SECTION 12: ENDURANCE TEST AND THERMAL TEST

12.1 General

This section specifies requirements relating to the endurance test and thermal tests of luminaires.

12.2 Selection of lamps and ballasts

Lamps used for the tests of this section shall be selected in accordance with Annex B.

The lamps used in the endurance test are operated above their rated wattage for extended periods, and shall not be used for the thermal tests. However, it is usually convenient to retain in the thermal test for abnormal operation those lamps that have been used in the thermal test for normal operation.

If the luminaire requires a separate ballast and this is not supplied with the luminaire, a ballast shall be selected for test purposes which is typical of normal production, and which complies with the relevant ballast specification. The power delivered to a reference lamp by the ballast under reference conditions shall be within ±3 % of rated lamp power.

NOTE 1 For reference conditions, see the relevant IEC controlgear standard.

NOTE 2 In the relevant lamp performance standards, the rated wattage can still be indicated as "objective" wattage. This wording will be corrected in future editions of these standards.

12.3 Endurance test

Under conditions representing cyclic heating and cooling in service, the luminaire shall not become unsafe.

Compliance is checked by carrying out the test described in 12.3.1.

12.3.1 Test

a) The luminaire shall be mounted in a thermal enclosure with means for controlling the ambient temperature within the enclosure.

The luminaire shall be positioned on a similar supporting surface (and in the same operating position) as for the normal operation thermal test (see 12.4.1).

b) The ambient temperature within the enclosure shall be maintained within ±2 °C of (t_a + 10) °C during the test; t_a is 25 °C unless otherwise marked on the luminaire.

The ambient temperature within the enclosure shall be measured in accordance with Annex K. Ballasts for operation separate from the luminaire shall be mounted in free air, not necessarily in the thermal enclosure, and shall be operated in an ambient temperature of 25 °C ± 5 °C.

c) The luminaire shall be tested in the enclosure for a total duration of 168 h consisting of seven successive cycles of 24 h. Supply voltage as specified in item d) below shall be applied to the luminaire for the first 21 h and disconnected for the remaining 3 h of each cycle. The initial heating period of the luminaire is part of the first test cycle.

The circuit condition shall be as in normal operation for the first six cycles, and as in abnormal operation (see Annex C) for the seventh cycle. For luminaires containing an electrical motor (e.g. a fan) the abnormal condition which most adversely affects the result of the test shall be selected.

For luminaires powered via information technology communication cable, the seventh cycle is carried out with the overvoltage condition as indicated in item d) considering the over voltage as an abnormal condition.

For luminaires for which there is no abnormal condition test according to 12.5.1, the total test duration shall be 240 h (i.e. 10 × 24 cycles at normal operation). For filament luminaires, the total test duration of 240 h shall apply in all cases.

d) *During operating periods, the supply voltage for filament lamp luminaires, other than ELV, shall be 1,05 ± 0,015 times the voltage at which the rated wattage of the lamp is obtained.*

During operating periods, the supply voltage for other luminaires shall be 1,10 ± 0,015 times the rated voltage or the maximum of the rated voltage range.

For luminaires for constant voltage or constant current operation not equipped with controlgear the test shall be performed with 1,1 times the rated input constant voltage or rated input constant current as appropriate.

During operating periods, the supply voltage for class III luminaires, powered via information technology communication cable, shall be:

for cycles 1 to 6 (representing normal operation)

– *110 % of the rated input voltage of the luminaire at the relevant input port;*

for cycle 7 (representing abnormal operation)

– *130 % of the rated input voltage of the luminaire at the relevant input port for circuits greater than 5 V_{DC}, with a minimum of 7,5 V_{DC} and*

– *150 % of the rated input voltage of the luminaire at the relevant input port for circuits equal to/less than 5 V_{DC}.*

e) *If the luminaire ceases to operate because of a failure, the following shall apply.*

– *In the case of chance failure of a part of the luminaire (including the lamp), the instructions of item g) of 12.4.1 shall apply.*

– *If a thermal protective device operates during the first six cycles, the test shall be modified as follows.*

1) *For luminaires with cyclic protective devices, the luminaire shall be allowed to cool until the device resets. For luminaires with one-shot thermal protective devices (thermal links), the device shall be replaced.*

2) *For all kinds of luminaires, the test shall then be continued up to 240 h in total with the circuit and the temperature adjusted in such a way that the protective device just fails to operate. The luminaire is deemed to have failed the test if adjustment below the luminaire's rated characteristics is necessary to prevent the protective device operating.*

– *If a thermal protective device operates during the seventh (abnormal conditions) cycle, it shall either be allowed to cool, or, in the case of a one-shot device, it shall be replaced, and the test continued with the circuit and temperature adjusted in such a way that the protective device just fails to operate.*

f) *In the case of luminaires incorporating a constant light output function, the luminaire shall be operated with the output of the controlgear set to deliver the maximum output to the light source for which the luminaire has been designed.*

NOTE It is possible that the manufacturer will need to provide a specially prepared test sample.

It is considered that if a cut-out device operates during the seventh (abnormal condition) cycle, then the functioning of the intended protection has been proven.

Arrangements should be made to signal a break in operation. The effective test duration shall not be reduced as a consequence of such a break.

12.3.2 Compliance

After the test of 12.3.1, the luminaire and, for track-mounted luminaries, also the track and component parts of the track system, shall be visually inspected. No part of the luminaire shall have become unserviceable (other than as a chance failure as described in item e) of 12.3.1) and plastic ES lampholders shall not be deformed. The luminaire shall not have become unsafe and shall not have caused damage to the track system. The marking of the luminaire shall be legible.

NOTE Symptoms of possible unsafe conditions include cracks, scorches and deformation.

12.4 Thermal test (normal operation)

Under conditions representing normal service, no part of the luminaire (including the lamp), the supply wiring within the luminaire, or the mounting surface shall attain a temperature which would impair safety.

In addition, parts intended to be touched, handled, adjusted or gripped by hand while the luminaire is at operating temperature shall not be too hot for the purpose.

Luminaires shall not cause excessive heating of lighted objects.

Track-mounted luminaires shall not cause excessive heating of tracks on which they are mounted.

Compliance is checked by carrying out the test described in 12.4.1. The test conditions for measuring the track temperature shall be as given in 12.1 of IEC 60570:2003.

For luminaires containing an electrical motor, this motor shall operate as intended during the test.

12.4.1 Test

The temperature shall be measured as indicated in 12.4.2 in accordance with the following conditions.

a) The luminaire shall be tested in a draught-proof enclosure designed to avoid excessive changes in ambient temperature. A luminaire suitable for surface mounting shall be mounted on a surface as described in Annex D. An example of a draught-proof enclosure is given in Annex D, but other types of enclosure may be used if the results obtained are compatible with those that would be obtained by the use of the enclosure described in Annex D. (For ballasts separate from the luminaire, see item h) of the present subclause.)

The luminaire shall be connected to the power supply with the wiring and any materials (for example insulating sleeves) supplied with the luminaire for the purpose.

In general, connection shall be in accordance with the instructions provided with the luminaire or marked on it. Otherwise, wiring required to connect the luminaire under test to the supply and not supplied with it should be of a type representative of common practice. Such wiring not supplied with the luminaire is hereafter referred to as the test piece.

Temperature measurements shall be made in accordance with Annex E and Annex K.

b) The operating position shall be the thermally most onerous operating position which may reasonably be adopted in service. For fixed non-adjustable luminaires, a position shall not be selected if it is stated to be not permissible in instructions supplied with, or marked on, the luminaire. For settable and adjustable luminaires, the required distance from lighted objects shall be respected if marked on the luminaire, except for luminaires without provision for mechanical locking in any position, when the front rim of the reflector if any, otherwise the lamp, shall be positioned 100 mm from the mounting surface.

c) *The ambient temperature within the draught-proof enclosure shall be within the range of 10 °C to 30 °C and should preferably be 25 °C. It shall not vary by more than ±1 °C during measurements and during a preceding period long enough to affect the results.*

If, however, a lamp has temperature-sensitive electrical characteristics (e.g. a fluorescent lamp), or if the t_a rating of the luminaire exceeds 30 °C, the ambient temperature within the draught-proof enclosure shall be within 5 °C of the t_a rating and should preferably be the same as the t_a rating.

An alternative test method is given in Clause D.3. In case of doubt the test method of 12.4.1 c) shall be taken as a reference test method.

d) *The test voltage for the luminaire shall be as follows.*

- *Filament lamp luminaires other than ELV: that voltage which produces 1,05 times the rated wattage of the test lamp (see Annex B) except that heat test source (HTS) lamps are always operated at the voltage marked on the lamp.*
- *For other luminaires: 1,06 times the rated voltage or the maximum of the rated voltage range.*
- *For motors contained in luminaires: 1,06 times the rated voltage (or the maximum of the rated voltage range of the luminaire).*

Exception

For determination of the average temperature of the winding of a component with t_w marking and for the determination of the case temperature of a component with t_c marking, except capacitors, the test voltage shall be 1,00 times the rated voltage. This exception applies only to the measurement of the winding or case temperature and does not apply, for example, to the measurement of a terminal block on the same component.

Capacitors whether carrying t_c or not are tested at 1,06 times the rated voltage when operated within fluorescent and other discharge luminaires.

NOTE 1 If a luminaire contains both a filament lamp and a tubular fluorescent or other discharge lamp or a motor, it can be necessary to provide it temporarily with two separate supplies.

For luminaires for constant voltage or constant current operation not equipped with controlgear the test shall be performed with 1,1 times the rated input constant voltage or rated input constant current as appropriate.

During operating periods, the supply voltage for class III luminaires, powered via information technology communication cable, shall be:

- *106 % of the rated input voltage of the luminaire at the relevant input port.*

e) *During and immediately before a measurement, the supply voltage shall be held within ±1 % and preferably within ±0,5 % of the test voltage. The supply voltage shall be held within ±1 % of the test voltage during such preceding period as may affect the measurement; this period shall be not less than 10 min.*

f) *Measurements shall not be taken until the luminaire has stabilized thermally, i.e. temperatures are changing at a rate less than 1 °C per hour.*

g) *If the luminaire ceases to operate because of a defective part of the luminaire (including the lamp), the part should be replaced and the test continued. Measurements already made need not be repeated, but the luminaire shall be stabilized before further measurements are made. If, however, a hazardous condition has arisen, or if any part becomes unserviceable as a type defect, then the luminaire is deemed to have failed the test. If a protective device in the luminaire operates, the luminaire is deemed to have failed.*

h) *If remote controlgear/components are supplied as part of a luminaire, they shall be mounted and operated in accordance with the manufacturer's instructions. Temperatures of all parts shall comply with the limits specified by Section 12.*

If remote controlgear is not supplied as part of the luminaire, the manufacturer will provide controlgear typical of normal use. The controlgear shall be operated in free air and in an ambient temperature of 25 °C ± 5 °C. The temperature of the controlgear shall not be measured.

i) In case of doubt in the test for filament lamp luminaires, the test shall be repeated with heat test source (HTS) lamps, if available. For temperatures which are mainly governed by the cap temperature of the lamp, the values obtained by HTS lamps are decisive. For those temperatures which are mainly governed by radiation, the values obtained by normal production lamps with clear bulbs are decisive.

j) The light beam from the luminaire, for luminaires covered by 3.2.13, is directed towards a matt black painted wooden surface mounted perpendicular to the main direction of the light and similar to that described in Annex D. In case of more than one lamp is in use, the centre lamp shall be directed as specified above. All other lamps shall be directed in order to achieve a common focus. Luminaires are mounted at the distance from the surface which is marked on the luminaire.

During the tests, measurements shall be made of the temperature of certain insulating parts, as required for the tests of Section 13.

k) For the measurement of lampholder temperatures for double-capped fluorescent lamps, the hot junction of the thermocouple shall be located flush with that surface of the holder adjacent to the lamp cap. If this is not possible, it should be placed as close as possible to this point but without touching the lamp cap.

NOTE 2 The luminaire manufacturer can provide the type test sample with a thermocouple already attached to the lampholder. Usually, only one lampholder is prepared in such a way.

l) During the test for compliance, the through wiring and the looping-in wiring shall be loaded to the maximum value allowed by the size of the wire, or at a value specified by the manufacturer in the installation instructions.

NOTE 3 In the following countries, during thermal testing, both the through wiring and the looping-in wiring are required to be loaded to the maximum value allowed by the size of the wire: Canada, USA.

m) In the case of luminaires incorporating a constant light output function the luminaire shall be operated with the output of the controlgear set to deliver the maximum output to the light source for which the luminaire has been designed.

NOTE 4 It is possible that the manufacturer will need to provide a specially prepared test sample.

12.4.2 Compliance

In the test of 12.4.1, none of the temperatures shall exceed the appropriate values given in Tables 12.1 and 12.2 (subject only to the concession of item a) of this subclause) when the luminaire is operated at its rated ambient temperature t_a.

In those cases where the temperature in the test enclosure differs from t_a, this difference shall be taken into account when applying the limits in the tables (see also item c) of 12.4.1).

a) The temperature shall not exceed the values specified in Tables 12.1 and 12.2 by more than 5 °C.

NOTE The allowance of 5 °C is made to take into account the inevitable variability of temperature measurements in luminaires.

b) The temperature of any part of the luminaire liable to thermal degradation in service shall not exceed a value which corresponds to a reasonable service period for the particular type of luminaire. Generally agreed values for principal parts of luminaires are given in Table 12.1 and values for common materials, when used in luminaires, are listed in Table 12.2. These values are specified here to obtain uniform assessment; slightly different values may be quoted elsewhere on the basis of other forms of materials testing or for other applications.

If materials are used which are claimed to withstand higher temperatures than those specified in Table 12.2, or if other materials are used, they shall not be exposed to temperatures in excess of those which have been proved permissible for these materials.

c) The temperature of the test piece (see item a) of 12.4.1), if PVC-insulated, shall not exceed 90 °C (or 75 °C where it is stressed, for example clamped), or such higher temperatures as may be indicated on the luminaire or in the manufacturer's instructions supplied with the luminaire in accordance with the requirements of Section 3. The limit shall be 120 °C for any PVC-insulated wire (internal or external wiring) even when additionally protected by a heat-resisting sleeve supplied with the luminaire. The sleeve shall comply with the requirements of 4.9.2.

Table 12.1 – Maximum temperatures under the test conditions of 12.4.2, for principal parts *(1 of 2)*

Part	Maximum temperature °C
Lamp caps	As specified in the appropriate IEC lamp standard[a]
Windings in ballasts or transformers with t_w marking	t_w
Case (of capacitor, starting device, electronic ballast or convertor, etc.)	
If t_c is marked	t_c[b]
For capacitor if t_c is not marked	50
Windings in transformers, motors, etc., if the winding insulation system according to IEC 60085 is:	
– of class A material[c]	100
– of class E material[c]	115
– of class B material[c]	120
– of class F material[c]	140
– of class H material[c]	165
Insulation of wiring:	See Table 12.2 and items b) and c) of 12.4.2
Contacts of ceramic lampholders and insulating material	
of lampholders and starterholders:	
T1 or T2 marked (B15 and B22)[d] (IEC 61184)	165 for T1 and 210 for T2
Other types with T marking	
(IEC 60238, IEC 60400, IEC 60838[e] and IEC 61184)	T marking
Other types without T marking	
(E14, B15) (IEC 60238 and IEC 61184)	135
(E27, B22) (IEC 60238 and IEC 61184) (E26)	165
(E40) (IEC 60238) (E 39)	225
Fluorescent lampholder/starterholders and miscellaneous lampholders without T marking (IEC 60400 and IEC 60838 (all parts)[e])	80
Switches marked with individual ratings:	
With T marking	T marking
Without T marking	55
Other parts of the luminaire (according to material and use):	See Table 12.2 and item b) of 12.4.2

Table 12.1 *(2 of 2)*

Part	Maximum temperature °C
Mounting surface:	
Normally flammable surface	90
Non-combustible surface	Not measured
Means of adjustment and its surrounding space[f]	
Metal parts	60
Non-metal parts	75
Objects lighted by spotlights (see 12.4.1 j)):	90 (of test surface)
Track (for track-mounted luminaires)	As stated by the track manufacturer[g]
Plug-in independent controlgear, mains socket-outlet mounted luminaires:	
– case parts intended to be gripped by hand	75
– plug/socket interface	70
– all other parts	85
Replaceable glow-starting devices	80 [h]
Surface of recessed luminaires above suspended ceiling, covered with thermal insulating material	90

[a] For luminaires marked with information concerning the use of special lamps, or if it is obvious that special lamps are to be used, a higher value, as specified by the lamp manufacturer, is allowed. IEC 60357 and IEC 60682 provide information for the measurement of pinch temperature for tungsten halogen lamps. These measurements are required for performance criteria of lamps and not safety criteria of the luminaire. (Single-capped fluorescent lamps are excluded from being measured under normal operation test conditions, see Table 12.3).

This does not apply to lamps covered by the scope of IEC 60432-2. The relevant information in this document for luminaire design shall be observed.

[b] Measured at the given reference point marked by the device manufacturer.

[c] The material classification is in accordance with IEC 60085 and IEC 60216 series.

[d] Temperature measured on the rim of a corresponding cap.

[e] For bi-pin lampholders, in case of doubt, the average of the contact temperature measurements should be used.

[f] For adjustable luminaires where the mounting instructions provide clear guidance to mount out of reach, and for settable luminaires, the temperature limits for the means of adjustment are not applicable

[g] For measuring conditions for the track temperature, see 12.1 of IEC 60570:2003.

[h] This temperature limit is a performance and not a not safety recommendation.

Table 12.2 – Maximum temperatures under the test conditions of 12.4.2, for common materials used in luminaires

Part	Maximum temperature °C
Insulation of wiring (internal and external), supplied with luminaire[b]:	
Glassfibre silicone-varnish impregnated	200[a]
Polytetrafluoroethylene (PTFE)	250
Silicone rubber (not stressed)	200
Silicone rubber (compressive stress only)	170
Rubber or ordinary polyvinyl chloride (PVC)	90 [a]
Heat-resisting polyvinyl chloride (PVC)	105 [a]
Ethylene vinyl acetate (EVA)	140 [a]
Insulation of fixed wiring (as a fixed part of the installation not supplied with the luminaire) [a]:	
Unsleeved	90 [c]
Appropriate sleeving supplied with the luminaire	120
Thermoplastics:	
Acrylonitrile-butadiene-styrene (ABS)	95
Cellulose acetate butyrate (CAB)	95
Polymethyl methacrylate (acrylic)	90
Polystyrene	75
Polypropylene	100
Polycarbonate	130
Polyvinyl chloride (PVC) (where NOT used for electrical insulation)	100
Polyamide (nylon)	120
Thermosetting plastics:	
Mineral-filled phenol-formaldehyde (PF)	165
Cellulose-filled phenol-formaldehyde (PF)	140
Urea-formaldehyde (UF)	90
Melamine	100
Glassfibre-reinforced polyester (GRP)	130
Other materials:	
Resin-bonded paper/fabric	125
Silicone rubber (where NOT used for electrical insulation)	230
Rubber (where NOT used for electrical insulation)	90
Wood, paper, textiles and the like	90

[a] Reduced by 15 °C where insulation is stressed, e.g. clamped or flexed.

[b] Cable specifications usually quote different maximum temperatures but these are based on continuous operating temperatures rather than the test conditions given in this specification.

[c] This temperature is the maximum permitted under the artificial test conditions given in this table, for example draught-proof enclosure and test supply voltage above the rated value for the luminaire. It is important to note that, in some countries, the European installation standards and the European cable standards specify a temperature of 70 °C to be the maximum that PVC fixed wiring can sustain in normal continuous operation.

12.5 Thermal test (abnormal operation)

Under conditions representing abnormal service conditions (where applicable, but not representing a defect in the luminaire or misuse), parts of the luminaire and the mounting surface shall not attain excessive temperatures and the wiring within the luminaire shall not become unsafe.

NOTE Symptoms of possible unsafe conditions include cracks, scorches and deformation.

Track-mounted luminaires shall not cause excessive heating of tracks on which they are mounted.

Compliance is checked by carrying out the test described in 12.5.1.

12.5.1 Test

Temperatures of parts listed in Table 12.3 shall be measured in accordance with the following conditions.

a) The test shall be made if, during service, the luminaire could be in an abnormal condition as in cases 1), 2), 3) or 4) below, and if this condition would cause any part to be at a higher temperature than during normal operation (in which case a preliminary trial may be needed).

If more than one abnormal condition is possible, that condition which most adversely affects the results of the tests shall be selected.

The test is not applicable to fixed non-adjustable filament lamp luminaires, except in case 3) below.

1) A possibly unsafe operating position, arising other than from misuse, e.g. if by accident an adjustable luminaire is bent in the direction of the mounting surface by using a force of 30 N minimum during a short period of time and on the most unfavourable point on the luminaire.

2) A possibly unsafe circuit condition arising other than from defective manufacture or misuse; for example a circuit condition occurring at the end of the service period of a lamp or of a starter (see Annex C).

3) A possibly unsafe operation condition arising from the use of a GLS lamp in a filament lamp luminaire intended for a special lamp; e.g. if, temporarily, a special lamp is replaced by a GLS lamp of the same wattage.

4) A possible unsafe circuit condition arising from a short circuit in the secondary circuit (including the transformer itself) of a luminaire with transformer fitted for lamp voltage supply.

5) A possible unsafe condition arising from overvoltage for a luminaire powered via information technology communication cable.

Test 2) is applicable only to tubular fluorescent and other discharge lamp luminaires.

Test 4) shall be made with a short-circuit in the lampholder. During test 4), the temperature rise due to heat emanating from the lamp to the mounting surface shall be checked by the test according to item 1), while the temperature rise due to heat emanating from the transformer shall be measured with the contacts of the lampholder being short-circuited.

Luminaires containing an electrical motor are operated with the rotor locked against rotation.

In the case of the presence of one or more motors, the test should be made in accordance with the most critical condition (see Annex C).

The luminaire shall be tested under the conditions specified in items a), c), e), f), h) and l) of 12.4.1. In addition, the following shall apply.

b) The test voltage shall be as follows.

Filament lamp luminaires: as specified in item d) of 12.4.1.

Tubular fluorescent and other discharge lamp luminaires: 1,1 times the rated voltage or the maximum of the rated voltage range.

For motors contained in luminaires: 1,1 times the rated voltage (or the maximum of the rated voltage range of the luminaire).

Luminaires containing transformer/convertors during short-circuit according to test 4): between 0,9 and 1,1 times the rated supply voltage, whichever is the most unfavourable.

During operating periods, the supply voltage for class III luminaires, powered via information technology communication cable, shall be:

- *130 % of the rated input voltage of the luminaire at the relevant input port for circuits greater than 5 V_{DC}, with a minimum of 7,5 V_{DC} and*
- *150 % of the rated input voltage of the luminaire at the relevant input port for circuits equal to/less than 5 V_{DC}.*

NOTE 1 If a luminaire contains both a filament lamp and a tubular fluorescent or other discharge lamp, or a motor, it may be necessary to provide it temporarily with two separate supplies.

For luminaires for constant voltage or constant current operation not equipped with controlgear the test shall be performed with 1,1 times the rated input constant voltage or rated input constant current as appropriate.

c) *If the luminaire ceases to operate because of a defective part of the luminaire (including the lamp), the part should be replaced and the test continued. Measurements already made need not be repeated, but the luminaire shall be stabilized before further measurements are made. If, however, a hazardous condition has arisen, or if any part becomes unserviceable as a type defect, then the luminaire is deemed to have failed the test.*

If a protective device in the luminaire (for example a thermal or current cut-out of the one-shot or cycling type) operates during the test, the highest temperatures reached should be taken as the final temperatures.

d) *If the luminaire incorporates a capacitor (other than a capacitor connected directly across the supply), this capacitor shall be short-circuited, notwithstanding the requirements of Annex C, if the voltage across it under test conditions would exceed 1,25 times its rated voltage for self-healing capacitors or 1,3 times its rated voltage for non-self-healing capacitors.*

e) *Luminaires for some metal halide lamps and some high pressure sodium vapour lamps which according to the lamp specification can lead to ballast, transformer or starting device or transformer overheating are tested in accordance with item b)2) of Annex C.*

f) *In the case of luminaires incorporating a constant light output function the luminaire shall be operated with the output of the controlgear set to deliver the maximum output to the light source for which the luminaire has been designed.*

NOTE 2 It is possible that the manufacturer will need to provide a specially prepared test sample.

12.5.2 Compliance

In the test of 12.5.1, none of the temperatures shall exceed the appropriate value given in Tables 12.3, 12.4 and 12.5 by more than 5 °C when the luminaire is operated at its rated ambient temperature ta. In cases where the temperature of the test enclosure differs from t_a, the difference shall be taken into account when applying the limits given in the table.