

IS 15885 (Part 1) : 2011

भारतीय मानक

(Reaffirmed 2016)

(Reaffirmed 2021)

लैम्प नियंत्रणगियर की सुरक्षा
भाग 1 सामान्य अपेक्षाएँ

Indian Standard

SAFETY OF LAMP CONTROLGEAR

PART 1 GENERAL REQUIREMENTS

ICS 29.140.99

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Electric Lamps and Their Auxiliaries Sectional Committee, ETD 23

FOREWORD

This Indian Standard (Part 1) was adopted by the Bureau of Indian Standards, after the draft finalized by the Electric Lamps and Their Auxiliaries Sectional Committee had been approved by the Electrotechnical Division Council.

This standard is published in two parts. The other part and sections are:

Part 2	Particular requirements
Section 1	Starting devices (other than glow starters)
Section 2	dc or ac supplied electronic step-down convertors for filament lamps
Section 3	ac supplied electronic ballasts for fluorescent lamps
Section 4	dc electronic ballast for general lighting
Section 5	dc supplied electronic ballast for public transport system
Section 6	dc supplied electronic ballast for aircraft lighting
Section 7	dc supplied electronic ballast for emergency lighting
Section 8	Ballasts for fluorescent lamps
Section 9	Ballasts for discharge lamps (excluding fluorescent lamps)
Section 10	Electronic invertors and convertors for high frequency operation of cold start tubular discharge lamps (neon tubes)
Section 11	Miscellaneous electronic circuits used with luminaires.

Formulation of standards in respect of (Part 2/Sec 2), (Part 2/Sec 4), (Part 2/Sec 6), (Part 2/Sec 7), (Part 2/Sec 10) and (Part 2/Sec 11) shall be taken up at a later date as when need arises.

This standard provides as set of general and safety requirements and tests which are considered to be generally applicable to most types of lamp controlgear and which can be called up as required by the appropriate Part 2 of this standard. This standard is thus not to be regarded as a specification in itself for any type of lamp controlgear, and its provisions apply only to particular types of lamp controlgear, to the extent determined by the appropriate Part 2 of this standard.

The formatting into separately published parts provides for ease of future amendments and revisions. Additional requirements will be added as and when a need for them is recognized.

This standard which make up Part 2, in referring to any of the clauses of this part, specify the extent to which such a clause 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 of this part are numbered has no particular significance, as the order in which their provisions apply is determined for each type of lamp controlgear by the appropriate series of Part 2 of this standard. All such parts are self-contained and therefore do not contain references to each other.

Where the requirements of any of the clauses of this standard are referred to in the various parts that make up Part 2 by the phrase "The requirements of clauses 'n' of Part 1 shall apply", this phrase will be interpreted as meaning that all requirements of the clause in question of Part 1 shall apply, except any which are clearly inapplicable to the particular type of lamp controlgear covered by the Part 2 concerned.

Lamp controlgear which complies with the text of this standard shall not necessarily be judged to comply with the safety principles of the standard if, when examined and tested, it is found to have other features which impair the level of safety covered by these requirements.

Lamp controlgear employing materials or having forms of construction differing from those detailed in the requirements of this standard may be examined and tested according to the intent of the requirement and, if found to be substantially equivalent, may be judged to comply with the safety principles of the standard.

Indian Standard

SAFETY OF LAMP CONTROLGEAR

PART 1 GENERAL REQUIREMENTS

1 SCOPE

1.1 This standard (Part 1) specifies general and safety requirements for lamp controlgear for use on dc supplies up to 250 V and/or ac supplies up to 1 100 V at 50 Hz.

The requirements specified in this standard are type tests. Requirements for testing individual lamp controlgear during production are not included.

Requirements for luminaires are given in IS 10322 (Part 1) : 1982 'Luminaires: Part 1 General requirements'.

In addition to the requirements given in this standard, Annex B sets out general and safety requirements applicable to thermally protected lamp controlgear.

Annex C sets out additional general and safety requirements as they apply to electronic lamp controlgear with means of protection against overheating.

2 REFERENCES

The following standards are necessary adjunct to this standard:

<i>IS No.</i>	<i>Title</i>
616 : 2003	Safety requirements for mains operated electronic and related apparatus for household and similar general use (<i>second revision</i>)
1534 (Part 1) : 1977	Ballast for fluorescent lamps: Part 1 For switch start circuits (<i>second revision</i>)
2215 : 2006	Starters for fluorescent lamps (<i>third revision</i>)
2418	Tubular fluorescent lamps for general lighting services:
(Part 1) : 1977	Requirements and tests (<i>first revision</i>)
(Part 2) : 1977	Standard lamp data sheets (<i>first revision</i>)
2824 : 1975	Method for determining the comparative tracking index of solid insulating materials under moist conditions (<i>first revision</i>)
4261 : 2001	Paper, board, pulp and related terms — Vocabulary

<i>IS No.</i>	<i>Title</i>
5921 (Part 1) : 1983	Metal clad base materials for printed circuits for use in electronic and telecommunication equipment: Part 1 General requirements and test
10322	Luminaires:
(Part 1) : 1982	General requirements
(Part 3) : 1984	Screw and screwless terminals
(Part 4) : 1984	Methods of tests
11000 (Part 2/ Sec 1) : 1984	Fire hazard testing: Part 2 Test methods, Section 1 Glow-wire test and guidance
11000 (Part 2/ Sec 2) : 1984	Fire hazard testing: Part 2 Test methods, Section 2 Needle-flame test
12063 : 1987	Classification of degree of protection provided by enclosures of electrical equipment
13021 (Part 2)	ac supplied electronic ballasts for tubular fluorescent lamps: Part 2 Performance requirements (<i>under printing</i>)
13730 (Part 0/ Sec 1) : 1993	Specification for particular types of winding wires: Part 0 General requirements, Section 1 Enameled round copper wire
IS 15382 (Part 3) : 2006/IEC 60664-3 (2003)	Insulation coordination for equipment within low voltage system: Part 3 Use of coatings, potting or moulding for protection against pollution
15687 (Part 2)	Single-capped fluorescent lamps : Part 2 Performance requirements (<i>under preparation</i>)
15882	Ballasts for discharge lamps (excluding tubular fluorescent lamps) — Performance requirements (<i>under printing</i>)
15885 (Part 2/ Sec 1) : 2011	Safety of lamp controlgear: Part 2 Particular requirements, Section 1 Starting devices (other than glow starters)
15885 (Part 2/ Sec 8) : 2011	Safety of lamp control gear: Part 2 Particular requirements, Section 8 Ballasts for fluorescent lamps

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<i>IS No.</i>	<i>Title</i>
15885 (Part 2/ Sec 9) : 2011	Safety of lamp control gear: Part 2 Particular requirements, Section 9 Ballasts for discharge lamps (excluding fluorescent lamps)
Doc: ET 23 (5943)	Ballasts for tubular fluorescent lamps: Performance requirements (<i>under preparation</i>)
IS/IEC 60691 : 1993	Thermal-links — Requirements and application guide

3 TERMINOLOGY

For the purpose of this part of the standard, the following definitions shall apply.

3.1 Lamp Controlgear — One or more components between the supply and one or more lamps which may serve to transform the supply voltage, limit the current of the lamp(s) to the required value, provide starting voltage and preheating current, prevent cold starting, correct power factor or reduce radio interference.

3.1.1 Built-in Lamp Controlgear — Lamp controlgear generally designed to be built into a luminaire, a box, an enclosure or the like and not intended to be mounted outside a luminaire, etc. without special precautions. The controlgear compartment in the base of a road lighting column is considered to be an enclosure.

3.1.2 Independent Lamp Controlgear — Lamp controlgear consisting of one or more separate elements so designed that it can be mounted separately outside a luminaire, with protection according to the marking of the lamp controlgear and without any additional enclosure. This may consist of a built-in lamp controlgear housed in suitable enclosure which provides all the necessary protection according to its marking.

3.1.3 Integral Lamp Controlgear — Lamp controlgear which forms a non-replaceable part of a luminaire and which cannot be tested separately from the luminaire.

3.2 Ballast — Unit inserted between the supply and one or more discharge lamps which by means of inductance, capacitance, or a combination of inductance and capacitance, serves mainly to limit the current of the lamps to the required value. It may also include means for transforming the supply voltage and arrangements which help provide starting voltage and pre-heating current.

3.2.1 dc Supplied Electronic Ballast — dc to ac inverter using semiconductor devices which may include stabilizing elements for supplying power to one or more fluorescent lamps.

3.2.2 Reference Ballast — Special inductive ballast designed for the purpose of providing comparison

standards for use in testing ballasts and for the selection of reference lamps. It is essentially characterized by a stable voltage-to-current ratio, which is relatively uninfluenced by variations in current, temperature and magnetic surroundings, as outlined in Doc: ET 23 (5943) and IS 15882.

3.3 Reference Lamp — Lamp selected for testing ballasts which, when associated with a reference ballast, has electrical characteristics which are close to the nominal values as stated in the relevant lamp standard.

3.4 Calibration Current of a Reference Ballast — value of the current on which are based the calibration and control of the reference ballast.

NOTE — Such a current should preferably be approximately equal to the nominal running current of the lamps for which the reference ballast is suitable.

3.5 Supply Voltage — Voltage applied to the complete circuit of lamps(s) and lamp controlgear.

3.6 Working Voltage — Highest rms voltage which may occur across any insulation at rated supply voltage, transients being neglected, in open-circuit conditions or during normal operation.

3.7 Design Voltage — Voltage declared by the manufacturer to which all the lamp controlgear characteristics are related. This value is not less than 85 percent of the maximum value of the rated voltage range.

3.8 Voltage Range — Range of supply voltage over which the ballast is intended to be operated.

3.9 Supply Current — Current supplied to the complete circuit of lamps(s) and lamp controlgear.

3.10 Live Part — Conductive part which may cause an electric shock in normal use. The neutral conductor is, however, regarded as a live part.

NOTE — The test to determine whether or not a conductive part is a live part which may cause an electric shock is given in Annex A.

3.11 Type Test — Test or series of tests made on a type-test sample for the purpose of checking compliance of the design of a given product with the requirements of the relevant standard.

3.12 Type Test Sample — Sample consisting of one or more similar units submitted by the manufacturer or responsible vendor for the purpose of a type test.

3.13 Circuit Power Factor (Φ) — Power factor of the combination of lamp controlgear and the lamp or lamps for which the lamp controlgear is designed.

3.14 High Power Factor Ballast — Ballast having as circuit power factor of at least 0.85 (leading of lagging).

NOTE — The value 0.85 takes into account the distortion of the current waveform.

3.15 Rated Maximum Temperature (t_c) — Highest permissible temperature which may occur on the outer surface (at the indicated place, if marked) under normal operating conditions and at the rated voltage or the maximum of the rated voltage range.

3.16 Rated Maximum Operating Temperature of a Lamp Controlgear Winding (t_w) — Winding temperature assigned by the manufacture as the highest temperature at which 50 Hz lamp controlgear may be expected to have a service life of at least 10 years continuous operation.


3.17 Rectifying Effect — Effect which may occur at the end of lamp life when one cathode is either broken or has insufficient electron emission, resulting in the arc current being constantly unequal in consecutive half-cycles.


3.18 Test Duration of Endurance Test (D) — Optional duration of the endurance test on which the temperature conditions are based.

3.19 Degradation of Insulation of a Ballast Winding (S) — Constant which determines the degradation of ballast insulation.

3.20 Igniter — Device intended to generate voltage pulses to start discharge lamps and which does not provide for the preheating of electrodes.

NOTE — The element that releases the starting voltage pulse may be either triggered or non-triggered.


3.21 Protective Earth (Ground)  — Terminal to which parts are connected to earth for safety reasons.

3.22 Functional Earth (Ground)  — Terminal to which are connected parts which may be necessary to connect to earth for reasons other than safety.

NOTES

1 In some instances, starting aids adjacent to the lamp(s) are connected to one of the output terminals but need not be connected to the earth on the supply side.

2 In some cases, functional earthing may be necessary to facilitate starting or for e.m.c. purposes.


3.23 Frame (Chassis)  — Terminal whose potential is taken as reference.

4 GENERAL REQUIREMENTS

Lamp controlgear shall be so designed and constructed that in normal use it operates without danger to the user or surroundings.

Compliance is checked by carrying out all the tests specified.

In addition, independent lamp controlgear shall comply with the requirements of IS 10322 (Part 1), including the classification and marking requirements of that standard such as IP classification,

 marking, etc.

5 GENERAL NOTES ON TESTS

5.1 Tests according to this standard are type tests.

NOTE — The requirements and tolerances permitted by this standard are related to testing of a type-test sample submitted by the manufacturer for that purpose. Compliance of the type-test sample does not ensure compliance of the whole production of a manufacturer with this safety standard.

Conformity of production is the responsibility of the manufacturer and may include routine tests and quality assurance in addition to type testing.

5.2 Unless otherwise specified, the tests are carried out at an ambient temperature of 10 °C to 30 °C.

5.3 Unless otherwise specified, the type test is carried out on one sample consisting of one or more items submitted for the purpose of the type test.

In general, all tests are carried out on each type of lamp controlgear or, where a range of similar lamp controlgear is involved, for each wattage in the range or on a representative selection from the range, as agreed with the manufacturer.

Certain countries require that three samples of lamp controlgear be tested and, in such cases, if more than one sample fails, then the type is rejected. If one sample fails, the test is repeated using three other samples and all of these shall comply with the test requirements.

5.4 The test shall be carried out in the order listed in this standard unless otherwise specified in Part 2 of this standard.

5.5 For the thermal test, independent lamp controlgear shall be mounted in a test corner consisting of three dull-black painted wooden/wood fibre boards 15 mm to 20 mm thick and arranged so as to resemble two walls and the ceiling of a room. The lamp controlgear is secured to the ceiling as close as possible to the walls, the ceiling extending at least 250 mm beyond the other side of the lamp controlgear.

5.6 For dc supplied ballasts intended for use from a battery supply it is permissible to substitute a dc power source other than a battery, provided that the source impedance is equivalent to that of a battery.

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NOTE — A non-inductive capacitor of appropriate rated voltage and with a capacitance of at least 50 F, connected across the supply terminals of the unit under test normally provides source impedance simulating that of a battery.

6 CLASSIFICATION


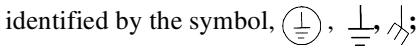
Lamp controlgear is classified, according to the method of installation, as:


- a) built-in;
- b) independent; and
- c) integral.

7 MARKING

7.1 Items to be Marked

Part 2 state which of the following items shall be marked as mandatory markings or provided as information to be given either on the lamp controlgear or made available in the manufacturer's catalogue or similar:

- a) Mark of origin (trade-mark, manufacturer's name or name of the responsible vendor/supplier);
- b) Model number or type reference of the manufacturer;
- c) Symbol for independent lamp controlgear , if applicable;
- d) The correlation between replaceable and interchangeable parts, including fuses, of lamp controlgear shall be marked unambiguously by legends on the lamp controlgear or, with the exception of fuses, be specified in the manufacturer's catalogue;
- e) Rated supply voltage (or voltages, if there are several), voltage range, supply frequency and supply current(s); the supply current may be given in the manufacturer's literature;
- f) The earthing terminals (if any) shall be identified by the symbol, ; or. These symbols shall not be placed on screws or other easily removable parts;
- g) The claimed value of the rated maximum operating temperature of the winding following the symbol t_w , values increasing in multiples of 5 °C;
- h) Indication that the lamp controlgear does not rely upon the luminaire enclosure for protection against accidental contact with live parts;
- j) Indication of the cross-section of conductors for which the terminals, if any, are suitable. Symbol: relevant value(s) in square millimetres (mm²) followed by a small square;

- k) The lamp type and rated wattage or wattage range for which the lamp controlgear is suitable, or the designation as indicated on the lamp data sheet of the type(s) of lamp(s) for which the lamp controlgear is designed. If the lamp controlgear is intended to be used with more than one lamp, the number and rated wattages of each lamp shall be indicated;
- m) Wiring diagram indicating the position and purpose of terminals. In the case of lamp controlgear having no terminals, a clear indication shall be given on the wiring diagram of the significance of the code used for connecting wires. Lamp controlgear that operates in specific circuits only shall be identified accordingly, for example by marking or wiring diagram;
- n) Value of t_c . If this relates to a certain place on the lamp controlgear, this place shall be indicated or specified in the manufacturer's catalogue;
- p) Symbol for temperature declared, thermally protected controlgear  (see Annex B). The dots in the triangle shall be replaced by the value of the rated maximum case temperature in degree Celsius assigned by the manufacturer, values increasing in multiples of 10;
- q) Heat sink(s) required additional to the lamp controlgear;
- r) The limiting temperature of the winding under abnormal conditions which shall be respected when the controlgear is built into a luminaire, as information for luminaire design;
NOTE — In the case of lamp controlgear intended for circuits which do not produce abnormal conditions, or are for use only with starting devices which exempt the lamp controlgear from the abnormal conditions as specified in relevant parts of IS 10322, the winding temperature under abnormal conditions is not indicated.
- s) The test period for the endurance test for lamp controlgear which, at the manufacturer's choice, shall be tested for a period longer than 30 days, may be indicated with the symbol D, followed by the appropriate number of days, 60, 90 or 120 in 10-day periods, the whole being placed between the brackets immediately after the t_w indication. For example, (D6) for controlgear to be tested for a period of 60 days;
NOTE — The standard endurance test period of 30 days need not be indicated.
- t) For lamp controlgear for which a constant S other than 4 500 is claimed by the manufacturer, the symbol 'S' together with

its appropriate value in thousands, for example 'S6', if S has a value of 6 000; and

NOTE — Preferred values of S are: 4 500, 5 000, 6 000, 8 000, 11 000, 16 000.

- u) Country of manufacture.

7.2 Durability and Legibility of Marking

Marking shall be durable and legible.

Compliance is checked by inspection and by trying to remove the marking by rubbing lightly, for 15 s each time, with two pieces of cloth, one soaked with water and the other with petroleum spirit.

The marking shall be legible after the test.

NOTE — The petroleum spirit used should consist of a solvent hexane with a content of aromatics of maximum 0.1 percent volume percentage, a kauri-butanol value of 29, an initial boiling-point of approximately 65 °C, a dry-point of approximately 69 °C and a density of approximately 0.68 g/cm³.

8 TERMINALS

Screw terminals shall comply with IS 10322 (Part 3).

Screwless terminals shall comply with IS 10322 (Part 3).

9 PROVISIONS FOR PROTECTIVE EARTHING

Earthing terminals shall comply with the requirements of 8. The electrical connection/clamping means shall be adequately locked against loosening, and it shall not be possible to loosen the electrical connection/clamping means by hand without the use of a tool. For screwless terminals, it shall not be possible to loosen the clamping means/electrical connection/unintentionally.

Earthing of lamp controlgear (other than independent lamp controlgear) via mean of fixing the lamp controlgear to earthed metal is permitted. However, if a lamp controlgear has an earthing terminal, this terminal shall only be used for earthing the lamp controlgear.

All parts of an earthing terminal shall be such as to minimize the danger of electrolytic corrosion resulting from contact with the earth conductor or any other metal in contact with them.

The screw and the other parts of the earthing terminal shall be made of brass or other metal no less resistant to corrosion, or material with a non-rusting surface and at least one of the contact surfaces shall be bare metal.

Compliance is checked by inspection, by manual test and according to the requirements of 8.

Lamp controlgear with conductors for protective earthing provided by tracks on printed circuit boards shall be tested as follows.

A current from a ac source of 25 A is passed for 1 min between the earthing terminal or earthing contact via the track on the printed and each of the accessible metal parts in turn.

After the test, the requirements specified in relevant Section of IS 10322 (Part 5) shall apply.

10 PROTECTION AGAINST ACCIDENTAL CONTACT WITH LIVE PARTS

10.1 Lamp controlgear which do not rely upon the luminaire enclosure for protection against electric shock shall be sufficiently protected against accidental contact with live parts when installed as in normal use.

Integral lamp controlgear, which relies upon the luminaire enclosure for protection, shall be tested according to its intended use.

Lacquer or enamel is not considered to be adequate protection or insulation for the purpose of this requirement.

Parts providing protection against accidental shall have adequate mechanical strength and shall not work loose in normal use. It shall not be possible to remove them without the use of a tool.

Compliance is checked by inspection and by a manual test, and with regard to protection against accidental contact, by means of the test finger as shown in Fig. 1 of IS 12063 using an electrical indicator to show contact. This finger is applied in all possible positions, if necessary, with a force of 10 N.

It is recommended that a lamp be used for the indication of contact and that the voltage be not less than 40 V.

10.2 Lamp controlgear incorporating capacitors of total capacitance exceeding 0.5 F shall be constructed so that the voltage at the controlgear terminations does not exceed 50 V, 1 min after disconnection of the lamp controlgear from a source of supply at rated voltage.

11 MOISTURE RESISTANCE AND INSULATION

Lamp controlgear shall be moisture-resistant. They shall not show any appreciable damage after being subjected to the following test.

The lamp controlgear is placed in the most unfavourable position of normal use, in a humidity cabinet containing air with a relative humidity maintained between 91 percent and 95 percent. The temperature of the air at all places where samples can be located shall be maintained with 1°C of any

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convenient value t between 20°C and 30°C.

Before being placed in the humidity cabinet, the sample is brought to a temperature between t and $(t + 4)$ °C. The sample shall be kept in the cabinet for 48 h.

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

Before the insulation test, visible drops of water, if any, are removed by means of blotting paper.

Immediately after the moisture treatment, the insulation resistance shall be measured with a dc voltage of approximately 500 V, 1 min after application of the voltage. Lamp controlgear having an insulating cover or envelope shall be wrapped with metal foil.

Insulation resistance shall be not less than 2 MΩ for basic insulation.

Insulation shall be adequate:

- a) between live parts of different polarity which are or can be separated;
- b) between live parts and external parts, including fixing screws; and
- c) between live parts and control terminals, where relevant.

In the case of lamp controlgear having an internal connection or component between one or more output terminals and the earth terminal, such a connection shall be removed during this test.

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 h before the humidity treatment.

12 ELECTRIC STRENGTH

Lamp controlgear shall have adequate electric strength.

Immediately after the measurement of the insulation resistance, the lamp controlgear shall withstand an electric strength test for 1 min applied between the parts specified in **11**.

The test voltage of substantially sine-wave form, having a frequency of 50 Hz shall correspond to the values in Table 1. Initially, not more than half the specified voltage shall be applied, the voltage then being raised rapidly to the prescribed value.

No flashover or breakdown shall occur during the test.

The high-voltage transformer used for the test shall be so designed that when the output terminals are short-

circuited after the output voltage has been adjusted to the appropriate test voltage, the output current is at least 200 mA.

Table 1 Electric Strength Test Voltage
(Clause 12)

Sl No.	Working Voltage U	Test Voltage V
(1)	(2)	(3)
i)	Up to and including 42 V	500
ii)	Above 42 V up to and including 1 000 V	2 U + 1 000

NOTE — For converters, the electric strength test between parts separated by reinforced insulation shall be in accordance with Fig. 9, curve B, of IS 616.

The over current relay shall not trip when the output current is less than 100 mA.

The rms value of the test voltage applied shall be measured to within ± 3 percent.

The metal foil referred to in **11** shall be placed so that no flashover occurs at the edges of the insulation.

Glow discharges without drop in voltage are neglected.

13 THERMAL ENDURANCE TEST FOR WINDINGS OF BALLASTS

Windings of ballasts shall have adequate thermal endurance.

Compliance is checked by the following test.

The purpose of this test is to check the validity of the rated maximum operating temperature (t_w) marked on the ballast. The test is carried out on seven new ballasts which have not been subjected to the preceding tests. They shall not be used for further testing.

This test may also be applied to ballasts which form an integral part of a luminaire and which cannot be tested separately, thereby enabling such integral ballasts to be made with a t_w value.

Before the test, each ballast shall start and operate a lamp normally, and the lamp arc current shall be measured under normal conditions of operation and at a rated voltage. Details of the thermal endurance test are prescribed below. The thermal conditions shall be so adjusted that the objective duration of the test is as indicated by the manufacturer. If no indication is given, the test period shall be 30 days.

The test is carried out in an appropriate oven.

The ballast shall function electrically in a manner similar to that in normal use, and, in the case of capacitors, components or other auxiliaries not

subjected to the test, these shall be disconnected and reconnected again in the circuit but outside the oven. Other components which do not influence the operating conditions of the windings may be removed.

In general, to obtain normal operating conditions, the ballast is tested with the appropriate lamp.

The ballast container, if of metal, is earthed. Lamps are always kept outside the oven.

For certain inductive ballasts of simple impedance (for example, switch-start choke ballasts). The test is made without a lamp or resistor, provided the current is adjusted to the same value as found with the lamp at rated supply voltage.

The ballast is connected to the power supply so that the voltage stress between the lamp controlgear winding and earth is similar to the one in the lamp method.

Seven ballasts are placed in the oven, and the rated supply voltage applied to each of the circuits.

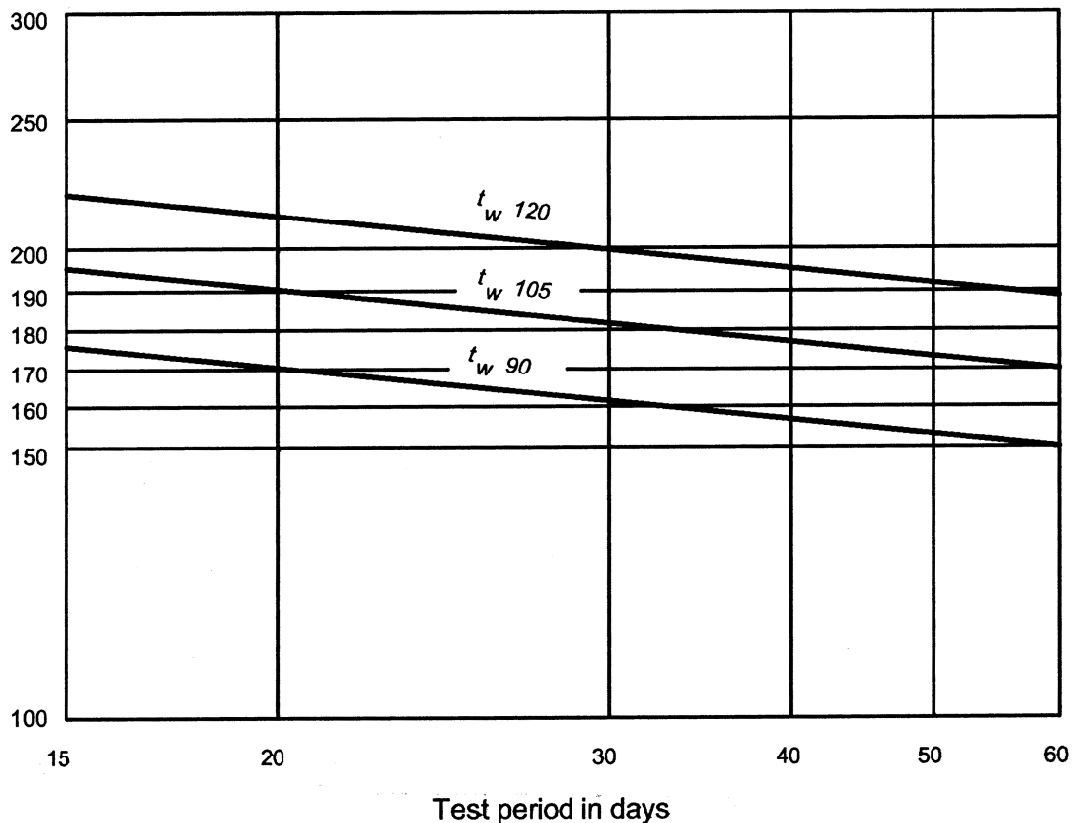
The oven thermostats are then regulated so that the internal temperature of the oven attains a value such that the temperature of the hottest winding in each of

the ballasts is approximately equal to the theoretical value given in Table 2.

For ballasts subjects to a test duration longer than 30 days, the theoretical test temperatures shall be calculated by means of equation (1) as explained in Note 3.

After 4 h, the actual temperature of the winding is determined by the 'change-in-resistance' method, and if necessary, the oven thermostats are readjusted to approximate as closely as possible the desired test temperature. Thereafter, a daily reading of the air temperature in the oven is taken to ensure that the thermostats are maintained at the correct value to within $\pm 2^\circ\text{C}$.

The winding temperatures are measured again after 24 h and the final test period for each lamp controlgear is determined from equation (2). Figure 1 illustrates this in graphical form. The permissible difference between the actual temperature of the hottest winding of any of the ballasts under test and the theoretical value shall be such that the final test period is at least equal to, but not more than twice, the foreseen test period.



NOTE — These curves are for information only and illustrate equation (2) using a constant S of 4 500 (see Annex E).

FIG. 1 RELATION BETWEEN WINDING TEMPERATURE AND ENDURANCE TEST DURATION

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No attempt shall be made to hold the winding temperature constant after the measurement taken after 24 h. Only the ambient air temperature shall be stabilized by the thermostatic control.

The test period for each ballast starts from the time the ballast is connected to the supply. At the end of its test, the relevant ballast is disconnected from the supply but is not removed from the oven until the tests on the other ballast have been completed.

After the test, when the ballasts have returned to room temperature, they shall satisfy the following requirements.

- a) At rated voltage, the ballast start the same lamp and the lamp arc current shall not exceed 115 percent of the value measured before the test, as described above.
- b) The insulation resistance between the winding and the ballast case, measured at approximately 500 V dc shall be not less than 1 MΩ.

The result of the test is considered to be satisfactory, if at least six of the seven ballasts satisfy these requirements. The test is considered to have failed if more than two ballasts fall the test.

In the case of two failures, the test is repeated with seven more ballasts and no failure of these is permitted.

NOTES

1 Where it is necessary to disconnect capacitors, components or other auxiliaries, it is recommended that the manufacturer supplies special ballasts with these parts removed and any necessary additional connections brought out from the ballast.

2 For the measurement of winding temperature by the

'change-in-resistance' method, the following equation (1) is applicable:

$$t_2 = \frac{R_2}{R_1}(234.5 + t_1) - 234.5 \quad \dots(1)$$

where

- t_1 = initial temperature in °C;
- t_2 = final temperature in °C;
- R_1 = resistance at temperature t_1 ; and
- R_2 = resistance at temperature t_2 .

The constant 234.5 relates to copper windings; for aluminium, this constant should be 229.

3 The theoretical test temperatures given in Fig. 1 correspond to a working life of 10 years' continuous operation at the rated maximum operating temperature t_w . They are computed using the following equation:

$$\log L = \log L_o + S \left(\frac{1}{T} - \frac{1}{T_N} \right) \quad \dots(2)$$

where

- L = objective endurance test life in days (30, 60, 90 or 120);
- L_o = 3 652 days (10 years);
- T = theoretical test temperature, in Kelvin ($t + 273$);
- T_w = rated maximum operating temperature, in Kelvin ($t_w + 273$); and
- S = constant depending on the design of the lamp controlgear and the winding insulation used.

4 This test is to determine any adverse change in the ballast setting.

14 FAULT CONDITIONS

Lamp controlgear shall be so designed that, when

**Table 2 Theoretical Test Temperatures for Ballasts Subjected to an Endurance Test
Duration of 30 Days
(Clause 13.1)**

SI No.	Constant S	Theoretical Test Temperature, °C					
		S 4.5	S 5	S 6	S 8	S 11	S 16
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
i)	For $t_w = 90$	163	155	142	128	117	108
ii)	95	171	162	149	134	123	113
iii)	100	178	169	156	140	128	119
iv)	105	185	176	162	146	134	125
v)	110	193	183	169	152	140	130
vi)	115	200	190	175	159	146	136
vii)	120	207	197	182	165	152	141
viii)	125	215	204	189	171	157	147
ix)	130	222	211	196	177	163	152
x)	135	230	219	202	184	169	158
xi)	140	238	226	209	190	175	163
xii)	145	245	233	216	196	181	169
xiii)	150	253	241	223	202	187	175

NOTE — Unless otherwise indicated on the ballast, the theoretical test temperatures specified in column S 4.5 apply. The use of a constant other than S 4.5 must be justified in accordance with Annex E.

operated under fault conditions, there shall be no emission of flames or molten material or production of flammable gases. The protection against accidental contact in accordance with 10.1 shall not be impaired.

Operation under fault conditions denotes that each of the conditions specified in 14.1 to 14.4 is applied in turn and, associated with it, those other fault conditions which are a logical consequence thereof; with the provision that only one component at a time should be subjected to a fault condition.

Examination of the apparatus and its circuit diagram will generally show the fault conditions which should be applied. These are applied in sequence in the order which is most convenient.


Totally enclosed lamp controlgear or components shall not be opened for examination nor for the application of internal fault conditions. However, in case of doubt, in conjunction with the examination of the circuit diagram, either the output terminals shall be short-circuited or, in agreement with the manufacturer, a specially prepared lamp controlgear shall be submitted for testing.

A lamp controlgear or component is considered to be totally enclosed if it is encapsulated in a self-hardening compound bonded to the relevant surfaces so that clearances in air do not exist.

Components in which, according to the manufacturer's specifications, a short circuit cannot occur, or which eliminate a short circuit, shall not be bridged. Components in which, according to the manufacturer's specification, an open circuit cannot occur shall not be interrupted.

The manufacturer shall show evidence that the components behave in the foreseen way, for example by showing compliance with the relevant standard.

Capacitors, resistors or inductors not complying with a relevant standard shall be short-circuited or disconnected whichever is the more unfavourable.

For lamp controlgear marked with , the lamp controlgear case temperature at any place shall not exceed the marked value.

14.1 Short Circuit Across Creepage Distances and Clearances

The short circuit across creepage distances and clearances if less than the values specified in 16, taking into account any reduction allowed in 14.1 to 14.4. Between conductors protected from surge energy from the supply (for example, by choke winding or capacitor) which are on a printed board complying with the pull-off and peel strength requirements specified in IS 5921 (Part 1), the creepage distance requirements

are modified. The distances of Table 3 are replaced by the values calculated from the following equation:

$$\log d = 0.78 \log \frac{V}{300} \quad \dots(3)$$

with a minimum of 0.5 mm

where

d = distance, in mm; and

V = peak value of the voltage, in V.

These distances can be determined by reference to Fig. 2.

Creepage distances of printed circuit boards may have lower values than described above if coating according to IS 15382 (Part 3) is used. This applies also for creepage distances between live parts and parts which are connected to accessible metal parts. Tests according to the relevant clauses of IS 15382 (Part 3) shall show compliance with the requirement.

NOTES

1 Lamp controlgear and filter coils without these symbols are checked together with the luminaire in accordance with IS 10322 (Part 1).

2 Creepage distances and clearance below the values of clause 16 are not allowed between live parts and accessible metal parts.

3 Coverings of lacquer or the like on printed circuit boards are ignored when calculating the distances.

14.2 Short Circuit Across or, if Applicable, Interruption of Semi-conductor Devices

Only one component at a time shall be short-circuited (or interrupted).

14.3 Short Circuit Across Insulation Consisting of Covering of Lacquer, Enamel or Textile

Such coverings are ignored in assessing the creepage distances and clearances specified in Table 3. However, if enamel forms the insulation of a wire and withstands the voltage test prescribed in 13 of IS 13730 (Part 0/ Sec 1), it is considered as contributing 1 mm to those creepage distances and clearances in air.

This clause does not imply a need to short-circuit the insulation between turns of coils, insulating sleeves or tubing.

14.4 Short Circuit Across Electrolytic Capacitors

Compliance is checked by operating the lamp controlgear at any voltage between 0.9 and 1.1 times the rated supply voltage with the lamp connected with the lamp controlgear case at t_c ; then, each of the fault conditions outlined in 14.1 to 14.4, inclusive shall be applied in turn.

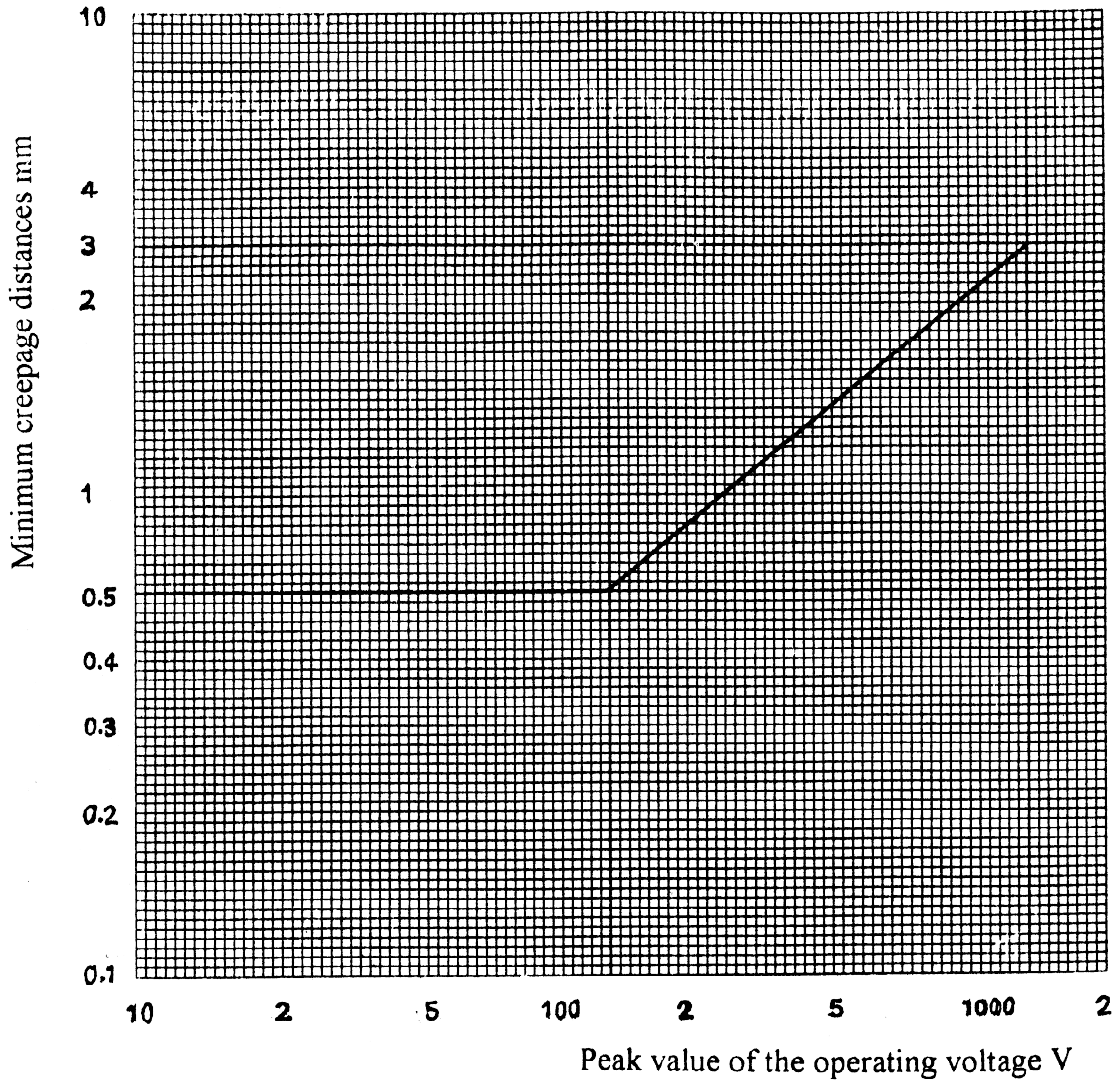


FIG. 2 CREEPAGE DISTANCES BETWEEN CONDUCTORS ON PRINTED BOARDS NOT CONDUCTIVELY CONNECTED TO THE SUPPLY MAINS

The test is continued until stable conditions are obtained, and the lamp controlgear case temperature is measured. When making the tests of 14.1 to 14.4 components such as resistors, capacitors, semiconductors, fuses, etc, may fail. It is permitted to replace such components so as to continue the test.

After the tests, when the lamp controlgear has returned to ambient temperature, the insulation resistance measured at approximately 500 V dc shall be not less than 1 MΩ.

To check whether gases liberated from component part are flammable or not, a test with a high-frequency spark generator is made.

To check whether accessible parts have become live, the test according to Annex A is carried out.

To check whether emission of flames or molten material might present a safety hazard, the test specimen is wrapped with a tissue paper, as specified in IS 4261 shall not ignite.

15 CONSTRUCTION

15.1 Wood, Cotton, Silk, Paper and Similar Fibrous Material

Wood, cotton, silk, paper and similar fibrous material shall not be used as insulation, unless impregnated.

Compliance is checked by inspection.

15.2 Printed Circuits

Printed circuits are permitted for internal connections.

Compliance is checked by reference to 14.

16 CREEPAGE DISTANCES AND CLEARANCES

Creepage distances and clearance shall be not less than the values given in Tables 3 and 4. As appropriate unless otherwise specified in 14.

The contribution to the creepage distance of any groove less than 1 mm wide shall be limited to its width.

Any air gap of less than 1 mm shall be ignored in computing the total air path.

A metal enclosure shall have an insulating lining in accordance with IS 10322 (Part 1) if, in the absence of such a lining, the creepage distance or clearance between the live parts and the enclosure would be smaller than the value prescribed in the relevant tables.

Lamp controlgear, where the components are so encapsulated in a self-hardening compound bounded

to the relevant surfaces that no clearances exist, are not checked.

Printed circuit boards are exempt from the requirements of this clause because they are tested according to 14.

For distance subjected to both sinusoidal voltage as well as non-sinusoidal pulses, the minimum required distance shall be not less than the highest value indicated in either Table 3 or Table 4.

Creepage distances shall be not less than the required minimum clearance.

NOTES

1 Creepage distances are distances in air, measured along the external surface of the insulating material.

2 Distances between ballast windings are not measured because they are checked with the endurance test. This applies also to distances between taps.

Table 3 Minimum Distances for ac (50 Hz) Sinusoidal Voltages
(Clause 16)

SI No.	Distances	RMS Working Voltage not Exceeding (V)					
		50	150	250	500	750	1 000
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
i)	Minimum clearance, mm						
	a) between live parts of different polarity, and						
	b) between live parts and accessible metal parts which are permanently fixed to the lamp controlgear, including screws or devices for fixing covers or fixing the lamp controlgear to its support,						
	— Creepage distance						
	Insulation PTI > 600	0.6	1.4	1.7	3	4	5.5
	< 600	1.2	1.6	2.5	5	8	10
	— Clearances	0.2	1.4	1.7	3	4	5.5
	c) between live parts and a flat supporting surface or a loose metal cover, if any, if the construction does not ensure that the values under (b) above are maintained under the most unfavourable circumstances						
	— Clearances	2	3.2	3.6	4.8	6	8

NOTES

1 PTI (proof tracking index) in accordance with IS 2824.

2 In the case of creepage distances to parts not energized or not intended to be earthed where tracking cannot occur, the values specified for material with PTI ≥ 600 apply for all materials (in spite of the real PTI). For creepage distances subjected to working voltages of less than 60 s duration, the values specified for materials with PTI ≥ 600 apply for all materials.

3 For creepage distances not liable to contamination by dust or moisture, the values specified for materials with PTI ≥ 600 apply (regardless of the real PTI).

4 For lamp controlgear specified in IS 15885 (Part 2), accessible metal parts are rigidly placed in relation to live parts.

5 The creepage distances and clearances specified in this clause do not apply to those devices specified in IS 15885 (Part 2/Sec 1) which comply with the dimensions specified in IS 2215. In such instances, the requirements of that standard apply.

Table 4 Minimum Distance for Non-sinusoidal Pulse Voltages
(Clause 16)

Minimum Clearance in mm	Rated Pulse Voltage Peak kV																	
	2.0	2.5	3.0	4.0	5.0	6.0	8.0	10	12	15	20	25	30	40	50	60	80	100
	1.0	1.5	2	3	4	5.5	8	11	14	18	25	33	40	60	75	90	130	170

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17 SCREWS, CURRENT-CARRYING PARTS AND CONNECTIONS

Screws, current-carrying parts and mechanical connections, the failure of which might cause the lamp controlgear to become unsafe, shall withstand the mechanical stresses occurring in normal use.

Compliance is checked by inspection and the tests specified in relevant parts of IS 10322.

18 RESISTANCE TO HEAT, FIRE AND TRACKING

18.1 Parts of insulating material either retaining live parts in position or providing protection against electric shock shall be sufficiently resistant to heat.

For materials other than ceramic, compliance is checked by subjecting the parts to the ball-pressure test as specified in relevant parts of IS 10322 (Part 4).

18.2 External parts of insulating material providing protection against electric shock and parts of insulating material retaining live parts in position shall be sufficiently resistant to flame and ignition/fire.

For materials other than ceramic, compliance is checked by the tests of **18.3** or **18.4** as appropriate.

Printed circuit boards are not tested as above, but in accordance with IS 5921 (Part 1).

18.3 External parts of insulating material providing protection against electric shock shall be subjected for 30 s to the glow-wire test in accordance with IS 11000 (Part 2/Sec 1), subject to the following details:

- a) Test sample shall be one specimen;
- b) Test specimen shall be a complete lamp controlgear;
- c) Temperature of the tip of the glow-wire shall be 650 °C; and
- d) Any (self-sustaining) flame or glowing of the specimen shall extinguish within 30 s of removal of the glow wire and any flaming drops shall not ignite a piece of tissue paper,

as specified in IS 4261, spread out horizontally 200 ± 5 mm below the test specimen.

18.4 Parts of insulating material retaining live parts in position shall be subjected to the needle-flame test in accordance with IS 11000 (Part 2/Sec 2), subject to the following details:

- a) Test sample shall be one specimen;
- b) Test specimen shall be a complete lamp controlgear. If it is necessary to take away parts of the lamp controlgear to perform the test, care shall be taken to ensure that the test conditions are not significantly different from those occurring in normal use;
- c) Test flame is applied to the centre of the surface to be tested;
- d) Duration of application is 10 s; and
- e) Any self-sustaining flame shall extinguish within 30 s of removal of the gas flame, and any flaming drops shall not ignite a piece of tissue paper as specified in IS 4261, spread out horizontally 200 ± 5 mm below the test specimen.

18.5 Lamp controlgear intended for building into luminaires other than ordinary, independent lamp controlgear, and lamp controlgear having insulation subject to starting voltages with a peak value higher than 1 500 V shall be resistant to tracking.

For materials other than ceramic, compliance is checked by subjecting the parts to the tracking test as specified in relevant parts of IS 10322.

19 RESISTANCE TO CORROSION

Ferrous parts, the rusting of which might cause the lamp controlgear to become unsafe, shall be adequately protected against rusting.

Compliance is checked by the test specified in relevant parts of IS 10322 (Part 1).

Protection by varnish is deemed to be adequate for the outer surfaces.

ANNEX A

(Foreword and Clauses 1.1 and 3.10)

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

Under consideration.

ANNEX B

(Foreword and Clause 1.1)

PARTICULAR REQUIREMENTS FOR THERMALLY PROTECTED LAMP CONTROLGEAR

B-1 INTRODUCTORY REMARK

Two different categories of thermally protected lamp controlgear are covered by this Annex. The first category comprises 'Class P' USA lamp controlgear, referred to in this standard as 'protected lamp controlgear', which are intended to prevent lamp controlgear overheating under any conditions of use including protection of the luminaire mounting surface against overheating due to end-of-life effects.

The second category comprises 'temperature declared thermally protected lamp controlgear'. This category provides thermal protection of the mounting surface which, depending on the marked operating temperature of the thermal protection in combination with the luminaire construction, provides protection against overheating due to end-of-life effects on the lamp controlgear.

The clauses listed in this Annex supplement the corresponding clauses in the main part of the standard. Where there is no corresponding clause or subclause in this Annex, the clause or subclause of the main part applies without modification.

NOTE — A third category of thermal lamp controlgear protection is recognized where the thermal protection of the mounting surface is achieved by a thermal protector external to the lamp controlgear. Relevant requirements may be found in IS 10322 (Part 1).

B-2 SCOPE

This Annex applies to lamp controlgear for discharge lamps, intended to be built into luminaires and incorporating a means of thermal protection that is intended to disconnect the supply circuit to the lamp controlgear before the lamp controlgear case temperature exceeds the specified limits.

B-3 TERMINOLOGY


B-3.1 'Class P' Thermally Protected Lamp Controlgear

Lamp controlgear incorporating a thermal protector which is intended to prevent overheating under any conditions of use and which will protect the luminaire mounting surface against overheating due to end-of-life effects.

B-3.2 Temperature Declared Thermally Protected Lamp Controlgear

Lamp controlgear incorporating means of protection against overheating to prevent the lamp controlgear case temperature under any conditions of use from exceeding the indicated value.

Lamp controlgear marked with values up to 130 provide protection against overheating due to end-of-life effects in accordance with luminaire marking requirements [see IS 10322 (Part 1)].

If the value exceeds 130,  marked luminaires shall in addition be tested in accordance with IS 10322 (Part 1) with respect to luminaires without temperature sensing controls.

NOTE — The dots in the triangle are replaced by the value of the rated maximum case temperature in degrees Celsius at any place on the outer surface of the lamp controlgear case, as claimed by the manufacturer under the conditions given in B-9.

B-3.3 Rated Opening Temperature

The no-load temperature at which a protector is designed to open.

B-4 GENERAL REQUIREMENTS FOR THERMALLY PROTECTED LAMP CONTROLGEAR

Thermal protectors shall be an integral part of lamp controlgear and located so as to be protected against mechanical damage. Renewable parts, if any, shall only be accessible by means of a tool.

If functioning of the protection means depends on polarity, then for cord-connected equipment where the plug is not polarized, the protection shall be in both leads.

Compliance is checked by inspection and by the tests of this standard.

B-5 GENERAL NOTES ON TESTS

The appropriate number of specially prepared samples according to B-9 shall be submitted.

Only one sample need be subjected to the most onerous fault condition described in B-9.2 and only one sample



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need be subjected to the conditions described in **B-9.3** or **B-9.4**. In addition, for both protected and temperature-declared lamp controlgear, at least one lamp controlgear shall be submitted, prepared to represent the most onerous of the fault conditions described in **B-9.2**.

B-6 CLASSIFICATION

Lamp controlgear are classified according to **B-6.1** or **B-6.2**.

B-6.1 According to the Class of Protection



- a) 'Class P' thermally protected lamp controlgear, symbol , and
- b) temperature declared thermally protected lamp controlgear, symbol 

B-6.2 According to the Type of Protection

- a) Automatic resetting (cyclic) type;
- b) Manual resetting (cyclic) type;
- c) Non-renewable, non-resetting (fuse) type;
- d) Renewable, non-resetting (fuse) type; and
- e) Other type of protective method providing equivalent thermal protection.

B-7 MARKING

B-7.1 Lamp controlgear incorporating means of protection against overheating shall be marked according to the class of protection:

- a) Symbol  for 'class P' thermally protected lamp controlgear; and
- b) Symbol  for temperature declared thermally protected lamp controlgear, values increasing in multiples of 10.

The terminal(s) to which the protector(s) is (are) connected shall be identified by this symbol.

In addition, for renewable protectors, the marking shall include the type of protector to be used.

NOTES

1 This marking is required by the luminaire manufacturer to ensure that the marked terminal is not connected to the lamp side of the lamp controlgear.

2 Local wiring rules may require the protector to be connected in the line conductor. This is essential in Class I equipment where polarized supplies are used.

B-7.2 In addition to the above marking, the lamp controlgear manufacturer shall declare the type of protection in accordance with **B-6**.

B-8 THERMAL ENDURANCE OF WINDINGS

Lamp controlgear incorporating a thermal protector shall comply with the thermal endurance test of windings with the protector short-circuited.

NOTE — For type testing, the manufacturer may be asked to supply samples with short-circuited protectors.

B-9 LAMP CONTROLGEAR HEATING

B-9.1 Pre-selection Test

Before starting the tests of this clause, the lamp controlgear shall be placed (non-energized) for at least 12 h in an oven, the temperature of which is maintained at 5 K less than the rated operating temperature of the protector.

In addition, lamp controlgear with thermal fuses are allowed to cool to a temperature at least 20 K less than the rated operating temperature of the protector before being removed from the oven.

At the end of this period, a small current, for example not more than 3 percent of the nominal supply current of the lamp controlgear, shall be passed through the lamp controlgear in order to determine whether the protector is closed.

Lamp controlgear in which the protector has operated shall not be used for further testing.

B-9.2 'Class P' Thermally Protected Lamp Controlgear

These lamp controlgear are limited to a maximum case temperature of the lamp controlgear of 90°C, a rated maximum winding temperature (t_w) of 105 °C and a capacitor rated maximum operating temperature (t_c) of 70 °C.

The lamp controlgear is operated at thermal equilibrium under normal conditions in the test enclosure of which a typical example is described in Annex D, at an ambient temperature of 40⁺⁰₋₅ °C.

The protector shall not open under these conditions of operation.

The most onerous of the following fault conditions shall then be introduced and applied throughout the complete test.

To obtain these conditions, specially prepared lamp controlgear will be necessary.

B-9.2.1 For transformers, the following relevant abnormal conditions apply (in addition to those specified in relevant parts of IS 10322):

- a) For lamp controlgear specified in IS 15885 (Part 2/Sec 8):
 - 1) the outer 10 percent of the turns of primary winding is short-circuited;
 - 2) the outer 10 percent of the turns of any secondary power winding is short-circuited; and
 - 3) any power capacitor short-circuited, if such condition will not short-circuit the ballast primary winding.
- b) For lamp controlgear specified in IS 15885 (Part 2/Sec 9):
 - 1) the outer 20 percent of the turns of primary winding is short-circuited;
 - 2) the outer 20 percent of the turns of any secondary power winding is short-circuited; and
 - 3) any power capacitor short-circuited, if such condition will not short-circuit the ballast primary winding.

B-9.2.2 For chokes, the following abnormal conditions apply (in addition to those specified in relevant parts of IS 10322):

- a) For lamp controlgear specified in IS 15885 (Part 2/Sec 8):
 - 1) the outer 10 percent of the turns of each winding is short-circuited; and
 - 2) a series capacitor is short-circuited, if applicable.
- b) For lamp controlgear specified in IS 15885 (Part 2/Sec 9):
 - 1) the outer 20 percent of the turns of each winding is short-circuited; and
 - 2) a series capacitor is short-circuited, if applicable.

Three cycles of heating and cooling shall be applied for the purpose of this measurement. For non-resetting type protectors, only one cycle shall be applied on each specially prepared lamp controlgear.

Temperatures on the case of the lamp controlgear shall continue to be measured after the protector opens. Except when testing for protector reclosing temperatures, the test may be discontinued when case temperatures start to decrease following the opening of the protector, or when the specified temperature limit is exceeded.

During the test, the temperature on the case of the lamp controlgear shall not exceed 110°C and shall be no more than 85°C when the protector recloses the circuit (with a resetting type protector), except that, during

any cycle of operation of the protector during the test, the case temperature may be more than 110°C, provided that the length of time between the instant when the case temperature first exceeds the limit and the instant of attainment of the maximum temperature indicated in Table 5 does not exceed the time correspondingly indicated in that table.

The temperature on the enclosure of a capacitor provided as part of such lamp controlgear shall be no more than 90°C, except that the capacitor temperature may be more than 90°C when the case temperature is more than 110°C.

NOTE — If the case reaches a temperature not exceeding 110 °C and either remains at that temperature or starts to decrease, the test may be discontinued after 1 h of operation after the peak temperature is first reached.

Table 5 Thermal Protection Operation

Sl No.	Maximum Temperature of the Lamp Controlgear Case °C	Maximum Time for Attainment of the Maximum Temperature from 110°C <i>Min</i>
(1)	(2)	(3)
i)	Over 150	0
ii)	145-150	5.3
iii)	140-145	7.1
iv)	135-140	10
v)	130-135	14
vi)	125-130	20
vii)	120-125	31
viii)	115-120	53
	110-115	120

B-9.3 Temperature Declared Thermally Protected Lamp Controlgear as Specified in IS 15885 (Part 2/ Sec 8), with a Rated Maximum Case Temperature of 130°C or Lower

The lamp controlgear is operated at thermal equilibrium under normal conditions in the test enclosure described in Annex D, in an ambient temperature such that a winding temperature of ($t_w + 5$) °C is obtained.

The protection means shall not operate under these conditions.

The most onerous of the fault conditions described in **B-9.2** shall then be introduced and applied throughout the complete test.

During the test, the temperature on the case of the lamp controlgear shall not exceed 135 °C and shall be no more than 110 °C when the protector recloses the circuit (with a resetting type protector). However, during any cycle of operation of the protector during the test, the case temperature may be more than 135 °C, provided that the length of time between the instant when the case temperature first exceeds the limit and

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the instant of attainment of the maximum temperature indicated in Table 6 does not exceed the time corresponding to that indicated in that table.

The temperature on the enclosure of a capacitor provided as part of such a lamp controlgear shall be not more than 50 °C or t_c under conditions of normal operation and not more than 60 °C or $(t_c + 10)$ °C under conditions of abnormal operation for capacitors with or without indication of rated maximum operating temperature (t_c) respectively.

NOTE — It is permitted to operate the lamp controlgear at a current producing a winding temperature equivalent to that of the most onerous of the fault conditions described in **B-9.2**.

Table 6 Thermal Protection Operation

Sl No.	Maximum Temperature of the Lamp Controlgear Case °C	Maximum Time for Attainment of the Maximum Temperature from 135°C Min
(1)	(2)	(3)
i)	Over 180	0
ii)	175-180	15
iii)	170-175	20
iv)	165-170	25
v)	160-165	30
vi)	155-160	40
vii)	150-155	50
viii)	140-145	60
ix)	130-145	90

B-9.4 Temperature Declared Thermally Protected Lamp Controlgear as Specified in IS 15885 (Part 2/ Sec 8) with a Rated Maximum Case Temperature Exceeding 130 °C

- a) The lamp controlgear shall be operated at thermal equilibrium under condition as specified in **D-4** at a short-circuit current producing a winding temperature of $(t_w + 5)$ °C. The protection means shall not open under this condition.
- b) The lamp controlgear shall then be operated at a current producing a winding temperature identical to that under the most onerous of the fault conditions described in **B-9.2**.

During the test, the lamp controlgear case temperature shall be measured.

Then, if necessary, the current through the windings shall be increased slowly and continuously until the protection means operates.

Time intervals and increments in current shall be such that thermal equilibrium between winding temperatures and lamp controlgear surface temperatures is achieved as far as is possible.

During the test, the highest temperature of the lamp controlgear surface shall be continuously measured.

For lamp controlgear fitted with automatic resetting thermal cut-outs/protectors [see **B-6.2(a)**] or protective mechanism of another type [see **B-6.2(e)**], the test shall be continued until stable surface temperature is achieved.

The automatic-resetting thermal cut-out/protector shall work three times by switching the lamp controlgear off and on under the given conditions.

For lamp controlgear fitted with manual reset thermal cut-outs/protectors, the test shall be repeated three times allowing a 30 min interval between tests. At the end of each 30 min interval, the cut-outs/protectors shall be reset.

For lamp controlgear fitted with non-renewable, non-resetting type, and for lamp controlgear with renewable type of thermal protectors, only one test is carried out.

Compliance is achieved if the highest temperature of any part of the lamp controlgear surface does not exceed the marked value.

An overshoot of 10 percent of the declared value is permissible within 15 min after the protection means has operated. After that period, the declared value shall not be exceeded.

B-9.5 Temperature Declared Thermally Protected Lamp Controlgear as Specified in IS 15885 (Part 2/Sec 9)

The lamp controlgear shall be operated at thermal equilibrium, under conditions as specified in **H-12**, at a short-circuit current producing a winding temperature of $(t_w + 5)$ °C. The protector shall not open under this condition.

The lamp controlgear shall then be operated at a current producing a winding temperature identical to that under the most onerous of the fault conditions described in **B-9.2**. During the test, the lamp controlgear case temperature shall be measured.

The circuit subjected to abnormal conditions shall be operated with a slowly and steadily increasing current through the windings until the thermal protector operates. Time intervals and increments in current shall be such that thermal equilibrium between winding temperatures and lamp controlgear surface temperatures is achieved as far as is practicable.

During the test, the highest temperature of any part of the lamp controlgear surface shall be continuously measured.

For lamp controlgear fitted with automatic resetting thermal protectors [see **B-6.2(a)**], or with a protective

method of another type [*see* **B-6.2(e)**], the test shall be continued until a stable surface temperature is achieved. The automatic setting thermal protector shall work three times by switching the lamp controlgear off and on under the given conditions.

For lamp controlgear fitted with a manual resetting thermal protector, the test shall be repeated three times allowing a 30 min interval between tests. At the end of each 30 min interval, the cut-outs shall be reset.

For lamp controlgear fitted with non-renewable, non-resetting type, and for ballasts with renewable types of thermal protectors, only one test is carried out.

For lamp controlgear where a combination of the protective devices mentioned is used, the lamp controlgear shall be tested as for the protection device that provides the primary protection for temperature control, as declared by the manufacturer.

Compliance is achieved if the highest temperature of any part of the lamp controlgear surface does not exceed the marked value.

An overshoot of 10 percent of the marked value is permissible within 15 min after the protection means has operated. After that period, the marked value shall not be exceeded.

ANNEX C

(Foreword and Clause 1.1)

PARTICULAR REQUIREMENTS FOR ELECTRONIC LAMP CONTROLGEAR WITH MEANS OF PROTECTION AGAINST OVERHEATING

C-1 SCOPE

This Annex applies to electronic lamp controlgear incorporating a means of thermal protection that is intended to open the supply circuits to the lamp controlgear before the lamp controlgear case temperature exceeds the declared limits.


C-2 TERMINOLOGY


C-2.1 Temperature Declared Thermally Protected

Lamp Controlgear 

Lamp controlgear incorporating means of protection against overheating to prevent the lamp controlgear case temperature exceeding the indicated value

NOTE — The three dots in the triangle are replaced by the value of the rated maximum case temperature in degrees Celsius at any place on the outer surface of the lamp controlgear case as claimed by the manufacturer under the conditions given in C-7.

Lamp controlgear marked with values up to 130 provide protection against overheating due to end-of-life effects in accordance with luminaire  marking requirements (*see* relevant parts of IS 10322).

If the value exceeds 130,  marked luminaires shall, in addition, be tested in accordance with relevant parts of IS 10322 with respect to luminaires without temperature sensing controls.

C-3 GENERAL REQUIREMENTS FOR ELECTRONIC LAMP CONTROLGEAR WITH MEANS OF PROTECTION AGAINST OVERHEATING

C-3.1 Thermal protection means shall be an integral part of lamp controlgear and located so as to be protected against mechanical damage. Renewable parts, if any, shall be accessible only by means of a tool.

If the functioning of the protection means depends on polarity, then, for cord-connected equipment where the plug is not polarized, the protection shall be in both leads.

Compliance is checked by inspection and by the tests of this standard.

C-3.2 The circuit breaking of the protection means shall not give rise to any fire risk.

Compliance is checked by the tests of C-7.

C-4 GENERAL NOTES ON TESTS

The appropriate number of specially prepared samples according to C-7 shall be submitted.

Only one sample need be subjected to the most onerous fault conditions described in C-7.2.

C-5 CLASSIFICATION


Thermally protected lamp controlgear are classified according to the type of protection:

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- a) Automatic resetting type;
- b) Manual resetting type;
- c) Non-renewable, non-resetting type;
- d) Renewable, non-resetting type; and
- e) Protective method of another type providing equivalent thermal protection.

C-6 MARKING

Thermally protected lamp controlgear shall be marked as follows:

C-6.1 The symbol  is used for temperature declared thermally protected lamp controlgear, values increasing in multiples of 10.

C-6.2 In addition to the above marking, the lamp controlgear manufacturer shall declare the type of protection in accordance with **C-5**. This information may be given in the manufacturer's catalogue or similar.

C-7 LIMITATION OF HEATING

C-7.1 Pre-selection Test

Before starting the tests of this clause, the lamp controlgear shall be placed (non-energized) for at least 12 h in an oven the temperature of which is maintained at 5 K less than the case temperature t_c .

Lamp controlgear in which the protector has operated shall not be used for further testing.

C-7.2 Functioning of the Protection Means

The lamp controlgear is operated at thermal equilibrium under normal conditions in the test enclosure described in Annex D, at an ambient temperature such that a case temperature of $(t_{c-5}^{+0})^{\circ}\text{C}$ is obtained. The protection means shall not operate under these conditions.

The most onerous of the fault conditions described in **14.1** to **14.4** shall then be introduced and be applied throughout the complete test.

If the lamp controlgear under test contains windings such as filter coils for suppressing harmonics, which are connected to mains supply, the output connections of these windings shall be short-circuited and the remaining part of the lamp controlgear shall be operated as under normal conditions. Filter coils for radio interference suppression are not subjected to the test.

Then, if necessary, the current through the windings shall be increased slowly and continuously until the protection means operates. Time intervals and increments in current shall be such that the thermal equilibrium between winding temperatures and lamp controlgear surface temperatures is achieved as far as possible. During the test, the highest temperature of the lamp controlgear surface shall be continuously measured.

For lamp controlgear fitted with automatic-resetting thermal protectors [see **C-5(a)**], or a protective method of another type [see **C-5(a)**], the test shall be continued until a stable surface temperature is achieved.

The automatic-resetting thermal protector shall work three times by switching the lamp controlgear off and on under the given conditions.

For lamp controlgear fitted with manual reset thermal protectors, the test shall be repeated six times allowing a 30 min interval between tests. At the end of each 30 min interval, the protectors shall be reset. For lamp controlgear fitted with non-renewable, non-resetting type protectors and for lamp controlgear with renewable type thermal protectors, only one test is carried out.

Compliance is achieved if the highest temperature of any part of the lamp controlgear surface does not exceed the marked value.

An overshoot of 10 percent of the marked value is permissible within 15 min after the protection means has operated. After that period, the marked value shall not be exceeded.

NOTE — This can be realized by specially prepared test samples.

ANNEX D

(Foreword and Clauses B-9.3, B-9.4 and C-7.2)

REQUIREMENTS FOR CARRYING OUT THE HEATING TESTS OF THERMALLY PROTECTED LAMP CONTROLGEAR

D-1 TEST ENCLOSURE

The heating tests are made in an enclosure in which the temperature of the ambient air is maintained as specified (*see* Fig. 3). The entire test enclosure shall be constructed of heat resistant material 25 mm thick. The test compartment of this enclosure shall have internal dimensions of 610 mm × 610 mm × 610 mm. The floor of the test compartment shall measure 560 mm × 560 mm, permitting an air space of 25 mm all around the platform for circulation of the heated air. A 75 mm heater compartment shall be provided below the floor of the test area for the heating elements. One side of the test compartment may be removable, but shall be so constructed that it can be securely fastened to the remainder of the enclosure. One of the sides shall have a 150 mm square opening located centrally at the bottom edge of the test compartment, and the enclosure so constructed that the only possibility of air circulation will be through this opening. The opening shall be covered by an aluminium shield as shown in Fig. 3.

D-2 HEATING OF ENCLOSURE

The heat source used for the test enclosure described above shall consist of four 300 W strip heaters having approximate heating surface dimensions of 40 mm × 300 mm. These elements shall be connected in parallel to the supply source. The elements shall be mounted in the 75 mm heater compartment midway between the test compartment floor and the base, and so arranged that they form a square with the outside edge of each element 65 mm from the adjacent inside wall of the enclosure. The element shall be controlled by a suitable thermostat.

D-3 LAMP CONTROLGEAR OPERATING CONDITIONS

During the test, the frequency of the supply circuit shall be the rated frequency of the lamp controlgear, and the voltage of the supply circuit shall be the rated supply voltage of the lamp controlgear. During the test,

the temperature in the enclosure shall be maintained at 40_{-5}^{+0} °C; prior to the test, the lamp controlgear (not energized) shall be placed in the chamber for a sufficient interval of time to allow all parts to attain the temperature of the air therein. If the temperature in the chamber at the end of the test differs from that at the beginning of the test, this temperature differential shall be taken into account in determining the temperature rise of the components of the lamp controlgear. The lamp controlgear shall supply the number and size of lamps for which it is intended. Lamps shall be placed outside the enclosure.

D-4 LAMP CONTROLGEAR POSITION IN THE ENCLOSURE

During the test, the lamp controlgear shall be in its normal operating position supported 75 mm above the floor of the test compartment by two 75 mm wooden blocks, and shall be centrally located with respect to the sides of the enclosure. Electrical connections may be brought out of the enclosure through the 150 mm square opening illustrated in Fig. 3. During the test, the enclosure shall be so located that the shielded opening is not exposed to draughts or rapid air currents.

D-5 TEMPERATURE MEASUREMENTS

The average ambient temperature in the enclosure is assumed to be the average air temperature at positions not less than 76 mm from the nearest wall and on a level with the centre of the lamp controlgear.

The temperature is usually measured by a glass thermometer. An alternative sensor is a thermocouple or 'thermistor' attached to a small metal vane shielded against radiation.

Temperatures on the case are usually measured by means of thermocouples. A temperature is considered to be constant when three successive readings, taken at intervals of 10 percent of the previously elapsed duration of the test (but not less than 5 min intervals), indicate no change.

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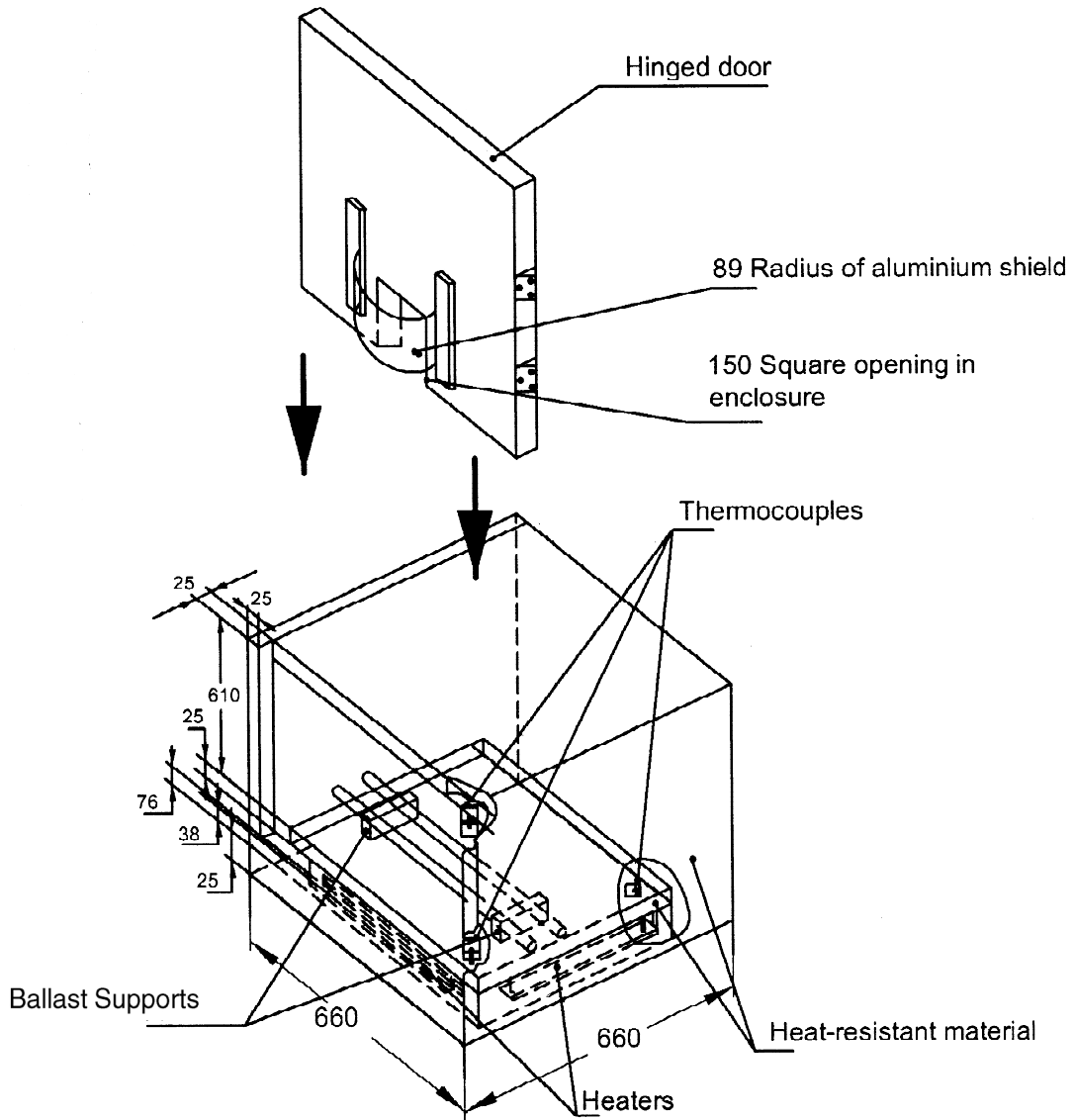


FIG. 3 EXAMPLE OF HEATING ENCLOSURE FOR THERMALLY PROTECTED BALLASTS

ANNEX E (Foreword)

USE OF CONSTANT S OTHER THAN 4 500 IN t_w TESTS

E-1 The test outlined in this Annex are intended to enable the manufacturer to prove a claimed value of S other than 4 500.

Theoretical test temperatures T for use in ballast endurance tests are calculated from equation (2) given in **13**.

If no claim is made to the contrary, S shall be taken to be 4 500 but a manufacturer may claim the use of any of the values given in Table 2 if this can be justified by procedures A or B.

If the use of a constant other than 4 500 for a particular ballast has been proved on the basis of procedures A or B, then that constant may be used in endurance tests for that ballast and others using the same construction and materials.

E-2 PROCEDURE A

The manufacturer submits experimental data relating life expectancy to winding temperature for the ballast design concerned, based on enough samples, but no fewer than 30.

From this data, the regression line relating T to $\log L$, together with the 95 percent confidence lines associated with it, are computed.

A straight line is then drawn through the points where the 10 days and 120 days abscissae intersect the upper and lower 95 percent confidence line respectively. See Fig. 4 for a typical presentation. If the inverse of the slope of this line is greater than, or equal to, the claimed value of S , then the latter has been proved within 95 percent confidence limits. For failure criteria, see procedure B.

NOTE — The points at 10 days and 120 days represent the smallest interval needed for the application of the confidence lines. Other points may be used provided a similar or greater interval is covered.

E-3 PROCEDURE B

The testing authority shall test 14 new ballasts submitted by the manufacturer in addition to those required for the endurance test, divided at random into groups of seven. The manufacturer shall state the value of S claimed and the test temperature T_1 — required to achieve nominal average ballast life of 10 days — together with the corresponding test and the claimed value of S in the following version of equation (2):

$$\frac{1}{T_2} = \frac{1}{T_1} + \frac{1}{S} \log \frac{120}{10} \text{ or } \frac{1}{T_2} = \frac{1}{T_1} + \frac{1.079}{S} \quad \dots(4)$$

where

T_1 = theoretical test temperature in kelvin for 10 days;

T_2 = theoretical test temperature in kelvin for 120 days; and

S = claimed constant.

Endurance tests are then carried out using the basic method described in clauses **13** on the two groups of seven ballasts, based on the theoretical temperature T_1 (Test 1) and T_2 (Test 2), respectively.

If the current deviates by more than 15 percent from the initial value measured 24 h after the commencement of the test, the test shall be repeated at a lower temperature. The duration of the test is calculated with the help of equation (2). Ballasts are considered to have failed, if during operation in the oven:

- a) ballast becomes open-circuit; and
- b) breakdown of the insulation occurs, as indicated by the operation of a fast-acting fuse with a current rating of 150 percent to 200 percent of the initial supply current measured after 24 h.

Test 1, the duration of which shall be equal to, or greater than, 10 days, is continued until all the ballasts have failed and the mean life L_1 has been calculated from the mean of the logarithm of the individual lives at temperature T_1 from this, the corresponding mean life L_2 at temperature T_2 is calculated with the help of equation (4):

$$L_2 = L_1 \exp \left[\frac{S}{\log_e \left(\frac{1}{T_2} - \frac{1}{T_1} \right)} \right]$$

Test 2 is continued until such time as the mean life at temperature T_2 exceeds L_2 ; this result implies that the constant for the sample is at least that claimed. However, if all the samples in test 2 fail before the mean life reaches L_2 , then the constant S claimed for the samples has not been verified.

The test lives shall be normalized from the actual test temperature to the theoretical test temperature using the claimed constant S .

In the case of ballasts incorporating temperature-sensitive materials, a nominal ballast life of 10 days might not be appropriate. In such cases, the

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manufacturer may adopt a longer life providing this is shorter than the appropriate endurance test period, for example, 30, 60, 90 or 120 days. In such cases, the longer nominal ballast life shall be at least 10 times that of the shorter (for example, 15/150 days, 18/180 days, etc).

NOTES

1 Care should be taken to ensure that the failure of one or more of the ballasts does not affect the temperature of the remaining ballast on test.

2 It is not generally necessary to continue test 2 until all the ballasts have failed. Calculation of the necessary duration of the test is simple but needs to be updated whenever a failure occurs.

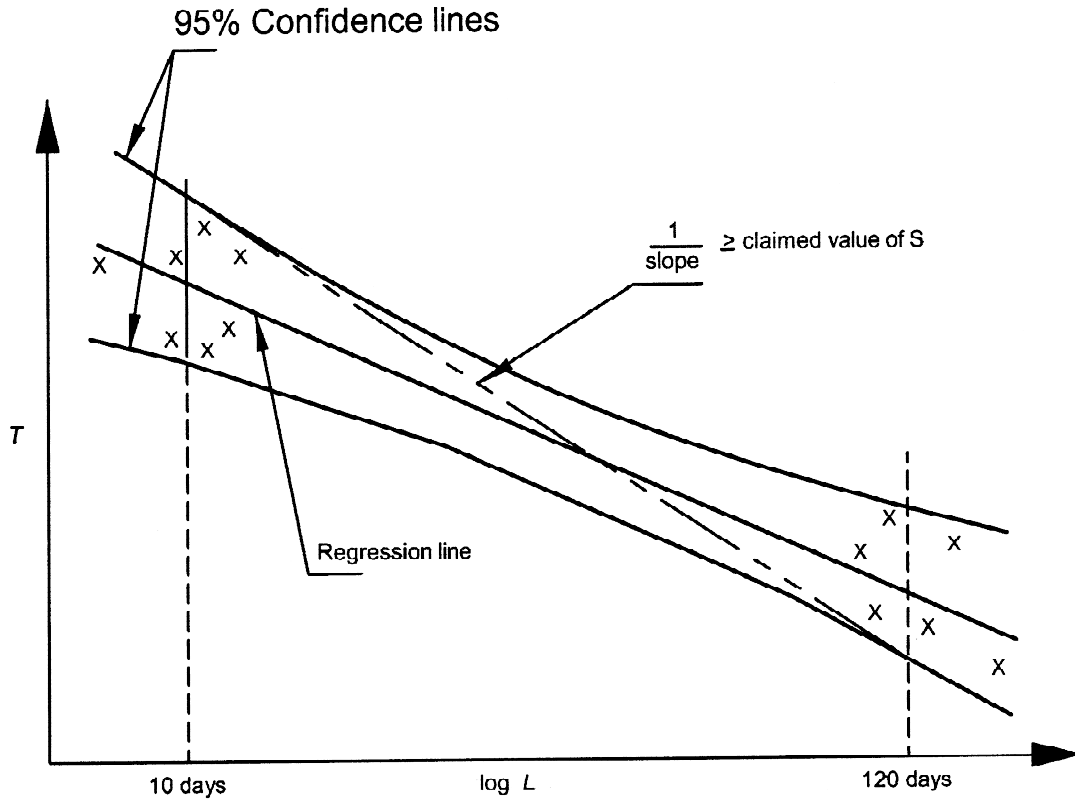


FIG. 4 ASSESSMENT OF CLAIMED VALUE OF *S*

ANNEX F

(Foreword)

DRAUGHT-PROOF ENCLOSURE

F-1 The following recommendations refer to the construction and use of a suitable draught-proof enclosure, as required for the test of lamp controlgear heating. Alternative constructions for draught-proof enclosures are permitted if it is established that similar results are obtained.

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

The internal surfaces should be painted with a matt paint. The three principal internal dimensions should each be at least 900 mm. There should be a clearance

of at least 200 mm between the internal surfaces and the top and four sides of the largest lamp controlgear for which the enclosure is designed.

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

Lamp controlgear under test should be positioned as far as possible from the five internal surfaces of the enclosure, the lamp controlgear with wooden blocks standing on the bottom of the enclosure, as required by Annex D.

NOTE — If it is required to test two or more sets of lamp controlgear in a large enclosure, care is taken that radiation from one lamp controlgear cannot affect any other.

ANNEX G

(Foreword)

EXPLANATION OF THE DERIVATION OF THE VALUES OF PULSE VOLTAGES

G-1 The pulse voltage rise time T is intended to shock-excite the input filter of the inverter and produce a 'worst-case' effect. The time of 5 μ s is chosen to be less than the rise time of a very poor input filter.

$$T = \sqrt{LC} \quad \dots(5)$$

where

L = the input filter inductance, and

C = the input filter capacitance.

G-2 The peak value for long-duration pulse voltages is given as two times the design voltage (*see* Fig. 5).

For 13 V and 26 V invertors, this gives a voltage applied to the inverter as follows:

$$(13 \times 2) + 15 = 41; \text{ and}$$

$$(26 \times 2) + 30 = 82.$$

NOTE — Fifteen and 30 are the maximum values of the voltage ranges of 13 V and 26 V invertors respectively.

G-3 The peak value for short-duration pulse voltages is given as eight times the design voltage.

For 13 V and 26 V invertors this gives a voltage applied to the inverter as follows:

$$(13 \times 8) + 15 = 119 \text{ V}; \text{ and}$$

$$(26 \times 8) + 30 = 238 \text{ V}.$$

NOTE — Fifteen and 30 are the maximum values of the voltage ranges of 13 V and 26 V invertors respectively.

G-4 Explanations referring to the choice of values for the components of the circuit for measuring short-duration pulse energy illustrated in Fig. 6.

The discharge shall be made aperiodic in order that the Zener diode receives one pulse only. Consequently,

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the resistance R shall be sufficiently large to ensure that,

- a) the influence of the self-inductance L of the circuit, due to the wiring, is sufficiently small; this implies that the time-constant L/R is definitely smaller than the time constant RC ; and
- b) the maximum value of the current [which may be assessed by $(V_{pk} - V_z)/R$] should be compatible with the good operation of the Zener diode.

On the other hand, this resistance R should not be too large if the pulse has to remain short-lived.

With a total inductance of 14 H (as indicated in the notes to Fig. 6) and the values for C Indicated below, it appears that the previous conditions may be fulfilled with values of R of the order of magnitude of 20 Ω for an inverter whose design voltage is 13 V rising to about 200 Ω for a design voltage of 110 V.

It should be noted that it is not necessary to insert a separate inductance L in the circuit of Fig. 6.

Assuming an aperiodic discharge, the value of the capacity C is related to the energy E_z applied to the Zener diode (which takes the place of the inverter) and to the voltages involved by the expression:

$$C = \frac{E_z}{(V_{pk} - V_z - V_{CT}) \times V_z} \quad \dots(5)$$

where

- V_{pk} = voltage initially applied to capacitor C ;
- V_z = voltage of the Zener diode; and
- V_{CT} = final voltage on capacitor C_T .

Let us denote by

- V_d = design voltage of the inverter to be tested; and
- V_{Max} = maximum value of its rated voltage range (1.25 V_d);

One will choose

$$V_z = V_{Max} \text{ (the best possible approximation); and}$$

$$V_{pk} = 8 V_d + V_{Max}$$

And, moreover, V_{CT} will remain equal to or less than 1 V.

This last condition allows this voltage V_{CT} to be neglected with respect to the difference $(V_{pk} - V_z)$ and one may thus write

$$C = \frac{E_z}{(V_{pk} - V_z) \times V_z} \quad \dots(7)$$

With the values for the voltage indicated above and with the prescribed conditions $E_z = 1$ mJ, the expression of C becomes

$$C (F) = \frac{125}{V_d \times V_{Max}} \quad \dots(8)$$

On the other hand, a minimum value for the capacity C_T may be computed starting from

$$E_z = C_T V_{CT} V_z \quad \dots(9)$$

And, adopting 1 mJ for E_C and 1 V for V_{CT} , we are led to

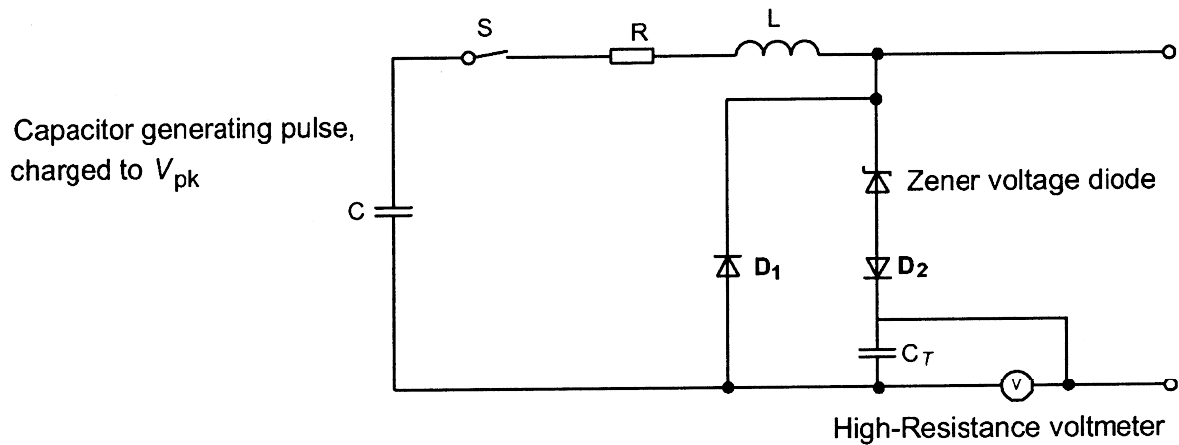
$$C_T (F) + \frac{1000}{V_{Max}} \quad \dots(10)$$

Considering the case where $V_{Max} = 1.25 V_d$, the values of capacities C and C_T may then be expressed as a function of the design voltage V_d as follows:

$$C (F) + \frac{100}{(V_d)^2} \quad \dots(11)$$

and

$$C_T (F) + \frac{800}{V_d} \quad \dots(12)$$



Components

R = resistance of the circuit (for the discussion on its value, see Annex G).

L = inductance representing the self-inductance of the circuit (it is thus not necessary to materialize it by a separate element in this measuring circuit).

Z = Zener diode whose voltage V_Z will be chosen as near as possible to the maximum value voltage range (V_{Max}).

C = capacitor initially charged to a voltage V_{pk} equal to eight times the design voltage of the inverter and intended to deliver an energy of 1 mJ into the diode Z .

As indicated in Annex G, the value of its capacity is given by

$$C (\mu\text{F}) + \frac{125}{V_d \times V_{Max}} \text{ or } \frac{100}{(V_d)^2} \text{ if } V_{Max} = 125 V_d \quad \dots(13)$$

C_T = integration capacitor chosen so that after discharge, the voltage V on it is equal to or less than 1 V.

The value of its capacity is given by

$$C_T (\mu\text{F}) + \frac{1000}{V_{Max}} \text{ or } \frac{800}{V_d} \text{ if } V_{Max} = 1.25 V_d \quad \dots(14)$$

This capacitor must be of a non-electrolytic type so that a voltage is not induced by the dielectric film before the initial charge.

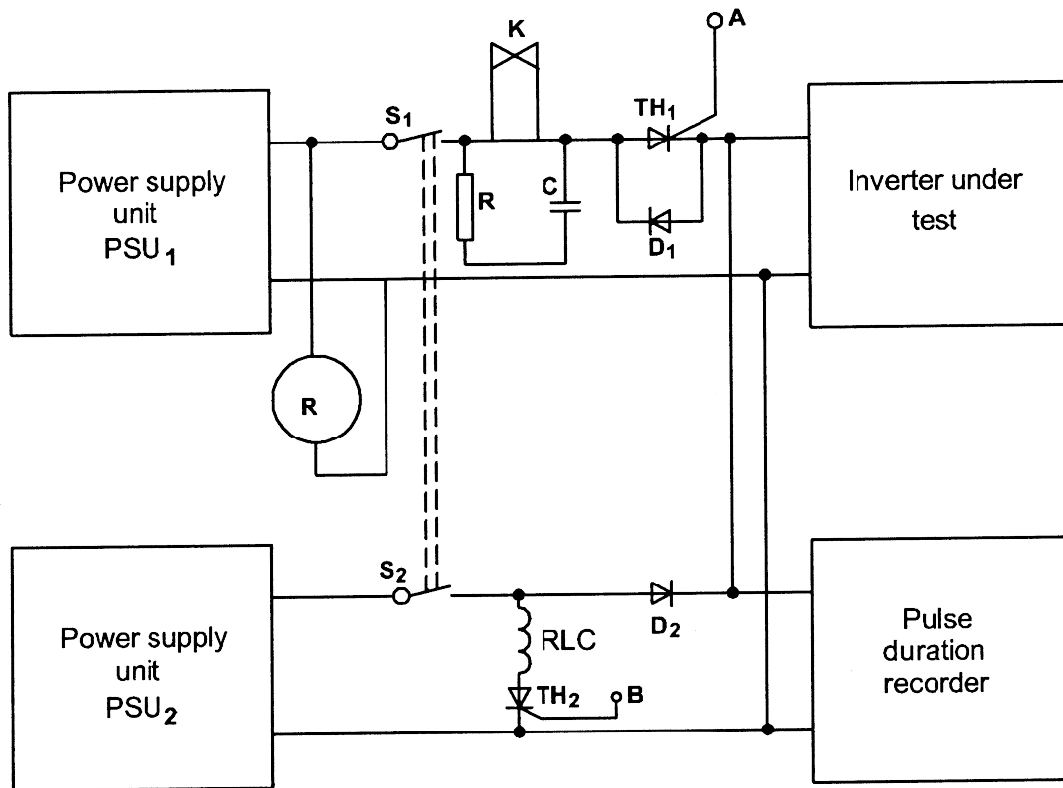
D_1 = reverse current by-pass diode, PIV rated 20 times design voltage, test t_{on} and t_{off} 200 ns.

D_2 = blocking diode for PSU₂. Prevents output impedance of PSU₂, loading voltage pulse source (PSU₁). Shall be fast type (approximately 1 μs turn-off) with voltage rating equal to twice the maximum pulse voltage.

S = switch

FIG. 5 CIRCUIT FOR MEASURING SHORT-DURATION PULSE ENERGY

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PSU_1 = power supply unit, capable of supplying maximum pulse voltage required (maximum of voltage range + X design voltage) with pulse current demanded by inverter at this voltage with 2 percent regulation (no load to full load).

PSU_2 = power supply unit adjusted to maximum of input voltage range.

TH_1 = main switching thyristor used to apply voltage pulse to the inverter. Many common thyristors should be suitable for this job. They shall have a turn-on-time of about 1 μ s and adequate pulse current capability.

TH_2 = thyristor controlling the action of the relay RLC .

D_1 = reverse current by-pass diode for TH_1 , allows initial oscillatory transients to operate. Shall be fast type (200 ns to 500 ns) with voltage rating equal to twice the maximum pulse voltage.

D_2 = blocking diode for PSU_2 loading voltage pulse source (PSU_1). Shall be fast type (approximately 1 μ s turn off) with voltage rating equal to twice the maximum pulse voltage.

RLC = pulse termination relay with contacts K.

R and C spark suppression components

Suggested values are 100 Ω and 0.1 μ F (for 26 V inverters).

S_1 = switch used as ON/OFF or reset control.

NOTES

1 Preferably both PSUs should be fitted with current limits to prevent damage in the event of the inverter under test breaking down.

2 The delay system for securing the correct duration of the pulse is not represented on the figure. It shall ensure the triggering of the thyristor TH_2 500 ms after the action of TH_1 account being taken of the operating time of the relay.

FIG. 6 SUITABLE CIRCUIT FOR PRODUCING AND APPLYING LONG-DURATION PULSES

ANNEX H (Foreword and Clause B-9.5)

TESTS

H-1 AMBIENT TEMPERATURE AND TEST ROOM

H-1.1 Measurements shall be made in a draught-free room and at an ambient temperature within the range of 20 °C to 27 °C. For those tests which require constant lamp performance, the ambient temperature around the lamp shall be within the range of 23 °C to 27 °C and shall not vary by more than 1 °C during the test.

H-1.2 Apart from the ambient temperature, air circulation also influences the temperature of the lamp controlgear. For reliable result, the test room shall be free from draughts.

H-1.3 Before measuring the resistance of a winding in the cold state, the lamp controlgear shall be left in the test room for a sufficient time prior to the test to ensure that it reaches the ambient temperature of the test room.

There may be differences in the ambient temperatures before and after heating of the lamp controlgear. This is difficult to correct because the temperature of the lamp controlgear will lag behind the changed ambient temperature. An additional lamp controlgear of the type to be tested shall be installed in the test room and its cold resistance measured at the beginning and end of the temperature test. The difference in resistance can be used as a basis for correcting the readings of the lamp controlgear under test, using the equation for determining the temperature.

The above difficulties can be eliminated by carrying out the measurements in a temperature-stabilized room, for which no corrections are necessary.

H-2 SUPPLY VOLTAGE AND FREQUENCY

H-2.1 Test Voltage and Frequency

Unless otherwise specified, the controlgear to be tested shall be operated at its design voltage and the reference ballast at its rated voltage and frequency.

H-2.2 Stability of Supply and Frequency

Unless otherwise specified, the supply voltage, and where appropriate for the reference ballasts, the frequency shall be maintained constant within ± 0.5 percent. However, during the actual measurement, the voltage shall be adjusted to within ± 0.2 percent of the specified testing value.

H-2.3 Supply Voltage Waveform for Reference Ballast only

The total harmonic content of the supply voltage shall

not exceed 3 percent, harmonic content being defined as the root-mean-square (rms) summation of the individual components using the fundamental as 100 percent.

H-3 ELECTRICAL CHARACTERISTICS OF LAMPS

The ambient temperature may affect the electrical characteristics of lamps (*see H-1*). In addition, lamps show an initial spread of characteristics independent of the ambient temperature; furthermore, such characteristics may change during the lamp's life.

For measurement of lamp controlgear temperatures at 100 percent and 110 percent of rated supply voltage, it is sometimes possible (for example, for chokes used in starter-operated circuits), to eliminate the influence of the lamp by operating the lamp controlgear at a short-circuit current equal to the value obtained with a reference lamp at 100 percent or 110 percent of rated voltage. The lamp is short-circuited and the supply voltage adjusted so that the required current passes through the circuit.

In case of doubt, the measurement shall be made with a lamp. These lamps shall be selected in the same manner as reference lamps, but disregarding the narrow tolerances on lamp voltage and wattage as required for reference lamps.

When assigning the temperature rise of lamp controlgear, the current flowing through the winding being measured shall be recorded.

H-4 MAGNETIC EFFECTS

Unless otherwise specified, no magnetic object shall be allowed within 25 mm of any face of the reference ballast or the lamp controlgear under test.

H-5 MOUNTING AND CONNECTION OF REFERENCE LAMPS

In order to ensure that the reference lamps repeat their electrical values with the greatest consistency, it is recommended that the lamps be mounted horizontally and be allowed to remain permanently in their test lamp holders. As far as identification of lamp controlgear terminals will permit, reference lamps should be connected in circuit maintaining the polarity of the connections used during ageing.

H-6 REFERENCE LAMP STABILITY

H-6.1 A lamp shall be brought to a condition of stable

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operation before carrying out measurements. No swirling shall be present.

H-6.2 The characteristics of a lamp shall be checked immediately before and after each series of tests.

H-7 INSTRUMENT CHARACTERISTICS

H-7.1 Potential Circuits

Potential circuits of instruments connected across the lamp shall not pass more than 3 percent of the nominal running current.

H-7.2 Current Circuits

Current circuits of instruments connected in series with the lamp shall have sufficiently low impedance such that the voltage drop shall not exceed 2 percent of the objective lamp voltage. Where measuring instruments are inserted into parallel heating circuits, the total impedance of the instruments shall not exceed 0.5 Ω .

H-7.3 RMS Measurements

Instruments shall be essentially free from errors due to waveform distortion and shall be suitable for the operating frequencies. Care shall be taken to ensure that the earth capacitance of instruments does not disturb the operation of the unit under test. It may be necessary to ensure that the measuring point of the circuit under test is at earth potential.

H-8 INVERTER POWER SOURCES

Where lamp controlgear are intended for use from battery supplies, it is permissible to substitute a dc power source other than a battery, provided that the source impedance is equivalent to that of a battery.

NOTE — A non-inductive capacitor of appropriate rated voltage and with a capacitance of at least 50 F, connected across the supply terminals of the units under test normally provides a source impedance simulating that of a battery.

H-9 REFERENCE BALLAST

When measured in accordance with the requirements given in IS 1534 (Part 1), reference ballasts shall have those characteristics specified both in that standard and on the appropriate lamp data sheets in IS 2418 (Part 2).

H-10 REFERENCE LAMPS

Reference lamps shall be measured and selected as outlined in Doc: ET 23 (5943) and have the characteristics specified on the appropriate lamp data sheet in IS 2418 (Part 2).

H-11 TEST CONDITIONS

H-11.1 Resistance Measurement Delays

Since the lamp controlgear may cool rapidly after switch-off, a minimum delay is recommended between switch-off and measurement of resistance. It is therefore recommended that the coil resistance be determined as a function of the elapsed time, from which the resistance at the moment of switch-off can be established.

H-11.2 Electrical Resistance of Contacts and Leads

Connections shall be eliminated from the circuit wherever possible. If switches are used to switch from operating to test conditions, a regular check shall be made to verify that contact resistances in the switches remain sufficiently low not to affect the test results. Due account shall also be taken of the resistance of any connecting leads between the lamp controlgear and the resistance measuring instruments.

To ensure an improvement in measuring accuracy, it is recommended to apply the so-called four-point measurement with double wiring.

H-12 LAMP CONTROLGEAR HEATING

H-12.1 Built-in Lamp Controlgear

H-12.1.1 Temperatures of Lamp Controlgear Parts

The lamp controlgear shall be placed in an oven as detailed in 13 for the thermal endurance test of windings.

The lamp controlgear shall function electrically in a manner similar to that in normal use at rated supply voltage, as detailed in H-12.4.

The oven thermostats are then regulated in such a way that the internal temperature of the oven attains a value such that the temperature of the hottest winding is approximately equal to the claimed value of t_w .

After 4 h, the actual temperature of the winding is determined by the 'change-in-resistance' method [see equation (1)] and, if the difference with the value t_w is more than ± 5 K, the oven thermostats are readjusted to approximate as closely as possible the t_w temperature.

After thermal stability has been obtained, winding temperatures are measured, if possible by the 'change-in-resistance' method [see equation (1)] and in other cases, by means of a thermocouple or the like.

The temperatures of lamp controlgear parts corrected for the difference between t_w and the measured winding temperature shall comply with 13.

H-12.1.2 Temperature of Lamp Controlgear Windings

For lamp controlgear for which a temperature rise of the windings under normal conditions is claimed, the test arrangement is as follows:

The lamp controlgear shall be placed in a draught-proof enclosure as detailed in Annex F, the lamp controlgear being supported by two wooden blocks as shown in Fig. 7.

The wooden blocks shall be 75 mm high, 10 mm thick and of a width equal to, or greater than the width of the lamp controlgear. Furthermore, the block shall be positioned with the extreme end of the lamp controlgear aligned with the outer vertical sides of the block.

Where the lamp controlgear consists of more than one unit, each unit may be tested on separate blocks. Capacitors, unless enclosed with the lamp controlgear case, shall not be placed in the draught-proof enclosure.

The lamp controlgear shall be tested under normal conditions at rated supply voltage and frequency until steady temperatures are obtained.

Winding temperatures are measured, if possible by the 'change-in-resistance' method [see Equation (1)].

H-12.2 Independent Lamp Controlgear

The lamp controlgear shall be placed in a draught-proof enclosure as detailed in Annex F, the lamp controlgear being mounted in a test corner consisting of three dull-black painted boards 15 mm to 20 mm thick and arranged so as to imitate two walls and the ceiling of a room. The lamp controlgear is secured to the ceiling of the test corner as close as possible to the walls, the ceiling extending at least 250 mm beyond the other sides of the lamp controlgear.

Other test conditions are the same as specified for luminaires in IS 10322 (Part 1).

H-12.3 Integral Lamp Controlgear

Integral lamp controlgear are not separately tested for limitation of lamp controlgear heating because they are tested as part of the luminaire in accordance with IS 10322 (Part 1).

H-12.4 Test Conditions

For the test under normal conditions, where lamp controlgear are operated with appropriate lamps, these shall be placed in such a way that the heat generated does not contribute to the heating of the lamp controlgear.

Lamps to be used for the limitation of lamp controlgear are operated with appropriate lamps, these shall be placed in such a way that the heat generated does not contribute to the heating of the lamp controlgear.

Lamps to be used for the limitation of lamp controlgear heating tests shall be deemed to be appropriate if, when associated with a reference ballast and operating in an ambient temperature of 25°C, the lamp's running current does not deviate by more than 2.5 percent from the corresponding objective values given in the relevant IEC lamp standard, or declared by the manufacturer for those lamps not yet standardized.

With a non-reactor type lamp controlgear, it is necessary to ensure that representative losses are obtained.

For starterless lamp controlgear with transformer parallel cathode heating, and where IS 2418 (Part 2) show that lamps of the same rating are available with either low or high resistance cathodes, the tests shall be carried out using lamps having low resistance cathodes.

NOTE — It is permitted, at the manufacturer's discretion, for reactor type lamp controlgear (simple choke impedance in series with the lamp). That the test and measurement be made without a lamp provided that the current is adjusted to the same value as found with the lamp at rated supply voltage.

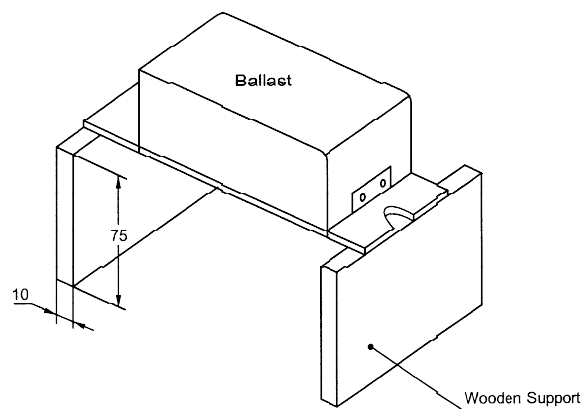


FIG. 7 TEST ARRANGEMENTS FOR HEATING TEST

Performance requirements for lamp controlgear covered under Part 2 series are covered under separate standard as appropriate for the type of lamp controlgear.

NOTE — Safety requirements ensure that electrical equipment constructed in accordance with these requirements does not endanger the safety of persons, domestic animals or property when properly installed and maintained and used in applications for which it was intended.

Requirements for electronic lamp controlgear for other types of lamps will be the subject of a separate standard, as and when need arise.

Annexes A to H form an integral part of this standard.

This standard is based on IEC 61347-1 (2000) 'Lamp controlgear — Part 1: General and safety requirements' issued by International Electrotechnical Commission (IEC).

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 or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off values should be the same as that of the specified value in this standard.

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This Indian Standard has been developed from Doc No.: ETD 23 (5717).

Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

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