BRITISH STANDARD

BS 4533-101: 1990
EN 60598-1: 1989
Incorporating Amendment No. 1

Luminaires —

Part 101: Specification for general requirements and tests

This European Standard EN 60598-1:1989 has the status of a British Standard

UDC 621.327/.328:620.1

Cooperating organizations

The European Committee for Electrotechnical Standardization (CENELEC), under whose supervision this European Standard was prepared, comprises the National Committee of the following countries:

Austria	Luxembourg
Belgium	Netherlands
Denmark	Norway
Finland	Portugal
France	Spain
Germany	Sweden
Greece	Switzerland
Iceland	United Kingdom
Ireland	
Italy	

This British Standard was published under the authority of the Board of BSI and comes into effect on
31 July 1990

The following BSI references relate to the work on this standard:
Committee reference LGL/3
Draft for comment 82/31321 DC

ISBN 0 580 18603 2

Amendments issued since publication

Amd. No.	Date of issue	Comments
8805	August 1995	Indicated by a sideline in the margin

Contents

National foreword

This British Standard has been prepared under the direction of the Electrical Illumination Standards Policy Committee and is the English language version of EN 60598-1 "*Luminaires — Part 1: General requirements and tests* including amendment A11", published by the European Committee for Electrotechnical Standardization (CENELEC). It was derived by that organization from IEC Publication 598-1 (1986) edition 2 and Amendment No 1 (1988) which has a similar title as that of the European Standard. This British Standard supersedes BS 4533-101:1987 "*Luminaires — Part 101: Specification for general requirements and tests",* which is withdrawn.

The CENELEC Common Modifications have been inserted at the appropriate places in the text of IEC Publication 598-1 (1986) edition 2 into which Amendment No 1 (1988) has been incorporated and are indicated by a side line in the margin. The relevant parts of the original IEC text have been quoted in National appendix NA. Annexes designated "normative" are part of the body of the standard. Annexes designated "informative" are given only for information. National appendices are designated "informative".

Cross-references. Details of other international publications quoted in this standard are given in Annex ZA. Where there are British Standards either identical or technically equivalent to these International Standards the relationship is given in National appendix NB.

Additional information

Wherever the expression "Part 1" appears, referring to this standard, it should be read as "Part 101". Wherever the expression "Part 2" appears, referring to IEC 598-2, it should be read as "BS 4533-102".

Classifications (**2.2**). Class 0 (defined in **1.2.21**) is not permitted in the UK by reason of the Electrical Equipment (Safety) Regulations and the Electricity (Factories Acts) Special Regulations 1908 and 1944.

Wiring regulations. In the UK the reference to "National Wiring Rules" means the "Regulations for Electrical Installations"[1)], published by the Institution of Electrical Engineers. The installation of a luminaire has to comply with those regulations. Particular attention should be paid to the suitability of luminaires for the locations in which they are to be installed. For example, those having exposed basic insulation may necessitate further precautions to be specified by the installation designer.

Additional marking (**3.3**). Attention is drawn to Statutory Instrument (SI) No. 310 of 1969 as amended by SI 811 of 1970 and SI 931 of 1977 for luminaires to which flexible cords are attached.

Safety regulations. This European Standard is a harmonized standard in the terms of the Low Voltage Electrical Equipment (Safety) Regulations 1989.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, the EN title page, pages 2 to 104, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

[1)] Available from the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London WQR 0BL.

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 60598-1

October 1989

+ *A11 February 1994*

UDC: 621.327/.328:620.1

Key words: General requirements; luminaire; rated voltage; extra-low-voltage; nominal current; rated voltage; flexible cable; flexible cord; temperature; capacitor; winding; ballast; switch; electric starter; cable; connector; flammable material; fire-resisting material; type test; electric earthing; protection against electric shock; resistance to dust; resistance to moisture; insulation resistance; electrical strength; creepage distance; insulation clearance; thermal endurance test; resistance to heat; resistance to fire; resistance to tracking; electric terminal; marking.

English version

Luminaires
Part 1: General requirements and tests

(include amendment A11:1994)
(IEC 598-1 (1986) ed 2 + Amdt 1 (1988), modified)

Luminaires
Première partie: Règles générales et généralités sur les essais
(inclut l' amendment A11:1994)
(IEC 598-1 (1986) ed 2 +
Amdt 1 (1988), modifiée)

Leuchten
Teil 1: Allgemeine Anforderungen und Prüfungen
(enthält Änderungen A11:1994)
(CEI 598-1 (1986) ed 2 +
Amdt 1 (1988), modifiziert)

This European Standard was ratified by CENELEC on 13 September 1988. CENELEC members are bound to comply with the requirements of the CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CENELEC Central Secretariat or to any CENELEC member.

This European Standard exists in three official versions (English, French and German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to CENELEC Central Secretariat has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxemburg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

Central Secretariat: rue de Stassart 35, B-1050 Brussels

Brief history

The CENELEC Questionnaire Procedure performed for finding out whether or not IEC 598-1 (1986) edition 2 could be accepted without textual changes, has shown that common modifications were necessary for the acceptance as European Standard (EN). The Reference Document modified by common modifications was submitted to the CENELEC members for formal vote and acceptance by CENELEC.

Technical text

The text of the International Standard IEC 598-1 [second edition (1986)], with agreed common modifications, was approved by CENELEC on 13 September 1988 as a European Standard.

The following dates are applicable:

— latest date of announcement of the EN at national level: (doa) 1989-04-01

— date of latest publication of a new harmonized standard: (dop) 1989-10-01

This European Standard supersedes EN 60598-1, issued April 1988, which is withdrawn. No date of withdrawal of conflicting national standards (dow) has been fixed because a national standard covering "general requirements for luminaires" may be required for use in conjunction with either:

— national standards based on Parts 2 in the IEC 598 series which are not yet harmonized within CENELEC (i.e. IEC Publication 598-2-20 or 598-2-22);

— national standards not based on Parts 2 of IEC Publication but which are published in the same format.

Attention is drawn to the fact that all Parts 2 to EN 60598 relate to the latest edition of the Part 1 (see the reference to "Sliding; latest edition" in Normative annexes ZA to all EN 60598-2 entitled "Other international publications quoted in this standard"). In this EN, Annex ZA and Annex ZB are normative and Annex ZC is informative.

This reprint of EN 60598-1 (October 1989) incorporates Amendment No. 1 (1988) to IEC 598-1. It includes the new necessary common modifications and excludes those no longer required. The text of the special national conditions (snc) and of the deviations has not been changed.

This text supersedes EN 60598-1 (January 1989).

Foreword to amendment A11

At the request of the Danish electrotechnical committee, a draft for an amendment to EN 60598-1:1989 was submitted to the CENELEC members for acceptance in December 1993.

The text of the draft was accpted by CENELEC as amendment A11 to EN 60598-1:1989 on 1994-02-14.

The following dates were fixed:

— latest date of announcement of the amendment at national level (doa) 1994-05-14

— latest date of publication of an identical national standard (dop) 1994-08-14

Text of amendment A11

In Annex ZC, delete the A-deviations for Denmark regarding subclause **12.4.2** (item c) and Table XI.

Contents

blank

Section 0. General Introduction

0.1 Scope

The sections of Part 1 of this standard specify general requirements for the classification and marking of luminaires and for their mechanical and electrical construction, together with related tests. The standard is applicable to luminaires for use with tungsten filament, tubular fluorescent and other discharge lamps on supply voltages not exceeding 1 000 V. Additional sections will be added, as and when a need for them is recognized.

Each section of IEC Publication 598-2: Luminaires, Part 2: Particular Requirements, details requirements for a particular type of luminaire or group of luminaires on supply voltages not exceeding 1 000 V. These sections are published separately for ease of revision and additional sections will be added as and when a need for them is recognized.

Attention is drawn to the fact that this standard covers all aspects of safety (electrical, thermal and mechanical).

The presentation of photometric data for luminaires is under consideration by the International Commission on Illumination (CIE) and is not, therefore, included in this standard.

Requirements are included in Part 1 for luminaires incorporating ignitors with nominal peak values of the voltage pulse not exceedings 5 kV. The requirements apply to luminaires with ignitors built into ballasts and to luminaires with ignitors separate from ballasts. For luminaires with ignitors built into lamps, the requirements are under consideration.

0.2 Object

In general, this standard covers safety requirements for luminaires. The object of Part 1 is to provide a set of requirements and tests which are considered to be generally applicable to most types of luminaires and which can be called up as required by the detail specifications of IEC Publication 598-2. Part 1 is thus not to be regarded as a specification by itself for any type of luminaire, and its provisions apply only to particular types of luminaires to the extent determined by the appropriate section of Part 2.

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

Where the requirements of any of the sections of Part 1 are referred to in the sections of Part 2 by the phrase "The requirements of Section . . . Publication 598-1 apply", this phrase is to be interpreted as meaning that all the requirements of that section of Part 1 apply except any which are clearly inapplicable to the particular type of luminaire covered by that section of Part 2.

A luminaire shall comply with a section of Part 2. If, however, an appropriate section of Part 2 does not exist for a particular luminaire or group of luminaires, the nearest applicable section of Part 2 may be used as a guide to the requirements and tests. Where the design of a luminaire is such that two, or more, sections of Part 2 are applicable, the luminaire shall comply with both, or all, the appropriate sections.

The appropriate standard for lamps should be consulted for luminaire design information, maximum lamp outlines and other relevant data.

0.3 General requirements

Luminaires shall be so designed and constructed that in normal use they function safely and cause no danger to persons or surroundings. In general compliance is checked by carrying out all the tests specified.

0.4 General test requirements

0.4.1 Tests according to this standard are type tests. For the definition of a "type test", see Section 1 of this Part 1.

0.4.2 Except where otherwise specified in the sections of Part 1 or Part 2, luminaires shall be tested in an ambient temperature of between 10 °C and 30 °C. Luminaires shall be tested as delivered, and installed as in normal use, having regard to the manufacturer's installation instructions. The lamp (or lamps) is (are) not included except where essential for the test.

In general, the tests are made on a single sample luminaire or, where a range of similar luminaires is involved, on a single luminaire of each rated wattage in the range or on a representative selection from the range as agreed with the manufacturer. This selection shall include the luminaire, together with any attachments, which represents the most unfavourable combination from a testing point of view.

Each sample luminaire shall withstand all the relevant tests. In order to reduce the time of testing and to allow for any tests which may be destructive, the manufacturer may submit additional luminaires or parts of luminaires provided that these are of the same materials and design as the original luminaire and that the results of the test are the same as if carried out on an identical luminaire. Where the test for compliance is shown as being "by inspection" this shall include any necessary handling.

For track-mounted luminaires the luminaire manufacturer shall provide, together with the luminaire, a sample of the appropriate track, connector and adaptators for the luminaire to be connected.

Combination luminaires are tested for safety requirements with that assemblage of parts which gives the most unfavourable result.

Certain parts of luminaires, such as joints, raising and lowering devices, may be tested separately provided that the design of these parts is such that their performance is not dependent upon the other parts of the luminaires.

Luminaires intended to be used with non-detachable flexible cables or cords are tested with the flexible cable or cord connected to the luminaire.

Luminaires cannot be regarded as meeting the requirements of this standard unless all internal wiring is complete.

0.5 Components of luminaires

0.5.1 Components, other than integral components, shall comply with the requirements of the relevant IEC standards, if any.

Integral components shall comply as far as is reasonable with the IEC components standards, as part of the luminaire.

NOTE This does not imply that components need to be separately tested before approval of the luminaire.

0.5.2 Components that have been shown to comply with the requirements of the relevant IEC standard for those components, shall only be tested to those requirements of this luminaire standard which are not covered by the component standard.

0.5.3 Components for which no appropriate IEC standard exists shall satisfy the relevant requirements of this luminaire standard as part of the luminaire. Lampholders and starterholders shall additionally comply with the gauging and interchangeability requirements of the appropriate IEC component standard where applicable.

NOTE Examples of components are lampholders, switches, transformers, ballasts, flexible cables and cords and plugs.

0.6 List of sections of Part 2

1) Fixed general purpose luminaires.

2) Recessed luminaires.

3) Luminaires for road and street lighting.

4) Portable general purpose luminaires.

5) Floodlights.

6) Luminaires with built-in transformers for tungsten filament lamps.

7) Portable luminaires for use in gardens and the like.

8) Hand lamps.

9) Photo and film luminaires (non-professional).

10) Portable child appealing luminaires.

11) Not used at present.

12) Not used at present.

13) Not used at present.

14) Not used at present.

15) Not used at present.

16) Not used at present.

17) Luminaires for stage lighting, television and film studios (outdoor and indoor).

18) Luminaires for swimming pools and the like.

19) Air-handling luminaires (safety requirements).

20) Lighting chains.

21) Not used at present.

22) Luminaires for emergency lighting.

Section 1. Definitions

1.1 Scope

This section gives general definitions applicable to luminaires for use with tungsten filament, tubular fluorescent and other discharge lamps on supply voltages not exceeding 1 000 V. It is to be read in conjunction with Section 0 and with the other relevant sections to which reference is made.

1.2 Definitions

For the purpose of all sections of this Part 1, the following definitions apply.

Where the terms voltage and current are used they imply the r.m.s. values unless otherwise stated.

1.2.1
luminaire

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

1.2.2
main part (of luminaire)

that which is fixed to the mounting surface or is directly suspended from it or standing on it (it may or may not carry the lamps, lampholders and auxiliary gear)

NOTE In luminaires for tungsten filament lamps, the part carrying the lampholder is normally the main part.

1.2.3
ordinary luminaire

a luminaire without special protection against dust or moisture

1.2.4
general purpose luminaire

a luminaire which is not designed for a special purpose. Examples of general purpose luminaires include pendants, some spotlights and certain fixed luminaires for surface or recessed mounting. Examples of special purpose luminaires are those for rough usage, photo and film applications and swimming pools

1.2.5
adjustable luminaire

a luminaire, part of which can be turned or moved by means of joints, raising and lowering devices, telescopic tubes or similar devices

NOTE An adjustable luminaire may be fixed or portable.

1.2.6
basic luminaire

the smallest number of assembled parts that can satisfy the requirements of any of the sections of Part 2 of this standard

1.2.7
combination luminaire

a luminaire consisting of a basic luminaire in combination with one or more parts which may be replaced by other parts, or used in a different combination with other parts and changed either by hand or with the use of tools

1.2.8
fixed luminaire

a luminaire which cannot easily be moved from one place to another, either because the fixing is such that the luminaire can only be removed with the aid of a tool, or because it is intended for use out of easy reach

in general, fixed luminaires are designed for permanent connection to the supply, but connection may also be made by means of a plug or similar device

examples of luminaires intended for use out of easy reach are pendants and luminaires designed for fixing to a ceiling

1.2.9
portable luminaire

a luminaire which, in normal use, can be moved from one place to another while connected to the supply

NOTE Luminaires for wall mounting provided with a non-detachable flexible cable or cord for connection to a plug and luminaires which may be fixed to their support by means of a wing screw, a clip or a hook so that they can easily be removed from their support by hand, are considered to be portable luminaires.

1.2.10
recessed luminaire

a luminaire intended by the manufacturer to be fully or partly recessed into a mounting surface. The term applies both to luminaires for operation in enclosed cavities and to luminaires for mounting through a surface such as a suspended ceiling

1.2.11
rated voltage

the supply voltage or voltages assigned to the luminaire by the manufacturer

1.2.12
supply current

the current at the supply terminals when the luminaire has stabilized in normal use at the rated voltage and frequency

1.2.13
rated wattage

the number and rated wattage of the lamps for which the luminaire is designed

1.2.14
non-detachable flexible cable or cord

a flexible cable or cord which can only be removed from the luminaire with the aid of a tool

1.2.15
live part

a conductive part which may cause an electric shock in normal use. The neutral conductor shall, however, be regarded as a live part

the test to determine whether or not a conductive part is a live part which may cause an electric shock is given in Appendix B

1.2.16
basic insulation

insulation applied to live parts to provide basic protection against electric shock

NOTE Basic insulation does not necessarily include insulation used exclusively for functional purposes.

1.2.17
supplementary insulation

independent insulation applied in addition to basic insulation in order to provide protection against electric shock in the event of a failure of basic insulation

1.2.18
double insulation

insulation comprising both basic insulation and supplementary insulation

1.2.19
reinforced insulation

a single insulation system applied to live parts, which provides a degree of protection against electric shock equivalent to double insulation

NOTE The term "insulation system" does not imply that the insulation must be one homogeneous piece. It may comprise several layers which cannot be tested singly as supplementary or basic insulation.

1.2.20

(not used at present)

1.2.21
class 0 luminaire (applicable to ordinary luminaires only)

a luminaire in which protection against electric shock relies upon basic insulation; this implies that there are no means for the connection of accessible conductive parts, if any, to the protective conductor in the fixed wiring of the installation, reliance in the event of a failure of the basic insulation being placed upon the environment

NOTE 1 Class 0 luminaires may have either an enclosure of insulating material which forms a part or the whole of the basic insulation or a metal enclosure which is separated from live parts by at least basic insulation.

NOTE 2 If a luminaire with an enclosure of insulating material has provision for earthing internal parts, it is Class I.

NOTE 3 Class 0 luminaires may have parts with double insulation or reinforced insulation.

1.2.22
class I luminaire

a luminaire in which protection against electric shock does not rely on basic insulation only, but which includes an additional safety precaution in such a way that means are provided for the connection of accessible conductive parts to the protective (earthing) conductor in the fixed wiring of the installation in such a way that accessible conductive parts cannot become live in the event of a failure of the basic insulation

NOTE 1 For a luminaire intended for use with a flexible cord or cable, this provision includes a protective conductor as part of the flexible cord or cable.

NOTE 2 Where a luminaire designed as Class I is fitted with a two-core flexible cord or cable with a plug which cannot be introduced into a socket-outlet with earthing contact (formerly Class 0I), the protection is then equivalent to that of Class 0, but the earthing provisions of the luminaire in all other respects should fully comply with the requirements of Class I.

1.2.23
class II luminaire

a luminaire in which protection against electric shock does not rely on basic insulation only, but in which additional safety precautions such as double insulation or reinforced insulation are provided, there being no provision for protective earthing or reliance upon installation conditions

NOTE 1 Such a luminaire may be of one of the following types:

a) A luminaire having a durable and substantially continuous enclosure of insulating material which envelopes all metal parts with the exception of small parts such as nameplates, screws and rivets which are isolated from live parts by insulation at least equivalent to reinforced insulation. Such a luminaire is called an insulation-encased Class II luminaire.

b) A luminaire having a substantially continuous enclosure of metal, in which double insulation is used throughout, except for those parts where reinforced insulation is used because the application of double insulation is manifestly impracticable. Such a luminaire is called a metal-encased Class II luminaire.

c) A luminaire which is a combination of types a) and b) above.

NOTE 2 The enclosure of an insulation-encased Class II luminaire may form a part or the whole of the supplementary insulation or the reinforced insulation.

NOTE 3 If earthing is provided to assist starting, but is not connected to an accessible metal part, the luminaire may still be deemed to be of Class II. Lamp caps shells and starting stripes on lamps are not regarded as accessible metal parts unless the tests of Appendix B show them to be live parts.

NOTE 4 If a luminaire with double insulation and/or reinforced insulation throughout has an earthing terminal or an earthing contact, it is Class I construction. However, a fixed Class II luminaire intended for looping-in may have an internal terminal for maintaining the electrical continuity of an earthing conductor not terminating in the luminaire, provided that the terminal is insulated from accessible metal parts by Class II insulation.

1.2.24
class III luminaire

a luminaire in which protection against electric shock relies on supply at safety extra-low voltage (SELV) and in which voltages higher than those of SELV are not generated

NOTE A Class III luminaire should not be provided with means for protective earthing.

1.2.25
rated maximum ambient temperature

the temperature assigned to a luminaire by the manufacturer to indicate the highest sustained temperature in which the luminaire may be operated under normal conditions

symbol: t_a

NOTE This does not preclude temporary operation at a temperature not exceeding (t_a + 10) °C.

1.2.26
rated maximum operating temperature (of the case of a ballast, capacitor or starting device)

the highest permissible temperature which may occur on the outer surface (at the indicated place if marked) of the component under normal operating conditions at the rated voltage or maximum of the rated voltage range

symbol: t_c

1.2.27
rated maximum operating temperature (of a winding)

the operating temperature of a ballast winding which gives an expectancy of 10 years' continuous service (at that temperature)

symbol: t_w

1.2.28
ballast

a unit inserted between the supply and one or more discharge lamps which by means of inductance, capacitance or resistance, singly or in combination, serves mainly to limit the current of the lamp(s) to the required value

it may also include means for transforming from the supply voltage and arrangements which help to provide starting voltage and pre-heating current, prevent cold starting, reduce stroboscopic effect, correct the power factor and suppress radio interference

1.2.29
independent ballast

a ballast consisting of one or more separate elements so designed that it, or they, can be mounted separately outside a luminaire with protection according to the marking of the ballast and without any additional enclosure

1.2.30
built-in ballast

a ballast generally designed to be built into a luminaire and not intended to be mounted outside a luminaire without special precautions

1.2.31
integral lampholder

a part of a luminaire which supports the lamp and provides electrical contact with it and which is designed as part of the luminaire

1.2.32
ballast compartment

that part of the luminaire in which the ballast is intended to be mounted

1.2.33
translucent cover

the light-transmitting parts of the luminaire which may also protect the lamps and other component parts. This term includes diffusers, lens panels and similar light-control elements

1.2.34
supply cable

a cable which is part of the fixed installation to which the luminaire is connected

NOTE Supply cables may be brought into the luminaire and connected to terminals, including terminals of lampholders, switches and the like.

1.2.35
appliance coupler

a means enabling a flexible cable to be connected at will to the luminaire. It consists of two parts: a connector provided with contact tubes which is the part integral with or designed to be attached to the flexible cable connected to the supply; an appliance inlet, provided with contact pins, which is the part incorporated in or fixed to the luminaire

1.2.36
external wiring

wiring generally outside the luminaire but delivered with it

NOTE 1 External wiring may be used for connecting the luminaire to the supply, to other luminaires, or to any external ballast.
NOTE 2 External wiring is not necessarily outside the luminaire for its full length.

1.2.37
internal wiring

wiring generally inside the luminaire and delivered with it, which forms the connection between terminals for external wiring or supply cables and terminals of lampholders, switches and similar components

NOTE Internal wiring is not necessarily inside the luminaire for its full length.

1.2.38
normally flammable material

material having an ignition temperature of at least 200 °C and which will not deform or weaken at this temperature

Examples: Wood and materials based on wood of more than 2 mm thickness

NOTE The ignition temperature and the resistance of normally flammable materials to deformation or weakening are based on widely accepted values determined during a test period of 15 min.

1.2.39
readily flammable material

material which cannot be classified as either normally flammable or non-combustible

Examples: Wood fibre and materials based on wood of up to 2 mm thickness

1.2.40
non-combustible material

material incapable of supporting combustion

NOTE For the purpose of this standard, materials such as metal, plaster and concrete are regarded as non-combustible materials.

1.2.41
flammable material

material which does not comply with the glow-wire test requirements of Sub-clause **13.3.2**

1.2.42
safety extra-low voltage (SELV)

a voltage which does not exceed 50 V a.c. r.m.s. (see Note 1) between conductors, or between any conductor and earth, in a circuit which is isolated from the supply mains by means such as a safety isolating transformer or converter with separate windings

NOTE 1 The d.c. value is under consideration.

NOTE 2 The voltage limit should not be exceeded either at full load or no-load, but it is assumed, for the purpose of this definition, that any transformer or converter is operated at its rated supply voltage.

1.2.43
working voltage

the highest r.m.s. voltage which may occur across any insulation at rated supply volts, transients being neglected, in open circuit conditions or during normal operation

1.2.44
type test

a 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 specification

1.2.44
a) type test sample

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

1.2.45
by hand

not requiring the use of a tool, coin or other object

1.2.46
terminal

that part of a luminaire or component which is necessary to make electrical connection to a conductor. See Sections 14 and 15

1.2.47
luminaire track system

a system, including a track with conductors, for the connection of luminaires to an electrical supply in a range of different positions determined only by the length and location of the track and comprising some or all of the components defined in Sub-clauses **1.2.48** to **1.2.53**

1.2.48
track

a generally linear assembly of conductors within a housing, providing for the mechanical support and electrical connection of luminaires

NOTE Luminaires may be positioned or repositioned along the length in a simple manner (that is, without the use of tools).

1.2.49
coupler

a component enabling electrical or mechanical connection to be made between tracks

1.2.50
connector

a component used for the connection of a mains supply to the track or for the electrical connection of a luminaire to the track

NOTE The functions of a coupler and a connector may be combined. A connector does not provide mechanical connection of a luminaire to the track.

1.2.51
adaptor

a component used for the electrical and mechanical connection of a luminaire to the track

NOTE An adaptor may incorporate a switch or a fuse.

1.2.52
track suspension device

a component used for the mechanical connection of the track system to the supporting surface

1.2.53
luminaire suspension device

a component used for the mechanical connection of a luminaire to the track

1.2.54
normal arm's reach

2.5 m upwards and 1.25 m sideways and downwards from the floor

NOTE National wiring rules may require different values, and may allow exceptions for special locations.

1.2.55
looping-in (feed through)

a system of mains supply connection to two or more luminaires where each supply conductor is taken into and out of the same terminal. A supply conductor may be cut to facilitate connections to a terminal (see Figure 20, page 79)

1.2.56
through wiring

wiring which passes through the luminaire but without connection to the luminaire

NOTE Some countries do not permit joints in through wiring.

1.2.57
starting devices

an apparatus that, by itself or in combination with other components in the circuit, provides the appropriate electrical conditions to start a discharge type of lamp

1.2.58
starter

a starting device, usually for fluorescent lamps, that provides for the necessary pre-heating of the electrodes and, in combination with the series impedance of the ballast, causes a surge in the voltage applied to the lamp

1.2.59
ignitor

a starting device that generates voltage pulses to start a discharge lamp and that does not provide for pre-heating of electrodes

1.2.60
terminal block

an assembly of one or more terminals in or on a housing or body of insulating material to facilitate interconnection between conductors

1.2.61
rough service luminaire

a luminaire designed for arduous service

NOTE Such luminaires are:
— luminaires for use in rough environmental situations, for example, heavy engineering workshops;
— luminaires for use on building sites and similar locations.

1.2.62
electro-mechanical contact system

a connection system within a luminaire by which the main part carrying the lampholder is electrically and mechanically connected to the base plate or suspension device. It may or may not incorporate an adjusting device

1.2.63
low voltage transistorized fluorescent luminaire

a luminaire for operation from a battery voltage not exceeding 48 V d.c. nominal and incorporating a d.c./a.c. inverter using transistors for supplying power to one or more fluorescent lamps

NOTE 1 Low voltage transistorized fluorescent luminaires may generate internal voltages higher than the supply voltage and thus might not be Class III. A possible electric shock hazard should therefore be taken into account and guarded against with such luminaires.
NOTE 2 The value of 48 V is under consideration.

1.2.64
mounting surface

that part of any building, furniture or other structure which a luminaire may in any way be attached to, suspended from, stood on or placed upon in normal use and which will or is intended to support the luminaire

1.2.65
integral component

a component which forms a non-replaceable part of a luminaire and which cannot be tested separately from the luminaire

Section 2. Classification of luminaires

2.1 Scope

This section describes the classification of luminaires for use with tungsten filament, tubular fluorescent and other discharge lamps on supply voltages not exceeding 1 000 V. It is to be read in conjunction with Section 0 and with the other relevant sections to which reference is made.

Luminaires are classified according to the type of protection against electric shock, the degree of protection against ingress of dust, solid objects and moisture and the material of the supporting surfaces.

2.2 Classification according to type of protection against electric shock

Luminaires shall be classified according to the type of protection against electric shock provided, as Class 0, Class I, Class II and Class III — See definitions in Section 1. Luminaires with a rated voltage in excess of 250 V shall not be classified as Class 0.

Rough service luminaires shall not be classified as Class 0.

Luminaires shall have only a single classification. For example, for a luminaire with a built-in extra low voltage transformer with provision for earthing, the luminaire shall be classified as Class I and part of the luminaire shall not be classified as Class III even though the lamp compartment is separated by an arm from the transformer compartment.

Track-mounted luminaires shall be classified as Class I or Class II.

NOTE Some national wiring rules may not allow portable luminaires to be Class 0. Other national wiring rules may not allow any luminaires to be Class 0.

2.3 Classification according to degree of protection against ingress of dust, solid objects and moisture

Luminaires shall be classified in accordance with the "IP number" system of classification explained in IEC Publication 529: Classification of Degrees of Protection Provided by Enclosures.

Symbols for the degrees of protection are given in Section 3.

Tests for the degrees of protection are given in Section 9.

NOTE 1 Luminaires classified as watertight are not necessarily suitable for operation under water; pressure watertight luminaires should be used for such applications.

NOTE 2 The IP numbers are the principal marking on luminaires but symbols may be used in addition to IP numbers if desired.

2.4 Classification according to material of supporting surface for which the luminaire is designed

Luminaires shall be classified according to whether they are primarily intended for direct mounting on normally flammable surfaces or are only suitable for mounting on non-combustible surfaces as follows:

Classification	*Symbol*
Luminaires suitable for direct mounting only on non-combustible surfaces	No symbol, but warning notice required — See Section 3.
Luminaires without built-in inductive ballasts or transformers suitable for direct mounting on normally flammable surfaces.	No symbol.
Luminaires with built-in inductive ballasts or transformers suitable for direct mounting on normally flammable surfaces.	Symbol — See Figure 1, page 64.

NOTE Readily flammable surfaces are not suitable for the direct mounting of luminaires.

Requirements for luminaires classified as primarily intended for direct mounting on normally flammable surfaces are given in Section 4 and related tests in Section 12.

Section 3. Marking

3.1 Scope

This section specifies the information to be marked on luminaires for use with tungsten filament, tubular fluorescent and other discharge lamps on supply voltages not exceeding 1 000 V. It is to be read in conjunction with Section 0 and with the other relevant sections to which reference is made.

3.2 Marking, luminaires

The following information shall be distinctly and durably marked on the luminaire in a position where it can be seen during maintenance, if necessary after the removal of covers or similar components. Such information shall not be marked on screws, or on parts likely to be removed when the luminaire is being connected. The information specified in Sub-clauses **3.2.2** and **3.2.8** may be marked on built-in ballasts, where these are provided, instead of on the luminaire itself.

The earthing symbol referred to in Sub-clause **3.2.12** may be marked on the ballast, instead of the luminaire, if the ballast is a non-replaceable type. Details of symbols are shown in Figure 1, page 64. The height of graphical symbols shall be not less than 5 mm, and for letters and numerals, not less than 2 mm.

For combination luminaires where the type references or the rated inputs are different for different combinations, the main part and the alternative parts may be marked with a type reference or a rated input, as appropriate, provided that the type can be identified and the rated input of the complete unit may be established from a catalogue or a similar document.

For luminaires with electro-mechanical contact systems the base plate shall be marked with the rated current of the electrical connection.

3.2.1 Mark of origin (this may take the form of a trade mark, manufacturer's identification mark or the name of the responsible vendor).

3.2.2 Rated voltage(s) in volts. Luminaires for tungsten filament lamps shall be marked only if the rated voltage is different from 250 V.

Portable Class III luminaires shall be marked with the rated voltage on the outside of the luminaire.

3.2.3 The rated maximum ambient temperature t_a, if other than 25 °C (see Figure 1).

NOTE Exceptions to this general requirement may be specified in particular sections of IEC Publication 598-2.

3.2.4 Symbol for Class II luminaire where applicable (see Figure 1).

For portable luminaires provided with a non-detachable flexible cable or cord, the symbol for Class II construction, if applicable, shall be on the outside of the luminaire.

3.2.5 Symbol for Class III luminaire where applicable (see Figure 1).

3.2.6 Marking (if applicable) with IP numbers for degree of protection against ingress of dust, solid objects and moisture and, if desired, additional symbols (see Figure 1 and Appendix A). Where X is used in an IP number in Figure 1, it indicates a missing numeral in the example, but both the appropriate numerals shall be marked on the luminaire.

Marking of IP20 on ordinary luminaires is not required.

3.2.7 Maker's model number or type reference.

3.2.8 Rated wattage of the lamp(s) in watts. Where the lamp wattage alone is insufficient, the number of lamps and the type shall also be given. Luminaires for tungsten filament lamps shall be marked with the maximum rated wattage and number of lamps.

Marking of maximum rated wattage is not required if luminaires for tungsten filament lamps having E14 or B15 lampholders comply with all the tests when fitted with lamps of 60 W.

Marking of maximum rated wattage for luminaires for tungsten filament lamps with more than one lampholder may be in the form:

"*n x* MAX . . . W", *n* being the number of lampholders.

3.2.9 Symbol (see Figure 1, page 64), if applicable, for luminaires with built-in ballasts or transformers, suitable for direct mounting on normally flammable surfaces.

3.2.10 Information concerning special lamps, if applicable.

In particular this applies to the symbols (see Figure 1) for luminaires for use with high-pressure sodium lamps having either an internal starting device or requiring an external ignitor where the lamp is required to be marked with the same symbol according to IEC Publication 662.

3.2.11 Symbol (see Figure 1), if applicable, for luminaires for lamps or similar shape to "cool beam" lamps but where the use of a dichroic reflectorized "cool beam" lamp might impair safety.

3.2.12 Terminations shall be clearly marked or otherwise identified to give a clear indication as to which termination should be connected to the live side of the supply, where necessary for safety, or to ensure satisfactory operation. Earthing terminations shall be clearly indicated by the appropriate symbol shown in IEC Publication 417.

For luminaires with non-detachable flexible cables or cords which are not fitted with a plug, a label giving information for proper connection shall be attached where it is easily seen during connection.

Low voltage transistorized fluorescent luminaires shall have positive supply terminations marked + or coloured red and negative supply terminations marked – or coloured black.

3.2.13 Symbol (see Figure 1, page 64) for minimum distance from lighted objects, if applicable, for spot lights and the like. The minimum distance marked shall be determined by the temperature test described in Sub-clause **12.4.1** item j).

The distance is measured on the optical axis of the luminaire from that part of the luminaire or lamp which is nearest to the lighted object.

The symbol for minimum distance and explanation of its meaning shall also be given either on the luminaire or in the instructions supplied with the luminaire.

3.2.14 Symbol (see Figure 1), if applicable, for rough service luminaires.

3.2.15 Symbol (see Figure 1), if applicable, for luminaires which are designed for use with bowl mirror lamps.

NOTE Separate bowls for attachment to GLS lamps without reference to luminaire testing are not within the scope of this standard.

3.2.16 Luminaires incorporating a glass safety shield shall be marked as follows:

"Replace any cracked safety shield"

3.3 Additional information

In addition to the above marking, all details which are necessary to ensure proper installation, use and maintenance shall be given either on the luminaire or on built-in ballasts or in the manufacturer's instructions provided with the luminaire, for instance:

1) For combination luminaires, the permissible ambient temperature, the class of protection or the protection against ingress of dust, solid objects and moisture of an alternative part if not at least equal to that of the basic luminaire.

2) Nominal frequency in hertz.

3) Operating temperatures:

a) The rated maximum operating temperature (of a winding) t_w in degrees Celsius.

b) The rated maximum operating temperature (of a capacitor) t_c in degrees Celsius.

c) The maximum temperature to which the insulation of supply cables and interconnecting cables will be subjected within the luminaire under the most unfavourable conditions of normal operation, if in excess of 90 °C. The symbol to indicate this requirement is given in Figure 1.

4) A warning notice that the luminaire is not suitable for mounting on a normally flammable surface.

5) A wiring diagram, except where the luminaire is suitable for direct connection to the mains supply.

6) Special conditions for which the luminaire, including the ballast, is suitable; for instance, whether or not the luminaire is intended for looping-in.

7) A recommendation that Class II luminaires shall be installed so that any exposed metal work is not in electrical contact with any part of the electrical installation connected to a protective conductor.

Instructions related to safety shall be in a language which is acceptable in the country in which the equipment is to be installed.

3.3.1 In addition, the manufacturer shall be prepared to supply information on the power factor and the supply current.

For connections suitable for both resistive and inductive loads, the rated current for the inductive load shall be indicated between brackets and shall immediately follow the rated current for resistive load.

The marking shall be as follows:

$$3(1)\text{A } 250\text{V or } 3(1)/250 \text{ or } \frac{3(1)}{250}$$

NOTE 1 This marking is in accordance with IEC Publication 328 and CEE Publication 24: Switches for Appliances.

NOTE 2 The rated current values do not apply to circuits in general but only to the rating of the luminaire as a whole.

3.4 Test for marking

The durability of the marking shall be checked by trying to remove it by rubbing lightly for 15 s with a piece of cloth soaked with water and, after drying, for a further 15 s with a piece of cloth soaked with hexane, and by inspection after the tests detailed in Section 12 have been completed. After the test, the marking shall be legible, marking labels shall not be easily removable and they shall show no curling.

Section 4. Construction

4.1 Scope

This section specifies general constructional requirements for luminaires for use with tungsten filament, tubular fluorescent and other discharge lamps on supply voltages not exceeding 1 000 V. It is to be read in conjunction with Section 0 and with the other relevant sections to which reference is made. See also Appendix H.

4.2 Replaceable components

Luminaires incorporating components or parts intended to be replaceable shall be so designed that there is sufficient space to permit replacement of such components or parts without difficulty and without impairing safety.

Sealed-in components and riveted parts are not replaceable components.

4.3 Wireways

Wireways shall be smooth and free from sharp edges, burrs, flashes and the like, which might cause abrasion of the insulation of the wiring. Parts such as metal set screws shall not protrude into wireways.

Compliance shall be checked by inspection and, if necessary, by dismantling and reassembling the luminaire.

4.4 Lampholders

4.4.1 The requirements for electrical safety of integral lampholders shall be those applicable to the luminaire as a whole with lampholder and lamp in position fully assembled, as for normal use. In addition, integral lampholders shall, when mounted in the luminaire, comply with the "safety during insertion of the lamp" requirements of the appropriate lampholder standard.

4.4.2 Connection of wiring to integral lampholders shall be made by any method giving reliable electrical contact over the service life of the lampholder.

4.4.3 Luminaires for double-ended lamps designed for end-to-end mounting shall be so designed that the lamp may be changed in the middle luminaire of a row without adjusting any other luminaire. In multi-lamp luminaires for double-ended lamps, the changing of any one lamp shall not impair the security of the other lamps.

Compliance shall be checked by inspection.

4.4.4 Lampholders which are put into position by the user shall be capable of easy and correct positioning.

The distance between the pair of fixed lampholders for a fluorescent lamp intended to be set in a fixed position shall comply with the relevant Standard Sheet of IEC Publication 61 or
(if IEC Publication 61 does not apply) the lampholder manufacturer's mounting instructions.
The fixing device of lampholders shall have adequate mechanical strength so as to withstand such rough handling as may be expected in normal use. These requirements apply both to lampholders put in position by the user and to lampholders put in position by the luminaire manufacturer.
Compliance shall be checked by inspection, measuring and, if applicable, by the following mechanical test:

Lampholders for a fluorescent lamp, with a test-cap in position, shall be subjected, for one minute, to a pressure applied to the centre of the cap in the direction of its axis of:

15N for G5 lampholders

30N for G13 lampholders

Value under consideration for other lampholders.

After the test, the distance between the holders shall comply with the relevant Standard Sheet of IEC Publication 61 and the lampholder shall show no damage. The test cap for this test shall comply with the following Standard Sheets in
IEC Publication 61-3:

— 7006-47C for lampholder G5

— 7006-60C for lampholders G13

Test-caps for other lampholders are under consideration.

4.4.5 For luminaires with ignitors, the peak pulse voltage occurring across lampholders which are part of the pulse voltage circuit shall not be greater than:

5 000 V for 750 V rated ES lampholders

3 500 V for 500 V rated ES lampholders

2 500 for all 250 V rated lampholders

4.6 U_R for other lampholders of rated voltage U_R

Compliance shall be checked by measurement of the voltage occurring across the lampholder during the test to Sub-clause **10.2.2** for luminaires with ignitors.

4.4.6 For luminaires with ignitors incorporating Edison screw lampholders, the centre contact of the lampholder shall be connected to the lead which supplies the pulse voltage.

4.4.7 The insulating parts of lampholders and plugs incorporated in rough service luminaires shall be of a material resistant to tracking.

4.5 Starter holders

Starter holders in luminaires other than Class II shall accept starters which comply with IEC Publication 155: Starters for Fluorescent Lamps.

Class II luminaires may require starters of Class II construction.

For Class II luminaires where the starter can be touched with the standard test finger when the luminaire is fully assembled for use or open for the replacement of lamps or starters, the starter holder shall be one accepting only starters complying with the requirements for starters for Class II luminaires, given in IEC Publication 155: Starters for Tubular Fluorescent Lamps.

4.6 Terminal blocks

4.6.1 If luminaires are provided with connecting leads (tails) requiring a separate terminal block for the connection to the supply cables, adequate space for this terminal block shall be provided within the luminaire or within a box delivered with the luminaire or specified by the manufacturer.

This requirement applies to terminal blocks for connecting leads (tails) with conductor nominal cross-sectional areas not exceeding 2.5 mm^2.

Test: Compliance shall be checked by measurement and by an installation test, using one terminal block for each two conductors to be connected together, as shown in Figure 2, page 64, and supply cables having a length of approximately 80 mm. The dimensions of the terminal blocks are those specified by the manufacturer or, in the absence of such a specification, 10 mm × 20 mm × 25 mm.

4.6.2 Unsecured terminal blocks are permitted when they are so designed and insulated that creepage distances and clearances in accordance with Section 11 are always maintained for any position of the terminal block, and that damage to internal wiring is prevented.

4.7 Terminals and supply connections

4.7.1 In portable luminaires of Class 0, Class I and Class II and in fixed luminaires of Class 0, Class I and Class II that are frequently adjusted, adequate precautions shall be taken to prevent metal parts, which can be touched with the standard test finger when the luminaire is fully assembled for use or open for the replacement of lamps or starters, becoming live by reason of a detached wire or screw. This requirement applies to all terminals (including supply terminals) for wires that may be subjected to stress during normal use. The requirement may be met by securing the wires adjacent to their entry to the terminals, by suitably dimensioning the enclosure for the terminals, by the use of an enclosure of insulating material or by the provision of an insulating lining in the enclosure.

Compliance shall be checked by inspection.

4.7.2 Supply terminals shall be located or shielded in such a way that, if a wire of a stranded conductor escapes from a terminal when the conductors are fitted, there is no risk of contact between live parts and metal parts which can be touched with the standard test finger when the luminaire is fully assembled for use or open for replacement of lamps or starters.

Test: Compliance shall be checked, for luminaires intended to be connected to the supply by means other than a non-detachable flexible cable or cord, by inspection, and for luminaires intended to be connected to the supply by means of a non-detachable flexible cable or cord, by inspection and by the following test:

An 8 mm length of insulation is removed from the end of a flexible conductor having the largest cross-sectional area specified in Section 5. One wire of the stranded conductor is left free and the remainder is fully inserted and clamped in the terminal. The free wire is bent, without tearing the insulation back, in every possible direction, but without making sharp bends around barriers.

The free wire of a conductor connected to a live terminal shall not touch any metal part which is accessible or is connected to an accessible metal part and the free wire of a conductor connected to an earthing terminal shall not touch any live part.

This test does not apply to lampholders which have been separately approved to an appropriate IEC standard and to terminals of components where the construction method justifies a shorter length of free wire.

4.7.3 Terminals for supply conductors, including those for non-detachable flexible cables and cords, shall be suitable for connection to be made by means of screws, nuts or equally effective devices.

Connecting leads (tails) shall comply with the requirements of Section 5.

For luminaires designed to be connected by means of rigid (solid or stranded) conductors, screwless terminals of the spring type are effective devices, including the earth connection. No requirements are specified at present for using such terminals for the connection of non-detachable flexible cables and cords.

For luminaires designed to be connected by means of non-detachable flexible cable or cord and having a rated current not exceeding 3 A, soldered, welded, crimped and similar connections, including snap-on connectors are effective devices, including the earth connection.

For luminaires having a rated current exceeding 3 A, snap-on connectors are suitable if the connection can also be made without making use of the receptacle, for example by means of a screwed connection for which a threaded hole is provided in the tab.

4.7.4 Terminals, other than those for supply connection, which are not covered by separate standards for components shall comply with the requirements of Sections 14 or 15.

Terminals of lampholders, switches and similar parts used for multiple connection of internal wiring shall have dimensions adequate for the purpose and shall not be used for the connection of external wiring.

4.7.5 If the external wiring or supply cable is unsuitable for the temperatures reached inside the luminaire, either a connection shall be provided at the point of entry of the external wiring into the luminaire for the use of heat-resistant wiring after this point, or heat-resisting parts shall be supplied with the luminaire to cover the part of the wiring placed inside it, which exceeds the wiring temperature limit.

4.8 Switches

Switches shall be adequately rated and so fixed that they are secured against rotation and cannot be removed by hand.

Switches in flexible cables or cords and switch-lampholders shall not be used in luminaires other than ordinary, unless the degree of protection against ingress of dust, solid objects or moisture of the switch is in accordance with the classification of the luminaire.

For luminaires intended for use on a polarized supply and where the luminaire has a single-pole on/off switch, the switch shall be wired into the live side of the supply or the side other than that identified as the neutral side.

Compliance shall be checked by inspection.

4.9 Insulating linings and sleeves

4.9.1 Insulating linings and sleeves shall be so designed that they are reliably retained in position when switches, lampholders, terminals, wires or similar parts have been mounted.

Self-hardening resins, such as epoxy resins, may be used to fix linings.

Test: Compliance shall be checked by inspection and by manual test.

4.9.2 Insulated linings, sleeves and similar parts shall have adequate mechanical and electrical strength.

Test: Compliance shall be checked by inspection, by manual test and by an electric strength test in accordance with Section 10.

4.10 Insulation of Class II luminaires

4.10.1 For Class II luminaires, contact between accessible metal parts and wiring with basic insulation only shall be effectively prevented. This wiring includes internal and external wiring of the luminaire and fixed wiring of the installation. The sheath of a flexible cable or cord is not supplementary insulation if it is subject to undue mechanical or thermal stress. Class II fixed luminaires shall be so designed that the required degree of protection against electric shock is not impaired as a result of the installation of the luminaires, for example by contact with conduits or metal sheaths of cables. Capacitors shall not be connected between live parts and the body of Class II luminaires.

Contact between accessible metal parts and basic insulation of internal wiring may be prevented by sleeves or similar parts which comply with the requirements for supplementary insulation.

Compliance shall be checked by inspection.

4.10.2 Assembly joints in basic insulation and in supplementary insulation shall not be coincidental, neither shall any assembly joint in reinforced insulation give straight access to live parts.

Compliance shall be checked by inspection.

4.10.3 For parts of Class II luminaires which serve as supplementary insulation or reinforced insulation:

— either they shall be fixed so that they cannot be removed without being seriously damaged;

— or they shall be unable to be replaced in an incorrect position.

Where sleeving is used as supplementary insulation on internal wiring and where insulated linings are used in lampholders as supplementary insulation on external or internal wiring, the sleeving and lining shall be retained in position by positive means.

Compliance shall be checked by inspection and by manual test.

NOTE Lining metal enclosures with a coating of lacquer or with any other material in the form of a coating which can be easily removed by scraping is not considered to meet this requirement. A sleeve is considered to be fixed by positive means if it can only be removed by breaking or cutting or if it is clamped at both ends or its movement on internal wiring is restricted by neighbouring components. A lining is considered to be fixed by positive means if it can only be removed by breaking or cutting or by dismantling the lampholder. Parts such as a tube of insulating material provided with a shoulder and used as a liner inside the nipple of a lampholder are considered to provide supplementary insulation on external or internal wiring if they can be removed only by dismantling the lampholder.

4.11 Electrical connections and current-carrying parts

4.11.1 Electrical connections shall be so designed that contact pressure is not transmitted through insulating material other than ceramic, pure mica or other material with characteristics at least equivalent, unless there is sufficient resilience in the metallic parts to compensate for any possible shrinkage of the insulating material.

Compliance shall be checked by inspection.

4.11.2 Self-tapping screws shall not be used for the connection of current-carrying parts, unless they clamp these parts directly in contact with each other and are provided with a suitable means of locking.

Thread-cutting screws shall not be used for the interconnection of current-carrying parts of metal which is soft or liable to creep, such as zinc or aluminium.

Self-tapping screws may be used to provide earth continuity, if it is not necessary to disturb the connection in normal use and at least two screws are used for each connection.

Compliance shall be checked by inspection.

NOTE See Figure 22 for some examples of self-tapping, thread-cutting and thread-forming screws.

4.11.3 Screws and rivets which serve as electrical as well as mechanical connections shall be locked against loosening. Spring washers may provide satisfactory locking. For rivets, a non-circular shank or an appropriate notch may be sufficient.

Sealing compound which softens on heating provides satisfactory locking only for screw connections not subject to torsion in normal use.

Compliance shall be checked by inspection and manual test.

4.11.4 Current-carrying parts shall be of copper, an alloy containing at least 50 % copper, or a material having at least equivalent characteristics.

This requirement does not apply to screws which do not essentially carry current, such as terminal screws.

Current-carrying parts shall be resistant to, or adequately protected against corrosion.

NOTE Copper and copper alloys containing at least 50 % copper are considered to meet this requirement.

Compliance shall be checked by inspection and, if necessary, by chemical analysis.

4.11.5 Live parts shall not be in direct contact with wood.

Compliance shall be checked by inspection.

4.11.6 Electro-mechanical contact systems shall withstand the electrical stresses occurring in normal use.

Test: The electro-mechanical contact systems shall be operated 100 times at a speed which corresponds to practical usage. (An operation is either making or breaking the contact). The test is made with a.c. at rated voltage and the test current shall be 1.25 times the rated current of the electrical contact system. The power factor of the load shall be approximately 0.6, unless a different rated current is marked for resistive loads, in which case the load power factor shall be unity. Where a luminaire is marked for both resistive and inductive loads, it shall be subjected to tests at power factors of both unity and 0.6.

Before and after the tests, the electro-mechanical contact systems shall be loaded with 1.5 times rated current, and the voltage drop across each contact shall not exceed 50 mV.

Following completion of these tests the electro-mechanical contact system shall withstand an electric strength test made in accordance with Clause **10.2** (the test voltage however being reduced to 1 500 V).

After the test the samples shall show:

— no wear impairing their further use;

— no deterioration of enclosures or barriers;

— no loosening of electrical or mechanical connections.

For electro-mechanical contact systems the mechanical test of Sub-clause **4.14.3** shall be made simultaneously with this electrical test.

4.12 Screws and connections (mechanical) and glands

4.12.1 Screws and mechanical connections, the failure of which might cause the luminaire to become unsafe, shall withstand the mechanical stresses occurring in normal use.

Screws shall not be of a metal which is soft or liable to creep, such as zinc and some grades of aluminium.

Screws which are operated for maintenance purposes shall not be of insulating material if their replacement by a metal screw could impair supplementary or reinforced insulation.

Test: Compliance shall be checked by inspection and screwed connections shall be tightened and loosened five times. During the test, no damage impairing the further use of the screwed connection shall occur.

The test is made by means of a suitable test screwdriver or spanner, applying a torque as shown in Table I, except that for screws of insulating material used in cord anchorages and bearing directly on the cable or cord the torque is 0.5 Nm.

The shape of the blade of the screwdriver shall suit the head of the screw to be tested. The screws shall not be tightened in jerks. Damage to covers is neglected. Column 1 of Table I applies to screws without heads if the screw, when tightened, does not protrude from the hole. Column 2 applies to other screws and to nuts.

The values given in Table I for screws over 6.0 mm diameter apply to steel screws and the like, which are used mainly in the mounting of the luminaire.

The values given in Table I for screws over 6.0 mm diameter do not apply to nipple threads of lampholders, the requirements for which are specified in Clause **15** of IEC Publication 238.

4.12.2 Screws transmitting contact pressure, screws which are operated when mounting or connecting the luminaires and having nominal diameter less than 3 mm, shall screw into metal.

Screws or nuts which are operated when mounting the luminaire or replacing lamps include screws or nuts for fixing covers, lids, etc. Connections for screwed conduits, screws for mounting the luminaire to its mounting surface, hand-operated fixing screws or nuts of glass covers and screwed lids are excluded.

Test: Compliance shall be checked by inspection and for screws which are operated when mounting the luminaire or when replacing the lamps, by the test described in Sub-clause **4.12.1**.

Table I — Torque tests on screws

Nominal diameter of screw (mm)	Torque	
	1 (Nm)	2 (Nm)
Up to and including 2.8	0.2	0.4
Over 2.8 up to and including 3.0	0.25	0.5
Over 3.0 up to and including 3.2	0.30	0.6
Over 3.2 up to and including 3.6	0.40	0.8
Over 3.6 up to and including 4.1	0.70	1.2
Over 4.1 up to and including 4.7	0.80	1.8
Over 4.7 up to and including 5.3	0.80	2.0
Over 5.3 up to and including 6.0	—	2.5
Over 6.0 up to and including 8.0	—	8.0
Over 8.0 up to and including 10.0	—	17.0
Over 10.0 up to and including 12.0	—	29.0
Over 12.0 up to and including 14.0	—	48.0
Over 14.0 up to and including 16.0	—	114.0

4.12.3 Screws or nuts that engage with a thread of insulating material shall have a length engagement of at least 3 mm plus one-third of the nominal screw diameter, except that this length need not exceed 8 mm. This requirement does not apply to screws of insulating material used in cord anchorages and bearing directly on the cable or cord.

Test: Compliance shall be checked by inspection, by measurement and by completely removing and replacing the screw or nut, ten times.

4.12.4 Screwed and other fixed connections between different parts of luminaires shall be made in such a way that they do not work loose through such torsion, bending stresses, vibration, etc., as may occur in normal use. Fixed arms and suspension tubes shall be securely attached.

NOTE Examples of means of preventing the loosening of connections are soldering, welding, lock nuts and set screws.

Test: Compliance shall be checked by inspection and by attempting to loosen locked connections with a torque not exceeding:

— 2.5 Nm for thread sizes up to and including M 10 or corresponding diameters;

— 5.0 Nm for thread sizes above M 10 or corresponding diameters.

For lampholders which are exposed to a rotary action during lamp replacement compliance shall be checked by inspection and by attempting to loosen locked screwed mechanical connections for one minute with a torque not exceeding:

4.0 Nm for E40 lampholders

2.0 Nm for E26, E27 and B22 lampholders

1.2 Nm for E14 and B15 lampholders

0.5 Nm for E10 lampholders

During the test, such screwed connections shall not loosen.

4.12.5 Screwed glands shall comply with the following test.

Test: Screwed glands shall be fitted with a cylindrical metal rod having a diameter equal to the nearest whole number of millimetres below the internal diameter of the packing. The glands shall then be tightened by means of a suitable spanner, the force shown in Table II being applied to the spanner for 1 min at a point 250 mm from the axis of the gland.

Table II — Torque tests on glands

Diameter of test rod (mm)	Force	
	Metal glands (N)	Glands of moulded material (N)
Up to and including 14	25	15
Over 14 up to and including 20	30	20
Over 20	40	30

After the test, the luminaire and the glands shall show no damage.

4.13 Mechanical strength

4.13.1 Luminaires shall have adequate mechanical strength and be so constructed as to be safe after such rough handling as may be expected in normal use.

Test: Blows shall be applied to the sample by means of the spring-operated impact test apparatus specified in IEC Publication 817 or by some other suitable means giving equivalent results.

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

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

The body comprises the housing, the striking element guide, the release mechanism and all parts rigidly fixed thereto. The mass of this assembly shall be 1.25 ± 0.01 kg.

The striking element comprises the hammer head, the hammer shaft and the cocking knob. The mass of this assembly shall be 0.250 ± 0.001 kg.

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

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

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

Table III — Impact energy and spring compression

Part to be tested	Impact energy (Nm)	Compression (mm)
Class II luminaires:		
Translucent covers forming part of the protection against dust and moisture, but not providing protection against electric shock	0.35	17
Ceramic lampholders	0.20	13
Ceramic covers providing protection against electric shock	0.35	17
Other translucent covers providing protection against electric shock	0.50	20
Other parts	0.70	24
Other luminaires:		
Translucent covers forming part of the protection against dust and moisture, but not providing protection against electric shock, parts of ceramic material and parts of ceramic lampholders integral with the luminaire	0.20	13
Translucent covers providing protection against electric shock and other parts, with the exception of parts of ceramic material	0.35	17
Translucent covers neither providing protection against electric shock nor forming part of the protection against dust and moisture are not subjected to the test.		
Fixed rough service luminaires	(See the test of Sub-clause **4.13.3**)	
Portable rough service luminaires (hand-held)	(See the test of Sub-clause **4.13.4**)	

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

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

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

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

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

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

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

1) live parts shall not have become accessible;

2) the effectiveness of insulating linings and barriers shall not have been impaired;

3) the sample shall continue to afford the degree of protection against ingress of dust, solid objects and moisture, in accordance with its classification;

4) it shall be possible to remove and to replace external covers without these covers or their insulating linings breaking.

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

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

Damage to the finish, small dents which do not reduce creepage distances or clearances below the value specified in Section 11, and small chips which do not adversely affect the protection against electric shock, dust or moisture, are neglected.

4.13.2 Metal parts enclosing live parts shall have adequate mechanical strength.

Compliance shall be checked by the following test:

Test: A straight unjointed test finger is used, with the same dimensions as the standard test finger specified in IEC Publication 529. The finger is pressed against the surface with a force of 30 N.

During the test, metal parts shall not touch live parts.

After the test, covers shall not be excessively deformed and the luminaire shall continue to meet the requirements of Section 11.

4.13.3 Test. Fixed rough service luminaires and portable rough service luminaires (not hand-held)

Each of three samples of the luminaire shall be subjected to three single impacts, to points likely to be the weakest, on any surface normally exposed. The sample without lamp (or lamps) is mounted as in normal use on a rigid supporting surface.

The impacts are produced by dropping a steel sphere 50 mm diameter weighing 0.51 kg from a height H (1.3 m) to produce an impact energy of 6.5 Nm, as shown in Figure 21, page 79.

Each of the three samples of a luminaire intended for outside use shall additionally be cooled to a temperature of -5 ± 2 °C and maintained at that temperature for 3 h.

Whilst the samples are at this temperature they shall be subjected to the impact test specified above.

4.13.4 Test. Portable rough service luminaires (hand-held)

The luminaire is caused to fall four times from a height of 1 m on to a concrete floor. The falls are made from four different horizontal starting positions, the luminaire being turned through 90° around its axis between each fall. Lamps are removed but protective glasses, if any, are not removed for this test.

After the test of Sub-clauses **4.13.3** or **4.13.4** the luminaire shall show no damage impairing safety and its further use. The parts protecting the lamp against damage shall not have loosened.

NOTE These parts may have become deformed. Breakage of a protective glass or translucent cover is neglected if the glass or cover is not the sole means of protecting the lamp against damage.

In addition, the compliance requirements of Sub-clauses **4.13.1** and **4.13.2** apply.

4.14 Suspensions and adjusting devices

4.14.1 Mechanical suspensions shall have adequate factors of safety. Compliance shall be checked by the appropriate following tests.

Test: For all suspended luminaires. A constant evenly distributed load equal to four times the weight of the luminaire shall be added to the luminaire in the normal direction of the load for a period of 1 h. There shall be no appreciable deformation of the components of the suspension system at the end of this period. Where alternative means of fixing or suspension are provided, each shall be tested separately. For adjustable suspension, the load shall be applied with the supporting cable fully extended.

Test: For rigid suspension luminaires. A torque of 2.5 Nm is applied to the luminaires for a period of 1 min, first in a clockwise and then in an anticlockwise direction. For this test, it shall not be possible to rotate the luminaire relative to the fixed part by more than one revolution in either direction.

Test: For rigid suspension brackets. Details of the test for rigid suspension brackets are as follows:

1) For heavy-duty brackets (for example workshop brackets), a force of 40 N shall be applied for 1 min, in various directions at the free end, with the bracket arm fixed as in normal use. The bending moment resulting from this test shall be not less than 2.5 Nm. When the test force has been removed, the bracket arm shall not be permanently displaced or deformed so as to endanger safety.

2) For light-duty brackets (for example domestic brackets), a similar test to Item 1) shall be applied for 1 min, but with a force of 10 N, and the bending moment resulting from this test shall be not less than 1.0 Nm.

Test: For track-mounted luminaires. The mass of the luminaire shall not exceed the value, recommended by the track manufacturer, of the maximum loading for which the luminaire suspension devices are suitable.

4.14.2 The mass of the luminaire suspended by flexible cables or cords shall not exceed 5 kg. The total nominal cross-sectional area of the conductors of flexible cables or cords suspending pendants shall be such that the stress in the conductors does not exceed 15 N/mm^2.

For the calculation of the stress, only the conductors are considered.

Where a luminaire of mass greater than 5 kg is intended to be suspended, the design of the luminaire or of the flexible cable or cord shall be such as to prevent any tension being applied to the conductors.

NOTE This requirement can be met by using a cable which incorporates suitable load-carrying cores.

4.14.3 Adjusting devices, for example joints, hoisting devices, adjusting brackets or telescopic tubes, shall be so constructed that cords or cables are not pressed, clamped, damaged or twisted by more than 360° during operation.

Test: The adjusting device, equipped with the appropriate cable or cord shall be operated in accordance with the details of Table IV. A cycle of operation is a movement from one extreme of the range to the other and back to the starting position. The rate of movement shall not cause the device to heat appreciably and shall not exceed 600 cycles per hour. For electro-mechanical contact systems this test is conducted simultaneously with the electrical connection test of Sub-clause **4.11.6**.

After the test, not more than 50 % of the strands in a conductor shall be broken nor shall there be any serious damage to the insulation, if any, of the flexible cord. Compliance shall be checked by inspection. The cord or cable shall also be subjected to and shall satisfy the insulation resistance and high-voltage tests specified in Section 10.

Ball-joints and the like where the clamping means can be adjusted are tested with the joints only lightly clamped to avoid excessive friction. If necessary, the clamping areas are readjusted during the test.

For adjusting devices that consist of a flexible tube the range of adjustment for this test is normally 135° in both directions from the vertical. However, where this adjustment cannot be achieved without using unreasonable force the flexible tube is bent only to the positions where it will remain by itself.

Table IV — Tests on adjusting devices

Type of luminaire	Number of cycles of operation
Luminaires intended to be frequently adjusted, for example drawing board luminaires	1 500
Luminaires intended to be occasionally adjusted, for example shopwindow spotlights	150
Luminaires intended to be adjusted during installation only for example floodlighting luminaires	45

4.14.4 Cords or cables passing through telescopic tubes shall not be fixed to the outer tube. Means shall be provided for avoiding strain on the conductors at the terminals.

Compliance shall be checked by inspection.

4.14.5 Guide pulleys for flexible cords shall be dimensioned to prevent damage to the cords by excessive bending. Grooves in the pulleys shall be well rounded, the diameter of the pulley at the bottom of the groove being at least three times the diameter of the cord. Accessible metal pulleys shall be earthed.

Compliance shall be checked by inspection.

4.15 Flammable materials

Covers, shades and similar parts not having an insulation function, and which do not withstand the 650 °C glow-wire test of Sub-clause **13.3.2** shall be adequately spaced from any heated part of the luminaire which could raise the material to its ignition temperature. These parts of flammable material shall have suitable fastenings or supporting devices to maintain this spacing.

The spacing from heated parts mentioned above shall be at least 30 mm, unless the material is protected by a screen spaced at least 3 mm from the heated parts. This screen shall comply with the needle-flame test of Sub-clause **13.3.1**, shall have no holes and shall have a height and length at least equal to the corresponding dimensions of the heated parts. A screen is not required in those cases where the luminaire provides an effective barrier to burning drops.

NOTE The requirements of this clause are illustrated in Figure 4.

Materials which burn fiercely, such as celluloid, shall not be used.

The requirements of this clause do not apply to small parts such as wiring clips and resin-bonded paper parts used inside the luminaire.

Spacing is not required from electronic circuits if under abnormal conditions the operating current does not exceed normal conditions current by more than 10 %.

Compliance shall be checked by inspection and by measurement.

Spacing is not required from parts of luminaires incorporating a temperature-sensing control which provides protection against overheating of the covers, shades or similar parts.

Compliance shall be checked by operating the luminaire in the abnormal condition with a slowly and steadily increasing current through the windings of the ballast or transformer, until the temperature-sensing control operates. During and after this test, covers, shades and similar parts, shall not catch fire and accessible parts shall not become live.

To check whether accessible parts have become live a test in accordance with Appendix B is made.

4.16 Luminaires marked with ▽F symbol

4.16.1 Not used.

4.16.2 For luminaires with an ▽F symbol, the excessive ballast/transformer temperatures which may arise due to ballast/transformer failure shall not cause a fire hazard.

This requirement shall be met by spacing the ballast/transformer from the mounting surface in accordance with Sub-clause **4.16.2.1**, by the use of thermal cut-outs in accordance with Sub-clause **4.16.2.2**, or by compliance with Sub-clause **4.16.2.3**.

4.16.2.1 The ballast/transformer case shall be spaced from the mounting surface by a distance, including the thickness of the luminaire case material, of either:

a) 35 mm, or

b) 10 mm, when the spacing shall include a minimum of 3 mm air space between the outer surface of the luminaire case and the mounting surface of the luminaire in the region of the ballast/transformer, and a minimum of 3 mm air space between the ballast/transformer case and the inner surface of the luminaire case.

In both instances the luminaire shall be so designed that any necessary air space between the mounting surface and the luminaire case is automatically obtained when it is mounted as in normal use.

Compliance shall be checked by inspection and by measurement.

NOTE The spacing of 35 mm in Item a) is primarily to take account of stirrup-mounted luminaires where the ballast/transformer case to mounting surface distance is often very much greater than 10 mm.

4.16.2.2 The luminaire shall incorporate a temperature-sensing control to limit the temperature of the mounting surface of the luminaire to a safe value. This temperature-sensing control may be either external to the ballast/transformer or be part of a thermally protected ballast in accordance with Appendix F of IEC Publication 82. Temperature-sensing controls shall not be of the plug-in type or otherwise easily replaceable type.

Temperature-sensing controls external to the ballast/transformer shall be kept in a fixed position with regard to the ballast/transformer.

NOTE The use of cement or the like as a means of attaching the temperature-sensing control to the ballast is not permitted.

Compliance shall be checked by inspection and by the test Clause **12.6** of Section 12.

4.16.2.3 If the luminaire does not comply with the spacing requirements of Sub-clause **4.16.2.1**, and does not incorporate thermal cut-outs in accordance with Sub-clause **4.16.2.2**, it shall be so designed that it satisfies the test of Clause **12.6** of Section 12.

NOTE The requirement and its test are based on the assumption that, during failure of the ballast/transformer for instance owing to short-circuited windings or a short circuit to the case, the ballast/transformer winding will not exceed 350 °C for a duration of more than 15 min and therefore the temperature of the mounting surface will not exceed 180 °C for a duration of more than 15 min.

4.16.3 The requirements of Sub-clause **4.16.2** do not apply in the case of luminaires incorporating electronic ballasts, provided the maximum temperature of the ballast case complies with the requirements specified in Appendix F of IEC Publication 82, for ▽PA and ▽PB thermally protected ballasts.

In the case of electronic ballasts incorporating a filter coil the requirements of Sub-clause **4.16.2** shall apply in addition. In that case specially prepared ballasts may be necessary for the purpose of the measurements specified in Sub-clause **4.16.2.3**.

4.17 Drain holes

Drip-proof, rain-proof, splash-proof and jet-proof luminaires shall be so designed that if water accumulates in the luminaire it can drain out effectively. Watertight luminaires shall have no provision for draining.

Test: Compliance shall be checked by inspection and by the tests of Section 9.

A drain hole in the back of a luminaire for surface mounting is effective only if the design ensures a clearance of at least 5 mm from the mounting surface, for example by means of projections from the back.

4.18 Resistance to corrosion

4.18.1 Ferrous parts of drip-proof, rain-proof, splash-proof, jet-proof, watertight and pressure-watertight luminaires, the rusting of which might cause the luminaire to become unsafe, shall be adequately protected against rusting.

Compliance shall be checked by the following test:

All grease is removed from the parts to be tested. The parts are then immersed for 10 min in a 10 % solution of ammonium chloride in water at a temperature of 20 ± 5 °C. Without drying, but after shaking off any drops, the parts are placed for 10 min in a box containing air saturated with moisture at a temperature of 20 ± 5 °C. After the parts have been dried for 10 min in a heating cabinet at a temperature of 100 ± 5 °C, their surfaces shall show no signs of rust.

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

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

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

Compliance shall be checked by the test given in Appendix J which shall be made on the samples not subjected to any other test.

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

Test under consideration.

4.19 Ignitors

Ignitors used in luminaires shall be electrically compatible with the associated ballast in the luminaire.

4.20 Rough service luminaires — vibration requirement

NOTE In the design of fixed rough service luminaires particular attention should be paid to resistance to damage owing to vibration. It is hoped that a test for assessing resistance to vibration will be agreed but there is no requirement for a test at present.

4.21 Safety shield (tungsten halogen lamps)

4.21.1 Luminaires for indoor use incorporating double-ended halogen lamps shall be fitted with a safety shield to provide protection against the effects of shattering lamps. This shield may, for example, be in the form of a glass screen.

4.21.2 All openings in the luminaire shall be such that no part of a shattered lamp can leave the luminaire by a direct path.

4.21.3 The safety shield shall withstand the impact from a shattering lamp.

Compliance shall be checked by operating the luminaire, at the rated voltage of the lamp, in a position of normal use for 30 s, and then causing the lamp to shatter, for example by abruptly increasing the voltage applied to the lamp by about 30 %.

After the shattering of this lamp, the shield shall show no damage. This test is repeated and, after the shattering of the second lamp, the shield (if of glass) may be cracked but no high velocity particles shall escape.

NOTE Safety shield requirements for indoor luminaires incorporating single-ended halogen lamps are under consideration.

4.22 Attachments to lamps

Luminaires shall not incorporate attachments to lamps which might cause overheating or damage of the lamp, lamp cap or lampholder.

NOTE Examples of attachments to lamps which might not comply with these requirements are bowl mirror reflectors, reflectors around lamps, etc. Examples which might be permitted are springs for attachment of lightweight shades to candle lamps and similar devices.

Section 5. External and internal wiring

5.1 Scope

This section specifies general requirements for the electrical connections to a supply and for the internal wiring of luminaires for use with tungsten filament, tubular fluorescent and other discharge lamps on supply voltages not exceeding 1 000 V. It is to be read in conjunction with Section 0 and with the other relevant sections to which reference is made.

5.2 Supply connection and other external wiring

5.2.1 Luminaires shall be provided with one of the following means of connection to the supply:

Fixed luminaires	terminals; appliance inlets; plugs for engagement with socket-outlets; connecing leads (tails); non-detachable flexible cables or cords; adaptors for engagement with supply tracks.
Ordinary portable luminaires	non-detachable flexible cables or cords; appliance inlets.
Other portable luminaires	non-detachable flexible cables or cords.
Track-mounted luminaires	adaptors or connectors.

Rough service luminaires shall not have socket-outlets.

Portable luminaires intended for wall mounting and incorporating a junction box and cord anchorage may be delivered without a non-detachable flexible cable or cord, if an instruction for mounting is enclosed with the luminaire.

5.2.2 Non-detachable flexible cables and cords shall be at least equal in mechanical and electrical properties to those indicated in Table V and specified in HD 21 S2 and HD 22 S2.

Table V — Non-detachable flexible cables or cords

	Rubber	PVC
Class 0 luminaires	H03RT-F	H03VH-H
Ordinary Class I luminaires	H03RT-F	H03VVH2-F H03VV-F
Ordinary Class II luminaires	H05RR-F	H03VVH2-F H03VV-F
Luminaires other than ordinary	H05RR-F	H05VVH2-F H05VV-F
Portable rough service luminaires	H07RN-F	—

For supply voltages greater than 250 V, higher voltage grade cables and cords than those given in the above table may be necessary.

In regions with cold climates, PVC-insulated flexible cables and cords may not be suitable for outdoor use; see Annex ZB — Special National Conditions.

To provide adequate mechanical strength, the nominal cross-sectional area of the conductors shall be not less than:

for ordinary luminaires	0.75 mm^2
for other luminaires	1.0 mm^2

5.2.3 Non-detachable flexible cables or cords shall be connected to rewirable luminaires in such a manner that replacement may be performed without special purpose tools, for example, crimping tools.

5.2.4 Compliance with the requirements of Sub-clauses **5.2.1** and **5.2.3** shall be checked by inspection and, if necessary, by fitting the appropriate flexible cable or cord.

5.2.5 For non-rewirable luminaires, where moulded-in flexible cables or cords may be used, the cable or cord shall not be connected by means of screwed connections.

5.2.6 Cable entries shall be suitable for the introduction of the conduit or the protective covering of the cable or flexible cord so that the cores are completely protected, and they shall provide the degree of protection against dust or moisture in accordance with the classification of the luminaire, when the conduit, cable or flexible cord is fitted.

5.2.7 Cable entries through rigid materials for external flexible cables and cords shall have smoothly rounded edges of minimum radius 0.5 mm.

5.2.8 If, in Class II luminaires, in adjustable luminaires or in portable luminaires other than those for wall mounting, a flexible cable or cord where entering or leaving the luminaire passes through accessible metal parts or through metal parts in contact with accessible metal parts, the opening shall be provided with a tough bushing of insulating material having smoothly rounded edges, so fixed that it cannot easily be removed. Bushings of material likely to deteriorate with age (e.g. rubber) shall not be used in openings with sharp edges.

NOTE The term "easily removable bushing" is used to describe a bushing which can be pulled out of its mounting by hand or a bushing screwed into a luminaire but not secured with a lock-nut or appropriate adhesive such as a self-hardening resin.

If tubes or other guards are provided for the protection of flexible cables or cords at the entry to the luminaire they shall be of insulating material.

Helical metal springs and similar components, even when covered with insulated material, are not guards.

Compliance shall be checked by inspection.

5.2.9 Bushings which screw into the luminaire shall be locked in position. If bushings are fixed with an adhesive, it shall be of the self-hardening resin type.

Compliance shall be checked by inspection.

5.2.10 Luminaires provided with or designed for use with non-detachable flexible cables or cords shall have a cord anchorage such that the conductors are relieved from strain, including twisting, where they are connected to the terminals, and such that their covering is protected from abrasion. It shall be clear how the relief from strain and the prevention of twisting is intended to be effected. For luminaires supplied without a cable or cord, suitable test cables or cords of the largest and smallest sizes recommended by the luminaire manufacturer shall be used for the tests.

It shall not be possible to push the flexible cable or cord into the luminaire to such an extent that the cable or cord is subjected to undue mechanical or thermal stress. Methods such as tying the cable or cord into a knot or tying the ends with string shall not be used.

Cord anchorage shall be of insulating material or be provided with a fixed insulating lining if an insulation fault on the cable or cord could make accessible metal parts live. This requirement does not apply to luminaires for wall mounting and to other luminaires provided with a sheathed flexible cable or cord that is unlikely to be stressed at the cord anchorage at any time during its life.

Cord anchorages shall be such that:

1) at least one part is fixed to, or is integral with, the luminaire:

NOTE A cord anchorage is described as fixed to, or held by the luminaire if this is actually the case when the wiring is inserted and the luminaire is completely assembled.

2) they are suitable for the different types of flexible cable or cord that are appropriate for connecting to the luminaire, except where the luminaire allows only one type of cable or cord to be fitted;

3) they do not damage the cable or cord and they are unlikely to be damaged when they are tightened or loosened in normal use;

4) the whole flexible cable or cord with its covering, if any, is capable of being mounted into the cord anchorage;

5) the cable or cord does not touch clamping screws of the cord anchorage if these screws are of metal and are accessible or electrically connected to accessible metal parts;

6) the cable or cord is not clamped by a metal screw which bears directly on the cable or cord;

7) replacement of the flexible cable or cord does not require the use of a tool specially designed for the purpose.

Glands shall not be used as cord anchorages in portable or adjustable luminaires, unless they have provision for clamping all types and sizes of cables and cords which might be used for the supply connection. Anchorages of labyrinth type may be used if it is evident from the design or by means of suitable marking how the flexible cable or cord is to be mounted.

5.2.10.1 *Test.* Compliance shall be checked by inspection and by the following tests which are made with the cable or cord which is fitted to the luminaire as delivered.

The conductors are introduced into the terminals and the terminal screws, if any, are tightened just sufficiently to prevent the conductors from easily changing their position.

The cord anchorage is used in the normal manner, clamping screws, if any, being tightened with a torque two-thirds of that specified in Table I.

After this preparation, it shall not be possible to push the cable or cord into the luminaire in such a way as to cause movement of the cable or cord at the terminals, or to cause the cable or cord to come into contact with moving parts or parts which operate at a temperature higher than that permissible for the insulation of the conductors.

Table VI — Tests for cord anchorage

Total nominal cross-sectional area of all conductors together (mm^2)	Pull (N)	Torque (Nm)
Up to and including 1.5	60	0.15
Over 1.5 up to and including 3	60	0.25
Over 3 up to and including 5	80	0.35
Over 5 up to and including 8	120	0.35

The cable or cord is then subjected 25 times to a pull of the value shown in Table VI. The pulls are applied without jerks, each time for 1 s. The measurement of the longitudinal displacement of the cable or cord is made during this test. A mark is made on the cable or cord at a distance of approximately 20 mm from the cord anchorage while it is subjected to the first pull and during the 25th pull the mark shall not have been displaced by more than 2 mm.

The cable or cord shall then be subjected to a torque of the value shown in Table VI.

During and after the above tests, the conductors shall not have moved noticeably in the terminals and the cable or cord shall not be damaged.

5.2.11 If external wiring passes into the luminaire, it shall comply with the appropriate requirements for internal wiring.

5.2.11.1 *Test.* Compliance shall be checked by the tests of Clause **5.3**.

5.2.12 Fixed luminaires for looping-in shall be provided with terminals intended for maintaining the electrical continuity of supply cables feeding the luminaire but not terminating in it.

Compliance shall be checked by inspection.

5.2.13 The ends of flexible stranded conductors may be tinned but shall not have additional solder applied unless a means is provided of ensuring that clamped connections cannot work loose owing to cold flow of the solder.

This requirement is met when spring terminals are used. Securing the clamping screws is not an adequate means of preventing the connection of soldered strands from working loose owing to cold flow of the solder.

5.2.14 If a plug is supplied with the luminaire by the luminaire manufacturer the plug shall have the same degree of protection against electric shock as the luminaire.

A Class III luminaire shall not be provided with a plug which permits connection with a socket-outlet according to IEC Publication 83: Plugs and Socket-outlets for Domestic and Similar General Use. Standards.

5.2.15 Connecting leads (tails) of low voltage transistorized fluorescent luminaires where supplied as the means of connection of the luminaire to the supply shall be colour coded red to indicate positive and black to indicate negative.

5.2.16 Appliance inlets incorporated into luminaires as the means of connection to the supply shall comply with the requirements of IEC Publication 320.

5.3 Internal wiring

5.3.1 Internal wiring shall be made with conductors of suitable size and type with nominal cross-sections not less than 0.5 mm^2 and a minimum nominal insulation thickness of 0.6 mm if of rubber or PVC.

However, a minimum nominal cross-sectional area of 0.4 mm^2 and a minimum nominal insulation thickness of 0.5 mm may be used where the current flowing through the conductor is not more than 2 A and the wiring is adequately protected, e.g. in pipes in a chandelier. Conductors having cross-sectional areas less than 0.4 mm^2 may be used, provided that they have adequate current-carrying capacity and suitable mechanical properties. The wiring shall be insulated with a material capable of withstanding the voltage and the maximum temperature to which it is subjected in normal use, without deterioration capable of affecting the safety of the luminaire when properly installed and connected to the supply. Sleeves to protect hot spots are suitable.
If conductors whose insulation is coloured green-yellow are used for internal wiring, they shall be reserved for making earth connections only.
Conductors without insulation may be used provided adequate precautions have been taken to ensure maintenance of the minimum clearance distances and compliance with the requirements of this standard.

NOTE For wiring insulation temperature limit requirements, see Sub-clause **12.4.2**.

If internal wiring of fixed luminaires for through-wiring acts as part of the fixed wiring, such wiring shall be copper conductors with not less than 1.5 mm^2 cross-sectional area.

5.3.1.1 *Test.* Compliance shall be checked by inspection after the temperature rise and heating tests of Section 12.

5.3.2 Internal wiring shall be so situated or protected that it cannot be damaged by sharp edges, rivets, screws and similar components or by moving parts of switches, joints, raising and lowering devices, telescopic tubes and similar parts. Wiring shall not be twisted through an angle exceeding 360°.

5.3.2.1 *Test.* Compliance shall be checked by inspection (see also Sub-clauses **4.14.4** and **4.14.5**) and by the test of Sub-clause **4.14.3**.

5.3.3 If, in Class II luminaires, in adjustable luminaires or in portable luminaires other than those for wall mounting, internal wiring passes through accessible metal parts or through metal parts in contact with accessible metal parts, the opening shall be provided with a tough bushing of insulating material having smoothly rounded edges, so fixed that it cannot easily be removed. Bushings of material likely to deteriorate with age (e.g. rubber and the like) shall not be used in openings with sharp edges.

NOTE The term "easily removable bushing" is used to describe a bushing which can be pulled out of its mounting by hand or a bushing screwed into a luminaire but not secured with a lock-nut or appropriate adhesive such as a self-hardening resin.

If the cable entry openings have smoothly rounded edges and the internal wiring is not required to be moved in service, this requirement is met by the use of a separate protective sheath over a cable that has no special protective sheath or by using a cable which incorporates a protective sheath.

5.3.4 Joints and junctions in internal wiring, excluding terminations on components, shall be easily accessible and shall be provided with an insulating covering no less effective than the insulation of the wiring.

5.3.5 *Test.* Compliance with the requirements of Sub-clauses **5.3.3** and **5.3.4** shall be checked by inspection.

5.3.6 Where internal wiring passes out of the luminaire and the design is such that the wiring may be subject to strain, the requirements for external wiring apply.

The requirements for external wiring do not apply to internal wiring of ordinary luminaires which has a length of less than 80 mm outside the luminaire. For luminaires other than ordinary, all wiring external to the enclosure shall comply with the external wiring requirements.

5.3.6.1 *Test.* Compliance shall be checked by the tests of Sub-clause **5.2.8** and Sub-clause **5.2.10**.

5.3.7 Wiring of adjustable luminaires shall be fixed by means of wire carriers, clips or similar parts of insulating material at all places where it might otherwise rub against metal parts in the normal movement of the luminaire in such a way that the insulation may be damaged.

Compliance shall be checked by inspection.

5.3.8 The ends of flexible stranded conductors may be tinned but shall not have additional solder applied unless a means is provided of ensuring that clamped connections cannot work loose owing to cold flow of the solder.

This requirement is satisfied when spring terminals are used. Securing the clamping screws is not an adequate means of preventing the connection of soldered strands from working loose owing to cold flow of the solder.

Section 6. Not used at present

Section 7. Provision for earthing

7.1 Scope

This section specifies requirements, where applicable, for the earthing of luminaires for use with tungsten filament, tubular fluorescent and other discharge lamps on supply voltages not exceeding 1 000 V. It is to be read in conjunction with Section 0 and with the other relevant sections to which reference is made.

7.2 Provision for earthing

7.2.1 Metal parts of Class I luminaires, which are accessible when the luminaire has been mounted or is opened for replacement of a lamp or replaceable starter or for cleaning purposes and which may become live in the event of an insulation fault, shall be permanently and reliably connected to an earthing terminal or earthing contact.

Metal parts screened from live parts by metal parts which are connected to the earthing terminal or earthing contact, and metal parts separated from live parts by double insulation or by reinforced insulation, are not, for the purpose of this requirement, regarded as likely to become live in the event of an insulation fault.

Metal parts of luminaires which may become live in the event of an insulation fault and which are not accessible when the luminaire is mounted but are liable to come into contact with the supporting surface shall be permanently and reliably connected to an earthing terminal.

The earthing of starters and lamp caps is not a requirement but earthing of lamp caps may be necessary as a starting aid.

The earthing connections shall be of low resistance.

Self-tapping screws may be used to provide earthing continuity, provided that it is not necessary to disturb the connection in normal use and that at least two screws are used for each connection. Thread-forming screws may be used to provide earthing continuity if they comply with the requirements for screw terminals (see Section 14).

For Class I luminaires with detachable parts provided with connectors or similar connecting devices, the earth connection shall be made before the current-carrying contacts are made and the current-carrying contacts shall separate before the earth connection is broken.

7.2.2 Surfaces in adjustable joints, telescopic tubes, etc., providing earthing continuity, shall be such that a good electrical contact is ensured.

7.2.3 *Test.* Compliance with the requirements of Sub-clauses **7.2.1** and **7.2.2** shall be checked by inspection and by the following test:

A current of at least 10 A, derived from a source with a no-load voltage not exceeding 12 V, shall be passed between the earthing terminal or earthing contact and each of the accessible metal parts in turn.

The voltage drop between the earthing terminal or earthing contact and the accessible metal part shall be measured and the resistance calculated from the current and the voltage drop. In no case shall the resistance exceed 0.5 Ω.

NOTE In the case of a luminaire with a non-detachable flexible cable for the supply connection, the earthing contact is at the plug or supply end of the flexible cable or cord.

7.2.4 Earthing terminals shall comply with the requirements of Sub-clause **4.7.3** of Section 4. The connection shall be adequately locked against accidental loosening.

For screw terminals, it shall not be possible to loosen the clamping means by hand.

For screwless terminals, it shall not be possible to loosen the clamping means unintentionally.

7.2.4.1 *Test.* Compliance shall be checked by inspection, by manual test and by the tests specified in Sub-clause **4.7.3** of Section 4.

NOTE In general, the designs commonly used for current-carrying terminals provide sufficient resilience to comply with this requirement; for other designs, special provisions, such as the use of an adequately resilient part which is not likely to be removed inadvertently may be necessary.

7.2.5 For a luminaire provided with a connector socket for a mains supply, the earth contact shall be an integral part of the socket.

7.2.6 For a luminaire to be connected to supply cables or provided with a non-detachable flexible cord or cable, the earth terminal shall be adjacent to the mains terminals.

7.2.7 For luminaires other than ordinary luminaires, all parts of an earth 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.

7.2.8 Either the screw or the other part of the earth terminal shall be made of brass or other non-rusting metal or a material with a non-rusting surface and the contact surfaces shall be bare metal.

7.2.9 *Test.* Compliance with the requirements of Sub-clauses **7.2.5** to **7.2.8** shall be checked by inspection and by manual test.

7.2.10 If a fixed Class II luminaire designed for looping-in is provided with an internal terminal for maintaining the electrical continuity of an earthing conductor not terminating in the luminaire, this terminal shall be insulated from accessible metal parts by double insulation or reinforced insulation.

Compliance shall be checked by inspection.

7.2.11 When a Class I luminaire is supplied with an attached flexible cord, this cord shall have an earthing core coloured green and yellow. The green-yellow core of a flexible cable or cord shall be connected to the earthing terminal of the luminaire and to the earthing contact of the plug if one is attached.

Any conductor, either internal or external, identified by the green-yellow colour combination shall not be connected to terminals other than earthing terminals.

Compliance shall be checked by inspection.

Section 8. Protection against electric shock

8.1 Scope

This section specifies requirements for protection against electric shock from luminaires for use with tungsten filament, tubular fluorescent and other discharge lamps on supply voltages not exceeding 1 000 V. A test to determine whether a conductive part is a live part which may cause an electric shock is described in Appendix B. This section is to be read in conjunction with Section 0 and with the other relevant sections to which reference is made.

8.2 Protection against electric shock

8.2.1 Luminaires shall be so constructed that their live parts are not accessible when the luminaire has been installed and wired as in normal use, and when it is opened as necessary for replacing lamps or (replaceable) starters, even if the operation cannot be achieved by hand.

Protection against electric shock shall be maintained for all methods and positions of installation in normal use having regard to the limitations indicated in the manufacturer's installation instructions, and for all adjustments of adjustable luminaires. Protection shall be maintained after removal of all parts which can be removed by hand, except lamps and the following parts of lampholders:

a) For BC lampholders:

1) domes (terminal covers);

2) skirts.

a) For ES lampholders:

1) domes (terminal covers) for cord grip types only;

2) outer shells.

Covers in fixed luminaires, other than tungsten filament lamp luminaires, which cannot be removed by a single action with one hand, are not removed. However, covers which have to be removed for changing lamps or starters are removed for this test.

Class 0, Class I and Class II luminaires intended for tubular tungsten filament lamps having a cap/base at each end, shall incorporate a means of automatic double-pole disconnection operable when the lamp is being changed. This requirement does not apply if the relevant cap and holder combination(s) is (are) covered by standards which incorporate special requirements with regard to accessibility of live parts which may cause an electric shock.

NOTE The insulating properties of lacquer, enamel, paper and similar materials should not be relied upon to give the required protection against electric shock.

8.2.2 For portable luminaires, protection against electric shock shall also be maintained after movable parts of the luminaires have been placed in the most unfavourable position, which can be effected by hand.

8.2.3 Metal parts of Class II luminaires which are insulated from live parts by basic insulation only are live parts for the purpose of this standard. This applies also to starters and non-current carrying parts of lamp caps, if they are accessible other than when the luminaire is open for lamp or starter changing. This does not apply to the caps of single ended compact fluorescent lamps which comply with IEC Publication 901.

For Class II luminaires, glass lamp bulbs are not required to have further protection against electric shock. If glass bowls and other protective glasses have to be removed when the lamp is replaced or if they do not withstand the test of Clause **4.13** of Section 4, they shall not be used as supplementary insulation.

8.2.4 Portable luminaires for connection to the supply by means of a non-detachable flexible cord and plug shall have protection against electric shock which is independent of the supporting surface.

For portable luminaires, terminal blocks shall be completely covered.

8.2.5 Compliance with the requirements of Sub-clauses **8.2.1** to **8.2.4** shall be checked by inspection and if necessary by a test with the standard test finger specified in IEC Publication 529.

This finger shall be applied to every possible position, if necessary with a force of 10 N, an electrical indicator being used to show contact with live parts. Movable parts, including shades, shall be placed in the most unfavourable position by hand; if of metal they shall not touch live parts of the luminaire or of the lamps.

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

8.2.6 Covers and other parts providing protection against electric shock shall have adequate mechanical strength and shall be reliably secured so that they will not work loose with normal handling.

8.2.6.1 *Test.* Compliance shall be checked by inspection, by manual test and by the tests of Section 4.

8.2.7 Luminaires (other than those mentioned below) incorporating a capacitor of capacitance exceeding 0.5 μF shall be provided with a discharge device so that the voltage across the capacitor 1 min after disconnection of the luminaire from the source of supply at rated voltage, does not exceed 50 V.

Luminaires designed to be connected to the supply by means of a plug and incorporating a capacitor of capacitance exceeding 0.1 μF (or 0.25 μF for luminaires with a rated voltage less than 150 V) shall be provided with a discharge device so that 1 s after disconnection, the voltage between the pins of the plug does not exceed 34 V.

The discharge device (for all types of luminaire) may be incorporated on or within the capacitor or mounted separately within the luminaire.

Section 9. Resistance to dust, solid objects and moisture

9.1 Scope

This section specifies the requirements and tests for luminaires classified as resistant to dust, solid objects and moisture in accordance with Section 2, including ordinary luminaires. It covers luminaires for use with tungsten filament, tubular fluorescent and other discharge lamps on supply voltages not exceeding 1 000 V. It is to be read in conjunction with Section 0 and with the other relevant sections to which reference is made.

9.2 Tests for ingress of dust, solid objects and moisture

The enclosure of a luminaire shall provide the degree of protection against ingress of dust, solid objects and moisture in accordance with the classification of the luminaire and the IP number marked on the luminaire.

NOTE The tests for the ingress of dust, solid objects and moisture specified in this standard are not all identical to the tests in IEC Publication 529 because of the technical characteristics of luminaires. An explanation of the IP numbering system is given in Appendix A.

Compliance shall be checked by the appropriate tests specified in Sub-clauses **9.2.0** to **9.2.8**, and for other IP ratings (other than first characteristic numerals 1 and 2), by the appropriate tests specified in IEC Publication 529.

Before the tests of Sub-clauses **9.2.3** to **9.2.7**, the luminaire complete with lamp(s) shall be switched on and brought to a stable operating temperature at rated voltage.

The water for the tests specified in Sub-clauses **9.2.3** to **9.2.8** shall be at a temperature of 15 ± 10 °C.

Luminaires shall be mounted and wired as in normal use, complete with their protective translucent covers, if any, for the tests of Sub-clauses **9.2.0** to **9.2.8**.

For tests of Sub-clauses **9.2.3** to **9.2.8**, a fixed luminaire intended for mounting with its body in contact with a surface shall be tested with an expanded metal spacer interposed between the luminaire and the mounting surface. The spacer shall be at least equal in overall size to the projection of the luminaire, and have dimensions as follows:

Longway of mesh	10 mm to 20 mm
Shortway of mesh	4 mm to 7 mm
Strand width	1.5 mm to 2 mm
Strand thickness	0.3 mm to 0.5 mm
Overall thickness	1.8 mm to 3 mm

Luminaires having provision for draining water by means of drain holes shall be mounted with the lowest drain hole open unless otherwise specified in the manufacturer's installation instructions.

If the installation instructions indicate that a drip-proof luminaire is for ceiling or under-canopy mounting, the luminaire shall be attached to the underside of a flat board or plate which extends 10 mm beyond that part of the luminaire perimeter in contact with the mounting surface.

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

Glands, if any, shall be tightened with a torque equal to two-thirds of that applied to glands in the test in Sub-clause **4.12.5** of Section 4.

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

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

After completion of the tests, the luminaire shall withstand the electric strength test, as specified in Section 10, and inspection shall show:

1) No deposit of talcum powder in dust-proof luminaires, such that if the powder were conductive, the insulation would fail to meet the requirements of this standard.

2) No deposit of talcum powder inside enclosure for dust-tight luminaires.

3) No trace of water on live parts or on insulation where it could become a hazard for the user or surroundings, e.g. where it could reduce the creepage distances below the values specified in Section 11.

4) No accumulation of water in drip-proof, rain-proof, splash-proof and jet-proof luminaires or their protective glasses, such as would impair safety.

5) No trace of water entered in any part of a watertight or pressure-watertight luminaire.

6) No entry into the luminare enclosure permitting contact with live parts by the appropriate probe (as in Sub-clause **9.2.0**), for solid-object-proof luminaires.

9.2.0 *Test.* Solid-object-proof luminaires (first characteristic IP numeral: 2) shall be tested with the standard test finger specified in IEC Publication 529 according to the requirements of Sections 8 and 11 and Item 2) of Table IX of this standard.

Solid-object-proof luminaires (first characteristic IP numerals 3[2)] and 4[2)]) shall be tested at every possible point (excluding gaskets) with a probe (straight rigid steel wire) applied with a force, as follows:

	Probe wire diameter	Application force
First IP numeral 3	$2.5\ ^{+0.05}_{-0.0}$ mm	3 N ± 10 %
First IP numeral 4	$1\ ^{+0.05}_{-0.0}$ mm	1 N ± 10 %

The end of the probe wire shall be at right angles to its length and free from burrs.

NOTE Luminaires with first characteristic IP numeral 2 are not required to be tested with the 12 mm diameter sphere specified in IEC Publication 529.

9.2.1 *Test.* Dust-proof luminaires (first characteristic IP numeral 5[2)]) shall be tested in a dust chamber similar to that shown in Figure 6, page 67 in which talcum powder is maintained in suspension by an air current. The chamber shall contain 2 kg of powder for every cubic metre of its volume. The talcum powder used shall pass through a square-meshed sieve whose nominal wire diameter is 50 µm and whose nominal free distance between wires is 75 µm and shall have a range of particle size down to and including 1 µm with at least 50 % by weight less than 5 µm. It should not have been used for more than 20 tests.

The test shall proceed as follows:

a) The luminaire is suspended outside the dust chamber and operated at rated supply voltage until operating temperature is achieved.

b) The luminaire whilst still operating, is placed with the minimum disturbance in the dust chamber.

c) The door of the dust chamber is closed.

d) The fan/blower, causing the talcum powder to be in suspension, is switched on.

e) After 1 min the luminaire is switched off and allowed to cool for 3 h whilst the talcum powder remains in suspension.

NOTE The 1 min interval between switching on the fan/blower and switching off the luminaire is to ensure that the talcum powder is properly in suspension around the luminaire during initial cooling, which is most important with smaller luminaires. The luminaire is operated initially as in Item a) to ensure the test chamber is not overheated.

9.2.2 *Test.* Dust-tight luminaires (first characteristic IP numeral 6[2)]) shall be tested in accordance with Sub-clause **9.2.1**.

9.2.3 *Test.* Drip-proof luminaires (second characteristic IP numeral 1[2)]) shall be subjected for 10 min to an artificial rainfall of 3 mm/min, falling vertically from a height of 200 mm above the top of the luminaire.

9.2.4 *Test.* Rain-proof luminaires (second characteristic IP numeral 3[2)]) shall be sprayed with water for 10 min by means of a spray apparatus as shown in Figure 7, page 68. The radius of the semicircular tube shall be as small as possible and compatible with the size and position of the luminaire. The tube shall be perforated so that jets of water are directed towards the centre of the circle and the water pressure at the inlet of the apparatus shall be approximately 80 kN/m^2.

The tube shall be caused to oscillate through an angle of 120°, 60° on either side of the vertical, the time for one complete oscillation (2 × 120°) being about 4 s.

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

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

9.2.5 *Test.* Splash-proof luminaires (second characteristic IP numeral 4[2)]) shall be sprayed from every direction with water for 10 min by means of the spray apparatus shown in Figure 7 and described in Sub-clause **9.2.4**. The luminaire shall be mounted under the pivot line of the tube so that the ends of the luminaire receive adequate coverage from the jets.

The tube shall be caused to oscillate through an angle of almost 360°, 180° on either side of the vertical, the time for one complete oscillation (2 × 360°) being about 12 s. The luminaire shall be turned about its vertical axis during the test at a rate of 1 rev/min.

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

[2)] See Section 2.

9.2.6 *Test.* Jet-proof luminaires (second characteristic IP numeral 5[3]) shall be switched off and immediately subjected to a water jet for 15 min from all directions by means of a hose having a nozzle with the shape and dimensions shown in Figure 8, page 69. The nozzle shall be held 3 m away from the sample.

The water pressure at the nozzle shall be approximately 30 kN/m^2.

9.2.7 *Test.* Watertight luminaires (second characteristic IP numeral 7[3]) shall be completely immersed for 30 min in water, so that there is at least 150 mm of water above the top of the luminaire and the lowest portion is subjected to at least 1 m head of water.

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

9.2.8 *Test.* Pressure watertight luminaires (second characteristic IP numeral 8[3]) shall be heated, either by switching on the lamp or by other suitable means, so that the temperature of the luminaire enclosure exceeds that of the water in the test tank by between 5 °C and 10 °C.

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

9.3 Humidity test

All luminaires shall be proof against humid conditions which may occur in normal use.

Compliance shall be checked by the humidity treatment described in Sub-clause **9.3.1**, followed immediately by the tests of Section 10.

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

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

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

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

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

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.

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

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

[3] See Section 2

Section 10. Insulation resistance and electric strength

10.1 Scope

This section specifies requirements and tests for the insulation resistance and electric strength of luminaires for use with tungsten filament, tubular fluorescent and other discharge lamps on supply voltages not exceeding 1 000 V. It is to be read in conjunction with Section 0 and with the other relevant sections to which reference is made.

10.2 Insulation resistance and electric strength

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

Compliance shall be checked by the tests of Sub-clauses **10.2.1** and **10.2.2** in the humidity cabinet or the room in which the sample was brought to the prescribed temperature, after reassembly of those parts which may have been removed.

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

During these tests the following components shall be disconnected, such that the test voltages are applied to the insulation of the components but not the capacitive or inductive functional elements of these components, as appropriate:

a) Shunt-connected capacitors;

b) Capacitors between live parts and the body;

c) Chokes or transformers connected between live parts.

If it is impossible to place metal foil in position on linings or barriers, the tests shall be made on three pieces of the lining or barrier which have been taken out and placed between two metal balls having a diameter of 20 mm, which shall be pressed together with a force of 2 N ± 0.5 N.

The conditions of test for transistorized ballasts shall be as specified in IEC Publication 458.

10.2.1 Test — Insulation resistance

The insulation resistance shall be measured with a d.c. voltage of approximately 500 V, 1 min after the application of the voltage.

The insulation resistance shall be not less than the values specified in Table VII.

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

Insulating linings and barriers shall be tested only if the distance between live parts and accessible metal parts would be less than that prescribed in Section 11 were the lining or barrier not there, or if the lining or barrier is necessary to comply with the requirement of Clause **4.9** of Section 4.

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

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

NOTE See Appendix B for a test for live parts.

Table VII — Minimum insulation resistance

Insulation	Minimum insulation resistance (MΩ)	
	Luminaires other than Class II	Class II luminaires
Between live parts of different polarity	2	2
Between live parts which can become of different polarity through the action of a switch	2	2
Between live parts and the body[a]	2	4
Between accessible metal parts and metal foil on the inside of insulating linings and barriers	2	4
Basic insulation of Class II luminaires	—	2
Supplementary insulation of Class II luminaires	—	2
Bushings prescribed in Section 5	2	4
Insulation of anchorages prescribed in Section 5	2	2
Insulation of wire carriers or clips prescribed in Section 5	2	2

[a] The term "body" includes accessible metal parts, accessible fixing screws and metal foil in contact with accessible parts of insulating material.

10.2.2 Test — Electric strength

A voltage of substantially sine-wave form, having a frequency of 50 Hz or 60 Hz and the value specified in Table VIII, shall be applied for 1 min across the insulation shown in that table.

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

For the high-voltage transformer used for the test, when the output terminals are short-circuited after the output voltage has been adjusted to the appropriate test voltage, the output current shall be at least 200 mA.

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

Care shall be taken that the r.m.s. value of the test voltage applied is measured within ± 3 %.

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

For Class II luminaires incorporating both reinforced insulation and double insulation, care shall be taken that the voltage applied to the reinforced insulation does not overstress the basic insulation or the supplementary insulation.

Glow discharges without drop in voltage are neglected.

No flashover or breakdown shall occur during the test.

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

For luminaires with ignitors, the electric strength of parts of the luminaire that are stressed by the pulse voltage is tested with the ignitor operating, but with no lamp in circuit, to ensure that the luminaire insulation, wiring and similar parts are adequate.

The luminaire with ignitor is connected to a supply of 100 % rated voltage, without a lamp, for a period of 30 days. Any ignitors that become defective during this period are replaced immediately. The electric strength test with the values specified in Table VIII is then applied to the luminaire with all the terminals (except any earthing terminals) of the ignitor connected together.

No flashover or breakdown shall occur during the electric strength test.

10.3 Leakage current

10.3.1 The leakage current that may occur during normal operation of the luminaire between each pole of the supply source and the body (see Table VIII) of the luminaire shall not exceed the following values when measured in accordance with Appendix K:

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

NOTE For luminaires incorporating a.c. supplied electronic ballasts the leakage current may be greatly dependent upon the spacing between the lamp and the earthed starting aid, due to the high frequency operation of the lamp.

Table VIII — Electric strength

Insulation	Test voltage (V)	
	Other than Class II luminaires	Class II luminaires
Between live parts of different polarity	$2U$ + 1 000	$2U$ + 1 000
Between live parts which can become of different polarity through the action of a switch	$2U$ + 1 000	$2U$ + 1 000
Between live parts and the body[a]	$2U$ + 1 000	$2U$ + 3 500
Between accessible metal parts and metal foil on the inside of insulation linings and barriers	$2U$ + 1 000	$2U$ + 3 500
Basic insulation of Class II luminaires	—	$2U$ + 1 000
Supplementary insulation of Class II luminaires	—	2 500
Bushings prescribed in Section 5	$2U$ + 1 000	$2U$ + 3 500
Insulation of anchorage prescribed in Section 5	$2U$ + 1 000	2 500
Insulation of wire carriers or clips prescribed in Section 5	$2U$ + 1 000	2 500

U = working voltage. Where the working voltage is 50 V or less, the test voltage shall be 500 V instead of ($2U$ + 1 000 V).

[a] The term "body" includes accessible metal parts, accessible fixing screws and metal foil in contact with accessible parts of insulating material (reinforced insulation of Class II luminaires).

10.3.2 The leakage current that may occur from contact with fluorescent lamps operated at high frequency from a.c. supplied electronic ballasts shall not exceed the values in Figure 23 when measured in accordance with Appendix L .

The limits of leakage current values for frequencies between the values shown in Figure 23 should be obtained by interpolation.

NOTE Limits of leakage current values for frequencies above 50 kHz are under consideration.

Leakage current values above 500 mA signify rejection of the luminaire.

Section 11. Creepage distances and clearances

11.1 Scope

This section specifies minimum requirements for creepage distances and clearances in luminaires which operate with tungsten filament, tubular fluorescent and other discharge lamps on supply voltages not exceeding 1 000 V. It is to be read in conjunction with Section 0 and with the other relevant sections to which reference is made.

11.2 Creepage distances and clearances

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

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

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

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

Any air gap less than 1 mm wide is ignored in calculating the total clearance.

For luminaires provided with an appliance inlet, the measurements are made with an appropriate connector inserted.

Distances through slots or openings in external parts of insulating material are measured with metal foil in contact with the accessible surface. The foil is pushed into corners and similar places by means of the standard test finger specified in IEC publication 529 but it is not pressed into openings.

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

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

The values in the table do not apply to components for which separate IEC publications exist, but apply only to the mounting distances in the luminaire.

For luminaires with ignitor, the creepage distances and clearances of functional insulation of pulse voltage circuits shall be based on the effective working voltage as follows:

$$U_R = \frac{U_S}{4.6}$$

where

U_R: effective value of the working voltage

U_s: peak value of the pulse voltage of the ignitor

Supply cables not supplied with the luminaire are not tested.

Table IX

Creepage distances and clearances in millimetres between:	Luminaires of Classes 0 and I				Luminaires of Class II			Luminaires of Class III
Working voltage (not exceeding)	**24** (V)	**250** (V)	**500**[a] (V)	**1 000**[a] (V)	**24** (V)	**250** (V)	**500** (V)	
1) Live parts of different polarity	2	3	4	6	2	3	4	2
2) Live parts and accessible metal parts, also between live parts and the outer accessible surface of insulating parts (this may be the outer surface of the luminaire if of insulating material)								
Creepage	2	4	5	6	2	8	10	2
Clearance	2	3	5	6	2	8	10	2
3) Parts which may become live due to the breakdown of functional insulation in luminaires of Class II and accessible metal parts	—	—	—	—	2	4	5	—
4) The outer surface of a flexible cord or cable and accessible metal to which it is secured by means of a cord grip, cable carrier or clip of insulating material	—	—	—	—	—	4	5	—
5) Live parts of switches mounted in luminaires and adjacent metal parts, after the removal of the insulating lining (if any) in the vicinity of the switch	—	2	—	—	—	4	—	—
6) Live parts and other metal parts between them and the supporting surface (ceiling, wall, table, etc.) or between live parts and the supporting surface where there is no intervening metal:								
a) if the sealing compound is less than 2.5 mm thick	2	6	8	10	2	8	10	2
b) through sealing compound with a thickness of not less than 2.5 mm	—	4	6	8	—	6	8	—

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

Section 12. Endurance test and thermal test

12.1 Scope

This section specifies requirements relating to the endurance test and thermal tests of luminaires for use with tungsten filament lamps, tubular fluorescent and other discharge lamps on supply voltages not exceeding 1 000 V. It is to be read in conjunction with Section 0 and with the other relevant sections to which reference is made.

12.2 Selection of lamps and ballasts

Lamps used for the tests of this section shall be selected in accordance with Appendix C.

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

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

NOTE For reference conditions see IEC Publication 82: Ballasts for Tubular Fluorescent Lamps.

12.3 Endurance test

Under conditions representing cyclic heating and cooling in service, the luminaire shall not become unsafe or fail prematurely. Compliance shall be checked by carrying out the test described in Sub-clause **12.3.1**.

12.3.1 Test

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

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

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

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

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

The circuit condition shall be as in normal operation for the first six cycles and abnormal operation (see Appendix D) for the seventh cycle.

For luminaires for which there is no abnormal condition e.g. fixed non-adjustable filament lamp luminaires, the total test duration shall be 240 h (i.e. 10 × 24 cycles at normal operation).

d) During operating periods, the supply voltage for filament lamp luminaires shall be 1.05 ± 0.015 times the voltage at which the rated wattage of the lamp is obtained and 1.10 ± 0.015 times the rated voltage for tubular fluorescent and other discharge lamp luminaires.

e) If the luminaire ceases to operate because of chance failure of a part of the luminaire (including the lamp), the instructions in Item g) of Sub-clause **12.4.1** apply, except that if a thermal protective device in the luminaire (e.g. a thermal cut-out) operates the test shall be modified as follows:

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

2) The test shall then be continued for a total duration of 240 h at a test temperature lowered to a value, such that the protective device just fails to operate. The luminaire is deemed to have failed the test if the temperature has to be reduced below t_a to prevent the protective device operating.

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

12.3.2 Compliance

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

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

12.4 Thermal test (normal operation)

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

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

Luminaires shall not cause excessive heating of lighted objects.

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

Compliance shall be checked by carrying out the test described in Sub-clause **12.4.1**.

The test conditions for measuring the track temperature shall be as given in Sub-clause **15.1** of IEC Publication 570: Electrical Supply Track Systems for Luminaires.

12.4.1 Test

Temperature shall be measured as indicated in Sub-clause **12.4.2** in accordance with the following conditions:

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

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

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

Temperature measurements shall be made in accordance with Appendix F and Appendix G.

b) The operating position shall be the thermally most onerous operating position which may reasonably be adopted in service. For fixed non-adjustable luminaires a position shall not be selected if it is stated to be not permissible in instructions supplied with, or marked on, the luminaire.

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

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

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

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

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

Exemption:

For determination of the average temperature of the winding of a component with t_w marking and for the determination of the case temperature of a component with t_c marking, the test voltage shall be 1.00 times the rated voltage. This exemption applies only to the measurement of the winding temperature and does not apply, for example to measurement of the temperature of a terminal block on the same component.

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

e) During and immediately before a measurement, the supply voltage shall be held within ± 1 % and preferably within ± 0.5 % of the test voltage. The supply voltage shall be held within ± 1 % of the test voltage during such preceding period as may affect the measurement; this period shall be not less than 10 min.

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

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

h) Ballasts for operation separate from the luminaire shall be operated in free air and shall be operated in an ambient temperature of 25 ± 5 °C. If a separate ballast is supplied with the luminaire, temperatures of the ballast shall be measured and shall comply with the same limits as incorporated ballasts. If a separate ballast is not supplied with the luminaire, the temperatures of the test ballast shall not be measured.

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

j) The light beam from spotlights and similar luminaires is directed towards the matt black painted wooden vertical surface similar to that described in Appendix E. Luminaires are mounted at the distance from the surface which is marked on the luminaire.

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

12.4.2 Compliance

In the test of Sub-clause **12.4.1** none of the temperatures shall exceed the appropriate values given in Table X and Table XI (subject only to the concession of Item a) of this sub-clause), when the luminaire is operated at its rated ambient temperature t_a.

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

a) The temperature shall not exceed the values shown in Table X and Table XI by more than 5 °C.

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

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

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

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

Table X — Maximum temperatures under the test conditions of Sub-clause 12.4.2, for principal parts

Part	Maximum temperature (°C)
Lamp caps:	
ES, BC types: junction with glass	
Cemented caps	210[a]
Mechanically locked (lamp life > 3 000 h)	250
Mechanically locked (lamp life ≯ 3 000 h)	275
Halogen types: pinch temperature	Values (where applicable) given in IEC Publication 357: Tungsten halogen lamps (non-vehicle)
Single capped compact fluorescent	See Clause **2.9** of IEC Publication 901
Winding: (ballast, transformer)	
If t_w is marked	t_w
If t_w is NOT marked (paper interleaved)	95
If t_w is NOT marked (not separated by paper)	85
Starter canister:	[b]
Capacitor case:	
If t_c is marked	t_c
If t_c is NOT marked	50
Insulation of wiring:	See Table XI and Sub-clauses **12.4.2** b) and **12.4.2** c)
Insulating material (other than ceramic) of lampholders and starterholders:	
Without *T* marking:	
E14 and B15	135
E26, E27 and B22	165
ED39 and E40	225
Lampholders for fluorescent lamps	80
Starterholders	80
All lampholders and starterholders with *T* marking	*T*
Switches marked with individual ratings:	
Without *T* marking	55
With *T* marking	*T*
Other parts of the luminaire:	
(according to material and use)	See Table XI and Sub-clause **12.4.2** b)
Mounting surface:	
Normally flammable surface	90
Non-combustible surface	Not measured
Parts intended to be handled or touched frequently[c]:	
Metal parts	70
Non-metal parts	85
Parts intended to be gripped by hand:	
Metal parts	60
Non-metal parts	75
Objects lighted by spotlights:	
[see Sub-clause **12.4.1** j)]	90 (of the test surface)
Track (for track-mounted luminairies)	As stated by the track manufacturer[d]
Case of starting device or electronic ballast:	t_c[e]

[a] For luminaires marked with information concerning the use of special lamps, or if it is obvious that special lamps are to be used, a higher value, as specified by the lamp manufacturer, is allowed.

[b] Values under consideration.

[c] Not applicable to parts intended only to be touched occasionally during adjustment, e.g. parts of spotlights.

[d] For the test conditions for measuring the track temperature, see Sub-clause **11.1** of IEC Publication 570.

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

Table XI — Maximum temperatures under the test conditions of Sub-clause 12.4.2, for common materials used in luminaires

Material	Maximum temperature (°C)
Insulation of wiring (internal and external, supplied with luminaire):	
Glass fibre silicone-varnish impregnated	200[a]
Polytetrafluoroethylene (PTFE)	250
Silicone rubber (not stressed)	200
Silicone rubber (compressive stress only)	170
Ordinary polyvinyl chloride (PVC)	90[ab]
Heat-resisting polyvinyl chloride (PVC)	105
Ethylene vinyl acetate (EVA)	140
Thermoplastics:	
Acrylonitrile-butadiene-styrene (ABS)	95
Cellulose acetate butyrate (CAB)	95
Polymethyl methacrylate (acrylic)	90
Polystyrene	75
Polypropylene	100
Polycarbonate	130
Polyvinyl chloride (PVC) (where NOT used for electrical insulation)	100
Polyamide (nylon)	120
Thermosetting plastics:	
Mineral-filled phenol-formaldehyde (PF)	165
Cellulose-filled phenol-formaldehyde (PF)	140
Urea-formaldehyde (UF)	90
Melamine	100
Glass fibre-reinforced polyester (GRP)	130
Other materials:	
Resin-bonded paper/fabric	125
Silicone rubber (where NOT used for electrical insulation)	230
Rubber where NOT used for electrical insulation	70

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

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

12.5 Thermal test (abnormal operation)

Under conditions representing abnormal service conditions (where applicable: but not representing a defect in the luminaire or misuse), no part of the luminaire, the supply wiring within the luminaire or the mounting surface, shall become unsafe.

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

Compliance shall be checked by carrying out the test described in Sub-clause **12.5.1**.

12.5.1 Test

Temperatures of parts listed in Table XII shall be measured when steady conditions have become established in accordance with the following requirements.

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

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

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

i) A possibly unsafe operating position arising other than from misuse; e.g. if by accident an adjustable luminaire is bent close to the mounting surface.

ii) A possibly unsafe circuit condition arising other than from defective manufacture or misuse; e.g. a circuit condition occurring at the end of the service period of a lamp or of a starter (see Appendix D).

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

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

The luminaire shall be tested under the conditions specified in Items a), c), e), f) and h) of Sub-clause **12.4.1**. In addition the following shall apply:

b) The test voltage shall be as follows:

Filament lamp luminaires—as specified in Item d) of Sub-clause **12.4.1**.

Tubular fluorescent and other discharge lamp luminaires—1.10 times the rated voltage.

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

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

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

d) If the luminaire incorporates a capacitor (other than a capacitor connected directly across the supply), this capacitor shall be short-circuited, notwithstanding the requirements of Appendix D, if the voltage across it under test conditions would exceed 1.25 times its rated voltage for self-healing capacitors or 1.3 times its rated voltage for non-self-healing capacitors.

12.5.2 Compliance

In the test of Sub-clause **12.5.1**, none of the temperatures shall exceed the appropriate value as given in Table XII (subject only to the concession of Item a) of this sub-clause), when the luminaire is operated at its rated temperature t_a. In those cases where the temperature of the test enclosure differs from t_a, the difference shall be taken into account when applying the limits in the table.

a) The temperature shall not exceed the values shown in Table XII by more than 5 °C.

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

Table XII — Maximum temperatures under the test conditions of Sub-clause 12.5.2

Part	Maximum temperature (°C)
Ballast or transformer winding	See Table XII-A and Table XII-B
Capacitor case: — If t_c is not marked — If t_c is marked	 60 t_c + 10
Mounting surface: Normally flammable surface (filament lamp luminaires)[b] Normally flammable surface (luminaires with F symbol) Non-combustible surface (luminaires without F symbol) Track (for track-mounted luminaires)	 175 130 Not measured As stated by the track manufacturer

[a] Applies to paper interleaved windings and those not separated by paper.
[b] Excluding luminaires incorporating transformers.

Table XII-A — Maximum temperatures of windings under abnormal conditions and at 110 % of rated voltage for ballasts/transformers subjected to an endurance test duration of 30 days

Maximum temperature (°C)							
Constant S		S4.5	S5	S6	S8	S11	S16
for t_w =	90	171	161	147	131	119	110
	95	178	168	154	138	125	115
	100	186	176	161	144	131	121
	105	194	183	168	150	137	126
	110	201	190	175	156	143	132
	115	209	198	181	163	149	137
	120	217	205	188	169	154	143
	125	224	212	195	175	160	149
	130	232	220	202	182	166	154
	135	240	227	209	188	172	160
	140	248	235	216	195	178	166
	145	256	242	223	201	184	171
	150	264	250	230	207	190	177

Table XII-B — Maximum temperatures of windings under abnormal conditions and at 110 % of rated voltage for ballasts/transformers marked "D6" which are subjected to an endurance test duration of 60 days

Maximum temperature (°C)							
Constant S		S4.5	S5	S6	S8	S11	S16
for t_w =	90	158	150	139	125	115	107
	95	165	157	145	131	121	112
	100	172	164	152	137	127	118
	105	179	171	158	144	132	123
	110	187	178	165	150	138	129
	115	194	185	171	156	144	134
	120	201	192	178	162	150	140
	125	208	199	184	168	155	145
	130	216	206	191	174	161	151
	135	223	213	198	180	167	156
	140	231	220	204	186	173	162
	145	238	227	211	193	179	168
	150	246	324	218	199	184	173

NOTE For ballasts/transformers subjected to an endurance test duration other than 30 or 60 days, equation (2) specified in IEC Publication 82 should be used to calculate the maximum temperature which should correspond to the number of days equal to two-thirds of the theoretical endurance test. (Explanations of the constant S and its use are given in IEC Publication 82.)

12.6 Thermal test (failed ballast or transformer conditions)

These tests apply only to luminaires marked with the ⍽F symbol that either do not meet the spacing requirements specified in Sub-clause **4.16.2.1** for ballasts or transformers, or that do not comply with the requirements specified in Sub-clause **4.16.3** for electronic ballasts.

These requirements and tests are based on the assumption that during failure of the ballast or transformer, for example owing to short-circuited windings or a short circuit to the case, the ballast or transformer winding will not exceed 350 °C for a duration of more than 15 min and, therefore, the temperature of the mounting surface will not exceed 180 °C for a duration of more than 15 min.

12.6.1 Test for luminaires without temperature sensing controls

The luminaire shall be tested under the conditions specified in Items a), c), e), f) and h) of Sub-clause **12.4.1**. In addition, the following also apply:

20 % of the lamp circuits in the luminaire, and not less than one lamp circuit, shall be subjected to abnormal conditions (see Item a) of Sub-clause **12.5.1**).

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

The circuits subjected to abnormal conditions shall be operated at 0.9, 1.0 and 1.1 times rated voltage. When conditions are stable at each of these three test voltages, the highest winding temperature and highest temperature of any part of the mounting surface shall be measured.

12.6.1.1 ***Compliance***

After the test of Sub-clause **12.6.1**:

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

b) The values of the temperatures measured at 0.9, 1.0 and 1.1 times rated voltage are plotted on a graph (Figure 9, page 70) and the best straight line is drawn through these points. The extrapolation of this straight line shall not reach a point representing a mounting surface temperature of 180 °C at a ballast or transformer winding temperature of less than 350 °C.

c) For track-mounted luminaires, no part of the track shall show symptoms of unsafe deterioration, for example cracks, scorches or deformation.

12.6.2 Test for luminaires with temperature sensing controls external to the ballast or transformer

The luminaire shall be set up for this test as described in the first three paragraphs of Sub-clause **12.6.1**.

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

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

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

12.6.2.1 ***Compliance***

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

For track-mounted luminaires, after the test no part of the track shall show symptoms of unsafe deterioration, for example cracks, scorches or deformation.

Section 13. Resistance to heat, fire and tracking

13.1 Scope

This section specifies requirements and tests relating to the resistance to heat, fire and tracking of certain parts of insulating material of luminaires for use with tungsten filament, tubular fluorescent and other discharge lamps on supply voltages not exceeding 1 000 V. It is to be read in conjunction with Section 0 and with the other relevant sections to which reference is made. For printed wiring boards, reference should be made to the requirements of IEC Publication 249.

13.2 Resistance to heat

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 heat.

13.2.1 *Test:* Compliance shall be checked by the following test.

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

The test shall be made in a heating cabinet having a temperature 25 ± 5 °C in excess of the operating temperature of the relevant part determined during the temperature test (normal operation) of Section 12 with a minimum temperature of 125 °C when parts retaining live parts in position are tested and 75 °C for other parts.

The surface of the part to be tested shall be placed in the horizontal position and a steel ball of 5 mm diameter pressed against this surface with a force of 20 N. A suitable apparatus for this test is shown in Figure 10, page 71. If the surface under test bends, the part where the ball presses should be supported.

After 1 h the ball shall be removed from the sample and the sample shall be cooled by immersion in cold water for l0 s. The diameter of the impression shall be measured and shall not exceed 2 mm.

13.3 Resistance to flame and ignition

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

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

The parts to be tested are subjected to the needle-flame test of IEC Publication 695-2-2, the test flame being applied to the sample for 10 s at the point where the highest temperatures are likely to occur, measured if necessary during the thermal tests of Section 12.

The duration of burning shall not exceed 30 s after removal of the test flame and any burning drop from the sample shall not ignite the underlying parts or tissue paper specified in IEC Publication 695-2-2, as appropriate.

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

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

Parts are subjected to a test using a nickel-chromium glow-wire heated to 650 °C. The test apparatus and test procedure shall be that described in IEC Publication 695-2-1: Fire Hazard Testing, Part 2: Test Methods. Glow-wire Test and Guidance.

Any flame or glowing of the sample shall extinguish within 30 s of withdrawing the glow-wire and any burning or molten drop shall not ignite a single layer of tissue paper, spread out horizontally 200 ± 5 mm below the sample.

The requirements of this sub-clause do not apply in those cases where the luminaire provides an effective barrier to burning drops or where the insulation material is ceramic.

13.3.3 Parts of insulating material which are not included in Sub-clauses **13.3.1** or **13.3.2**, for example covers, shades or the like shall:

a) withstand the 650 °C glow-wire test of Sub-clause **13.3.2**, or

b) comply with the spacing requirements of Clause **4.15** of Section 4.

13.4 Resistance to tracking

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

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

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

A flat surface of the part to be tested, if possible at least 15 mm × 15 mm, with a thickness corresponding to that of the material used in the luminaire, shall be placed in a horizontal position. Two electrodes of platinum, of the dimensions shown in Figure 11, page 71, shall be placed on a surface of the sample in the manner shown in this figure, so that the rounded edges are in contact with the sample over their whole lengths.

The force exerted on the surface by each electrode shall be about 1 N. The electrodes shall be connected to a 50 Hz supply source having a voltage of 175 V of substantially sine-wave form. The total impedance of the circuit when the electrodes are short-circuited shall be adjusted by means of a variable resistor, so that the current is 1.0 ± 0.1 A with cos φ = 0.9 to 1. An overcurrent relay, with a tripping time of at least 0.5 s, shall be included in the circuit.

The surface of the sample shall be wetted by allowing drops of a solution of ammonium chloride in distilled water to fall centrally between the electrodes. The solution shall have a volume resistivity of 400 Ωcm at 25 °C, corresponding to a concentration of about 0.1 %. The drops shall have a volume between 20 mm^3 and 25 mm^3 and fall from a height of 30 mm to 40 mm. The time interval between one drop and the next shall be 30 ± 5 s.

13.4.1.2 No flashover or breakdown between electrodes shall occur before a total of 50 drops has fallen.

In case of doubt, the test shall be repeated, if necessary on a new sample.

Care should be taken that the electrodes are clean, correctly shaped and correctly positioned before each test is started.

Section 14. Screw terminals

14.1 Scope

This section specifies requirements for all types of terminals, which employ screws, incorporated in luminaires for use with tungsten filament, tubular fluorescent and other discharge lamps on supply voltages not exceeding 1 000 V. It is to be read in conjunction with Section 0 and with the other relevant sections to which reference is made.

Examples of screw terminals are shown in Figure 12 to Figure 16, pages 72 and 76.

14.2 Definitions

14.2.1
pillar terminal

a terminal in which the conductor is inserted in a hole or cavity, where it is clamped under the shank of the screw or screws. The clamping pressure may be applied directly by the shank of the screw or through an intermediate clamping member to which pressure is applied by the shank of the screw

examples of pillar terminals are shown in Figure 12, page 72

14.2.2
screw terminal

a terminal in which the conductor is clamped under the head of the screw. The clamping pressure may be applied directly by the head of the screw or through an intermediate part, such as a washer, clamping plate or anti-spread device

examples of screw terminals are shown in Figure 13, page 73

14.2.3
stud terminal

a terminal in which the conductor is clamped under a nut. The clamping pressure may be applied directly by a suitably shaped nut or through an intermediate part, such as a washer, clamping plate or anti-spread device

examples of stud terminals are shown in Figure 13

14.2.4
saddle terminal

a terminal in which the conductor is clamped under a saddle by means of two or more screws or nuts

examples of saddle terminals are shown in Figure 14, page 74

14.2.5
lug terminal

a screw terminal or a stud terminal, designed for clamping a cable lug or bar by means of a screw or nut

examples of lug terminals are shown in Figure 15, page 75

14.2.6
mantle terminal

a terminal in which the conductor is clamped against the base of a slot in a threaded stud by means of a nut. The conductor is clamped against the base of the slot by a suitably shaped washer under the nut, by a central peg if the nut is a cap nut, or by equally effective means for transmitting the pressure from the nut to the conductor within the slot

examples of mantle terminals are shown in Figure 16, page 76

14.3 General requirements and basic principles

14.3.1 These requirements apply to terminals with screw clamping carrying a current not exceeding 63 A, intended for the connection, by clamping only, of copper conductors of cables and flexible cords.

These requirements do not exclude terminals of types other than those shown in Figure 12 to Figure 16, pages 72 and 76.

14.3.2 Terminals are of varied design and have different shapes: they include, among others, terminals in which the conductor is clamped directly or indirectly under the shank of the screw, terminals in which the conductor is clamped directly or indirectly under the head of the screw, terminals in which the conductor is clamped directly or indirectly under a nut, and terminals intended solely for use with cable lugs or bars.

The basic principles governing these requirements are specified in Sub-clauses **14.3.2.1** to **14.3.2.3**.

14.3.2.1 Terminals are primarily for the connection of only one conductor, although, owing to the wide range of conductors that each terminal is required to clamp, they may in some cases be suitable for clamping two conductors having the same nominal cross-sectional area, which is smaller than the maximum value for which the terminal is designed.

Certain types of terminals, in particular pillar terminals and mantle terminals, may be used for looping-in, when two or more conductors of the same or different nominal cross-sectional area or composition have to be connected. In such cases, the terminal sizes specified in this standard may not be applicable.

14.3.2.2 In general, terminals will be suitable for the connection of cables and flexible cords without special preparation of the conductor but provision is made in certain cases for connection by means of cable lugs or for connection to bars.

Table XII — Nominal cross-sectional areas of conductors according to terminal size

Terminal size	Flexible conductors				Rigid conductors solid or standard			
	Nominal cross-sectional areas (mm^2)			Diameter of largest conductor (mm)	Nominal cross-sectional areas (mm^2)			Diameter of largest conductor (mm)
0[a]	0.5	0.75	1	1.45	—	—	—	—
1[b]	0.75	1	1.5	1.73	0.75	1	1.5	1.45
2	1	1.5	2.5	2.21	1	1.5	2.5	2.13
3	1.5	2.5	4	2.84	1.5	2.5	4	2.72
4[c]	2.5	4	6	3.87	2.5	4	6	3.34
5	2.5	4	6	4.19	4	6	10	4.32
6	4	6	10	5.31	6	10	16	5.46
7	6	10	16	6.81	10	16	25	6.83

[a] Not suitable for rigid conductors. Suitable for flexible conductors of 0.4 mm^2 cross-sectional area (see Sub-clause **5.3.1**).
[b] Also suitable for flexible conductors having a nominal cross-sectional area of 0.5 mm^2, if the end of the conductor is folded back on itself.
[c] Not suitable for 6 mm^2 flexible conductors of some special constructions.

14.3.2.3 A numerical classification for terminals is adopted, based on the nominal cross-sectional areas of the conductors that the terminal can accept. According to this classification each terminal can accept any one of three successive sizes of conductors in the range of nominal cross-sectional areas specified in IEC Publications 227 and 245.

With one exception, the sizes of the conductors within each range advance by one step for each increase in the size of the terminal.

The nominal cross-sectional areas of the conductors assigned to each terminal are given in Table XIII, which also gives the diameter of the largest conductor that each terminal can accept. Terminals may be used with conductors smaller than the nominal given range, provided the conductor is clamped with sufficient pressure to ensure adequate electrical and mechanical connection.

14.3.3 Terminals shall allow the proper connection of copper conductors having nominal cross-sectional areas as given in Table XIV and the conductor space shall be at least that given in Table XVIII, Table XIX, Table XX or Table XXII, pages 72, 74, 74 or 76, as appropriate.

These requirements do not apply to lug terminals.

Compliance shall be checked by inspection, by measurement and by fitting conductors of the smallest and largest cross-sectional areas specified.

14.3.4 Terminals shall provide adequate connection of the conductors.

Compliance shall be checked by carrying out all the tests specified.

14.4 Mechanical tests

14.4.1 For pillar terminals, the distance between the clamping screw and the end of the conductor when fully inserted, shall be at least that given in Table XVIII.

The minimum distance between the clamping screw and the end of the conductor applies only to pillar terminals through which the conductor cannot pass.

For mantle terminals, the distance between the fixed part and the end of the conductor when fully inserted, shall be at least that given in Table XXII.

Compliance shall be checked by measurement, after a solid conductor of the largest cross-sectional area given in Table XIV has been fully inserted and fully clamped.

14.4.2 Terminals shall be so designed or placed that neither a solid conductor nor a strand of a stranded conductor can slip out while the clamping screws or nuts are being tightened.

This requirement does not apply to lug terminals.

For fixed luminaires solely intended for permanent connection to fixed (external) wiring this requirement only applies to the use of solid or rigid stranded conductors. The test is made with rigid stranded conductors.

Compliance shall be checked by the following test.

Terminals are fitted with a conductor having the composition given in Table XV.

Table XIV — Nominal cross-sectional areas of conductors according to maximum current

Maximum current carried by the terminal (A)	Flexible conductors		Rigid conductors solid or stranded	
	Nominal cross-sectional areas[a] (mm^2)	Terminal size	Nominal cross - sectional areas[a] (mm^2)	Terminal size
2	0.4	0	—	—
6	0.5 to 1	0	0.75 to 1.5	1
10	0.75 to 1.5	1	1 to 2.5	2
16	1 to 2.5	2	1.5 to 4	3
20	1.5 to 4	3	1.5 to 4	3
25	1.5 to 4	3	2.5 to 6	4
32	2.5 to 6	4 or 5[b]	4 to 10	5
40	4 to 10	6	6 to 16	6
63	6 to 16	7	10 to 25	7

[a] These requirements do not apply to terminals used for the interconnection of different components of luminaires by means of cables or flexible cords not complying with IEC Publications 227, 227A or 245, if the other requirements of this standard are met.
[b] Terminal size 4 is not suitable for 6 mm^2 flexible conductors of some special constructions, in which case terminal size 5 should be used.

Table XV — Composition of conductors

Terminal size	Number of strands and nominal diameter of strands in millimetres	
	Flexible conductors	Rigid stranded conductors
0	32 × 0.20	—
1	30 × 0.25	7 × 0.50
2	50 × 0.25	7 × 0.67
3	56 × 0.30	7 × 0.85
4	84 × 0.30	7 × 1.04
5	84 × 0.30	7 × 1.35
6	80 × 0.40	7 × 1.70
7	126 × 0.40	7 × 2.14

Before insertion in the terminal, strands of rigid conductors are straightened and flexible conductors are twisted in one direction so that there is a uniform twist of one complete turn in a length of approximately 20 mm.

The conductor is inserted in the terminal for the minimum distance prescribed or, where no distance is prescribed, until it just projects from the far side of the terminal and in the position most likely to assist the strand to slip out. The clamping screw is then tightened with a torque equal to two-thirds of that given in the appropriate column of Table XVI.

For flexible conductors, the test is repeated with a new conductor which is twisted as before, but in the opposite direction.

After the test, no strand of the conductor shall have slipped out through the gap between the clamping means and the retaining device.

14.4.3 Terminal sizes up to and including size 5 shall allow the conductor to be connected without special preparation.

Compliance shall be checked by inspection.

The term "special preparation" covers the application of additional solder to the strands of the conductor, use of cable lugs, formation of eyelets, etc., but not the reshaping of the conductor for its introduction into the terminal or the twisting of a stranded conductor to consolidate the end.

The bonding together by heating of the tinned strands of a flexible conductor without the addition of solder is not a special preparation.

14.4.4 Terminals shall have adequate mechanical strength.

Screws and nuts for clamping the conductors shall have a metric ISO thread. Terminals for external wiring shall not serve to fix any other component, except that they may also clamp internal conductors if these are so arranged that they are unlikely to be displaced when fitting external conductors.

Screws shall not be of metal which is soft or liable to creep, such as zinc or aluminium.

Compliance shall be checked by inspection and by tests of Sub-clauses **14.3.3**, **14.4.6**, **14.4.7** and **14.4.8**.

14.4.5 Terminals shall be resistant to corrosion.

Compliance shall be checked by the corrosion test specified in Section 4.

14.4.6 Terminals shall be fixed to the luminaire or to a terminal block or otherwise fixed in position. When the clamping screws or nuts are tightened or loosened, the terminals shall not work loose, internal wiring shall not be subjected to stress, and creepage distances and clearances shall not be reduced below the values specified in Section 11.

These requirements do not imply that the terminals should be so designed that their rotation or displacement is prevented, but any movement shall be sufficiently limited so as to ensure compliance with this standard.

Covering with sealing compound or resin is sufficient to prevent a terminal from working loose, provided that the sealing compound or resin is not subject to stress during normal use and the effectiveness of the sealing compound or resin is not impaired by temperatures attained by the terminal under the most unfavourable conditions specified in Section 12.

Compliance shall be checked by inspection, by measurement and by the following test.

A rigid copper conductor of the largest cross-sectional area given in Table XIV is placed in the terminal.

Screws and nuts are tightened and loosened five times by means of a suitable test screwdriver or wrench, the torque applied when tightened being equal to that given in the appropriate column of Table XVI or in the appropriate Table XVIII, Table XIX, Table XX, Table XXI orTable XXII, pages 72, 74, 74, 75 or 76, whichever is the higher.

The conductor is moved each time the screw or nut is loosened.

Column I applies to screws without heads if the screw when tightened does not protrude from the hole, and to other screws which cannot be tightened by means of a screwdriver with a blade wider than the diameter of the screw.

Column II applies to nuts of mantle terminals with cap nuts which are tightened by means of a screwdriver.

Column III applies to other screws which are tightened by means of a screwdriver.

Column IV applies to screws and nuts, other than nuts of mantle terminals, which are tightened by means other than a screwdriver.

Column V applies to nuts of mantle terminals in which the nut is tightened by means other than a screwdriver.

Where a screw has a hexagonal head with means for tightening with a screwdriver and the values in columns III and IV are different, the test is made twice, first applying to the hexagonal head the torque given in column IV, and then on another set of samples, applying the torque given in column III by means of a screwdriver. If the values in columns III and IV are the same, only the test with the screwdriver is made.

During the test, terminals shall not work loose and there shall be no damage, such as breakage of screws or damage to the head slots, threads, washers or stirrups that will impair the further use of the terminals.

For mantle terminals, the specific nominal diameter is that of the slotted stud.

The shape of the blade of the test screwdriver shall suit the head of the screw to be tested. The screws and nuts shall not be tightened in jerks.

Table XVI — Torque to be applied to screws and nuts

Nominal diameter of thread (mm)	Torque (Nm)				
	I	II	III	IV	V
Up to and including 2.8	0.2	—	0.4	0.4	—
Over 2.8 up to and including 3.0	0.25	—	0.5	0.5	—
Over 3.0 up to and including 3.2	0.3	—	0.6	0.6	—
Over 3.2 up to and including 3.6	0.4	—	0.8	0.8	—
Over 3.6 up to and including 4.1	0.7	1.2	1.2	1.2	1.2
Over 4.1 up to and including 4.7	0.8	1.2	1.8	1.8	1.8
Over 4.7 up to and including 5.3	0.8	1.4	2.0	2.0	2.0
Over 5.3 up to and including 6.0	—	1.8	2.5	3.0	3.0
Over 6.0 up to and including 8.0	—	2.5	3.5	6.0	4.0
Over 8.0 up to and including 10.0	—	3.5	4.0	10.0	6.0
Over 10.0 up to and including 12.0	—	4.0	—	—	8.0
Over 12.0 up to and including 15.0	—	5.0	—	—	10.0

14.4.7 Terminals shall clamp the conductor reliably between metal surfaces.

For lug terminals, a spring washer, or equally effective locking means, shall be provided and the surface within the clamping area shall be smooth.

For mantle terminals, the bottom of the conductor space shall be slightly rounded in order to obtain a reliable connection.

Compliance shall be checked by inspection and by the following test.

The terminals are fitted with rigid conductors of the smallest and largest cross-sectional areas given in Table XIV, the terminal screws being tightened with a torque equal to two-thirds of that given in the appropriate column of Table XVI.

If the screw has a hexagonal head with a slot, the torque applied is equal to two-thirds of that given in column III of that table.

Each conductor is then subjected to a pull of the value, in newtons, given in Table XVII; the pull is applied without jerks, for 1 min, in the direction of the axis of the conductor space.

Table XVII — Pull to be applied to conductor

Terminal size	0	1	2	3	4	5	6	7
Pull (N)	30	40	50	50	60	80	90	100

During the test, the conductor shall not move noticeably in the terminal.

14.4.8 Terminals shall clamp the conductor without undue damage to the conductor.

Compliance shall be checked by inspection of the conductors, after conductors of the smallest and largest cross-sectional areas given in Table XIV have been clamped once and loosened, the torque applied to clamp the conductor being equal to two-thirds of that given in Table XVI.

If the screw has a hexagonal head with a slot, the torque applied is equal to two-thirds of that given in column IV of Table XVI.

NOTE Conductors are unduly damaged if they show deep or sharp indentations.

Section 15. Screwless terminals and electrical connections

General

15.1 Scope

This section specifies requirements, excluding dimensions, for all types of terminals and electrical connections which do not employ screws, for solid or stranded copper conductors up to 2.5 mm^2, for internal wiring of luminaires and for connections to external wiring of luminaires for use with tungsten filament, tubular fluorescent and other discharge lamps on supply voltages not exceeding 1 000 V. It is to be read in conjunction with Section 0 and with the other relevant sections to which reference is made.

Some examples of screwless terminals and electrical connections are shown in Figure 17, Figure 18 and Figure 19, pages 77 and 78.

15.2 Definitions

15.2.1
screwless terminals

parts required to make connections in electrical circuits by mechanical means without screws

15.2.2
permanent connections

connections designed to be made only once with the same conductor (for example wire wrapping or crimping)

15.2.3
non-permanent connections

connections which allow lead assemblies or conductors to be connected and disconnected several times (for example pin or tab and receptacle, or some spring-type terminals)

15.2.4
lead assemblies

conductors fitted with auxiliary parts usually by permanent connection

15.2.5
non-prepared conductors

conductors without special preparation or auxiliary parts. Insulation may, however, be stripped to expose the conductor

the term "special preparation" covers the application of additional solder to the strands of the conductor, use of cable lugs, tabs and receptacles, formation of eyelets, etc., but not the reshaping of the conductor for its introduction into the terminal or the twisting of a stranded conductor to consolidate the end

the bonding together by heating of the tinned strands of a flexible conductor without the addition of solder is not a special preparation

15.2.6
test current

that current assigned to a terminal or connection by the manufacturer. When terminals are part of a component, the test current shall be the rated current of the component

15.3 General requirements

15.3.1 Parts of terminals or connections for carrying current shall be made of one of the following materials:

— copper

— an alloy containing at least 58 % copper for parts that are worked cold or at least 50 % copper for other parts

— another metal no less resistant to corrosion than copper and having mechanical properties no less suitable.

15.3.2 Terminals and connections shall clamp the conductor with sufficient pressure and without undue damage to the conductor.

The conductor shall be clamped between metal surfaces. However, terminals for circuits having a rated current not exceeding 2 A, may have one non-metallic surface if the requirements of Sub-clause **15.3.5** are met.

NOTE Conductors are unduly damaged if they show deep or sharp indentations.

15.3.3 Terminals shall be so designed that, when the conductor has been introduced and fully inserted into the terminal, further insertion is prevented by an end stop.

15.3.4 Terminals other than those for lead assemblies, shall accept "non-prepared conductors" (see Sub-clause **15.2.5**).

Compliance with the requirements of Sub-clauses **15.3.2**, **15.3.3** and **15.3.4** shall be checked by inspection of the terminals or connections, after fitting with appropriate conductors, and after the heating test of Sub-clauses **15.6.2** or **15.9.2**.

15.3.5 Electrical connections shall be so designed that the pressure essential for good electrical conductivity is not transmitted via insulating material other than ceramic, pure mica, or other material with characteristics no less suitable, unless there is sufficient resilience in the metallic parts to compensate for any possible shrinking of the insulating material (see Figure 17 and Figure 18, page 77).

15.3.6 It shall be clear in which way the connection of the conductor to, and the disconnection from, spring-type non-permanent screwless terminals is effected.

The disconnection of a conductor shall require an operation other than a pull of the conductor and shall be such that it can be made by hand or with the aid of a simple, generally available device.

15.3.7 Terminals for connection to several conductors under spring clamps clamp each conductor independently.

For terminals designed for non-permanent connections, it shall be possible to withdraw the conductors together or separately.

15.3.8 Terminals shall be suitably fixed to the equipment or to a terminal block or otherwise fixed in position. They shall not work loose when conductors are inserted or withdrawn.

Compliance shall be checked by inspection and, if there is a doubt, by applying the mechanical test given in Clauses **15.5** or **15.8**. During the test, the terminals shall not work loose and there shall be no damage that will impair their further use.

The above conditions apply not only to terminals which are fixed equipment but also to terminals which are delivered separately. Covering with sealing compound without other means of locking is not sufficient. Self-hardening resins may however be used to lock terminals which are not subject to torsion in normal use.

15.3.9 Terminals and connections shall withstand the mechanical, electrical and thermal stresses occurring in normal use.

Compliance shall be checked by the tests of Clauses **15.5**, **15.6**, **15.8** or **15.9** as appropriate.

15.3.10 Manufacturers shall state the conductor size or sizes for which the component is designed and the type of conductor, for example solid or stranded.

15.4 General instructions on tests

15.4.1 Preparation of samples

The "tests for ingress of dust and moisture" of Section 9, if appropriate, shall be carried out before testing terminals or connections contained within the luminaires.

15.4.2 Test conductors

Tests shall be carried out with copper conductors of the types and dimensions recommended by the manufacturer. If a range of conductors is specified, the smallest and largest shall be selected for testing.

15.4.3 Multi-conductor terminals

Screwless terminals, having provision for the simultaneous connection of several conductors, shall be tested with the number of conductors indicated in the data provided by the manufacturer.

15.4.4 Multi-way terminals

Each terminal in a group or strip of terminals, for example a terminal block on a ballast, may be used as a separate sample.

15.4.5 Test quantities

The tests described in Clauses **15.5** to **15.8** are carried out on four terminals (or connections). At least three terminals shall meet the requirements. If one terminal fails, four further terminals are tested and all these terminals shall meet the requirements.

The tests described in Clause **15.9** are carried out on ten terminals.

Terminals and connections for internal wiring

15.5 Mechanical tests

15.5.1 Non-permanent connections

The mechanical strength of the terminals (or connections) is checked on a set of four terminals. If all the terminals contained within the luminaire are not of the same design, one set of four terminals of each design is subjected to the test.

This test shall only be applied to devices on which the user may work to complete assembly of the luminaire before it is put into service.

15.5.1.1 In the case of spring-type terminals (see Figure 8, page 69) the test is made with solid copper conductors of the size or sizes specified by the manufacturer. If a range of conductors is specified, the smallest and largest are selected for testing.

Of the four terminals, two are tested with conductors having the smallest cross-sectional area, and the two remaining samples with conductors having the largest cross-sectional area. These conductors are connected to, and disconnected from, each terminal five times.

For the first four connections, new conductors are used each time. For the fifth connection, the same conductor is used as for the fourth connection and it is clamped at the same place. For each connection, the conductors are pushed into the terminals as far as the stop.

If the terminal is suitable for stranded conductors, an additional test is then made with one rigid-stranded copper conductor. If, however, a range of conductors is specified, those with smallest and largest cross-sectional areas are selected for testing. Each conductor is subjected to only one connection and disconnection with the corresponding terminal used for the testing with solid conductors.

After the final connection, each conductor is subjected to a test pull of 4 N.

15.5.1.2 Pin or tab and receptacle type connections are also subjected to a test pull of 4 N.

The pull is applied without jerks, for 1 min, in the direction opposite to that used for the application or insertion of the conductor or lead assembly.

During the test, the conductor or lead assembly shall not move from the terminal and neither the terminal nor the conductor or lead assembly shall undergo any alteration impairing their future use.

The maximum force for application or insertion of the conductor or lead assembly shall not exceed 50 N, and in the case of pin or tab and receptacle type connections the force for disconnection shall not exceed this value.

15.5.2 Permanent connections

The connection shall remain fully effective when a pull-off force of 20 N is applied, for 1 min, in a direction opposite to that used for the application or insertion of the conductors. In some cases, a special tool may be used to apply the force correctly (e.g. in the case of wire-wrapped terminals).

Multi-conductor terminals are tested with the above force applied to each conductor in turn.

15.6 Electrical tests

15.6.1 Contact resistance test

The electrical performance of terminals (or connections) is checked on a set of four terminals. If all the terminals contained within the luminaire are not of the same design, one set of four terminals of each design is subjected to the test.

15.6.1.1 For spring-type terminals, the test according to Sub-clause **15.6.1.3** is made with four solid copper non-insulated conductors.

If a range of conductors is specified, two of the terminals are tested with conductors having the smallest cross-sectional area and the two remaining terminals with conductors having the largest cross-sectional area.

15.6.1.2 In the case of pin or tab and receptacle type terminals, the test according to Sub-clause **15.6.1.3** is made with lead assemblies.

15.6.1.3 Each terminal with its conductor is loaded with the test current (a.c. or d.c.) and, after 1 h, the voltage drop across the terminal, still at the test current, is measured. The measuring points are located as close as possible to the contact point across which the voltage drop is being measured. The measured voltage drop shall not exceed 15 mV.

The voltage drop for each joint or contact is considered separately, for example, the junction of conductor to receptacle is considered separately from the junction of receptacle to pin.

The total voltage drop of two inseparable joints, when measured together, shall not exceed twice the value given in Sub-clause **15.6.1.3**.

15.6.2 Heating tests

15.6.2.1 Terminals (or connections) are then subjected to an ageing test, without current, of 25 cycles, each cycle comprising 30 min at a temperature of 100 ± 5 °C, followed by a cooling down to a temperature between 15 °C and 30 °C.

15.6.2.2 The voltage drop is again measured on each terminal:

a) after the 10th cycle;

b) after the 25th cycle.

If, for all terminals, the voltage drop, in both cases, does not exceed by more than 50 % the voltage drop measurements on the same terminal tested under Sub-clause **15.6.1**, or if the increase in voltage drop is less than 2 mV, the terminals comply with the requirement.

If the voltage drop of any terminals exceeds 22.5 mV, the terminals are rejected.

If, for one of the terminals, the voltage drop measured under a) or b) exceeds by more than 50 %, with a minimum of 2 mV, the voltage drop measured on the same terminal under Sub-clause **15.6.1** but does not exceed 22.5 mV, the four terminals are subjected to a new ageing test of 25 cycles without current. After the 10th and the 25th cycles, the voltage drops are again measured. For any terminal, the voltage drop shall not exceed 22.5 mV.

The total voltage drop of two inseparable joints, when measured together, shall not exceed twice the values given in Sub-clause **15.6.2.2**.

15.6.2.3 If a terminal is so designed that the conductor is tightened against a surface of insulating material, this surface shall not be deformed during these heating tests.

Compliance shall be checked by inspection.

Terminals and connections for external wiring

15.7 Conductors

Spring-type terminals shall be suitable for the connection of rigid conductors, solid or stranded, with the nominal cross-sectional areas given in the following table:

Maximum rated current of terminals (A)	Nominal cross-sectional areas of conductors (mm^2)
6	0.5 to 1
10	1 to 1.5
16	1.5 to 2.5

NOTE Terminals are usually referred to by a size designation and Size 0, for example, is generally a 6 A rating. If the component rating is less than the terminal capacity, the component rating is used.

Compliance shall be checked by inspection, by measurement and by fitting conductors of the smallest and largest cross-sectional areas specified.

15.8 Mechanical tests

The mechanical strength of the terminals (or connections) shall be checked by the following test, which is made on one terminal of each of four samples.

15.8.1 In the case of spring-type terminals, the test is made alternately with solid copper conductors having the largest and then the smallest cross-sectional areas specified in Clause **15.7**. These conductors are connected to, and disconnected from, each terminal five times. If all the terminals contained within the luminaire are not of the same design, one terminal of each of the various designs is subjected to the test.

For the first four connections, new conductors are used each time. For the fifth connection, the same conductor is used as for the fourth connection and it is clamped at the same place. For each connection, the conductor are pushed into the terminals as far as the stop.

If the terminal is stated by the manufacturer to be suitable for stranded conductors (see Sub-clause **15.3.10**), an additional test is then made with two rigid stranded copper conductors, the first having the largest cross-sectional area specified in Clause **15.7**, and the second having the smallest cross-sectional area. These conductors are subjected to only one connection and disconnection.

After the final connection, each conductor is subjected to a pull test according to the following table.

15.8.2 Pin or tab and receptacle type connections are also subjected to a pull test according to the following table:

Maximum rated current of terminals (A)	Pull (N)	
	Spring-type	Pin or tab and receptacle type
6	20	8
10	30	15
16	30	15

NOTE If the component rating is less than the terminal capacity, the component rating is used.

The pull is applied without jerks, for 1 min, in the direction opposite to that used for the application or insertion of the conductor or lead assembly.

During the test, the conductor or lead assembly shall not move out from the terminal and neither the terminal nor the conductor or lead assembly shall undergo any alteration impairing their future use.

15.9 Electrical tests

15.9.1 Contact resistance test

The electrical performance of terminals (or connections) shall be checked on a set of ten terminals. If all the terminals contained within the luminaire are not of the same design, one set of ten terminals of each design is subjected to the test.

15.9.1.1 For spring-type terminals, the test according to Sub-clause **15.9.1.3** is made with ten solid copper non-insulated conductors.

Five conductors having the largest cross-sectional areas specified in Clause **15.7** are connected as in normal use, each to one terminal.

Five conductors having the smallest cross-sectional areas specified in Clause **15.7** are connected as in normal use, each to one of the five remaining terminals.

15.9.1.2 In the case of pin or tab and receptacle type terminals, the test according to Sub-clause **15.9.1.3** is made with lead assemblies.

15.9.1.3 Each terminal with its conductor is loaded with the test current (a.c. or d.c.) and after 1 h, the voltage drop across the terminal, still at the test current, is measured. The measuring points are located as close as possible to the contact point across which the voltage drop is being measured.

The measured voltage drop shall not exceed 15 mV.

The total voltage drop of two inseparable joints, when measured together, shall not exceed twice the value given in Sub-clause **15.9.1.3**.

15.9.2 Heating tests

The thermal performance of terminals (or connections) is checked on the terminals which have been subjected to the test of Sub-clause **15.9.1**.

15.9.2.1 After having cooled down to the ambient temperature, each conductor is replaced by a new solid copper non-insulated conductor having the largest cross-sectional area specified in Clause **15.7** and each lead assembly is replaced by a new appropriate lead assembly which is then connected to, and withdrawn from, the terminal or the relevant part of the connection five times.

The conductors are then replaced by new non-insulated conductors.

15.9.2.2 Each terminal with its conductor is loaded with the test current (a.c. or d.c.) for a time just sufficient for the voltage drop to be measured.

For these measurements and the measurements of Sub-clause **15.9.2.4**, the requirements of Sub-clause **15.9.1** apply.

15.9.2.3 Terminals are then subjected to an ageing test, without current, of 25 cycles, each cycle comprising 30 min at a temperature of 100 ± 5 °C, followed by a cooling down to a temperature between 15 °C and 30 °C.

15.9.2.4 The voltage drop is again measured on each terminal:

a) after the 10th cycle;

b) after the 25th cycle.

If, for all terminals, the voltage drop, in both cases, does not exceed by more than 50 % the voltage drop measurements on the same terminal under Sub-clause **15.9.2.2** or if the increase in voltage drop is less than 2 mV, the terminals comply with the requirement.

If the voltage drop of any terminals exceeds 22.5 mV, the terminals are rejected.

If, for one of the terminals, the voltage drop measured under a) or b) exceeds by more than 50 %, with a minimum of 2 mV, the voltage drop measured on the same terminal under Sub-clause **15.9.2.2** but does not exceed 22.5 mV, the ten terminals are subjected to a new ageing test of 25 cycles without current. After the 10th and the 25th cycles, the voltage drops are again measured. For any terminal, the voltage drop shall not exceed 22.5 mV.

The total voltage drop of two inseparable joints, when measured together, shall not exceed twice the value given in Sub-clause **15.9.2.4**.

15.9.2.5 If a terminal is so designed that the conductor is tightened against a surface of insulating material, this surface shall not become deformed during these heating tests.

Compliance shall be checked by inspection.

Symbols

NOTE The marking of the symbols corresponding to IP numbers is optional.

Amperes	**A**		
Frequency (hertz)	**Hz**		
Volts	**V**		
Watts	**W**		
Class II			
Class III			
Rated maximum ambient temperature	t_a ... °C		
Warning against the use of cool-beam lamps			
Minimum distance from lighted objects (metres)			
Luminaires with built-in ballasts or transformers suitable for direct mounting on normally flammable surfaces			
Ordinary	**IP20**	no symbol	
Drip-proof	**IPX1**		(one drop)
Rain-proof	**IPX3**		(one drop in square)
Splash-proof	**IPX4**		(one drop in triangle)
Jet-proof	**IPX5**		(two triangles with one drop in each)
Watertight (immersible)	**IPX7**		(two drops)
Pressure-watertight (submersible)	**IPX8**		(two drops followed by an indication of the maximum depth of submersion in metres)
Protected against solid objects greater than 2.5 mm	IP3X	no symbol.	
Protected against solid objects greater than 1 mm	IP4X	no symbol.	

Figure 1

Dust-proof	IP5X	(a mesh without frame)
Dust-tight	IP6X	(a mesh with frame)
Use of heat resistant supply cables, interconnecting cables or external wiring	*t*....°C	
Luminaires designed for use with bowl mirror lamps		
Rough service luminaires		
Luminaires for use with high pressure sodium lamps that require an external ignitor (to the lamp)	E	
Luminaires for use with high pressure sodium lamps having an internal starting device . .	I	

Figure 1

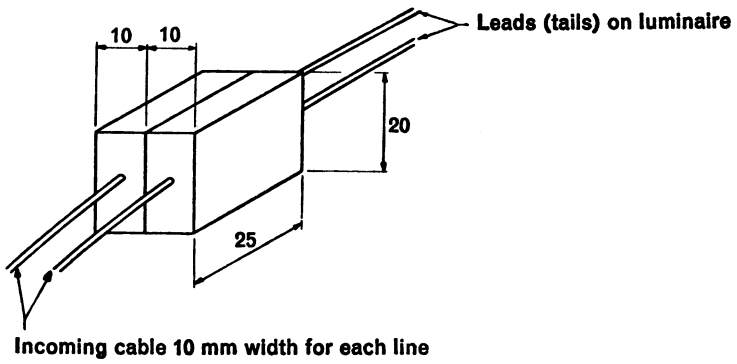


Figure 2 — Terminal block arrangement for installation test for luminaires with connecting leads (tails)

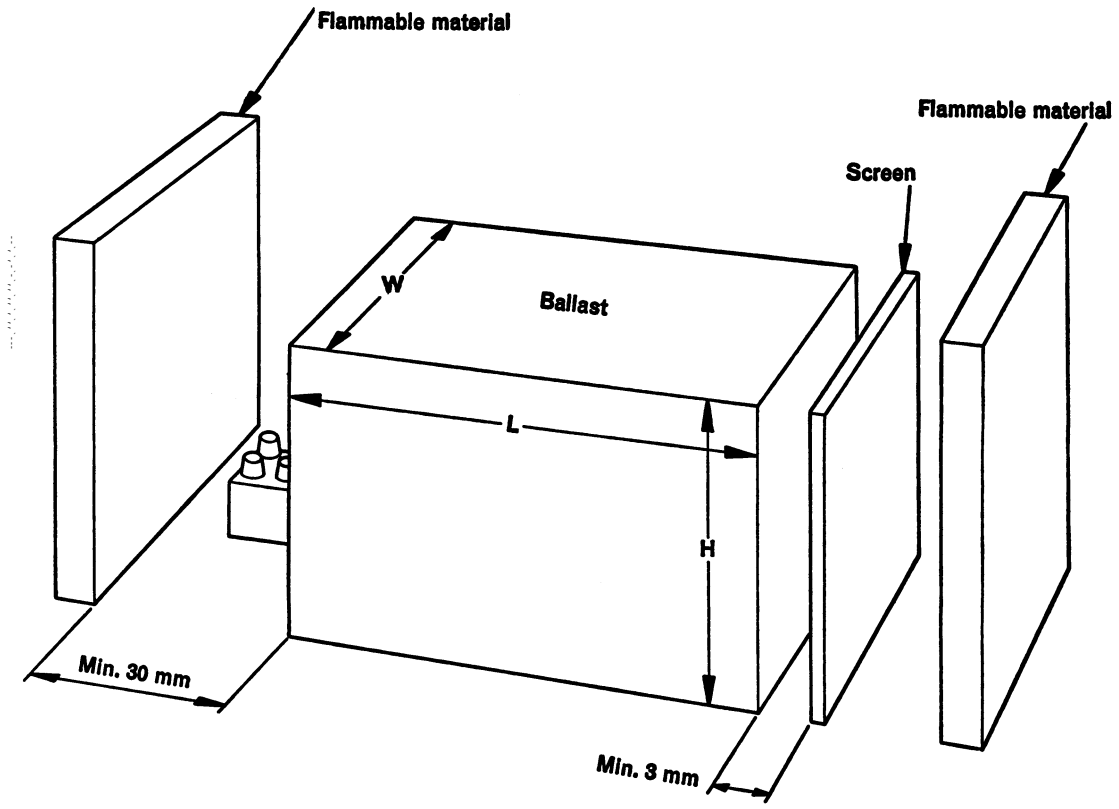


Figure 4 — Illustration of the requirements of Clause 4.15

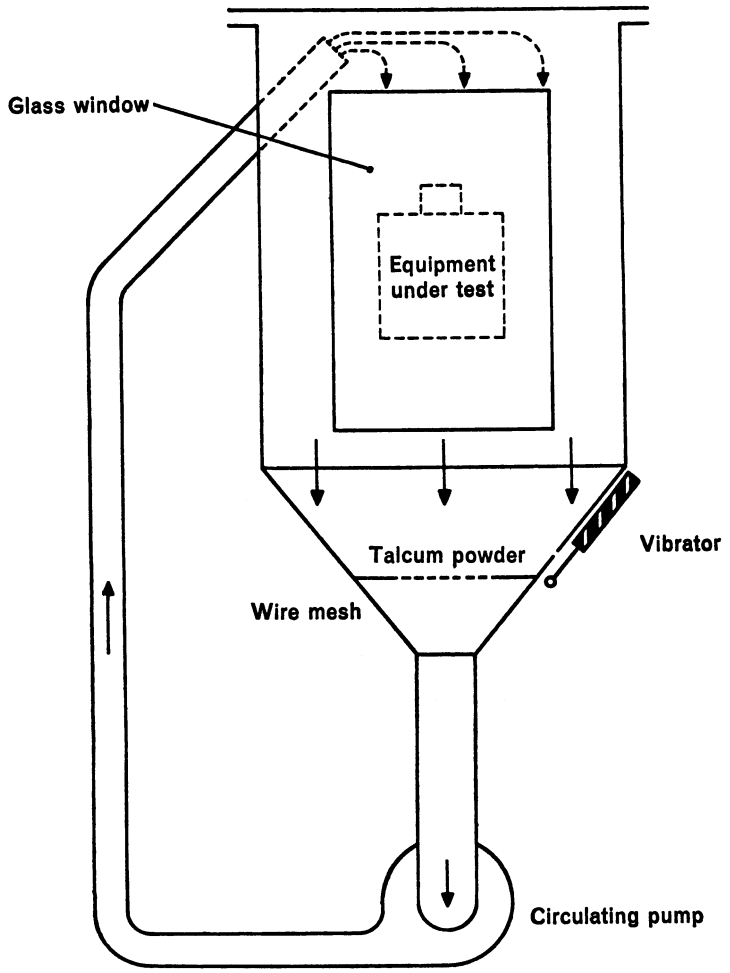
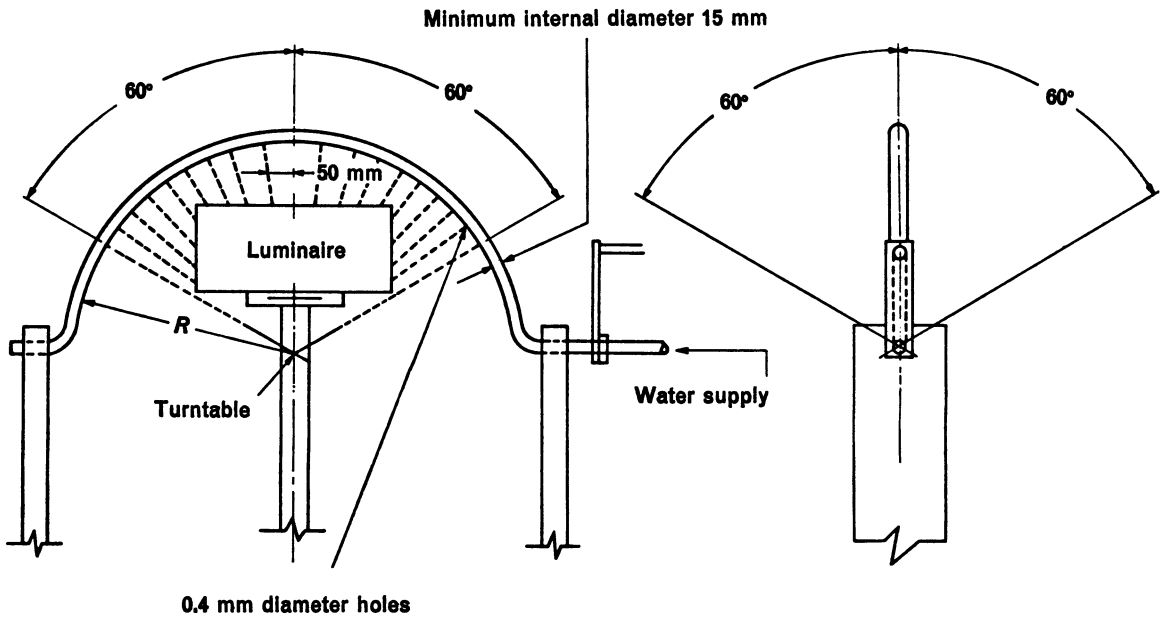


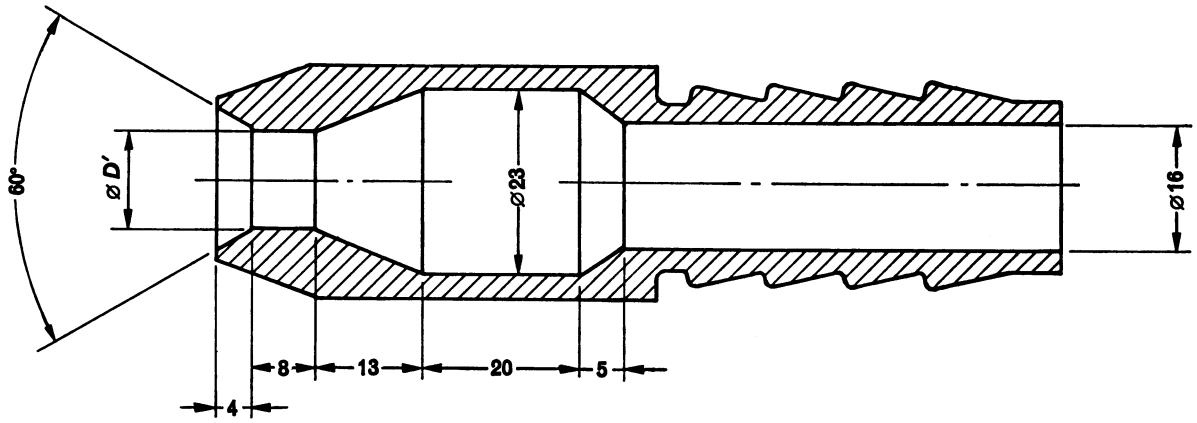
Figure 6 — Apparatus for proving protection against dust



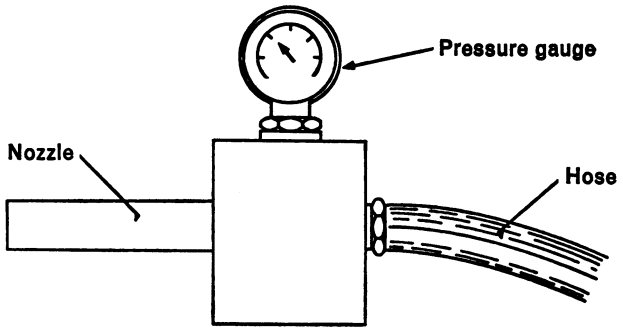
R = 200 mm or multiples thereof

	Luminaire protection	
	rain-proof	splash-proof
Oscillation half-angle	±60°	±180°
Holes within half-angle	±60°	±90°

Figure 7 — Apparatus for testing protection against rain and splashing

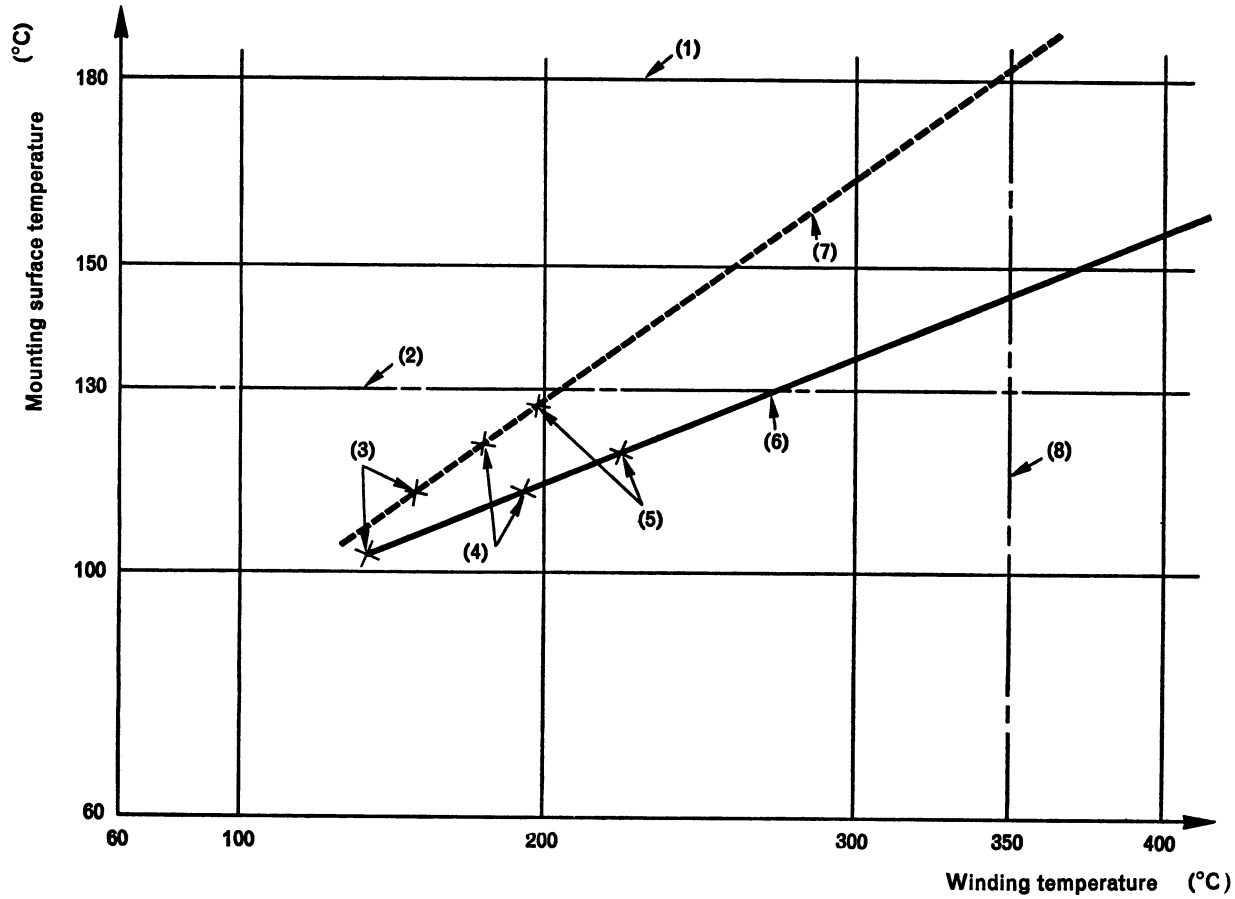


Detail of nozzle



Dimensions in millimetres

Figure 8 — Nozzle for spray test



(1) Limiting value of mounting surface temperatures in case of failed winding.

(2) Limiting value of mounting surface temperatures during abnormal operation at 1.1 times rated voltage [see Sub-clause **12.6.1.1** b)].

(3)
(4)
(5) } Measuring points at 0.9, 1.0 and 1.1 times rated voltage respectively [see Sub-clause **12.6.1.1** a)].

(6) Straight line drawn through three measuring points and indicating a satisfactory luminaire as the extrapolation of the line to a winding temperature of 350 °C is below a mounting surface temperature of 180 °C.

(7) Straight line drawn through three measuring points and indicating a luminaire which fails the test because the extrapolation of the line exceeds a mounting surface temperature of 180 °C before reaching a winding temperature of 350 °C.

(8) Assumed maximum value of the winding temperature of a failed winding.

Figure 9

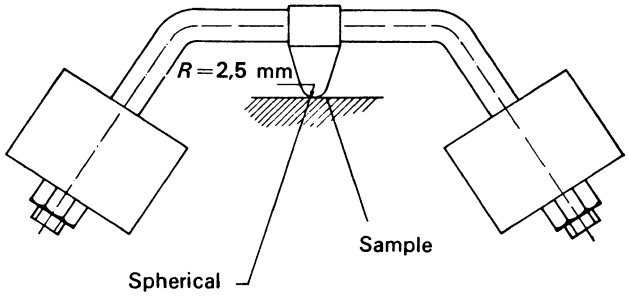
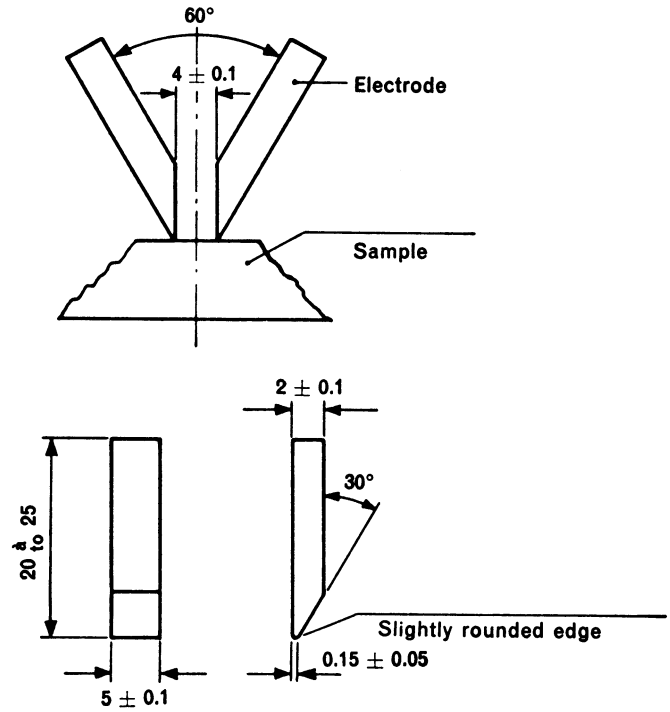
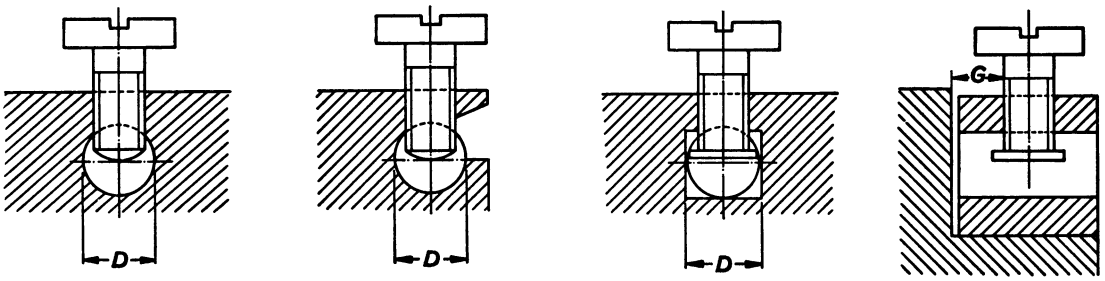


Figure 10 — Ball-pressure apparatus



Dimensions in millimetres

Figure 11 — Arrangement and dimensions of the electrodes for the tracking test



Terminals without pressure plate *Terminals with pressure plate*

D = Conductor space

G = Distance between clamping screw and end of conductor when fully inserted

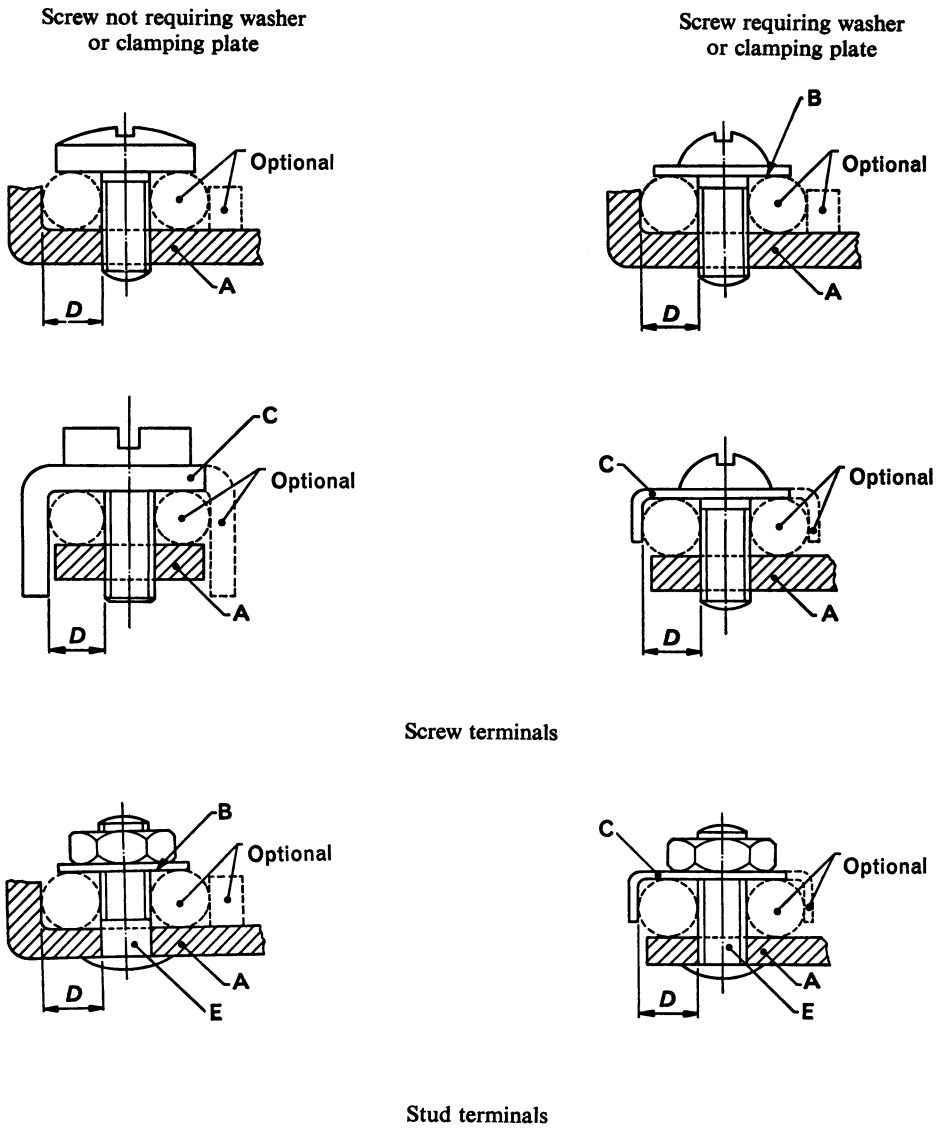
NOTE The part of the terminal containing the threaded hole and the part of the terminal against which the conductor is clamped by the screw may be two separate parts, as in the case of terminals provided with a stirrup.
The shape of the conductor space may differ from those shown, provided a circle with a diameter equal to the minimum value specified for D can be inscribed.

Figure 12 — Pillar terminals

Table XVIII — Pillar terminals (see Figure 12)

Terminal size	Minimum diameter D of conductor space (mm)	Minimum distance G between clamping screw and end of conductor when fully inserted		Torque (Nm)					
				I[a]		III[a]		IV[a]	
		One screw	Two screws	One screw	Two screws	One screw	Two screws	One screw	Two screws
1	2,5	1,5	1,5	0,2	0,2	0,4	0,4	0,4	0,4
2	3,0	1,5	1,5	0,25	0,2	0,5	0,4	0,5	0,4
3	3,6	1,8	1,5	0,4	0,2	0,8	0,4	0,8	0,4
4	4,0	1,8	1,5	0,4	0,25	0,8	0,5	0,8	0,5
5	4,5	2,0	1,5	0,7	0,25	1,2	0,5	1,2	0,5
6	5,5	2,5	2,0	0,8	0,7	2,0	1,2	2,0	1,2
7	7,0	3,0	2,0	1,2	0,7	2,5	1,2	3,0	1,2

[a] The values specified apply to the screws covered by the corresponding columns in Table XVI.



A = Fixed part

B = Washer or clamping plate

C = Anti-spread device

D = Conductor space

E = Stud

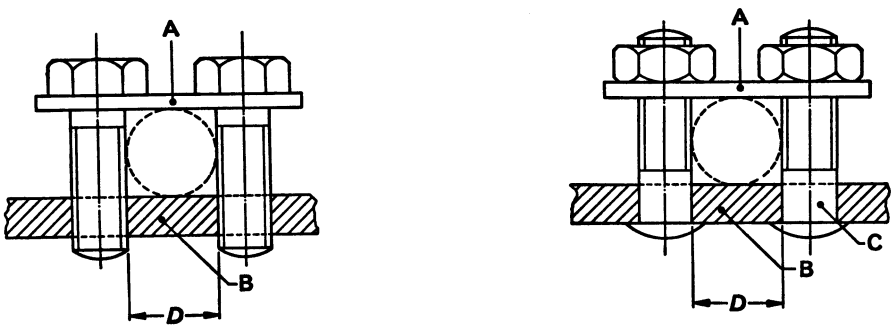
NOTE The part which retains the conductor in position may be of insulating material provided the pressure necessary to clamp the conductor is not transmitted through the insulating material.

Figure 13 — Screw terminals and stud terminals

Table XIX — Screw terminals and stud terminals (see Figure 13)

Terminal size	Minimum diameter *D* of conductor space (mm)	Torque (Nm)			
		III[a]		IV[a]	
		One screw	Two screws	One screw or stud	Two screws or studs
0	1,4	0,4	—	0,4	—
1	1,7	0,5	—	0,5	—
2	2,0	0,8	—	0,8	—
3	2,7	1,2	0,5	1,2	0,5
4	3,6	2,0	1,2	2,0	1,2
5	4,3	2,0	1,2	2,0	1,2
6	5,5	2,0	1,2	2,0	1,2
7	7,0	2,5	2,0	3,0	2,0

[a] The values specified apply to the screws or studs covered by the corresponding columns in Table XVI.



A = Saddle

B = Fixed part

C = Stud

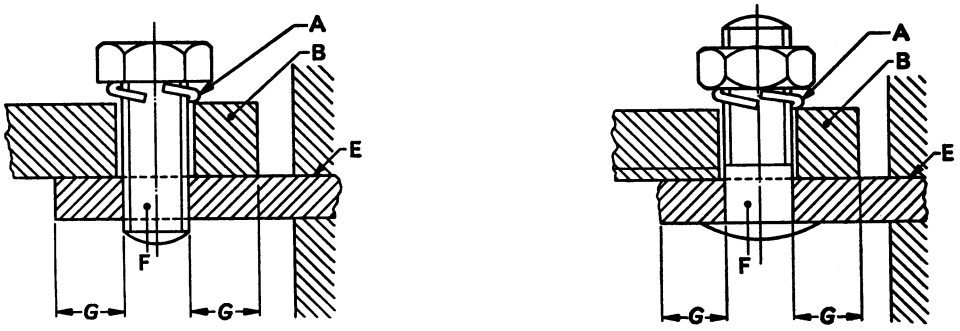
***D* = Conductor space**

NOTE The shape of the section of the conductor space may differ from that shown in the figures, provided a circle with a diameter equal to the minimum value specified for *D* can be inscribed.
The shape of the upper and lower faces of the saddle may be different, to accommodate conductors of either small or large cross-sectional area, by reversing the saddle.
The terminals may have more than two clamping screws or studs.

Figure 14 — Saddle terminals

Table XX — Saddle terminals (see Figure 14)

Terminal size	Minimum diameter *D* of conductor space (mm)	Torque (Nm)
3	3,0	0,5
4	4,0	0,8
5	4,5	1,2
6	5,5	1,2
7	7,0	2,0



A = Locking means

B = Cable lug or bar

E = Fixed part

F = Stud

***G* = Distance between edge of hole and side of clamping area**

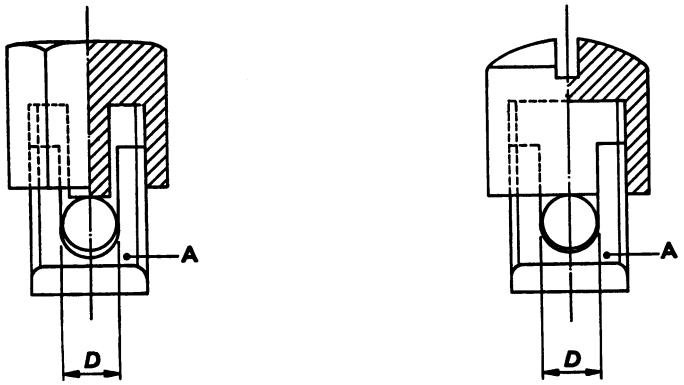
NOTE For certain types of equipment, the use of lug terminals of a size smaller than those specified is allowed.

Figure 15 — Lug terminals

Table XXI — Lug terminals (see Figure 15)

Terminal size	**Minimum distance *G* between edge of hole and side of clamping area** (mm)	**Torque** (Nm)	
		III[a]	**IV**[a]
6	7,5	2,0	2,0
7	9,0	2,5	3,0

[a] The values specified apply to the studs covered by the corresponding columns in Table XVI.



A = Fixed part

***D* = Conductor space**

Figure 16 — Mantle terminals

Table XXII — Mantle terminals (see Figure 16)

Terminal size	**Minimum diameter *D* of conductor space**[a] (mm)	**Minimum distance between fixed part and end of conductor when fully inserted** (mm)
0	1,4	1,5
1	1,7	1,5
2	2,0	1,5
3	2,7	1,8
4	3,6	1,8
5	4,3	2,0
6	5,5	2,5
7	7,0	3,0

[a] The torque value to be applied is that specified in column II or V of Table XVI as appropriate.

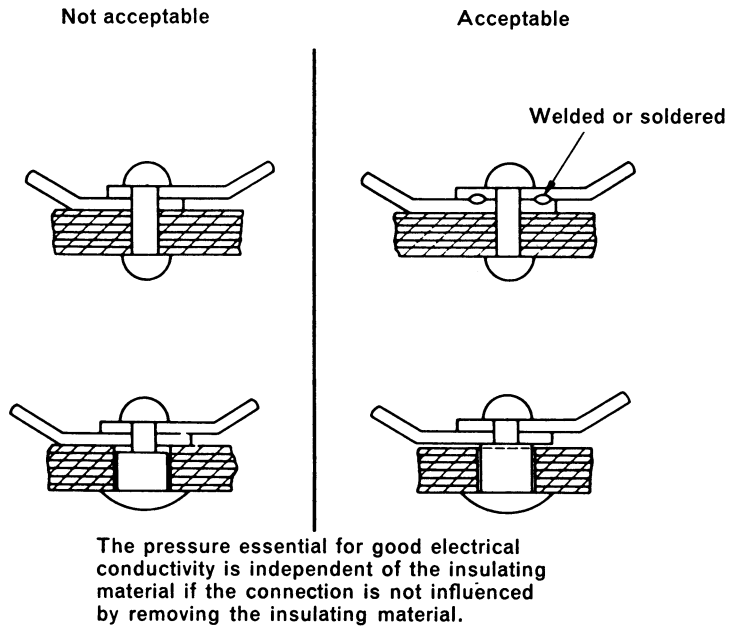


Figure 17 — Construction of electrical connections

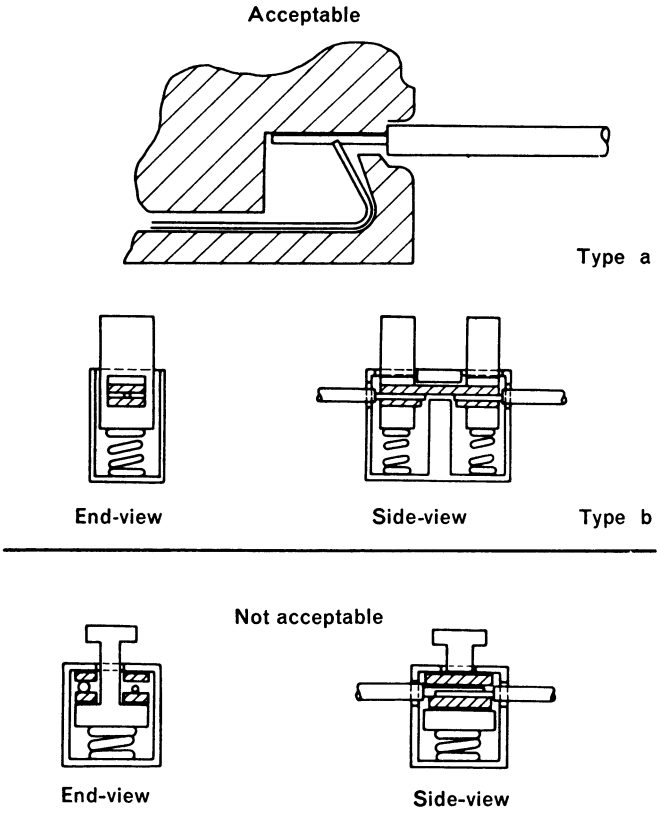


Figure 18 — Examples of spring-type screwless terminals

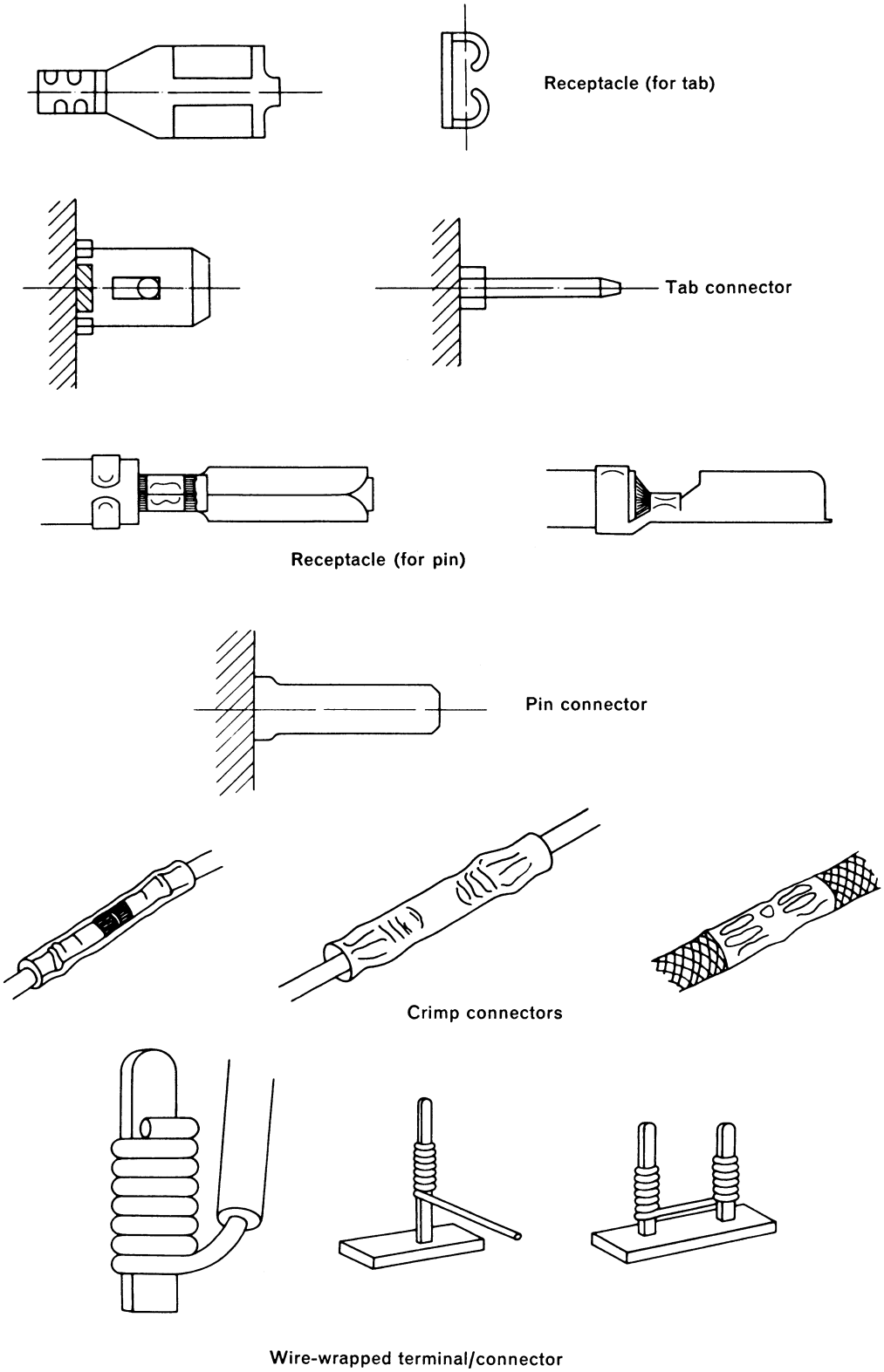


Figure 19 — Further examples of screwless terminals

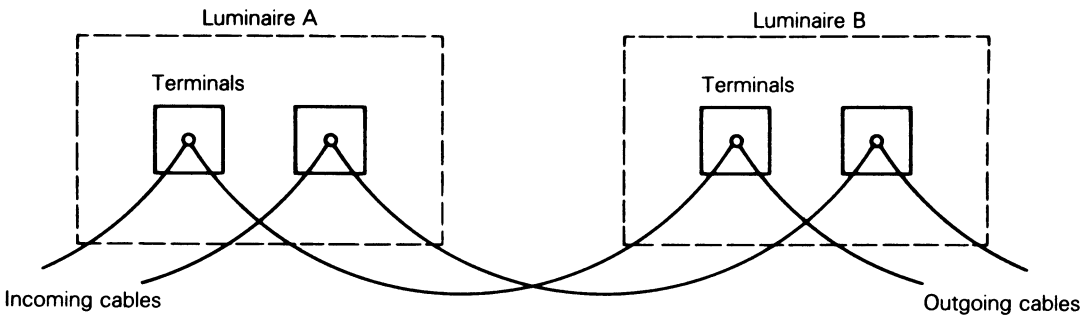
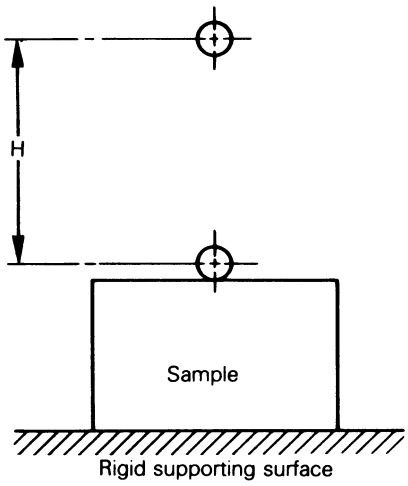


Figure 20 — Illustration of the term "looping-in" (feed through)

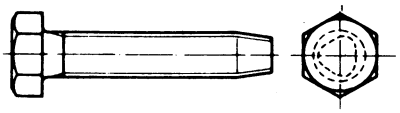


The supporting surface should be arranged vertically for side impact tests.

Figure 21 — Apparatus for ball impact tests

Hexagon head tapping screw, Type AB point;
Type B point

Hexagon head thread-cutting screw



Hexagon head thread-forming screw (thread formed by deformation)

Figure 22 — Examples of self-tapping, thread-cutting and thread-forming screws (from ISO Standard 1891)

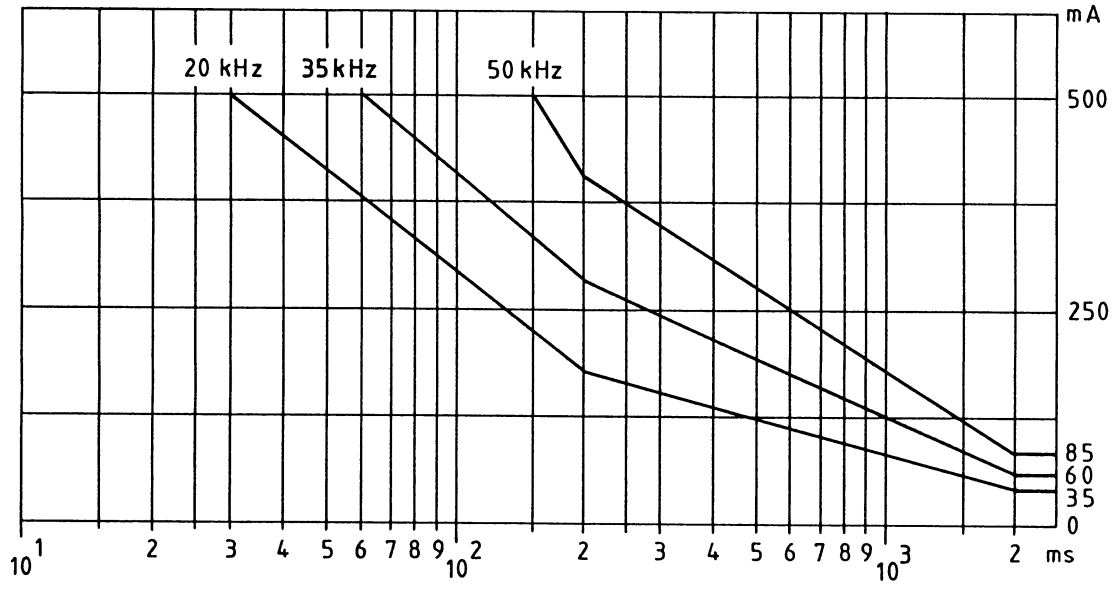


Figure 23 — Limits for capacitive leakage current of HF-operated tubular fluorescent lamps

Appendix A Explanation of IP numbers for degrees of protection

For full details see IEC Publication 529 from which the following is an extract.

The type of protection covered by this system of classification is as follows:

a) Protection of persons against contact with or approach to live parts and against contact with moving parts (other than smooth rotating shafts and the like) inside the enclosure and protection of the equipment against ingress of solid foreign bodies.

b) Protection of the equipment inside the enclosure against harmful ingress of water.

The designation to indicate the degrees of protection consists of the characteristic letters IP followed by two numerals (the "characteristic numerals") indicating conformity with the conditions stated in Table XXIII and Table XXIV respectively. The first numeral indicates the degree of protection described under Item a) above and the second numeral the degree of protection described under Item b) above.

Table XXIII — Degrees of protection indicated by the first characteristic numeral

First characteristic numeral	Degree of protection	
	Short description	Brief details of objects which will be "excluded" from the enclosure
0	Non-protected	No special protection
1	Protected against solid objects greater than 50 mm	A large surface of the body, such as a hand (but no protection against deliberate access). Solid objects exceeding 50 mm in diameter
2	Protected against solid objects greater than 12 mm	Fingers or similar objects not exceeding 80 mm in length. Solid objects exceeding 12 mm in diameter
3	Protected against solid objects greater than 2.5 mm	Tools, wires, etc., of diameter or thickness greater than 2.5 mm. Solid objects exceeding 2.5 mm in diameter
4	Protected against solid objects greater than 1.0 mm	Wires or strips of thickness greater than 1.0 mm. Solid objects exceeding 1.0 mm in diameter
5	Dust-protected	Ingress of dust is not totally prevented but dust does not enter in sufficient quantity to interfere with satisfactory operation of the equipment
6	Dust-tight	No ingress of dust

Table XXIV — Degrees of protection indicated by the second characteristic numeral

Second characteristic numeral	Degree of protection	
	Short description	Details of the type of protection provided by the enclosure
0	Non-protected	No special protection
1	Protected against dripping water	Dripping water (vertically falling drops) shall have no harmful effect
2	Protected against dripping water when tilted up to 15°	Vertically dripping water shall have no harmful effect when the enclosure is tilted at any angle up to 15° from its normal position
3	Protected against spraying water	Water falling as a spray at an angle up to 60° from the vertical shall have no harmful effect
4	Protected against splashing water	Water splashed against the enclosure from any direction shall have no harmful effect
5	Protected against water jets	Water projected by a nozzle against the enclosure from any direction shall have no harmful effect
6	Protected against heavy seas	Water from heavy seas or water projected in powerful jets shall not enter the enclosure in harmful quantities
7	Protected against the effects of immersion	Ingress of water in a harmful quantity shall not be possible when the enclosure is immersed in water under defined conditions of pressure and time
8	Protected against submersion	The equipment is suitable for continuous submersion in water under conditions which shall be specified by the manufacturer. NOTE Normally, this will mean that the equipment is hermetically sealed. However with certain types of equipment it can mean that water can enter but only in such a manner that it produces no harmful effects

Appendix B Test to establish whether a conductive part is a live part which may cause an electric shock

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

1) The current flowing between the part concerned and earth is measured, the measuring circuit having a non-inductive resistance of 2 000 Ω. The part concerned is a live part if a current of more than 0.7 mA (peak) is measured.

2) The voltage between the part concerned and any accessible part is measured, the measuring circuit having a non-inductive resistance of 50 000 Ω. The part concerned is a live part if a voltage of more than 34 V (peak) is measured.

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

Appendix C Test lamps

For the tests of Section 12, it is convenient to keep a stock of lamps of types commonly required. These should be carefully selected from normal production lamps for characteristics as close as possible to the objective characteristics listed in the appropriate standards. The selected lamps should be aged (at least 24 h for filament lamps and at least 100 h for tubular fluorescent and other discharge lamps, with occasional off-periods), and a further check should be made that their characteristics are still satisfactory and stable. Lamps should not be retained as test lamps for longer than about three-quarters of their typical operating period in normal service. Lamps should be inspected before each test for any damage or signs of approaching unserviceability. Discharge lamps should be checked regularly to ensure that there has been no appreciable shift in electrical characteristics which influence the temperatures in luminaires. If a lamp can be inserted in a circuit in more than one position — e.g. a fluorescent lamp — marks should be made to assist consistent insertion. Great care should be taken in handling test lamps; in particular, sodium and mercury-halide discharge lamps and amalgam fluorescent lamps should not be moved while still hot.

For heat test source (H.T.S.) lamps, see IEC Publication 634.

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

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

Filament lamps

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

Lamps are chosen in accordance with the rated wattage of the luminaire, but when the luminaire has E27 or B22 lampholders, a GLS lamp with a rated wattage of not less than 60 W shall be used and if the luminaire has El4 or B15 lampholders a GLS lamp with a rated wattage of not less than 40 W shall be used. In cases of doubt, for luminaires with E27 lampholders, a 40 W round bulb lamp shall also be used.

This requirement does not apply if it is obvious that the luminaire should not be used with such lamps.

The voltage rating of a test lamp shall be typical of the voltage rating of filament lamps in the market for which the luminaire is intended. If the luminaire is intended for two or more different groups of voltage supplies, e.g. for 200 V–250 V and for 100 V–125 V, then the test lamp shall be the one suited to the lowest voltage range (i.e. the one with the highest current).

If a lamp is operated in conjunction with a component (e.g. a transformer with 24 V output) inside the luminaire, the voltage rating of the test lamp shall be in accordance with the marking of the component or similar instructions.

Tubular fluorescent and other discharge lamps

When a lamp is operated under reference conditions (according to the lamp IEC standard), the lamp voltage, current and power shall be as close as possible to the IEC objective values, and shall be within 2.5 % of these values.

If a reference ballast is not available, lamps may be selected using a production ballast which at the calibration current has an impedance within ± 1 % of that of the reference ballast.

NOTE 1 Self-ballasted lamps are considered as fluorescent or other discharge lamps for the purpose of Section 12. If the luminaire is for use with filament lamps and self-ballasted lamps or other discharge lamps incorporating series filaments, it should be tested with the most onerous lamp (which in general will be with filament lamps).

NOTE 2 If the luminaire is for use with a combination of lamp types (e.g. a filament lamp plus a discharge lamp), it should be tested with the thermally most onerous combination.
If the luminaire is for use with either filament or discharge lamps, it should be tested with the more onerous (or, if not known, with each in turn).
It is usually found that translucent materials attain a higher temperature with a discharge lamp or a discharge lamp incorporating a series filament than with a filament lamp, for a given lamp power.
NOTE 3 If the luminaire is designed for a lamp type for which specifications have not yet been established, a test lamp should be selected after consultation with the lamp manufacturer.
NOTE 4 standards relating to lamps are included in the list on pages 3 and 4 of the back cover of IEC Publication 598-1:1988.

Appendix D Abnormal circuit conditions

The following is a list of abnormal circuit conditions which may be applicable to a tubular fluorescent or other discharge lamp luminaire and from which the thermally most onerous condition shall be taken (see Sub-clause **12.5.1**). If the luminaire contains more than one lamp, the abnormal condition shall be applied only to the one lamp which leads to the most adverse results. The abnormal condition shall be set up before the test is started. Conditions 4) and 5) refer only to lamps with two preheated electrodes (e.g. fluorescent lamps). The descriptions include instructions on test arrangements. Conveniently the abnormal circuit condition may be produced or simulated by remote switching so that it is not necessary to disturb a luminaire which has just completed the test of normal operation.

1) Short circuit of starter contacts.

This condition applies to starters with moving contacts, including starters incorporated in lamps.

2) Lamp rectification.

This is a fault condition which may occur after extended use in luminaires employing starterless ballasts with capacitive reactance control. Luminaires employing this type of circuit shall be tested in accordance with the requirements of IEC Publication 82, and the circuit arrangements for this test shall be as specified in that standard.

3) Lamps removed and not replaced.

4) One electrode of lamp open-circuit.

The condition may be produced by switching. (Alternatively, a test lamp may be suitably modified.) The electrode shall be selected which more adversely affects the results.

5) Lamp will not start but both electrodes intact. For this condition, a non-serviceable or modified test lamp may be used.

Appendix E Draught-proof enclosure

The following recommendations refer to the construction and use of a suitable draught-proof enclosure for luminaires, as required for the tests of normal and abnormal operation. Alternative constructions for draught-proof enclosures are suitable if it is established that similar results are obtained.

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

The internal surfaces are painted with a matt paint. The three principal internal dimensions are each at least 900 mm. There should be a clearance of at least 200 mm between the internal surfaces and any part of the largest luminaire for which the enclosure is designed.

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

There is a clearance of at least 300 mm above the top of the enclosure and around the perforated sides. The enclosure is at a location protected as far as possible from draughts and sudden changes in air temperature; it is also protected from sources of radiant heat.
A luminaire under test is positioned as far away as possible from the six internal surfaces of the enclosure. The luminaire is mounted (subject to the requirements of Sub-clauses **12.4.1** and **12.5.1**) as under service conditions.

A luminaire for direct fixing to a ceiling or wall should be fixed to mounting surface comprising a wood or wood-fibre board. A non-combustible insulating material should be used if the luminaire is not suitable for mounting on a combustible surface. The board is 15 mm to 20 mm thick, and extends not less than 100 mm (but preferably not more than 200 mm) beyond the normal projection of the smoothed outline of the luminaire. There is a clearance of at least 100 mm between the board and the internal surfaces of the enclosure. The board is painted black with a matt non-metallic paint.

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

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

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

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

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

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

A track-mounted luminaire is connected to a track system appropriate to the luminaire. The track is mounted as in normal use, according to the manufacturer's installation instructions. The luminaire is connected to the track in the most onerous thermal position of normal use permitted by mounting instructions or marking. The luminaire is operated under the conditions specified in Sub-clauses **12.4.1** and **12.4.5**.

Appendix F Temperature measurement

The following recommendations refer to methods of making temperature measurements on luminaires in a draught-proof enclosure in accordance with Sub-clause **12.4.1**. These methods of measurement have evolved as particularly suitable for luminaires: alternative methods may be used if it is established that they are of at least equal precision and accuracy.

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

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

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

The following methods have been found useful for attaching thermocouple junctions at measuring points:

a) Mechanical clamping, e.g. under a fixing device (clamping under current-carrying parts is deprecated).

b) Soldering to a metal surface (with a minimum amount of solder).

c) By an adhesive (minimum amount required). The adhesive should not separate the thermocouple from the measuring point. An adhesive used with a translucent material should be as translucent as possible. A suitable adhesive for use with glass is formed of one part of sodium silicate to two parts of calcium sulphate, with water medium.

On non-metal parts the last 20 mm of the thermocouple is attached to the surface to offset the flow of heat from the measuring point.

d) Cables. The insulation is slit and the thermocouple inserted (without touching a conductor); the insulation is then bound up.

e) Mounting surfaces (see Appendix E). A thermocouple is attached to a copper disc (approximately 5 mm diameter, 1 mm thickness, and with a matt black finish), sunk level with the surface at the hottest point.

The average ambient temperature in the draught-proof enclosure is taken to be the air temperature at a position near one of the perforated walls on a level with the centre of the luminaire.

The temperature is usually measured by a mercury-in-glass thermometer, the bulb of which is shielded against radiation by a double walled cylinder of polished metal.

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

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

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

Appendix G Determination of winding temperature rises by the change-in-resistance method

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

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

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

The test procedure is as follows:

The luminaire remains unenergized for a period long enough to ensure that the complete luminaire, including the ballast windings, is thermally stable in a substantially constant ambient temperature (t_1), which should not change by more than 3 °C during this period.

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

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

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

Since the resistance of copper, over the range of temperatures of ballasts, varies in direct proportion to the temperature as measured from a reference point of – 234.5 °C, the hot temperature t_2 may be calculated from the ratio of the hot resistance R_2 to the cold R_1 by means of the equation:

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

Hence, for windings of copper wire:

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

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

temperature rise = $(t_2 - t_3)$ °C

Appendix H Guide to good practice in luminaire design

H.1 Scope

This guide to good practice is intended to advise luminaire manufacturers on the behaviour of plastics materials and finishes under the influence of temperature, U.V. radiation, moisture and aggressive atmospheres.

It applies to luminaires for indoor use and outdoor use and advises on generally accepted constructions on an informative basis and without being exhaustive. This guide should therefore never be interpreted as a requirement since other solutions can be equally effective or even better in specific applications.

A classification of external influences is given in IEC Publication 364-3: Electrical Installations of Buildings, Part 3: Assessment of General Characteristics.

H.2 Plastics in luminaires

In modern luminaire construction, plastics components have become important and proven functional elements, which are chosen, established and used in accordance with the latest technology. This applies to internal parts and wiring, and to components such as translucent covers, shields or parts for structural support.

The applications relative to the "normal" usage of luminaires determine the normal running life "ageing" of these plastics parts.

Inadmissible hard usage and damaging influences diminish the resistance to ageing.

Damaging influence	Causes	Effects[a]
High operating temperature	Operating voltage too high	Deformation
	Ambient temperature too high	Embrittlement
	Inappropriate mounting	Discolouration
U.V. radiation	Mercury-dosed high-pressure lamps with excessive U.V. component	Yellowing
	Germicidal lamps	Embrittlement
Aggressive substances	Softeners (Plasticizers)	Cracking
	Incorrect cleaning (with) disinfecting means	Reduced strength
		Outer surface damage

[a] All causes can relate to all effects.

Special attention should be given to:

— continuous service temperature;

— U.V. and visible radiation;

— static and dynamic mechanical impact;

— oxidizing atmospheres.

Some combinations of these influences have particular importance and may make the material unsuitable for the intended application. For example, the combination of U.V. radiation and heat may produce a green substance from PVC cable insulation, indicating the degradation of the insulation. The properties published in respect of particular materials of given generic names can differ depending on the fillers or inhibitors used, the procedure of manufacturing and the design.

H.3 Rust resistance

Luminaires for use in normal indoor atmospheres may be made from a wide variety of materials.

Sheet metal components of the luminaire should be suitably pre-treated and surface finished e.g. stove enamelled.

Unpainted aluminium reflectors and louvres should be of an aluminium alloy with an anodic coating.

Auxiliary components of luminaires, such a clips, hinges, etc., when electroplated with suitable materials will give satisfactory service in normal indoor atmospheres. Suitable coatings are zinc, nickel/chromium and tin.

NOTE The electrical safety of luminaires for indoor use under humid conditions is checked by the tests of Section 9 of this standard.

H.4 Corrosion resistance

Luminaires for use outdoors, or indoors in atmospheres of high humidity should have adequate resistance to corrosion. Although it is assumed that these luminaires will not be required to operate in conditions where chemical vapours are present, it should be remembered that all atmospheres contain a small proportion of corrosive gases such as sulphur dioxide and that in the presence of moisture these can cause severe corrosion over a long period of time.

In the assessment of the resistance to corrosion of a luminaire it should be borne in mind that the interior of a closed luminaire (even if it has one or more drain-holes) is much less subject to corrosion than the exterior.

The following metals or combinations are known to provide adequate corrosion resistance:

a) Copper and bronze; or brass containing not less than 80 % copper.

b) Stainless steel.

c) Aluminium (sheet, extruded or cast) and die-cast zinc, known to be resistant to atmospheric corrosion.

d) Cast iron or malleable iron at least 3.2 mm thick, coated with a minimum thickness of 0.05 mm zinc on the outside surfaces and a visible coating of such material on the inside surface.

e) Sheet steel, zinc coated, average coating thickness 0.02 mm.

f) Polymeric materials, see under Clause **H.1**.

Metal components in contact with one another should be made from metals which lie close to each other in the galvanic series to avoid electrolytic corrosion. For example, brass or other copper alloys should not be used in contact with aluminium or aluminium alloys; contact between either of these groups of materials and stainless steel is much more acceptable.

Plastic materials used outdoors should usually be chosen from those such as the acrylics, whose characteristics do not change significantly during long periods of service. Cellulose materials are in general unsatisfactory for conditions of high humidity, either indoors or outdoors, and others including polystyrene, while suitable for use indoors, are liable to severe deterioration if used outdoors owing to the combination of moisture and solar radiation.

Where the construction of plastics luminaires intended for high humidity conditions (indoor or outdoors), includes cemented joints, it is essential that the cement used be able to withstand continuous exposure to moisture for long periods without deterioration.

NOTE The electrical safety of luminaires for outdoor use under humid conditions is checked by the tests of Section 9 of this standard.

H.5 Chemically corrosive atmospheres

Luminaires to be used in atmospheres where chemically corrosive gases or vapours may be present in considerable concentration, and especially where condensation appears, require that the precautions given above for outdoor luminaires be observed and that the following additional precautions be taken:

a) In general, luminaires whose bodies are made by casting a corrosion-resistant metal will give better service than sheet metal luminaires.

b) Where metals are used they should, as far as possible, be chosen for resistance to the particular corrosive substance present, as most metals are subject to attack by some corrosive substance. Die-cast aluminium will be satisfactory for most applications.

c) Similarly, the paints or other protective systems used should be chosen with regard to particular corrosive substances or groups of corrosive substances. For example, paints which are highly acid-resistant may not be able to withstand attack by some alkalis.

d) Plastics such as acrylics, PVC and polystyrene are very resistant to attack by most inorganic acids and alkalis. They are, however, liable to attack by a number of organic liquids and vapours and as the effect depends on both the type of plastics and the particular chemical, materials should be chosen to suit the particular conditions.

e) Vitreous enamel finishes are resistant to many chemicals, but it is essential that the enamel coating be free from broken areas or cracks if satisfactory service is to be obtained in highly corrosive atmospheres.

Appendix J Test for resistance to stress corrosion of copper and copper alloys

The surface of the samples is carefully cleaned, varnish being removed by acetone, and grease and fingerprints by petroleum spirit or the like.

The samples are placed for 24 h in a test cabinet, the bottom of which is covered by an ammonium chloride solution having a pH value of 10 to 11.

For 1.01 of ammonium chloride solution, the proper pH value may be achieved as follows:

107 g of ammonium chloride (NH_4Cl AR grade) is mixed with 0.75 l of distilled water and made up to 1.01 by adding 30 % solution hydroxide (prepared from NaOH AR grade and distilled water).

After this treatment, the samples are washed in running water; 24 h later the samples shall show no cracks visible to the naked eye after having been compressed lightly between the fingers.

Appendix K Measurement of leakage current

K.1 The luminaire shall be tested in an ambient temperature of 25 ± 5 °C and at rated supply voltage and frequency in the test circuit as shown in Figure K.1.

K.2 The luminaire shall be operated with the lamp(s) of the type for which it is intended, such that, when stabilized at rated voltage, the lamp wattage and voltage of fluorescent and other discharge lamps are within ± 5 % of rated values.

K.3 The test sequence shall be as detailed in Clause **K.6**, except that Item f) is not applicable to luminaires that use only filament lamps. The test finger is applied to accessible metal parts, or accessible insulating parts wrapped in foil, of the luminaire body.

K.4 The measurement circuit is defined in Items a) to c) below:

a) The meter shall have an input impedance of 1 500 Ω resistive shunted by a capacitance of 0.15 μF.

b) The meter shall indicate 1.11 times the average full-wave rectified composite waveform of voltage across the resistor or current through the resistor.

c) Over a frequency range of 0 kHz to 100 kHz, the measurement circuitry shall have a frequency response (ratio of indicated to actual current value) that is equal to the ratio of the impedance of a 1 500 Ω resistor shunted by a 0.15 μF capacitor to 1 500 Ω. At an indication of 0.75 mA the measurement shall have an error of not more than 5 % at 50 Hz or 60 Hz.

K.5 The test circuit of Figure K.1 shall employ an isolating transformer and the "neutral" conductor connected to the meter shall be reliably earthed for safety reasons. Switch S2 has a centre off position.

K.6 Test sequence

a) With Switch S1 in the off position and Switch S2 in the centre off position, close the line switch and adjust input voltage to rated luminaire input voltage.

b) With Switch S1 in the off position, Switch S2 is transferred to position (A) and the leakage current measured. Switch S2 is then transferred to position (B) and the leakage current measured.

c) Switch S2 is then returned to the centre off position and Switch S1 closed. Switch S2 is transferred to position (A) and leakage current measured within 5 s. Switch S2 is then transferred to position (B) and the leakage current measured within 5 s, after transfer.

d) With Switch S2 in the centre off position, the luminaire is operated until constant temperatures are obtained. Switch S2 is transferred to position (A) and the leakage current measured. Switch S2 is then transferred to position (B) and the leakage current measured.

e) Switch S2 is returned to the centre off position and Switch S1 turned off. Switch S2 is transferred to position (A) and the leakage current measured. Switch S2 is then transferred to position (B) and the leakage current measured.

f) In the case of luminaires for use with fluorescent or other discharge lamps, Switch S2 is returned to the centre off position and switch S1 turned on. Before the lamp restarts, Switch S2 is transferred to position (A) and the leakage current measured. Switch S2 is then transferred to position (B) and the leakage current measured.

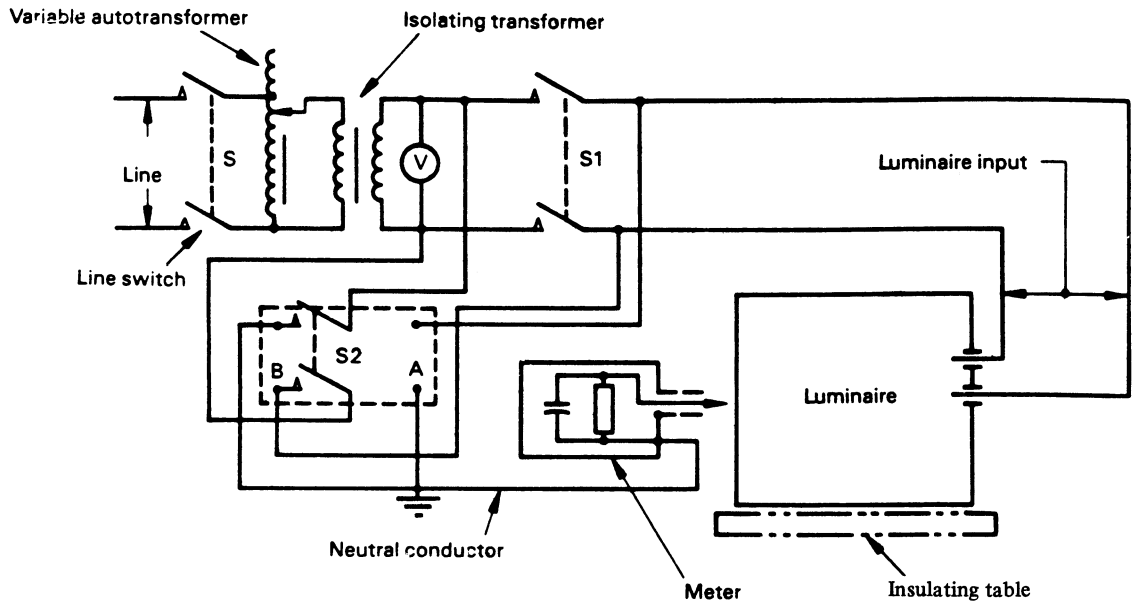


Figure K.1 — Measurement of leakage current

Appendix L Measurement of high-frequency leakage current

Luminaires incorporating a.c. operated electronic ballasts are tested for capacitive high-frequency leakage current, as follows:

The luminaire is tested in the circuit shown in Figure L.1 with a deactivated lamp.

The glass tube of the lamp is wrapped with a 75 mm wide metal foil, positioned 10 mm from the cap shell. This metal foil together with a non-inductive 2 kΩ resistor and a suitable measuring device form the test circuit.

The leakage current — i.e the high-frequency current flowing from the metal foil through the 2 000 ± 50 Ω resistor to earth shall be measured under the following operating conditions:

a) a deactivated lamp is inserted into a pair of holders with the supply voltage switched on;

b) a deactivated lamp is removed from a pair of holders with the supply voltage switched on.

In order to take care of the most adverse condition — that is to say, to safeguard that the highest leakage current which may occur will be measured — both of the procedures a) and b) shall be carried out in such a way that all of the four possible holder contact/cap pin combinations are covered.

Multilamp ballasts are operated accordingly.

Under each of the specified operation conditions the capacitive leakage current measured shall not exceed the limits specified in Figure 23.

NOTE Instead of deactivated lamps referred to in a) and b), it is convenient to use the ends of two separate lamps for the purpose of these measurements.

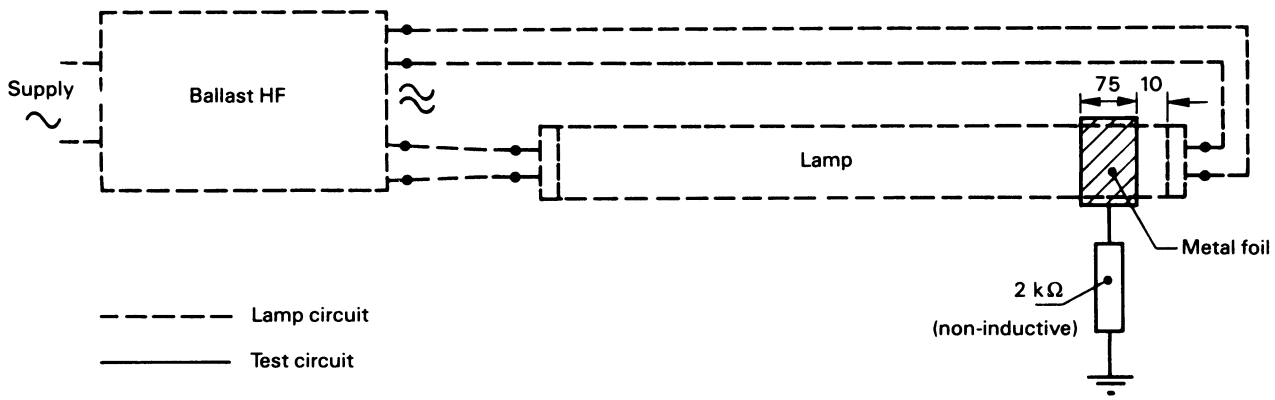


Figure L.1 — Test arrangement

Annex ZA (normative)
Other international publications quoted in this standard

When the international publication has been modified by CENELEC common modifications (mod = modified by CENELEC common modifications) the relevant EN/HD applies.

ZA1

IEC Publications	*EN/HD*	*Date of issue of EN/HD*
61 *Lamp caps and holders together with gauges for the control of interchangeability and safety.*	HD 65	Sliding, latest edition
82 *Ballasts for tubular fluorescent lamps.*	—	—
83 *Plugs and socket-outlets for domestic and similar general use. Standards.*	—	—
155 (mod) *Starters for tubular fluorescent lamps.*	EN 60155	89-06-20
227 (mod) *Polyvinyl chloride insulated cables of rated voltages up to and including 450/750 V.*	HD 21 S2	82-10-04
238 *Edison screw lampholders*	EN 60238	86-02-18
245 (mod) *Rubber insulated cables of rated voltages up to and including 450/750 V.*	HD 22 S2	82-10-17
249-1 *Base materials for printed circuits* Part 1: *Test Methods.*	HD 313.1 S4	87-11-10
320 (mod) *Appliance couplers for household and similar general purposes.*	EN 60320-1	87-06-24
328 *Switches for appliances*	—	—
357 (mod) *Tungsten halogen lamps (non-vehicle)*	EN 60357	88-01-22
364-3 (mod) *Electrical installations of buildings* Part 3: *Assessment of general characteristics.*	HD 384.3 S1	85-10-14
417 *Graphical symbols for use on equipment. Index, survey and compilation of the single sheets.*	HD 243 S7	88-01-22
458 *Transistorized ballasts for tubular fluorescent lamps.*	HD 302 S1	77-09-30
529 *Classification of degrees of protection provided by enclosures.*	HD 365 S3	85-05-31

IEC Publications	*EN/HD*	*Date of issue of EN/HD*
570 (mod) *Electrical supply track systems for luminaires.*	EN 60570	89-02-08
598-2 *Luminaires* *Particular requirements*	EN 60598-2	88-04-14
634 *Heat test source (H.T.S.) lamps for carrying out heating tests of luminaires.*	HD 392 S2	85-06-25
662 *High pressure sodium vapour lamps.*	EN 60662	87-02-10
695-2-1 *Fire hazard testing* *Glow wire test and guidance.*	HD 444.2.1 S1	83-03-04
695-2-2 *Needle flame test.*	HD 444.2.2 S1	83-03-04
817 *Spring-operated impact-test apparatus and its calibration.*	HD 495 S1	87-11-23
901 *Single-capped fluorescent lamps* *Safety and performance requirements.*	—	—

ZA 2

ISO Publications

ISO 196
Wrought copper and copper alloys — Detection of residual stress — Mercury (I) nitrate test.

ISO 1891
Bolts, screws, nuts and accessories.

ZA 3

CEE Publications

CEE 24
Specification for switches for appliances.

Annex ZB (normative)
Special national conditions

The following special national conditions exist in the countries mentioned; in general, they are due to the electricity supply system and the wiring rules. They apply to all Parts 2 unless otherwise specified.

Clause	Special national conditions	Justification
2.2	If in the CENELEC countries the wiring rules do not allow luminaires of Class 0, then luminaires shall not be classified according to the type of protection against electric shock provided, as class 0. NOTE In Germany, Greece, Ireland and the United Kingdom, wiring rules do not allow any luminaire to be Class 0. In France, luminaires of Class 0 are not allowed except for fixed installations intended for use in homes, provided the manufacturer's instructions draw attention to the necessary characteristics of the place of intended installations. These luminaires are exclusively those specified in the particular requirements of standards EN 60598-2-1 and EN 60598-2-2. In Sweden, luminaires of Class 0 are accepted in certain locations until 1991-01-01. After that date, no luminaires of Class 0 will be accepted. In Finland, luminaires of Class 0 are accepted until 1991-01-01. After that date, no luminaires of Class 0 will be accepted.	This statement is considered to be necessary.
3.3	In the United Kingdom: — power supply cords of Class I luminaires shall be provided with a label bearing the following words in legible characters: "IMPORTANT". The cores in this mains lead are coloured in accordance with the following code: — green and yellow : earth — blue : neutral — brown : live	This statement is considered to be useful.

Clause	Special national conditions	Justification
	— for Class I luminaires fitted with a power supply cord, the instruction sheet and the label required shall also include the substance of the following text: "As the colours of the cores in the mains lead of this luminaire may not correspond with the coloured markings identifying the terminals in your plug, proceed as follows: — the core which is coloured green and yellow must be connected to the terminal in the plug which is marked with the letter E or by the earth symbol ⏚, or coloured green or green and yellow, — the core which is coloured blue must be connected to the terminal which is marked with the letter N or coloured black, — the core which is coloured brown must be connected to the terminal which is marked with the letter L or coloured red." — for Class II luminaires fitted with a power supply cord, the instruction sheet shall give instructions for the correct connection of a plug, making it clear that neither core is to be connected to the earth terminal of a three-pin plug. — for Class I luminaires, the instruction sheet and, for portable Class I luminaires, also the label attached to the power supply cord, shall quote the following warning: WARNING — THIS LUMINAIRE MUST BE EARTHED.	
	In Denmark: — supply cords of Class I luminaires, which are delivered without a plug, shall be provided with a visible tag with the following text: Vigtigt! Ledere med grønn/gul isolation maa kun tilsluttes en klemme mærket ⏚ eller ⏚ — if essential for the safety of the luminaire, the tag shall in addition be provided with a diagram, which shows the connection of the other conductors, or be provided with the following text: For tilslutning af de øvrige ledere, Se medfølgende vejledning.	This statement is considered to be useful.

Clause	Special national conditions	Justification
	— for Class I luminaires which, according to the exemption for Denmark in Sub-clause **5.2.1**, are delivered with a supply cord with a plug in accordance with Standard Sheet II, IV, VI, VII, 2 or 2a, shall either be provided with the above tag or the same information shall be given in an enclosed instruction. The text concerning conductors having green/yellow insulation shall be quoted word-for-word. NOTE: ϕ may be replaced by oe; æ may be replaced by ae.	
4.5.1	In Denmark: — socket-outlets for providing power to other appliances, shall ensure protection against electric shock during insertion of the plug, according to Section 107 of the Danish Heavy Current Regulations, for portable socket-outlets. NOTE This requirement implies that the socket-outlets shall be provided with a protecting rim. — socket-outlets shall be in compliance with Section 107 of the Danish Heavy Current Regulations, the Standard Sheets being applied as follows: — Class 0 ..... Standard Sheet I, 1 or 1a — Class I ..... Standard Sheet 3 or 3a	This statement is considered to be useful.

<table>
<tr><th>Clause</th><th>Special national conditions</th><th>Justification</th></tr>
<tr><td>5.2.1</td><td>
In Denmark:
— supply cords for portable single phase luminaires having a rated current not exceeding 10 A shall be provided with a plug according to the following table:
<table>
<tr><th colspan="2" rowspan="2">Class of luminaire</th><th colspan="3">Plug</th></tr>
<tr><th>Danish Heavy Current Regulations Section 107 Standard Sheet</th><th>CEE 7 Standard Sheet</th><th>CEE 17 Standard Sheet</th></tr>
<tr><td colspan="2">0</td><td>II, 2, 2a</td><td>II</td><td></td></tr>
<tr><td rowspan="2">I</td><td>protection against indirect contact required[a]</td><td>4, 4a</td><td>—</td><td>II</td></tr>
<tr><td>earthing connection not required</td><td>II, IV, VI, VII, 2, 2a, 4, 4a</td><td>II, IV, VI, VII</td><td>II</td></tr>
<tr><td colspan="2">II</td><td>II, 2, 2</td><td>II, XVI, XVII</td><td>II[b]</td></tr>
<tr><td colspan="5">[a] — Luminaires fitted with a socket-outlet for providing power to other appliances.
— Luminaires which are mainly used in locations where protection against indirect contact is required, see Section 10, of the Danish Heavy Current Regulations.
[b] — Earthing contact not connected.</td></tr>
</table>
— if other single phase luminaires having a rated current not exceeding 10 A are provided with a supply cord with a plug, this plug shall comply with the above requirements; with the exemption that if single phase fixed Class I luminaires intended for use in homes, and for which protection against indirect contact is required according to Section 10 of the Danish Heavy Current Regulations, are provided with a plug, this plug may until further notice, be in accordance with Standard Sheet II, IV, VI, VII, 2 or 2a provided that the cord close to the plug is marked as described in Sub-clause 3.3.
</td><td>This statement is considered to be useful.</td></tr>
</table>

Clause	Special national conditions	Justification
	In Finland and Sweden: — for luminaires provided with non-detachable flexible cables and cords and a plug, the plug shall comply with the requirements of CEE Publication 7, the Standard Sheets to be applied being as follows: — Class 0 luminaires Sheet II — Class I luminaires Sheet IV or VII — Class II luminaires Sheet XVI or XVII	This statement is considered to be useful.
5.2.2	In Finland, Norway or Sweden: PVC-insulated flexible cables and cords are not accepted on luminaires intended for use outdoors.	This statement is considered to be useful.

Annex ZC (normative)
National deviations

The following national deviations are designated A-deviations which means:

A-deviation: A national deviation due to regulations, the alteration of which is — at least for the time being — outside the competence of the CEN/CENELEC member.

Clause in EN 60598-1	National deviations due to legal requirements
3.3 [item 3) c)] and **4.7.5**	*Finland. Resolution No. 205/74, Sub-clause **24.2*** *Sweden. Wiring Regulations STEV-FS 1985:1, 21b* The highest permissible temperature of the insulation of cables or cords belonging to the fixed wiring shall not at any place exceed 70 °C, unless they are covered by heat-resistant sleeves, when a temperature not exceeding 90 °C is permissible. The temperature of the insulation of a flexible cable or cord shall not exceed 90 °C.
4.14.2	*Belgium. General Regulation of Electrical Installations (R.G.I.E.) — Section 242.04* The mass of the luminaire suspended by flexible cables or cords shall not exceed 2 kg.
12.4.2 [item c)] Table XI	*Denmark. Heavy Current Regulations* For fixed installation wiring the temperature shall not exceed 70 °C. If heat-resisting sleeves are supplied a temperature of 90 °C is allowed for the PVC insulation. For wiring insulation the temperature shall not exceed the values indicated in the specifications for cables and cords, however, for PVC insulated flexible cables and cords and internal wiring, a temperature of 90 °C is allowed. Cables and cords for which there are no standards or specifications are generally not accepted.
12.4.2	*Finland. Resolution No. 205/74, Sub-clause **24.2*** *Sweden. Building Regulations PFS 1980:1, 45:34* The temperature of mounting surfaces, lighted objects or the like of normally flammable material, including recesses for recessed luminaires (Publication 598-2-2, Sub-clause **2.12.2**, and Publication 598-2-19, Sub-clause **19.12.1.2**) and parts of the luminaire made of wood, paper, textile and the like must not exceed 85 °C.

Clause in EN 60598-1	National deviations due to legal requirements
	Norway. Regulations for Electrical Installations by the Norwegian Water Resources and Energy Administration
2.4	Luminaires for direct mounting on a supporting surface of non-combustible material only, are not accepted.
3.3 [item 3) c)]	The higest temperature allowed for insulation of cables and cords of the fixing wiring in buildings is 70 °C.
	Insulation of other cables and cords used in luminaires, shall not be exposed to higher temperatures than rated temperature for the insulation concerned.
5.2.2	The cord types H03VH-H and H03RT-F are not accepted as flexible cords for connection of portable luminaires. The smallest cross-sectional area is 0.75 mm^2.
12.4.2	The highest temperature allowed for insulation of cables and cords of the fixed wiring in buildings is 70 °C.
	Insulation of other cables and cords in luminaires, shall not be exposed to higher temperatures than rated temperature for the insulation concerned. The maximum temperature for PVC insulation covered by a heat-resisting sleeve is 70 °C.
	(Table X)
	The maximum temperature allowed on “Normally flammable surface” is 80 °C.
	(Table XI)
	Addition to the table:
	Maximum allowed temperature on wood, paper, textile and the like is 80 °C. All other materials given in the 2nd, 3rd and 4th clause, shall not be exposed to temperatures in excess of those which have been proved permissible for these materials.

National appendix NA (informative)
Deletions from IEC Publication 598-1 (1986) edition 2 as amended by Amendment No. 1 (1988), as a result of the common modifications

Foreword of IEC Publications 598-1 (1986) edition 2

1) The formal decisions or agreements of the IEC on technical matters, prepared by Technical Committees on which all the National Committees having a special interest therein are represented, express, as nearly as possible, an international consensus of opinion on the subjects dealt with.
2) They have the form of recommendations for international use and they are accepted by the National Committees in that sense.
3) In order to promote international unification, the IEC expresses the wish that all National Committees should adopt the text of the IEC recommendation for their national rules in so far as national conditions will permit. Any divergence between the IEC recommendation and the corresponding national rules should, as far as possible, be clearly indicated in the latter.

Preface of IEC Publication 598-1 (1986) edition 2

This standard has been prepared by Sub-Committee 34D: Luminaires, of IEC Technical Committee No. 34, Lamps and Related Equipment.

It forms the second edition of IEC Publication 598-1 and replaces the first edition, 1979, Amendment No. 1, 1982, and Amendment No. 2, 1984.

The text of this standard is based on the first edition including its amendments and the following documents:

Six Months' Rule	Report on Voting
34D(Central Office)89	34D(Central Office)98
34D(Central Office)94	34D(Central Office)104
34D(Central Office)96	34D(Central Office)105
34D(Central Office)101	34D(Central Office)107

Further information can be found in the relevant Reports on Voting indicated in the table above.

Preface of IEC Publication 598-1 (1986) Amendment No. 1 (1988)

This amendment has been prepared by Sub-Committee 34D: Luminaires, of IEC Technical Committee No. 34: Lamps and Related Equipment.

The text of this amendment is based upon the following documents:

Six Months' Rule	Report on Voting	Two Months' Procedure	Report on Voting
34D(CO)120	34D(CO)143		
34D(CO)121	34D(CO)137		
34D(CO)122	34D(CO)138		
34D(CO)123	34D(CO)139		
34D(CO)126	34D(CO)142		
34D(CO)127	34D(CO)145	34D(CO)146	34D(CO)147
34D(CO)144	34D(CO)148		

Full information on the voting for the approval of this amendment can be found in the Voting Reports indicated in the above table.

Section 3. Marking

3.2.12 *The following Note to the second paragraph has been deleted.*

NOTE In the Netherland, luminaires with non-detachable flexible cables or cords which are not fitted with a plug are not permitted.

Section 5. External and internal wiring

The following text has been replaced

5.2.2 Flexibles cables or cords used as a means of connection to the supply, when supplied by the luminaire manufacturer, shall be at least equal in their mechanical and electrical properties to those specified in IEC Publications 227: Polyvinyl Chloride Insulated Cables of Rated Voltages up to and including 450/750V, and 245: Rubber Insulated Cables of Rated Voltages up to and Including 450/750V, as indicated in Table V and shall be capable of withstanding, without deterioration, the highest temperature to which they may be exposed under normal conditions of use. Materials other than polyvinyl chloride and rubber are suitable if the above requirements are met, but in this instance the particular specifications of the Parts 2 of the above publications do not apply.

Table V — Non-detachable flexible cables or cords

	Rubber	PVC
Class 0 luminaires	245 IEC 51S	227 IEC 42
Ordinary Class I luminaires	245 IEC 51S	227 IEC 52
Ordinary Class II luminaires	245 IEC 53	227 IEC 52
Luminaires other than ordinary	245 IEC 53	227 IEC 53
Portable rough service luminaires	245 IEC 66	—

For supply voltages greater than 250 V or 440 V (as appropriate), higher voltage grade cables and cords than those given in Table V are necessary.

To provide adequate mechanical strength, the nominal cross-sectional area of the conductors shall be not less than:

0.75 mm^2 for ordinary luminaires

1.0 mm^2 for other luminaires

The following text has been replaced.

5.2.15 Non-detachable flexible cables and cords and connecting leads (tails) of low voltage transistorized fluorescent luminaires where supplied as the means of connection of the luminaire to the supply shall be colour coded red to indicate positive and black to indicate negative.

5.3.1 *The following Note to the second paragraph has been deleted.*

NOTE In the Netherlands internal wiring with a cross-sectional area less than 0.4 mm^2 is not permitted.

Section 10. Insulation resistance and electric strength

10.3.2 *The following figure has been replaced.*

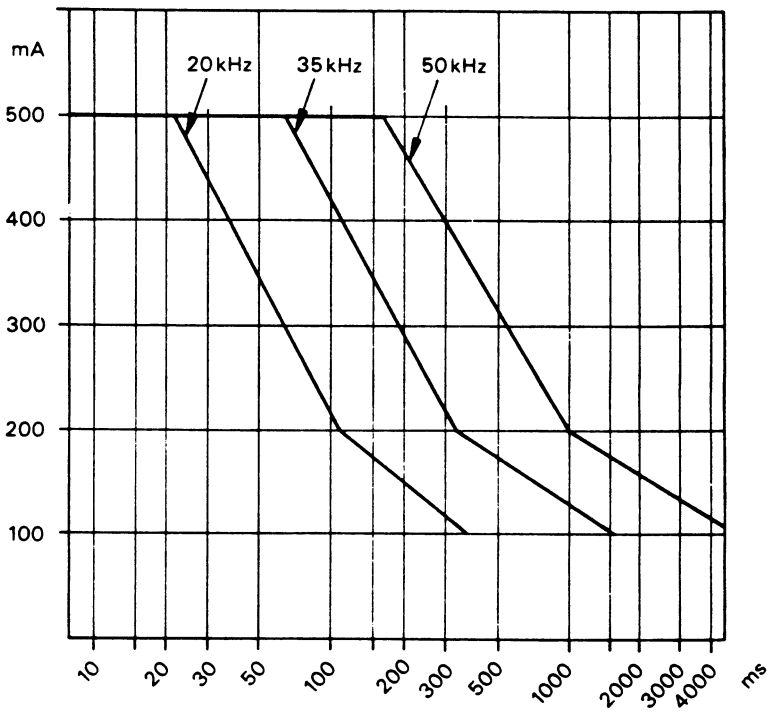


Figure 23 — Limits for capacitive leakage current of HF-operated tubular fluorescent lamps

National appendix NB (informative)

The British Standards corresponding to the International Standards referred to in EN 60598-1 are as follows:

International Standard	British Standards
IEC 61	BS 5101 *Specification for lamp caps and holders together with guages for the control of interchangeability and safety*.
IEC 61-1	Part 1:1975 *Lamp caps* (Identical)
IEC 61-2	Part 2:1975 *Lamp holders* (Identical)
IEC 61-3	Part 3:1975 *Gauges* (Identical)
IEC 82	BS 2818 *Ballasts for tubular fluorescent lamps* Part 1:1985 *Specification for ballasts for use internationally* (Identical)
IEC 155 (mod) EN 60155	BS 3722:1990 *Specification for starters for fluorescent lamps* (Identical)
IEC 238	BS 6776: 1990 *Specification for Edison screw lampholders*[a] (Identical)
IEC 249-1	BS 4584 *Metal-clad base materials for printed wiring boards* Part 1:1983 *Methods of test* (Identical)
IEC 320-1 (mod) EN 60320-1	BS 4491 *Appliance couplers for household and general purposes* Part 1:1989 *Specification of general requirements* (Identical)
IEC 357 (mod) EN 60357	BS 1075:1989 *Specification for tungsten halogen lamps (non vehicle)* (Identical)
IEC 417	BS 6217:1981 *Guide to graphical symbols for use on electrical equipment* (Identical)
IEC 458	BS 5717:1984 *Specification for transistorized ballasts for tubular fluorescent lamps* (Identical)
IEC 529	BS 5490:1977 *Specification for classification of degrees of protection provided by enclosures* (Identical)
IEC 570 (mod) EN 60598-2-6	BS 4533 *Luminaires*[a] Part 102 *Particular requirements* Section 102.6:1990 *Specification for luminaires with built-in transformers for filament lamps* (Identical)
IEC 634	BS 6012:1980 *Specification for heat test source (H.T.S) lamps for carrying out heating test on luminaires* (Technically equivalent)
IEC 662	BS 6193:1988 *Specification for high pressure sodium vapour lamps* (Identical)

[a] In preparation

International Standard	British Standards
	BS 6458 *Fire hazard testing for electrotechnical products* Part 2 *Methods of test*
IEC 695-2-1	Section 2.1:1984 *Glow-wire test* (Identical)
IEC 695-2-2	Section 2.2:1984 *Needle-flame test* (Identical)
IEC 817	BS 7003:1988 *Specification for spring-operated impact-test apparatus and its calibration* (Identical)
IEC 901	BS 6982:1988 *Specification for safety and performance of single-capped fluorescent lamps* (Identical)
ISO 1891	BS 6040:1981 *Nomenclature for bolts, screws, nuts and accessories* (Identical)
International Standard	**Related British Standards**
IEC 227 (mod)	BS 6004:1990 *Specification for PVC-insulated cables (non-armoured) for electric power and lighting* BS 6500:1990 *Specification for insulated flexible cords and cables*[a] BS 6746:1990 *Specification for PVC insulation and sheath of electric cables*[a]

[a] In preparation

National appendix NC (informative)
Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Electrical Illumination Standards Policy Committee (LGL/-) to Technical Committee LGL/3, upon which the following bodies were represented:

Association of County Councils
Association of Manufacturers Allied to the Electrical and Electronic Industry (BEAMA Ltd.)
British Lighting Association for the Preparation of Standards (Britlaps)
Chartered Institution of Building Services Engineers
Consumer Standards Advisory Committee of BSI
Decorative Lighting Association
Department of Trade and Industry (Consumer Safety Unit, CS Division)
Electrical Contractors Association
Electrical Installation Equipment Manufacturers Association (BEAMA Ltd.)
Electricity Supply Industry in England and Wales
Health and Safety Executive
Institution of Lighting Engineers
Lighting Industry Federation Ltd.
Society of Glass Technology

The following bodies were also represented in the drafting of the standard, through sub committees and panels:

Association of Consulting Scientists
Chief and Assistant Chief Fire Officers' Association
Department of Health and Social Security

BS 4533-101: 1990
EN 60598-1: 1989

BSI — British Standards Institution

BSI is the independent national body responsible for preparing British Standards. It presents the UK view on standards in Europe and at the international level. It is incorporated by Royal Charter.

Revisions

British Standards are updated by amendment or revision. Users of British Standards should make sure that they possess the latest amendments or editions.

It is the constant aim of BSI to improve the quality of our products and services. We would be grateful if anyone finding an inaccuracy or ambiguity while using this British Standard would inform the Secretary of the technical committee responsible, the identity of which can be found on the inside front cover. Tel: 020 8996 9000. Fax: 020 8996 7400.

BSI offers members an individual updating service called PLUS which ensures that subscribers automatically receive the latest editions of standards.

Buying standards

Orders for all BSI, international and foreign standards publications should be addressed to Customer Services. Tel: 020 8996 9001. Fax: 020 8996 7001.

In response to orders for international standards, it is BSI policy to supply the BSI implementation of those that have been published as British Standards, unless otherwise requested.

Information on standards

BSI provides a wide range of information on national, European and international standards through its Library and its Technical Help to Exporters Service. Various BSI electronic information services are also available which give details on all its products and services. Contact the Information Centre. Tel: 020 8996 7111. Fax: 020 8996 7048.

Subscribing members of BSI are kept up to date with standards developments and receive substantial discounts on the purchase price of standards. For details of these and other benefits contact Membership Administration. Tel: 020 8996 7002. Fax: 020 8996 7001.

Copyright

BSI
389 Chiswick High Road
London
W4 4AL