

Electrical apparatus for potentially explosive atmospheres —

Part 6: Increased safety “e”

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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, the EN title page, pages 2 to 42 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.

English version

Electrical apparatus for potentially explosive atmospheres Increased safety “e”

(Includes Amendments 1:1979 + 2:1982 + 3:1985 + 4:1989 + 5:1990)

Matériel électrique pour atmosphères
explosibles — Sécurité augmentée “e”
(Inclut les amendements 1:1979 +
2:1982 + 3:1985 + 4:1989 + 5:1990)

Elektrische Betriebsmittel für
explosionsgefährdete Bereiche —
Erhöhte Sicherheit “e”
(Einschließlich Änderungen 1:1979 +
2:1982 + 3:1985 + 4:1989 + 5:1990)

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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

IEC Publications referred to in European Standard EN 50019

IEC 61	<i>Lamp caps and holders together with gauges for the control of interchangeability and safety</i> Part 1: <i>Lamp caps</i> (HD 65.1)
IEC 61-1K:1983	<i>Tenth supplement</i> (to IEC 61-1:1969) Part 2: <i>Lampholders</i> (HD 65.2)
IEC 61-2G:1983	<i>Seventh supplement</i> (to IEC 61-2:1969)
IEC 64:1973 (4th edition)	<i>Tungsten filament lamps for general service</i> (HD 199.1 S2)
IEC 64A:1979	<i>First supplement</i> (to IEC 64:1961) <i>Lamps with a life of 2 500 hours</i> (HD 199.2 S2)
IEC 68-2-27:1987 (3rd edition)	<i>Basic environmental testing procedures</i> Part 2: <i>Tests</i> <i>Test Ea and guidance: Shock</i> (HD 323.2.27 S2)
IEC 79-4:1975 (2nd edition)	<i>Electrical apparatus for explosive gas atmospheres</i> Part 4: <i>Method of test for ignition temperature</i>
IEC 85:1984 (2nd edition)	<i>Thermal evaluation and classification of electrical insulation</i>
IEC 112:1979 (3rd edition)	<i>Method for determining the comparative and the proof tracking indices of solid insulating materials under moist conditions</i> (HD 214 S2)
IEC 182-2:1964 (1st edition)	<i>Basic dimensions of winding wires</i> Part 2: <i>Maximum overall diameters of enamelled round winding wires</i> (HD 42.2 S2 ^a)
IEC 182-2A:1972	<i>First supplement</i> [to IEC 182-2:1964] (HD 42.2 S2 ^a)
IEC 251-1:1978 (2nd edition)	<i>Methods of test for winding wires</i> Part 1: <i>Enamelled round wires</i>
IEC 364-3:1977 (1st edition)	<i>Electrical installations of buildings</i> Part 3: <i>Assessment of general characteristics</i> [amended in accordance with Amendment No. 1:1980] (HD 384.3 ^b)
IEC 432:1973 (1st edition)	<i>General requirements for tungsten filament lamps for domestic and similar general lighting purposes</i> (HD 217)
IEC 529:1976 (1st edition)	<i>Classification of degrees of protection provided by enclosures</i> [amended in accordance with Amendment No. 1:1978] (HD 365 S2 ^c)
IEC 755:1983 (1st edition)	<i>General requirements for residual current operated protective devices</i>

European Standards referred to in European Standard EN 50019

EN 50014:1977 (1st edition)	<i>Electrical apparatus for potentially explosive atmospheres — General requirements</i> [including Amendment 1 (July 1979), Amendment 2 June 1982), Amendment 3 (December 1982) and Amendment 4 (December 1982)]
EN 50018 (1977) (1st edition)	<i>Electrical apparatus for potentially explosive atmospheres — Flameproof enclosure “d”</i> [including Amendment 1 (July 1979) and Amendment 2 (December 1982)]
EN 60034-5 (1986) (1st edition)	<i>Rotating electrical machines</i> Part 5 <i>Classification of degrees of protection provided by enclosures for rotating machines</i> (IEC 34-5 (1981) + CENELEC common modifications)
EN 60 238 (1984) (1st edition)	<i>Edison screw lampholders</i> (IEC 238 (1982), 3rd edition)

This European Standard has been prepared by the CENELEC Technical Subcommittee 31.4.

^a This HD refers to both the standard and the supplement.

^b This HD refers to Amendment No. 1 and Supplements 64-3A (1979) and 364-3B (1980) and includes common modifications.

^c This HD refers also to Amendment No. 1.

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Section I. General

1 Scope

1.1 This European Standard contains the specific requirements for the construction and testing of increased safety electrical apparatus, type of protection “e”, intended for use in potentially explosive atmospheres.

1.2 This European Standard supplements European Standard EN 50014 “*General requirements*”, the requirements of which apply to increased safety electrical apparatus.

1.3 This European Standard applies to electrical apparatus and parts of electrical apparatus which do not produce sparks or arcs or dangerous temperatures in normal service and which have rated voltages not exceeding 11 kV.

NOTE Electrical apparatus which does not produce electric sparks or arcs in normal service attains the degree of safety required for electrical apparatus of type of protection increased safety “e” only by the application of the specific measures prescribed in this European Standard.

2 Definitions

The following definitions specific to type of protection increased safety “e” are applicable in this European Standard; they supplement the definitions which are given in European Standard EN 50014 “*General requirements*”.

2.1

increased safety “e”

a type of protection by which measures are applied so as to prevent with a higher degree of security the possibility of excessive temperatures and of the occurrence of arcs or sparks in the interior and on the external parts of electrical apparatus which does not produce them in normal service

2.2

limiting temperature

the highest permissible temperature of an electrical apparatus or a part of an electrical apparatus. It is the lower of the two following temperatures:

the maximum surface temperature in accordance with European Standard EN 50014 “*General requirements*”;

the temperature determined by the limit of the thermal stability of the materials used.

2.3

starting current I_A

the highest r.m.s. value of that current which flows in the primary of a stalled induction motor or in an alternating current magnet with the armature clamped in the position of maximum air gap, after the transient phenomena have ceased, when the electrical apparatus is supplied at rated voltage and rated frequency

2.4

starting current ratio I_A/I_N

the ratio between starting current I_A and rated current I_N

2.5

time t_E

the time taken for an a.c. winding, when carrying the starting current I_A , to be heated up from the temperature reached in rated service and at the maximum ambient temperature, to the limiting temperature

2.6

thermal current limit I_{th}

the r.m.s. value of the current by which the conductor is, within 1 s, heated up from the temperature reached in rated service and at the maximum ambient temperature, to the limiting temperature

2.7

dynamic current limit I_{dyn}

the peak value of that current, the dynamic effect of which the electrical apparatus can sustain without damage

2.8

creepage distance

the shortest distance between two conducting parts along the surface of the insulating parts

2.9

clearance

the shortest distance through the air between two bare conducting parts

2.10

accumulator

rechargeable, electro-chemical energy storage unit

NOTE A sketch illustrating various parts of a battery is given in Annex C (Supplementary information). This sketch is included for descriptive purposes only and is not intended to imply any requirement or preference for a particular form of construction.

2.10.1

cell

smallest electrical unit of a battery. It consists substantially of positive and negative plates and separators, of the items needed for assembling and connecting (plate lugs, group bars, terminal posts), of the cell container, and the electrolyte

2.10.2

battery

assembly of several cells connected to each other

2.10.3

battery container

enclosure to accommodate the battery. The cover is a part of the enclosure

2.10.4

capacity

the quantity of electricity in ampere-hours (Ah) which can be withdrawn from a battery under specified conditions

2.10.5

partition wall

integral part of a battery container dividing it into individual sections and increasing its mechanical strength

2.10.6

insulating barrier

insulating material between groups of cells subdividing the battery

2.10.7

intercell connector

electrical conductor between the poles of two cells

2.11

resistance heating device and resistance heating unit

2.11.1

resistance heating device

part of a resistance heating unit, comprising one or more heating resistors, typically made of metallic conductors or electrically conductive compound suitably insulated and protected

2.11.2**resistance heating unit**

assembly of one or more resistance heating devices, associated with any protective devices necessary to ensure that the limiting temperature is not exceeded

NOTE This standard does not require that protective devices outside the hazardous area have type of protection “e”.

2.11.3**workpiece**

object to which a resistance heating device or unit is applied

2.11.4**self-limiting characteristic**

characteristic of a resistance heating device, where the thermal output at its rated voltage decreases as the temperature of its surroundings increases until the device reaches a temperature at which its thermal output is reduced to an insignificant amount

NOTE The temperature of the surface of the device is then effectively the temperature of the environment.

2.11.5**stabilized design**

concept where the temperature of the resistance heating device or unit will, by design and use, stabilize below the limiting temperature, under the most unfavourable conditions, without the need for a protective system to limit the temperature

2.12**working voltage**

highest r.m.s. value of the a.c. or d.c. voltage which may occur (locally) across any installation at rated supply volts, transients being disregarded, in open circuit conditions or under normal operating conditions.

Section II. Specific constructional requirements**3 Requirements for the construction of all electrical apparatus**

3.1 Terminals for external connections. Terminals for external connections shall be generously dimensioned to permit the effective connection of conductors of cross section at least that corresponding to the rated current of the electrical apparatus.

NOTE Service conditions may make the provision of larger terminals necessary.

These terminals shall

- be fixed in their mountings without possibility of self-loosening;
- and be constructed in such a way that the conductors cannot slip out from their intended location;
- and be such that proper contact is assured without deterioration of the conductors, even if multi-stranded cores are used in terminals which are intended for direct clamping of the cores.

In particular the following are not allowed:

- terminals with sharp edges which could damage the conductors;
- terminals which may turn, be twisted or permanently deformed during normal tightening.

The terminals shall be such that the contact they assure is not appreciably impaired by temperature changes in normal service. It is particularly forbidden to use insulating material to transmit the contact pressure.

Terminals which are intended for clamping stranded cores shall include a resilient intermediate part. Terminals for conductors of cross sections up to 4 mm² shall also be suitable for the effective connection of conductors having a smaller cross section.

NOTE 1 Special precautions may be necessary against vibration or mechanical shocks.

NOTE 2 Special precautions against electrolytic corrosion are required if aluminium is used.

3.2 Internal connections. In the interior of electrical apparatus, connections shall not be subject to undue mechanical stress. The following means of connection of conductors are permitted:

- a screwed or bolted connection which is locked against loosening;
- a crimped connection;

soldering, provided that the conductors to be connected are additionally mechanically supported;
 brazing;
 welding.

NOTE Special precautions against electrolytic corrosion are required if aluminium is used.

3.3 Clearances. Clearances between conductive parts at different potentials shall be as given in Table 1. Clearances shall be calculated as a function of the highest working voltage specified by the manufacturer.

Table 1 — Clearances

Rated voltage for the insulation V	Minimum Clearance mm
60	3
250	5
380	6
500	8
660	10
1 000	14
3 000	36
6 000	60
10 000	100
The rated voltage of the apparatus may exceed the values stated in the table by 10 %.	

3.4 Creepage distances. The required lengths of creepage paths are dependent on the rated voltage for the insulation, on the tracking resistance of the insulating material and on the shape of the surface of the insulating parts.

The grading of materials by tracking index (in accordance with IEC 112) is given in Table 2. The grading given in this table applies to insulating parts without ribs or notches. Where the insulating parts are provided with ribs or notches in accordance with 3.4.3, the minimum permissible creepage distances are to be based on those for insulating materials of the next higher grade, e.g. Grade b instead of Grade c.

NOTE Ceramic materials need not be subjected to the above tests and are, conventionally, classified in Grade a.

Table 2 — Tracking resistance of insulating materials

Grade	Comparative tracking index	Test voltage V	Number of drops
a	—	600	More than 100
b	500	500	More than 50
c	375	375	More than 50
d	175	175	More than 50

3.4.1 Creepage distances between conductive parts at different potentials shall be as given in Table 3.

3.4.2 The requirements given in the second paragraph of 3.3 are also valid for creepage distances.

3.4.3 Notches in the surface of insulating parts may be taken into consideration for calculating the creepage distance only if the notches are at least 3 mm deep and 3 mm broad.

Ribs on the surface of insulating parts may be taken into consideration for calculating the creepage distances only if the ribs are at least 3 mm high and their breadth is appropriate to the mechanical strength of the material, the minimum being 1 mm.

3.4.4 Figure 1 to Figure 5 shall be considered for the calculation of the creepage distances. Figure 5 is valid only when the gaps between the insulating parts are filled with a suitable bonding agent so that the creepage distance runs exclusively over the exterior surface.

Dimensions in millimetres

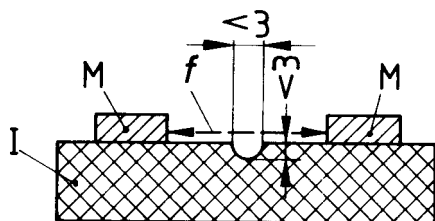


Figure 1a

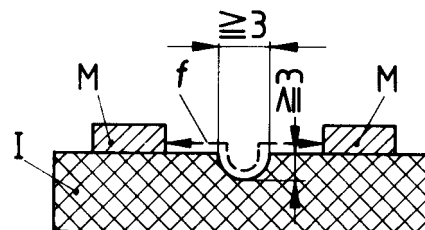


Figure 1b

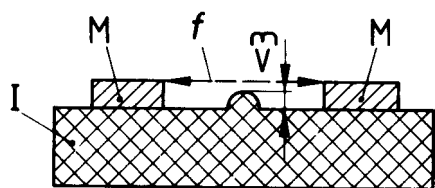


Figure 2a

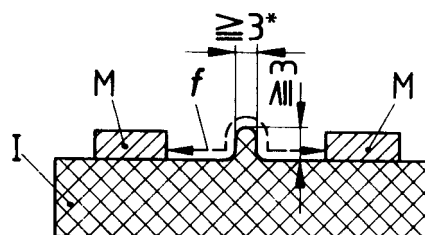


Figure 2b

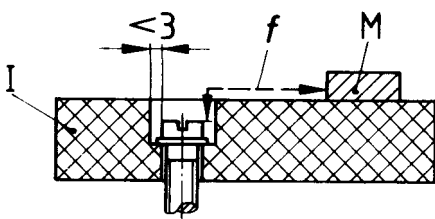


Figure 3a

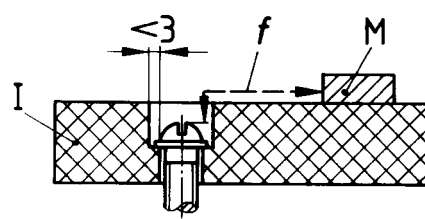


Figure 3b

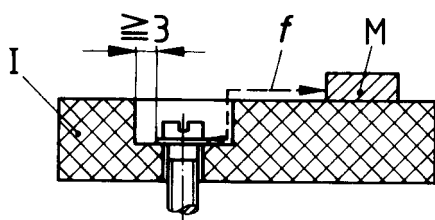


Figure 3c

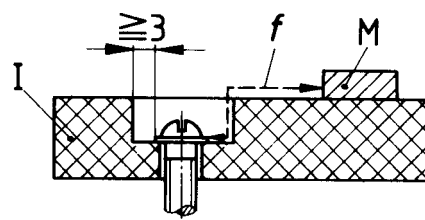


Figure 3d

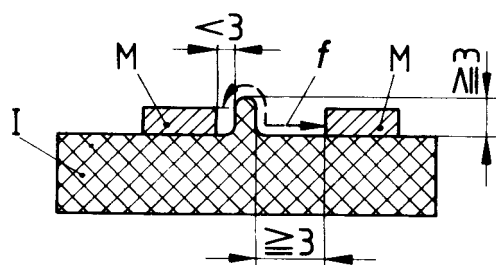


Figure 4

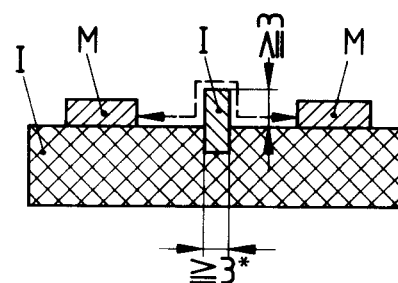


Figure 5

 f = creepage distance

M = metal

I = insulation material

* or ≥ 1 mm if the requirement of the second paragraph of 3.4.3 are satisfied.

Figure 1 — Determination of creepage distances

Table 3 — Creepage distances

Rated voltage for the insulation V	Minimum creepage distance mm			
	Grade			
	a	b	c	d
30	3	3	3	3
60	3	4	5	6
250	6	8	10	12
380	8	10	12	15
500	10	12	15	18
660	12	16	20	25
1 000	20	25	30	36
3 000	45	60	75	90
6 000	85	110	135	160
10 000	125	150	180	240

The rated voltage of the apparatus may exceed the values stated in the table by 10 %.

3.5 Solid insulating materials

3.5.1 The mechanical characteristics of solid insulating materials shall be satisfactory either:

- a) at a temperature up to at least 20 K above the maximum temperature attained in rated service and at least 80 °C, or
- b) for insulated windings (see 3.7.3 and Table 5), for internal wiring (see 3.8) and for cables permanently connected to electrical apparatus (see 14.1 of European Standard EN 50014 “General requirements”) up to the maximum temperature attained in rated service.

3.5.2 Insulating parts made of plastics or of laminated material shall be covered with insulating varnish having at least the same grade of tracking resistance if the moulded skin or the surface is damaged or removed during manufacture. This requirement does not apply to materials whose tracking resistance is unaffected by these actions or when undamaged parts provide the prescribed creepage distances.

3.6 Windings

3.6.1 The conductors shall be covered with at least two layers of insulation except when complying with 3.6.2.

3.6.2 Enamelled wires require no additional coating if

- a) either they comply with Grade 1 of IEC 182-2 such that when tested in accordance with clause 13 of IEC 251-1, no breakdown occurs at the a.c. test voltage given in Table 4 below, and when tested in accordance with clause 14 of IEC 251-1, independent of the diameter, not more than six faults occur for each specimen length of 30 m;
- b) or they comply with Grade 2 of IEC 182-2 or with Grade 3 of IEC 182-2A.

3.6.3 Windings shall be dried after having been fastened or wrapped and shall subsequently be impregnated with a suitable impregnating substance by dipping, trickling or vacuum impregnation. Coating by painting or spraying is not recognized as impregnation.

The impregnation shall be carried out in compliance with the special instructions of the manufacturer of the relevant type of impregnating substance and in such a way that the spaces between the conductors are filled as completely as possible and that good cohesion between the conductors is achieved.

This does not apply to fully insulated coils and conductors of high voltage windings if, prior to their fitting into the electrical apparatus, the slot portions and end windings of these coils and conductors have been impregnated, provided with filling material or otherwise insulated in an equivalent way, and if, after embedding, they are no longer accessible for the stated insulating procedures.

If impregnating substances containing solvents are used, the impregnation and drying processes shall be carried out at least twice.

3.6.4 The nominal diameter of wires used for windings shall be at least 0.25 mm, except for the sensors of resistance thermometers embedded in the slots of electrical machines and impregnated or sealed together with the windings.

NOTE Other methods of protection have to be used for windings made with wires having a nominal diameter smaller than 0.25 mm, e.g. the type of protection “intrinsic safety”, or encapsulation.

Table 4 — A.C. test voltage

Nominal wire diameter d mm	A.C. test voltage (r.m.s.) V
$0.250 \leq d < 0.315$	2 200
$0.315 \leq d < 0.400$	2 400
$0.40 \leq d < 0.50$	2 800
$0.50 \leq d < 0.71$	3 100
$0.71 \leq d < 0.85$	3 500
$0.85 \leq d < 0.95$	3 700
$0.95 \leq d < 1.12$	3 800
$1.12 \leq d < 1.32$	3 900
$1.32 \leq d < 1.60$	4 000
$1.60 \leq d < 1.9$	4 300
$1.9 \leq d < 2.5$	4 400

3.7 Limiting temperature

3.7.1 In order to prevent ignition of an explosive atmosphere, no part of electrical apparatus shall attain a higher temperature than that prescribed in clause 4 of European Standard EN 50014 “*General requirements*”. This applies to starting, normal duty, and with recognized overload, if any, e.g. at the end of time t_E .

The above requirement applies also to bare conductors, e.g. cage rotors of motors (for exceptions see **3.7.2** and **4.1.4**).

For the limiting temperature for lamps in luminaires, see **4.3.4**, **4.3.5** and **4.3.6**.

3.7.2 The permissible temperature of conductors and other metal parts is furthermore limited by

- a) reduction of their mechanical strength;
- b) unacceptable mechanical stress due to thermal expansion;
- c) damage to neighbouring insulating parts.

In determining the temperature of conductors, both the self-heating of the conductors and the heating effect from neighbouring parts shall be taken into account.

3.7.3 The limiting temperature of insulated windings shall not exceed the values given in Table 5, which take account of the thermal endurance of insulating materials, provided that the electrical apparatus still complies with the requirements of **3.7.1**.

3.7.4 Windings shall be protected by suitable devices to ensure that the limiting temperature (see **3.7.1** to **3.7.3**) cannot be exceeded in service. Such devices are not required if the temperature of the windings does not exceed the limiting temperature given for rated service in **3.7.3**, even when the windings are subjected to continuous overload (e.g. locked rotor of a motor) or if the windings cannot be subjected to overload (e.g. ballasts for fluorescent lamps).

NOTE The protective device may be inside and/or outside the electrical apparatus.

3.8 Internal wiring. Wiring which might come in contact with a metallic part shall be either mechanically protected or fixed to avoid any damage.

3.9 Degrees of protection for enclosures. Enclosures containing live bare parts shall provide at least degree of protection IP 54 and enclosures containing insulated parts only shall provide at least degree of protection IP 44, these degrees of protection being defined in IEC 529 and European Standard EN 60034-5 “*Classification of degrees of protection provided by enclosures for rotating machines*”.

NOTE Relaxations in these requirements are permitted in accordance with clause 4.