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Pre-Standard

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Electrical installations for lighting and beaconing of aerodromes – Characteristics of inset and elevated luminaires used on aerodromes and heliports

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

ELECTRICAL INSTALLATIONS FOR LIGHTING AND BEACONING OF AERODROMES – CHARACTERISTICS OF INSET AND ELEVATED LUMINAIRES USED ON AERODROMES AND HELIPORTS

FOREWORD

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- the subject is still under technical development or where, for any other reason, there is the future but no immediate possibility of an agreement on an International Standard.

Technical Specifications are subject to review within three years of publication to decide whether they can be transformed into International Standards.

IEC 61827, which is a Technical Specification, has been prepared by IEC technical committee 97: Electrical installations for lighting and beaconing of aerodromes.

The text of this Technical Specification is based on the following documents:

Enquiry draft	Report on voting
97/98A/DTS	97/99/RVC

Full information on the voting for the approval of this Technical Specification can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

The committee has decided that the contents of this publication will remain unchanged until 2007. At this date, the publication will be

- reconfirmed;
- withdrawn;
- replaced by a revised edition, or
- amended.

A bilingual version of this Technical Specification may be issued at a later date.

INTRODUCTION

Aeronautical ground lighting (AGL) at an aerodrome or heliport provides the pilot of an aircraft with location, orientation and alignment information in adverse visibility conditions and at night. This includes those aircraft in flight, i.e. on approach to or take off from the aerodrome, and those aircraft and other vehicles moving on the aerodrome surface. The type of lighting is dependent upon the aerodrome operations, type and density of traffic, aerodrome layout and other environmental considerations and may be realised in many different forms. For the purpose of this Technical Specification, the various types of lighting, referred to as AGL services, are considered as components of the overall AGL system.

This Technical Specification describes the system component requirements and it deals with the inset and elevated luminaires used in AGL.

This Technical Specification should be considered with the AGL requirements produced by the International Civil Aviation Organisation (ICAO). ICAO requirements are published in the form of annexes to the Chicago Convention on International Civil Aviation (1944) to which signatory nations apply to the air traffic and navigation services within their control regions. The annexes contain Standards and Recommended Practices (SARPs), describing performance requirements, based on operational requirements, for the safety, regularity or efficiency of international air navigation. Other ICAO publications contain additional procedures, performance specifications and guidance material for the interpretation and implementation of the SARPs.

Annex 14, Aerodromes (Volumes I and II), to the Convention contains the requirements for aerodrome and heliport operations and includes those aspects relating to AGL. The Aerodrome Design Manual Doc. 9157 Part 4 (Visual Aids) contains guidance material on the interpretation of the AGL requirements in Annex 14, Aerodromes. Part 5 of the Aerodrome Design Manual Doc. 9157 (Electrical Systems) contains technical information on the electrical supply and installation of AGL Systems. Recommended maintenance policies and practices for AGL Systems are contained in Part 9 of the Airport Services Manual Doc. 9137 (Airport Maintenance Practices).

The safety and technical specifications, requirements and working practices within this International Technical Specification are intended to be compatible with the Standards and Recommended Practices contained in Annex 14, Aerodromes and to complement the information contained in the Aerodrome Design Manual Doc. 9157 and the Aerodrome Services Manual Part 9 (Aerodrome Maintenance Practices).

The AGL system will evolve with the introduction of new technology and the implementation of new operational requirements. The general requirements for the AGL system in this Technical Specification are therefore to be considered generic.

To conform to this Technical Specification, it should be demonstrated to the relevant bodies that the requirements have been satisfied and therefore that the clause objective(s) has been met.

NOTE 1 Examples of relevant bodies would include the following:

- aerodrome management;
- certification and licensing authorities;
- safety regulators;
- notified bodies for international or European directives;
- national standards bodies.

ELECTRICAL INSTALLATIONS FOR LIGHTING AND BEACONING OF AERODROMES – CHARACTERISTICS OF INSET AND ELEVATED LUMINAIRES USED ON AERODROMES AND HELIPORTS

1 Scope

This Technical Specification defines the requirements and testing procedures for inset and elevated luminaires with lamps used in aeronautical ground lighting systems and excluding luminaires for general lighting.

This Technical Specification is applicable to inset or elevated luminaires used for:

– approach lights: centreline, crossbars, supplementary approach;
– runway lights: runway guard, threshold, threshold wingbar, centreline, edge, touch down zone, runway end, stopway lights;
– taxiway lights : centreline, edge, stopbar, intermediate holding position lights;
– heliports: aiming point, perimeter, fato luminaires.

The purpose of this Technical Specification is to provide a set of requirements and tests, which are applicable to the luminaires and their control equipment. In general, this Technical Specification includes safety requirements for the luminaires.

This Technical Specification is not applicable to visual approach slope indicator systems (PAPI (precision approach path indicators) etc.) and signs. Any other equipment not described in this Technical Specification is excluded from its scope.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60068-2-5, *Environmental testing – Part 2: Tests. Test Sa: Simulated solar radiation at ground level*

IEC 60068-2-9, *Environmental testing – Part 2: Tests. Guidance for solar radiation testing*

IEC 60068-2-11, *Environmental testing – Part 2: Tests. Test Ka: Salt mist*

IEC 60068-2-52, *Environmental testing – Part 2: Tests – Test Kb: Salt mist, cyclic (sodium chloride solution)*

IEC 60417-DB:2002[1], *Graphical symbols for use on equipment*

IEC 60598-1: 2003, *Luminaires – Part 1: General requirements and tests*

IEC 61000-6-2, *Electromagnetic compatibility (EMC) – Part 6-2: Generic standards – Immunity for industrial environments*

[1] "DB" refers to the IEC on-line database.

IEC 61000-6-4, *Electromagnetic compatibility (EMC) – Part 6: Generic standards – Section 4: Emission standard for industrial environments*

IEC 61821, *Electrical installations for lighting and beaconing of aerodromes – Maintenance of aeronautical ground lighting constant current series circuits*

IEC 61822, *Electrical installations for lighting and beaconing of aerodromes – Constant current regulators*

IEC 61823, *Electrical installations for lighting and beaconing of aerodromes – AGL series transformers*

ISO 2859 (all parts), *Sampling procedures for inspection by attributes*

ICAO Annex 14: *Aerodromes – Volume I: Aerodrome Design and Operations [Annex 14 to the Convention on International Civil Aviation, International Standards and Recommended Practices]*

ICAO Annex 14: *Aerodromes – Volume II: Heliports [Annex 14 to the Convention on International Civil Aviation, International Standards and Recommended Practices]*

ICAO 9137, *Airport Services Manual (Doc 9137) Part 9 — Airport Maintenance Practices*

ICAO 9157, *Aerodrome Design Manual (Doc 9157) Part 4 — Visual Aids*

ICAO 9157, *Aerodrome Design Manual (Doc 9157) Part 5 — Electrical Systems*

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3 Terms, definitions and abbreviations

3.1 Terms and definitions

For the purposes of this document, the following terms and definitions apply:

3.1.1
(aerodrome and heliport) luminaire
apparatus which distributes, filters or transforms the light transmitted from one or more lamps and which includes all the parts necessary for supporting, aiming, fixing and protecting the lamps, but not the lamps themselves and, where necessary, circuit auxiliaries together with the means for connecting them to supply

NOTE Aerodrome luminaires will be identified as luminaires in this Technical Specification.

3.1.2
elevated luminaire
luminaire above ground in values more than 40 mm and designed to break, distort or yield on impact so as to present the minimum hazard to aircraft

3.1.3
inset luminaire
luminaire installed inside the pavement of the movement area of an aerodrome and heliport, protruding 40 mm or less above grade and capable of withstanding the load of a standing or moving aircraft

3.1.4
omni-directional luminaires
luminaire with a fixed light output that shows light about a vertical angle for the specified application at all angles in the azimuth

3.1.5
lamp
source made in order to produce an optical radiation, usually visible

(IEV 845-07-03)

3.1.6
incandescent (electric) lamp
lamp in which light is produced by means of an element heated to incandescence by the passage of an electric current

(IEV 845-07-04)

3.1.7
base
installation accessory made to be fastened into a pavement possessing structural strength equal to the surrounding pavement and properties allowing to transfer the heating from the luminaire and the load imposed by standing or moving aircraft

3.1.8
interface
standard flange connection between the base and the luminaire or other accessory intended to remain firmly fastened when exposed to forces acting on them

3.1.9
type test
test to ascertain that one or more luminaires, made to a certain design, meet(s) applicable specifications

3.1.10
acceptance test
agreed procedure between any manufacturer and his customer, which allows the customer to check if the supplied equipment meets the technical specifications of the product

3.1.11
type test sample
sample consisting of one or more similar units submitted by the manufacturer for the purpose of a type test

3.1.12
lamp life
life of a batch of lamps with the lamps operated at rated current and/or voltage

3.1.13
useful lamp life
time during which the lamp, installed in the luminaire and operated at rated current and/or voltage, will produce 50 % of the required luminous intensity as specified in ICAO Annex 14

3.1.14
standard useful lamp life
under given conditions, the operating time of a lamp, installed in the luminaire and powered at rated current and/or voltage, beginning at a given instant of time and ending when the photometric intensity becomes unacceptable

3.2 Abbreviations

Abbreviations used in this Technical Specification include:

O DIA Outer diameter of a luminaire

BC DIA Bolt circle diameter of a luminaire

IC DIA Inner clearance diameter of a luminaire

The explanation of each term is shown in Figure 1.

4 Classification

Classification for inset luminaires used in this Technical Specification includes:

Table 1 – Inset luminaires classification

Classification	Maximum height above ground mm
Style 1	40
Style 2	25
Style 3	13
Style 4	6

4.1 Dielectric rigidity

The luminaires shall be classified according to Section 10 of IEC 60598-1.

5 General requirements

5.1 General

This Technical Specification covers the requirements for inset and elevated luminaires used on aerodrome and heliport runways and taxiways.

5.1.1 Marking

A nameplate shall be securely attached to the luminaire and contain at least the following information:

– manufacturer's name and luminaire identification;

– lamp type number and wattage;

– serial number.

5.2 Dimensional requirements

5.2.1 Inset luminaires

The slope α of the top surface of the luminaire, which protrudes above finish grade, shall not exceed 20° as shown in Figure 1. All recesses shall be provided with «running-on surfaces» on all sides. The construction of the recesses shall have no influence on the slope of the run-on surface.

The flange thickness of the band of the inset luminaire as specified in Figure 1 shall be 19 mm for sizes 1, 2 and 3 and 32 mm for size 4. The inset luminaire maximum height above ground shall be one of the values shown in Table 1.

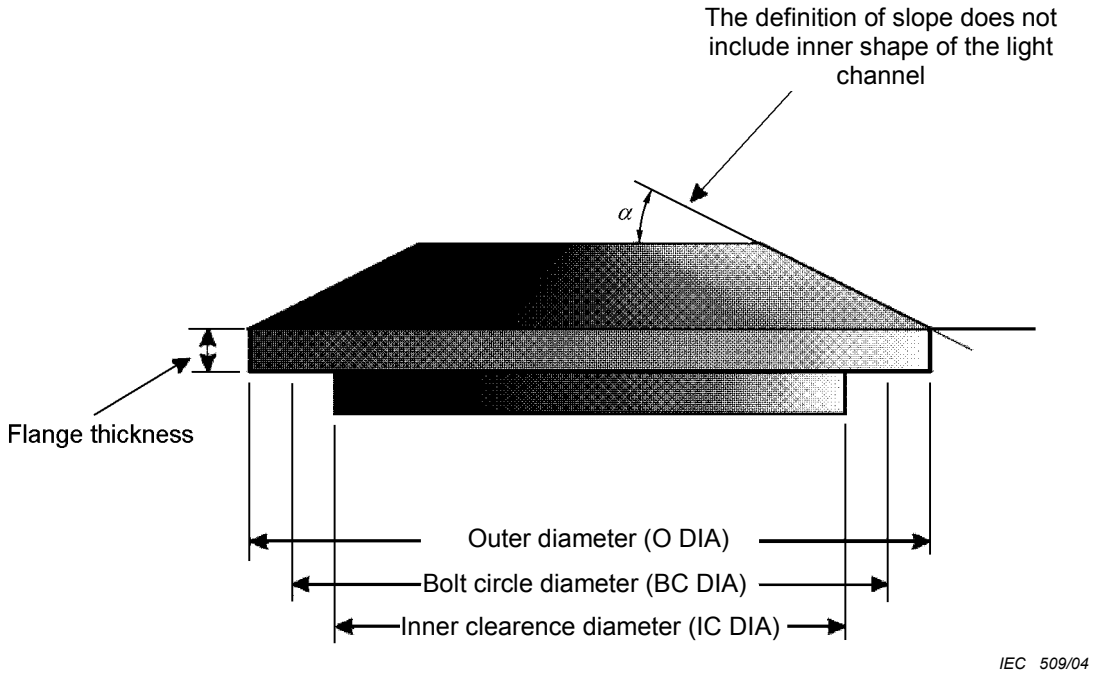


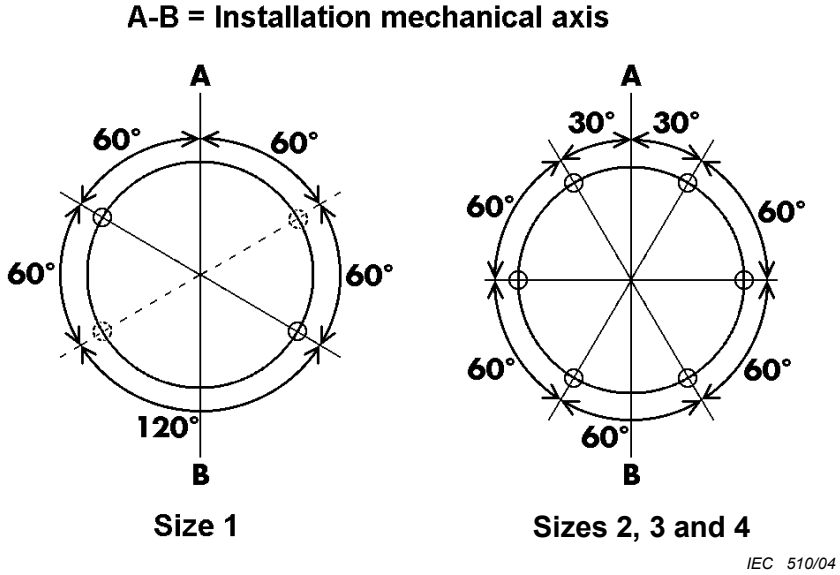
Figure 1 – Dimensions of inset luminaires

The diameters of the luminaires as shown in Figure 1 shall be of one of the four sizes specified in Table 2.

Table 2 – Specifications of dimensions of inset luminaires

References of diameters	Size 1 mm	Size 2 mm	Size 3 mm	Size 4 mm
O DIA ± 0,5 mm	203	254	304	438
BC DIA ± 0,2 mm	184	235	286	362
IC DIA ± 0,2 mm	165	201	252,2	312

The diameter of the luminaire hole shall accommodate a M10 bolt or stud. Location of fixation holes on the bolt circle is shown in Figure 2.



NOTE For size 1, both methods of fixation, using respectively 2 or 4 bolts or screws, are accepted. In case of using 2 bolts or screws, the holes on the top left and bottom right will be used.

Figure 2 – Location of fixation holes on the bolt circle

5.2.2 Elevated luminaires

The overall height of an elevated luminaire intended to be used within the runway or taxiway safety area shall not exceed 350 mm above pavement except for heliports where the height limit shall be 250 mm. In case of elevated runway guard lights, the height shall not exceed 650 mm.

These heights could be increased with the approval of the competent aerodrome authority.

5.3 Environmental requirements

The luminaires shall achieve specified performance under the following environmental conditions.

5.3.1 Temperature

The luminaires shall withstand the exposure to any temperature from –55 °C to + 55 °C.

5.3.2 Thermal shock

The luminaires shall withstand the exposure of the hot luminaire to cold water spray.

5.3.3 Corrosion

The luminaires shall withstand the exposure to a corrosive salt atmosphere in accordance with IEC 60068-2-11 and IEC 60068-2-52.

NOTE Various de-icing or chemical agents may be utilised at aerodromes; therefore, corrosion is the minimum performance requirement.

5.3.4 Moisture

The elevated luminaires shall withstand the exposure to moisture, snow, ice and standing water in accordance with Section 9 of IEC 60598-1. The degree of protection provided by the enclosure shall be at least IP24.

5.3.5 Solar radiation

The elevated luminaires shall withstand the exposure to solar radiation in accordance with IEC 60068-2-5 and IEC 60068-2-9.

5.3.6 EMC

The luminaires shall comply with the EMC requirements specified in IEC 61000-6-2 for immunity and IEC 61000-6-4 for emission.

5.4 Construction requirements

5.4.1 Design and construction requirements

The luminaires described in this Technical Specification should be installed directly in the ground or pavement or on a mounting interface. All the metal parts as well as their contact surfaces with other metals shall resist a corrosive environment. All surfaces of the finished top assembly shall be smooth, without burrs or sharp edges.

For inset luminaires, all edges above the pavement shall be rounded to not less than 1,5 mm radius, and the surface on the luminaire that mates with the base flange shall provide good load transfer and shall have a smooth mating surface.

5.4.2 Terminations

The luminaire powered by a series circuit shall be provided with a connection device to connect to the secondary lead of the AGL series transformer specified in IEC 61823. Earthing terminal(s), if required, shall be provided and shall be clearly indicated by the appropriate symbol shown in IEC 60417.

5.5 Structural requirements

5.5.1 Inset luminaires

5.5.1.1 Static load

When installed according to the manufacturer's recommendations, the luminaire assembly shall withstand a total static load in kilograms of 32 times the top area of the luminaire in cm^2, distributed uniformly over the top surface.

5.5.1.2 Shear load

The luminaire assembly shall withstand a shear load of 13 600 N applied to the top of the luminaire in any direction parallel to the mounting surface.

5.5.1.3 Mechanical impact

The luminaire assembly, except omni-directional luminaires, shall withstand the repeated impact of a steel ball dropped with energy of 40 J.

5.5.1.4 Hydraulic impact

The top of the luminaire assembly, except omni-directional luminaires, shall withstand a momentary hydraulic pressure of 1 380 kPa (all surfaces exposed when installed according to manufacturer recommendations).

5.5.1.5 Vibration

Inset luminaire assemblies with lamp(s), installed and shunted, shall withstand vibration along any axis without damage. They shall withstand an acceleration of 15 G when vibrated at frequencies between 20 Hz and 2 000 Hz and operating at rated current.

If a lamp fails, a new lamp installed in the luminaire but not shunted shall withstand an acceleration of 3 G when vibrated between 20 Hz and 2 000 Hz and operating at rated current.

5.5.1.6 Watertightness

The subassembly containing the optical components, including the lamp, shall be resistant to water leakage or infiltration from above or below the luminaire. The luminaire shall be at least IP67. Specifically, the optical assembly shall withstand an internal pressure of 140 kPa without leakage.

5.5.1.7 Surface temperature

The luminaire shall be designed so that the surface temperature will not exceed 160 °C when the luminaire is operating at maximum intensity for a period of 10 min.

5.5.2 Elevated luminaires

5.5.2.1 Jet blast

The elevated luminaire shall withstand a force corresponding to jet blast of 480 km/h.

5.5.2.2 Frangibility

Each elevated luminaire shall be designed to be frangible as specified by ICAO Annex 14. All elevated luminaires shall have a frangible device.

5.6 Interface requirements

5.6.1 Inset luminaires

The interface details and dimensions shall meet a size specified in Table 2.

5.6.2 Elevated luminaires

The luminaires should be equipped with a 2” 11 TPI GAS (60 mm O.D.) or a 2” 11 TPI BSP (60 mm O.D.) or a 2” 11,5 TPI NPT (60 mm O.D.) interface to fit with a straight loose fit thread.

5.7 Drainage requirements

5.7.1 Inset luminaires

If necessary, drainage may be provided to avoid water accumulation, which interferes with photometric performances in front of the useful output window. In that case, it shall not reduce the watertightness of the optical compartment, which shall be IP67.

5.7.2 Elevated luminaires

The luminaire shall comply with the requirements of Section 9 of IEC 60598-1, have a degree of protection IP24 and, if necessary, be provided with a drain hole with a diameter of at least 5,0 mm.

5.8 Electrical requirements

5.8.1 Connections

The luminaires leads shall terminate with connectors fitting the ones of the AGL series transformer specified in IEC 61823.

5.8.2 Dielectric rigidity

The luminaire shall provide adequate protection against shock.

5.8.3 Creepage and clearance

The luminaire shall provide adequate clearance from live conductors or conductive parts.

5.8.4 Insulation requirements

The luminaire, with the lamps inserted, shall be tested for a minimum insulation resistance per Class 1 of IEC 60598-1, Section 10.

5.9 Photometric requirements

5.9.1 Light output of the luminaires

The luminaires shall meet the photometric performances as specified in ICAO Annex 14. The isocandela diagrams of the intensity of the luminaires shall be as specified in ICAO Annex 14 Vol. 1, Appendix 2 and Vol. 2 in relation with their predicted use on the runways, taxiways and heliports.

Not all luminaires are covered by ICAO in terms of minimum luminous intensity and beam aperture. For the case of blue taxiway edge lights, the light beam specifications of a luminaire shall be in accordance with Table 3:

Table 3 – Light beam specifications not covered by ICAO for luminaires

Application	Minimum luminous intensity cd	Beam aperture (vertical angles)	Beam aperture (horizontal angles)
Blue luminaires used as taxiway edge lights	2	0º up to and including 6º	360º
	0,2	from 6º (6º not included) up to 90º	360º

5.9.2 Colour of the emitted light

The colour of the emitted light shall match the colours specified in ICAO Annex 14, Appendix 1.

5.10 Optical requirements

The internal components of the optical assemblies of the luminaires shall be protected from environment factors that might degrade their performance.

Covers shall resist abrasion or other damage from jet blast, sunlight and chemicals in the air as specified in the test procedure.

5.11 Maintenance requirements

Changing of lamps of luminaires shall be carried out without damage to any component. Maintenance shall be performed using appropriate tools and in accordance with IEC 61821.

5.12 Accelerated life of luminaires

Elevated and inset luminaires shall be tested to determine that there is no deterioration in the luminaire or parts of the luminaire.

5.13 Lamp life requirements

The lamp life while installed and operated at rated current and/or voltage in the corresponding luminaire in the mounting configuration which simulates the actual installed condition shall not be less than 500 h.

5.14 Instruction manual

The manufacturers shall specify in their instruction manuals the conditions for the installation, operation and maintenance of the luminaire and the equipment contained herein.

The instructions for the transport, installation and operation of the luminaire shall indicate the measurements that are of particular importance for proper and correct installation, commissioning and operation of the luminaire.

The instruction manual shall indicate the recommended extent and frequency of maintenance.

If the circuit is not obvious from the physical arrangement of the apparatus installed, suitable information shall be supplied (e.g.: wiring diagram or tables).

The instruction manual shall contain a parts list, troubleshooting information and preventive maintenance information.

6 Test procedures for airfield lighting luminaires

The type test of a product according to this Technical Specification shall be performed after any significant change (including lamp changes) or every 7 years.

All the tests shall be conducted on an inset luminaire with an adapter ring, if it is used.

Except where the type tests are destructive, the type tests shall be carried out on two completely mounted luminaires of each type, including all relevant accessories. The acceptance tests shall be conducted on a simple sample lot according to ISO 2859.

The test plan for airfield lighting luminaires shall follow the tests specified in Table 4.

Table 4 – Test plan for airfield lighting luminaires

Tests	Sample Number	Inset luminaires		Elevated luminaires	
		Type	Acceptance LEVEL S4/AQL 1.5	Type	Acceptance LEVEL S4/AQL 1.5
a. Dimensional tests	Any	6.2		6.2	
b. Environmental tests	1				
• High temperature		6.3.1.1		6.3.1.1	
• Low temperature		6.3.1.2.1		6.3.1.2.2	
• Thermal shock		6.3.2.1		6.3.2.2	
• Corrosion (salt spray)		6.3.3.1		6.3.3.2	
• Moisture		No test		6.3.4	
• Solar radiation		No test		6.3.5	
• EMC		6.3.6		6.3.6	
c. Structural tests					
• Static load [a]	2	6.4.1.1		No test	
• Shear load	3	6.4.1.2		No test	
• Mechanical impact	2	6.4.1.3		No test	
• Hydraulic impact [a]	4	6.4.1.4		No test	
• Vibration [a]	2	6.4.1.5		No test	
• Watertightness		6.4.1.6.1	6.4.1.6.2	No test	
• Surface temperature	2	6.4.1.7		No test	
• Jet blast		No test		6.4.2.1	Except approach
• Frangibility		No test		6.4.2.2	
d. Electrical tests	2				
• Dielectric rigidity		6.5.1		6.5.1	
• Creepage and clearance		6.5.2		6.5.2	
• Insulation resistance		6.5.3		6.5.3	
• Electrical shock		6.5.4		6.5.4	
e. Functional tests	5				
• Photometry		6.6.1.1	6.6.1.2	6.6.1.1	6.6.1.2
• Chromaticity		6.6.2		6.6.2	
f. Endurance tests	5				
• Accelerated life		6.7.1.1		6.7.1.2	
• Standard useful lamp life (10 luminaires)		6.7.2		6.7.2	

[a] Conduct watertightness test shall be carried out after each of these tests.

6.1 General test requirements

The luminaire powered by a series circuit shall be tested using constant current regulators according to IEC 61822 or using an equivalent power source providing identical or better performances from the output current stabilisation point of view.

6.2 Dimensional tests

All types of inset luminaires shall be tested to verify the dimensions in relation to Table 1 and Table 2.

All types of elevated luminaires shall be tested for their relation to the mounting interfaces as specified in 5.2.2.

6.3 Environmental tests

All tests will be done at the ambient temperature of 20 °C ± 5 °C unless otherwise specified.

6.3.1 Temperature

6.3.1.1 High temperature

The luminaire shall be installed in a normal configuration and shall be operated throughout the test with the rated current. This test shall be run with the highest wattage lamp and lowest transmissivity filter to be qualified. The luminaire is energized for 24 h continuously at the ambient temperature of 55 °C ± 2 °C. Any deterioration in the materials shall be cause for rejection.

6.3.1.2 Low temperature

6.3.1.2.1 Inset luminaires

The inset luminaire shall be 5 cm below the surface of water level. While immersed, the luminaire shall be subjected to a low temperature of –55 °C ± 2 °C for a period of 24 h. The cold period shall be followed immediately by operation at rated current for 30 min or until free from ice, whichever comes first. This shall be repeated for a total of 3 cycles. Any evidence of damage and of water in the optical chamber shall be cause for rejection.

6.3.1.2.2 Elevated luminaires

The luminaire shall be subjected to a 24 h period at –55 °C ± 2 °C and shall be operated 5 min at the beginning and 5 min after the end of the test period at the rated current and/or voltage. Any deterioration of materials shall be cause for rejection.

6.3.2 Thermal shock

6.3.2.1 Inset luminaires

The luminaire shall be subjected to an on-off cycling test (at least, 4 h on and 4 h off) by operating it at rated current and/or voltage at room temperature (dry). The luminaire shall then be de-energised and immediately submerged below 30 cm of water for at least 4 h. The temperature of the water before submersion shall be 5 °C or lower. This cycle shall be repeated a total of three times, and the luminaire shall be immediately inspected at the completion of the third cycle. Any evidence of glass breakage or lens damage, any leakage of water into the optical assembly, or damage to any part of the luminaire shall be cause for rejection.

6.3.2.2 Elevated luminaires

The luminaire shall be run with the light unit equipped with the most powerful lamp for each filter combination the fitting has been designed for and powered at the maximum current level at an ambient temperature until its temperature has stabilised. It shall then be sprayed with water at a temperature of 15 °C ± 2 °C lower than the normal ambient temperature during which no cracking, damage or functional defect shall be observed. The droplet size shall be between 2 mm and 4,5 mm and produce a rainfall of 9 m/s. The rain shall start slow and achieve 9 m/s in 15 s.

6.3.3 Corrosion

6.3.3.1 Inset luminaires

A salt fog test shall be conducted on the assembled luminaire according to IEC 60068-2-11 and IEC 60068-2-52. If the luminaire is protected by a coating, a cross shall be cut through the coating until the based metal is reached prior to running the test. Any evidence of functional damage caused by pitting or separation of the protective coating shall be reason for rejection.

6.3.3.2 Elevated luminaires

A salt fog test shall be conducted on the assembled luminaire according to IEC 60068-2-11 and IEC 60068-2-52. If the luminaire is protected by a coating, a cross shall be cut through the coating, until the base metal is reached prior to running the test. Any evidence of functional damage caused by rust, pitting or corrosion shall be reason for rejection.

6.3.4 Moisture

The elevated luminaire, with drain hole plugged, shall be tested as specified in Section 9 of IEC 60598-1 to determine the degree of protection of the luminaires. Elevated luminaires shall be at least IP24.

6.3.5 Solar radiation

A sunshine test shall be conducted on elevated luminaires according to IEC 60068-2-5 and IEC 60068-2-9 for all luminaires with non-metallic exterior parts. The material shall be subjected to a minimum of 50 cycles. At the conclusion of the test, any evidence of deterioration or alteration of the luminaire shall be cause for rejection. For plastic optical lenses or covers, the photometric performance shall be measured after this test.

6.3.6 EMC

For luminaires using other than incandescent lamps, the test shall be carried out in accordance with IEC 61000-6-2 for immunity and IEC 61000-6-4 for emission.

6.4 Structural tests

6.4.1 Inset luminaires

6.4.1.1 Static load

A static load test shall be performed on the complete inset luminaire installed on the smallest support structure as installed.

The test load shall be applied to the top part of the test assembly through a rubber block of a diameter at least 25 mm less than the outside diameter of the luminaire assembly. The thickness of the rubber block shall be between 25 mm to 40 mm and have a Shore A hardness of 55-70. The total load in kilograms to be applied shall be 32 times the area in cm^2 of the luminaire. The load shall be applied uniformly over the rubber at a rate not greater than 4 536 kg/min, the full load shall be applied for at least 1 min.

The test luminaire shall be considered unsatisfactory if there is any permanent deformation, cracking of material or finish, breaking, or damage to any part of the luminaire.

6.4.1.2 Shear load

This test is to simulate the shearing load applied to the top of any inset luminaire by a braking aircraft tire.

A bar of sufficient length to extend beyond the fixture shall be welded to the top of the luminaire so it is parallel to the runway centreline when the luminaire is installed. The ends of the bar shall extend beyond the edges of the luminaire to facilitate loading. The luminaire, attached to a standard mounting interface and torqued to manufacturer's specifications, shall be installed in a sufficient anti-rotation device. A force of 13,5 kN shall be applied axially to the end of the bar. The force shall be applied and released 20 times. Any structural damage, movement of any part, or loosening of fasteners shall be cause for rejection.

6.4.1.3 Mechanical impact

For inset luminaires, except omni-directional luminaires, the assembly shall be mounted rigidly on either a 25 mm thick steel plate or a 100 mm or more thick concrete base. The dimensions of the steel or concrete base shall be at least 1 m x 1 m. The luminaire shall be turned on at full brightness for at least 2 h prior to starting the test.

With the luminaire still on at full brightness, a case hardened steel ball with a mass of 2,3 kg shall be dropped as close as possible to the centre of the top of the luminaire, but not on any part consisting of glass, from a height of 1,80 m, 10 times with a 5 min interval between each drop, as close as possible to the centre but not over the supporting flange. The steel ball must be immediately removed after each first touch. Upon conclusion, the light fixture shall be opened to determine if the optical assembly has been damaged or any component displaced. Any evidence of damage inclusive of lamps and filament shall be cause for rejection.

6.4.1.4 Hydraulic impact

For inset luminaires, except omni-directional luminaires, the assembly shall be submerged in water to a depth of approximately 15 mm. The upper surfaces of the light fixture around the windows shall be encased in a leak-proof metal cylinder with a 45 mm diameter piston. The cylinder shall be filled with water and purged of all air beforehand. Then a steel ball weighing 2,3 kg shall be dropped onto the piston from a height of 1,80 m. The steel ball must be removed after the first touch. After repeating 5 times, the light must not have any mechanical failure, optical damage or water penetration into the optical cavity.

After this test, the luminaire shall be confirmed to satisfy the photometric test specified in 6.6.1.

6.4.1.5 Vibration

The inset luminaire with shunted light source is mounted on a test equipment and applied with the rated current and then subjected to a sinusoidal vibration along 3 mutually perpendicular axes in sequence shown below, with a frequency and an acceleration as specified in Table 5.

Vibration axes:

- Vertical;
- horizontal, parallel to the horizontal axis of the beam;
- horizontal, perpendicular to the projection .

Table 5 – Frequency and acceleration of vibration test

Sweep duration min	Maximum acceleration Gs	Frequency Hz
10	10	From 20 to 500
10	15	From 500 to 2 000
NOTE Limit amplitude to 1,2 mm.		

After the vibration test, the following items shall be confirmed:

- no loss of continuity during the test;
- no mechanical damage of the components;
- no loosening of any part or fasteners; and
- no deformation, displacement and twisting of the filament.

If the lamp on its outer surface or the filament is damaged during the test, it is replaced and the shunt is removed. Then the luminaire is applied with rated current and subjected to a vibration with a frequency range of 20 Hz to 2 000 Hz and a maximum acceleration of 3 Gs, for 20 min. After the test, the luminaire shall have no damage.

6.4.1.6 Watertightness

6.4.1.6.1 Type test

Prior to performing this test, the wire leads shall be subjected to a tension of either 14 kg or the weight of the fixture, whichever is greater, for 5 min to test the integrity of the seal where the leads enter the luminaire. The entire luminaire shall then be submerged in water at least 76 mm below the surface, subjected to an internal air pressure of 140 kPa and maintained for a period of 10 min. Any leakage shall be reason for rejection.

6.4.1.6.2 Acceptance test

Assembled luminaire equipped with the additional air inlet connected to the section to be airtight is submerged in water and subjected to an internal air pressure of 140 kPa through the inlet for 1 min. It shall be confirmed that there is no air leakage.

6.4.1.7 Surface temperature

The tests shall be conducted at the ambient temperature of 20 °C ± 2 °C on inset luminaires to demonstrate that the maximum temperature on top of the luminaire does not exceed 160 °C, when the luminaire is completely covered with a rubber block between 25 mm and 40 mm thick and a loading of at least 700 kg is placed on the luminaire for a period of 10 min. The fixture shall be mounted on its normal support structure installed in pavement or surrounded with a minimum of at least 10 cm of sand for testing.

Before this 10-min test period, the luminaire, still in air at the ambient temperature of 20 °C ± 2 °C, shall be operated at high intensity for at least 2 h. The luminaire shall use the lowest transmissivity filter to be qualified. The thermocouple shall be located between the hottest point of the luminaire and the rubber block to register the test temperature.

6.4.2 Elevated luminaires

6.4.2.1 Jet blast

The testing shall be performed with the elevated luminaire fully assembled at nominal height and mounted to a rigidly secured support structure.

The load shall be applied perpendicular to the mounting surface on the body at a point just below the lens, no faster than 220 N per minute until the minimum bending moment of 408 Nm is achieved.

For other than approach luminaires, the manufacturer shall additionally demonstrate (by wind or static loading) that, when subjected to a jet blast of 480 km/h, no part of the luminaire, mounting system or yield device is damaged, and the luminaire shall return to the original position. If a luminaire support for snow areas is offered, the luminaire shall also be tested with this mounting arrangement.

6.4.2.2 Frangibility

After it has been determined that the luminaire will sustain this jet blast load, the loading shall continue at the same rate until fracture occurs. The test shall be repeated on a total of five luminaires. Fracture shall be reached before a bending moment of 678 Nm is achieved. The yield point shall be no more than 37 mm above ground and shall give way before any other part of the fixture is damaged.

6.5 Electrical tests

6.5.1 Dielectric rigidity

The luminaire shall meet the requirements of section 10 of IEC 60598-1.

6.5.2 Creepage and clearance

The luminaire shall conform to section 11 of IEC 60598-1. The voltage shall be 2 kV a.c. peak.

6.5.3 Insulation resistance

The luminaires shall be subjected to a 500 V d.c. insulation resistance test (live parts to enclosure). The initial resistance shall be at least 50 MΩ. The luminaire assembly shall operate for 1 h at rated current. The resistance test shall be repeated. Resistance shall be at least 50 MΩ.

6.5.4 Electrical shock

The luminaire shall meet the requirements of Section 8 of IEC 60598-1.

6.6 Functional tests

6.6.1 Photometry

6.6.1.1 Type test

The luminaires shall be tested for photometric performance and shall be in accordance with the relevant figures specified in ICAO Annex 14, Volume I, Appendix 2 or Volume II. Each luminaire shall be tested with each type of filter, lamp and optical system to be used in the luminaire to ensure that it meets the intensity and chromaticity requirements.

Before carrying out photometric measurements, test equipment shall be calibrated in accordance with the relevant publications of the CIE (International Commission on Illumination).

The photometric axes are established in relation to a properly installed luminaire. The horizontal axis runs through the centre of the luminaire and is parallel to the runway centreline. The vertical axis runs through the centre of the luminaire.

Before beam intensity testing, the luminaire unit shall be energised at the rated current and/or voltage until its properties have stabilised.

For accurate measurements, the distance between the luminaire and the device used for photometric measurements should be great enough so that the inverse square law applies. The photometric test distance shall be greater than 50 times the largest dimensions of the luminaire optical aperture. In case of luminaires with less than 5 cd, a shorter test distance of less than 50 times may be applied to avoid the increase of error caused by low illumination measurement.

The photometric test shall be performed using three sets of different lamps supplied by the manufacturer installed in the same luminaire.

For omni-directional luminaires, the vertical beam spread shall be measured at least every 30 degrees of the horizontal beam width. Each reading shall meet the minimum luminous intensity requirements, and the average of each vertical «cut» shall meet the minimum average intensity requirement.

In addition to the general specifications described in the paragraph above, for inset luminaires, photometric tests shall follow the shock and hydraulic impact tests to determine if the lamp filament has sustained any damage.

If an inset luminaire is designed so that any portion of the exterior lens or prism is below the anticipated pavement level, that portion shall be obscured by opaque tape, but in the case of fixtures with means of draining the light channel, no more than half the lens area shall be blocked. The resulting intensity distribution, in the applicable colour, shall be no less than 70 % of that of the design output.

NOTE 1 The anticipated pavement level is the highest level of the pavement where the manufacturer´s instruction manual recommends a depressing of the fixture to avoid snowplow damage.

NOTE 2 The design output is the actual output of the fixture as determined by the manufacturer. Refer to Annex 14.

6.6.1.2 Acceptance test

A simplified test is authorised for an acceptance test, provided there is documented evidence that correspondence between the results of the acceptance and type testing exist.

6.6.2 Chromaticity

The luminaire fitting is operated at rated current and/or voltage until its characteristics have stabilised and then the chromaticity is measured, with a filter if designated to be equipped, and shall be confirmed to satisfy the specifications in ICAO Annex 14 Appendix 1.

6.7 Endurance tests

6.7.1 Accelerated life test

6.7.1.1 Inset luminaires

The luminaire shall be set in dry sand with at least 10 cm thick on side and bottom and sprinkled with the sand over its upper surface until covered lightly. The sand shall be cleared away from the window located above the ground level. The luminaire shall be operated for 250 h in an ambient temperature of 55 °C ± 2 °C at a rated current and then subjected to a beam luminous intensity test to confirm that the light output is in excess of 80 % of the

minimum specified luminous intensity. The luminaire shall have no evidence of deformation, blistering, heat damage or corrosion.

6.7.1.2 Elevated luminaires

The luminaire operated in an ambient temperature of 55 °C ± 2 °C shall be continuously illuminated at the rated current and/or voltage for 250 h and then subjected to a beam intensity and chromaticity test. Upon completion of testing, the luminaire unit should have a luminous intensity of at least 80 % of the minimum average value. Furthermore, the luminaire unit and its components should not be deformed, swollen, flawed by heat or corroded.

6.7.2 Standard useful lamp life test

6.7.2.1 Testing

The test shall consist of a minimum of 10 luminaires with the corresponding approved lamps installed. If additional lamps are to be tested, the tests shall be performed in multiples of 10 lamps.

Lamps shall be installed in the luminaire and tested in the configuration which simulates the actual as installed condition of the light system (e.g., inset lights should be tested with the lamp fixture installed on the smallest support structure which in turn is buried in a non-heat absorbing medium such as dry sand). For lamps using electronic power supplies, the power supplies shall be part of the test.

Where lighting system power conditioning equipment is located remote from lamp units in the field, cabling between lamp and system components shall be the shortest allowed by design.

Light system shall be operated at lamp rated voltage and/or current using an a.c. power supply having 1 % regulation. The duty cycle shall consist of 20 h lamp operating time and 4 h de-energised.

Testing shall continue until 90 % of all original lamps have reached the end of the lamp useful life or 5 000 h, whichever comes first. End of useful life may be determined by use of spot meter or photocell or other device.

Electrical service voltage and current and lamp voltage and current shall be randomly recorded using calibrated instruments during the test period to verify that control circuits are functioning and that input energy is maintained within tolerance. As a minimum, these parameters shall be checked twice a week.

A daily log shall be maintained at the test site. The log shall record the lamp condition (e.g., whether the photometric output of the lamp exceeds minimum specification requirements), date, time, comments and person performing the check.

6.7.2.2 Analysis of data

The calculation of the useful life of a lamp should be performed according to the following procedure.

- Form a list of 90 % of the original lamps which have reached the end of the useful lamp life or 5 000 h. The list should include lamp number and lamp operating time as calculated below. This information should be arranged in ascending order of lamp operating time.
- Lamp operating time is calculated by multiplying the number of full days that the lamp was operating by 20 (hours).
- Delete the lamps with the 10 % lowest lamp operating times from the calculations below.
- Calculate the mean and standard deviation for the 80 % of the lamps remaining on the list.

- If the standard deviation is greater than 50 % of the mean, delete the lamps with the 10 % highest and 10 % lowest lamp operating times from the table. Recalculate the mean and standard deviation for the remaining 60 % of the lamps in the list.
- Lamp life is the mean calculated value above, rounded to the nearest 50 h.
- When the luminaire has more than one lamp installed, if one lamp extinguishes, it shall be replaced by a new lamp to maintain the thermal environment in the luminaire. All replacement lamps shall not be part of analysis of data.

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IEC 60529, *Degrees of protection provided by enclosures (IP code)*

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standard is incomplete ❑
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