

Street Lighting Luminaire Specification - LED

GENERAL

The State of Qatar is in a transitional phase of highway assets and management improvement. Ashghal aims to embrace new technology, focusing on sustainability, and apply this to the highway infrastructure of Primary, Secondary and Tertiary roads under the control of Ashghal, Public Works Authority for The State of Qatar and other areas as required, such as; sikkas/foot/cycle paths and landscape/recreational areas.

It is the intention of Ashghal to specify energy efficient, green and economically sustainable initiatives incorporating low carbon technology and thus embracing the deployment of LED luminaires in The State of Qatar.

This specification aims to initiate the investigation, evaluation and application of Light Emitting Diode (LED) technology to all exterior lighting works. The outcome of this specification and associated evaluations and trials will be the production of an approved suite of exterior LED luminaires for implementing on the Primary, Secondary and Tertiary roads under the control of Ashghal, Public Works Authority and other areas as required.

This specification stipulates the requirements for any Light Emitting Diode (LED) luminaire that is intended for use as an exterior light in highway areas under control of Ashghal, Public Works Authority and other areas as required. No luminaire shall be utilised or installed without prior approval and written authority of Ashghal. Luminaire shall be defined so as to include all associated components to enable its operation.

The luminaire shall comply with all applicable standards and requirements specified herein. The luminaire shall be purpose designed for LED light sources only. The luminaire shall be suitable for lighting specified areas within the rights of way, to a predefined lighting standard. Luminaires originally designed to be used with non-LED sources and proposed subsequently with LED light engines shall not be considered.

Luminaires shall be commercially available and shall be delivered in a protective covering completely assembled and operationally ready, all associated component parts shall be new and unused. Luminaires shall be “future proofed” by allowing the LED modules to be upgraded easily in situ, as LED efficiency improves. Upgrading of luminaires, or replacement of faulty components, with manufacturer approved components shall not have any detrimental impact whatsoever on the luminaires warranty. Prototypes shall not be accepted.

A sample of each luminaire type, or model, shall be provided for evaluation and approval by Ashghal prior to authorisation or installation together with the necessary test and photometric data in a suitable format stipulated by Ashghal. The manufacturer shall provide all samples and requested data at their own cost. The manufacturer shall also facilitate authorised Ashghal representatives, and/or their appointed representative, to examine the test and manufacturing facilities and witness manufacturing processes and sample testing related to the luminaire and associated components submitted for evaluation, at no cost to Ashghal or their appointed representative.

Equivalent or more onerous standards can be proposed, by the manufacturer, as an alternative to the detailed standards, with the exception of Qatar documents. Evidence shall be submitted detailing the equivalent or more onerous sections that deviates from the intended standard.

This specification shall be incorporated into the Qatar Construction Standards, currently QCS 2010, section 6, part 12 Road Lighting. This QCS shall be referenced in all street lighting specifications.

Manufacturers are expected to and shall notify Ashghal of any errors or omissions within this document.

Information contained in this document is subject to change without notice. Please ensure you have the current version.

PHYSICAL AND ENVIRONMENTAL REQUIREMENTS

Application

The luminaires are intended for exterior use in rights of way areas, incorporating the Primary, Secondary and Tertiary network under the control of Ashghal, Public Works Authority in The State of Qatar and other areas as required.

Environment

Unless otherwise specified the LED luminaires shall be designed and suitably rated to ensure correct operation and continuous trouble free service under the prevailing climatic conditions which as a guidance is referenced below. The luminaire shall be designed to withstand the effects of direct sun exposure during the day and dusty weather conditions including the occasional sand storm. The luminaire manufacturer shall guarantee the performance and life time claims of; lumen maintenance and luminaire life of the luminaire under the stated climatic conditions.

Climatic conditions

The State of Qatar is a peninsula surrounded on three sides by the waters of the Persian Gulf and connected by land to Saudi Arabia. According to its geographical location and climate, Qatar is classified as a hot subtropical desert. The Qatar Construction Specifications 2010, Section 21, Part 1. General Provisions for Electrical Installation, clause 1.1.14 states;

1. *The climate in Qatar in the summer months is hot and humid and a humidity of 100 % at 30 °C has been recorded.*
 - (a) *violent sand and dust storms of several hours duration occur and even on comparatively still days, fine dust is carried in suspension in the atmosphere.*
 - (b) *all apparatus and equipment shall, therefore, be so designed and constructed that they operate satisfactorily and without any deleterious effect for prolonged and continuous periods in the conditions stated above and at the following ambient temperature conditions:*
 - (i) *maximum sun radiation temperature in summer - 84 °C*
 - (ii) *maximum ambient temperature in summer - 52 °C*
 - (iii) *average max. ambient temperature in summer - 45 °C*
 - (iv) *minimum ambient temperature in winter - 0 °C*
 - (v) *the altitude of Qatar may be taken as sea level.*

As a minimum, manufacturers shall consider 50 °C as the night time ambient temperature with 100% humidity.

Ingress protection (IP)

The degree of protection provided by the luminaire, including the facility for a switching device, against ingress shall be rated at least IP66 in accordance with EN60529 (IEC529)

Specification for degrees of protection provided by enclosures (IP code). This shall be certified by an independent IP testing and examination laboratory accredited by UKAS or equivalent accreditation body.

Impact protection (IK code)

The degree of protection provided by the luminaire against external mechanical impact shall be rated at least IK10 (metals and plastics) and IK08 (glass) in accordance with EN62262:2002 (IEC62262:2002) *Degrees of protection provided by enclosures for electrical equipment against external mechanical impacts (IK code).* This shall be certified by an independent IK testing and examination laboratory accredited by UKAS or equivalent accreditation body.

Safety standards

The luminaire assembly shall be tested and approved by an independent ENEC (European Norms Electrical Certification) national Certification Body and awarded the ENEC mark or equivalent international standards.

Other standards

The luminaire shall be fully compliant with all relevant EN (European Norms) standards and EC Directives as required by the CE (Conformité Européenne) Community Marking Directive or equivalent international standards.

CONSTRUCTION

Housing

The luminaire housing shall be constructed from corrosion resistant marine grade aluminium alloy conforming to BS EN 1676, 1559-1, 1559-4 and 1706 and powder coated by an Akzo Nobel approved applicator, or equivalent, conforming to EN12206-1:2004 *Paints and varnishes. Coating of aluminium and aluminium alloys for architectural purposes. Coatings prepared from coating powder.*

The manufacturer shall supply a RAL colour chart depicting the range of powder coat colours available for the external finish of the luminaire. Luminaire colour shall be specified at the time of ordering.

The optical assembly and control gear components shall be integral to the luminaire body.

For maintenance the luminaire shall allow tool-less access and incorporate quick disconnect features and universal fittings. All component parts shall be easily accessible and securely mounted to prevent accidental falling and manufactured from corrosion resistant materials or treated to prevent corrosion. The luminaire cover shall include an optional security feature to enable locking by means of a tool. The cover shall also incorporate a safety switch to disconnect power on opening and any upward rising hinged canopy shall be secured in an open position by means of a brace to prevent accidental closing.

Mounting

The luminaire series shall be suitable for mounting directly on top of a vertical post with a spigot of up to 76mm in diameter and for mounting from the side on a bracket arm of up to 60mm in diameter. The angle of tilt of the installed luminaire shall be 0° and adjustable by at least 5° to 10° above the horizontal.

The luminaire shall be securely fixed to the mounting post or bracket by means of a clamping system that will prevent movement in high winds. All component parts shall be manufactured from non-corrosive materials.

Light source

The luminaire light source shall consist of an LED system suitable for lighting the rights of way incorporating the Primary, Secondary and Tertiary network and other areas as required to a predefined lighting class standard.

The LED's shall be produced by a prominent manufacturer of solid state lighting (SSL) components and comply with the related standards and guidelines set by the Illuminating Engineering Society of North Americas (IESNA) and the JEDEC Solid State Technology Association. The rated system efficacy of the LED luminaire shall be equal to or greater than 100 lm/w (lumens per watt) operating within the climate conditions previously stated.

The light source is required to control light output with the aim of optimising luminaire performance and efficiency in relation to the specific lighting application. The luminaire, or luminaire series, shall provide the facility for varying luminous flux output ranging from 5klm up to at least 40klm using an appropriate number of LED's and a suitable control method for each different lumen package.

The luminaire LED module shall comply with International Electrical Commission Publicly Available Specification IEC/PAS62717 *LED modules for general lighting – Performance requirements*.

The LED array's shall be capable of operating within the climate conditions previously described and shall have documentation and certification supporting the claimed minimum life expectancy of 50,000 hours at L70 in the stated conditions as within this specification.

Optical system

Technical details shall be provided of the light source optical system and range of optics or optical settings available for each model of luminaire including performance characteristics. The optical system is required to control light output with the aim of optimising luminaire performance and efficiency in relation to the specific lighting application. The system should meet the lighting requirements of most rights of way types and configurations and maximise the 'light output ratio' (LOR) of the luminaire.

The inadvertent failure of any LED's during the life of the luminaire shall not bring about any reduction in uniformity of light output. Therefore, the multi-layer method of light distribution shall take precedence over multiple spot methods.

Diffuser systems may be required for some lighting applications to eliminate the effect of multiple-source shadows.

Electrical supply

The luminaire shall be suitable for connection to the low voltage single phase supply of the main network grid in The State of Qatar.

The Qatar General Electricity & Water Corporation "KAHRAMAA" *Regulations for the Installation of Electrical Wiring, Electrical Equipment and Air Conditioning Equipment* states:

The declared voltage for The State of Qatar is:

Rated Voltage: 240/415V $\pm 6\%$, 3Phase 4 Wire.

Neutral: Solidly Earthed.

Fault Level: 31 MVA at 415V

The nominal mains frequency is 50Hz. Under normal operating conditions there may be a variation of ± 0.1 Hz. Industrial conditions in the state may occasionally result in a short term variation of ± 0.15 Hz for duration of only a few seconds.

Wiring

All internal and external wiring of the luminaire shall comply with EN60598-1:2008 *Luminaires, General requirements and tests* and shall be flexible and suitably rated and insulated to withstand the voltages and temperatures encountered in service.

Any luminaire wiring passing through metal shall have suitable grommets or otherwise be protected to avoid abrasion of the insulation.

All luminaire terminals and supply connections shall comply with EN60598-1:2008. The conducting material of any terminal block shall be made of brass and shall have screw down plates bearing on the wires. Terminals where screws bear down directly on wires will not be acceptable.

Luminaires shall be earthed in accordance with EN60598-1:2008. An earth terminal forming part of the luminaire body shall be provided. All parts of an earth terminal shall be made of brass.

Control Gear

The luminaire control gear (driver) shall be produced by a prominent manufacturer of semiconductor components and comply with IEC 62384 *DC or AC supplied electronic control gear for LED modules - Performance requirements*. The manufacturer shall confirm that the packaged driver assembly is fabricated from high quality integrated circuit components including long-life electrolytic capacitors and provide data relating to the reliability of the device, in the climatic conditions stated in this specification.

The drivers shall be encapsulated / potted and Class II double insulated (IEC61140) and have a minimum energy efficiency of 85% and power factor ≥ 0.9 (full load). The control gear shall feature Surge Protection Device (SPD) for lightning strikes (IEC62305), short-circuit protection and transient overvoltage protection (IEC61643-1 / IEC61000-4-5).

The LED drivers shall be housed on a removable gear tray accessible with the luminaire cover open and be compatible with the Qatar power supply. The supply cable shall pass through the mounting post, or bracket, directly into the luminaire through an M20 cable gland located at the base of the luminaire mounting socket.

For protection in the event of temperatures reaching predefined critical levels, both LED's and drivers shall have thermal protection, which will initially dim down and eventually switch off the light. Manufacturers shall state the predefined critical temperature level at which the dim down and switch off protection events occur and relate to junction temperature and ambient temperature. The luminaire shall be constructed in such a way that this protection method shall not occur during climate conditions stated within this specification.

The driver system shall be compatible with Lighting Control Systems / Lighting Management Systems (LMS), using both analogue (1-10V) and Digital Addressable Lighting Interface

(DALI) protocols including WiMAC. The driver system shall also be capable of being configured for single, and multi-stage, stand-alone dimming configurations when not connected to a CMS.

The drivers shall be programmable and permanently configured to operate under the principle of 'constant flux' output or maintenance factor harvesting or similar. During this process light output is initially dimmed to an equivalent end of life level value and then the operating current is gradually increased throughout service life to compensate for lumen depreciation and maintain a constant lighting level. The advantage of this system is to give energy savings and improve LED life and reliability. The manufacturer shall provide details of how this facility is maintained following replacement of a faulty driver or LED array.

The driver shall be capable of operating within the climate conditions previously described and shall have documentation and certification supporting the claimed minimum life expectancy of 50,000 hours in the stated conditions within this specification.

The luminaire shall conform to CE marking directives including the European Electromagnetic Compatibility (EMC) Directive EN 61000-3-2:2009 (IEC 61000-3-2:2009) Electromagnetic compatibility (EMC) - Part 3-2: Limits - Limits for harmonic current emissions (equipment input current ≤ 16 A per phase).

Switching

The upper luminaire cover shall have the facility for installation and wiring of one of the following devices: an integral miniature photocell, NEMA socket (detachable photocell), telemetry device. This facility shall be included within the IP testing.

Luminaire

The luminaire shall be produced by a prominent luminaire manufacturer that publishes product specifications measured in compliance with the IEC/PAS performance requirements or equivalent.

The luminaire shall be capable of withstanding severe climate conditions, as stated previously, and be vandal resistant. The ingress of insects through any system vent or aperture shall be prevented by means of a filter.

The luminaire shall be designed to provide satisfactory heat dissipation for any powered component parts and maintain safe operating temperatures at all times under the stated climatic conditions. Heat dissipation shall be by passive thermal management, active or mechanical cooling is not acceptable.

All materials used in the luminaire shall be resistant to high temperature UV (ultra violet) exposure and be 100% UV-stable.

The complete luminaire shall be at least 98% recyclable.

The luminaire shall be compliant with the Waste Electrical and Electronic Equipment (WEEE) Directive (2002/96/EC) and the Restriction of the use of certain Hazardous Substances in electrical and electronic equipment (RoHS) Directive (2002/95/EC).

The luminaire shall be compliant with EN60598-1:2008 *Luminaires. General requirements and tests*, and EN60598-2-3:2003 *Luminaires. Particular requirements. Luminaires for road and street lighting*.

The luminaire shall restrict glare and control obtrusive light in accordance with the 'full cut-off' and 'semi cut-off' concepts and associated luminous intensity classes defined in EN13201-2:2003 *Road lighting (Part 2): Performance requirements* or an equivalent standard. Individual project design specifications shall detail the luminous intensity class requirement.

The luminaire shall control light output to limit light pollution and minimise sky glow in accordance with Commission Internationale de l'Éclairage (CIE) 126-1997 *Guidelines for minimizing sky glow* and meet the requirements therein for maximum permissible upward light output ratio (ULOR) expressed as the percentage of luminous flux acceptable in each of four different Environmental Zones.

The efficacy of the luminaire is given by the total lumen output divided by the power into the system and shall be equal to or greater than 100 lm/w (lumens per watt) operating within the climate conditions previously stated. The luminaire manufacturer shall submit a statement declaring that quoted performance figures correspond to the stated ambient air temperature and ensure that the specifics of operating in the Qatar environment are written into any applicable section of the warranty agreement.

Luminaire specification data sheet arrangement

For each model of luminaire the manufacturer shall produce a data sheet providing a detailed and comprehensive description of the luminaires characteristics and component parts. The data sheet will contain adequate information for the reader to select and specify a particular model from the luminaire range. This will include;

- luminaire diagram external dimensions, weight and windage
- LED configuration (numbers and lumen output for each package, CCT, CRI)
- optical arrangement (lens and reflectors types and settings)
- driver type (drive current, system power consumption)
- luminaire output (lm)
- luminaire efficiency (lm/W)
- glare rating
- control and switching options (photocell, programmed stand alone, CMS, etc.)

Apparatus identification

Each luminaire shall have a barcode securely attached internally within the gear compartment identifying the luminaires reference/catalogue number, total wattage and LED current setting and other attributes as required by Ashghal and as required of the Enterprise Asset Management System (EAMS). The barcode type shall be compatible with the hand held device chosen and utilized by Ashghal.

THERMAL MANAGEMENT

LED's

The luminaire shall incorporate a passive thermal management system, active cooling such as fan assisted systems will not be accepted. The manufacturer shall demonstrate that the luminaire is suitable for continuous operation in the Qatar environment. Within the stated climate conditions the LED junction temperatures shall be shown to remain within the range required to limit the risk of accelerated degradation of the LED's based on the stated life expectancy of the luminaire.

Junction temperature cannot be measured directly and must be derived using calculation formulae and temperature measurements read from a thermocouple device attached to a

series of defined reference points (thermal pads) on the outer casing (package) of the LED. Thermal verification testing is carried out as a laboratory based operation with ambient conditions simulated.

The luminaire manufacturer shall submit a statement declaring that quoted LED performance figures correspond to the stated ambient air temperature and ensure that the specifics of operating in the Qatar environment are written into any applicable section of the warranty agreement.

Drivers

The driver manufacturers device data sheet will typically provide specification details and the maximum permissible ambient temperature range in which the driver can operate (free air convection) at the defined driver current. The luminaire manufacturer shall demonstrate that the LED driver is suitable for continuous operation in the Qatar environment. Within the stated climate conditions the driver compartment enclosure shall be shown to remain within the range required to limit the risk of driver failure during operation based on the stated life expectancy of the luminaire.

The luminaire manufacturer shall submit a statement declaring that quoted driver performance figures correspond to the stated ambient air temperature and ensure that the specifics of operating in the Qatar environment are written into any applicable section of the warranty agreement.

Luminaire

The maximum allowable ambient temperature for the LED lighting shall be stated, in which the LED lighting can operate without adversely affecting any components life, luminaire light output or colour stability. This shall take into consideration the maximum case temperature of the driver and the design LED junction temperature.

Manufacturers shall state the predefined critical temperature level at which the dim down and switch off protection events occur and relate to junction temperature and ambient temperature. The luminaire shall be constructed in such a way that this protection method shall not occur during climate conditions stated within this specification.

TECHNICAL REQUIREMENTS

Chromaticity

Chromaticity tolerance and associated colour consistency of luminaire LED modules shall be measured in terms of the CIE 1931 chromaticity diagram and the CCT quadrangles defined by the American National Standards Institute (ANSI) C78.377-2008 *Specifications for the Chromaticity of Solid State Lighting Products for Electric Lamps*. The ANSI quadrangle is made up by smaller quadrangles, commonly referred to as bins. The x y chromaticity components of each LED module shall be enclosed by one bin and the bin size shall not exceed a 4-step MacAdam ellipse. The binning process shall be in compliance with National Electrical Manufacturers Association (NEMA) SSL 3:2010 *High-Power White LED Binning for General Illumination*.

The chromaticity shift shall be measured and reported in accordance with IES_LM-80-08 *Approved Method: Measuring Lumen Maintenance of LED Light Sources*.

For highway lighting the Correlated Colour Temperature (CCT) of the light emitted from the luminaire shall be in the range $\geq 4000\text{K}$ with a Colour Rendering Index (CRI) of ≥ 60 . The manufacturer shall state the CCT ranges available with a $\pm 275\text{K}$ warranted window. The CCT and CRI shall include the effects of colour shift over the life of the luminaire. Other CCT ranges may be applicable to individual projects and manufacturers shall be notified as required.

Photometry

Luminaire lighting performance shall be measured using an independent photometric testing laboratory accredited by UKAS or equivalent accreditation body. The test procedure and measurements shall be carried out in accordance and compliance with IES_LM-79-08 *Approved Method: Photometric Measurements of Solid State Lighting Products*. The photometric test report shall list all significant data for each SSL product tested together with performance data and also pertinent data concerning conditions of testing, type of equipment, and reference standards.

The photometric test procedure shall also be used to calculate correction factors in allowance of the stated climate conditions.

Photometric data for each luminaire optical setting shall be available in electronic file format in accordance and compliance with IES_LM-63-02 *Standard File Format for Electronic Transfer of Photometric Data and Related Information* and EN13032-1:2004+A1:2012 *Light and lighting. Measurement and presentation of photometric data of lamps and luminaires. Measurement and file format*. The photometry files shall be compatible for use with industry recognised road lighting design software packages or as requested by Ashghal and include applied correction factors specific to the declared ambient conditions.

Lighting performance of the LED luminaire in terms of design spacing's relative to a specified road lighting class should be comparable to a modern HID lamp based luminaire with similar lumen output.

The luminaire manufacturer shall submit a statement declaring that quoted photometric performance figures correspond to the stated ambient air temperature (not LED junction temperature) and ensure that the specifics of operating in the Qatar environment are written into any applicable section of the warranty agreement.

The luminaire shall be tested in accordance and compliance with EN62471:2008 (IEC62471:2006) *Photobiological safety of lamps and lamp systems* or an equivalent standard. Any assumptions made during testing shall be clearly stated.

Lumen maintenance

The luminaire LED light source shall be tested in accordance and compliance with IES_LM-80-08 *Approved Method: Measuring Lumen Maintenance of LED Light Sources*. The LM-80-08 test report produced for the LED light source shall meet the eligibility criteria necessary for submission to the U.S Department of Energy (DOE) Energy Star Program *Requirements for Solid State Lighting Luminaires*.

In Situ Temperature Measurement Test (ISTMT)

In order to relate the LM-80 test to the luminaire and stated climatic conditions, testing shall be completed that simulate this application. This shall be achieved by In Situ Temperature Measurement Test (ISTMT) which follows ANSI/UL 1598-2004 *Luminaires*.

Rated life and failure fraction

Lumen maintenance (L) is the luminous flux emitted by the light source at any specified time during its operational life and is expressed as a percentage of the luminous flux emitted at the start of life (L%). The rated lumen maintenance life of the LED light source shall not exceed L70, or 30% lumen depreciation.

The luminaire manufacturer shall define the estimated service life of the light source in terms of operating hours and rated lumen maintenance. The minimum standard expected shall be 50,000 operating hours at L70.

The method of deriving rated lumen maintenance life beyond the limits of lumen maintenance determined from actual measurements shall be demonstrated. The method for projecting the lumen maintenance of LED light sources from the data obtained by the procedures found in IES document LM-80-08 shall be in accordance and compliance with IES_TM-21-11 *Projecting Long Term Lumen Maintenance of LED Light Sources*.

In combination with rated life predications the reliability of the LED modules shall also be expressed in terms of the percentage (fraction) of failures in accordance with IEC/PAS 62722-2-1:2011 *Luminaire performance - Part 2-1: Particular requirements for LED luminaires*. The failure fraction (Fy) corresponds to the percentage of LED's that fail before end of rated life. This failure fraction expresses the combined effect of all components of a module including mechanical, as far as the light output is concerned. The effect of the LED could either be less light than claimed or no light at all.

The failure fraction shall also be expressed in terms of its component parts, gradual failure fraction (By) and abrupt failure fraction (Cy). The reliability curve relative to operating hours is calculated using statistical formulae and data gathered under test conditions during luminaire monitoring periods.

Maintenance factors

Luminaire maintenance factors (LMF) to follow model used in BS5489-1:2003+A2:2008 Annex D Table D1 with figures extrapolated to extend cleaning cycle interval up to 6 years and also adjusted to take account of specific environmental conditions.

Lamp flux maintenance factor (LFMF) shall be calculated by the manufacturer in accordance with calculated lumen depreciation relative to a predefined cleaning cycle interval. Currently the perceived cleaning interval is biannually due to the intense dust laden atmosphere.

LIGHTING STANDARDS

LED highway luminaires shall be suitable to achieve the lighting class standards as detailed in EN 13201 with reference to CIE 115 and with particular reference to lighting classes; ME(M)1-4, CE(C)0-3 and S(P)1-3 inclusive and as applicable to Primary, Secondary and Tertiary roads in The State of Qatar, under the control of Ashghal and other areas as required, taking into consideration the allowable reduction of lighting levels due to 'white light' and Scotopic/Photopic ratio application.

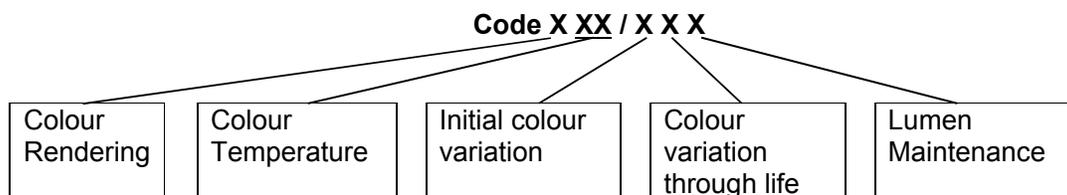
The lighting class stated may change, as the Qatar Highway Design Manual (QHDM) will detail the lighting class and subsequent standards that are required to be attained. Please note the QHDM is currently under revision.

It shall be noted that the optimum luminaire mounting heights and spacing arrangement shall be calculated and selected, by the designer, for individual projects so that it is designed for the maximum possible overall luminous and energy efficiency and in compliance with the specified lighting class.

QUALITY CRITERIA

To ensure consistency in quality criteria the manufacturers shall submit data in accordance with IEC/PAS 62717 *Performance requirements – LED modules for general lighting* and IEC/PAS 62722 *Performance requirements – LED luminaires for general lighting*. These documents were developed together to provide; the definition of a set of quality criteria related to the initial specifications of a product and a standardised description on how to measure these quality criteria. The following list of quality criteria, as detailed in the Lighting Industry Liaison Group – *A Guide to the Specification of LED Lighting Products 2012*, will be considered during the evaluation process.

1. *Rated input power*. The rated input power shows the amount of energy consumed by a luminaire, including its power supply. It is expressed in watts.
2. *Rated luminous flux*. This is the light emitted by the luminaire which is expressed in lumens. For LED luminaires Absolute photometric values shall be used.
3. *LED luminaire efficacy*. The measured initial luminous flux divided by the measured initial input power of the same individual LED luminaire. It is expressed in lumens per watt.
4. *Luminous intensity distribution*. The spatial distribution of the luminous flux graphically depicted in a luminous intensity distribution curve, which is usually expressed in a polar diagram representing the light intensity as a function of angle about a light source. It is expressed in cd.
5. *Photometric code*. A six digit photometric code that displays the important 'quality of light' parameters; CRI, CCT, chromaticity co-ordinates and luminous flux.



Example:

Initial CRI value of 84 – code 8

Initial CCT value of 300K – code 30

Initial chromaticity co-ordinates within a 3-step MacAdam ellipse – code 3

Maintained chromaticity co-ordinates within a 5-step MacAdam ellipse – code 5

Maintained luminous flux of 91% - code 9

Photometric Code = 830/359

- a. *Correlated Colour Temperature (CCT)*. In order to classify the different types of white light, the concept of colour temperature is applied which is described as the colour impression of a perfect black-body radiator at certain temperatures. The initial CCT value classification for the photometric code can be obtained by taking the initial CCT value divided by 100.
- b. *Rated Colour Rendering Index (CRI)*. Although light sources may have the same colour appearance, this doesn't necessarily mean that colour surfaces will look the same under them. The initial CRI value classification for the photometric code can be obtained by using the following intervals:

Code	CRI Range	Colour rendering properties
6	57-66	Poor
7	67-76	Moderate
8	77-86	Good
9	87-100	Excellent

- c. *Rated chromaticity co-ordinate values both initial and maintained.* MacAdam ellipses are scaled up to a larger size of 3x, 5x or 7x the original. This is indicated as a 3-step, 5-step or 7-step MacAdam ellipse. The initial and maintained chromaticity co-ordinates are measured for the maintained value at 25% of rated life up to a maximum of 6000 hours. The classification for the photometric code can be obtained by using the following intervals:

Size of MacAdam ellipse, centered on the rated colour target	Colour variation category	
	initial	maintained
3-step	3	3
5-step	5	5
7-step	7	7
>7-step ellipse	7+	7+

- d. *Lumen maintenance code.* The code number does not imply a prediction of achievable life time. The maintained luminous flux is measured at 25% of rated life up to a maximum of 6000 hours and expressed as a percentage of the initial values. The maintained value determines the lumen maintenance code.

Lumen maintenance (%)	Code
>90	9
>80	8
>70	7

6. *Rated life (in h) of the LED module and the associated rated lumen maintenance (Lx).* The length of time expressed in hours, during which a population of LED modules provides more than the claimed percentage (x) of the initial luminous flux always published in combination with the failure fraction. The series of values for (x) is 70, 80 and 90.
7. *Failure fraction (Fy), corresponding to the rated life of the LED module in the luminaire.* The percentage (y) of a number of LED modules of the same type at their rated life that have failed. This failure fraction expresses the combined effect of all components of a module including mechanical, as far as the light output is concerned. The series of values for (y) is 10 and 50.
8. *Ambient temperature (ta) for a luminaire.* The ambient temperature around the luminaire related to the specified performance. For a given performance claim the ambient temperature (ta) is a fixed value. It is expressed in degrees Celsius.
9. *Power Factor.* The power factor shall be clearly stated in all cases.
10. *Intensity Distribution.* Absolute Photometry shall be used. Relative Photometry shall not be accepted. Absolute photometry of LED luminaires shall be conducted according to IES LM-79-08 Photometric Measurements of Solid-State Lighting Products.

11. *Drive Current.* The power supply and electronics must provide a well-controlled DC drive current. Drive current is expressed in mA.
12. *Optical Risk.* Optical risk identifies the risk group related to the exposure to hazardous sources of artificial optical radiation. When light sources are placed in a luminaire, the Risk Group classification can change due to the optics used in the luminaire.

Risk Group 0	Exempt
Risk Group 1	Low
Risk Group 2	Moderate
Risk Group 3	High

Luminaire manufacturers data

To enable each LED luminaire performance to be evaluated on a comparable base, the manufacturer shall provide a standardised set of quality criteria, measured in compliance with the appropriate standard. The performance claims shall be matched against traceable data.

The performance data required is summarised below and shall be headed Quality Criteria:

1. Rated input power (in W)
2. Rated luminous flux of the luminaire (in lm)
3. LED luminaire efficacy (in lm/W)
4. Luminous intensity distribution
5. Photometric code
 - a. Rated Colour Rendering Index (CRI)
 - b. Correlated Colour Temperature (CCT in K)
 - c. Rated chromaticity co-ordinate values (initial and maintained)
 - d. Maintained luminous flux
6. Rated life (in h) of the LED module and the associated rated lumen maintenance (Lx)
7. Failure fraction (Fy), corresponding to the rated life of the LED module in the luminaire
8. Ambient temperature (ta) for the luminaire
9. Power Factor
10. Intensity Distribution
11. Drive Current
12. Optical Risk Group

This data shall be submitted on a pre-approved form. Forms shall be submitted to Ashghal for approval prior to submitting data for consideration.

Further data shall be provided to evidence compliance with all aspects of this specification. Additional data shall be provided as and when requested by Ashghal.

WARRANTY

The luminaire manufacturer shall provide a written undertaking to the satisfaction of Ashghal and its advisors to warranty the materials and performance as follows:

- LED arrays shall have a written warranty for a minimum of 50,000 hours and shall be replaced on a one for one basis upon failure. An LED array will be deemed to have failed when;
 - equal to or greater than 10% of the individual LED chips in an array has failed or
 - an array does not provide the required lumen maintenance (L70).

- Drivers shall have a written warranty for a minimum 50,000 hours and shall be replaced on a one for one basis.
- Luminaire housing and all external components such as; lenses, gaskets & fastenings and the fixture finish shall have a written warranty for a minimum twenty (20) years against the deterioration of, but not limited to, mechanical failure, UV degradation, corrosion, yellowing, blistering, chalking, cracking, peeling or fading.
- The Warranty shall be transferable without limitations and in its entirety to Ashghal, Public Works Authority, Qatar.

STANDARDS

The current version of the following standards, guidelines and codes of practice, or equivalent international standards, guidelines and codes of practice, shall apply to this luminaire specification.

Equivalent international standards, guidelines and codes of practice, shall be the same as or be more onerous than the following documents. Evidence shall be submitted detailing the equivalent or more onerous sections that vary from the intended document.

- Qatar Construction Standards (QCS) 2010, or current edition, with particular reference to;
 - Section 6, Part 12, Road Lighting,
 - Section 21, Part 1, General Provisions for Electrical Installations.
- The Qatar General Electricity & Water Corporation “KAHRAMAA” *Regulations for the Installation of Electrical Wiring, Electrical Equipment and Air Conditioning Equipment.*
- The Qatar Highway Design Manual (QHDM). Current edition.
- WEEE Directive (2002/96/EC).
- RoHS Directive (2002/95/EC).
- EN13201-2:2003, Road Lighting. Performance Requirements.
- BS5489-1:2003+A2:2008, Code of Practice for the design of road lighting. Lighting of roads and public amenity areas.
- CIE 115, Lighting of Roads for Motor and Pedestrian Traffic.
- EN60598-1:2008 Luminaires. General requirements and tests.
- EN60598-2-3:2003 Luminaires. Particular requirements. Luminaires for road and street lighting.
- CIE 126-1997 Guidelines for minimizing sky glow.
- EN60529 (IEC529) Specification for degrees of protection provided by enclosures.
- EN62262:2002 (IEC62262:2002) Degrees of protection provided by enclosures for electrical equipment against external mechanical impacts.
- BS EN1559-1 Founding. Technical conditions of delivery. General.
- BS EN1559-4 Founding. Technical conditions of delivery. Additional requirements for aluminium alloy castings.
- BS EN1676 Aluminium and aluminium alloys. Alloyed ingots for remelting.
- BS EN1706 Aluminium and aluminium alloys. Castings. Chemical composition and mechanical properties.
- EN12206-1:2004 Paints and varnishes. Coating of aluminium and aluminium alloys for architectural purposes. Coatings prepared from coating powder.
- RAL International colour standard.
- IEC61140, Protection against electric shock.
- IEC62305, Protection against lightning.
- IEC61643-1, Low-voltage surge protection devices.

- IEC61000-4-5, Electromagnetic compatibility (EMC).
- EN61000-3-2:2009 (IEC61000-3-2:2009) Electromagnetic compatibility (EMC) – Part 3-2: Limits – Limits for harmonic current emissions.
- Relevant IESNA standards and guidelines.
- Relevant JEDEC standards and guidelines.
- IEC/PAS62717 LED modules for general lighting – performance standards.
- IEC62384 DC or AC supplied electronic control gear for LED modules – Performance requirements.
- ANSI C78.377-2008 Specifications for the Chromaticity of Solid State Lighting products for Electric Lamps.
- NEMA SSL 3:2010 High-Power White LED Binning for General Illumination.
- IES LM-80-08 Approved Method: Measuring Lumen Maintenance of LED Light Sources.
- ANSI/UL 1598-2004 Luminaires.
- IES LM-79-08 Approved Method: Photometric Measurements of Solid State Lighting Products.
- IES LM-63-02 Standard File Format for Electronic Transfer of Photometric Data and Related Information
- EN13032-1:2004+A1:2012 Light and lighting. Measurement and presentation of photometric data of lamps and luminaires. Measurement and file format.
- EN62471:2008 (IEC62471:2006) Photobiological safety of lamps and lamp systems.
- DOE Energy Star Program. Requirements for Solid State Lighting Luminaires.
- IES TM-21-11 Projecting Long Term Lumen Maintenance of LED Light Sources.
- IEC/PAS 62722-2-1:2011 luminaire Performance. Particular requirements for LED luminaires.
- Lighting Industry Liaison Group – A Guide to the Specification of LED Lighting Products 2012.

It is the manufacturers responsibility to ensure that all relevant and associated standards, guidelines and codes of practice are identified and complied with, whether identified here or not.

Ashghal retain the right to amend or withdraw this specification at their discretion without consequence or recourse from any person, manufacturer, supplier or organisation whatsoever.