IS/IEC 60079-0 (2007): Electrical apparatus for explosive gas atmospheres, Part 0: General Requirements [ETD 22: Electrical Apparatus for Explosive Atmosphere]

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विस्फोटी पर्यावरण

भाग 0 उपस्कर — सामान्य अपेक्षाएँ

(पहला पुनरीक्षण)

Indian Standard

EXPLOSIVE ATMOSPHERES

PART 0 EQUIPMENT — GENERAL REQUIREMENTS

(First Revision)

ICS 29.260.20

BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

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Electrical Apparatus for Explosive Atmospheres Sectional Committee, ETD 22

NATIONAL FOREWORD

This Indian Standard (Part 0) (First Revision) which is identical with IEC 60079-0 : 2007 'Explosive atmospheres — Part 0 : Equipment — General requirements' issued by the International Electrotechnical Commission (IEC) was adopted by the Bureau of Indian Standards on the recommendation of the Electrical Apparatus for Explosive Atmospheres Sectional Committee and approval of the Electrotechnical Division Council.

This standard was first issued in 2007 and was identical to IEC 60079-0 : 2004 (Edition 4.0). This first revision has been undertaken to align it with IEC 60079-0 : 2007 (Edition 5.0).

The significant changes with respect to IS/IEC 60079-0 : 2004 are listed below:

a) Requirements for explosive dust atmospheres transferred from IEC 61241-0.
b) The marking Group "II" alone has been replaced by "IIA", "IIB", or "IIC" as many of the enclosure requirements are now aligned with a specific sub-group.
c) Dust groups defined as Group IIIA, IIIB and IIIC.
d) Limits for ultrasonic and electromagnetic radiation introduced.
e) Remainder of "electrostatic" requirements transferred from IEC 60079-26.
f) Equipment protection levels (EPL) introduced.
g) Transition of term from "apparatus" to "equipment" (where appropriate).

The text of IEC Standard has been approved as suitable for publication as an Indian Standard without deviations. Certain conventions are, however, not identical to those used in Indian Standards. Attention is particularly drawn to the following:

a) Wherever the words 'International Standard' appear referring to this standard, they should be read as 'Indian Standard'.
b) Comma (,) has been used as a decimal marker while in Indian Standards, the current practice is to use a point (.) as the decimal marker.

In this adopted standard, reference appears to certain International Standards for which Indian Standards also exist. The corresponding Indian Standards, which are to be substituted in their respective places are listed below along with their degree of equivalence for the editions indicated:

International Standard	*Corresponding Indian Standard*	*Degree of Equivalence*
IEC 60034-1 Rotating electrical machines — Part 1: Rating and performance	IS/IEC 60034 (Part 1) : 2004 Rotating electrical machines: Part 1 Rating and performance	Identical to IEC 60034-1 : 2004
IEC 60034-5 Rotating electrical machines — Part 5: Classification of degrees of protection provided by the enclosures of rotating electrical machines (IP Code)	IS/IEC 60034 (Part 5) : 2000 Rotating electrical machines: Part 5 Degrees of protection provided by the integral design of rotating electrical machines (IP Code) — Classification	Identical to IEC 60034-5 : 2000
IEC 60050(426) International Electrotechnical Vocabulary (IEV) — Chapter 426: Electrical apparatus for explosive atmospheres	IS 1885 (Part 60) : 1993 Electro-technical vocabulary: Part 60 Electrical apparatus for explosive atmospheres (*first revision*)	Identical to IEC 60050 (426) : 1990

International Standard	*Corresponding Indian Standard*	*Degree of Equivalence*
IEC 60079-1 Explosive atmospheres — Part 1: Equipment protection by flameproof enclosures "d"	IS/IEC 60079 (Part 1) : 2007 Explosive atmospheres: Part 1 Equipment protection by flameproof enclosures "d"	Identical to IEC 60079-1 : 2007
IEC 60079-2 Explosive atmospheres — Part 2: Equipment protection by pressurized enclosures "p"	IS/IEC 60079 (Part 2) : 2007 Explosive atmospheres: Part 2 Equipment protection by pressurized enclosures "p"	Identical to IEC 60079-2 : 2007
IEC 60079-4 Electrical apparatus for explosive gas atmospheres — Part 4: Method of test for ignition temperature	IS 7820 : 2004 Electrical apparatus for explosive gas atmospheres — Method of test for ignition temperatures (*first revision*)	Identical to IEC 60079-4 : 1975
IEC 60079-5 Explosive atmospheres — Part 5: Equipment protection by powder filling "q"	IS/IEC 60079 (Part 5) : 2007 Explosive atmospheres: Part 5 Equipment protection by powder filling "q"	Identical to IEC 60079-5 : 2007
IEC 60079-6 Explosive atmospheres — Part 6: Equipment protection by oil-immersion "o"	IS/IEC 60079 (Part 6) : 2007 Explosive atmospheres: Part 6 Equipment protection by oil-immersion "o" (*first revision*)	Identical to IEC 60079-6 : 2007
IEC 60079-7 Explosive atmospheres — Part 7 : Equipment protection by increased safety "e"	IS/IEC 60079 (Part 7) : 2007 Explosive atmospheres: Part 7 Equipment protection by increased safety "e"	Identical to IEC 60079-7 : 2007
IEC 60079-11 Explosive atmospheres — Part 11: Equipment protection by intrinsic safety 'i'	IS/IEC 60079 (Part 11) : 2006 Explosive atmospheres: Part 11 Equipment protection by intrinsic safety "i"	Identical to IEC 60079-11 : 2006
IEC 60079-15 Electrical apparatus for explosive gas atmospheres — Part 15: Construction, test and marking of type of protection "n" electrical apparatus	IS/IEC 60079 (Part 15) : 2005 Electrical apparatus for explosive gas atmospheres: Part 15 Construction, test and marking of type of protection "n" electrical apparatus	Identical to IEC 60079-15 : 2005
IEC 60079-18 Electrical apparatus for explosive gas atmospheres — Part 18: Construction, test and marking of type of protection encapsulation "m" electrical apparatus	IS/IEC 60079 (Part 18) : 2004 Electrical apparatus for explosive gas atmospheres: Part 18 Construction, test and marking of type of protection encapsulation "m" electrical apparatus	Identical to IEC 60079-18 : 2004
IEC 60079-25 Electrical apparatus for explosive gas atmospheres — Part 25: Intrinsically safe systems	IS/IEC 60079 (Part 25) : 2003 Electrical apparatus for explosive gas atmospheres: Part 25 Intrinsically safe systems	Identical to IEC 60079-25 : 2003
IEC 60086-1 Primary batteries — Part 1: General	IS 6303 : 1984 General requirements and methods of tests for dry cells and batteries	Technically Equivalent
IEC 60095-1 Lead-acid starter batteries — Part 1: General requirements and methods of test	IS 7372 : 1995 Lead-acid storage batteries for motor vehicles (*first revision*) IS 7624 : 1990 Lead-acid starter batteries for diesel locomotives and rail cars (*first revision*)	do

International Standard	*Corresponding Indian Standard*	*Degree of Equivalence*
IEC 60216-1 Electrical insulating materials — Properties of thermal endurance — Part 1: Ageing procedures and evaluation of test results	IS 8504 (Part 1) : 1994 Guide for determination of thermal endurance properties of electrical insulating materials: Part 1 General guidelines for ageing procedures and evaluation of test results (*first revision*)	Technically Equivalent
IEC 60216-2 Electrical insulating materials — Thermal endurance properties — Part 2: Determination of thermal endurance properties of electrical insulating materials — Choice of test criteria	IS 8504 (Part 2) : 1983 Guide for determination of thermal endurance properties of electrical insulating materials: Part 2 List of materials and available tests	do
IEC 60243-1 Electrical strength of insulating materials — Test methods — Part 1: Tests at power frequencies	IS 2584 : 1963 Method of test for electric strength of solid insulating materials at power frequencies	do
IEC 60423 Conduits for electrical purposes — Outside diameters of conduits for electrical installations and threads for conduits and fittings	IS 14763 : 2000 Conduits for electrical purposes — Outside diameters of conduits for electrical installations and threads for conduits and fittings — Specification	do
IEC 60529 Degrees of protection provided by enclosures (IP Code)	IS/IEC 60529 : 2001 Classification of degrees of protection provided by enclosures (IP Code)	Identical to IEC 60529 : 2001
IEC 60623 Secondary cells and batteries containing alkaline or other non-acid electrolytes — Vented nickel-cadmium prismatic rechargeable single cells	IS 10918 : 1984 Vented type nickel cadmium batteries	Technically Equivalent
IEC 60662 High pressure sodium vapour lamps	IS 9974 (Part 1) : 1981 High pressure sodium vapour lamps: Part 1 General requirements and tests IS 9974 (Part 2) : 1981 High pressure sodium vapour lamps: Part 2 Standard lamp data sheets	do
IEC 60664-1 Insulation coordination for equipment within low-voltage systems — Part 1: Principles, requirements and tests	IS 15382 (Part 1) : 2003 Insulation coordination for equipment within low-voltage systems: Part 1 Principles, requirements and tests	Identical to IEC 60664-1 : 2002
IEC 60947-1 Low-voltage switchgear and controlgear — Part 1: General rules	IS/IEC 60947 (Part 1) : 2004 Low-voltage switchgear and controlgear: Part 1 General rules	Identical to IEC 60947-1 : 2004
IEC 61241-1 Electrical apparatus for use in the presence of combustible dust — Part 1: Protection by enclosures “tD”	IS/IEC 61241 (Part 1) : 2004 Electrical apparatus for use in the presence of combustible dust: Part 1 Protection by enclosures “tD”	Identical to IEC 61241-1 : 2004
IEC 61241-4 Electrical apparatus for use in the presence of combustible dust — Part 4: Type of protection “pD”	IS/IEC 61241 (Part 4) : 2004 Electrical apparatus for use in the presence of combustible dust: Part 4 Type of protection “pD”	Identical to IEC 61241-4 : 2004
IEC 61241-11 Electrical apparatus for use in the presence of combustible dust — Part 11: Protection by intrinsic safety “iD”	IS/IEC 61241 (Part 11) : 2005 Electrical apparatus for use in the presence of combustible dust: Part 11 Protection by intrinsic safety “iD”	Identical to IEC 61241-11 : 2005

International Standard	*Corresponding Indian Standard*	*Degree of Equivalence*
ISO 48 Rubber, vulcanized or thermoplastic — Determination of hardness (hardness between 10 IRHD and 100 IRHD)	IS 3400 (Part 2) : 2003 Method of test for vulcanized rubber: Part 2 Rubber, vulcanized or thermoplastic — Determination of hardness (hardness between 10 IRHD and 100 IRHD) (*third revision*)	Identical to ISO 48 : 1994
ISO 178 Plastics — Determination of flexural properties	IS 13360 (Part 5/Sec 7) : 1996 Plastics — Methods of testing: Part 5 Mechanical properties, Section 7 Determination of flexural properties	Identical to ISO 178 : 1983
ISO 179 (All parts) Plastics — Determination of charpy impact properties	IS 13360 (Part 5/Sec 5) : 1996 Plastics — Methods of testing: Part 5 Mechanical properties, Section 5 Determination of charpy impact strength	Identical to ISO 179 : 1993
ISO 262 ISO general purpose metric screw threads — Selected sizes for screws, bolts and nuts	IS 4218 (Part 4) : 2001 ISO metric screw threads: Part 4 Selected sizes for screws, bolts and nuts (*second revision*)	Identical to ISO 262 : 1998
ISO 273 Fasteners — Clearance holes for bolts and screws	IS 1821 : 1987 Dimensions for clearance holes for bolts and screws (*third revision*)	Identical to ISO 273 : 1979
ISO 286-2 ISO system of limits and fits — Part 2: Tables of standard tolerance grades and limit deviations for holes and shafts	IS 919 (Part 2) : 1993 ISO system of limits and fits: Part 2 Tables of standard tolerance grades and limit deviations for holes and shafts	Identical to ISO 286-2 : 1988
ISO 527-2 Plastics — Determination of tensile properties — Part 2: Test conditions for moulding and extrusion plastics	IS 13360 (Part 5/Sec 2) : 1996 Plastics — Methods of testing: Part 5 Mechanical properties, Section 2 Determination of tensile properties — Test conditions for moulding and extrusion plastics	Identical to ISO 527-2 : 1993
ISO 965-1 ISO general-purpose metric screw threads — Tolerances — Part 1: Principles and basic data	IS 14962 (Part 1) : 2001 ISO general-purpose metric screw threads — Tolerances: Part 1 Principles and basic data	Identical to ISO 965-1 : 1998
ISO 965-3 ISO general-purpose metric screw threads — Tolerances — Part 3 : Deviations for constructional screw threads	IS 14962 (Part 3) : 2001 ISO general-purpose metric screw threads – Tolerances: Part 3 Deviations for constructional screw threads	Identical to ISO 965-3 : 1998
ISO 1817 Rubber, vulcanized — Determination of the effect of liquids	IS 3400 (Part 6) : 2005 Methods of test for vulcanized rubbers: Part 6 Resistance to liquids (*second revision*)	Identical to ISO 1817 : 1999
ISO 4014 Haxagon head bolts — Product grades A and B	IS 1364 (Part 1) : 2002 Haxagon head bolts, screws and nuts of product grades A and B: Part 1 Hexagon head bolts (size range M 1.6 to M 64) (*fourth revision*)	Identical to ISO 4014 : 1999
ISO 4017 Hexagon head screws — Product grades A and B	IS 1364 (Part 2) : 2002 Haxagon head bolts, screws and nuts of product grades A and B: Part 2 Hexagon head screws (size range M 1.6 to M 64) (*fourth revision*)	Identical to ISO 4017 : 1999

International Standard	*Corresponding Indian Standard*	*Degree of Equivalence*
ISO 4026 Hexagon socket set screws with flat point	IS 6094 (Part 1) : 2006 Hexagon socket set screws: Part 1 With flat point (*first revision*)	Identical to ISO 4026 : 2003
ISO 4027 Hexagon socket set screws with cone point	IS 6094 (Part 2) : 2006 Hexagon socket set screws: Part 2 With cone point (*first revision*)	Identical to ISO 4027 : 2003
ISO 4028 Hexagon socket set screws with dog point	IS 6094 (Part 3) : 2006 Hexagon socket set screws: Part 3 With dog point (*first revision*)	Identical to ISO 4028 : 2003
ISO 4029 Hexagon socket set screws with cup point	IS 6094 (Part 4) : 2006 Hexagon socket set screws: Part 4 With cup point (*first revision*)	Identical to ISO 4029 : 2003
ISO 4032 Hexagon nut style 1 — Product grades A and B	IS 1364 (Part 3) : 2002 Hexagon head bolts, screws and nuts of product grades A and B: Part 3 Hexagon nuts, style 1 (size range M 1.6 to 64) (*fourth revision*)	Identical to ISO 4032 : 1999
ISO 4762 Hexagon socket head cap screws	IS 2269 : 2006 Hexagon socket head cap screws (*fourth revision*)	Identical to ISO 4762 : 2004

The technical committee has reviewed the provisions of the following International Standards/Other Publications referred in this adopted standard and has decided that they are acceptable for use in conjunction with this standard.

International Standards/ Other Publications	*Title*
IEC 60079-26[1)]	Explosive atmospheres — Part 26: Equipment with equipment protection level (EPL) Ga
IEC 60079-28[1)]	Explosive atmospheres — Part 28: Protection of equipment and transmission systems using optical radiation
IEC 60079-30-1[1)]	Explosive atmospheres — Part 30-1: Electrical resistance trace heating – General and testing requirements
IEC 60079-31[1)]	Explosive atmospheres — Part 31: Equipment dust ignition protection by enclosures “tD”
IEC 60192	Low pressure sodium vapour lamps — Performance specifications
IEC 60622	Secondary cells and batteries containing alkaline or other non-acid electrolytes — Sealed nickel-cadmium prismatic rechargeable single cells
IEC 61056-1	General purpose lead-acid batteries (valve-regulated types) — Part 1: General requirements, functional characteristics – Methods of tests
IEC 61951-1	Secondary cells and batteries containing alkaline and other non-acid electrolytes — Portable sealed rechargeable single cells — Part 1: Nickel-cadmium
IEC 61951-2	Secondary cells and batteries containing alkaline and other non-acid electrolytes — Portable sealed rechargeable single cells — Part 2:Nickel-metal hydride

[1)] To be adopted as an Indian Standard.

International Standards/ Other Publications	*Title*
IEC 62013-1	Caplights for use in mines susceptible to firedamp — Part 1: General requirements — Construction and testing in relation to the risk of explosion
ISO 4892-1	Plastics — Methods of exposure to laboratory light sources — Part 1: General guidance
ANSI/UL 746B	Polymeric Materials — Long-term property evaluations

Only the English language text has been retained while adopting it in this Indian Standard and as such the page numbers given here are not the same as in the IEC Standard.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated expressing the result of a test, shall be rounded off in accordance with IS 2 : 1960 ‘Rules for rounding off numerical values (*revised*)’. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

EXPLOSIVE ATMOSPHERES

PART 0 EQUIPMENT — GENERAL REQUIREMENTS

(First Revision)

1 Scope

This part of IEC 60079 specifies the general requirements for construction, testing and marking of electrical equipment and Ex components intended for use in explosive atmospheres.

Unless modified by one of the standards supplementing this standard, electrical equipment complying with this standard is intended for use in hazardous areas in which explosive atmospheres exist under normal atmospheric conditions of

- temperature –20 °C to +60 °C;
- pressure 80 kPa (0,8 bar) to 110 kPa (1,1 bar); and
- air with normal oxygen content, typically 21 % v/v.

The application of electrical equipment in atmospheric conditions outside this range requires special consideration and may require additional assessment and testing.

NOTE 1 Although the normal atmospheric conditions above give a temperature range for the atmosphere of -20°C to +60°C, the normal ambient temperature range for the equipment is -20°C to +40°C, unless otherwise specified and marked. See 5.1.1.

NOTE 2 In designing equipment for operation in explosive atmospheres under conditions other than the atmospheric conditions given above, this standard may be used for guidance. However, additional testing related specifically to the intended conditions of use is recommended. This is particularly important when the types of protection 'flameproof enclosure "d"' (IEC 60079-1) and 'intrinsic safety "i"' (IEC 60079-11 or IEC 61241-11) are applied.

NOTE 3 Requirements given in this standard result from an ignition hazard assessment made on electrical equipment. The ignition sources taken into account are those found associated with this type of equipment, such as hot surfaces, mechanically generated sparks, thermite reactions, electrical arcing and static electric discharge in normal industrial environments.

NOTE 4 It is acknowledged that, with developments in technology, it may be possible to achieve the objectives of the IEC 60079 series of standards in respect of explosion prevention by methods that are not yet fully defined. Where a manufacturer wishes to take advantage of such developments, this International Standard, as well as other standards in the IEC 60079 series, may be applied in part. It is intended that the manufacturer prepare documentation that clearly defines how the IEC 60079 series of standards has been applied, together with a full explanation of the additional techniques employed. The designation "Ex s" has been reserved to indicate a type of protection that is not defined by the IEC 60079 series of standards, but may be referenced in national requirements.

NOTE 5 Where an explosive gas atmosphere and a combustible dust atmosphere are, or may be, present at the same time, the simultaneous presence of both should be considered and may require additional protective measures.

This standard does not specify requirements for safety, other than those directly related to the explosion risk. Ignition sources like adiabatic compression, shock waves, exothermic chemical reaction, self ignition of dust, naked flames and hot gases/liquids, are not addressed by this standard.

NOTE 6 Such equipment should be subjected to a hazard analysis that identifies and lists all of the potential sources of ignition by the electrical equipment and the measures to be applied to prevent them becoming effective.

This standard is supplemented or modified by the following standards concerning specific types of protection:

– IEC 60079-1: Gas – Flameproof enclosures "d";
– IEC 60079-2: Gas – Pressurized enclosures "p";
– IEC 60079-5: Gas – Powder filling "q";
– IEC 60079-6: Gas – Oil immersion "o";
– IEC 60079-7: Gas – Increased safety "e";
– IEC 60079-11: Gas – Intrinsic safety "i";
– IEC 60079-15: Gas – Type of protection “n”;
– IEC 60079-18: Gas and Dust – Encapsulation "m";
– IEC 61241-1: Dust – Protection by enclosures “tD”;
– IEC 61241-2 (IEC 61241-4): Dust – Pressurization “pD”;
– IEC 61241-11: Dust – Intrinsic safety “iD”.

NOTE 7 The former requirements of IEC 61241-18, Encapsulation “mD”, have been incorporated in IEC 60079-18.

This standard is supplemented or modified by the following equipment standards:

IEC 60079-25: Electrical apparatus for explosive gas atmospheres – Part 25: Intrinsically safe systems

IEC 60079-26: Explosive atmospheres – Part 26: Equipment with equipment protection level (EPL) Ga

IEC 60079-28: Explosive atmospheres – Part 28: Protection of equipment and transmission systems using optical radiation

IEC 62013-1: Caplights for use in mines susceptible to firedamp – Part 1: General requirements – Construction and testing in relation to the risk of explosion

IEC 60079-30-1: Explosive atmospheres – Part 30-1: Electrical resistance trace heating – General and testing requirements.

This standard with the additional standards mentioned above, are not applicable to the construction of

- electromedical apparatus,
- shot-firing exploders,
- test devices for exploders, and
- shot-firing circuits.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60034-1, *Rotating electrical machines – Part 1: Rating and performance*

IEC 60034-5*, Rotating electrical machines – Part 5: Classification of degrees of protection provided by the enclosures of rotating electrical machines (IP Code)*

IEC 60050(426), *International Electrotechnical Vocabulary (IEV) – Chapter 426: Electrical apparatus for explosive atmospheres*

IEC 60079-1*, Explosive atmospheres – Part 1: Equipment protection by flameproof enclosures "d"*

IEC 60079-2*, Explosive atmospheres – Part 2: Equipment protection by pressurized enclosures "p"*

IEC 60079-4*, Electrical apparatus for explosive gas atmospheres – Part 4: Method of test for ignition temperature*

IEC 60079-5*, Explosive atmospheres – Part 5: Equipment protection by powder filling "q"*

IEC 60079-6, *Explosive atmospheres – Part 6: Equipment protection by oil-immersion "o"*

IEC 60079-7, *Explosive atmospheres – Part 7: Equipment protection by increased safety "e"*

IEC 60079-11, *Explosive atmospheres – Part 11: Equipment protection by intrinsic safety "i"*

IEC 60079-15, *Electrical apparatus for explosive gas atmospheres – Part 15: Construction, test and marking of type of protection "n" electrical apparatus*

IEC 60079-18, *Electrical apparatus for explosive gas atmospheres – Part 18: Construction, test and marking of type of protection encapsulation "m" electrical apparatus*

IEC 60079-25: *Electrical apparatus for explosive gas atmospheres – Part 25: Intrinsically safe systems*

IEC 60079-26: *Explosive atmospheres – Part 26: Equipment with equipment protection level (EPL)Ga*

IEC 60079-28: *Explosive atmospheres – Part 28: Protection of equipment and transmission systems using optical radiation*

IEC 60079-30-1: *Explosive atmospheres – Part 30-1: Electrical resistance trace heating – General and testing requirements*

IEC 60079-31, *Explosive atmospheres – Part 31: Equipment dust ignition protection by enclosures "tD"*

IEC 60086-1, *Primary batteries – Part 1: General*

IEC 60095-1, *Lead-acid starter batteries – Part 1: General requirements and methods of test*

IEC 60192, *Low-pressure sodium vapour lamps – Performance specifications*

IEC 60216-1, *Electrical insulating materials – Properties of thermal endurance – Part 1: Ageing procedures and evaluation of test results*

IEC 60216-2, *Electrical insulating materials – Thermal endurance properties – Part 2: Determination of thermal endurance properties of electrical insulating materials – Choice of test criteria*

IEC 60243-1, *Electrical strength of insulating materials – Test methods – Part 1: Tests at power frequencies*

IEC 60423, *Conduits for electrical purposes – Outside diameters of conduits for electrical installations and threads for conduits and fittings*

IEC 60529, *Degrees of protection provided by enclosures (IP Code)*

IEC 60622, *Secondary cells and batteries containing alkaline or other non-acid electrolytes – Sealed nickel-cadmium prismatic rechargeable single cells*

IEC 60623, *Secondary cells and batteries containing alkaline or other non-acid electrolytes – Vented nickel-cadmium prismatic rechargeable single cells*

IEC 60662, *High-pressure sodium vapour lamps*

IEC 60664-1, *Insulation coordination for equipment within low-voltage systems – Part 1: Principles, requirements and tests*

IEC 60947-1, *Low-voltage switchgear and controlgear – Part 1: General rules*

IEC 61056-1, *General purpose lead-acid batteries (valve-regulated types) – Part 1: General requirements, functional characteristics – Methods of tests*

IEC 61241-1, *Electrical apparatus for use in the presence of combustible dust – Part 1: Protection by enclosures "tD"*

IEC 61241-4, *Electrical apparatus for use in the presence of combustible dust – Part 4: Type of protection "pD"*

IEC 61241-11, *Electrical apparatus for use in the presence of combustible dust – Part 11: Protection by intrinsic safety "iD"*

IEC 61951-1, *Secondary cells and batteries containing alkaline and other non-acid electrolytes – Portable sealed rechargeable single cells – Part 1: Nickel-cadmium*

IEC 61951-2, *Secondary cells and batteries containing alkaline and other non-acid electrolytes – Portable sealed rechargeable single cells – Part 2:Nickel-metal hydride*

IEC 62013-1, *Caplights for use in mines susceptible to firedamp – Part 1: General requirements – Construction and testing in relation to the risk of explosion*

ISO 48, *Rubber, vulcanized or thermoplastic – Determination of hardness (hardness between 10 IRHD and 100 IRHD)*

ISO 178, *Plastics – Determination of flexural properties*

ISO 179 (all parts), *Plastics – Determination of Charpy impact properties*

ISO 262, *ISO general-purpose metric screw threads – Selected sizes for screws, bolts and nuts*

ISO 273, *Fasteners – Clearance holes for bolts and screws*

ISO 286-2, *ISO system of limits and fits – Part 2: Tables of standard tolerance grades and limit deviations for holes and shafts*

ISO 527-2, *Plastics – Determination of tensile properties – Part 2: Test conditions for moulding and extrusion plastics*

ISO 965-1, *ISO general-purpose metric screw threads – Tolerances – Part 1: Principles and basic data*

ISO 965-3, *ISO general-purpose metric screw threads – Tolerances – Part 3: Deviations for constructional screw threads*

ISO 1817, *Rubber, vulcanized – Determination of the effect of liquids*

ISO 4014, *Hexagon head bolts – Product grades A and B*

ISO 4017, *Hexagon head screws – Product grades A and B*

ISO 4026, *Hexagon socket set screws with flat point*

ISO 4027, *Hexagon socket set screws with cone point*

ISO 4028, *Hexagon socket set screws with dog point*

ISO 4029, *Hexagon socket set screws with cup point*

ISO 4032, *Hexagon nuts, style 1 – Product grades A and B*

ISO 4762, *Hexagon socket head cap screws*

ISO 4892-1, *Plastics – Methods of exposure to laboratory light sources – Part 1: General guidance*

ANSI/UL 746B, *Polymeric Materials – Long-Term Property Evaluations*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

For the definitions of any other terms, particularly those of a more general nature, reference should be made to IEC 60050(426) or other appropriate parts of the IEV (International Electrotechnical Vocabulary).

3.1
ambient temperature
temperature of the air or other media, in the immediate vicinity of the equipment or component

NOTE This does not refer to the temperature of any process media, unless the equipment or component is totally immersed in the process media. See 5.1.1.

3.2
associated apparatus
electrical apparatus which contains both energy-limited and non-energy-limited circuits and is constructed so that the non-energy-limited circuits cannot adversely affect the energy-limited circuits

NOTE Associated apparatus may be either:

a) electrical apparatus which has an alternative type of protection included in this standard for use in the appropriate explosive atmosphere;

b) electrical apparatus not so protected and which therefore is not to be used within an explosive atmosphere, for example, a recorder which is not of itself in an explosive atmosphere but is connected to a thermocouple situated within an explosive atmosphere where only the recorder input circuit is energy limited.

3.3
cells and batteries

3.3.1
battery
assembly of two or more cells electrically connected to each other to increase the voltage or capacity

3.3.2
capacity
quantity of electricity or electric charge, which a fully charged battery can deliver under specified conditions

3.3.3
cell
assembly of electrodes and electrolyte which constitutes the smallest electrical unit of a battery

3.3.4
charging
act of forcing current through a secondary cell or battery in the opposite direction to the normal flow to restore the energy

3.3.5
deep discharge
event which reduces a cell voltage below that recommended by the cell or battery manufacturer

3.3.6
inherently safe (ihs) cell (or battery)
primary cell or battery in which the short-circuit current and maximum surface temperature are limited to a safe value by its internal resistance

3.3.7
maximum open-circuit voltage (of a cell or battery)
maximum attainable voltage under normal conditions, that is, from either a new primary cell, or a secondary cell just after a full charge

NOTE See Tables 10 and 11 which show the maximum open-circuit voltage for acceptable cells.

3.3.8
nominal voltage
(of a cell or battery) is that specified by the manufacturer

3.3.9
vented cell or battery
secondary cell, or battery, having a cover provided with an opening through which gaseous products may escape

3.3.10
primary cell or battery
electrochemical system capable of producing electrical energy by chemical reaction

3.3.11
reverse charging
act of forcing current through either a primary cell or secondary cell in the same direction as the normal flow, for example, in an expired battery

3.3.12
sealed gas-tight cell or battery
cell or battery which remains closed and does not release either gas or liquid when operated within the limits of charge or temperature specified by the manufacturer

NOTE 1 Such cells and batteries may be equipped with a safety device to prevent dangerously high internal pressure. The cell or battery does not require addition to the electrolyte and is designed to operate during its life in its original sealed state.

NOTE 2 The above definition is taken from IEC 60079-11. It differs from the definitions in IEV 486-01-20 and IEV 486-01-21 by virtue of the fact that it applies to either a cell or battery.

3.3.13
sealed valve-regulated cell or battery
cell or battery which is closed under normal conditions but which has an arrangement which allows the escape of gas if the internal pressure exceeds a pre-determined value. The cell cannot normally receive an addition to the electrolyte

3.3.14
secondary cell or battery
electrically rechargeable electrochemical system capable of storing electrical energy and delivering it by chemical reaction

3.3.15
container (battery)
enclosure to contain the battery

NOTE The cover is a part of the battery container.

3.4
bushing
insulating device carrying one or more conductors through an internal or external wall of an enclosure

3.5
cable gland
device permitting the introduction of one or more electric and/or fibre optics cables into an electrical equipment so as to maintain the relevant type of protection

3.5.1
clamping device
element of a cable gland for preventing tension or torsion in the cable from being transmitted to the connections

3.5.2
compression element
element of a cable gland acting on the sealing ring to enable the latter to fulfil its function

3.5.3
sealing ring
ring used in a cable gland or with a conduit entry to ensure the sealing between the entry and the cable or conduit

3.5.4
ex cable gland
cable gland tested separately from the equipment enclosure but certified as equipment and which can be fitted to the equipment enclosure during installation

3.6
certificate
document that assures the conformity of a product, process, system, person, or organization with specified requirements

NOTE The certificate may be either the supplier's declaration of conformity or the purchaser's recognition of conformity or certification (as a result of action by a third party) as defined in ISO/IEC 17000.

3.7
conduit entry
means of introducing a conduit into electrical equipment so as to maintain the relevant type of protection

3.8
connection facilities
terminals, screws or other parts, used for the electrical connection of conductors of external circuits

3.9
continuous operating temperature
COT
maximum temperature which ensures the stability and integrity of the material for the expected life of the equipment, or part, in its intended application

3.10
degree of protection of enclosure
IP
numerical classification according to IEC 60529 preceded by the symbol IP applied to the enclosure of electrical equipment to provide

– 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,
– protection of the electrical equipment against ingress of solid foreign objects, and
– where indicated by the classification, protection of the electrical equipment against harmful ingress of water

NOTE 1 The detailed test requirements for rotating electrical machines are in IEC 60034-5.

NOTE 2 The enclosure which provides the degree of protection IP is not necessarily identical to the equipment enclosure for the types of protection listed in the Foreword.

3.11
dust
generic term including both combustible dust and combustible flyings

3.11.1
combustible dust
finely divided solid particles, 500 μm or less in nominal size, which may be suspended in air, may settle out of the atmosphere under their own weight, may burn or glow in air, and may form explosive mixtures with air at atmospheric pressure and normal temperatures

NOTE 1 This includes dust and grit as defined in ISO 4225.

NOTE 2 The term solid particles is intended to address particles in the solid phase and not the gaseous or liquid phase, but does not preclude a hollow particle.

3.11.1.1

conductive dust
combustible dust with electrical resistivity equal to or less than 10^3 Ω·m

NOTE IEC 61241-2-2 contains the test method for determining the electrical resistivity of dusts.

3.11.1.2
non-conductive dust
combustible dust with electrical resistivity greater than 10^3 Ω·m

3.11.2
combustible flyings
solid particles, including fibres, greater than 500 µm in nominal size which may be suspended in air and could settle out of the atmosphere under their own weight

NOTE Examples of flyings include rayon, cotton (including cotton linters and cotton waste), sisal, jute, hemp, cocoa fibre, oakum, and baled waste kapok.

3.12
dust-tight enclosure
enclosure capable of excluding the ingress of observable dust particle deposits

3.13
dust-protected enclosure
enclosure in which the ingress of dust is not totally excluded, but is unlikely to enter in sufficient quantity to interfere with the safe operation of the equipment and does not accumulate in a position within the enclosure where it is liable to cause an ignition hazard

3.14
electrical equipment
items applied as a whole or in part for the utilization of electrical energy

NOTE These include, amongst others, items for the generation, transmission, distribution, storage, measurement, regulation, conversion and consumption of electrical energy and items for telecommunications.

3.15
electrical parameters – apparatus with energy limitation

3.15.1
maximum external capacitance
C_o
maximum capacitance that can be connected to the connection facilities of the apparatus without invalidating the type of protection

3.15.2
maximum external inductance
L_o
maximum value of inductance that can be connected to the connection facilities of the apparatus without invalidating the type of protection

3.15.3
maximum input current
I_i
maximum current (peak a.c. or d.c.) that can be applied to the connection facilities of apparatus without invalidating the type of protection

3.15.4
maximum input power
P_i
maximum power that can be applied to the connection facilities of apparatus without invalidating the type of protection

3.15.5
maximum input voltage
U_i
maximum voltage (peak a.c. or d.c.) that can be applied to the connection facilities of apparatus without invalidating the type of protection

3.15.6
maximum internal capacitance
C_i
maximum equivalent internal capacitance of the apparatus which is considered as appearing across the connection facilities

3.15.7
maximum internal inductance
L_i
maximum equivalent internal inductance of the apparatus which is considered as appearing at the connection facilities

3.15.8
maximum output current
I_o
maximum current (peak a.c. or d.c.) in apparatus that can be taken from the connection facilities of the apparatus

3.15.9
maximum output power
P_o
maximum electrical power that can be taken from the apparatus

3.15.10
maximum output voltage
U_o
maximum voltage (peak a.c. or d.c.) that can appear at the connection facilities of the apparatus at any applied voltage up to the maximum voltage

3.15.11
maximum r.m.s. a.c. or d.c. voltage
U_m
maximum voltage that can be applied to the non energy-limited connection facilities of associated apparatus without invalidating the type of protection

3.16
enclosure
all the walls, doors, covers, cable glands, rods, spindles, shafts, etc. which contribute to the type of protection and/or the degree of protection IP of the electrical equipment

3.17
equipment (for explosive atmospheres)
general term including apparatus, fittings, devices, components, and the like used as a part of, or in connection with, an electrical installation in an explosive atmosphere

3.18
equipment protection level
EPL
level of protection assigned to equipment based on its likelihood of becoming a source of ignition and distinguishing the differences between explosive gas atmospheres, explosive dust atmospheres, and the explosive atmospheres in mines susceptible to firedamp

NOTE The equipment protection level may optionally be employed as part of a complete risk assessment of an installation, see IEC 60079-14.

3.18.1
EPL Ma
equipment for installation in a mine susceptible to firedamp, having a "very high" level of protection, which has sufficient security that it is unlikely to become an ignition source in normal operation, during expected malfunctions or during rare malfunctions, even when left energized in the presence of an outbreak of gas

3.18.2
EPL Mb
equipment for installation in a mine susceptible to firedamp, having a "high" level of protection, which has sufficient security that it is unlikely to become a source of ignition in normal operation or during expected malfunctions in the time span between there being an outbreak of gas and the equipment being de-energized

3.18.3
EPL Ga
equipment for explosive gas atmospheres, having a "very high" level of protection, which is not a source of ignition in normal operation, during expected malfunctions or during rare malfunctions

3.18.4
EPL Gb
equipment for explosive gas atmospheres, having a "high" level of protection, which is not a source of ignition in normal operation or during expected malfunctions,

3.18.5
EPL Gc
equipment for explosive gas atmospheres, having a "enhanced" level of protection, which is not a source of ignition in normal operation and which may have some additional protection to ensure that it remains inactive as an ignition source in the case of regular expected occurrences (for example failure of a lamp)

3.18.6
EPL Da
equipment for explosive dust atmospheres, having a "very high" level of protection, which is not a source of ignition in normal operation, during expected malfunctions, or during rare malfunctions

3.18.7
EPL Db
equipment for explosive dust atmospheres, having a "high" level of protection, which is not a source of ignition in normal operation or during expected malfunctions

3.18.8
EPL Dc
equipment for explosive dust atmospheres, having a "enhanced" level of protection, which is not a source of ignition in normal operation and which may have some additional protection to ensure that it remains inactive as an ignition source in the case of regular expected occurrences (for example failure of a lamp)

3.19
Ex blanking element
threaded blanking element tested separately from the equipment enclosure but having an equipment certificate and which is intended to be fitted to the equipment enclosure without further consideration

NOTE 1 This does not preclude an Ex component certificate for blanking elements

NOTE 2 Non-threaded blanking elements are not equipment.

3.20
Ex component
part of electrical equipment or a module (other than an Ex cable gland), marked with the symbol "U", which is not intended to be used alone and requires additional consideration when incorporated into electrical equipment or systems for use in explosive atmospheres

3.21
Ex thread adapter
thread adapter tested separately from the enclosure but having an equipment certificate and which is intended to be fitted to the equipment enclosure without further consideration

NOTE This does not preclude an Ex component certificate for thread adapters.

3.22
explosive atmosphere
mixture with air, under atmospheric conditions, of flammable substances in the form of gas, vapour, dust, fibres, or flyings which, after ignition, permits self-sustaining propagation

3.23
explosive dust atmosphere
mixture with air, under atmospheric conditions, of flammable substances in the form of dust, or flyings which, after ignition, permits self-sustaining propagation

3.24
explosive gas atmosphere
mixture with air, under atmospheric conditions, of flammable substances in the form of gas or vapour, which, after ignition, permits self-sustaining flame propagation

3.25
explosive test mixture
specified explosive mixture used for the testing of electrical equipment for explosive gas atmospheres

3.26
ignition temperature of an explosive gas atmosphere
lowest temperature of a heated surface which, under specified conditions according to IEC 60079-4, will ignite a flammable substance in the form of a gas or vapour mixture with air

3.27
ignition temperature of a dust layer
lowest temperature of a hot surface at which ignition occurs in a dust layer of specified thickness on a hot surface

NOTE The ignition temperature of a dust layer may be determined by the test method given in IEC 61241-2-1.

3.28
ignition temperature of a dust cloud
lowest temperature of the hot inner wall of a furnace at which ignition occurs in a dust cloud in air contained therein

NOTE The ignition temperature of a dust cloud may be determined by the test method given in IEC 61241-2-1.

3.29
malfunction
equipment or components which do not perform their intended function with respect to explosion protection

NOTE For the purposes of this standard this can happen due to a variety of reasons, including:

– failure of one (or more) of the component parts of the equipment or components;

– external disturbances (e.g. shocks, vibration, electromagnetic fields);

– design error or deficiency (e.g. software errors);

– disturbance of the power supply or other services;

– loss of control by the operator (especially for handheld equipment).

3.29.1
expected malfunction
disturbances or equipment faults which normally occur in practice

3.29.2
rare malfunction
type of malfunction, which is known to happen, but only in rare instances. Two independent foreseeable malfunctions which, separately, would not create a source of ignition, but which, in combination, do create a source of ignition, are regarded as a single rare malfunction

3.30
maximum surface temperature
highest temperature which is attained in service under the most adverse conditions (but within the specified tolerances) by any part or surface of electrical equipment

NOTE 1 For electrical equipment in an explosive gas atmosphere, this temperature may occur on an internal component or on the external surface of the enclosure, depending upon the type of protection employed.

NOTE 2 For electrical equipment in an explosive dust atmosphere, this temperature occurs on the external surface of the enclosure and may include a defined dust layer condition.

3.31
normal operation
operation of equipment conforming electrically and mechanically with its design specification and used within the limits specified by the manufacturer

NOTE 1 The limits specified by the manufacturer may include persistent operational conditions, e.g. operation of a motor on a duty cycle.

NOTE 2 Variation of the supply voltage within stated limits and any other operational tolerance is part of normal operation.

3.32
radio frequencies

3.32.1
averaging time
time over which the threshold power is averaged

3.32.2
continuous transmission
transmission where the duration of the pulse is greater than the half of the thermal initiation time

3.32.3
pulsed transmission
transmission where the duration of the pulse is shorter than the half of the thermal initiation time, but the time between two consecutive pulses, however, is longer than three times the thermal initiation time

3.32.4
thermal initiation time
time during which energy deposited by the spark accumulates in a small volume of gas around it without significant thermal dissipation

NOTE For times shorter than the thermal initiation time the total energy deposited by the spark will determine whether or not ignition occurs. For increasingly longer times, the power or rate at which energy is deposited becomes the determining factor for ignition.

3.32.5
threshold energy
Z_{th}
for a pulsed radio-frequency discharge, the maximum energy of the single pulse which can be extracted from the receiving body

3.32.6
threshold power
P_{th}
product of the effective output power of the transmitter multiplied by the antenna gain

3.33
rated value
quantity value, assigned generally by the manufacturer, for a specified operating condition of a component, device or apparatus

3.34
rating
set of rated values and operating conditions

3.35
replaceable battery pack
assembly consisting of one or more interconnected cells, along with any integrated protective components, which form a complete replaceable battery

3.36
service temperature
temperature reached when the equipment is operating at rated conditions

NOTE Each equipment may reach different service temperatures in different parts.

3.37
symbol “U”
symbol used to denote an Ex component

NOTE The symbol “U” is used to identify that the equipment is incomplete and is not suitable for installation without further evaluation.

3.38
symbol “X”
symbol used to denote specific conditions of use

NOTE The symbol “X” is used to provide a means of identifying that essential information for the installation, use, and maintenance of the equipment is contained within the certificate.

3.39
termination compartment
separate compartment, or part of a main enclosure, communicating or not with the main enclosure, and containing connection facilities

3.40
test, routine
test to which each individual device is subjected during or after manufacture to ascertain whether it complies with certain criteria

3.41
test, type
test of one or more devices made to a certain design to show that the design meets certain specifications

3.42
type of protection
specific measures applied to electrical equipment to avoid ignition of a surrounding explosive atmosphere

3.43
working voltage
highest r.m.s. value of the a.c. or d.c. voltage across any particular insulation which can occur when the equipment is supplied at rated voltage

NOTE 1 Transients are disregarded.

NOTE 2 Both open-circuit conditions and normal operating conditions are taken into account.

4 Equipment grouping

Electrical equipment for explosive atmospheres is divided into the following groups:

4.1 Group I

Electrical equipment of Group I is intended for use in mines susceptible to firedamp.

NOTE The types of protection for Group I take into account the ignition of both firedamp and coal dust along with enhanced physical protection for equipment used underground.

Electrical equipment intended for mines where the atmosphere, in addition to firedamp, may contain significant proportions of other flammable gases (i.e. other than methane), shall be constructed and tested in accordance with the requirements relating to Group I and also to the subdivision of Group II corresponding to the other significant flammable gases. This electrical equipment shall then be marked appropriately (for example, "Ex d I/IIB T3" or "Ex d I/II (NH_3)").

4.2 Group II

Electrical equipment of Group II is intended for use in places with an explosive gas atmosphere other than mines susceptible to firedamp.

Electrical equipment of Group II is subdivided according to the nature of the explosive gas atmosphere for which it is intended.

Group II subdivisions

- IIA, a typical gas is propane
- IIB, a typical gas is ethylene
- IIC, a typical gas is hydrogen

NOTE 1 This subdivision is based on the maximum experimental safe gap (MESG) or the minimum ignition current ratio (MIC ratio) of the explosive gas atmosphere in which the equipment may be installed. (See IEC 60079-12 and IEC 60079-20).

NOTE 2 Equipment marked IIB is suitable for applications requiring Group IIA equipment. Similarly, equipment marked IIC is suitable for applications requiring Group IIA or Group IIB equipment.

4.3 Group III

Electrical equipment of Group III is intended for use in places with an explosive dust atmosphere other than mines susceptible to firedamp.

Electrical equipment of Group III is subdivided according to the nature of the explosive dust atmosphere for which it is intended.

Group III subdivisions:

- IIIA: combustible flyings
- IIIB: non-conductive dust
- IIIC: conductive dust

NOTE Equipment marked IIIB is suitable for applications requiring Group IIIA equipment. Similarly, equipment marked IIIC is suitable for applications requiring Group IIIA or Group IIIB equipment.

4.4 Equipment for a particular explosive atmosphere

The electrical equipment may be tested for a particular explosive atmosphere. In this case, the information shall be recorded on the certificate and the electrical equipment marked accordingly.

5 Temperatures

5.1 Environmental influences

5.1.1 Ambient temperature

Electrical equipment designed for use in a normal ambient temperature range of –20 °C to +40 °C does not require marking of the ambient temperature range. However, electrical equipment designed for use in other than this normal ambient temperature range is considered to be special. The marking shall then include either the symbol T_a or T_{amb} together with both the upper and lower ambient temperatures or, if this is impracticable, the symbol "X" shall be used to indicate specific conditions of use that include the upper and lower ambient temperatures. See item e) of 29.2 and Table 1.

NOTE The ambient temperature range may be a reduced range, e.g. $-5^{\circ}C \leq T_{amb} \leq 15^{\circ}C$.

Table 1 – Ambient temperatures in service and additional marking

Electrical equipment	Ambient temperature in service	Additional marking
Normal	Maximum: +40 °C Minimum: −20 °C	None
Special	Specified by the manufacturer	T_a or T_{amb} with the special range, for example, −30 °C ≤ T_a ≤ +40 °C or the symbol "X"

5.1.2 External source of heating or cooling

Where the electrical equipment is intended to be physically connected to a separate external source of heating or cooling, such as a heated or cooled process vessel or pipeline, the ratings of the external source shall be specified in the manufacturer's instructions.

NOTE 1 The way in which these ratings are expressed will vary according to the nature of the source. For sources generally larger than the equipment, the maximum or minimum temperature will usually be sufficient. For sources generally smaller than the equipment, or for heat conduction through thermal insulation, the rate of heat flow may be appropriate.

NOTE 2 The influence of radiated heat may need to be considered on the final installation. See IEC 60079-14.

5.2 Service temperature

Where this standard, or the standard for the specific type of protection, requires the service temperature to be determined at any place in the equipment, the temperature shall be determined for the rating of the electrical equipment when the equipment is subjected to maximum or minimum ambient temperature and, where relevant, the maximum rated external source of heating or cooling. Service temperature testing, when required, shall be in accordance with 26.5.1.

NOTE The rating of the electrical equipment includes the ambient temperature, characteristics of the electrical supply and load, duty cycle or duty type, as assigned by the manufacturer.

5.3 Maximum surface temperature

5.3.1 Determination of maximum surface temperature

Maximum surface temperature shall be determined according to 26.5.1 or the specific requirement of the standard for the type of protection, and when the equipment is subjected to maximum ambient temperature and, where relevant, the maximum rated external source of heating.

5.3.2 Limitation of maximum surface temperature

5.3.2.1 Group I electrical equipment

For electrical equipment of Group I, the maximum surface temperature shall be specified in relevant documentation according to Clause 24.

This maximum surface temperature shall not exceed

– 150 °C on any surface where coal dust can form a layer,

– 450 °C where coal dust is not likely to form a layer (i.e., inside of a dust-protected enclosure).

NOTE When choosing Group I electrical equipment, the user should take into account the influence and the smouldering temperature of coal dusts if they are likely to be deposited in a layer on surfaces with temperatures above 150 °C.

5.3.2.2 Group II electrical equipment

The maximum surface temperature determined (see 26.5.1) shall not exceed:

– the temperature class assigned (see Table 2), or

– the maximum surface temperature assigned, or

– if appropriate, the ignition temperature of the specific gas for which it is intended.

Table 2 – Classification of maximum surface temperatures for Group II electrical equipment

Temperature class	Maximum surface temperature °C
T1	450
T2	300
T3	200
T4	135
T5	100
T6	85

NOTE More than one temperature class may be established for different ambient temperatures and different external sources of heating and cooling.

5.3.2.3 Group III electrical equipment

5.3.2.3.1 Maximum surface temperature determined without a dust layer

The maximum surface temperature determined (see 26.5.1) shall not exceed:

– the maximum surface temperature assigned;

– the layer or cloud ignition temperature of the specific combustible dust for which it is intended.

5.3.2.3.2 Maximum surface temperature with respect to dust layers

In addition to the maximum surface temperature required in 5.3.2.3.1, the maximum surface temperature may also be determined for a given depth of layer, T_L, of dust surrounding all sides of the apparatus, unless otherwise specified in the documentation, and marked with the symbol “X” to indicate this specific condition of use in accordance with item d) of 29.4.

NOTE 1 A maximum depth of layer, T_L, may be specified by the manufacturer.

NOTE 2 Additional information on the application of equipment where dust layers up to 50 mm may accumulate on the equipment is given in IEC 61241-14.

5.3.3 Small component temperature for Group I or Group II electrical equipment

The maximum surface temperature shall not exceed the temperature class unless subjected to the following.

Small components, for example transistors or resistors, whose temperature exceeds that permitted for the temperature classification, shall be acceptable providing that they conform to one of the following:

a) when tested in accordance with 26.5.3, small components shall not cause ignition of the flammable mixture and any deformation or deterioration caused by the higher temperature shall not impair the type of protection; or

b) for T4 and Group I classification, small components shall conform to Table 3a and Table 3b; or

c) for T5 classification, the surface temperature of a component with a surface area smaller than 1 000 mm^2 (excluding lead wires) shall not exceed 150 °C.

Table 3a – Assessment of temperature classification according to component size at 40°C ambient temperature

Total surface area excluding lead wires	Group II T4		Group I	
			Dust excluded	
	Maximum surface temperature	Maximum power dissipation	Maximum surface temperature	Maximum power dissipation
	°C	W	°C	W
<20 mm²	275		950	
≥20 mm² ≤1 000 mm²	200, or	1,3		3,3
>1 000 mm²		1,3		3,3

Table 3b – Assessment of temperature classification according to component size – Variation in maximum power dissipation with ambient temperature

Maximum ambient temperature	°C	Apparatus group	40	50	60	70	80
Maximum power dissipation	W	Group II	1,3	1,25	1,2	1,1	1,0
		Group I	3,3	3,22	3,15	3,07	3,0

For potentiometers, the surface to be considered shall be that of the resistance element and not the external surface of the component. The mounting arrangement and the heat-sinking and cooling effect of the overall potentiometer construction shall be taken into consideration during the test. Temperature shall be measured on the track with that current which flows under the test conditions required by the standard for the specific type of protection. If this results in a resistance value of less than 10 % of the track resistance value, the measurements shall be carried out at 10 % of the track resistance value.

For surface areas of not more than 1 000 mm², the surface temperature may exceed that for the temperature class marked on the Group II electrical equipment or the corresponding maximum surface temperature for Group I electrical equipment, if there is no risk of ignition from these surfaces, with a safety margin of

- 50 K for T1, T2 and T3,
- 25 K for T4, T5 and T6 and Group I.

This safety margin shall be ensured by experience of similar components or by tests of the electrical equipment itself in representative explosive mixtures.

NOTE During the tests, the safety margin may be provided by increasing the ambient temperature.

6 Requirements for all electrical equipment

6.1 General

Electrical equipment and Ex Components shall

a) comply with the requirements of this standard, together with one or more of the specific standards listed in Clause 1, and

NOTE 1 These specific standards may vary the requirements of this standard.

NOTE 2 All of the requirements for cable glands marked as type of protection “e” are located in IEC 60079-0.

b) be constructed in accordance with the applicable safety requirements of the relevant industrial standards.

NOTE 3 It is not a requirement of this standard that a certification body check compliance with this requirement. The manufacturer should indicate compliance by marking the equipment or component in accordance with Clause 29 (and by stating the basis of compliance in the documentation, see Clause 28).

NOTE 4 If the electrical equipment or Ex component is intended to withstand particularly adverse service conditions (for example, rough handling, humidity effects, ambient temperature variations, effects of chemical agents, corrosion), these should be specified to the manufacturer by the user. If certification is sought, it is not a requirement of this standard that the certification body confirm suitability for the adverse conditions. Special precautions should be taken when vibration effects on terminals, fuse holders, lampholders and current-carrying connections in general may impair safety, unless they comply with specific standards.

6.2 Mechanical strength of equipment

The equipment shall be subjected to the tests of 26.4. Guards relied upon to provide protection from impact shall be removable only by the use of a tool and shall remain in place for the required impact tests.

6.3 Opening times

Enclosures which can be opened more quickly than

a) any incorporated capacitors, charged by a voltage of 200 V or more, to discharge to a value of residual energy of
   - 0,2 mJ for electrical equipment of Group I or Group IIA,
   - 0,06 mJ for electrical equipment of Group IIB,
   - 0,02 mJ for electrical equipment of Group IIC, including equipment marked Group II only,
   - 0,2 mJ for electrical equipment for Group III,

or double the above energy levels if the charging voltage is less than 200 V, or

b) the surface temperature of enclosed hot components reduces to below the assigned maximum surface temperature of the electrical equipment

shall be marked with one of the following warning markings:

- an enclosure opening delay marking as specified in item a) of 29.11; or
- an enclosure opening marking as specified in item b) of 29.11.

6.4 Circulating currents

Where necessary, precautions shall be taken to guard against any effect due to the presence of circulating currents caused by stray magnetic fields, and the arcs or sparks that may occur as a result of interrupting such currents, or excessive temperatures caused by such currents.

NOTE 1 Stray magnetic fields can result in significant currents flowing in the enclosure of larger rotating electrical machines, particularly during the starting of motors. It is important to avoid sparking from intermittent interruption of these currents.

NOTE 2 Examples of precautions that can be taken include:

– the provision of equipotential bonding; or

– the provision of an adequate quantity of fasteners.

Bonding conductors shall be such that they will only conduct through the designed connection points and not through any insulated joints. In order to ensure reliable current transfer without the risk of sparking under adverse operating conditions, such as vibration or corrosion, the bonds shall be protected against corrosion and loosening in accordance with 15.4. Particular care shall be taken with bare flexible conductors in close proximity to the bonded parts.

Bonding conductors are not required where insulation ensures that circulating currents cannot flow between parts. The insulation of such parts shall be capable of withstanding a test of 100 V r.m.s for 1 min. However, provision shall be made for adequate earthing of isolated exposed conductive parts.

6.5 Gasket retention

Where the degree of protection provided by the enclosure depends on a gasketed joint which is intended to be opened for installation or maintenance purposes, gaskets shall be attached or secured to one of the mating faces to prevent loss, damage or incorrect assembly. The gasket material shall not itself adhere to the other joint face.

NOTE An adhesive may be used for attaching a gasket to one of the mating faces.

6.6 Electromagnetic and ultrasonic energy radiating equipment

The energy levels shall not exceed the values given below.

NOTE Additional guidance on the application of higher power radiating sources can be found in CLC/TR50427.

6.6.1 Radio frequency sources

The threshold power of radio frequency (9 kHz to 60 GHz) for continuous transmissions and for pulsed transmissions whose pulse durations exceed the thermal initiation time shall not exceed the values shown in Table 4. Programmable or software control intended for setting by the user shall not be permitted.

Table 4 – Radio frequency power thresholds

Equipment for	Threshold power W	Thermal initiation time (Averaging period) μs
Group I	6	200
Group IIA	6	100
Group IIB	3,5	80
Group IIC	2	20
Group III	6	200

NOTE The same values are applied for Ma, Mb, Ga, Gb, Gc, Da, Db, or Dc equipment due to the large safety factors involved.

For pulsed radar and other transmissions where the pulses are short compared with the thermal initiation time, the threshold energy values Z_{th} shall not exceed those given in Table 5.

Table 5 – Radio-frequency energy thresholds

Equipment for	Threshold energy Z_{th} μJ
Group I	1 500
Group IIA	950
Group IIB	250
Group IIC	50
Group III	1 500

6.6.2 Lasers or other continuous wave sources

NOTE The values for Ga, Gb, and Gc can be found in IEC 60079-28.

The output parameters of lasers or other continuous wave sources of electrical equipment of EPL Ma or Mb shall not exceed the following values:

- 20 mW/mm^2 or 150 mW for continuous wave lasers and other continuous wave sources, and
- 0,1 mJ/mm^2 for pulse lasers or pulse light sources with pulse intervals of at least 5 s.

The output parameters of lasers or other continuous wave sources of electrical equipment of EPL Da or Db shall not exceed the following values.

- 5 mW/mm^2 or 35 mW for continuous wave lasers and other continuous wave sources, and
- 0,1 mJ/mm^2 for pulse lasers or pulse light sources with pulse intervals of at least 5 s.

The output parameters of lasers or other continuous wave sources of electrical equipment of EPL Dc shall not exceed the following:

- 10 mW/mm^2 or 35 mW for continuous wave lasers and other continuous wave sources, and
- 0,5 mJ/mm^2 for pulse lasers or pulse light sources.

Radiation sources with pulse intervals of less than 5 s are regarded as continuous wave sources.

6.6.3 Ultrasonic sources

The output parameters from ultrasonic sources of electrical equipment of EPL Ma, Mb, Ga, Gb, Gc, Da, Db, or Dc shall not exceed the following values:

- 0,1 W/cm^2 and 10 MHz for continuous sources,
- average power density 0,1 W/cm^2 and 2 mJ/cm^2 for pulse sources.

7 Non-metallic enclosures and non-metallic parts of enclosures

7.1 General

7.1.1 Applicability

The requirements given in this clause and in 26.7 shall apply to non-metallic enclosures and non-metallic parts of enclosures, on which the type of protection depends.

NOTE 1 Some examples of non-metallic parts of enclosures upon which the type of protection depends include cover sealing rings of an “e” or “tD” enclosure, filling compounds of a “d” or “e” cable gland, sealing rings of cable glands, seals of switch actuators for an “e” enclosure, etc.

The requirements of 7.4 also apply to non-metallic parts which are applied to the external surface of an enclosure.

NOTE 2 Non-metallic paints, films, foils, and plates are typically attached to external surfaces of enclosures to provide additional environmental protection. Their ability to store an electrostatic charge is addressed by this clause.

7.1.2 Specification of materials

The documents according to Clause 24 shall specify the material of the enclosure or part of the enclosure.

7.1.3 Plastic materials

The specification for plastic materials shall include the following:

a) the name of the manufacturer;

b) the exact and complete reference of the material, including its colour, percentage of fillers and any other additives, if used;

c) the possible surface treatments, such as varnishes, etc.;

d) the temperature index TI, corresponding to the 20 000 h point on the thermal endurance graph without loss of flexural strength exceeding 50 %, determined in accordance with IEC 60216-1 and IEC 60216-2 and based on the flexing property in accordance with ISO 178. If the material does not break in this test before exposure to the heat, the index shall be based on the tensile strength in accordance with ISO 527-2 with test bars of Type 1A or 1B. As an alternative to the TI, the relative thermal index (RTI – mechanical impact) may be determined in accordance with ANSI/UL 746B.

The data by which these characteristics are defined shall be supplied.

NOTE It is not a requirement of this standard that conformity to the manufacturer's specification of the plastic material needs to be verified.

7.1.4 Elastomeric materials

The specification for elastomeric materials shall include the following:

a) the name of the manufacturer;

b) the exact and complete reference of the material, including its colour, percentage of fillers and any other additives, if used;

c) the possible surface treatments, such as varnishes, etc.;

d) the continuous operating temperature (COT). As an alternative to the COT, the relative thermal index (RTI – mechanical impact) may be determined in accordance with ANSI/UL 746B.

The data by which these characteristics are defined shall be supplied.

NOTE It is not a requirement of this standard that conformity to the manufacturer's specification of the elastomeric material needs to be verified.

7.2 Thermal endurance

7.2.1 Tests for thermal endurance

The tests for endurance to heat and to cold shall be conducted in accordance with 26.8 and 26.9.

7.2.2 Material selection

The plastic materials shall have a temperature index "TI" corresponding to the 20 000 h point or RTI – mechanical of at least 20 K greater than the temperature of the hottest point of the enclosure or the part of the enclosure (see 26.5.1), having regard to the maximum ambient temperature in service.

The elastomeric materials shall have a continuous operating temperature (COT) below, or equal to, the minimum service temperature and at least 20 K above the maximum service temperature.

7.3 Resistance to light

The resistance to light of the enclosures, or parts of enclosures, of non-metallic materials shall be satisfactory (see 26.10).

Where not otherwise protected from exposure to light, a test of resistance of the material to ultraviolet light shall be made if the enclosure or parts of the enclosure, upon which the type of protection depends, are made of non-metallic materials. For Group I equipment, the test applies only to luminaires.

If the equipment is protected from light (for example, daylight or light from luminaires) when installed, and, in consequence, the test is not carried out, the equipment shall be marked by the symbol "X" to indicate this specific condition of use according to item e) of 29.2.

NOTE It is generally acknowledged that glass and ceramic materials are not adversely affected by the resistance to light test, and testing may not be necessary.

7.4 Electrostatic charges on external non-metallic materials

7.4.1 Applicability

The requirements of this subclause only apply to external non-metallic materials of electrical equipment.

7.4.2 Avoidance of a build-up of electrostatic charge on Group I or Group II electrical equipment

Electrical equipment shall be so designed that under normal conditions of use, maintenance and cleaning, danger of ignition due to electrostatic charges shall be avoided. This requirement shall be satisfied by one of the following:

a) by suitable selection of the material so that surface resistance is $\leq 10^9$ Ω tested according to 26.13;

b) by limitation of the surface area of non-metallic parts of enclosures as shown in Table 6.

   The surface area is defined as follows:

   - for sheet materials, the area shall be the exposed (chargeable) area;
   - for curved objects, the area shall be the projection of the object giving the maximum area;
   - for individual non-metallic parts, the area shall be evaluated independently if they are separated by conductive earthed frames.

   NOTE 1 The values for surface area can be increased by a factor of four if the exposed area of non-metallic material is surrounded by conductive earthed frames.

   Alternatively, for long parts with non-metallic surfaces, such as tubes, bars, or ropes, the surface area need not be considered, but the diameters or widths shall not exceed the values shown in Table 7. Cables for connection of external circuits are not considered to fall under this requirement. See 16.6.

c) by limitation of a non-metallic layer bonded to a conductive surface. The thickness of the non-metallic layer shall not exceed the values shown in Table 8;

d) by limitation of the transferred charge using the test method described in 26.14;

e) by the inability to store a dangerous charge by measurement of capacitance when tested in accordance with the test method in 26.15;

f) by provision of a conductive coating. Non-metallic surfaces may be covered with a bonded durable conductive coating. The resistance between coating and the point of bond shall not exceed 10^9 Ω. The resistance shall be measured in accordance with 26.13 but using a 100 mm^2 electrode at the worst case position of the surface and the point of bond. The equipment shall be marked "X" in accordance with item e) of 29.2 and the documentation

shall provide guidance on the use of the bonding connection and provide information to enable the user to decide on the durability of the coating material with respect to the environmental conditions;

g) for electrical equipment intended for fixed installations, the precautions to avoid risk from electrostatic discharge may form part of the intended installation or be a feature of the process in which the equipment is mounted. In this case, the equipment shall be marked "X" in accordance with item e) of 29.2 and the documentation shall indicate all the necessary information to ensure the installation minimizes the risk from electrostatic discharge. Where practicable, the equipment shall also be marked with the electrostatic charge warning given in item g) of 29.11.

NOTE 2 Care should be taken when selecting the use of a warning label for static risk control. In many industrial applications, especially coal mining, it is highly likely that warning labels may become illegible through the deposition of dusts. If this is the case, it is possible that the act of cleaning the label may cause a static discharge.

NOTE 3 When selecting electrical insulating materials, attention should be paid to maintaining a minimum insulation resistance to avoid problems arising from touching exposed non-metallic parts that are in contact with live parts.

Table 6 – Limitation of surface areas

Maximum surface area mm^2				
Group I equipment	**Group II equipment**			
	Equipment protection level	**Group IIA**	**Group IIB**	**Group IIC**
10 000	EPL Ga	5 000	2 500	400
	EPL Gb	10 000	10 000	2 000
	EPL Gc	10 000	10 000	2 000

Table 7 – Diameter or width of long parts

Maximum diameter or width mm				
Group I equipment	**Group II equipment**			
	Equipment protection level	**Group IIA**	**Group IIB**	**Group IIC**
30	EPL Ga	3	3	1
	EPL Gb	30	30	20
	EPL Gc	30	30	20

Table 8 – Limitation of thickness of non-metallic layer

Maximum thickness mm				
Group I equipment	**Group II equipment**			
	Equipment protection level	**Group IIA**	**Group IIB**	**Group IIC**
2	EPL Ga	2	2	0,2
	EPL Gb	2	2	0,2
	EPL Gc	2	2	0,2

7.4.3 Avoidance of a build-up of electrostatic charge on equipment for Group III

Equipment of plastic material shall be so designed that under normal conditions of use, danger of ignition due to propagating brush discharges is avoided. This can be achieved by not using plastic, which is covering a conductive material. If however the plastic is covering a conductive material the plastic shall have one or more of the following characteristics:

a) surface resistance $\leq 10^9\ \Omega$ tested according to 26.13;

b) a breakdown voltage ≤4 kV (measured across the thickness of the insulating material according to the method described in IEC 60243-1);

c) a thickness ≥8 mm of the external insulation on metal parts;

NOTE External insulation of 8 mm and greater on metal parts such as measurement probes or similar components make propagating brush discharges unlikely to occur. When evaluating the minimum thickness of the insulation to be used or specified it is necessary to allow for any expected wear under normal usage.

d) by limitation of the transferred charge using the test method described in 26.14;

e) by the inability to store a dangerous charge by measurement of capacitance when tested in accordance with the test method in 26.15.

7.5 Threaded holes

Threaded holes for fasteners which secure covers intended to be opened in service for adjustment, inspection and other operational reasons, shall only be tapped into the non-metallic material when the thread form is compatible with the non-metallic material of the enclosure.

8 Metallic enclosures and metallic parts of enclosures

8.1 Material composition

The documents according to Clause 24 shall specify the material of the enclosure or part of the enclosure.

NOTE It is not a requirement of this standard that the chemical composition of material needs to be verified by test.

8.1.1 Group I

Materials used in the construction of enclosures of Group I electrical equipment of EPL Ma or Mb shall not contain, by mass, more than

a) 15 % in total of aluminium, magnesium, titanium and zirconium, and

b) 7,5 % in total of magnesium, titanium and zirconium.

The above requirement need not apply to Group I portable measuring equipment, but this equipment shall then be marked “X” in accordance with item e) of 29.2 and the specific condition of use shall indicate the special precautions to be applied during storage, transportation and use.

8.1.2 Group II

Materials used in the construction of enclosures of Group II electrical equipment for the identified equipment protection levels shall not contain, by mass, more than:

- for EPL Ga

  10 % in total of aluminium, magnesium, titanium and zirconium, and

  7,5 % in total of magnesium, titanium and zirconium;

- for EPL Gb

7,5 % magnesium and titanium;

- for EPL Gc

  no requirements except for fans, fanhoods and ventilating screens, which shall comply with the requirements for EPL Gb.

When the 10 % in total of aluminium, magnesium, titanium and zirconium limit is exceeded for equipment of EPL Ga, the equipment shall be marked with an "X" in accordance with item e) of 29.2 and the specific conditions of use shall contain sufficient information to enable the user to determine the suitability of the equipment for the particular application, for example, to avoid an ignition hazard due to impact or friction.

8.1.3 Group III

Materials used in the construction of enclosures of Group III electrical equipment for the identified equipment protection levels shall not contain, by mass, more than:

- for EPL Da

  7,5 % in total of magnesium and titanium;

- for EPL Db

  7,5 % in total of magnesium and titanium;

- for EPL Dc

  no requirements except for fans, fanhoods and ventilating screens, which shall comply with the requirements for EPL Db.

8.2 Threaded holes

Threaded holes for fasteners which secure covers intended to be opened in service for adjustment, inspection and other operational reasons shall only be tapped into the material when the thread form is compatible with the material of the enclosure.

9 Fasteners

9.1 General

Parts necessary to achieve a specific type of protection or used to prevent access to uninsulated live parts shall be capable of being released or removed only with the aid of a tool.

Fastening screws for enclosures of materials containing light metals may be made of light metal or non-metallic material if the material of the fastener is compatible with that of the enclosure.

9.2 Special fasteners

When any of the standards for a specific type of protection requires a special fastener, this shall conform to the following:

– the thread shall be a metric thread of coarse pitch in accordance with ISO 262, with a tolerance fit of 6g/6H in accordance with ISO 965-1 and ISO 965-3;

– the head of the screw or nut shall be in accordance with ISO 4014, ISO 4017, ISO 4032, ISO 4762, or ISO 7380, and, in the case of hexagon socket set screws, ISO 4026, ISO 4027, ISO 4028 or ISO 4029; Other heads of a screw or nut are permitted if the equipment is marked “X” in accordance with item e) of 29.2 and the specific condition of use shall fully specify the fasteners and indicate that the fasteners shall only be replaced with identical ones;

– the holes in the electrical equipment shall comply with the requirements of 9.3.

NOTE For Group I electrical equipment, the heads of special fasteners liable to mechanical damage in normal service, which may invalidate the type of protection, should be protected, for example, by the use of shrouds or counter-bored holes.

9.3 Holes for special fasteners

9.3.1 Thread engagement

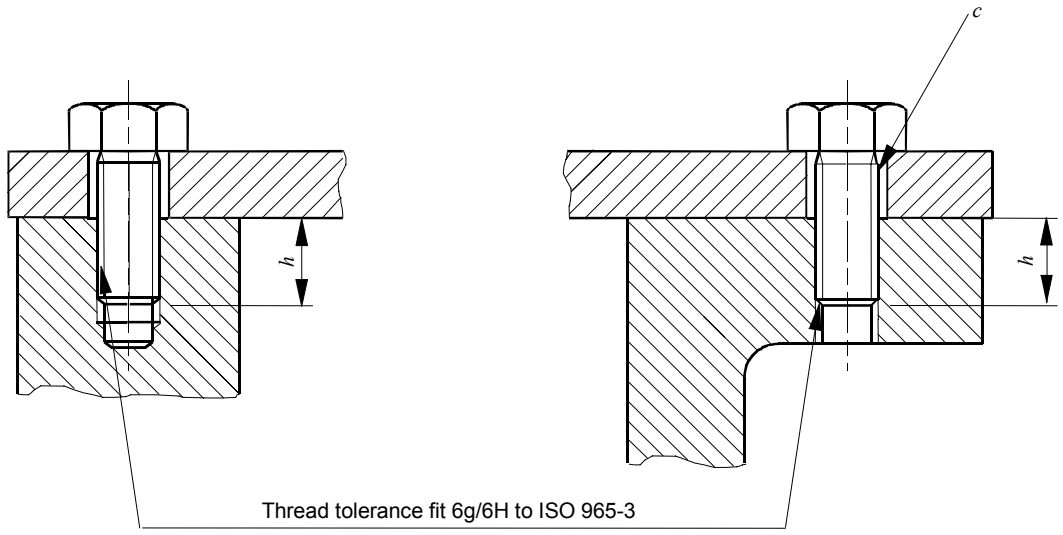
Holes for special fasteners, as specified in 9.2, shall be threaded for a distance to accept a thread engagement, h, at least equal to the major diameter of the thread of the fastener (see Figures 1 and 2).

9.3.2 Tolerance and clearance

The female thread shall have a tolerance class of 6H in accordance with ISO 965-1 and ISO 965-3, and either

a) the hole under the head of the associated fastener shall allow a clearance not greater than a medium tolerance class of H13 in accordance with ISO 286-2 (see Figure 1 and ISO 273); or

b) the hole under the head (or nut) of an associated reduced shank fastener shall be threaded to enable the fastener to be retained. The dimensions of the threaded hole shall be such that the surrounding surface in contact with the head of such a fastener shall be at least equal to that of a fastener without a reduced shank in a clearance hole (see Figure 2).

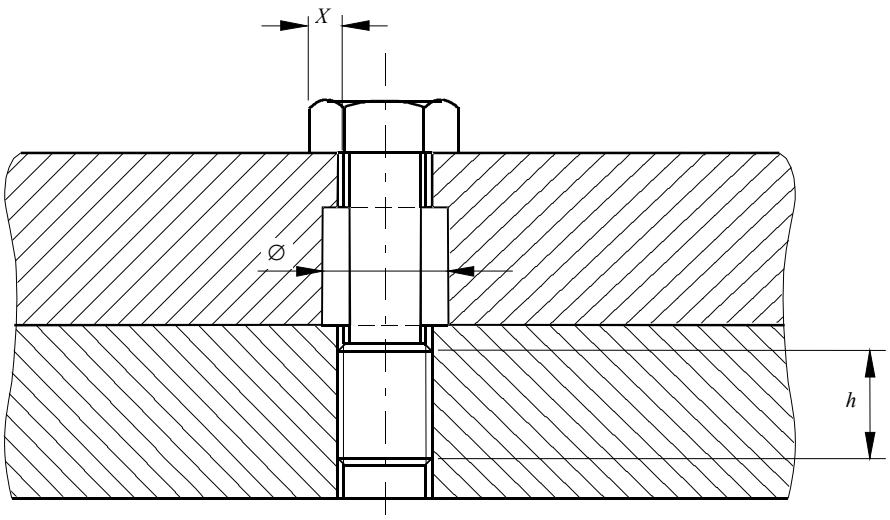


Key

$h \geq$ major diameter of the thread of the fastener

$c \leq$ maximum clearance permitted by tolerance of fit H13 of ISO 286-2

Figure 1 – Tolerances and clearance for threaded fasteners



Key

∅ standard clearance hole appropriate to the thread form

h ≥ major diameter of the thread of the fastener

X contact dimension of a reduced shank fastener

X ≥ the contact dimension of a standard head of a standard fastener (without reduced shank) threaded throughout its length with the size of thread used

Figure 2 – Contact surface under head of fastener with a reduced shank

9.3.3 Hexagon socket set screws

In the case of hexagon socket set screws, the screw shall have a tolerance class of 6h in accordance with ISO 965-1 and ISO 965-3 and shall not protrude from the threaded hole after tightening.

10 Interlocking devices

Where an interlocking device is used to maintain a specific type of protection, it shall be so constructed that its effectiveness cannot easily be defeated.

NOTE The intent is that the interlock be designed such that it cannot be easily defeated by common tools such as a screwdriver, pliers, or a similar tool.

11 Bushings

Bushings used as connection facilities and which may be subjected to a torque during connection or disconnection, shall be mounted in such a way that all parts are secured against turning.

The relevant torque test is specified in 26.6.

12 Materials used for cementing

The documents, according to Clause 24, shall testify that for the intended operating conditions, the materials used for cementing on which the type of protection depends, have a thermal stability adequate for the minimum and maximum temperatures to which they shall be subjected, within the rating of the electrical equipment.

The thermal stability shall be considered adequate if the limiting values for the continuous operating temperature (COT) of the material are below, or equal to, the lowest service temperature and at least 20 K above the maximum service temperature.

NOTE If the cementing is to withstand adverse service conditions, appropriate measures should be agreed between user and manufacturer (see 6.1).

13 Ex components

13.1 General

Ex components shall comply with the requirements given in Annex B. Examples of Ex components include:

a) an empty enclosure; or

b) components or assemblies of components for use with equipment which complies with the requirements of one or more of the types of protection listed in Clause 1.

13.2 Mounting

Ex components may be mounted:

a) completely within an equipment enclosure (for example, a type "e" terminal, ammeter, heater or indicator; a type "d" switch component or thermostat, a type “m” switch component or thermostat, a type "i" supply); or

b) completely external to the equipment enclosure (for example, a type "e" earth terminal, a type "i" sensor); or

c) partly within and partly external to the equipment enclosure (for example, a type "d" push button switch, a type “t” push button switch, a limit switch or indicating lamp, a type "e" ammeter, a type "i" indicator).

13.3 Internal mounting

Where the Ex component is mounted completely within the enclosure, the only parts that shall be tested or assessed are those parts which have not been tested and/or assessed as a separate component (for example, test or assessment of surface temperature, creepage distance and clearance from the component to surrounding conducting parts).

13.4 External mounting

Where the Ex component is mounted external to the enclosure or partly within and partly external to the enclosure, the interface between the Ex component and the enclosure shall be tested or assessed for compliance with the relevant type of protection and the enclosure tests as specified in 26.4.

14 Connection facilities and termination compartments

14.1 General

Electrical equipment intended for connection to external circuits shall include connection facilities, with the exception of electrical equipment that is manufactured with a cable permanently connected to it.

14.2 Termination compartment

Termination compartments and their access openings shall be dimensioned so that the conductors can be readily connected.

14.3 Type of protection

Termination compartments shall comply with one of the specific types of protection listed in Clause 1.

14.4 Creepage and clearance

Termination compartments shall be so designed that after proper connection of the conductors, the creepage distances and the clearances comply with the requirements, if any, of the specific type of protection concerned.

15 Connection facilities for earthing or bonding conductors

15.1 Equipment requiring earthing

15.1.1 Internal

A connection facility for the connection of an earthing conductor shall be provided inside the electrical equipment adjacent to the other connection facilities.

15.1.2 External

An additional external connection facility for an equipotential bonding conductor shall be provided for electrical equipment with a metallic enclosure, except for electrical equipment which is designed to be:

a) moved when energized and is supplied by a cable incorporating an earthing or equipotential bonding conductor; or

b) installed only with wiring systems not requiring an external earth connection, for example, metallic conduit or armoured cable.

The manufacturer shall provide details on any earthing or equipotential bonding required for the installation under conditions a) or b) above in the instructions provided in accordance with Clause 30.

The additional external connection facility shall be electrically in contact with the connection facility required in 15.1.1.

NOTE The expression "electrically in contact" does not necessarily involve the use of a conductor.

15.2 Equipment not requiring earthing

Where there is no requirement for earthing or bonding, for example, in some types of electrical equipment having double or reinforced insulation, or for which supplementary earthing is not necessary, an internal or external earthing or bonding facility need not be provided.

NOTE Double insulated equipment, while not presenting a risk of electrical shock, may need to be earthed or bonded to reduce the risk of ignition.

15.3 Size of conductor connection

Protective earthing connection facilities shall allow for the effective connection of at least one conductor with a cross-sectional area given in Table 9.

Table 9 – Minimum cross-sectional area of protective conductors

Cross-sectional area of phase conductors, S mm²	Minimum cross-sectional area of the corresponding protective conductor, S_p mm²
$S \leq 16$	S
$16 < S \leq 35$	16
$S > 35$	$0,5\ S$

Equipotential bonding connection facilities on the outside of electrical equipment shall provide effective connection of a conductor with a cross-sectional area of at least 4 mm².

15.4 Protection against corrosion

Connection facilities shall be effectively protected against corrosion. Special precautions shall be taken if one of the parts in contact consists of a material containing light metal, for example, by using an intermediate part made of steel when making a connection to a material containing light metals.

15.5 Secureness of electrical connections

Connection facilities shall be designed so that the electrical conductors cannot be readily loosened or twisted. Contact pressure on the electrical connections shall be maintained and not be affected by dimensional changes of insulating materials in service, due to factors such as temperature or humidity. For non-metallic walled enclosures provided with an internal earth continuity plate, the test of 26.12 shall be applied.

NOTE The material and dimensions of the earth continuity plate should be appropriate for the anticipated fault current.

16 Entries into enclosures

16.1 General

Entry into the equipment shall be either by a plain or threaded hole located in

- the wall of the enclosure, or
- an adaptor plate designed to be fitted in or on the walls of the enclosure.

NOTE Further information on the installation of conduit or associated fittings into threaded or plain holes can be found in IEC 60079-14.

16.2 Identification of entries

The manufacturer shall specify, in the documents submitted according to Clause 24, the entries, their position on the equipment and the number permitted. The thread form (for example, metric or NPT) of threaded entries shall be marked on the equipment or shall appear in the installation instructions (see Clause 30).

NOTE 1 It is not intended that individual entries be marked, unless required by the specific type of protection.

NOTE 2 Where a great variety of possible locations for entries is foreseen, the area for the entries, the size of entries and entry spacing are typically provided.

16.3 Cable glands

Cable glands, when installed in accordance with the instructions required by Clause 30, shall not invalidate the specific characteristics of the type of protection of the electrical equipment

on which they are mounted. This shall apply to the whole range of cable dimensions specified by the manufacturer of the cable glands as suitable for use with those glands. Cable glands may form an integral part of the equipment, i.e. one major element or part forms an inseparable part of the enclosure of the equipment. In such cases, the glands shall be tested with the equipment.

NOTE Cable glands, which are separate from, but installed with, the equipment are usually tested separately from the equipment but may be tested together with the equipment if the equipment manufacturer so requests.

Cable glands, whether integral or separate, shall meet the relevant requirements of Annex A.

16.4 Blanking elements

Blanking elements, intended to close unused openings in the enclosure walls of electrical equipment, shall satisfy the requirements of the specific type of protection concerned. The blanking element shall only be removable with the aid of a tool.

16.5 Temperature at branching point and entry point

When the temperature under rated conditions is higher than 70 °C at the entry point or 80 °C at the branching point of the conductors, information shall be marked on the equipment exterior to provide guidance to the user on the proper selection of cable and cable gland or conductors in conduit.

NOTE In cases where the information for the proper selection of cables, cable glands, and conductors in conduit is extensive, the marking need only be a reference to detailed information in the equipment instructions.

16.6 Electrostatic charges of cable sheaths

For the purposes of this standard, the sheaths of cables used for the connection of external circuits are not considered non-metallic enclosures or parts of enclosures as described by Clause 7 and need not be assessed against those requirements.

NOTE The electrostatic risk of cables is addressed by IEC 60079-14.

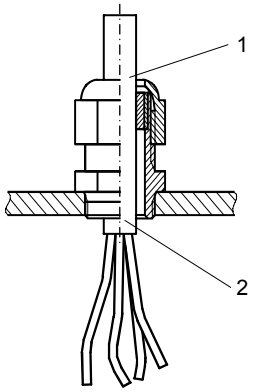


Figure 3a – Cable gland

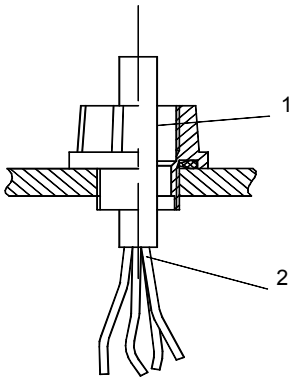


Figure 3b – Conduit entry

Key

1 entry point (where the sealing, if any, occurs)

2 branching point

Figure 3 – Illustration of entry points and branching points

17 Supplementary requirements for rotating electrical machines

17.1 Fans and fan hoods

External shaft-driven cooling fans of rotating electrical machines shall be enclosed by a fan hood which is not considered to be part of the enclosure of the electrical equipment. Such fans and fan hoods shall meet the requirements of 17.2 to 17.5.

17.2 Ventilation openings for external fans

The degree of IP protection of ventilation openings for external fans of rotating electrical machines shall be at least:

– IP20 on the air inlet side,

– IP10 on the air outlet side,

according to IEC 60034-5.

For vertical rotating electrical machines, foreign objects shall be prevented from falling into the ventilation openings. For Group I rotating electrical machines, the degree of protection IP10 is adequate only when the openings are designed or arranged so that foreign objects with dimensions above 12,5 mm cannot be carried onto the moving parts of the machine either by falling vertically or by vibration.

17.3 Construction and mounting of the ventilating systems

Fans, fan hoods and ventilation screens shall be constructed to meet the requirements of the resistance to impact test according to 26.4.2 and the acceptance criteria given in 26.4.4.

17.4 Clearances for the ventilating system

Taking into account design tolerances, the clearances in normal operation between the external fan and its hood, the ventilation screens and their fasteners, shall be at least one-hundredth of the maximum diameter of the fan, except that the clearances need not exceed 5 mm and may be reduced to 1 mm where the opposing parts are manufactured so as to have controlled dimensional concentricity and dimensional stability. In no case shall the clearance be less than 1 mm.

17.5 Materials for external fans and fan hoods

Except for fans fitted to Group II rotating electrical machines and having a peripheral speed of below 50 m/s, external fans, fan hoods and ventilation screens shall have a surface resistance not exceeding 10^9 Ω, measured in accordance with 26.13.

The thermal stability of non-metallic materials shall be considered adequate if the TI specified by the manufacturer of the non-metallic material exceeds the maximum temperature to which the material is subjected in service (within the rating) by at least 20 K.

The external fans, fan hoods, ventilation screens, of rotating electrical machines, manufactured from materials containing light metals shall comply with Clause 8.

17.6 Equipotential bonding conductors

NOTE Stray magnetic fields can result in significant currents flowing in the enclosures of larger rotating electrical machines, particularly during the starting of motors. It is particularly important to avoid sparking from intermittent interruption of these currents.

Depending on the design and rating of the machine, the manufacturer shall specify the cross-sectional area and construction of equipotential bonding conductors which shall be fitted across enclosure joints, symmetrically placed with respect to the axis of the shaft.

The bonds shall be installed in accordance with the requirements of 6.4.

18 Supplementary requirements for switchgear

18.1 Flammable dielectric

Switchgear shall not have contacts immersed in flammable dielectric.

18.2 Disconnectors

Where switchgear includes a disconnector, it shall disconnect all poles. The switchgear shall be designed so that either

– the position of the disconnector contacts is visible, or
– their open position is reliably indicated (see IEC 60947-1).

Any interlock between the disconnector and the cover or door of the switchgear shall allow this cover or door to be opened only when the separation of the disconnector contacts is effective.

Disconnectors, which are not designed to be operated under the intended load, shall either

– be electrically or mechanically interlocked with a suitable load breaking device, or
– for Group II equipment only, be marked at a place near the actuator of the disconnector, with the operation under load marking given in item c) of 29.11.

18.3 Group I – Provisions for locking

For Group I switchgear, the operating mechanism of disconnectors shall be capable of being padlocked in the open position. Provision shall be made to enable short-circuit and earth-fault relays, if used, to latch out. If the switchgear has a local resetting device which is accessible from the outside of the enclosure, its access cover shall have a special fastener according to 9.2.

18.4 Doors and covers

Doors and covers giving access to the interior of enclosures containing remotely operated circuits with switching contacts which can be made or broken by non-manual influences (such as electrical, mechanical, magnetic, electromagnetic, electro-optical, pneumatic, hydraulic, acoustic or thermal) shall either

a) be interlocked with a disconnector which prevents access to the interior, unless it has been operated to disconnect unprotected internal circuits; or
b) be marked with the enclosure opening marking of item d) of 29.11.

In the case of a) above, where it is intended that some internal parts shall remain energized after operation of the disconnector, in order to minimize the risk of explosion, those energized parts shall be protected by either

1) one of the appropriate types of protection listed in Clause 1; or
2) protection as follows:
   – clearances and creepage distances between phases (poles) and to earth in accordance with the requirements of IEC 60079-7; and
   – an internal supplementary enclosure which contains the energized parts and provides a degree of protection of at least IP20, according to IEC 60529; and
   – marking on the internal supplementary enclosure as required by item h) of 29.11.

19 Supplementary requirements for fuses

Enclosures containing fuses shall either

– be interlocked so that insertion or removal of replaceable elements can be carried out only with the supply disconnected and so that the fuses cannot be energized until the enclosure is correctly closed, or
– the equipment shall be marked with the enclosure opening marking as required by item d) of 29.11.

20 Supplementary requirements for plugs, socket outlets and connectors

The requirements in 20.1 and 20.2 for socket outlets shall also be applied to connectors.

20.1 Interlocking

Plugs and socket outlets shall be either

a) interlocked mechanically, or electrically, or otherwise designed so that they cannot be separated when the contacts are energized and the contacts cannot be energized when the plug and socket outlet are separated, or

b) fixed together by means of special fasteners according to 9.2 and the equipment marked with the separation marking as required by item e) of 29.11.

Where they cannot be de-energized before separation because they are connected to a battery, the marking shall state the separation warning required by item f) of 29.11.

20.1.1 Explosive gas atmospheres

It is not necessary for plugs and socket outlets of EPL Gb, where the rated current of a single pin does not exceed 10 A and rated voltage between any two pins does not exceed either 254 V a.c. or 60 V d.c., to comply with the requirements of this subclause if all of the following conditions are met:

– the part which remains energized is a socket outlet;

– there is a delay time for the separation of the plug and socket outlet such that the rated current flow ceases so no arc will occur on separation;

– the plug and socket outlet remain flameproof in accordance with IEC 60079-1 during the arc-quenching period;

– the contacts remaining energized after separation are protected according to one of the specific types of protection listed in Clause 1.

20.1.2 Explosive dust atmospheres

It is not necessary for plugs and socket outlets of EPL Db or EPL Dc, where the rated current of a single pin does not exceed 10 A and rated voltage between any two pins does not exceed either 254 V a.c. or 60 V d.c., to comply with the requirements of this subclause if all the following conditions are met:

– the part which remains energized is a socket outlet;

– the plug and socket outlet break the rated current with delayed release to permit the arc to be extinguished before separation;

– the plug and socket outlet shall comply with type of protection “t” according to IEC 60079-31 during the arc-quenching period.

20.2 Energized plugs

Plugs and components remaining energized when not engaged with a socket outlet are not permitted.

21 Supplementary requirements for luminaires

21.1 General

The source of light of luminaires shall be protected by a light-transmitting cover that may be provided with an additional guard. Dependent on the size of the openings in a guard, the tests according to 26.4.2 Table 12 are to be applied as follows:

- Guard openings greater than 2 500 mm^2; tests a) and c) of Table 12.
- Guard openings between 625 mm^2 and 2 500 mm^2; tests a), b) and d) of Table 12.
- Guard openings less than 625 mm^2; tests a) and b) of Table 12.
- No guard; tests a) and c) of Table 12.

The mounting of luminaires shall not depend on just one screw. A single eyebolt may be used only if this is an integral part of the luminaire, for example by being cast or welded to the enclosure or, if threaded, the eyebolt is locked by a separate means against loosening when twisted.

21.2 Covers for luminaires of EPL Gb or EPL Db

Covers giving access to the lampholder and other internal parts of luminaires shall either be

a) interlocked with a device which automatically disconnects all poles of the lampholder as soon as the cover opening procedure begins, or

b) marked with the opening marking as required by item d) of 29.11.

In the case of a) above, where it is intended that some parts other than the lampholder will remain energized after operation of the disconnecting device, in order to minimize the risk of explosion, those energized parts shall be protected by either

1) one of the appropriate types of protection listed in Clause 1, or

2) the means of protection given below:

   – the disconnecting device shall be so arranged that it cannot be operated manually to inadvertently energize unprotected parts; and

   – clearances and creepage distances between phases (poles) and to earth in accordance with the requirements of IEC 60079-7; and

   – an internal supplementary enclosure, which can be the reflector for the light source, which contains the energized parts and provides a degree of protection of at least IP20, according to IEC 60529; and

   – marking on the internal supplementary enclosure as required by item h) of 29.11.

21.3 Covers for luminaires of EPL Gc or EPL Dc

Covers giving access to the lampholder and other internal parts of luminaires shall either be

a) interlocked with a device which automatically disconnects all poles of the lampholder as soon as the cover opening procedure begins, or

b) marked with the opening marking as required by item d) of 29.11.

In the case of a) above, where it is intended that some parts other than the lampholder will remain energized after operation of the disconnecting device, in order to minimize the risk of explosion, those energized parts shall be protected by

- clearances and creepage distances between phases (poles) and to earth in accordance with the requirements of IEC 60664-1 with over-voltage category II and pollution degree 3; and

- an internal supplementary enclosure, which can be the reflector for the light source, which contains the energized parts and provides a degree of protection of at least IP20, according to IEC 60529; and

- marking on the internal supplementary enclosure as required by item h) of 29.11.

21.4 Special lamps

Lamps containing free metallic sodium (for example, low-pressure sodium lamps in accordance with IEC 60192) are not permitted. High-pressure sodium lamps (for example, in accordance with IEC 60662) may be used.

22 Supplementary requirements for caplights and handlights

22.1 Group I caplights

NOTE The requirements for caplights for use in mines susceptible to firedamp are contained in IEC 62013-1.

22.2 Group II and Group III caplights and handlights

Leakage of the electrolyte shall be prevented in all positions of the equipment.

Where the source of light and the source of supply are housed in separate enclosures, which are not mechanically connected other than by an electric cable, the cable glands and the connected cable shall be tested according to A.3.1 or A.3.2, as appropriate. The test shall be carried out using the cable which is to be used for connecting both parts. The type, dimensions and other relevant information about the cable which is to be used shall be specified in the manufacturer's documentation.

23 Equipment incorporating cells and batteries

23.1 General

The requirements in 23.2 to 23.12 shall apply for all cells and batteries incorporated into explosion-protected equipment.

23.2 Batteries

Batteries incorporated into explosion-protected equipment shall be formed only from cells connected in series.

23.3 Cell types

Only cell types referred to in published IEC cell standards having known characteristics shall be used. Tables 10 and 11 below list cells for which suitable standards either exist or are to be produced.

Table 10 – Primary cells

IEC 60086-1 type	Positive electrode	Electrolyte	Negative electrode	Nominal voltage V	Maximum open-circuit voltage V
-	Manganese dioxide	Ammonium chloride, zinc chloride	Zinc	1,5	1,73
A	Oxygen	Ammonium chloride, zinc chloride	Zinc	1,4	1,55
B	Carbon monofluoride	Organic electrolyte	Lithium	3	3,7
C	Manganese dioxide	Organic electrolyte	Lithium	3	3,7
E	Thionyl chloride ($SOCl_2$)	Non-aqueous inorganic	Lithium	3,6	3,9
F	Iron disulfide (FeS_2)	Organic electrolyte	Lithium	1,5	1,83
G	Copper (II) oxide (CuO)	Organic electrolyte	Lithium	1,5	2,3
L	Manganese dioxide	Alkali metal hydroxide	Zinc	1,5	1,65
P	Oxygen	Alkali metal hydroxide	Zinc	1,4	1,68
S	Silver oxide (Ag_2O)	Alkali metal hydroxide	Zinc	1,55	1,63
T	Silver oxide (AgO, Ag_2O)	Alkali metal hydroxide	Zinc	1,55	1,87
[a]	Sulphur dioxide	Non-aqueous organic salt	Lithium	3,0	3,0
[a]	Mercury	Alkali metal hydroxide	Zinc	Data awaited	Data awaited

NOTE Zinc/manganese dioxide cells are listed in IEC 60086-1, but not classified by a type letter.

[a] May only be used if an IEC cell standard exists.

Table 11 – Secondary cells

Relevant IEC standard type	Type	Electrolyte	Nominal voltage V	Maximum open-circuit voltage V
Type K IEC 61056-1 IEC 60095-1	Lead-acid (WET) Lead-acid (DRY)	Sulphuric acid (SG 1,25)	2,2 2,2	2,67 2,35
Type K IEC 61951-1 IEC 60623 IEC 60622	Nickel-cadmium	Potassium hydroxide (SG 1,3)	1,2	1,55
[a]	Nickel-iron	Potassium hydroxide (SG1,3)	Data awaited	1,6
[a]	Lithium	Non-aqueous organic salt	Data awaited	Data awaited
IEC 61951-2	Nickel metal hydride	Potassium hydroxide	1,2	1,5

[a] May only be used if an IEC cell standard exists.

23.4 Cells in a battery

All cells in a battery shall be of the same electrochemical system, cell design and rated capacity and shall be made by the same manufacturer.

23.5 Ratings of batteries

All batteries shall be arranged and operated so as to be within the allowable limits defined by the cell or battery manufacturer.

23.6 Interchangeability

Primary and secondary cells or batteries shall not be used inside the same equipment enclosure if they are readily interchangeable.

23.7 Charging of primary batteries

Primary batteries shall not be re-charged. Where another voltage source exists inside equipment containing primary batteries and there is a possibility of interconnection, precautions shall be taken to prevent charging current passing through them.

23.8 Leakage

All cells shall be constructed, or arranged so as to prevent leakage of electrolyte, which would adversely affect the type of protection or components on which safety depends.

23.9 Connections

Only the manufacturer’s recommended method(s) of making electrical connections to a battery shall be used.

23.10 Orientation

Where a battery is mounted inside equipment and the battery orientation is important for safe operation, the correct orientation of the equipment shall be indicated on the outside of the equipment enclosure.

NOTE Correct orientation of the battery is often important to prevent electrolyte leakage.

23.11 Replacement of cells or batteries

Where it is necessary for the user to replace cells or batteries contained within an enclosure, the relevant parameters to allow correct replacement shall be legibly and durably marked on or inside the enclosure as detailed in 29.12, or detailed in the manufacturer's instructions in accordance with 30.2. That is, either the manufacturer's name and part number, or the electrochemical system, nominal voltage and rated capacity.

23.12 Replaceable battery pack

Where it is intended for the user to replace the battery pack, the battery pack shall be legibly and durably marked on the outside of the battery pack as detailed in 29.12.

Replaceable battery packs shall be either:

- located completely inside the equipment enclosure, or
- connected to the equipment and shall comply with the requirements for the applicable type of protection when disconnected from the equipment, or
- connected to the equipment and shall employ disconnecting means that comply with the requirements of Clause 20.

24 Documentation

The manufacturer shall prepare documents that give a full and correct specification of the explosion safety aspects of the electrical equipment.

25 Compliance of prototype or sample with documents

The prototype or sample of the electrical equipment subjected to the type verifications and tests shall comply with the manufacturer's documents referred to in Clause 24.

26 Type tests

26.1 General

The prototype or sample shall be tested in accordance with the requirements for type tests of this standard and of the specific standards for the types of protection concerned. However, certain tests judged to be unnecessary, may be omitted from the testing programme. A record shall be made of all tests carried out and of the justification for those omitted.

It is not necessary to repeat the tests that have already been carried out on an Ex component.

NOTE Due to the safety factors incorporated in the types of protection, the uncertainty of measurement inherent in good quality, regularly calibrated measurement equipment is considered to have no significant detrimental effect and need not be taken into account when making the measurements necessary to verify compliance of the equipment with the equipment requirements of the relevant part of IEC 60079.

26.2 Test configuration

Each test shall be made in the configuration of the electrical equipment considered to be the most unfavourable.

26.3 Tests in explosive test mixtures

IEC 60079 series states if such tests are required and specifies the explosive test mixtures to be used.

NOTE The purity of commercially available gases and vapours is in general satisfactory for these tests but, if their purity is below 95 %, they should not be used. The effects of normal variations in the laboratory temperature and of atmospheric pressure and the effects of variations in the humidity of the explosive test mixture are acceptable because they have been found to have negligible effect.

26.4 Tests of enclosures

26.4.1 Order of tests

26.4.1.1 Metallic enclosures, metallic parts of enclosures and glass parts of enclosures

Tests for metallic enclosures, metallic parts of enclosures and glass parts of enclosures shall be performed in the following order:

– tests for resistance to impact (see 26.4.2);
– drop test, if applicable (see 26.4.3);
– tests for degrees of protection (IP) (see 26.4.5);
– any other tests required by this standard;
– any other test specific to the type of protection concerned.

Tests shall be made on the number of samples specified by each test method.

NOTE Where the degree of protection IP is provided by non-metallic sealing materials, the requirements of 26.4.1.2 will apply.

26.4.1.2 Non-metallic enclosures or non-metallic parts of enclosures

Tests for non-metallic enclosures or non-metallic parts of enclosures shall be performed in the following order.

26.4.1.2.1 Group I electrical equipment

The tests shall be made on samples as follows:

– Four samples shall be used. All four samples shall be submitted to the tests of thermal endurance to heat (see 26.8), then to thermal endurance to cold (see 26.9). Two samples shall then be submitted to the tests for resistance to impact (see 26.4.2), then to the drop test if applicable (see 26.4.3), with the tests being conducted at the ‘upper test temperature’ (see 26.7.2). The other two samples shall also be submitted to the tests for resistance to impact (see 26.4.2), then to the drop test if applicable (see 26.4.3), but with the tests being conducted at the ‘lower test temperature’ (see 26.7.2). Any joint that is intended to be opened during installation or in normal operation shall be opened and re-closed in accordance with the manufacturer’s instructions. Subsequently, all four samples shall be submitted to the tests for degree of protection by enclosures (see 26.4.5), and then subjected to the appropriate tests specific to the type of protection concerned.
– Alternatively, only two samples may be used. In this case, both samples shall be submitted to the tests of thermal endurance to heat (see 26.8), then to thermal endurance to cold (see 26.9). Both samples shall then be submitted to the tests for resistance to impact (see 26.4.2), and to the drop test if applicable (see 26.4.3), with the tests being

conducted at the 'upper test temperature' (see 26.7.2). Thereafter, both samples shall also be submitted to the tests for resistance to impact (see 26.4.2), then to the drop test if applicable (see 26.4.3), but with the tests now being conducted at the 'lower test temperature' (see 26.7.2). Any joint that is intended to be opened during installation or in normal operation shall be opened and re-closed in accordance with the manufacturer's instructions. Subsequently, both samples shall be submitted to the tests for degree of protection by enclosures (see 26.4.5), and then subjected to the appropriate tests specific to the type of protection concerned.

NOTE As a result of the thermal endurance testing for either of the test sequences described above, condensation may occur inside the enclosure. Such condensation will need to be removed prior to ingress protection (IP) testing to ensure valid results.

– Two samples shall be submitted to the tests of resistance to oils and greases (see 26.11) then to the tests for resistance to impact (see 26.4.2), then to the drop test if applicable (see 26.4.3), then the tests for degrees of protection (IP) if applicable (see 26.4.5), and finally to the tests specific to the type of protection concerned.
– Two samples shall be submitted to the tests of resistance to hydraulic liquids for mining applications (see 26.11) then to tests for resistance to impact (see 26.4.2), then to the drop test if applicable (see 26.4.3), then the tests for degrees of protection (IP) if applicable (see 26.4.5), and finally to the tests specific to the type of protection concerned.

In the procedures and test sequences described above, the objective is to demonstrate the ability of the non-metallic material to maintain the specific type of protection listed in Clause 1 after exposure to extremes of temperature and harmful substances likely to be met in use. In an attempt to keep the number of tests to a minimum, it is not necessary to perform all of the tests specific to the type of protection on every sample if it is obvious that a sample has not been damaged in such a way as to impair the type of protection offered. Similarly, the number of samples can be reduced if it is possible for the exposure tests and protection-proving tests to be performed in parallel on the same two samples.

26.4.1.2.2 Group II and Group III electrical equipment

Four samples shall be used. All four samples shall be submitted to the tests of thermal endurance to heat (see 26.8), then to thermal endurance to cold (see 26.9). Two samples shall then be submitted to the tests for resistance to impact (see 26.4.2), then to the drop test if applicable (see 26.4.3), with the tests being conducted at the 'upper test temperature' (see 26.7.2). The other two samples shall also be submitted to the tests for resistance to impact (see 26.4.2), then to the drop test if applicable (see 26.4.3), but with the tests being conducted at the 'lower test temperature' (see 26.7.2). Any joint that is intended to be opened during installation or in normal operation shall be opened and re-closed in accordance with the manufacturer's instructions. Subsequently, all four samples shall be submitted to the tests for degree of protection by enclosures (see 26.4.5), and then subjected to the appropriate tests specific to the type of protection concerned.

Alternatively, only two samples may be used. In this case, both samples shall be submitted to the tests of thermal endurance to heat (see 26.8), then to thermal endurance to cold (see 26.9). Both samples shall then be submitted to the tests for resistance to impact (see 26.4.2), and to the drop test if applicable (see 26.4.3), with the tests being conducted at the 'upper test temperature' (see 26.7.2). Thereafter, both samples shall also be submitted to the tests for resistance to impact (see 26.4.2), then to the drop test if applicable (see 26.4.3), but with the tests now being conducted at the 'lower test temperature' (see 26.7.2). Any joint that is intended to be opened during installation or in normal operation shall be opened and re-closed in accordance with the manufacturer's instructions. Subsequently, both samples shall be submitted to the tests for degree of protection by enclosures (see 26.4.5), and then subjected to the appropriate tests specific to the type of protection concerned.

NOTE As a result of the thermal endurance testing for either of the test sequences described above, condensation may occur inside the enclosure. Such condensation will need to be removed prior to ingress protection (IP) testing to ensure valid results.

26.4.2 Resistance to impact

The electrical equipment shall be submitted to the effect of a test mass of 1 kg falling vertically from a height h. The height h is specified in Table 12 according to the application of the electrical equipment. The mass shall be fitted with an impact head made of hardened steel in the form of a hemisphere of 25 mm diameter.

Before each test, it is necessary to check that the surface of the impact head is in good condition.

The resistance to impact test shall be made on electrical equipment which is completely assembled and ready for use; however, if this is not possible (for example, for light-transmitting parts), the test shall be made with the relevant parts removed but fixed in their mounting or an equivalent frame. Tests on an empty enclosure are permitted with appropriate justification in the documentation (see Clause 24).

For light-transmitting parts made of glass, the test shall be made on three samples, but only once on each sample. In all other cases, the test shall be made on at least two samples, at two separate places on each sample, see 26.4.1.

The points of impact shall be the places considered to be the weakest and shall be on the external parts which may be exposed to impact. If the enclosure is protected by another enclosure, only the external parts of the assembly shall be subjected to the resistance to impact tests.

The electrical equipment shall be mounted on a steel base so that the direction of the impact is normal to the surface being tested if it is flat, or normal to the tangent to the surface at the point of impact if it is not flat. The base shall have a mass of at least 20 kg or be rigidly fixed or inserted in the floor, for example, secured in concrete. Annex C gives an example of a suitable test rig.

Table 12 – Tests for resistance to impact

	Drop height h with 1 kg mass m			
Equipment grouping	**Group I**		**Group II or III**	
Risk of mechanical danger	**High**	**Low**	**High**	**Low**
a) Enclosures and external accessible parts of enclosures (other than light-transmitting parts)	2	0,7	0,7	0,4
b) Guards, protective covers, fan hoods, cable glands	2	0,7	0,7	0,4
c) Light-transmitting parts without guard	0,7	0,4	0,4	0,2
d) Light-transmitting parts with guard having individual openings from 625 mm^2 to 2 500 mm^2; see 21.1 (tested without guard)	0,4	0,2	0,2	0,1
NOTE A guard for light-transmitting parts having individual openings from 625 mm^2 to 2 500 mm^2 reduces the risk of impact, but does not prevent impact.				

When, at the request of the manufacturer, electrical equipment is submitted to tests corresponding to the low risk of mechanical danger, it shall be marked with the symbol “X” to indicate this specific condition of use in accordance with item e) of 29.2.

The test shall be carried out at an ambient temperature of (20 ± 5) °C, except where the material data shows it to have a reduction in resistance to impact at lower temperatures within the specified ambient range. In this case, the test shall be performed at the lower test temperature, in accordance with 26.7.2.

When the electrical equipment has an enclosure or a part of an enclosure made of a non-metallic material, including non-metallic fan hoods and ventilation screens in rotating electrical machines, the test shall be carried out at the upper and lower test temperatures, in accordance with 26.7.2.

26.4.3 Drop test

In addition to being submitted to the resistance to impact test in accordance with 26.4.2, hand-held electrical equipment or electrical equipment carried on the person, ready for use, shall be dropped four times from a height of at least 1 m onto a horizontal concrete surface. The position of the sample for the drop test shall be that which is considered to be the most unfavourable.

The drop test shall be conducted with any replaceable battery pack connected to the equipment.

For electrical equipment with an enclosure which is of a metallic material, the test shall be carried out at a temperature of (20 ± 5) °C, except where the material data shows it to have a reduction in resistance to impact at lower temperatures within the specified ambient range. In this case, the test shall be performed at the lower test temperatures, in accordance with 26.7.2.

For electrical equipment which has enclosures or parts of enclosures made of non-metallic material, the tests shall be carried out at the lower test temperature in accordance with 26.7.2.

26.4.4 Acceptance criteria

The resistance to impact and drop tests shall not produce damage so as to invalidate the type of protection of the electrical equipment.

Superficial damage, chipping to paint work, breakage of cooling fins or other similar parts of the electrical equipment and small dents shall be ignored.

External fan hoods and ventilation screens shall resist the tests without displacement or deformation causing contact with the moving parts.

26.4.5 Degree of protection (IP) by enclosures

26.4.5.1 Test procedure

When a degree of protection is required by this standard or by other parts of this series for a specific type of protection, the test procedures shall be in accordance with IEC 60529, except for rotating electrical machines which shall be in accordance with IEC 60034-5.

When tested in accordance with IEC 60529,

– enclosures shall be considered as belonging to “Category 1 enclosure” as specified in IEC 60529,

– the equipment shall not be energized,

– where applicable, the dielectric test specified in IEC 60529 shall be carried out at [(2 U_n + 1 000) ± 10 %] V r.m.s. applied between 10 s and 12 s, where U_n is the maximum rated or internal voltage of the equipment.

NOTE The “category 1 enclosure” is defined in IEC 60529 and bears no relation to the “category 1” defined in the European directive 94/9/EC (ATEX).

26.4.5.2 Acceptance criteria

For electrical equipment tested in accordance with IEC 60529, the acceptance criteria shall be in accordance with IEC 60529 except where the manufacturer specifies acceptance criteria more onerous than those described in IEC 60529, for example, those in a relevant product standard. In this case, the acceptance criteria of the relevant product standard shall be applied unless it adversely affects explosion protection.

The acceptance criteria in IEC 60034-5 shall be applied to rotating electrical machines insofar as compliance with an IEC explosion protection standard is concerned in addition to the conditions specified in IEC 60034-5.

Where a standard for electrical equipment for explosive atmospheres specifies acceptance criteria for IPXX, these shall be applied instead of those in IEC 60529 or IEC 60034-5.

26.5 Thermal tests

26.5.1 Temperature measurement

26.5.1.1 General

For electrical equipment which can normally be used in different positions, the temperature in each position shall be considered. When the temperature is determined for certain positions only, the electrical equipment shall be marked with the symbol “X” to indicate this specific condition of use according to item e) of 29.2.

The measuring devices (thermometers, thermocouples, etc.) and the connecting cables shall be selected and so arranged that they do not significantly affect the thermal behaviour of the electrical equipment.

The final temperature shall be considered to have been reached when the rate of rise of temperature does not exceed 2 K/h.

The temperature of the hottest point of any enclosure, or part of enclosure, of non-metallic material (see 7.1.4) shall be determined.

For electrical equipment of Group III evaluated with a dust layer in accordance with 5.3.2.3.2, the equipment to be tested shall be mounted in accordance with the instructions and surrounded on all available surfaces by a dust thickness at least equal to the specified layer depth L. The measurement for the maximum surface temperature shall be determined using a test dust having a thermal conductivity of no more than 0,10 W/(m.K) measured at (100 ± 5) ºC.

NOTE Some equipment may require the provision of integral temperature sensitive devices to limit surface temperatures.

26.5.1.2 Service temperature

The test to determine service temperatures shall be made at the rating of the electrical equipment, with the exception of the test to determine the maximum surface temperature.

26.5.1.3 Maximum surface temperature

The test to determine maximum surface temperature shall be performed under the most adverse ratings with an input voltage between 90 % and 110 % of the rated voltage of the electrical equipment that gives the maximum surface temperature.

For electrical machines, determination of the maximum surface temperature may alternatively be conducted at the worst case test voltage within “Zone A” per IEC 60034-1. In this case, the equipment shall be marked with the symbol “X” in accordance with item e) of 29.2 and the

specific condition of use shall include the information that the surface temperature determination was based on operation within “Zone A” (IEC 60034-1), typically ± 5% of rated voltage.

NOTE 1 Where the input voltage does not directly effect the temperature rise of the equipment or Ex component, such as a terminal or a switch, the test current may need to be increased to 110 % of the rated current to simulate the increase in current that would occur with an increase of the input voltage during final application of the equipment.

NOTE 2 Where equipment rating is a range (e.g. 90-264 V), the testing should be performed at the rated condition likely to be most arduous or, if the most arduous condition cannot be determined, at all rated conditions. For example, when determining surface temperature the test should be performed at 90% of the lowest voltage in the range and at 110% of the highest voltage in the range. When determining service temperature, the test should be performed at both the highest and lowest voltage in the range.

NOTE 3 Unless the manufacturer has specified a range of supply frequencies, it may be assumed that normal tolerances both of the supply in use and of the supply for test purposes is sufficiently small to be ignored.

The measured maximum surface temperature shall not exceed:

– for Group I equipment, those values as given in 5.3.2.1,
– for Group II equipment subjected to routine testing for maximum surface temperature, the temperature or temperature class marked on the electrical equipment,
– for Group II equipment subjected to type testing for maximum surface temperature, the marked temperature or temperature class, less 5 K for temperature classes T6, T5, T4 and T3 (or marked temperatures ≤200 °C), and less 10 K for temperature classes T2 and T1 (or marked temperatures >200 °C),
– for Group III equipment, those values assigned, see 5.3.2.3.

The result shall be corrected for the maximum ambient temperature specified in the rating. The measurement of temperatures as prescribed in this standard, and in the specific standards for the types of protection concerned, shall be made in still ambient air, with the electrical equipment mounted in its normal service position.

26.5.2 Thermal shock test

Glass parts of luminaires and windows of electrical equipment shall withstand, without breaking, a thermal shock caused by a jet of water of about 1 mm diameter at a temperature (10 ± 5) °C sprayed on them when they are at not less than the maximum service temperature.

26.5.3 Small component ignition test (Group I and Group II)

26.5.3.1 General

A small component tested to demonstrate that it shall not cause temperature ignition of a flammable mixture in accordance with item a) of 5.3.3, shall be tested in the presence of a specified gas/air mixture as described in 26.5.3.2.

26.5.3.2 Procedure

The test shall be carried out with the component either

– mounted in the equipment as intended and precautions shall be taken to ensure that the test mixture is in contact with the component, or
– mounted in a model which ensures representative results. In this case, such a simulation shall take into account the effect of other parts of the equipment in the vicinity of the component being tested which affect the temperature of the mixture and the flow of the mixture around the component as a result of ventilation and thermal effects.

The component shall be tested under normal operation, or under the fault conditions specified in the standard for the type of protection which produces the highest value of surface

temperature. The test shall be continued either until thermal equilibrium of the component and the surrounding parts is attained or until the component temperature drops. Where component failure causes the temperature to fall, the test shall be repeated five times using five additional samples of the component. Where, in normal operation or under the fault conditions specified in the standard for the type of protection, the temperature of more than one component exceeds the temperature class of the equipment, the test shall be carried out with all such components at their maximum temperature.

The safety margin required by 5.3.3 shall be achieved either by raising the ambient temperature at which the test is carried out or, where this is possible, by raising the temperature of the component under test and other relevant adjacent surfaces by the required margin.

For Group I, the test mixture shall be a homogenous mixture between 6,2 % and 6,8 %, v/v methane and air.

For T4 temperature classification, the mixture shall be either

a) a homogeneous mixture of between 22,5 % and 23,5 % v/v diethyl ether and air, or
b) a mixture of diethyl ether and air obtained by allowing a small quantity of diethyl ether to evaporate within a test chamber while the ignition test is being carried out.

For other temperature classifications, the choice of suitable test mixtures shall be at the discretion of the testing station.

26.5.3.3 Acceptance criteria

The appearance of a cool flame shall be considered as an ignition. Detection of ignition shall either be visual or by measurement of temperature, for example, by a thermocouple.

If no ignition occurs during a test, the presence of the flammable mixture shall be verified by igniting the mixture by some other means.

26.6 Torque test for bushings

26.6.1 Test procedure

Bushings used for connection facilities and which are subjected to torque during connection or disconnection of conductors shall be tested for resistance to torque.

The stem in the bushing, or the bushing when mounted, shall be subjected to a torque of the value given in Table 13.

Table 13 – Torque to be applied to the stem of bushing used for connection facilities

Diameter of the stem of the bushings	Torque Nm
M 4	2,0
M 5	3,2
M 6	5
M 8	10
M 10	16
M 12	25
M 16	50
M 20	85
M 24	130
NOTE Torque values for sizes other than those specified above may be determined from a graph plotted using these values. In addition, the graph may be extrapolated to allow torque values to be determined for stems of bushings larger than those specified.	

26.6.2 Acceptance criteria

When mounted, neither the stem in the bushing, nor the bushing itself, shall turn when the stem is subjected to a torque.

26.7 Non-metallic enclosures or non-metallic parts of enclosures

26.7.1 General

In addition to the relevant tests given in 26.1 to 26.6, non-metallic enclosures shall also satisfy the requirements in 26.8 to 26.15, as appropriate.

26.7.2 Test temperatures

When, according to this standard or to the specific standards listed in Clause 1, tests have to be carried out as a function of the permissible upper and lower service temperature, these test temperatures shall be

– for the upper temperature, the maximum service temperature (see 5.2) increased by at least 10 K but at most 15 K,

– for the lower temperature, the minimum service temperature (see 5.2) reduced by at least 5 K but at most 10 K.

26.8 Thermal endurance to heat

The thermal endurance to heat shall be determined by submitting the enclosures or parts of enclosures in non-metallic materials, on which the integrity of the type of protection depends, to continuous storage for four weeks at (90 ± 5) % relative humidity at a temperature of (20 ± 2) K above the maximum service temperature, but at least 80 °C.

In the case of a maximum service temperature above 75 °C, the period of four weeks specified above shall be replaced by a period of two weeks at (95 ± 2) °C and (90 ± 5) % relative humidity followed by a period of two weeks in an air oven at a temperature of (20 ± 2) K higher than the maximum service temperature.

NOTE It is generally acknowledged that glass and ceramic materials are not adversely affected by the thermal endurance to heat test, and testing may not be necessary.

26.9 Thermal endurance to cold

The thermal endurance to cold shall be determined by submitting the enclosures and parts of enclosures of non-metallic materials, on which the type of protection depends, to storage for 24 h in an ambient temperature corresponding to the minimum service temperature reduced according to 26.7.2.

NOTE It is generally acknowledged that glass and ceramic materials are not adversely affected by the thermal endurance to cold test, and testing may not be necessary.

26.10 Resistance to light

26.10.1 Test procedure

The test shall be made on six test bars of standard size (80 ± 2)mm × (10 ± 0,2)mm × (4 ± 0,2)mm according to ISO 179. The test bars shall be made under the same conditions as those used for the manufacture of the enclosure concerned; these conditions are to be stated in the test report of the electrical equipment.

The test shall be made in accordance with ISO 4892-2 in an exposure chamber using a xenon lamp and a sunlight simulating filter system, at a black panel temperature of (65 ± 3) °C. The exposure time shall be at least 1 000 h.

Where the preparation of test samples in accordance with ISO 179 is not practical due to the nature of the non-metallic material, an alternative test shall be permitted with the justification stated in the test report for the electrical equipment.

26.10.2 Acceptance criteria

The evaluation criterion is the impact bending strength in accordance with ISO 179. The impact bending strength following exposure in the case of an impact on the exposed side shall be at least 50 % of the corresponding value measured on the unexposed test pieces. For materials whose impact bending strength cannot be determined prior to exposure because no rupture has occurred, not more than three of the exposed test bars shall be allowed to break.

26.11 Resistance to chemical agents for Group I electrical equipment

The non-metallic enclosures and non-metallic parts of enclosures shall be submitted to tests of resistance to the following chemical agents:

– oils and greases;

– hydraulic liquids for mining applications.

The relevant tests shall be made on four samples of enclosure sealed against the intrusion of test liquids into the interior of the enclosure:

– two samples shall remain for (24 ± 2) h in oil No. 2 according to the annex "Reference liquids" of ISO 1817, at a temperature of (50 ± 2) °C;

– the other two samples shall remain for (24 ± 2) h in fire-resistant hydraulic fluid intended for operating at temperatures between –20 °C and +60 °C, comprising an aqueous solution of polymer in 35 % water at a temperature of (50 ± 2) °C.

At the end of the test, the enclosure samples concerned shall be removed from the liquid bath, carefully wiped and then stored for (24 ± 2) h in the laboratory atmosphere. Subsequently, each of the enclosure samples shall pass the tests of enclosures according to 26.4.

If one or more of the enclosure samples do not withstand these tests of enclosures after exposure to one or more of the chemicals, the enclosure shall be marked with the symbol “X” to indicate this specific condition of use according to item e) of 29.2, i.e. exclusion of exposure to specific chemicals during use.

26.12 Earth continuity

The material from which the enclosure is manufactured may be tested as a complete enclosure, part of an enclosure, or as a sample of the material from which the enclosure is made, provided that the relevant critical dimensions of the sample are the same as those of the enclosure.

The cable gland shall be represented by a 20 mm (nominal) diameter test bar manufactured from brass ($CuZn_{39}Pb_3$ or $CuZn_{38}Pb_4$) carrying an ISO metric thread with a tolerance class 6g, 1,5 mm pitch in accordance with IEC 60423. The length of the test bar shall ensure that at least one full thread remains free at each end when assembled, as shown in the diagram.

Complete earth plates or parts of earth plates that are intended to be used with the enclosure shall be used for the purpose of this test.

The clearance hole provided in the samples used for the test shall be between 22 mm and 23 mm diameter and the method of assembly shall ensure that the screw thread of the test bar does not make contact directly with the inside of the clearance hole.

The clamping nuts shall be manufactured from brass ($CuZn_{39}Pb_3$ or $CuZn_{38}Pb_4$) and shall be provided with an ISO metric thread with a tolerance class 6H, 1,5 mm pitch in accordance with IEC 60423. The thickness of the nuts shall be 3 mm (nominal).

The components are assembled as shown in Figure 4. The torque applied to each pair of the nuts, in turn, shall be 10 Nm ($\pm$ 10 %).

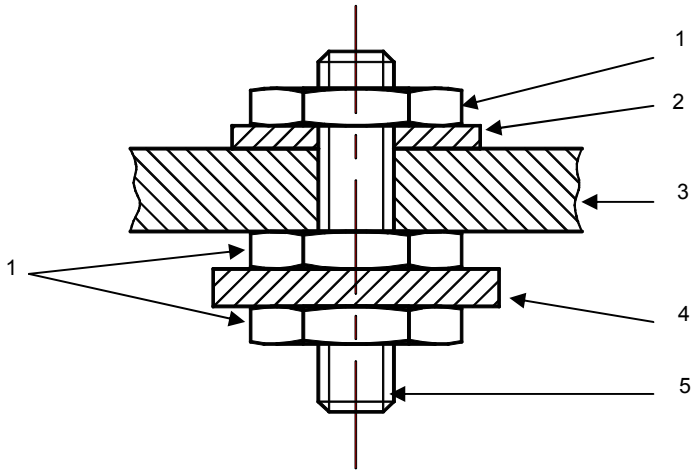
The hole in the wall (or part of the wall or the test sample) may be a plain through-hole or a tapped hole having a thread form compatible with the test bar.

After the test sample has been assembled it shall be subjected to the conditions for the test for thermal endurance to heat as described in 26.8.

This shall be followed by a further period of 14 days in an air oven at a temperature of 80 °C.

On completion of conditioning, the resistance between the earth plates or parts of earth plates shall be calculated by passing a direct current of 10 A to 20 A between the earth plates and measuring the voltage drop between them.

The non-metallic material that has been tested in this manner is deemed to be satisfactory if the resistance between the earth plates or parts of earth plates does not exceed $5 \times 10^{-3}\ \Omega$.



Components

1 nut
2 earth plate
3 enclosure wall (non-metallic)
4 earth plate or part of earth plate
5 test bar

Figure 4 – Assembly of test sample for earth-continuity test

26.13 Surface resistance test of parts of enclosures of non-metallic materials

The surface resistance shall be tested on the parts of enclosures if size permits, or on a test piece comprising a rectangular plate with dimensions in accordance with Figure 5. The test piece shall have an intact clean surface. Two parallel electrodes are painted on the surface, using a conducting paint with a solvent which has no significant effect on the surface resistance.

The test piece shall be cleaned with distilled water, then with isopropyl alcohol (or any other solvent that can be mixed with water and will not affect the material of the test piece or the electrodes), then once more with distilled water before being dried. Untouched by bare hands, it shall then be conditioned for at least 24 h at (23 ± 2)°C and (50 ± 5)% relative humidity. The test shall be carried out under the same ambient conditions.

The direct voltage applied for (65 ± 5) s between the electrodes shall be (500 ± 10) V.

During the test, the voltage shall be sufficiently steady so that the charging current due to voltage fluctuation will be negligible compared with the current flowing through the test piece.

The surface resistance is the quotient of the direct voltage applied at the electrodes to the total current flowing between them.

Dimensions in millimetres

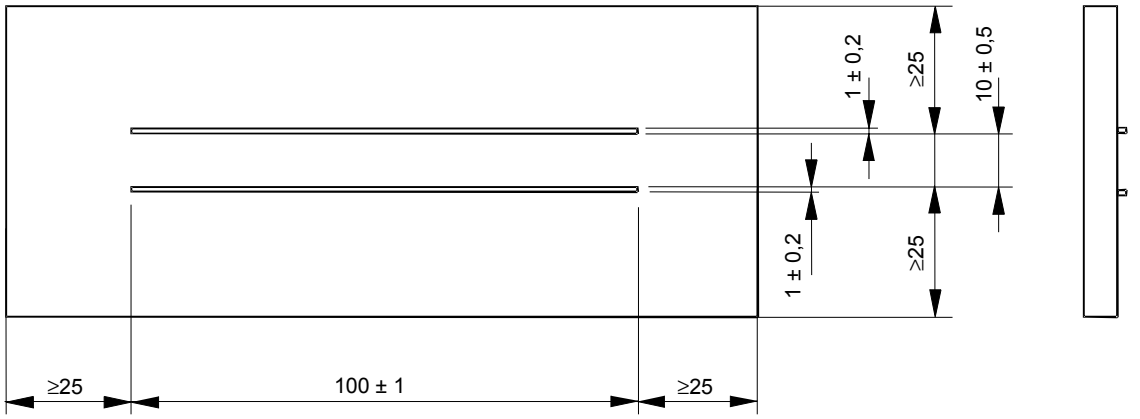


Figure 5 – Test piece with painted electrodes

26.14 Charging tests

26.14.1 Introduction

This test is performed with the part itself or a 22 500 mm^2 flat sample of the non-metallic material from which the equipment is constructed.

NOTE The size of the flat sample is relevant because experimental evidence shows that 22 500 mm^2 is an optimum value for the surface area in terms of charge distribution density. Other factors influencing the validity of the test results are the humidity of the test environment, which should be kept to 30 % RH or less at (23 ± 2) °C to minimize leakage of the electrostatic charge. Also, the size of the spark discharge electrode to produce a single spark is important. If the electrodes are too small, this can lead to multiple discharge sparks and/or corona discharging of lower energy. Therefore, a spherical electrode with a diameter of (15 ± 1) mm is used to produce a single-point discharge spark. Furthermore, the extent of the person's perspiration is also of influence.

26.14.2 Principle of the test

Either the actual sample, or if it is not possible because of its size or shape, a 150 mm × 150 mm × 6 mm plate-shaped sample of the material, shall be conditioned for at least 24 h at (23 ± 2) °C and a relative humidity not higher than 30 % RH. Its surface is then electrically charged, under the same environmental conditions as it was conditioned, by three separate methods. The first method involves rubbing the surface with a polyamide material (for example, polyamide 6,6). The second method involves rubbing the same surface with a cotton cloth and the third method involves exposing the same surface to a high-voltage spray electrode.

After completion of each of the charging methods, the charge Q from a typical surface discharge is measured. This is done by discharging the sample by a hemispherical electrode (10 mm to 15 mm radius) into a known value fixed capacitor C and measuring the voltage V across it. The charge Q is given by the formula $Q = C\ V$ where C is the value of the fixed capacitor in farads (F) and V is the highest voltage. This procedure is used to find the method that produces the highest measured charge to assess of the incendivity of the discharge according to 26.14.7.

Where there is a general trend of decreasing stored charges during these tests, new samples have to be used for the following tests. The highest value shall be used for the assessment procedure according to 26.14.7.

NOTE In some cases, the properties of the charged material might have altered due to the discharges so that the transferred charge decreases in subsequent tests.

As this kind of experiment may be influenced by, for example, the person's perspiration, it has to be demonstrated by a calibration experiment with a reference material of PTFE that the transferred charge is at least 60 nC.

26.14.3 Samples and test apparatus

The test sample shall be composed of either the actual sample or, if it is not practical because of its size or shape, a 150 mm × 150 mm × 6 mm flat plate of the non-conductive material. The test apparatus shall include the following:

a) a d.c. high-voltage power supply capable of delivering at least 30 kV;

b) an electrostatic voltmeter (0 V to 10 V) with a measuring accuracy of ± 10 % or better and an input resistance higher than 10^9 Ω;

c) a 0,10 µF capacitor for at least 400 V (0,01 µF is also suitable if the input resistance of the voltmeter is greater than 10^{10} Ω);

d) a cotton cloth large enough to avoid contact between the test sample and the operator's fingers during the rubbing process;

e) a polyamide cloth large enough to avoid contact between the test sample and the operator's fingers during the rubbing process;

f) a PTFE handle, or tongs, able to move the test sample without discharging its charged surface;

g) a flat disk made of PTFE with an area of 22 500 mm^2 as a highly chargeable reference;

h) an earth-grounded plate.

26.14.4 Ambient conditions

All the tests shall be conducted in a room with a temperature of (23 ± 2) °C and no more than 30 % relative humidity.

26.14.5 Conditioning

The test piece shall be cleaned with isopropyl alcohol, rinsed with distilled water and dried, for example, in a drying oven at no more than 50 °C. The test piece shall then be stored in the test room for at least 24 h at (23 ± 2) °C.

26.14.6 Determination of the most efficient charging method

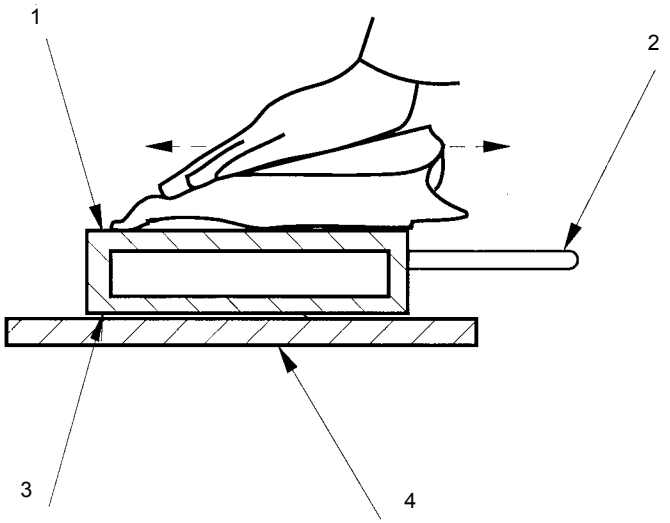
26.14.6.1 Method A: Rubbing with a pure polyamide cloth (Figure 6)

Lay the sample on an isolated plate with its surface upwards. Charge the surface by quickly rubbing it 10 times with the polyamide cloth. The last rub shall finish on the edge of the sample. Discharge the sample by slowly moving the spherical electrode which is connected to a 0,1 µF or 0,01 µF capacitor (Figure 7), towards the test piece until a discharge occurs. The electrode is then to be moved away from the test piece and the resulting voltage across the capacitor measured. The surface charge is given by the formula:

$$Q = CV$$

where V is the voltage across the capacitor at t = 0.

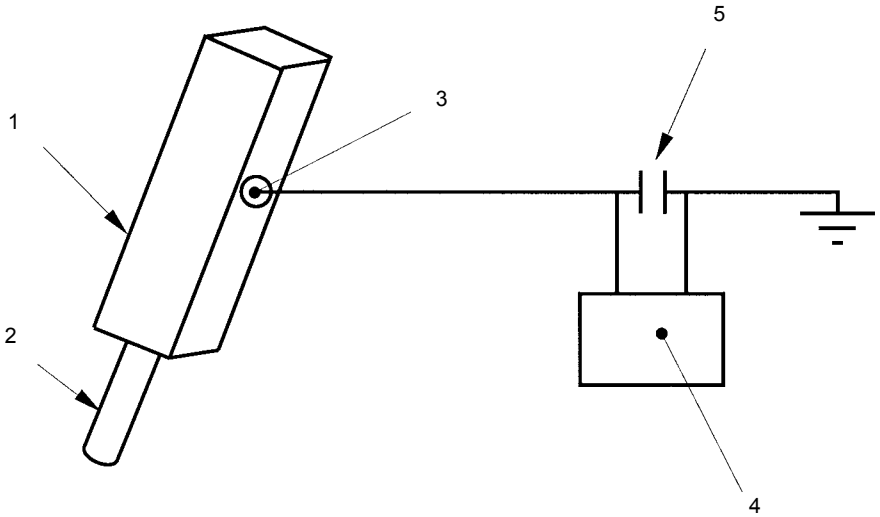
The test shall be repeated 10 times.



Components

1 face A	2 PTFE handle
3 face B	4 PTFE

Figure 6 – Rubbing with a pure polyamide or cotton cloth



Components

1 charged container	2 PTFE handle
3 hemisphere, 10 - 15 mm radius	4 voltmeter
5 C_M = 0,1 µF	

Figure 7 – Discharging of a container with a probe connected to earth via a 0,1 µF capacitor

26.14.6.2 Method B: Rubbing with a cotton cloth (Figure 6)

Repeat the procedure given in Method A using a pure cotton cloth instead of the polyamide cloth. The test shall be repeated 10 times. The highest value shall be used for the assessment procedure according to 26.14.7.

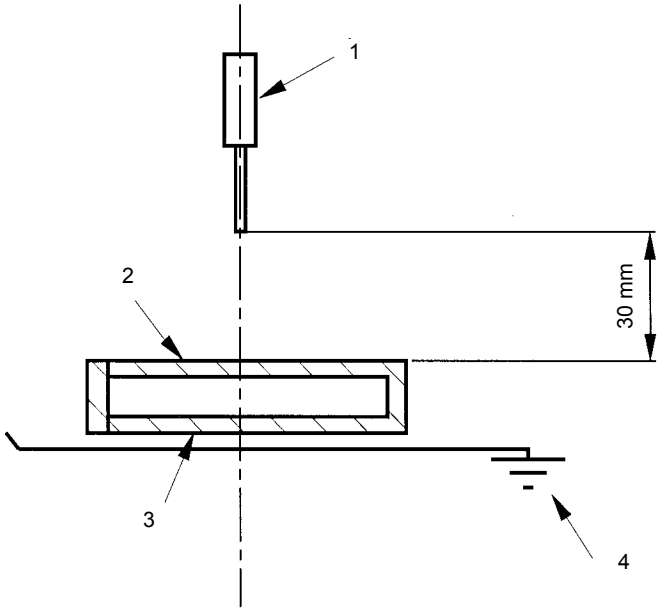
26.14.6.3 Method C: Charging by influence with a d.c. high-voltage power supply (Figure 8)

Position the spray electrode above the test sample 30 mm from the centre of the exposed surface and charge it with a voltage of at least 30 kV between the negative electrode and ground. Move the sample for 1 min in order to charge the whole surface and discharge the sample according to 26.14.6.1. The test shall be repeated 10 times. The highest value shall be used for the assessment procedure according to 26.14.7.

26.14.7 Assessment of discharge

The maximum transferred charge Q of non-conductive enclosure materials shall be less than the following, provided the transferred charge of the reference material lies clearly above 60 nC:

- 60 nC for Group I or IIA equipment;
- 30 nC for Group IIB equipment;
- 10 nC for Group IIC equipment;
- 200 nC for Group III equipment.



Components

1 charge needle	2 face A
3 face B	4 conducting plate (brass)

Figure 8 – Charging by influence with a d.c. voltage power supply

26.15 Measurement of capacitance

26.15.1 Test procedure

The test shall be carried out on two fully assembled samples of the electrical equipment. The samples shall be conditioned in a climatic conditioning chamber for at least 1 h at a temperature of (20 ± 2) °C and a relative humidity of (50 ± 5) % RH. The sample under test shall be placed on an earth-grounded metal plate sized approximately 90 mm × 160 mm × 3 mm (but which may be larger if the sample necessitates it). The capacitance between each exposed metallic part on the equipment shall be measured in the range 0 pF to 200 pF with an accuracy of ± 5 % of reading and with connection leads as short as possible but, in any case, less than 1 m. If there are no exposed metallic parts, a test point shall be created by inserting a screw into the position considered to give the most unfavourable results. The position(s) of the equipment shall be that (those) considered to give the most unfavourable results.

26.15.2 Acceptance criteria

The maximum capacitance shall be as follows:

- for Group I equipment 50 pF
- for Group IIA equipment 50 pF
- for Group IIB equipment 15 pF
- for Group IIC equipment 5 pF
- for Group III equipment 10 pF

NOTE For Group III equipment intended for use in ducts or pipes subject to the presence of fast moving dust, a lower limiting value for capacitance is under consideration.

27 Routine tests

The manufacturer shall also carry out any routine tests required by any of the standards listed in Clause 1 which were used for the examination and testing of the equipment.

28 Manufacturer's responsibility

28.1 Conformity with the documentation

The manufacturer shall carry out the verifications or tests necessary to ensure that the electrical equipment produced complies with the documentation.

NOTE It is not the intent of this subclause to require 100 % inspection of parts. Statistical methods may be employed to verify compliance.

28.2 Certificate

The manufacturer shall prepare, or have prepared, a certificate confirming that the equipment is in conformity with the requirements of this standard along with its other applicable parts and additional standards mentioned in Clause 1. The certificate can relate to Ex equipment or an Ex component.

28.3 Responsibility for marking

By marking the electrical equipment in accordance with Clause 29, the manufacturer attests on his own responsibility that

– the electrical equipment has been constructed in accordance with the applicable requirements of the relevant standards in safety matters,

– the routine verifications and routine tests in 28.1 have been successfully completed and that the product complies with the documentation.

29 Marking

It is essential that the system of marking indicated below only be applied to electrical equipment or Ex components which comply with the applicable standards for the types of protection listed in Clause 1.

29.1 Location

The electrical equipment shall be legibly marked on a main part on the exterior of the equipment and shall be visible prior to the installation of the equipment.

NOTE 1 The marking should be in a location that is likely to be visible after installation of the equipment.

NOTE 2 Where the marking is located on a removable part of the equipment, a duplicated marking on the interior of the equipment may be useful during installation and maintenance by helping to avoid confusion with similar equipment. See 29.10 for additional guidance on extremely small equipment and Ex components.

29.2 General

The marking shall include the following:

a) the name of the manufacturer or his registered trade mark;

b) the manufacturer's type identification;

c) a serial number, except for

   – connection accessories (cable glands, blanking element, thread adaptor and bushings);

   – very small electrical equipment on which there is limited space;

   (The batch number can be considered to be an alternative to the serial number.)

d) the name or mark of the certificate issuer and the certificate reference in the following form: the last two figures of the year of the certificate followed by a “.” followed by a unique four character reference for the certificate in that year;

   NOTE 1 For some regional third-party certification, the separating character “.” may be replaced by another separating designator such as “ATEX”.

e) if it is necessary to indicate specific conditions of use, the symbol “X” shall be placed after the certificate reference. An advisory marking may appear on the equipment as an alternative to the requirement for the “X” marking;

   NOTE 2 The manufacturer should ensure that the requirements of the specific conditions of use are passed to the purchaser together with any other relevant information.

f) the specific Ex marking for explosive gas atmospheres, see 29.3, or for explosive dust atmospheres, see 29.4. The Ex marking for explosive gas atmospheres and explosive dust atmospheres shall be separate and not combined;

g) any additional marking prescribed in the specific standards for the types of protection concerned, as in Clause 1.

   NOTE 3 Additional marking may be required by the applicable industrial safety standards for construction of the electrical equipment.

29.3 Ex marking for explosive gas atmospheres

The Ex marking shall include the following:

a) the symbol Ex, which indicates that the electrical equipment corresponds to one or more of the types of protection which are the subject of the specific standards listed in Clause 1;

b) the symbol for each type of protection used:
   - "d": flameproof enclosure, (for EPL Gb or Mb)
   - "e": increased safety, (for EPL Gb or Mb)
   - "ia": intrinsic safety, (for EPL Ga or Ma)
   - "ib": intrinsic safety, (for EPL Gb or Mb)
   - "ic": intrinsic safety, (for EPL Gc)
   - "ma": encapsulation, (for EPL Ga or Ma)
   - "mb": encapsulation, (for EPL Gb or Mb)
   - *"mc": encapsulation, (for EPL Gc) – Under Consideration*
   - "nA": non-sparking, (for EPL Gc)
   - "nC": protected sparking, (for EPL Gc)
   - "nR": restricted breathing, (for EPL Gc)
   - "nL": energy limited, (for EPL Gc)
   - "o": oil immersion, (for EPL Gb)
   - "px": pressurization, (for EPL Gb or Mb)
   - "py": pressurization, (for EPL Gb)
   - "pz": pressurization, (for EPL Gc)
   - "q": powder filling, (for EPL Gb or Mb)

c) the symbol of the group:
   - I for electrical equipment for mines susceptible to firedamp;
   - IIA, IIB or IIC for electrical equipment for places with an explosive gas atmosphere other than mines susceptible to firedamp.

   When the electrical equipment is for use only in a particular gas, the chemical formula or the name of the gas in parentheses.

   When the electrical equipment is for use in a particular gas in addition to being suitable for use in a specific group of electrical equipment, the chemical formula shall follow the group and be separated with the symbol "+", for example, "IIB + H_2";

   NOTE 1 Equipment marked "IIB" is suitable for applications requiring Group IIA equipment. Similarly, equipment marked "IIC" is suitable for applications requiring Group IIA and Group IIB equipment.

d) for Group II electrical equipment, the symbol indicating the temperature class. Where the manufacturer wishes to specify a maximum surface temperature between two temperature classes, he may do so by marking that maximum surface temperature in degrees Celsius alone, or by marking both that maximum surface temperature in degrees Celsius and, in parentheses, the next highest temperature class, for example, T1 or 350 °C or 350 °C (T1).

   Group II electrical equipment, having a maximum surface temperature greater than 450 °C, shall be marked only with the maximum surface temperature in degrees Celsius, for example, 600 °C.

   Group II electrical equipment, marked for use in a particular gas, need not have a temperature class or maximum surface temperature marking.

   Where appropriate according to 5.1.1, the marking shall include either the symbol T_a or T_{amb} together with the range of ambient temperature or the symbol "X" to indicate this specific condition of use according to item e) of 29.2.

   Ex cable glands, Ex blanking elements, and Ex thread adapters need not be marked with a temperature class or maximum surface temperature in degrees Celsius.

e) the equipment protection level, "Ga", "Gb", "Gc", "Ma", or "Mb" as appropriate.

The markings a) to e) according to 29.3 shall be placed in the order in which they are given in 29.3 and shall each be separated by a small space.

For associated apparatus suitable for installation in a hazardous area, and where the energy limitation is provided inside the apparatus in the hazardous area, the symbols for the type of protection *shall be* enclosed within square brackets, for example, Ex d[ia] IIC T4 Gb. When the equipment group of the associated apparatus differs from that of the apparatus, the equipment group of the associated apparatus *shall be* enclosed within the square brackets, for example, Ex d [ia IIC Ga] IIB T4 Gb.

NOTE 2 A typical example is a shunt diode safety barrier located inside a flameproof enclosure.

For associated apparatus suitable for installation in a hazardous area, and where the energy limitation is provided from outside the apparatus in hazardous area, the symbols for the type of protection *shall not be* enclosed within square brackets, for example, Ex d ia IIC T4 Gb.

NOTE 3 A typical example is a flameproof luminaire with an intrinsically safe photocell connected to a safe area.

For associated apparatus not suitable for installation in a hazardous area, both the symbol Ex and the symbol for the type of protection *shall be* enclosed within the same square brackets, for example, [Ex ia Ga] IIC.

For equipment that includes both associated apparatus and intrinsically safe apparatus with no connections required to be made to the intrinsically safe part of the apparatus by the user, the “associated apparatus” marking shall not appear unless the equipment protection levels differ. For example, Ex d ib IIC T4 Gb and not Ex d ib[ib Gb] IIC T4 Gb, but Ex d ia[ia Ga] IIC T4 Gb is correct for differing equipment protection levels.

NOTE 4 For associated apparatus not suitable for installation in a hazardous area, a temperature class is not included.

29.4 Ex marking for explosive dust atmospheres

The Ex marking shall include the following:

a) the symbol Ex, which indicates that the electrical equipment corresponds to one or more of the types of protection which are the subject of the specific standards listed in Clause 1;

b) the symbol for each type of protection used:
   - "ta": protection by enclosure, (for EPL Da)
   - "tb": protection by enclosure, (for EPL Db)
   - "tc": protection by enclosure, (for EPL Dc)
   - "ia": intrinsic safety, (for EPL Da)
   - "ib": intrinsic safety, (for EPL Db)
   - *"ic": intrinsic safety, (for EPL Dc) – Under Consideration*
   - "ma": encapsulation, (for EPL Da)
   - "mb": encapsulation, (for EPL Db)
   - *"mc": encapsulation, (for EPL Dc) – Under Consideration*
   - "p": pressurization, (for EPL Db or Dc)

c) the symbol of the group:
   - IIIA, IIIB or IIIC for electrical equipment for places with an explosive dust atmosphere;

   NOTE 1 Equipment marked “IIIB” is suitable for applications requiring Group IIIA equipment. Similarly, equipment marked “IIIC” is suitable for applications requiring Group IIIA and Group IIIB equipment.

d) the maximum surface temperature in degrees Celsius and the unit of measurement °C preceded with the letter “T”, (e.g. T 90 °C).

   Where appropriate according to 5.3.2.3, the maximum surface temperature T_L shall be shown as a temperature value in degrees Celsius and the unit of measurement °C, with

the layer depth $_L$ indicated as a subscript in mm, (e.g. T_{500} 320 °C) or marking shall include the symbol “X” to indicate this condition of use according to item e) of 29.2.

Where appropriate according to 5.1.1, the marking shall include either the symbol T_a or T_{amb} together with the range of ambient temperature or the symbol “X” to indicate this specific condition of use according to item e) of 29.2.

Ex cable glands, Ex blanking elements, and Ex thread adapters need not be marked with a maximum surface temperature;

e) the equipment protection level, “Da”, “Db”, or “Dc”, as appropriate;

f) the degree of protection (e.g. IP54).

The markings a) to e) according to 29.4 shall be placed in the order in which they are given in 29.4 and shall each be separated by a small space.

For associated apparatus suitable for installation in a hazardous area, and where the energy limitation is provided inside the apparatus in the hazardous area, the symbols for the type of protection shall be enclosed within square brackets, for example, Ex t[ia Da] IIIC T100 ºC Db. When the equipment group of the associated apparatus differs from that of the apparatus, the equipment group of the associated apparatus **shall be enclosed** within the square brackets, for example, Ex t [ia IIIC Da] IIIB T100 ºC Db.

NOTE 2 A typical example is a shunt diode safety barrier located inside a dust-protected enclosure.

For associated apparatus suitable for installation in a hazardous area, and where the energy limitation is provided from outside the apparatus in hazardous area, the symbols for the type of protection **shall not be enclosed** within square brackets, for example, Ex t ia IIIC T100 ºC Db.

NOTE 3 A typical example is a dust-protected luminaire with an intrinsically safe photocell connected to a safe area.

For associated apparatus not suitable for installation in a hazardous area, both the symbol Ex and the symbol for the type of protection shall be enclosed within the same square brackets, for example, [Ex ia Da] IIIC.

For equipment that includes both associated apparatus and intrinsically safe apparatus with no connections required to be made to the intrinsically safe part of the apparatus by the user, the associated apparatus marking shall not appear unless the equipment protection levels differ. For example, Ex ib t IIIC T100 ºC Db and not Ex ib t [ib Db] IIIC T100 ºC Db, but Ex ia t [ia Da] IIIC T100 ºC Db is correct for differing equipment protection levels.

NOTE 4 For associated apparatus not suitable for installation in a hazardous area, a temperature marking is not included.

29.5 Combined types of protection

Where different types of protection are employed for different parts of electrical equipment or an Ex component, the Ex marking shall include the symbols for all of the types of protection employed. The symbols for the types of protection shall appear in alphabetical order, with small separating spaces. When associated apparatus is incorporated, the symbols for the type of protection, including the square brackets as applicable, shall follow those symbols of the type of protection for the equipment.

29.6 Multiple types of protection

Equipment may be designed using multiple types of protection so that it is suitable for installation in different ways, using the appropriate installation requirements for the selected type of protection. For example, equipment which is designed to comply simultaneously with the equipment requirements for Ex i and also with the equipment requirements for Ex de; may be installed, according to the selection of the installer/user.

In this case,

– each respective Ex marking shall be separately indicated on the equipment marking and shall be prefixed by a place for an identification marking to allow the selected Ex marking to be identified at the time of installation,

– each respective Ex marking shall be separately indicated on the certificate.

When a single certificate is prepared with each Ex marking shown individually in the certificate, the applicable marking and any variation in the parameters or specification for each of the different Ex markings shall be shown without ambiguity.

When a separate certificate is prepared for each Ex marking, all the relevant parameters or specifications shall be provided in the certificate for the individual Ex marking.

29.7 Ga using two independent Gb types of protection

Where two independent types of protection, with EPL Gb, are employed for the same piece of electrical equipment in order to achieve EPL Ga, the Ex marking shall include the symbols for the two types of protection employed with the symbols for the types of protection joined with a "+". See IEC 60079-26.

29.8 Ex components

Ex components, according to Clause 13, shall be legibly marked and the marking shall include the following:

a) the name or the registered trade mark of the manufacturer;

b) the manufacturer's type identification;

c) the symbol Ex;

d) the symbol for each type of protection used;

e) the symbol of the group of the electrical equipment of the Ex component;

f) the name or mark of the issuer of the certificate, and the number of the certificate;

g) the symbol "U"; and

NOTE 1 The symbol "X" is not used.

h) the additional marking prescribed in the specific standard for the types of protection concerned, as in Clause 1.

NOTE 2 Additional marking may be required by the standards for construction of the electrical equipment.

i) As much of the remaining marking information per 29.3 or 29.4, as applicable, as can be accommodated.

The Ex marking for explosive gas atmospheres and explosive dust atmospheres shall be separate and not combined.

29.9 Small equipment and small Ex components

On small electrical equipment and on Ex components where there is limited space, a reduction in the marking is permitted. The following lists the minimum marking that is required on the equipment or Ex component:

a) the name or registered trademark of the manufacturer;

b) the manufacturer's type identification. The type identification is permitted to be abbreviated or omitted if the certificate reference allows identification of the specific type;

c) the name or mark of the issuer of the certificate, and the number of the certificate; and

d) the symbol "X" or "U" (if appropriate);

NOTE The symbols "X" and "U" are never used together.

e) As much of the remaining marking information per 29.3 or 29.4, as applicable, as can be accommodated.

29.10 Extremely small equipment and extremely small Ex components

In the case of extremely small electrical equipment and extremely small Ex components where there is no practical space for marking, a marking intended to be linked to the equipment or Ex component is permitted. This marking shall be identical to the marking of 29.2, 29.3, and 29.4, as applicable, shall appear on a label provided with the equipment or Ex component for field installation adjacent to the equipment or Ex component.

29.11 Warning markings

Where any of the following warning markings are required on the equipment, the text as described in Table 14, following the word "WARNING," may be replaced by technically equivalent text. Multiple warnings may be combined into one equivalent warning.

Table 14 – Text of warning markings

	Reference	WARNING marking
a)	6.3	WARNING – AFTER DE-ENERGIZING, DELAY *Y* MINUTES BEFORE OPENING *(Y* being the value in minutes of the delay required)
b)	6.3	WARNING – DO NOT OPEN WHEN AN EXPLOSIVE ATMOSPHERE MAY BE PRESENT
c)	18.2	WARNING – DO NOT OPERATE UNDER LOAD
d)	18.4 b), 19 21.2 b, 21.3 b)	WARNING – DO NOT OPEN WHEN ENERGIZED
e)	20.1 b)	WARNING – DO NOT SEPARATE WHEN ENERGIZED
f)	20.1 b)	WARNING – SEPARATE ONLY IN A NON-HAZARDOUS AREA
g)	7.4.2 g)	WARNING – POTENTIAL ELECTROSTATIC CHARGING HAZARD – SEE INSTRUCTIONS
h)	18.4 2) 21.2 2 21.3.2)	WARNING – LIVE PARTS BEHIND COVER – DO NOT CONTACT

29.12 Alternate marking of equipment protection levels (EPLs)

The marking of the equipment protection levels is shown by the use of an upper case letter for the specific explosive atmosphere for which the equipment is suitable and a lower case letter indicating the level. As an alternate to the marking given in 29.3 and 29.4 the 'M', 'G' and 'D' are not used as the specific explosive atmosphere is recognised by the marking of the Equipment Groups 'I' (mining), 'II' (gases and vapours) and 'III' (combustible dusts) and the lower case letter for the level is added to the type of protection where it does not already exist.

The alternate marking of equipment Protection Levels (EPLs) is not permitted when IEC 60079-26 is applied for equipment intended for installation in the boundary wall between an area requiring EPL Ga and a less hazardous area. See the "Marking" clause of IEC 60079-26.

29.12.1 Alternate marking of type of protection for explosive gas atmospheres

As an alternate to marking of the type of protection in 29.3b) the following symbols shall include the level as:

– "db": flameproof enclosure.
– "eb": increased safety.
– "ia": intrinsic safety.
– "ib": intrinsic safety.
– "ic": intrinsic safety.
– "ma": encapsulation.
– "mb": encapsulation.
– "nAc": non-sparking.
– "nCc": protected sparking.
– "nRc": restricted breathing.
– "nLc": energy limited.
– "ob": oil immersion.
– "pxb": pressurization.
– "pyb": pressurization.
– "pzc": pressurization.
– "qb": powder filling.

29.12.2 Alternate marking of type of protection for explosive dust atmospheres

As an alternate to marking of the type of protection in 29.4b) the following symbols shall include the level as:

– "ta": protection by enclosure.
– "tb": protection by enclosure.
– "tc": protection by enclosure.
– "ia": intrinsic safety.
– "ib": intrinsic safety.
– "ma": encapsulation.
– "mb": encapsulation.
– "pb": pressurization.
– "pc": pressurization.

29.13 Cells and batteries

In accordance with 23.11, where it is necessary for the user to replace cells or batteries contained within an enclosure, the relevant parameters to allow correct replacement shall be legibly and durably marked on or inside the enclosure. Either the manufacturer's name and part number, or the electrochemical system, nominal voltage and rated capacity shall be included.

When replaceable battery packs are employed, the replaceable battery pack shall be marked on the outside of the battery pack with the following:

- manufacturer;
- manufacturer's type identification;
- the words "Use only on…" followed by the type identification of the intended equipment.

And the equipment shall be marked with the words "Use only replaceable battery pack" followed by the manufacturer and the manufacturer's type identification of the replaceable battery pack.

29.14 Examples of marking[3]

Electrical equipment with type of protection flameproof enclosure “d” (EPL Mb) for use in mines susceptible to firedamp:

BEDELLE S.A
TYPE A B 5
Ex d I Mb alternate Ex db I
No. 325
ABC 02.1234
.....
.....

Ex component, with type of protection flameproof enclosure “d” (EPL Gb) with intrinsically safe “ia” (EPL Ga) output circuit, for explosive gas atmospheres other than in mines susceptible to firedamp, gas of subdivision C, manufactured by H. RIDSTONE and Co. Ltd. Type KW 369:

Ex d [ia Ga] IIC Gb alternate Ex db [ia] IIC
DEF 02.0536 U
.....

.....

Electrical equipment, utilizing types of protection increased safety “e” (EPL Gb) and pressurized enclosure “px” (EPL Gb), maximum surface temperature of 125 °C, for explosive gas atmospheres other than mines susceptible to firedamp, with gas of ignition temperature greater than 125 °C and with specific conditions of use indicated in the certificate.

H. ATHERINGTON Ltd
TYPE 250 JG 1
Ex e px IIC 125 °C (T4) Gb alternate Ex eb pxb IIC 125 °C (T4)
No. 56732
GHI 02.0076 X
.....
.....

Electrical equipment, utilizing types of protection flameproof enclosure “d” (EPL Mb and Gb) and increased safety “e” (EPL Mb and Gb) for use in mines susceptible to firedamp and explosive gas atmospheres other than mines susceptible to firedamp with gas of subdivision B and ignition temperature greater than 200 °C.

A.R. ACHUTZ A.G.
TYPE 5 CD
Ex d e I Mb alternate Ex db eb I
Ex d e IIB T3 Gb alternate Ex db eb IIB T3
No. 5634
JKL 02.0521
.....
.....

Electrical equipment with type of protection flameproof enclosure “d” (EPL Gb) for explosive gas atmospheres other than mines susceptible to firedamp on the basis of ammonia gas only.

---

[3] Attention is drawn to the possibility that some of the elements of this standard may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

WOKAITERT SARL
TYPE NT 3
Ex d II (NH_3) Gb alternate Ex db II (NH_3)
No. 6549
MNO 02.3102
.....
.....

Electrical equipment with type of protection encapsulation “ma” (EPL Da) for explosive dust atmospheres containing conductive dusts of Group IIIC with a maximum surface temperature of less than 120 °C.

ABC company

Type RST
Serial No. 123456
Ex ma IIIC T120 °C Da alternate Ex ma IIIC T120 °C
IP68
N.A. 01.9999
.....
.....

Electrical equipment with type of protection "ia" (EPL Da) for explosive dust atmospheres containing conductive dusts of Group IIIC with a maximum surface temperature of less than 120 °C.

ABC company
Type XYZ
Serial No. 123456
Ex ia IIIC T120 °C Da alternate Ex ia IIIC T120 °C
IP20
N.A. 01.9999
.....
.....

Electrical equipment with type of protection "p" (EPL Db) for explosive dust atmospheres containing conductive dusts of Group IIIC with a maximum surface temperature of less than 120 °C.

ABC company
Type KLM
Serial No. 123456
Ex p IIIC T120 °C Db alternate Ex pb IIIC T120 °C
IP65
N.A. 01.9999
.....
.....

Electrical equipment with type of protection "t” (EPL Db) for explosive dust atmospheres containing conductive dusts of Group IIIC with a maximum surface temperature of less than 225 °C and less than 320 °C when tested with a 500 mm dust layer.

ABC company
Type RST
Serial No. 987654
Ex t IIIC T225 °C T_{500} 320 °C Db alternate Ex tb IIIC T225 °C T_{500} 320 °C
IP65
N.A. 02.1111
.....
.....

Electrical equipment with type of protection "t” (EPL Db) for explosive dust atmospheres containing conductive dusts of Group IIIC with a maximum surface temperature of less than 175 °C with an extended ambient temperature range of -40 °C to +120 °C.

ABC company
Type RST
Serial No. 987654
Ex t IIIC T175 °C Db alternate Ex tb IIIC T175 °C
IP65
-40ºC ≤ T_{amb} ≤ 120 °C
N.A. 02.1111
.....
.....

Electrical equipment with type of protection encapsulation “ma” (EPL Ga) for explosive gas atmospheres of Group IIC with a maximum surface temperature of less than 135 °C and with type of protection encapsulation “ma” (EPL Da) for explosive dust atmospheres containing conductive dusts of Group IIIC with a maximum surface temperature of less than 120 °C. A single certificate has been prepared.

ABC company
Type RST
Serial No. 123456
Ex ma IIC T4 Ga alternate Ex ma IIC T4
Ex ma IIIC T120 °C Da alternate Ex ma IIIC T120 °C
IP67
N.A. 01.9999
.....
.....

Electrical equipment with type of protection encapsulation “ma” (EPL Ga) for explosive gas atmospheres of Group IIC with a maximum surface temperature of less than 135 °C and with type of protection encapsulation “ma” (EPL Da) for explosive dust atmospheres containing conductive dusts of Group IIIC with a maximum surface temperature of less than 120 °C. Two independent Certificates have been prepared.

ABC company
Type RST
Serial No. 123456
Ex ma IIC T4 Ga alternate Ex ma IIC T4
N.A. 01.1111

Ex ma IIIC T120 °C Da alternate Ex ma IIIC T120 °C
IP54
N.B. 01.9999
.....
.....

30 Instructions

30.1 General

The documentation prepared as required by Clause 24 shall include instructions, providing the following particulars as a minimum:

- a recapitulation of the information with which the electrical equipment is marked, except for the serial number (see Clause 29), together with any appropriate additional information to facilitate maintenance (for example, address of the importer, repairer, etc.);
- instructions for safety, i.e.
  - putting into service;
  - use;
  - assembling and dismantling;
  - maintenance, overhaul and repair;
  - installation;

– adjustment;

- where necessary, training instructions;
- details which allow a decision to be made as to whether the equipment can be used safely in the intended area under the expected operating conditions;
- electrical and pressure parameters, maximum surface temperatures and other limit values;
- where applicable, specific conditions of use according to 29.2 e);
- where applicable, any special conditions of use, including particulars of possible misuse which experience has shown might occur;
- where necessary, the essential characteristics of tools which may be fitted to the equipment;
- a list of the standards, including the issue date, with which the equipment is declared to comply. The certificate can be used to satisfy this requirement.

30.2 Cells and batteries

In accordance with 23.11, where it is necessary for the user to replace cells or batteries contained within an enclosure, the relevant parameters to allow correct replacement shall be included in the instructions, including either the manufacturer's name and part number, or the electrochemical system, nominal voltage and rated capacity.

Annex A
(normative)

Supplementary requirements for cable glands

A.1 General

This annex specifies the additional requirements for the construction, testing and marking of cable glands and may be further supplemented or modified by the standards listed in Clause 1.

NOTE The minimum diameter of cable for which the entry is suitable is specified by the manufacturer. The user should ensure that, taking tolerances into account, the minimum dimensions of the cable selected for use in the cable gland are equal to, or exceed, these specified values.

A.2 Constructional requirements

A.2.1 Cable sealing

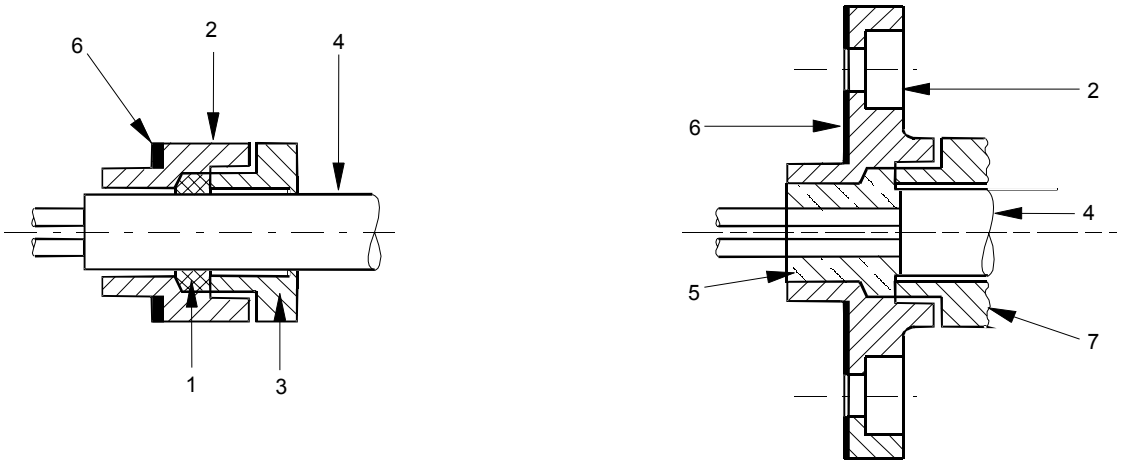
The cable sealing between the cable and the gland body shall be ensured by one of the following means (see Figure A.1):

– an elastomeric sealing ring;
– a metallic or composite sealing ring;
– a filling compound.

The cable sealing may be made of a single material or a combination of materials and shall be appropriate to the shape of the cable concerned.

NOTE 1 In selecting the materials for metallic or composite sealing rings, attention is drawn to Note 3 of 6.1.

NOTE 2 The type of protection of the enclosure may also depend on the internal construction of the cable.



Components

1 sealing ring
2 gland body
3 compression element
4 cable
5 filling compound
6 gasket (where required)
7 compound retaining element

Figure A.1 – Illustration of the terms used for cable glands

A.2.2 Filling compounds

Materials used as filling compounds shall comply with the requirements of Clause 12 for materials used for cementing.

A.2.3 Clamping

A.2.3.1 General

Cable glands shall provide clamping of the cable in order to prevent pulling or twisting applied to it from being transmitted to the connections. Such clamping can be provided by a clamping device, sealing ring or filling compound. Whichever clamping arrangement is used, it shall be capable of meeting the relevant type tests in Clause A.3.

A.2.3.2 Group II or III cable glands

Cable glands for Group II or III equipment, without a clamping device, shall also be accepted as complying with this annex if they are capable of passing the clamping tests with values reduced to 25 % of those required in Clause A.3. The descriptive documents shall then state that such cable glands may not provide sufficient clamping and that the user shall provide additional clamping of the cable to ensure that pulling and twisting is not transmitted to the terminations. Such cable glands shall be marked with the symbol “X” to indicate this specific condition of use according to item e) of 29.2.

A.2.4 Lead-in of cable

A.2.4.1 Sharp edges

Cable glands shall not have sharp edges capable of damaging the cable.

A.2.4.2 Point of entry

In the case of flexible cables, the point of entry shall include a rounded edge at an angle of at least 75°, the radius R of which is at least equal to one-quarter of the diameter of the maximum admissible cable in the entry but which need not exceed 3 mm (see Figure A.2).

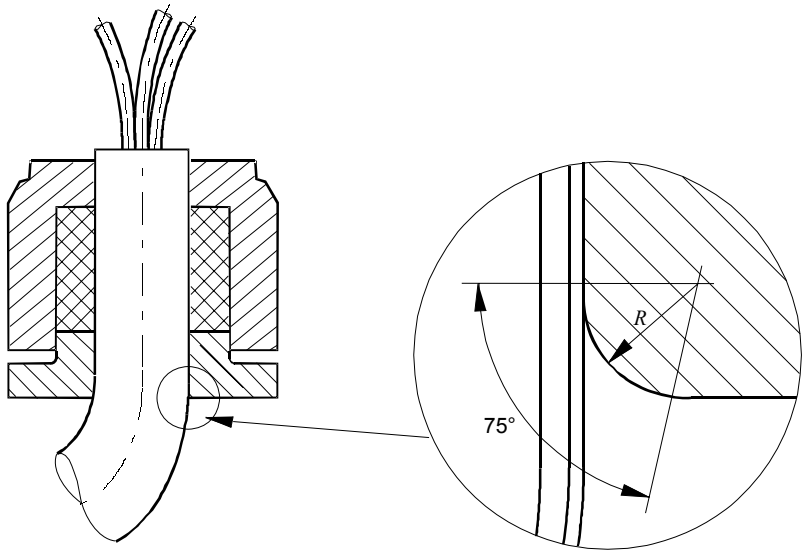


Figure A.2 – Rounded edge of the point of entry of the flexible cable

A.2.5 Release by a tool

Cable glands shall be designed so that after installation they are only capable of being released or dismantled by means of a tool.

A.2.6 Fixing

The means of fixing cable glands to enclosures of electrical equipment shall be capable of retaining the cable gland when subjected to the mechanical tests of clamping and resistance to impact in Clause A.3.

A.2.7 Degree of protection

Cable glands, when installed in accordance with the instructions required by Clause 30, shall be capable of providing, with the enclosure on which they are fixed, the same degree of protection as required for the enclosure.

Cable glands marked with a degree of protection (IP) shall be tested in accordance with A.3.4.

A.3 Type tests

A.3.1 Tests of clamping of non-armoured and braided cables

A.3.1.1 Cable glands with clamping by the sealing ring

The tests of clamping shall be carried out using for each type and size of cable gland, two sealing rings; one equal to the smallest admissible size and the other equal to the largest admissible size.

For elastomeric sealing rings for circular cables, each ring shall be mounted on a clean, dry, polished, cylindrical, steel or stainless steel mandrel, with a maximum surface roughness of 1,6 μm, Ra, equal to the smallest cable diameter allowable in the ring and specified by the manufacturer of the cable gland.

For non-circular cables, the ring for each type/size/shape of cable shall be mounted on a sample of dry, clean cable of dimensions equal to the size specified by the manufacturer of the cable gland. Such cable glands shall be marked with the symbol “X” to indicate this specific condition of use according to item e) of 29.2.

For metallic-sheathed cables, the ring for each size of cable shall be mounted on a sample of dry, clean cable constructed with the sheath material and with dimensions equal to the size as specified by the manufacturer of the cable gland. Such cable glands shall be marked with the symbol “X” to indicate this specific condition of use according to item e) of 29.2.

For metallic sealing rings, each ring shall be mounted on a clean, dry, polished, cylindrical, metal mandrel, with a maximum surface roughness of 1,6 μm, Ra, equal to the smallest cable diameter allowable in the ring and specified by the manufacturer of the cable gland.

The sealing ring with the mandrel or the cable, as appropriate, shall be fitted into the cable gland. A torque shall then be applied to the screws (in the case of a flanged compression element fitted with screws) or to the nut (in the case of a screwed compression element) to compress the sealing ring to prevent slipping of the mandrel or cable.

The complete cable gland and mandrel assembly shall then be subjected to the thermal endurance tests, if applicable. The maximum service temperature shall be considered to be 75 °C unless otherwise specified by the manufacturer.

NOTE 1 The 75 °C service temperature is the median of the branching point and entry point temperatures.

NOTE 2 Cable glands employing only metallic sealing rings and metallic parts do not require thermal endurance tests.

The sealing ring shall prevent slippage of the cable or mandrel when the force applied to the cable or mandrel, in newtons, is equal to

– 20 times the value in millimetres of the diameter of the mandrel or cable when the cable gland is designed for round cable, or
– 6 times the value in millimetres of the perimeter of the cable when the cable gland is designed for non-circular cable.

Where the direction of pull is other than horizontal, the means of application of the force shall be adjusted to compensate for the weight of the mandrel and associated parts.

For cable glands intended for use with braided cables, this clamping test is intended to demonstrate the effectiveness of the cable gland in clamping the cable, not the strength of the braid. Where the test is performed with braided cable, the braid shall not be clamped.

The test conditions and acceptance criteria are given in A.3.1.4.

NOTE 3 The torque figures referred to above may be determined experimentally prior to the tests or they may be supplied by the manufacturer of the cable gland.

A.3.1.2 Cable glands with clamping by filling compound

The tests of clamping shall be carried out for each type and size of cable glands using two samples of clean, dry cable or metal mandrels if applicable; one equal to the smallest admissible size and the other equal to the largest admissible size.

The available space shall be filled with the filling compound, which has been prepared and hardened in accordance with the manufacturer of the cable gland's instructions prior to being submitted to the tests.

The complete cable gland and mandrel assembly shall then be subjected to the thermal endurance tests. The maximum service temperature shall be considered to be 75 °C unless otherwise specified by the manufacturer.

NOTE The 75 °C service temperature is the median of the branching point and entry point temperatures.

The filling compound shall prevent slippage of the cable when the force applied, in newtons, is equal to

– 20 times the value in millimetres of the diameter of the cable sample when the cable gland is designed for circular cable, or
– 6 times the value in millimetres of the perimeter of the cable sample when the cable gland is designed for non-circular cable.

For cable glands intended for use with braided cables, this clamping test is intended to demonstrate the effectiveness of the cable gland in clamping the cable, not the strength of the braid. Where the design of the cable gland is such that the braid is intended to be surrounded by compound, the contact of the compound with the braid shall be minimized for this test.

The test conditions and acceptance criteria are given in A.3.1.4.

A.3.1.3 Cable glands with clamping by means of a clamping device

The clamping test shall be carried out on each type and size of cable gland for the different allowable sizes of each type of cable gland clamping device.

Each device shall be mounted on a sample of clean, dry cable of a size allowable in the device as specified by the manufacturer of the cable gland.

The clamping device with any required sealing ring and the largest size of cable allowable in that clamping device, as specified by the manufacturer of the cable gland, shall be fitted in the cable gland. The gland shall be assembled with compression of any required sealing ring and tightening of the clamping device. The test procedure shall be carried out in accordance with A.3.1.1 and then repeated with the smallest size of cable allowable in that clamping device, as specified by the manufacturer of the cable gland.

For cable glands intended for use with braided cables, this clamping test is intended to demonstrate the effectiveness of the cable gland in clamping the cable, not the strength of the braid. Where the test is performed with braided cable, the braid shall not be clamped.

A.3.1.4 Tensile test

The test sample, as prepared in A.3.1.1 to A.3.1.3, as appropriate, shall be subjected to a constant tensile force equal to that given in A.3.1.1 or A.3.1.2, as appropriate, shall be applied for not less than 6 h. The test shall be carried out at an ambient temperature of (20 ± 5) °C.

The clamping assured by the sealing ring, filling compound or by the clamping device shall be acceptable if the slippage of the mandrel or cable sample is not more than 6 mm.

A.3.1.5 Mechanical strength

After the tensile test, the cable gland shall be removed from the tensile testing machine and submitted to the tests and examinations of a) to c) as appropriate.

a) For cable glands with clamping by sealing ring or a clamping device, a mechanical strength test on which a torque of at least 1,5 times the value needed to prevent slipping shall be applied to the screws or nuts (whichever is the case). The cable gland shall then be dismantled and the components examined. The mechanical strength of the cable gland shall be acceptable if no deformation affecting the type of protection is found. Any deformation of the sealing rings shall be ignored.
b) For cable glands manufactured from non-metallic materials, it is possible that the prescribed proof torque cannot be met due to temporary deformations of the thread. If no noticeable damage is found, the cable gland shall be deemed to have passed the test if the tensile test of A.3.1.4 can still be achieved without adjustment.
c) For cable glands with clamping by filling compound, the gland shall be dismantled as far as possible without damaging the filling compound. Upon examination, there shall be no physical or visible damage to the filling compound that would affect the type of protection afforded.

A.3.2 Tests of clamping of armoured cables

A.3.2.1 Tests of clamping where the armourings are clamped by a device within the gland

The tests shall be carried out using a sample of armoured cable of the smallest size specified for each type and size of gland. The sample of armoured cable shall be fitted into the clamping device of the cable gland. A torque shall then be applied to the screws (in the case of a flanged clamping device) or to the nut (in the case of a screwed clamping device) in order to compress the clamping device and prevent slipping of the armour.

The complete cable gland and armoured cable shall then be subjected to the thermal endurance tests. The maximum service temperature shall be considered to be 75 °C unless otherwise specified by the manufacturer.

NOTE 1 The 75 °C service temperature is the median of the branching point and entry point temperatures.

NOTE 2 Cable glands employing only metallic sealing rings and metallic parts do not require thermal endurance tests. The clamping device should prevent slippage of the armour when the force applied to the armour, in newtons, is equal to:

– 80 times the value in millimetres of the diameter of the cable over the armour for Group I equipment, or

– 20 times the value in millimetres of the diameter of the cable over the armour for Group II or III equipment.

NOTE 3 The torque values referred to above may be determined experimentally prior to the tests, or they may be supplied by the manufacturer of the cable gland.

A.3.2.1.1 Tensile test

The test sample shall be subjected to a constant tensile force equal to that defined in A.3.2.1 shall be applied for (120 ± 10) s. The test shall be carried out at an ambient temperature of (20 ± 5) °C.

The clamping assured by the clamping device shall be acceptable if the slipping of the armour is effectively negligible.

A.3.2.1.2 Mechanical strength

Where screws and nuts are fitted they shall be tightened to at least 1,5 times the values in A.3.2.1.1 and then the cable gland dismantled. The mechanical strength shall be acceptable if no deformation affecting the type of protection is found.

A.3.2.2 Tests of clamping where the armourings are not clamped by a device within the gland

The cable gland shall be treated as if it were a non-armoured type according to A.3.1.

A.3.3 Type test for resistance to impact

For the tests of 26.4.2, the cable gland shall be tested with the smallest specified cable fitted.

For testing purposes, the cable gland shall be fixed on a rigidly mounted steel plate or secured as specified by the manufacturer of the cable gland. The torque applied in fixing the threaded cable gland shall be according to A.3.2.1.

A.3.4 Test for degree of protection (IP) of cable glands

The test shall be carried out in accordance with IEC 60529 as below, using one cable-sealing ring of each of the different permitted sizes for each type of cable gland.

Group I – IP54 Minimum

Group II – IP54 minimum

Group III, EPL Da – IP6X minimum

Group III, EPL Db – IP6X minimum

Group IIIC, EPL Dc – IP6X minimum

Group IIIA or IIIB, EPL Dc – IP5X minimum

For sealing tests, each sealing ring shall be mounted on a sample of clean, dry cable; or a clean, dry, polished, metal mandrel, with a maximum surface roughness of 1,6 μm Ra, of a diameter equal to the smallest diameter allowable in the ring as specified by the manufacturer of the cable gland. For the purposes of this test, the cable gland with cable or mandrel shall be tested after being fixed to a suitable enclosure ensuring that the sealing method at the interface between the gland and enclosure does not compromise the test results.

A.4 Marking

A.4.1 Marking of cable glands

Cable glands shall be marked in accordance with 29.2, including type of protection “e”, and, if a threaded entry, with the type and size of thread.

NOTE 1 The additional requirements for cable glands of type of protection “d” are found in IEC 60079-1.

NOTE 2 The additional requirements for cable glands of type of protection “t” are found in IEC 60079-31.

Where marking space is limited, the reduced marking requirements of 29.9 may be applied.

A.4.2 Marking of cable-sealing rings

The cable-sealing rings for cable glands that allow a variety of ring sizes shall be marked with the minimum and maximum diameters, in millimetres, of the permitted cables.

When the cable-sealing ring is bound with a metal washer, the marking may be made on the washer.

The cable-sealing rings shall be identified allowing the user to determine if the ring is appropriate for the cable gland.

Where the gland and the ring are intended to be used at service temperatures outside the range –20 °C to +80 °C, they shall be marked with the temperature range.

Annex B
(normative)

Requirements for Ex components

Ex components shall comply with the requirements of the clauses listed in Table B.1.

Table B.1 – Clauses with which Ex components shall comply

Clause or subclause	Applies (yes or no)	Remarks
1 to 4 (inclusive)	Yes	
5	No	Except that the operating temperature limits shall be specified
6.1	Yes	
6.2	No	
6.3	No	
6.4	No	
6.5	Yes	
6.6	Yes	
7.1	Yes	
7.1.4	Yes	See Note 1
7.3	Yes	If external (see Note 1)
7.4	Yes	If external (see Note 1)
7.5	Yes	If external (see Note 1)
8	Yes	
9.1	Yes	
9.2	Yes	But only if it is an equipment enclosure
9.3	Yes	But only if it is an equipment enclosure
10	Yes	
11	Yes	
12	Yes	
13	Yes	
14	Yes	
15.1.1	Yes	But only if it is an equipment enclosure
15.1.2	Yes	But only if it is an equipment enclosure
15.2	Yes	
15.3	Yes	
15.4	Yes	
15.5	Yes	
16	Yes	But only if it is an equipment enclosure
17	No	Except for machine enclosures
18	Yes	
19	Yes	
20	Yes	
21	Yes	
22.1	Yes	
22.2	No	
23	Yes	

Table B.1 *(continued)*

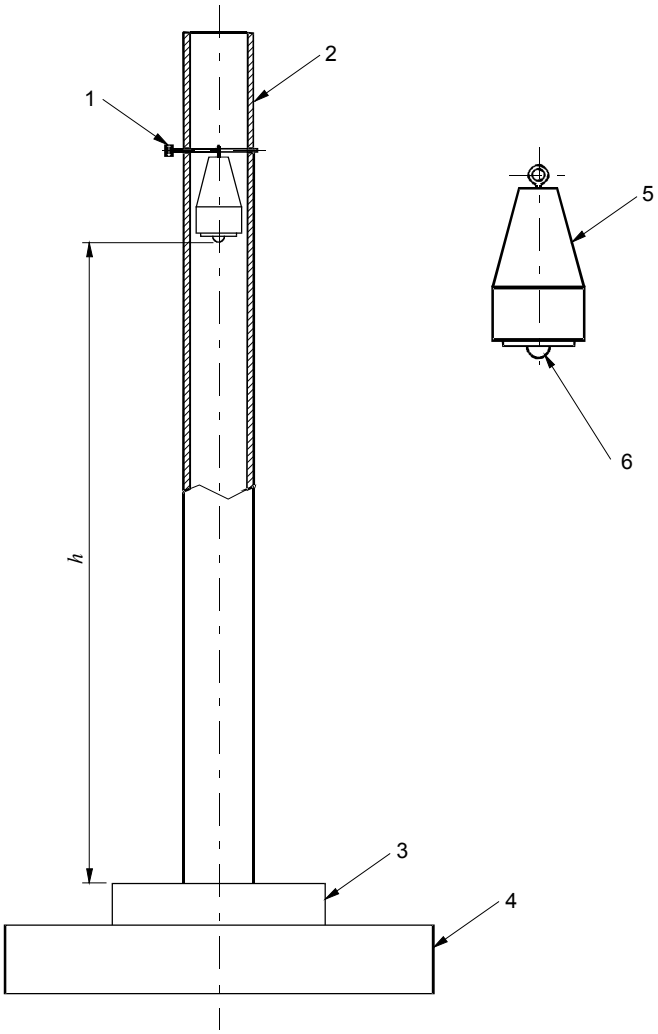
Clause or subclause	Applies (yes or no)	Remarks
24	Yes	
25	Yes	
26.1	Yes	
26.2	No	
26.3	Yes	
26.4	Yes	But only if it is an equipment enclosure
26.5	Yes	But only if it is an equipment enclosure
26.5.1	No	
26.5.2	Yes	Where the maximum temperature is specified
26.5.3	Yes	Where the “small component” relaxation has been employed
26.6	Yes	
26.7	Yes	Where the maximum temperature is specified
26.8	Yes	
26.9	Yes	
26.10	Yes	But only if it is an equipment enclosure
26.11	Yes	But only if it is a Group I equipment enclosure
26.12	Yes	But only if it an equipment enclosure
26.13	Yes	But only if it an equipment enclosure
26.14	Yes	But only if it an equipment enclosure
26.15	Yes	But only if it an equipment enclosure
27	Yes	
28	Yes	
29.1	Yes	Marking is required on the Ex component
29.2	No	
29.3	Yes	See Note 2
29.4	Yes	See Note 2
29.5	Yes	
29.6	Yes	
29.7	Yes	
29.8	Yes	
29.9	Yes	
29.10	Yes	
29.11	No	
29.12	Yes	
29.13	Yes	
29.14	No	
30	Yes	

NOTE 1 It is necessary to consider the circumstances in which these requirements apply to components placed in other enclosures.

NOTE 2 The temperature classification is not applied to Ex components.

Annex C
(informative)

Example of rig for resistance to impact test



Components

1	adjustment pin	5	steel mass of 1 kg
2	plastic guide tube	6	impact head of hardened steel, 25 mm in diameter
3	test piece	*h*	height of fall
4	steel base (mass ≥20 kg)		

Figure C.1 – Example of rig for resistance to impact test

Annex D
(informative)

Introduction of an alternative risk assessment method encompassing “equipment protection levels” for Ex equipment

This annex provides an explanation of the concept of a risk assessment method encompassing equipment protection levels (EPLs). These EPLs are introduced to enable an alternative approach to current methods of selecting Ex equipment.

D.1 Historical background

Historically, it has been acknowledged that not all types of protection provide the same level of assurance against the possibility of an incendive condition occurring. The installation standard, IEC 60079-14, allocates specific types of protection to specific zones, on the statistical basis that the more likely or frequent the occurrence of an explosive atmosphere, the greater the level of security required against the possibility of an ignition source being active.

Hazardous areas (with the normal exception of coal mining) are divided into zones, according to the degree of hazard. The degree of hazard is defined according to the probability of the occurrence of explosive atmospheres. Generally, no account is taken of the potential consequences of an explosion, nor of other factors such as the toxicity of materials. A true risk assessment would consider all factors.

Acceptance of equipment into each zone is historically based on the type protection. In some cases the type of protection may be divided into different levels of protection which again historically correlate to zones. For example, intrinsic safety is divided into levels of protection ia and ib. The encapsulation “m” standard includes two levels of protection ‘’ma’’ and ‘’mb’’.

In the past, the equipment selection standard has provided a solid link between the type of protection for the equipment and the zone in which the equipment can be used. As noted earlier, nowhere in the IEC system of explosion protection is there any account taken of the potential consequences of an explosion, should it occur.

However, plant operators often make intuitive decisions on extending (or restricting) their zones in order to compensate for this omission. A typical example is the installation of "zone 1 type" navigation equipment in zone 2 areas of offshore oil production platforms, so that the navigation equipment can remain functional even in the presence of a totally unexpected prolonged gas release. In the other direction, it is reasonable for the owner of a remote, well secured, small pumping station to drive the pump with a "zone 2 type" motor, even in zone 1, if the total amount of gas available to explode is small and the risk to life and property from such an explosion can be discounted.

The situation became more complex with the publication of the first edition of IEC 60079-26 which introduced additional requirements to be applied for equipment intended to be used in zone 0. Prior to this, Ex ia was considered to be the only technique acceptable in zone 0.

It has been recognized that it is beneficial to identify and mark all products according to their inherent ignition risk. This would make equipment selection easier and provide the ability to better apply a risk assessment approach, where appropriate.

D.2 General

A risk assessment approach for the acceptance of Ex equipment has been introduced as an alternative method to the current prescriptive and relatively inflexible approach linking equipment to zones. To facilitate this, a system of equipment protection levels has been introduced to clearly indicate the inherent ignition risk of equipment, no matter what type of protection is used.

The system of designating these equipment protection levels is as follows.

D.2.1 Mines susceptible to firedamp (Group I)

D.2.1.1 EPL Ma

Equipment for installation in a mine susceptible to firedamp, having a "very high" level of protection, which has sufficient security that it is unlikely to become an ignition source in normal operation, during expected malfunctions or during rare malfunctions, even when left energized in the presence of an outbreak of gas.

NOTE Typically communications circuits and gas detection equipment will be constructed to meet the Ma requirements – for example an Ex ia telephone circuit.

D.2.1.2 EPL Mb

Equipment for installation in a mine susceptible to firedamp, having a "high" level of protection, which has sufficient security that it is unlikely to become a source of ignition in normal operation or during expected malfunctions in the time span between there being an outbreak of gas and the equipment being de-energized.

NOTE Typically Group I equipment will be constructed to meet the Mb requirements – for example Ex d motors and switchgear.

D.2.2 Gases (Group II)

D.2.2.1 EPL Ga

Equipment for explosive gas atmospheres, having a "very high" level of protection, which is not a source of ignition in normal operation, during expected malfunctions or during rare malfunctions.

D.2.2.2 EPL Gb

Equipment for explosive gas atmospheres, having a "high" level of protection, which is not a source of ignition in normal operation or during expected malfunctions.

NOTE The majority of the standard protection concepts bring equipment within this equipment protection level.

D.2.2.3 EPL Gc

Equipment for explosive gas atmospheres, having a "enhanced" level of protection, which is not a source of ignition in normal operation and which may have some additional protection to ensure that it remains inactive as an ignition source in the case of regular expected occurrences (for example failure of a lamp).

NOTE Typically, this will be Ex n equipment.

D.2.3 Dusts (Group III)

D.2.3.1 EPL Da

Equipment for combustible dust atmospheres, having a "very high" level of protection, which is not a source of ignition in normal operation, during expected malfunctions, or during rare malfunctions.

D.2.3.2 EPL Db

Equipment for combustible dust atmospheres, having a "high" level of protection, which is not a source of ignition in normal operation or during expected malfunctions.

D.2.3.3 EPL Dc

Equipment for combustible dust atmospheres, having an "enhanced" level of protection, which is not a source of ignition in normal operation and which may have some additional protection to ensure that it remains inactive as an ignition source in the case of regular expected occurrences. for example failure of a lamp).

For the majority of situations, with typical potential consequences from a resultant explosion, it is intended that the following would apply for use of the equipment in zones. (This is not directly applicable for mines susceptible to firedamp, as the zone concept does not generally apply). See Table D.1.

Table D.1 – Traditional relationship of EPLs to zones (no additional risk assessment)

Equipment protection level	Zone
Ga	0
Gb	1
Gc	2
Da	20
Db	21
Dc	22

D.3 Risk of ignition protection afforded

The various levels of protection of equipment must be capable of functioning in conformity with the operational parameters established by the manufacturer to that level of protection. See Table D.2.

Table D.2 – Description of risk of ignition protection provided

Protection afforded	Equipment protection level Group	Performance of protection	Conditions of operation
Very high	Ma Group I	Two independent means of protection or safe even when two malfunctions occur independently of each other	Equipment remains functioning when explosive atmosphere present
Very high	Ga Group II	Two independent means of protection or safe even when two malfunctions occur independently of each other	Equipment remains functioning in zones 0, 1 and 2
Very high	Da Group III	Two independent means of protection or safe even when two malfunctions occur independently of each other	Equipment remains functioning in zones 20, 21 and 22
High	Mb Group I	Suitable for normal operation and severe operating conditions	Equipment de-energized when explosive atmosphere present
High	Gb Group II	Suitable for normal operation and frequently occurring disturbances or equipment where malfunctions are normally taken into account	Equipment remains functioning in zones 1 and 2
High	Db Group III	Suitable for normal operation and frequently occurring disturbances or equipment where malfunctions are normally taken into account	Equipment remains functioning in zones 21 and 22
Enhanced	Gc Group II	Suitable for normal operation	Equipment remains functioning in zone 2
Enhanced	Dc Group III	Suitable for normal operation	Equipment remains functioning in zone 22

D.4 Implementation

The fourth edition of IEC 60079-14 (encompassing the former requirements of IEC 61241-14) will introduce the EPLs to allow a system of “risk assessment" as an alternative method for the selection of equipment. Reference will also be included in the classification standards IEC 60079-10 and IEC 61241-10.

The additional marking and the correlation of the existing types of protection are being introduced into the revisions to the following IEC standards:

- IEC 60079-0 (encompassing the former requirements of IEC 61241-0)
- IEC 60079-1
- IEC 60079-2 (encompassing the former requirements of IEC 61241-4)
- IEC 60079-5

- IEC 60079-6
- IEC 60079-7
- IEC 60079-11 (encompassing the former requirements of IEC 61241-11)
- IEC 60079-15
- IEC 60079-18 (encompassing the former requirements of IEC 61241-18)
- IEC 60079-26
- IEC 60079-28

For the types of protection for explosive gas atmospheres the EPLs require additional marking. For explosive dust atmospheres the present system of marking the zones on equipment is being replaced by marking the EPLs.

Annex E
(informative)

Motors supplied by converters

It is normally expected that motors and converters are evaluated as a system. When motors are supplied from a converter to enable operation at varying speeds and loads, it is necessary to establish the thermal performance with the particular converter (and output filter, if used) throughout the specified speed and torque range. This needs to be done through a combination of type testing and calculation. The specific methods to be used are described in the specific standards for the type of protection.

NOTE 1 Because of possible difficulties in arranging a test with the exact motor/converter combination, tests using a similar converter may be acceptable subject to comparison of the characteristics.

NOTE 2 Additional factors may also need to be taken into account, in discussion between manufacturer, user and installer. These include the provision by the user of additional output filters, or reactors, and the length of cable between converter and motor, which both affect motor input voltage and can cause additional motor heating.

For some types of protection, it will usually be necessary to use a protective device. This device needs to be specified in the documentation and its effectiveness needs to be proven by test or by calculation.

NOTE 3 High-frequency switching in converters can lead to rapid rise time voltage stress in the windings and cable circuits and therefore a further potential source of ignition. It is necessary to consider the effects of this stress according to the type of protection. In some circumstances, it will be necessary to add an additional output filter after the converter.

The descriptive documentation for the motor needs to include the necessary parameters and conditions required for use with a converter.

NOTE 4 Bearing currents require special consideration. Possible solutions include the use of insulated bearings, either alone, or in combination with, a filter that reduces common mode voltages and/or dv/dt. Further information is given in IEC TS 60034-17 and IEC 60034-25.

Bibliography

IEC TS 60034-17, *Rotating electrical machines – Part 17: Cage induction motors when fed from converters – Application guide*

IEC TR 60034-25, *Rotating electrical machines – Part 25: Guidance for the design and performance of a.c. motors specifically designed for converter supply*

IEC 60079-10, *Electrical apparatus for explosive gas atmospheres – Part 10: Classification of hazardous areas*

IEC TR 60079-12, *Electrical apparatus for explosive gas atmospheres – Part 12: Classification of mixtures of gases or vapours with air according to their maximum experimental safe gaps and minimum igniting currents*

IEC 60079-14, *Electrical apparatus for explosive gas atmospheres – Part 14: Electrical installations in hazardous areas (other than mines)*

IEC 60079-17, *Electrical apparatus for explosive gas atmospheres – Part 17: Inspection and maintenance of electrical installations in hazardous areas (other than mines)*

IEC 60079-19, *Explosive atmospheres – Part 19: Equipment repair, overhaul and reclamation*

IEC TR 60079-20, *Electrical apparatus for explosive gas atmospheres – Part 20: Data for flammable gases and vapours, relating to the use of electrical apparatus*

IEC 60079-27: *Electrical apparatus for explosive gas atmospheres – Part 27: Fieldbus intrinsically safe concept (FISCO)and fieldbus non-incendive concept (FNICO)*

IEC 61241-2-1:1994, *Electrical apparatus for use in the presence of combustible dust – Part 2: Test methods – Section 1: Methods for determining the minimum ignition temperatures of dust*

IEC TR 61241-2-2, *Electrical apparatus for use in the presence of combustible dust – Part 2:Test methods – Section 2:Method for determining the electrical resistivity of dust in layers*

IEC 61241-14, *Electrical apparatus for use in the presence of combustible dust – Part 14: Selection and installation*

ISO/IEC 17000, *Conformity assessment – General vocabulary and general principles*

ISO 4225: 1994, *Air quality – General aspects – Vocabulary*

CLC/TR50427 – *Assessment of inadvertent ignition of flammable atmospheres by radio-frequency radiation – Guide*

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BUREAU OF INDIAN STANDARDS

Headquarters:

Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi 110002
Telephones: 2323 0131, 2323 3375, 2323 9402 *Website*: www.bis.org.in

Regional Offices: *Telephones*

Central : Manak Bhavan, 9 Bahadur Shah Zafar Marg, NEW DELHI 110002 — 2323 7617, 2323 3841

Eastern : 1/14, C.I.T. Scheme VII M, V.I.P. Road, Kankurgachi, KOLKATA 700054 — 2337 8499, 2337 8561, 2337 8626, 2337 9120

Northern : SCO 335-336, Sector 34-A, CHANDIGARH 160022 — 260 3843, 260 9285

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