen after 20000 burning hours and 70% of the initial lumen after 50000 hours . The initial lumen will be taken after 100 hours aging.

Photometric test shall be conducted as per annexure B of IEC 60081-97.

The lumen maintenance test shall be done as per annexure C of IEC 60081-97.

xi) Lux measurement

Lux measurement with the help of Lux meter shall be done at a distance as shown in para 5.8 above. Value obtained shall not be less than the Lux specified in the table no. , considering 10% Lumen is absorbed by the reflector.

xii) Fire retardant Test

Fire Retardant test shall be conducted as per IEC 60332-1 of the wire used in the fittings.

xiii) Test for IP20 protection

This test shall be conducted as per IEC 60529.

xiv) Environmental tests

The Luminiar shall meet the following tests as prescribed in IEC – 60571.

a) Dry heat test.
b) Damp heat test
c) Test in corrosive atmosphere
d) Combined dust, humidity and heat test

xv) Reliability Test

The reliability can only be determined in actual service. However, the following tests shall be carried out on the prototype to simulate as close as possible, the service conditions. There shall be no failure during this test.

a) The light unit shall be mounted in an oven maintained at 45°C.
b) The light will be operated at the specified maximum voltage and at 45°C for a period of 100 hours.

xvi) Life Test

The lumen maintenance & life test shall be done as per annexure C of LM 80 Report of LEDs.

xvii) Endurance Test

The Luminiar shall be kept “ON” with input voltage of 250VAC for 200 hours. After this the Luminiar is subjected to 20,000 cycles of “ON” and “OFF”, each cycle consisting of 3 seconds “ON” and 10 seconds “OFF” period. Luminiar should survive this test. Test is to be continued for 20,000 cycles, followed by performance test.

xviii) Safety:

The Luminaire shall comply with the safety requirements as per IEC 61195.

8.0 INFRINGEMENT OF PATENT RIGHTS

Indian Railways shall not be responsible for infringement of patent rights arising due to similarity in design, manufacturing process, use of the components, used in design, development and manufacturing of these light fittings and any other factor which may cause such dispute. The responsibility to settle any issue rises with the manufacturer.

9.0 MARKING:

The following information shall be distinctly and indelibly marked on the housing:

a) Year of manufacture/Batch Number/ Serial Number
b) Name of Manufacturer
c) Rated watt and voltage
d) Input frequency

10.0 APPROVAL

The manufacturer shall also submit details like make, type, reliability grade, rating and loading of various electronic components used in the circuit. The temperature rise of the various components under the most adverse conditions shall also be declared.

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