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IS 10322-4 (1984): Luminaires, Part 4: Methods of Tests  
[ETD 24: Illumination Engineering and Luminaries]



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*Indian Standard*

SPECIFICATION FOR LUMINAIRES

**PART 4 METHODS OF TESTS**

UDC 628.94 : 620.1



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MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG  
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*Indian Standard*

## SPECIFICATION FOR LUMINAIRES

## PART 4 METHODS OF TESTS

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**AMENDMENT NO. 1 DECEMBER 2011**  
**TO**  
**IS 10322 (PART 4) : 1984 SPECIFICATION FOR LUMINAIRES**

**PART 4 METHODS OF TESTS**

*(Page 12, clause 3.3.4, Note 2)* — Insert the following new clause at the end:

**3.3.5** For the high-voltage transformers used for the test, when the output terminals are short-circuited after the output voltages have been adjusted to the appropriate test voltage, the output current shall be at least 200 mA. The over-current relay shall not trip when the output current is less than 100 mA.

Care shall be taken that the rms value of the test voltage applied is measured within  $\pm 3$  percent.

Care shall also be taken that the metal foil is so placed that no flashover occurs at the edges of the insulation.'

(ET 24)

# *Indian Standard*

## SPECIFICATION FOR LUMINAIRES

### PART 4 METHODS OF TESTS

#### 0. FOREWORD

**0.1** This Indian Standard was adopted by the Indian Standards Institution on 8 August 1984, after the draft finalized by the Illuminating Engineering and Luminaires Sectional Committee had been approved by the Electrotechnical Division Council.

**0.2** This standard ( Part 4 ) is one of the series of Indian Standards which deals with luminaires. This series consists of the following parts:

- Part 1 General requirements,
- Part 2 Constructional requirements,
- Part 3 Screw and screwless terminals,
- Part 4 Methods of tests, and
- Part 5 Particular requirements.

**0.3** In general, Parts 1, 2, 3 and 4 of this standard cover safety requirements for luminaires. The object of these parts is to provide a set of requirements and tests which are considered to be generally applicable to most types of luminaires and which can be called up as required by the detail specifications under Part 5. Parts 1, 2, 3 and 4 are thus not to be regarded as a specification by itself for any type of luminaire, and its provisions apply only to particular type of luminaires to the extent determined by the appropriate section of Part 5.

**0.4** The sections of Part 5 in making reference to any other parts of the standard, specify the extent to which that section is applicable and the order in which the tests are to be performed; they also include additional requirements as necessary. The order in which the clauses in Parts 1, 2, 3 and 4 are numbered, therefore, has no particular significance as the order in which their provisions apply is determined for each type of luminaire or group of luminaires by the appropriate section of the Parts 5. All sections of Part 5 are self-contained and therefore do not contain reference to other sections of Part 5.

**0.5** A luminaire shall comply with a section of Part 5. If, however, an appropriate section of Part 5 does not exist for a particular luminaire or



group of luminaires, the nearest applicable section of Part 5 may be used as a guide to the requirements and tests.

**0.6** This standard is intended to establish essential requirements of general nature and minimum standard for design and construction of lighting fittings in order to ensure their safe performance, good construction and high class of workmanship. This standard, therefore, along with other appropriate parts of this standard, will ultimately replace IS : 1913 ( Part 1 )-1978\*.

**0.7** In the preparation of this standard assistance has been derived from IEC Publication: 598-1 ( 1979 ): ' Luminaires Part 1 General requirements and tests ', published by International Electrotechnical Commission.

**0.8** For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test, shall be rounded off in accordance with IS : 2 - 1960†. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

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## **1. SCOPE**

**1.1** This standard ( Part 4 ) covers the methods of tests applicable to luminaires for use with tungsten filament, tubular fluorescent and other discharge lamps on supply voltage not exceeding 1 000 V.

## **2. RESISTANCE TO DUST AND MOISTURE**

**2.1 Tests for Ingress of Dust and Moisture** — The enclosure of dust-proof, dust-tight, drip-proof, rain-proof, splash-proof, jet-proof, watertight and pressure watertight luminaires shall provide the degree of protection against dust or moisture in accordance with the classification of the luminaire.

Compliance shall be checked by the appropriate tests specified in **2.1.1** to **2.1.8**.

Before the tests of **2.1.3** to **2.1.8** the luminaire complete with lamp(s) shall be switched on and brought to a stable operating temperature at rated voltage.

The water for the tests, specified in **2.1.3** to **2.1.8** shall be at a temperature of  $15 \pm 10^{\circ}\text{C}$ .

After completion of the tests, the luminaire shall withstand the electric strength test, as specified in **3** and inspection shall show:

\*Specification for general and safety requirements for luminaires: Part 1 Tubular fluorescent lamps ( *second revision* ).

†Rules for rounding off numerical values ( *revised* ).

- a) No deposit of talcum powder in dust-proof luminaires, such that if the power were conductive, the insulation would fail to meet the requirements of this standard.
- b) No deposit of talcum powder inside enclosure for dust-tight luminaires.
- c) No trace of water on live parts or on insulation where it could become a hazard for the user or surroundings, for example where it could reduce the creepage distances below the values specified in 4.
- d) No accumulation of water in drip-proof, rain-proof, splash-proof and jet-proof luminaires or their protective glasses, such as would impair safety.
- e) No trace of water entered in any part of a watertight or pressure watertight luminaire.

Fixed drip-proof, rain-proof, splash-proof and jet-proof luminaires complete with their protective translucent covers, if any, shall be mounted and wired as in normal use.

Portable luminaires, wired as in normal use, shall be placed in the most unfavourable position of normal use.

Glands, if any, shall be tightened with a torque equal to two-thirds of that applied to glands in the appropriate test specified in Part 2.

Fixing screws of covers, other than hand-operated fixing screws of glass covers, shall be tightened with a torque equal to two-thirds of that specified in Table 1 of Part 2.

Screwed lids shall be tightened with a torque having a value in newton metres numerically equal to one-tenth of the nominal diameter of the screw thread in millimetres. Screws fixing other caps shall be tightened with a torque equal to two-thirds of that specified in Table 1 of Part 2.

**2.1.1 Test** — Dust-proof luminaires ( first characteristic IP numeral 5 ) shall be tested in a dust chamber similar to that shown in Fig. 1 in which talcum powder is maintained in suspension by an air current. The chamber shall contain 2 kg of powder for every cubic metre of its volume. The talcum powder used shall pass through a square-meshed sieve whose nominal wire diameter is 50  $\mu\text{m}$  and whose nominal free distance between wires is 75  $\mu\text{m}$  and shall have a range of particle size down to and including 1  $\mu\text{m}$  with at least 50 percent by weight less than 5  $\mu\text{m}$ . It should not have been used for more than 20 tests.

The luminaire shall be hung inside the chamber, brought up to operating temperature, switched off and left for 2.5 hours. The luminaire

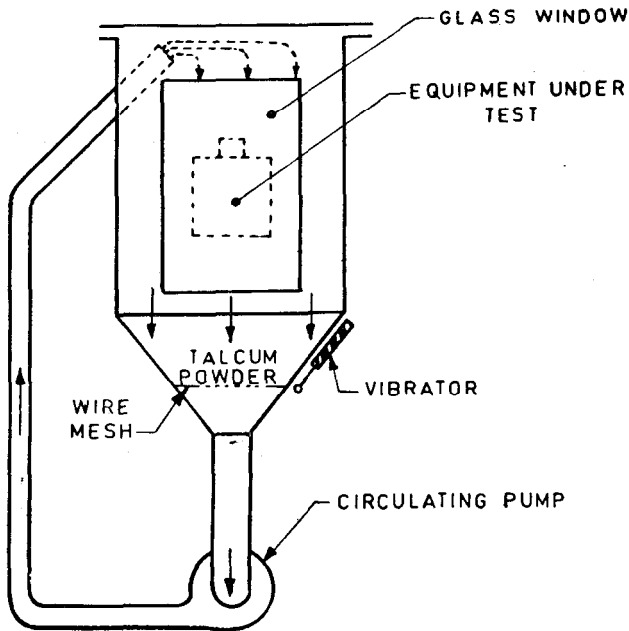


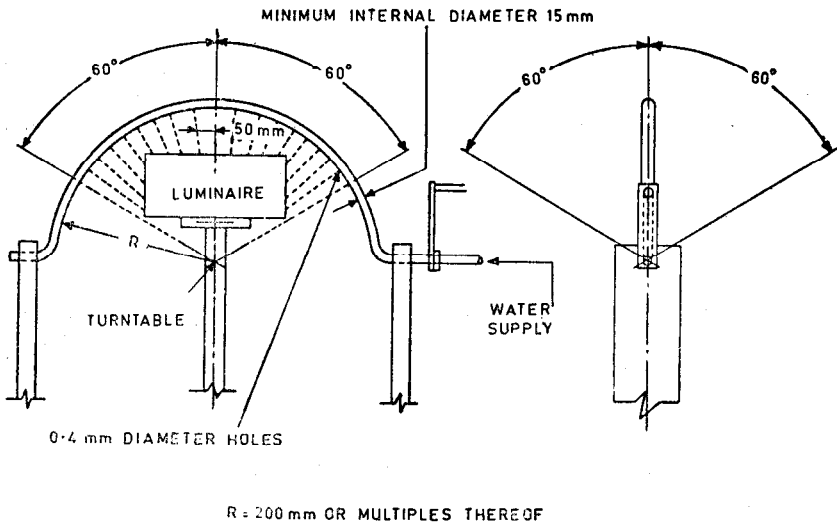
FIG. 1 APPARATUS FOR PROVING PROTECTION AGAINST DUST

is then switched on and operated under normal operating conditions for 3 hours at the conclusion of which period it is switched off and left for a further period of 2.5 hours. The total testing time is thus 8 hours.

**2.1.2 Test** — Dust-tight luminaires ( first characteristic IP numeral 6 ) shall be tested in accordance with 2.1.1.

**2.1.3 Test** — Dirp-proof luminaires (second characteristic IP numeral 1) shall be subjected for 10 minutes to an artificial rainfall of 3 mm/min, falling vertically from a height of 200 mm above the top of the luminaire.

**2.1.4 Test** — Rain-proof luminaires (second characteristic IP numeral 3) shall be sprayed with water for 10 minutes by means of a spray apparatus as shown in Fig. 2. The radius of the semi-circular tube shall be as small as possible and compatible with the size and position of the luminaire. The tube shall be perforated so that jets of water are directed towards the centre of the circle and the water pressure at the inlet of the apparatus shall be approximately 80 kN/m<sup>2</sup>.



	LUMINAIRE PROTECTION	
	Rain-proof	Splash-proof
Oscillation half-angle	$\pm 60^\circ$	$\pm 180^\circ$
Holes within half-angle	$\pm 60^\circ$	$\pm 90^\circ$

FIG. 2 APPARATUS FOR TESTING PROTECTION AGAINST RAIN AND SPLASHING

The tube shall be caused to oscillate through an angle of  $120^\circ$ ,  $60^\circ$  on either side of the vertical, the time for one complete oscillation ( $2 \times 120^\circ$ ) being about 4 seconds.

The luminaire shall be mounted above the pivot line of the tube so that the ends of the luminaire receive adequate coverage from the jets. The luminaire shall be turned about its vertical axis during the test at a rate of 1 rev/min.

After 10-minute period, the luminaire shall be switched off and allowed to cool naturally whilst the water spray is continued for a further 10 minutes.

**2.1.5 Test** — Splash-proof luminaires ( second characteristic IP numeral 4 ) shall be sprayed from every direction with water for 10 minutes by means of the spray apparatus shown in Fig. 2 and described in 2.1.4. The

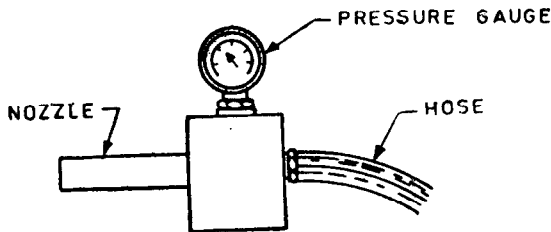
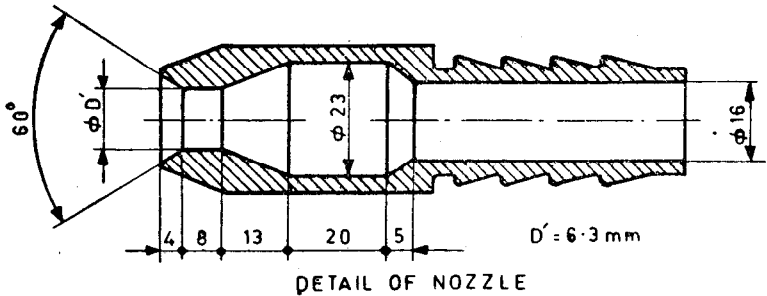
luminaire shall be mounted under the pivot line of the tube so that the turned ends of the luminaire receive adequate coverage from the jets.

The tube shall be caused to oscillate through an angle of almost  $360^\circ$ ,  $180^\circ$  on either side of the vertical, the time for one complete oscillation ( $2 \times 360^\circ$ ) being about 8 seconds. The luminaire shall be about its vertical axis during the test at a rate of 1 rev/min.

The support for the equipment under test shall be grid-shaped in order to avoid acting as a baffle. After 10-minute period, the luminaire shall be switched off and allowed to cool naturally whilst the water spray is continued for a further 10 minutes.

**2.1.6 Test** — Jet-proof luminaires ( second characteristic IP numeral 5 ) shall be switched off and immediately subjected to a water jet for 15 minutes from all directions by means of a hose having a nozzle with the shape and dimensions shown in Fig. 3. The nozzle shall be held 3 m from the sample.

The water pressure at the nozzle shall be approximately  $30 \text{ kN/m}^2$ .



All dimensions in millimetres.

FIG. 3 NOZZLE FOR SPRAY TEST

**2.1.7 Test** — Watertight luminaires ( second characteristic IP numeral 7 ) shall be completely immersed for 30 minutes in water, so that there is

at least 150 mm of water above the top of the luminaire and the lowest portion is subjected to at least 1 m head of water.

NOTE — This treatment is not sufficiently severe for luminaires intended for operation under water.

**2.1.8 Test** — Pressure watertight luminaires ( second characteristic IP numeral 8 ) shall be heated, either by switching on the lamp or by other suitable means, so that the temperature of the luminaire enclosure exceeds that of the water in the test tank be between 5 and 10°C.

The luminaire shall then be switched off and subjected to a water pressure of 1.3 times that pressure which corresponds to the rated maximum immersion depth for a period of 30 minutes.

**2.2 Humidity Test** — All luminaires shall be proof against humid conditions which may occur in normal use.

Compliance shall be checked by the humidity treatment described in 2.2.1, followed immediately by the tests of 3.

Cable entries, if any, shall be left open; if knock-outs are provided, one of them shall be opened.

Electrical components, covers, protective glasses and other parts which can be removed by hand shall be removed and subjected, if necessary, to the humidity treatment with the main part.

**2.2.1 Test** — The luminaire shall be placed in the most unfavourable position in normal use, in a humidity cabinet containing air with a relative humidity maintained between 91 and 95 percent. The temperature of the air at all places where samples can be located shall be maintained within 1°C of any convenient value  $t$  between 20 and 30°C.

Before being placed in the humidity cabinet, the sample shall be brought to a temperature between  $t$  and  $(t + 4)$ °C.

The sample shall be kept in the cabinet for 48 hours.

NOTE — In most cases, the sample may be brought to the specified temperature between  $t$  and  $(t + 4)$ °C by keeping it in a room at this temperature for at least 4 hours before the humidity treatment.

In order to achieve the specified conditions within the cabinet, it is necessary to ensure constant circulation of the air within, and in general, to use a cabinet which is thermally insulated.

After this treatment, the sample shall show no damage affecting compliance with the requirements of this standard.

### 3. INSULATION RESISTANCE AND ELECTRIC STRENGTH

**3.1** The insulation resistance and the electric strength of luminaires shall be adequate.

## IS : 10322 ( Part 4 ) - 1984

**3.1.1** Compliance shall be checked by the tests of **3.2** and **3.3** in the humidity cabinet or the room in which the sample was brought to the prescribed temperature, after reassembly of those parts which may have been removed.

**3.1.2** The switch, if any, shall be placed in the ON position for all tests, except for tests between live parts which are separated by the action of a switch.

**3.1.3** Shunt connected capacitors and capacitors between live parts and the body shall be disconnected during these tests as shall any choke or transformer connected between live parts.

**3.1.4** If it is impossible to place metal foil in position on linings or barriers, the tests shall be made on three pieces of the lining or barrier which have been taken out and placed between two metal balls having a diameter of 20 mm, which shall be pressed together with a force of 2 N.

### 3.2 Insulation Resistance Test

**3.2.1** The insulation resistance shall be measured with a dc voltage of approximately 500 V, 1 minute after the application of the voltage.

**3.2.2** The insulation resistance shall not be less than the values specified in Table 1.

**TABLE 1 MINIMUM INSULATION RESISTANCE**

INSULATION	MINIMUM INSULATION RESISTANCE ( M $\Omega$ )	
	Luminaires Other Than Class II	Class II Luminaires
Between live parts of different polarity	2	2
Between live parts which can become of different polarity through the action of a switch	2	2
Between live parts and the body*	2	4
Between accessible metal parts and metal foil on the inside of insulating linings and barriers	2	4
Basic insulation of Class II luminaires	—	2
Supplementary insulation of Class II luminaires	—	2
Bushings prescribed in Part 2 of this standard	2	4
Insulation of anchorages prescribed in Part 2 of this standard	2	2
Insulation of wire carriers or clips prescribed in Part 2 of this standard	2	2

\*The term 'body' includes accessible metal parts, accessible fixing screws and metal foil in contact with accessible parts of insulating materials.

**3.2.3** The insulation between live parts and the body of Class II luminaires shall not be tested if the basic insulation and the supplementary insulation can be tested separately.

**3.2.4** Insulating linings and barriers shall be tested only if the distance between live parts and accessible metal parts would be less than that prescribed in Part 4 were the lining or barrier not there, or if the lining or barrier is necessary to comply with the requirement of appropriate clause in Part 2 of this standard.

**3.2.5** For the tests on the insulation of bushings, cord grips, wire carriers and clips, the cable or cord shall be covered by metal foil or replaced by a metal rod of the same diameter.

**3.2.6** These requirements do not apply to starting aids which are purposely connected to the mains if they are not live parts.

NOTE — See Appendix A for a test for live parts.

### 3.3 Electric Strength Test

**3.3.1** A voltage of substantially sine-wave form, having a frequency of 50 or 60 Hz and the value specified in Table 2, shall be applied for 1 minute across the insulation.

**TABLE 2 ELECTRIC STRENGTH**

(Clauses 3.3.1 and 3.3.4)

INSULATION	TEST VOLTAGE (V)	
	Other Than Class II Luminaires	Class II Luminaires
Between live parts of different polarity	2U + 1 000	2U + 1 000
Between live parts which can become of different polarity through the action of a switch	2U + 1 000	2U + 1 000
Between live parts and the body*	2U + 1 000	2U + 3 500
Between accessible metal parts and metal foil on the inside of insulation linings and barriers	2U + 1 000	2U + 3 500
Basic insulation of Class II luminaires	—	2U + 1 000
Supplementary insulation of Class II luminaires	—	2 500
Bushings prescribed in Part 2 of this standard	2U + 1 000	2U + 3 500
Insulation of anchorage prescribed in Part 2 of this standard	2U + 1 000	2 500
Insulation of wire carriers or clips prescribed in Part 2 of this standard	2U + 1 000	2 500

U = Working voltage. Where the working voltage is 42 V or less, the test voltage shall be 500 V instead of (2U + 1 000 V).

\*The term ' body ' includes accessible metal parts, accessible fixing screws and metal foil in contact with accessible parts of insulating material (reinforced insulation of class II luminaires).



**3.3.2** Initially, no more than half the prescribed voltage shall be applied, then it is raised gradually to the full value.

**3.3.3** No flashover or breakdown shall occur during the test.

**3.3.4** These requirements do not supply to starting aids which are purposely connected to the mains if they are not live parts.

**NOTE 1** — For Class II luminaires incorporating both reinforced insulation and double insulation, care should be taken that the voltage applied to the reinforced insulation does not stress the basic insulation or the supplementary insulation more than they are stressed by the voltage specified in Table 2.

**NOTE 2** — Glow discharges which do not cause a drop in voltage ( when measured across the points of application ) should be neglected.

### **3.4 Measurement of Leakage Current**

**3.4.1** The luminaire shall be connected to a voltage equal to 1.1 times rated supply voltage at rated frequency. The current measured between each pole of the supply source and the metal body of the luminaire with and without lamps, shall not exceed the following values:

All luminaires Class 0 and Class II	0.5 mA
Portable luminaires Class I	1.0 mA
Fixed luminaires Class I	1.0 mA
up to 1 kVA rated input, increasing by 1.0 mA/kVA up to a maximum of	5.0 mA

The resistance of the measuring circuit shall be  $2\,000 \pm 50 \Omega$ .

## **4. CREEPAGE DISTANCES AND CLEARANCES**

**4.1** Live parts and adjacent metal parts shall be adequately spaced. Creepage distances and clearances shall not be less than those specified in Table 3.

**NOTE** — The minimum requirements of Table 3 are for luminaires of Class 0 and Class I which are intended for use in conditions where the risk of contamination due to condensation, dust or dirt is low. For use in other conditions where contamination may occur due to the nature of the work or surroundings, extra care is necessary in the protection of live parts and their insulation.

**4.2 Test** — Compliance shall be checked by measurement made with and without conductors of the largest section connected to the terminals of the luminaires.

The contribution to the creepage distance over the surface of any groove less than 1 mm wide shall be ignored when measuring the total surface path.

Any part of the sealing compound protruding beyond the end of the cavity containing a live part shall be ignored in Item 6(b) of Table 3.

TABLE 3 CREEPAGE DISTANCES AND CLEARANCES

( Clauses 4.1 and 4.2 )

CREEPAGE DISTANCES AND CLEARANCES IN MILLIMETRES BETWEEN	LUMINAIRES OF CLASSES 0 AND I				LUMINAIRES OF CLASS II			LUMI- NAIRES OF CLASS III
	24	250	500*	1 000*	24	250	500	
	(V)	(V)	(V)	(V)	(V)	(V)	(V)	
Working voltage ( not exceeding )	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
i) Live parts of different polarity	2	3	4	6	2	3	4	2
ii) Live parts and accessible metal parts, also between live parts and the outer accessible surface of in- sulating parts ( this may be the outer surface of the luminaire if of insula- ting material )								
Creepage	2	4	5	6	2	8	10	2
Clearance	2	3	5	6	2	8	10	2
iii) Parts which may become live due to the breakdown of functional insulation in luminaires of Class II and accessible metal parts	—	—	—	—	2	4	5	—
iv) The outer surface of a flexible cord or cable and accessible metal to which it is secured by means of a cord grip, cable carrier or clip of insulating material	—	—	—	—	—	4	5	—
v) Live parts of switches mounted in luminaires and adjacent metal parts, after the removal of the insulating lining ( if any ) in the vicinity of the switch	—	2	—	—	—	4	—	—
vi) Live parts and other metal parts between them and the supporting surface ( ceiling, wall, table, etc ) or between live parts and the suppor-								

( Continued )

TABLE 3 CREEPAGE DISTANCES AND CLEARANCES — *Contd*

CREEPAGE DISTANCES AND CLEARANCES IN MILLIMETRES BETWEEN	LUMINAIRES OF CLASSES 0 AND I				LUMINAIRES OF CLASS II			LUMI- NAIRES OF CLASS III	
	24 (V)	250 (V)	500* (V)	1 000* (V)	24 (V)	250 (V)	500 (V)		
Working voltage ( not exceeding )	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
ting surface where there is no intervening metal:									
a) with no covering over the live part	2	6	8	10	2	8	10	2	
b) through sealing com- pound with a thick- ness of not less than 2.5 mm	—	4	6	8	—	6	8	—	

\*These values are working voltages and therefore they do not conflict with the 250 V limit for rated voltage of Class 0 luminaires.

NOTE 1 — Internal creepage distances in permanently sealed components are not measured. Examples of permanently sealed components are components sealed-off or compound filled.

NOTE 2 — The value in the table do not apply to components for which separate Indian Standards exist, but apply only to the mounting distances in the luminaire.

NOTE 3 — In the case of starting transients up to 5 000 V peak, a 50 percent increase in the values given in the table is applicable.

NOTE 4 — Supply cables not supplied with the luminaire are not tested.

## 5. MECHANICAL STRENGTH TEST

**5.1** The luminaires shall be tested for the adequate mechanical strength by the following method.

**5.2 Tests** — Blows shall be applied to the sample by means of the spring-operated impact test apparatus shown in Fig. 4 or by other suitable means giving equivalent results.

NOTE — Equivalent impact energies obtained by different methods do not necessarily give the same test result.

**5.2.1** The apparatus consists of three main parts, the body, the striking element and the spring-loaded release cone.

**5.2.2** The body comprises the housing, the striking element guide, the release mechanism and all parts rigidly fixed thereto. The mass of the assembly shall be 1.25 kg.

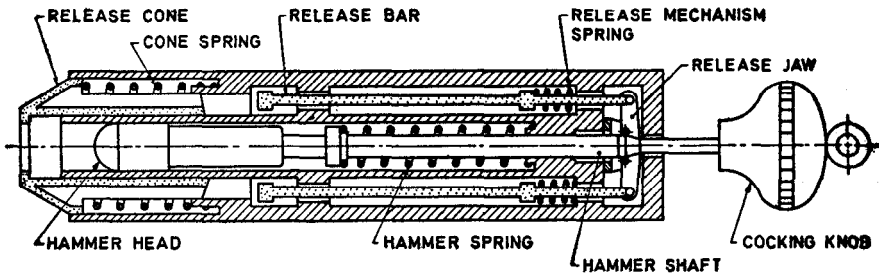


FIG. 4 IMPACT TEST APPARATUS

5.2.3 The striking element comprises the hammer head, the hammer shaft and the cocking knob. The mass of this assembly shall be 0.25 kg.

5.2.4 The hammer head shall have a hemispherical face of polyamide having a rockwell hardness of R100, with a radius of 10 mm; it shall be fixed to the hammer shaft in such a way that the distance from its tip to the plane of the front of the cone when the striking element is on the point of release, is equal to the value shown for the compression in Table 4.

TABLE 4 IMPACT ENERGY AND SPRING COMPRESSION

(Clauses 5.2.4 and 5.2.6)

PART TO BE TESTED	IMPACT ENERGY (Nm)	COMPRESSION (mm)
(1)	(2)	(3)
<i>Class II Luminaires</i>		
Translucent covers forming part of the protection against dust and moisture, but not providing protection against electric shock	0.35	17
Translucent covers providing protection against electric shock	0.50	20
Other parts	0.70	24
<i>Other Luminaires</i>		
Translucent covers forming part of the protection against dust and moisture, but not providing protection against electric shock, parts of ceramic material and parts of ceramic lamp-holders integral with the luminaire	0.20	13
Translucent covers providing protection against electric shock and other parts, with the exception of parts of ceramic material	0.35	17

NOTE — Translucent covers, neither providing protection against electric shock nor forming part of the protection against dust and moisture, are not subjected to the test.

**5.2.5** The cone shall have a mass of 0.06 kg and the cone spring shall be such that it exerts a force of 20 N when the release jaws are on the point of releasing the striking element.

**5.2.6** The hammer spring shall be such that the product of the compression in millimetres and the force exerted in newtons, equals 1 000, the compression being approximately 20 mm. The spring shall be adjustable so as to cause the hammer to strike with an impact energy and spring compression as shown in Table 4.

**5.2.7** The release mechanism springs shall be adjusted so that they exert just sufficient pressure to keep the release jaws in the engaged position.

**5.2.8** The apparatus is cocked by pulling the cocking knob back until the release jaws engage with the groove in the hammer shaft.

**5.2.9** The blows shall be applied by pushing the release cone against the sample in a direction perpendicular to the surface at the point to be tested.

**5.2.10** The pressure shall be slowly increased so that the cone moves back until it is in contact with the release bars, which then move to operate the release mechanism and allow the hammer to strike.

**5.2.11** The sample is mounted or supported as in normal use on a rigid wooden board, cable entries being left open, knockouts opened, and cover-fixing and similar screws lightened with a torque equal to two-thirds of that specified in Table 1 of Part 2 of this standard.

**5.2.12** Three blows shall be applied to the point which is likely to be the weakest, paying special attention to insulating material enclosing live parts and to bushings of insulating material, if any. Additional samples may be necessary to find the weakest point; in case of doubt, the test shall be repeated on a fresh sample to which only three blows are applied.

**5.2.13** After the test, the sample shall show no damage, in particular:

- a) live parts shall not have become accessible;
- b) the effectiveness of insulating linings and barriers shall not have been impaired;
- c) the sample shall continue to afford the degree of protection against ingress of dust and moisture, in accordance with its classification; and
- d) it shall be possible to remove and replace external covers without these covers or their insulating linings breaking.

Breakage of an enclosure is, however, allowed if its removal does not impair safety.

**5.2.14** If a translucent cover of a Class II luminaire that forms part of the protection against electric shock fails the impact energy test at 0.50 Nm, a further three samples shall be subjected to an impact energy test at 0.50 Nm and two of these samples shall pass the second test.

**5.2.15** Damage to the finish, small dents which do not reduce creepage distances or clearances below the value specified in 4, and small chips which do not adversely affect the protection against electric shock, dust or moisture, are neglected.

## **6. ENDURANCE TEST AND THERMAL TEST**

### **6.1 Selection of Lamps and Ballasts**

**6.1.1** Lamps used for the tests of this clause shall be selected in accordance with Appendix B.

**6.1.2** The lamps used in the endurance test are operated above their rated wattage for extended periods and should 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.

**6.1.3** 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  $\pm 3$  percent of objective lamp power.

NOTE - For reference conditions [ see IS : 1534 ( Part 1 )-1977\* ].

### **6.2 Endurance Test**

**6.2.0** Under conditions representing cyclic heating and cooling in service, the luminaire shall not become unsafe or fail prematurely. Compliance shall be checked by carrying out the test described in 6.2.1.

#### **6.2.1 Test**

- a) The luminaire shall be mounted in a thermal enclosure with means for controlling the ambient temperature within the thermal 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 6.3.1 ).

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\*Specification for ballasts for tubular fluorescent lamps: Part 1 For switch start circuits ( second revision ).

- b) The ambient temperature within the enclosure shall be maintained within  $\pm 2^\circ\text{C}$  of  $(t_a + 10)^\circ\text{C}$  during the test.  $t_a$  is  $25^\circ\text{C}$ , unless otherwise marked on the luminaire. The initial heating period of the luminaire is included as part of the test duration.

The ambient temperature within the enclosure shall be measured in accordance with Appendix C. 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  $25 \pm 5^\circ\text{C}$ .

- c) The luminaire shall be tested in the enclosure for a total duration of 168 hours, made up of seven successive cycles of 24 hours. Supply voltage, as described in 6.2.1 (d) shall be applied to the luminaire during each cycle, except that the luminaire shall be switched off for a continuous period of 3 hours at approximately the same point in each of the 24 hour-cycles.

The circuit condition shall be as in normal operation for the first six cycles, and abnormal operation for the seventh cycle.

For luminaires for which there is no abnormal condition, for example, fixed non-adjustable filament lamp luminaires, the total test duration shall be 240 hours ( that is  $10 \times 24$  cycles at normal operation ).

- d) During operating periods, the supply voltage for filament lamp luminaires shall be  $1.05 \pm 0.015$  times the voltage at which the rated wattage of the lamp is obtained and  $1.10 \pm 0.015$  times rated voltage for tubular fluorescent and other discharge lamp luminaires.
- e) If the luminaire ceases to operate because of chance failure of a part of the luminaire ( including the lamp ), the instructions in 6.3.1 (g) shall apply.

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. If a protective device in the luminaire ( for example, a thermal or current cut-out ) operates, the device shall be effectively short-circuited and the test shall be continued.

**6.2.2 Compliance** — After the test of 6.2.1, the luminaire shall be visually inspected. No part shall have become unserviceable ( other than as a chance failure as permitted in 6.2.1(e) and the luminaire shall not have become unsafe. The marking shall be legible.

Symptoms of possible unsafe deterioration include cracks, scorches and deformation.

**6.3 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.

Compliance shall be checked by carrying out the test described in **6.3.1**.

**6.3.1 Test** — Temperature shall be measured as indicated in **6.3.2** in accordance with the following conditions:

- a) The luminaire shall be tested on a mounting surface which is suspended in a draught-proof enclosure so designed to avoid excessive changes in ambient temperature. The mounting surface and an example of a draught-proof enclosure are given in Appendix 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 Appendix D [ For ballasts separate from the luminaire [ see **6.3.1** (h) ].

The luminaire shall be connected to the power supply with 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 thereafter referred to as the test piece.

Temperature measurements shall be made in accordance with the Appendices C and E.

- 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.
- c) The ambient temperature within the draught-proof enclosure shall be within the range 10 to 30°C and should preferably be 25°C. It shall not vary by more than  $\pm 1^\circ\text{C}$  during measurements and during a preceding period long enough to affect the results.



If, however, a lamp has temperature-sensitive electrical characteristics ( for example, a fluorescent lamp ), or if the  $t_a$  rating of the luminaire exceeds  $30^\circ\text{C}$ , the objective ambient temperature shall be within  $5^\circ\text{C}$  of the  $t_a$  rating, and should preferably be as the  $t_a$  rating.

- d) The test voltage for the luminaire shall be as follows:

Filament lamp luminaires: That voltage which produces 1.05 times, the rated wattage of the test lamp ( *see* Appendix B ) except that heat test source ( H. T. S. ) lamps are always operated at the voltage marked on the lamp.

Tubular fluorescent and other discharge lamp luminaires: 1.06 times the rated voltage.

**Exemption:**

For determination of the average winding temperature of a component with  $t_w$  marking, the test voltage shall be same as the rated circuit voltage. This exemption does not apply, for example, to measurement of a terminal block on the same component.

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

- e) During and immediately before a measurement, the supply voltage shall be held within  $\pm 1$  percent and preferably within  $\pm 0.5$  percent of the test voltage. The supply voltage shall be held within  $\pm 1$  percent of the test voltage during such preceding period as may affect the measurement; this period shall not be less than 10 minutes.
- f) Measurements shall not be taken until the luminaire has stabilized thermally, that is, temperatures are changing at a rate less than  $1^\circ\text{C}$  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 ( for example, thermal or current cut-out of the one-shot or cycling types ) operates, the luminaire is deemed to have failed.

- h) Ballasts for operation separate from the luminaire shall be operated in free air and shall be operated in an ambient temperature of  $25 \pm 5^\circ\text{C}$ . If a separate ballast is supplied with the luminaire, temperatures of the ballast shall be measured and shall comply with the same limits as incorporated ballasts. If a separate ballast is not supplied with the luminaire, the temperatures of the test ballast shall not be measured.
- j) In case of doubt in the test for filament lamp luminaires, the test shall be repeated with heat test source (H.T.S.) lamps, if available. For temperatures which are mainly governed by the cap temperature of the lamp, the values obtained by H. T. S. lamps are decisive. For those temperatures which are mainly governed by radiation, the values obtained by normal production lamps with clear bulbs are decisive.
- k) The light beam from spotlights and similar luminaires is directed towards the matt black painted wooden vertical surface similar to that described in Appendix D. Luminaires are mounted at a 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 in 7.

**TABLE 5 MAXIMUM TEMPERATURES UNDER THE TEST CONDITIONS FOR PRINCIPAL PARTS**

( Clause 6.3.2 )

PART	MAXIMUM TEMPERATURE ( °C )
<b>Lamp caps:</b>	
ES, BC types: junction with glass cemented caps	210*
Mechanically locked ( lamp life $> 3\ 000$ h )	250
Mechanically locked ( lamp life $\geq 3\ 000$ h )	275
Halogen types: pinch temperature	Value under consideration
<b>Winding ( ballast, transformer ):</b>	
If $t_w$ is marked	$t_w$
If $t_w$ is not marked ( paper interleaved )	95
If $t_w$ is not marked ( not separated by paper )	85
<b>Starter canister:</b>	†

( Continued )

**TABLE 5 MAXIMUM TEMPERATURE UNDER THE TEST CONDITIONS FOR PRINCIPAL PARTS — Contd**

PART	MAXIMUM TEMPERATURE ( °C )
Capacitor case:	
If $t_c$ is marked	$t_c$
If $t_c$ is not marked	50
Insulation of wiring	[ see Table 6 and 6.3.2(b) and 6.3.2(c) ]
Insulating material ( other than ceramic ) of lampholders:	
E14 and B15	135
E26, E27 and B22	165
E39 and E40	225
Switches marked with individual ratings:	
Without T marking	55
With T marking	T
Other parts of the luminaire: ( according to material and use )	[ see Table 6 and 6.3.2(b) ]
Mounting surface:	
Normally flammable surface	90
Non-combustible surface	Not measured
Parts intended to be handled or touched frequently†:	
Metal parts	70
Non-metal parts	85
Parts intended to be gripped by hand:	
Metal parts	60
Non-metal parts	75
Objects lighted by spotlights [ see 6.3.5( k ) ]	90 ( of the test surface )

\*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.

†Value under consideration.

‡Not applicable to parts intended only to be touched occasionally during adjustment, for example parts of spotlights.

**TABLE 6 MAXIMUM TEMPERATURES UNDER THE TEST CONDITIONS FOR COMMON MATERIALS USED IN LUMINAIRES**

( Clause 6.3.2 )

MATERIAL	MAXIMUM TEMPERATURE ( °C )
Insulation of wiring ( internal and external, supplied with luminaire ):	
Glassfibre silicon-varnish impregnated	200*
Polytertrafluoroethylene ( PTFE )	250
Silicone rubber ( not stressed )	200
Silicone rubber ( compressive stress only )	170
Ordinary polyvinyl chloride ( PVC )	90†
Heat-resisting polyvinyl chloride ( PVC )	105
Ethylene vinyl acetate ( EVA )	140
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	70

\*Reduced by 15°C where insulation is stressed, for example, lamped or flexed.

†Cable specifications usually quote 70°C *Max*, for ordinary grade PVC. The value of 90°C is justified, however, because of the special conditions under which luminaires are tested for relatively short periods even for "normal operation", for example, draught-proof enclosure and test supply voltage above the rated value for the luminaire.

**6.3.2 Compliance** — In the test of **6.3.1** none of the temperatures shall exceed the appropriate values given in Tables 5 and 6 ( subject only to the concession of **6.3.2(a)**, 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 6.3.1(c)* ].

- a) The temperatures shall not exceed the values shown in Tables 5 and 6 by more than 10°C. If the temperature of any part exceeds the value shown in tables by 10°C or less, the test shall be repeated, the luminaire measuring devices, including thermocouples, being dismantled and reassembled before retesting.

Then, the temperature of the mounting surface shall not exceed the value shown in the table and the temperature of any other part shall not exceed the value shown in the table by more than 5°C.

*NOTE* — The allowance of 10°C and repetition of the test with an allowance of 5°C are 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 5 and values for common materials, when used in luminaires, are listed in Table 6. These values are prescribed 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 used are claimed to withstand higher temperatures than those shown in Table 6, 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 6.3.1(a)* ] of 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 in **6** of Part 2 of this standard. The limit shall be 120°C for a wire in a heat-resisting sleeve supplied with the luminaire.

**6.4 Thermal Test ( Abnormal Operation )** — Under conditions representing abnormal service conditions ( where applicable; but not

representing a defect in the luminaire or misuse ), no part of the luminaire, the supply wiring within the luminaire or the mounting surface, shall become unsafe.

Compliance shall be checked by carrying out the test described in 6.4.1.

**6.4.1 Test** — Temperatures of parts listed in Table 7 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 (i), (ii) or (iii) below, and if this condition would cause any part to be at a higher temperature than during normal operation ( for which a preliminary trial may be needed ).

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

The test is not applicable to fixed non-adjustable filament lamp luminaires except in case of (iii) below:

- i) A possibly unsafe operating position arising other than from misuse; for example, if by accident an adjustable luminaire is bent close to the supporting surface.
- ii) 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 of a starter ( see Appendix F ).
- iii) A possibly unsafe operation condition arising from the use of a GLS lamp in a filament lamp luminaire intended for a special lamp; if, temporarily, a special lamp is replaced by a GLS lamp of the same wattage.

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

The luminaire shall be tested under the conditions specified in (a), (c), (e), (f) and (h) of 6.3.1. In addition the following shall apply:

- b) The test voltage shall be as follows:

Filament lamp luminaires — as specified in 6.3.1(d). Tubular fluorescent and other discharge lamp luminaires — 1.10 times the rated voltage.

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

- 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 types ) operates during the test, the highest temperature reached should be taken as the final temperatures.


- d) If the luminaire incorporates a capacitor ( other than a capacitor connected directly across the supply ), the capacitor shall be short-circuited, notwithstanding the requirements of Appendix F 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.

**6.4.2 Compliance** — In the test of **6.4.1**, none of the temperatures shall exceed the appropriate value as given in Table 7 [ subject only to the concession of **6.4.2(a)** ], when the luminaire is operated at its rated temperature  $t_a$ . In those cases where the temperature of the test enclosure differs from  $t_a$ , the difference shall be taken into account when applying the limits in the table.

- a) The temperatures shall not exceed the values shown in Table 7 by more than 10°C. If the temperature of any part exceeds the value shown in Table 7 by 10°C or less, the test shall be repeated, the luminaire measuring devices, including thermocouples, being dismantled and reassembled before retesting. Then, the temperature of the mounting surface shall not exceed the value shown in Table 7 and the temperature of any other part shall not exceed the value shown in Table 7 by more than 5°C.

## 6.5 Thermal Test ( Failed Ballast or Transformer Conditions )

These tests apply only to luminaires marked with the  symbol



and incorporating ballasts and transformers which, during failure of the winding or windings, may cause overheating of the mounting surface. These tests do not apply where the  symbol requirements are met by

spacing the ballasts and transformers from the mounting surface in accordance with the requirements of **16.2.1** and **16.2.2** of Part 2 of this standard.

These requirements and tests are based on the assumption that during failure of the ballast or transformer, for example, owing to short-

circuited windings or a short-circuit to the case, the ballast or transformer winding will not exceed 350°C for a duration of more than 15 minutes and, therefore, the temperature of the mounting surface will not exceed 180°C for a duration of more than 15 minutes.

**TABLE 7 MAXIMUM TEMPERATURES UNDER THE TEST CONDITIONS**  
( Clause 6.4.2 )

PART	MAXIMUM TEMPERATURE ( °C )
<b>Winding ( ballast, transformer ):</b>	
If $t_w$ is not marked	170*
If $t_w$ is marked:	
$t_w$ 90	170
95	177
100	185
105	193
110	200
115	208
120	216
125	223
130	230
<b>Capacitor case:</b>	
If $t_c$ is not marked	60
If $t_c$ is marked	$t_c + 10$
<b>Mounting surface:</b>	
Normally flammable surface ( filament lamp luminaires )†	175
Normally flammable surface ( luminaires symbol )	130
 symbol )	
Non-combustible surface ( luminaires without  symbol )	Not measured

\*Applies to paper interlayered windings and those not separated by paper.

†Excluding luminaires incorporating transformers.

**6.5.1 Test for Luminaires Without Thermal Cut-outs** — The luminaire shall be tested under the conditions specified in (a), (c), (e), (f) and (h) of 6.3.1. In addition, the following also apply:

20 percent of the lamp circuits in the luminaire, and not less than one lamp circuit, shall be subjected to abnormal conditions ( see Appendix F ).

The circuits which have the most thermal influence on the mounting surface shall be chosen and other lamp circuits shall be operated at rated voltage under normal conditions.

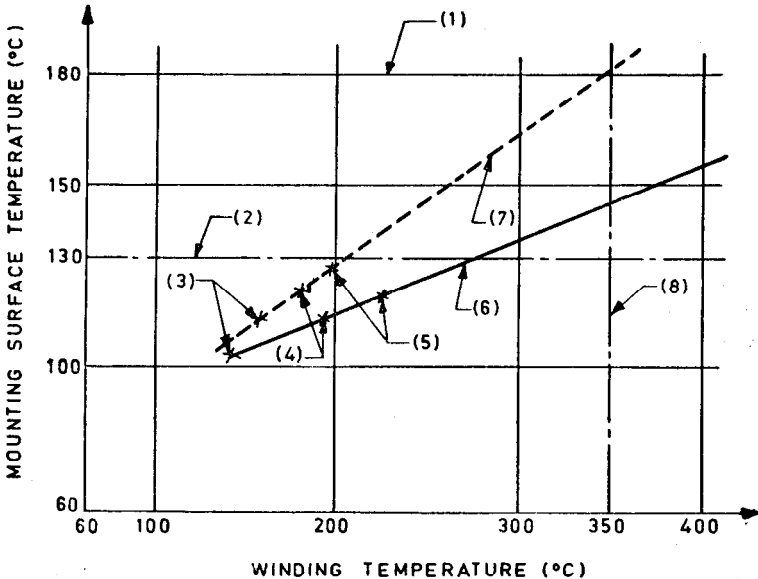
The circuits subjected to abnormal conditions shall be operated at 0.9, 1.0 and 1.1 times rated the voltage. When conditions are stable at



each of these three test voltages, the highest winding temperature and highest temperature of any part of the mounting surface shall be measured.

**6.5.1.1 Compliance** — After the test of 6.5.1:

- a) The temperature of the mounting surface shall not exceed 130°C when the lamp circuits subjected to abnormal conditions, is ( are ) operated at 1.1 times the rated voltage.



**Explanation of points on the graph**

- (1) Limiting value of mounting surface temperature in case of failed winding.
- (2) Limiting value of mounting surface temperatures during abnormal operation at 1.1 times rated voltage [ see 6.5.1.1(a) ].
- (3) } Measuring points at 0.9, 1.0 and 1.1 times rated voltage respectively
- (4) } [ see 6.5.1.1(b) ].
- (5) }
- (6) Straight line drawn through three measuring points and indicating a satisfactory luminaire as the extrapolation of the line to a winding temperature of 35°C is below a mounting surface temperature of 180°C.
- (7) Straight line drawn through three measuring points and indicating a luminaire which fails the test because the extrapolation of the line exceeds a mounting surface temperature of 180°C before reaching a winding temperature of 350°C.
- (8) Assumed maximum value of the winding temperature of a failed winding.

FIG. 5 GRAPH AS PER CLAUSE 6.5.1.1

- b) The values of the temperatures measured at 0.9, 1.0 and 1.1 times the rated voltage are plotted on a graph ( See Fig. 5 ) and the best straight line is drawn through these points. The extrapolation of this straight line shall not reach a point representing a mounting surface temperature of 180°C at a ballast or transformer-winding temperature of less than 350°C.

**6.5.2 Test for Luminaires with Thermal Cut-outs External to the Ballast Transformer** — The luminaire shall be set up for this test as described in 6.5.1.

The circuits subjected to abnormal conditions shall be operated with slowly and steadily increasing current through the windings until the thermal cut-out operates. Time intervals and increments in current shall be such that thermal equilibrium between winding temperatures and mounting surface temperatures is achieved as far as is practicable. During the test, the highest temperature of any part of the surface on which the luminaire is mounted shall be continuously measured. This completes the test for luminaires fitted with thermal links.

For luminaire fitted with manual-reset thermal cut-outs, the test shall be repeated six times allowing a 30 minutes interval between tests. At the end of each 30 minutes interval, the cut-out shall be reset.

For luminaires fitted with auto-reset thermal cut-outs, the test shall be continued until a stable mounting surface temperature is achieved.

**6.5.2.1 Compliance** — The highest temperature of any part of the mounting surface shall not exceed 180°C at any time during tests for thermal links and manual-reset thermal cut-outs, or 130°C during test for auto-reset thermal cut-outs.

## 7. RESISTANCE TO HEAT, FIRE AND TRACKING

**7.1 Resistance to Heat** — External part of insulating material providing protection against electric shock, and retaining live parts in position shall be sufficiently resistant to heat.

**7.1.1 Test** — Compliance shall be checked by the following test:

The test is not made on parts of ceramic material or on the insulating of wiring.

The test shall be made in a heating cabinet having a temperature of  $25 \pm 5^\circ\text{C}$  in excess of the operating temperature of the relevant part determined during the temperature test ( normal operation ) of 6 with a minimum temperature of 125°C when parts retaining live parts in position are tested.

The surface of the part to be tested shall be placed in the horizontal position and a steel ball of 5 mm diameter pressed against this surface with a force of 20 N. A suitable apparatus for this test is shown in Fig. 6. If the surface under test bends, the part where the ball presses should be supported.

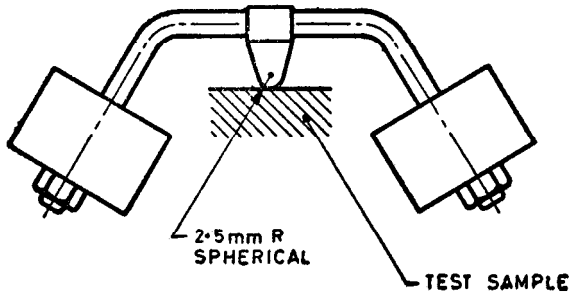


FIG. 6 BALL-PRESSURE APPARATUS

After 1 hour the ball shall be removed from the sample and the sample shall be cooled by immersion in cold water for 10 s. The diameter of the impression shall be measured and shall not exceed 2 mm.

## 7.2 Resistance to Flame and Ignition

**7.2.0** Parts of insulating material retaining live parts in position and external parts of insulating material providing protection against electric shock shall be resistant to flame and ignition.

**7.2.1** Parts of insulating material retaining live parts in position shall withstand the following tests:

The parts to be tested are subjected for 10 s to a butane gas flame (at least 95 percent purity)  $12 \pm 2$  mm long from a burner consisting of a tube having a bore of  $0.5 \pm 0.1$  mm. The test is conducted in still air and at least half the flame shall be applied to the sample.

Any self-sustaining flame shall extinguish within 30 s of removal of the gas flame and any burning drop from the sample shall not ignite a piece of cotton gauze, consisting of five layers, spread out horizontally 500 mm below the test sample.

The requirements of this clause do not apply in those cases where the luminaire provides an effective barrier to burning drops.

**7.2.2** Parts of insulating material which do not retain live parts in position but which provide protection against electric shock, shall withstand the following tests:

Parts are subjected to a test using an electrically heated conical mandrel in an apparatus shown in Fig. 7.

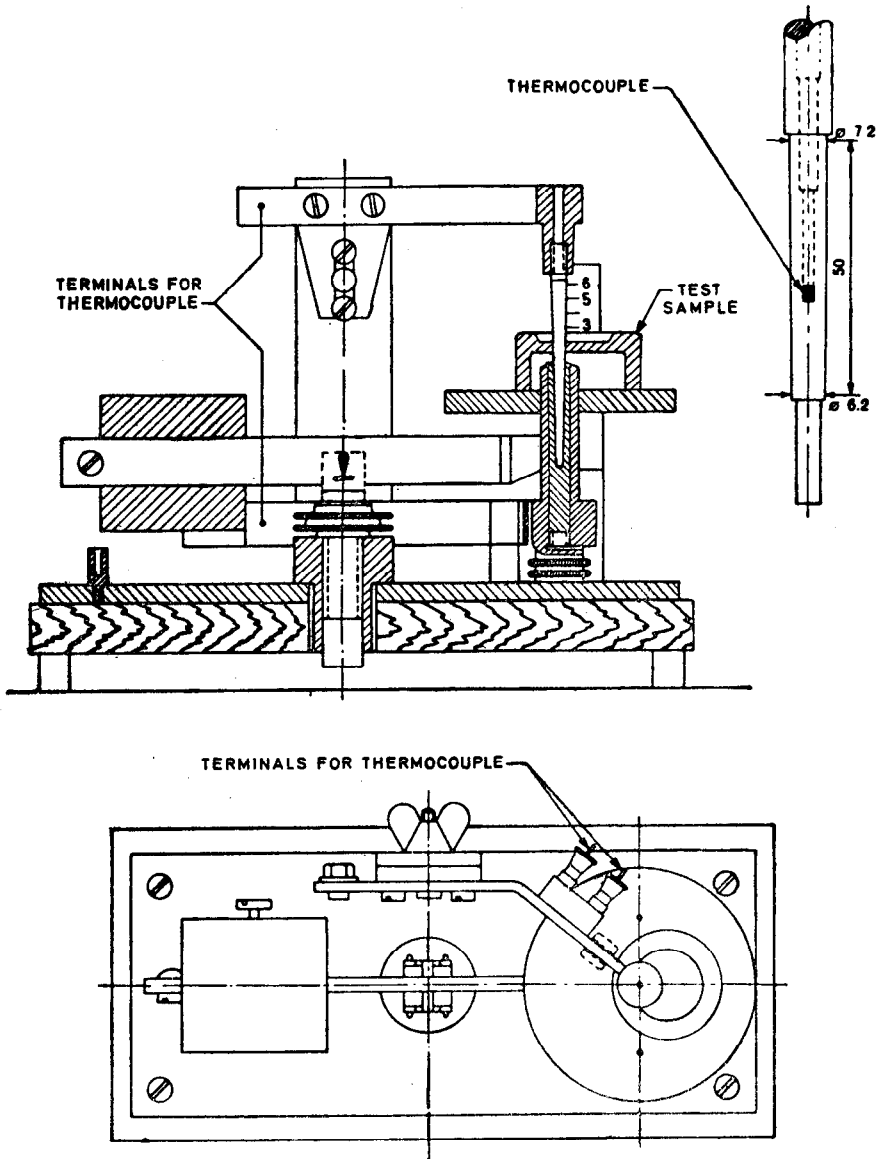


FIG. 7 HOT MANDREL APPARATUS

The mandrel is inserted into a conical hole reamed in the part to be tested in such a way that portions of the conical part of the mandrel of equal lengths protrude from both sides. The sample is pressed against the mandrel with a force of 12 N. The means by which the force is applied is then locked to prevent any further movement. The mandrel is heated to 300°C in approximately 3 minutes and this temperature is maintained within  $\pm 10^\circ\text{C}$  for 2 minutes and is measured by means of a thermo-couple inside the mandrel. During the test, sparks of about 6 mm in length are produced at the upper surface of the sample where the mandrel protrudes, by means of a high-frequency spark generator.

Neither the sample nor any gas produced during the heating shall be ignited by the sparks.

The spark generator shall produce only sufficient energy for this purpose. It shall not ignite an unheated sample.

The test is not made on parts of ceramic material.

**7.2.3** Parts of insulating material which are not included in **7.2.1** or **7.2.2**, for example, covers, shades or the like, shall:

- a) withstand the 300°C hot mandrel test of **7.2.2**.
- b) comply with the spacing requirements of appropriate clause in Part 2 of this standard.

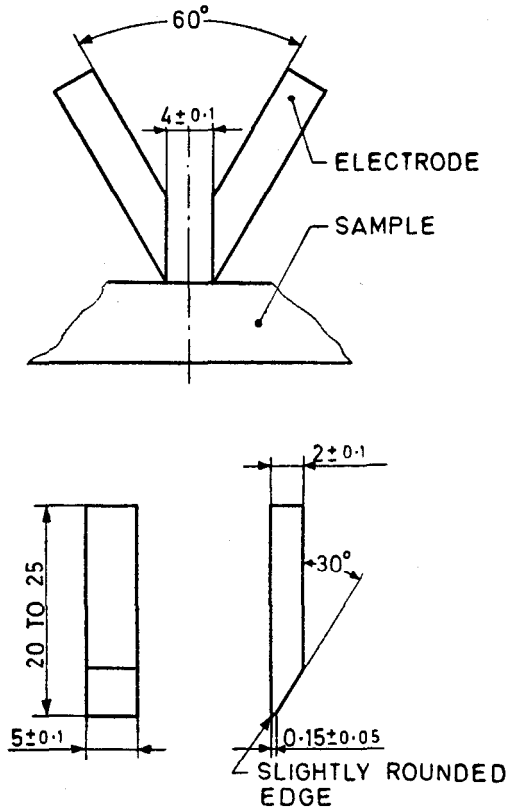
**7.3 Resistance to Tracking** — Insulating parts of luminaires other than ordinary luminaires, which retain live parts in position or are in contact with such parts, shall be of material resistant to tracking unless they are protected against dust and moisture.

**7.3.1 Test** — Compliance shall be checked by the following test which shall be made at three places on the test sample:

The test should not be made on parts of ceramic material.

A flat surface of the part to be tested, if possible at least 15 × 15 mm with a thickness corresponding to that of the material used in the luminaire, shall be placed in a horizontal position. Two electrodes of platinum of the dimensions shown in Fig. 8, shall be placed on a surface of the sample in a manner shown, so that the rounded edges are in contact with the sample over their whole lengths.

The force exerted on the surface by each electrode shall be about 1 N. The electrodes shall be connected to a 50 Hz supply source having a voltage of 175 V of substantially sine-wave form. The total impedance



All dimensions in millimetres.

FIG. 8 ARRANGEMENT AND DIMENSIONS OF THE ELECTRODES FOR THE TRACKING TEST

of the circuit when the electrodes are short-circuited shall be adjusted by means of a variable resistor so that the current is  $1.0 \pm 0.1$  A with  $\cos \phi = 0.9$  to 1. An overcurrent relay, with a tripping time of at least 0.5 s, shall be included in the circuit.

The surface of the sample shall be wetted by allowing drops of a solution of ammonium chloride in distilled water to fall centrally between the electrodes. The solution shall have a volume resistivity of  $400 \Omega \text{ cm}$  at  $25^\circ\text{C}$ , corresponding to a concentration of about 0.1 percent. The drops shall have a volume between 20 and 25  $\text{mm}^3$  and fall from a height of 30 to 40 mm. The time interval between one drop and the next shall be  $30 \pm 5$  s.

**7.3.1.1** No flashover or breakdown between electrodes shall occur before a total of 50 drops has fallen. In case of doubt, the test shall be repeated, if necessary, on a new sample. Care should be taken that the electrodes are clean, correctly shaped and positioned before each test is started.

## **8. RESISTANCE TO CORROSION**

**8.1** Ferrous parts of drip-proof, rain-proof, splash-proof, jet-proof, water-tight and pressure water-tight luminaires, the resulting of which might cause the luminaire to become unsafe, shall be adequately protected against rusting. Luminaires shall be checked for resistance to corrosion by the following tests:

All grease is removed from the parts to be tested, by immersion in carbon tetrachloride for 10 minutes. The parts are then immersed for 10 minutes in a 10 percent solution of ammonium chloride in water at a temperature of  $20 \pm 5^{\circ}\text{C}$ . Without drying, but after shaking off any drops, the parts are placed for 10 minutes in a box containing air saturated with moisture at a temperature of  $20 \pm 5^{\circ}\text{C}$ . After the parts have been dried for 10 minutes in a heating cabinet at a temperature of  $100 \pm 5^{\circ}\text{C}$ , their surface shall show no signs of rust.

Traces of rust on sharp edges and any yellowish film removable by rubbing are ignored.

For small helical springs and the like, and for inaccessible parts exposed to abrasion, a layer of grease may provide sufficient protection against rusting. Such parts are subjected to the test only if there is doubt about the effectiveness of the grease film, and the test is then made without previous removal of the grease.

**8.1.1** Contacts and other parts made of rolled copper or copper alloy sheet, the failure of which might cause the luminaire to become unsafe, shall be free from season cracking.

Compliance shall be checked by inspection and for luminaires other than ordinary, by the test given in **8.5**.

The test given in **8.5** is made only in case of doubt.

**8.1.2** Parts of aluminium or aluminium alloy in drip-proof, rain-proof, splash-proof, jet-proof, water-tight and pressure water-tight luminaires, shall be resistant to corrosion, if otherwise the luminaire might become unsafe.

### **8.2 Mercurous Nitrate Test for Copper and Copper Alloys**

This describes the technique for conducting the mercurous nitrate test of wrought copper and copper alloy products. It is an accelerated test

for the purpose of detecting the presence of residual ( internal ) stresses that might bring about failure of the material in service or storage through stress corrosion cracking.

While this method has also been used for testing assemblies and partial assemblies, the method is not intended for that purpose, and some modification may be required for such use.

**8.2.1 Mercurous Nitrate Solution** — The solution is an aqueous mercurous nitrate solution containing 10 g of  $\text{HgNO}_3$  and 10 ml of  $\text{HNO}_3$  ( density 1.40 to 1.42g/cm<sup>3</sup> ) per litre of solution.

This aqueous mercurous nitrate solution is to be prepared by either of the following procedures A or B:

*Procedure A* : Dissolve 11.4 g of  $\text{HgNO}_3 \cdot 2\text{H}_2\text{O}$  or 10.7 g of  $\text{HgNO}_3$ ,  $\text{H}_2\text{O}$  in approximately 40 ml of distilled water, acidified with 10 ml of  $\text{HNO}_3$ . After the crystals are completely dissolved, dilute the solution with distilled water to 1 000 ml.

*Procedure B* : Dissolve 76 g of mercury in 114 ml of diluted  $\text{HNO}_3$  ( one part water to one part  $\text{HNO}_3$  ). Carefully dilute with distilled water to 1 000 ml. This provides a concentration of 100 g of  $\text{HgNO}_3$  per litre and an excess of 30 ml of  $\text{HNO}_3$  after a slight loss due to heating. Add the water in small portions while stirring to prevent local overdilution. This gradual dilution, together with the excess acid, will prevent precipitation of basic salts of mercury. Dilute 100 ml of this solution ( 10 percent ) with 7 ml of  $\text{HNO}_3$  and 893 ml of water.

A solution of which the concentration is not in accordance with that specified should not be used.

The mercurous nitrate crystals are obtainable in both the monohydrate and dihydrate form and should be handled with caution because of their highly toxic effects. When weighing crystals, the weight of water of crystallization should be taken into consideration. The mercurous nitrate crystals are photosensitive and when they have turned yellow are difficult to dissolve.

If heating is used in either of these procedures for preparing the mercurous nitrate solution, care should be exercised to avoid loss of  $\text{HNO}_3$ .

**8.2.1.1 Test piece** — The test is made on test pieces taken from the luminaire.

**8.2.1.2 Procedure** — The test piece should be first degreased. Totally immerse the test piece in an aqueous solution of sulphuric acid ( 15 percent by volume ) or in an aqueous solution of 60 percent water and 40 per-



cent concentrated  $\text{HNO}_3$  for a period not exceeding 30 seconds, to remove all traces of carbonaceous matter and oxide films. Remove the test piece from the pickling solution and wash it immediately in running water. Then drain the test piece free of excess water and totally immerse it in the mercurous nitrate solution with at least 15 ml of mercurous nitrate solution per square centimetre of exposed surface of the test piece.

After 30 minutes, remove the test piece from the mercurous nitrate solution and wash it in running water. Wipe off any excess mercury from the surface of the test piece. The test piece is allowed to dry.

The test piece shall show no crack visible to the naked eye 24 hours after washing.

In cases of doubt regarding the presence of cracks, volatilize ( with caution ) the mercury on the surface of the test piece by the application of heat on a hot-plate or in an oven. Then examine the specimen for cracks under suitable magnifying equipment at a magnification of 10 to 18 diameters.

**CAUTION** — Equipment for the detection and removal of mercury vapour produced in volatilization should be used. The use of rubber gloves is advisable.

## **A P P E N D I X A**

( Clause 3.2.6 )

### **TEST TO ESTABLISH WHETHER A CONDUCTIVE PART IS A LIVE PART WHICH MAY CAUSE AN ELECTRIC SHOCK**

**A-1.** In order to determine whether a conductive part is a live part which may cause an electric shock, the luminaire is operated at rated supply-voltage and nominal frequency and the following tests conducted:

- a) The current flowing between the part concerned and earth is measured, the measuring circuit having a non-inductive resistance of 2 000  $\Omega$ . The part concerned is a live part if a current of more than 0.7 mA ( peak ) is measured.
- b) The voltage between the part concerned and any accessible part is measured, the measuring circuit having a non-inductive resistance of 50 000  $\Omega$ . The part concerned is a live part if a voltage of more than 34 V ( peak ) is measured.

**A-2.** For the above tests, one pole of the test supply shall be at earth potential.

**APPENDIX B**

( Clause 6.1.1 )

**TEST LAMPS**

**B-1.** For the tests of 6, it is convenient to keep a stock of lamps of types commonly required. These should be carefully selected from normal production lamps for characteristics as close as possible to the objective characteristics listed in the appropriate standards. The selected lamps should be aged ( at least 24 hours for filament lamps and at least 100 h for tubular fluorescent and other discharge lamps, with occasional off-periods ), and a further check should be made that their characteristics are still satisfactory and stable. Lamps should not be retained as test lamps for longer than about three-quarters of their typical operating period in normal service. Lamps should be inspected before each test for any damage or signs of approaching unserviceability. Discharge lamps should be checked regularly to ensure that there has been no appreciable shift in electrical characteristics which influence the temperatures in luminaires. If a lamp can be inserted in a circuit in more than one position — for example a fluorescent lamp — marks should be made to assist consistent insertion. Great care should be taken in handling test lamps; in particular, sodium and mercury-halide discharge lamps and amalgam fluorescent lamps should not be moved while still hot.

**B-2.** A lamp selected for a particular test shall be of a rating and type for which the luminaire is claimed to be suitable. If a choice of lamp shape, construction or finish is indicated by the manufacturer, the thermally most onerous shall be taken. Otherwise, the most common type shall be used.

**B-3.** The following requirements refer to the selection of lamps as test lamps, and to lamp selection for particular test of a luminaire.

**B-3.1 Filament lamps**

**B-3.1.1** For types in common use, a selection should be made of lamps with cap temperature measured under the conditions described in IS : 8913-1978\* above the average for production lamps and preferably from the high-temperature end of the production spread. ( This requirement does not apply to lamps for use only in the endurance test. )

**B-3.1.2** If the luminaire is provided with a marking for special lamps, if it is obvious that special lamps are to be used in the luminaire, the test is made with such special lamps. In all other cases, the luminaire is fitted with general lighting service ( GLS ) lamps.

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\*Standard method of measurement of lamp cap temperature rise.

**B-3.1.3** Lamps are chosen in accordance with the rated wattage of the luminaire, but when the luminaire has E 27 or B 22 lampholders, a GLS lamp with a rated wattage of not less than 60 W shall be used and if the luminaire has E14 or B15 lampholders a GLS lamp with a rated wattage of not less than 40 W shall be used.

**B-3.1.4** This requirement does not apply, however, if it is obvious that the luminaire should not be used with such lamps.

**B-3.1.5** The voltage rating of a test lamp shall be typical of the voltage rating of filament lamps in the market for which the luminaire is intended. If the luminaire is intended for two or more different groups of voltage supplies. For example, for 200 — 250 V and for 100 — 125 V, then the test lamp shall be the one suited to the lowest voltage range ( that is the one with the highest current ).

**B-3.1.6** If a lamp is operated in conjunction with a component ( for example, a transformer with 24 V output ) inside the luminaire, the voltage rating of the test lamp shall be in accordance with the marking of the component or similar instructions.

### **B-3.2 Tubular Fluorescent and Other Discharge Lamps**

**B-3.2.1** When a lamp is operated under reference conditions ( according to the IS standard ), the lamp voltage, current and power shall be as close as possible to the ISI objective values, and shall be within 2.5 per cent of these values.

**B-3.3** If a reference ballast is not available, lamps may be selected using a production ballast, which at the calibration current, has an impedance within  $\pm 1$  percent of that of the reference ballast. The characteristics of preheated electrodes shall be as close as possible to the objective values.

**NOTE 1** — A discharge lamp, incorporating a series filament, is described as a filament lamp for the purpose of clause 6. If the luminaire is for use with filament lamps or discharge lamps incorporating series filament, it should be tested with the more onerous ( or if not known, with each in turn ).

**NOTE 2** — If the luminaire is for use with a combination of lamp types ( for example, a filament lamp plus a discharge lamp ), it should be tested with the thermally most onerous combination.

If the luminaire is for use with either filament or discharge lamps, it should be tested with the more onerous ( or, if not known, with each in turn ).

It is usually found that translucent materials attain a higher temperature with a discharge lamp or a discharge lamp incorporating a series filament than with a filament lamp, for a given lamp power.

**NOTE 3** — If the luminaire is designed for a lamp type for which specifications have not yet been established, a test lamp should be selected after consultation with the lamp manufacturer.

**APPENDIX C**  
( Clause 6.2.1 and 6.3.1 )

**TEMPERATURE MEASUREMENT**

**C-1.** The following recommendations refer to methods of making temperature measurements on luminaires in a draught-proof enclosure in accordance with 6.3.5. These methods of measurement have been evolved as particularly suitable for luminaires; alternative methods may be used if it is established that they are of at least equal precision and accuracy.

**C-2.** Temperatures of solid materials are usually measured by means of thermocouples. The output voltage is ready by a high-impedance device such as a potentiometer. With a direct-reading instrument it is important to check that its input impedance is suited to the impedance of the thermocouple. Temperature-indicators of the chemical type are at present suitable only for rough checks of measurements.

**C-3.** The thermocouple wires should be of low thermal conductivity. A suitable thermocouple consists of 80/20 nickel-chromium paired with 40/60 nickel-copper ( or with 40/60 nickel-aluminium ). Each of the two wires ( usually of strip form, or circular in section ) is fine enough to pass through a 0.3 mm hole. All the end-portions of the wires liable to be exposed to radiation have a high-reflectance metal finish. The insulation of each wire is of suitable temperature and voltage rating; it is also thin but robust.

**C-4.** Thermocouples are attached to the measuring point with minimum disturbance of thermal conditions and with low-resistance thermal contact. If a particular point on a part is not specified, the point of highest temperature should be found by preliminary exploration ( for this purpose, a thermocouple may be mounted in a holder made of material of low thermal conductance; instruments using thermistors are also convenient ). It is important to explore materials such as glass, since temperature may vary rapidly with position. Thermocouples mounted within or near a luminaire should have minimum exposure to conducted or radiant heat. Care should also be taken to avoid voltage from current carrying parts.

**C-5.** The following methods have been found useful for attaching thermocouple junctions at measuring points:

- a) Mechanical clamping, for example, under fixing device ( clamping under current carrying parts is deprecated ).
- b) Soldering to a metal surface ( with a minimum account of solder ).

- c) By an adhesive ( minimum amount required ). The adhesive ( should not separate the thermocouple from the measuring point. An adhesive used with a translucent material should be as translucent as possible. A suitable adhesive for use with glass is formed of one part of sodium silicate to two parts of calcium sulphate with water medium. On non-metal parts the last 20 mm of the thermocouple is attached to the surface to offset the flow of heat from the measuring point.
- d) Cables. The insulation is slit and the thermocouple inserted ( without touching a conductor ); the insulation is then bound up.
- e) Mounting surface ( *see* Appendix D ). A thermocouple is attached to a copper disc ( approximately 5 mm diameter, 1 mm thickness, and with a matt black finish ), sunk level with the surface at the hottest point.

**C-6.** The average ambient temperature in the draught-proof enclosure is taken to be the air temperature at a position near one of the perforated walls on a level with the centre of the luminaire. The temperature is usually measured by a mercury-in-glass thermometer. An alternative sensor is a thermocouple or thermistor attached to a small metal vane shielded against radiation.

**C-7.** The average temperature throughout a winding is measured by the change-in-resistance method. The procedure to be followed is described in Appendix E.

**NOTE** — It is found that errors are often made in the estimated calculation; an independent rough check should be made by measuring the case temperature of the component and adding a winding-to-case differential appropriate to the construction.

**C-8.** It is important that all temperature measuring instruments should be checked regularly. It is also recommended that measuring authorities should interchange luminaires to improve consistency in the measurement of different materials at different temperature levels.

## **APPENDIX D**

( *Clause 6.3.1* )

### **DRAUGHT-PROOF ENCLOSURE**

**D-1.** The following recommendations refer to the construction and use of a suitable draught-proof enclosure for luminaires, as required for the tests of normal and abnormal operation. Alternative constructions

for draught-proof enclosures are suitable if it is established that similar results are obtained.

The draught-proof enclosure is rectangular, with a double skin on top and on at least three sides, and with a solid base. The double skins are of perforated metal, spaced apart approximately 150 mm, with regular perforations of 1 to 2 mm diameter, occupying about 40 percent of the whole area of each skin.

The internal surfaces are painted with a matt paint. The three principal internal dimensions are each at least 900 mm. There should be a clearance of at least 200 mm between the internal surfaces and any part of the largest luminaire for which the enclosure is designed. Alternative constructions for draught-proof enclosures are suitable if it is established that similar test results are obtained.

NOTE — If it is required to test two or more luminaires in a large enclosure, care should be taken that radiation from one luminaire cannot affect any other.

There is a clearance of at least 300 mm above the top of the enclosure and around the perforated sides. The enclosure is at a location protected as far as possible from draughts and sudden changes in air temperature; it is also protected from sources of radiant heat.

A luminaire under test is positioned as far away as possible from the six internal surfaces of the enclosure. The luminaire is mounted ( subject to the requirements of 6.3.1 and 6.4.1 ) as under service conditions.

A luminaire for direct fixing to a ceiling or wall should be fixed to a mounting surface comprising a wood or wood-fibre board. A non-combustible insulating material should be used if the luminaire is not suitable for mounting on a combustible surface. The board is approximately 15 mm thick, and extends not less than 100 mm ( but preferably not more than 200 mm ) beyond the normal projection of the smoothed outline of the luminaire. There is a clearance of at least 100 mm between the board and the internal surfaces of the enclosure. The board is painted black with a matt non-metallic paint.

A luminaire for corner-fixing should be fixed in a corner comprising two boards each complying with the preceding requirements.

A third board is required if the luminaire is to be fixed in a vertical corner immediately below a simulated ceiling.

Recessed luminaires are mounted in a test recess, consisting of a suspended ceiling, on top of which is a rectangular box with vertical sides and horizontal top.

The suspended ceiling is made of a 12 mm thick porous wood fibre board, in which a suitable opening has been made for the luminaire. The wood fibre board reaches at least 100 mm outside the projection of the luminaire on this board. The vertical sides of the box are made of 19 mm thick laminated wood. During the test, these sides are placed at a distance of 50 mm or 75 mm from the luminaire, where it is mounted in the suspended ceiling. The top of the box is placed at a distance of approximately 25 mm from the substantially flat top surface of the luminaire, and is made of a 12 mm thick porous wood fibre board which is tightly sealed to the sides of the box. If there are spacers or connecting boxes on top of the luminaire which project more than 25 mm above its top surface, these spacers or connecting boxes should be placed in direct contact with the top of the test box.

The suspended ceiling and the interior of the box are painted black with a matt non-metallic paint and there is a gap of not less than 100 mm between this assembly and the inside walls, ceiling and floor of the test enclosure.

When luminaire is intended to be recessed into a wall, the test is made using a test recess similar to that described above, but with the board placed vertically.

## **APPENDIX E**

( *Clause 6.3.1* )

### **DETERMINATION OF WINDING TEMPERATURE RISES BY THE INCREASE IN RESISTANCE METHOD**

**NOTE** — Reference to ballasts also applies to similar components such as transformers.

**E-1.** Before commencing the test, arrangements are made by which the ballast may be quickly connected by appropriate means of negligible resistance to a Wheatstone bridge, or other suitable resistance measuring instrument, after the luminaire has been disconnected from the supply.

**E-2.** A chronometer with an easily-read second hand is essential.

**E-3.** The test procedure is as follows.

**E-3.1** The luminaire remains unenergized for a period long enough to ensure that the complete luminaire, including the ballast windings is ther-

mally stable in a substantially constant ambient temperature ( $t_1$ ), which should not change by more than 3°C during this period.

**E-3.2** The resistance ( $R_1$ ) of the cold ballast winding is measured and  $t_1$  noted. The luminaire is operated until thermal stability has been achieved as indicated by a suitable temperature measuring device attached to the body of the ballast. The ambient air temperature ( $t_3$ ) in the draught-proof enclosure is noted.

**E-3.3** The luminaire is then disconnected from the supply, the time noted, and the ballast connected immediately to the Wheatstone bridge. The resistance is measured as quickly as possible and the corresponding time noted.

**E-3.4** Further resistance measurements, if necessary, are made at suitable intervals whilst the ballast is cooling, the times at which the measurements are made being recorded. These measurements enable a time/resistance curve to be plotted which is extrapolated back to the point corresponding to the instant of disconnection of the supply and the resistance  $R_2$  of the hot winding is read.

Since the resistance of copper, over the range of temperatures of ballasts, varied in direct proportion to the temperature as measured from a reference point of  $-234.5^\circ\text{C}$ , the hot temperature  $t_2$  may be calculated from the ratio of the hot resistance  $R_2$  to the cold  $R_1$  by means of the equation:

$$\frac{R_2}{R_1} = \frac{t_2 + 234.5}{t_1 + 234.5}$$

Hence, for windings of copper wire:

$$t_2 = \frac{R_2}{R_1} (t_1 + 234.5) - 234.5$$

The temperature rise is the difference between the calculated temperature  $t_2$  and the ambient air temperature  $t_3$  at the conclusion of the test, that is:

$$\text{temperature rise} = (t_2 - t_3)^\circ\text{C}$$



## APPENDIX F

( Clause 6.4 )

### ABNORMAL CIRCUIT CONDITIONS

**F-1.** The following is a list of abnormal circuit conditions which may be applicable to a tubular fluorescent or other discharge lamp luminaire and from which the thermally most onerous condition shall be taken ( see 6.3.1 ). If the luminaire contains more than one lamp, the abnormal condition shall be applied only to the one lamp which leads to the most adverse results. The abnormal condition shall be set up before the test is started. Conditions (d) and (e) refer only to lamps with two preheated electrodes ( for example, fluorescent lamps ). The descriptions include instructions on test arrangements. Conveniently the abnormal circuit condition may be produced or simulated by remote switching so that it is not necessary to disturb a luminaire which has just completed the test of normal operation.

- a) *Short-circuit of starter contacts* — This condition applies to starters with moving contacts, including starters incorporated in lamps.
- b) *Lamp rectification* — This is a fault condition which may occur after extended use in luminaires employing starterless ballasts with capacitive reactance control. Luminaires employing this type of circuit shall be tested in accordance with the requirements of relevant Indian Standard on tubular fluorescent lamps and the circuit arrangements for this test shall be as specified in that standard.
- c) Lamps removed and not replaced.
- d) *One electrode of lamp open-circuit* — The condition may be produced by switching. ( Alternatively, a test lamp may be suitably modified. ) The electrode shall be selected which more adversely affects the results.
- e) Lamp will not start but both electrodes intact. For this condition, a non-serviceable or modified test lamp may be used.