

# INTERNATIONAL STANDARD

# IEC 60079-0

Fourth edition  
2004-01

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## Electrical apparatus for explosive gas atmospheres –

### Part 0: General requirements

*This **English-language** version is derived from the original **bilingual** publication by leaving out all French-language pages. Missing page numbers correspond to the French-language pages.*



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### Part 0: General requirements

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## CONTENTS

FOREWORD.....	11
INTRODUCTION.....	17
1 Scope.....	19
2 Normative references.....	21
3 Terms and definitions.....	27
4 Apparatus grouping and temperature classification.....	39
4.1 Apparatus grouping.....	39
4.2 Group II.....	39
5 Temperatures.....	39
5.1 Environmental influences.....	39
5.2 Service temperature.....	41
5.3 Maximum surface temperature.....	41
5.4 Surface temperature and ignition temperature.....	43
5.5 Small components.....	43
6 Requirements for all electrical apparatus.....	45
6.1 General.....	45
6.2 Mechanical strength of apparatus.....	45
6.3 Opening times.....	45
6.4 Circulating currents.....	47
6.5 Gasket retention.....	47
7 Non-metallic enclosures and non-metallic parts of enclosures.....	47
7.1 General.....	47
7.2 Thermal endurance.....	49
7.3 Electrostatic charges on external non-metallic materials of enclosures.....	49
7.4 Threaded holes.....	51
8 Enclosures containing light metals.....	53
8.1 Material composition.....	53
8.2 Threaded holes.....	53
Fasteners.....	53
9.1 General.....	53
9.2 Special fasteners.....	55
9.3 Holes for special fasteners.....	55
10 Interlocking devices.....	59
11 Bushings.....	59
12 Materials used for cementing.....	59
13 Ex components.....	59
13.1 General.....	59
13.2 Mounting internal to apparatus.....	59
13.3 Mounting external to apparatus.....	61
14 Connection facilities and terminal compartments.....	61
14.1 General.....	61
14.2 Connection space.....	61
14.3 Type of protection.....	61
14.4 Creepage and clearance.....	61

15	Connection facilities for earthing or bonding conductors .....	61
15.1	Internal.....	61
15.2	External.....	61
15.3	Apparatus not requiring earthing .....	63
15.4	Size of conductor connection.....	63
15.5	Protection against corrosion .....	63
15.6	Secureness .....	63
16	Entries into enclosures .....	65
16.1	General .....	65
16.2	Identification of entries .....	65
16.3	Cable glands .....	65
16.4	Blanking elements .....	65
16.5	Conductor temperature.....	65
17	Supplementary requirements for rotating electrical machines .....	67
17.1	Fans and fan hoods.....	67
17.2	Ventilation openings for external fans.....	67
17.3	Construction and mounting of the ventilating systems .....	69
17.4	Clearances for the ventilating system .....	69
17.5	Materials for external fans and fan hoods .....	69
17.6	Equipotential bonding conductors.....	69
18	Supplementary requirements for switchgear .....	69
18.1	Flammable dielectric .....	69
18.2	Disconnectors .....	71
18.3	Group I – Provisions for locking.....	71
18.4	Doors and covers .....	71
19	Supplementary requirements for fuses .....	73
20	Supplementary requirements for plugs and sockets .....	73
20.1	Interlocking .....	73
20.2	Energized plugs .....	73
21	Supplementary requirements for luminaires .....	73
21.1	General .....	73
21.2	Covers .....	75
21.3	Special lamps.....	75
22	Supplementary requirements for caplights and handlights .....	75
22.1	Group I caplights and handlights .....	75
22.2	Group II caplights and handlights .....	75
23	Apparatus incorporating cells and batteries .....	77
23.1	Batteries.....	77
23.2	Cell types .....	77
23.3	Cells in a battery .....	79
23.4	Ratings of batteries .....	79
23.5	Mixture of cells .....	79
23.6	Interchangeability .....	79
23.7	Charging of primary batteries .....	79
23.8	Leakage .....	79

23.9	Connections .....	81
23.10	Orientation.....	81
23.11	Replacement of cells or batteries.....	81
24	Documentation .....	81
25	Compliance of prototype or sample with documents .....	81
26	Type tests .....	81
26.1	General .....	81
26.2	Test configuration.....	81
26.3	Tests in explosive test mixtures .....	81
26.4	Tests of enclosures .....	83
26.5	Thermal tests.....	91
26.6	Torque test for bushings .....	93
26.7	Non-metallic enclosures or non-metallic parts of enclosures .....	95
26.8	Thermal endurance to heat.....	95
26.9	Thermal endurance to cold .....	97
26.10	Resistance to light.....	97
26.11	Resistance to chemical agents for Group I electrical apparatus .....	99
26.12	Earth continuity .....	99
26.13	Surface resistance test of parts of enclosures of non-metallic materials.....	101
26.14	Charging tests .....	103
26.15	Measurement of capacitance .....	111
27	Routine verifications and tests.....	111
28	Manufacturer's responsibility .....	111
28.1	Certificate.....	111
28.2	Responsibility for marking.....	111
29	Marking .....	111
29.1	Location .....	113
29.2	General .....	113
29.3	Different types of protection.....	115
29.4	Order of marking.....	117
29.5	Ex components.....	117
29.6	Small apparatus and Ex components .....	117
29.7	Extremely small apparatus and Ex components .....	117
29.8	Warning markings.....	117
29.9	Cells and batteries.....	119
29.10	Examples of marking .....	119
30	Instructions.....	121
30.1	General .....	121
30.2	Cells and batteries.....	123
Annex A (normative) Ex cable glands.....		125
Annex B (normative) Requirements for Ex components.....		139
Annex C (informative) Example of rig for resistance to impact test.....		143
Bibliography.....		145

Figure 1 – Tolerances and clearance for threaded fasteners .....	57
Figure 2 – Contact surface under head of fastener with a reduced shank .....	57
Figure 3 – Illustration of entry points and branching points .....	67
Figure 4 – Assembly of test sample for earth-continuity test.....	101
Figure 5 – Test piece with painted electrodes .....	103
Figure 6 – Rubbing with a pure nylon cloth .....	107
Figure 7 – Discharging of a container with a probe connected to earth via a 0,1 $\mu$ F capacitor.....	109
Figure 8 – Charging by influence with a d.c. voltage power supply.....	109
Figure A.1 – Illustration of the terms used for cable glands .....	125
Figure A.2 – Rounded edge of the point of entry of the flexible cable .....	129
Figure C.1 – Example of rig for resistance to impact test .....	143
Table 1 – Ambient temperatures in service and additional marking .....	41
Table 2 – Classification of maximum surface temperatures for Group II electrical apparatus .....	43
Table 3 – Assessment for T4 classification according to component size and ambient temperature .....	43
Table 4 – Limitations of areas .....	51
Table 5 – Minimum cross-sectional area of protective conductors .....	63
Table 6 – Primary cells .....	77
Table 7 – Secondary cells.....	79
Table 8 – Tests for resistance to impact.....	87
Table 9 – Torque to be applied to the stem of bushing used for connection facilities.....	95
Table 10 – Text of warning markings .....	119
Table B.1 – Clauses with which Ex components shall comply .....	139

## INTERNATIONAL ELECTROTECHNICAL COMMISSION

**ELECTRICAL APPARATUS FOR EXPLOSIVE  
GAS ATMOSPHERES –****Part 0: General requirements**

## FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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International Standard IEC 60079-0 has been prepared by technical committee 31: Electrical apparatus for explosive atmospheres.

This fourth edition cancels and replaces the third edition, published in 1998, and constitutes a full technical revision.

The significant changes with respect to the previous edition are listed below:

- Standard atmospheric conditions re-introduced
- All requirements for third-party certification removed
- New type of protection "n" introduced
- New apparatus standards for caplights, intrinsically safe systems, Zone 0 apparatus, and trace heating introduced
- Clarification of the status of symbol "s"
- Definitions for symbols "U" and "X" revised to align with current usage

- Definition for Ex component transferred from IEC 60079-18
- New definitions drafted for “energy limited” parameters to allow common usage by types of protection “i” and “n”
- New definitions for batteries transferred from IEC 60079-7
- Definition added for ambient temperature
- Definition added for continuous operating temperature (COT)
- Definition for certificate transferred from IEC 60079-15 and revised based on ISO/IEC 17000
- Definition added for cable gland
- Clause 5 for temperature re-written to address the influences of ambient temperature, internal sources of heat, and external sources of heating or cooling
- Small component ignition test transferred from IEC 60079-11 and IEC 60079-15
- Requirements for bonding transferred from IEC 60079-7 and IEC 60079-15
- Requirements for gasket retention transferred from IEC 60079-15 for wider applicability
- Relative thermal index (RTI) added as an alternative to thermal index (TI)
- Electrostatic requirements transferred and rationalized from IEC 60079-15 and IEC 60079-26 to apply to all of Group I and Group II
- Introduction of two additional test methods to evaluate the use of non-metallic materials with respect to the storage of electrostatic charges
- Light metal requirements transferred and rationalized from IEC 60079-15 and IEC 60079-26 to apply to all of Group I and Group II
- Introduction of an existing test to evaluate the use of a non-metallic enclosure wall in an earth bonding connection
- Clause 16 rewritten to align with industry usage of the terms *cable gland* and *conduit entry*.
- Equipotential bonding requirements for machines transferred from IEC 60079-7 and IEC 60079-15
- Requirement for disconnectors in switchgear and luminaires revised to provide IP20 protection for live parts and include additional marking
- General requirements for cells and batteries transferred from IEC 60079-7 and IEC 60079-15
- Impact test revised to specify drop height in lieu of energy
- Clarification of application of 5 °C and 10 °C temperature margins to type-tested samples
- Clarification of order of tests for metallic materials
- Clarification of number of samples and order of tests for non-metallic materials
- Clarification of order of marking
- Clarification of marking details for associated apparatus
- Clarification of marking of specific gases
- Clarification of marking of temperature class
- Clarification of usage of compulsory certificate number

- Clarification of marking of small apparatus
- Compilation of all warning markings into a table
- Clarification of marking examples
- Addition of a clause on instructions
- Deletion of Annex A as information is available in more appropriate standards (IEC 60079-20)
- Revision and clarification of Annex A (previously Annex B) to accommodate term *cable gland*

The text of this standard is based on the following documents:

FDIS	Report on voting
31/474A/FDIS	31/487/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

The committee has decided that the contents of this publication will remain unchanged until 2008. At this date, the publication will be

- reconfirmed;
- withdrawn;
- replaced by a revised edition, or
- amended.

## INTRODUCTION

It is acknowledged that, with developments in technology, it will 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. In this case, the letter “s” has been reserved to indicate a method of protection that is not fully defined in the standards. Compliance with this standard cannot be claimed in these circumstances.

# ELECTRICAL APPARATUS FOR EXPLOSIVE GAS ATMOSPHERES –

## Part 0: General requirements

### 1 Scope

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

Unless modified by one of the parts in the IEC 60079 series, electrical apparatus complying with this standard is intended for use in hazardous areas in which explosive gas atmospheres, caused by mixtures of air and gases, vapours or mists, exist under normal atmospheric conditions of

- temperature  $-20\text{ °C}$  to  $+60\text{ °C}$ ;
- 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 apparatus in atmospheric conditions outside this range may need special consideration.

NOTE 1 The determination of the maximum surface temperature is based on an operational ambient temperature of  $-20\text{ °C}$  to  $+40\text{ °C}$ , if not otherwise specified by the manufacturer. See also 5.1.1.

NOTE 2 In designing apparatus for operation in explosive gas atmospheres under conditions other than the atmospheric conditions given above, this standard may be used as a guide. However, additional testing related specifically to the intended conditions of use is recommended. This is particularly important when the types of protection 'flameproof enclosures "d"' (IEC 60079-1) and 'intrinsic safety "i"' (IEC 60079-11) 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. For other ignition sources like adiabatic compression, shock waves, exothermic chemical reaction, self ignition of dust, naked flames, hot gases/liquids the apparatus are subjected to a hazard analysis that identifies and lists all of the potential sources of ignition by the electrical apparatus and the measures to be applied to prevent them becoming effective.

This standard does not specify requirements for safety, other than those directly related to the explosion risk.

This standard is supplemented or modified by the following parts of IEC 60079 concerning specific types of protection:

- IEC 60079-1: Flameproof enclosures "d";
- IEC 60079-2: Pressurized enclosures "p";
- IEC 60079-5: Powder filling "q";
- IEC 60079-6: Oil immersion "o";
- IEC 60079-7: Increased safety "e";
- IEC 60079-11: Intrinsic safety "i";
- IEC 60079-15: Type of protection "n";
- IEC 60079-18: Encapsulation "m".

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

- IEC 60079-25
- IEC 60079-26
- IEC 62013-1
- IEC 62086-1.

This part of IEC 60079, along with other parts in the IEC 60079 series and the additional standards mentioned above, is not applicable to the construction of electromedical apparatus, shot-firing exploders, test devices for exploders and for 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 60034-5, *Rotating electrical machines – Part 5: Degrees of protection provided by the integral design of rotating electrical machines (IP code) – Classification*

IEC 60079-1, *Electrical apparatus for explosive gas atmospheres – Part 1: Flameproof enclosures "d"*

IEC 60079-2, *Electrical apparatus for explosive gas atmospheres – Part 2: Pressurized enclosures "p"*

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

IEC 60079-5, *Electrical apparatus for explosive gas atmospheres – Part 5: Powder filling "q"*

IEC 60079-6, *Electrical apparatus for explosive gas atmospheres – Part 6: Oil-immersion "o"*

IEC 60079-7, *Electrical apparatus for explosive gas atmospheres – Part 7: Increased safety "e"*

IEC 60079-10, *Electrical apparatus for explosive gas atmospheres – Part 10: Classification of hazardous areas*

IEC 60079-11, *Electrical apparatus for explosive gas atmospheres – Part 11: Intrinsic safety "i"*

IEC 60079-15, *Electrical apparatus for explosive gas atmospheres – Part 15: Type of protection "n"*

IEC 60079-18, *Electrical apparatus for explosive gas atmospheres – Part 18: Encapsulation "m"*

IEC 60079-25: *Electrical apparatus for explosive gas atmospheres – Part 25: Intrinsically safe systems*<sup>1</sup>

IEC 60079-26: *Electrical apparatus for explosive gas atmospheres – Part 26: Construction, test and marking of zone 0 electrical apparatus*<sup>2</sup>

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, *Guide for the determination of thermal endurance properties of electrical insulating materials – Part 2: Choice of test criteria*

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

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

IEC 61150, *Alkaline secondary cells and batteries – Sealed nickel-cadmium rechargeable monobloc batteries in button cell design*

IEC 61436, *Secondary cells and batteries containing alkaline or other non-acid electrolytes – Sealed nickel-metal hydride rechargeable single cells*

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

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 62086-1: *Electrical apparatus for explosive gas atmospheres – Electrical resistance trace heating – Part 1: General and testing requirements*

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<sup>1</sup> To be published.

<sup>2</sup> In preparation.

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, *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 definitions apply.

#### 3.1

##### **ambient temperature**

temperature of the air or other media, in the immediate vicinity of the apparatus or component

NOTE This does not refer to the temperature of any process media, unless the apparatus 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 gas atmosphere;
- b) electrical apparatus not so protected and which therefore is not to be used within an explosive gas atmosphere, for example, a recorder which is not of itself in an explosive gas atmosphere but is connected to a thermocouple situated within an explosive gas 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 6 and 7 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****open cell or battery**

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

[IEV 486-01-18]

**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

[IEV 486-01-20 and IEV 486-01-21, modified]

**3.3.14****secondary cell or battery**

electrically rechargeable electrochemical system capable of storing electrical energy and delivering it by chemical reaction

**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 apparatus 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 apparatus enclosure but certified as an apparatus and which can be fitted to the apparatus 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 DIS 17000.

### 3.7

#### **conduit entry**

means of introducing a conduit into an electrical apparatus 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 apparatus, 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 apparatus 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 apparatus against ingress of solid foreign objects, and
- where indicated by the classification, protection of the electrical apparatus against harmful ingress of water

NOTE The enclosure which provides the degree of protection IP is not necessarily identical to the apparatus enclosure for the types of protection listed in Clause 1.

### 3.11

#### **electrical apparatus**

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.

### 3.12

#### **electrical parameters – apparatus with energy limitation**

##### 3.12.1

##### **maximum external capacitance**

$C_o$

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

##### 3.12.2

##### **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

##### 3.12.3

##### **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

##### 3.12.4

##### **maximum input power**

$P_i$

power that can be applied to the connection facilities of apparatus without invalidating the type of protection

##### 3.12.5

##### **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

##### 3.12.6

##### **maximum internal capacitance**

$C_i$

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

##### 3.12.7

##### **maximum internal inductance**

$L_i$

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

**3.12.8****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

**3.12.9****maximum output power** $P_o$ 

maximum electrical power that can be taken from the apparatus

**3.12.10****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

**3.12.11****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

**3.13****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 apparatus

**3.14****Ex component**

part of electrical apparatus 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 apparatus or systems for use in explosive gas atmospheres

**3.15****explosive gas atmosphere**

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

**3.16****explosive test mixture**

specified explosive mixture used for the testing of electrical apparatus for explosive gas atmospheres

**3.17****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

**3.18****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 an electrical apparatus, which would be able to produce an ignition of the surrounding explosive atmosphere

NOTE 1 The manufacturer will prescribe the product standard and also, in their particular design, they should take into account the following other conditions:

- fault conditions specified in the standard for the type of protection concerned;
- all operating conditions specified in any other standard and specified by the manufacturer, including recognized overloads;
- any other operating condition specified by the manufacturer.

NOTE 2 The relevant surface temperature may be internal or external depending upon the type of protection concerned.

### **3.19**

#### **normal operation**

operation of apparatus 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.

### **3.20**

#### **rated value**

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

### **3.21**

#### **rating**

set of rated values and operating conditions

### **3.22**

#### **service temperature**

temperature reached when the apparatus is operating at rated conditions

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

### **3.23**

#### **symbol “U”**

symbol used to denote an Ex component

### **3.24**

#### **symbol “X”**

symbol used to denote special conditions for safe use

### **3.25**

#### **terminal compartment**

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

### **3.26**

#### **type of protection**

specific measures applied to electrical apparatus to avoid ignition of a surrounding explosive atmosphere

## 4 Apparatus grouping and temperature classification

### 4.1 Apparatus grouping

Electrical apparatus for explosive gas atmospheres is divided into the following:

- Group I: electrical apparatus for mines susceptible to firedamp;
- Group II: electrical apparatus for places with an explosive gas atmosphere other than mines susceptible to firedamp.

Electrical apparatus 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 apparatus shall then be marked appropriately (for example, "Ex d I/IIB T3" or "Ex d I/II (NH<sub>3</sub>)").

### 4.2 Group II

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

#### 4.2.1 Group II subdivisions

For the types of protection "d", "i", "nC" and "nL", electrical apparatus of Group II is subdivided into IIA, IIB and IIC, as required in the specific standards concerning these types of protection.

NOTE 1 This subdivision is based on the maximum experimental safe gap (MESG) for flameproof enclosures or the minimum ignition current ratio (MIC ratio) for intrinsically safe electrical apparatus (see IEC 60079-12 and IEC 60079-20).

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

#### 4.2.2 Group II – Surface temperature marking

For all types of protection, apparatus of Group II shall be marked as a function of its maximum surface temperature according to 5.3.2.2.

#### 4.2.3 Apparatus for a particular explosive atmosphere

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

## 5 Temperatures

### 5.1 Environmental influences

#### 5.1.1 Ambient temperature

Electrical apparatus shall normally be designed for use in an ambient temperature range between –20 °C and +40 °C; in this case, no additional ambient temperature marking is necessary.

Electrical apparatus designed for use in a different range of ambient temperatures is considered to be special, and the ambient temperature range shall then be stated by the manufacturer. The marking shall then include either the symbol  $T_a$  or  $T_{amb}$  together with the special range of ambient temperatures or, if this is impracticable, the symbol "X" shall be used to indicate special conditions of use that include a special range of ambient temperature. See item i) of 29.2 and Table 1.

**Table 1 – Ambient temperatures in service and additional marking**

Electrical apparatus	Ambient temperature in service	Additional marking
Normal	Maximum: +40 °C Minimum: –20 °C	None
Special	Stated by the manufacturer	$T_a$ or $T_{amb}$ with the special range, for example, $-30\text{ °C} \leq T_a \leq +40\text{ °C}$ or the symbol "X"

### 5.1.2 External source of heating or cooling

Where the electrical apparatus 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 this source shall be stated.

NOTE 1 The way in which these ratings are expressed will vary according to the nature of the source. For large body sources, the maximum or minimum temperature will usually be sufficient. For small body sources, 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 apparatus, the temperature shall be determined for rated duty of the electrical apparatus when the apparatus is subjected to maximum or minimum ambient temperature and, where relevant, the maximum rated external source of heating or cooling. Temperature testing, when required, shall be in accordance with 26.5.1.

## 5.3 Maximum surface temperature

### 5.3.1 Determination of maximum surface temperature

Maximum surface temperature shall be determined for rated duty of the electrical apparatus but with the voltage chosen according to 26.5.1 or the specific requirement of the standard for the type of protection, and when the apparatus 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 apparatus

For electrical apparatus 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 expected to form a layer (for example, due to sealing or ventilation), provided that the actual maximum surface temperature is marked on the apparatus.

NOTE When choosing Group I electrical apparatus, 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 apparatus

Group II electrical apparatus shall be marked according to item f) of 29.2 and shall be either

- classified in a temperature class given in Table 2, or
- defined by the maximum surface temperature determined by 26.5.1, or
- if appropriate, restricted to the specific gas for which it is intended.

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

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.

### 5.4 Surface temperature and ignition temperature

The maximum surface temperature shall not exceed the lowest ignition temperature of the explosive atmospheres concerned unless subjected to the requirements of 5.5.

### 5.5 Small components

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 3; or
- c) for T5 classification, the surface temperature of a component with a surface area smaller than 1 000 mm<sup>2</sup> (excluding lead wires) shall not exceed 150 °C.

**Table 3 – Assessment for T4 classification according to component size and ambient temperature**

Total surface area excluding wire terminations	Requirement for T4 classification
< 20 mm <sup>2</sup>	Surface temperature ≤ 275 °C
≥ 20 mm <sup>2</sup>	Power dissipation ≤ 1,3 W <sup>a</sup>
≥ 20 mm <sup>2</sup> ≤ 1 000 mm <sup>2</sup>	Surface temperature ≤ 200 °C
<sup>a</sup> Reduced to 1,2 W with 60 °C ambient temperature or 1,0 W with 80 °C ambient temperature.	

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 components having a total surface area of not more than 10 cm<sup>2</sup>, their surface temperature may exceed that for the temperature class marked on the Group II electrical apparatus or the corresponding maximum surface temperature for Group I electrical apparatus, if there is no risk of ignition from these components, 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 apparatus 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 apparatus

### 6.1 General

Electrical apparatus and Ex components for use in explosive gas atmospheres 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.

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

NOTE 2 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 apparatus or component in accordance with Clause 29 (and by stating the basis of compliance in the documentation, see Clause 28).

NOTE 3 If the electrical apparatus 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 apparatus

The apparatus 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 apparatus of Group I or Group IIA, or
  - 0,06 mJ for electrical apparatus of Group IIB, or

- 0,02 mJ for electrical apparatus of Group IIC, including apparatus marked Group II only,
  - 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 temperature class of the electrical apparatus

shall be marked with one of the following warning markings:

- an enclosure opening delay marking as specified in item a) of 29.8; or
- an enclosure opening marking as specified in item b) of 29.8.

#### **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 Examples of precautions that can be taken include:

- the provision of equipotential bonding between parts of an enclosure or structure of apparatus; 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 15.5. 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. However, provision shall be made for adequate earthing of isolated exposed conductive parts. The insulation of such parts shall be capable of withstanding a test of 100 V r.m.s for 1 min.

#### **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.

### **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.

However, for sealing rings (see 3.5.3) on which the type of protection depends, the proof furnished according to A.3.3 shall be sufficient.

### 7.1.2 Specification of materials

The documents according to Clause 24 shall specify both the material and the manufacturing process 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 by the manufacturer.

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

## 7.2 Thermal endurance

The endurance to heat and to cold of the enclosures, or parts of enclosures, of non-metallic materials shall be satisfactory (see 26.8 and 26.9).

Plastic materials shall have a TI corresponding to the 20 000 h point (see 7.1.3) 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 (see 5.1.1).

## 7.3 Electrostatic charges on external non-metallic materials of enclosures

### 7.3.1 Applicability

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

### 7.3.2 Avoidance of a build-up of electrostatic charge

Electrical apparatus 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 the surface resistance of the enclosure, measured in accordance with 26.13, does not exceed 1 G $\Omega$  at (23  $\pm$  2) °C and (50  $\pm$  5) % relative humidity; or
- b) by limitation of the surface area of non-metallic parts of enclosures as shown in Table 4.

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; or

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.

**Table 4 – Limitations of areas**

Maximum surface area mm <sup>2</sup>				
Group I apparatus	Group II apparatus			
	Zone (as defined in IEC 60079-10)	Group IIA	Group IIB	Group II or IIC
10 000	0	5 000	2 500	400
	1	10 000	10 000	2 000
	2	10 000	10 000	2 000

- c) by limitation of the transferred charge using the test method described in 26.14; or
- d) for hand-held apparatus only, the inability to store a dangerous charge by measurement of capacitance when tested in accordance with the test method in 26.15; or
- e) for electrical apparatus 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 apparatus is mounted. In this case, the apparatus shall be marked “X” in accordance with item i) 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 apparatus shall also be marked with the electrostatic charge warning given in item g) of 29.8.

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.

#### 7.4 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 Enclosures containing light metals

### 8.1 Material composition

#### 8.1.1 Group I

Materials used in the construction of enclosures of Group I electrical apparatus shall not contain, by mass, more than

- a) 15 % in total of aluminium, magnesium and titanium, and
- b) 6 % in total of magnesium and titanium.

The above requirement does not apply to Group I surveying instruments carried by persons.

#### 8.1.2 Group II

Materials used in the construction of enclosures of Group II electrical apparatus for the different zones (as defined in IEC 60079-10) shall not contain, by mass, more than:

- for Zone 0  
10 % in total of aluminium, magnesium, titanium and zirconium, or  
7,5 % in total of magnesium, titanium and zirconium;
- for Zone 1  
7,5 % magnesium;
- for Zone 2  
no requirements except for fans, fanhoods, and ventilating screens which shall comply with the requirements for Zone 1.

Where the above compositions are exceeded, the apparatus shall be marked with an "X" in accordance with item i) of 29.2 and the special conditions for safe use shall contain sufficient information to enable the user to determine the suitability of the apparatus for the particular application, for example, to avoid an ignition hazard due to impact or friction.

### 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 class 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 or ISO 4762, and, in the case of hexagon socket set screws, ISO 4026, ISO 4027, ISO 4028 or ISO 4029;
- the holes in the electrical apparatus shall comply with the requirements of 9.3.

NOTE For Group I electrical apparatus, 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

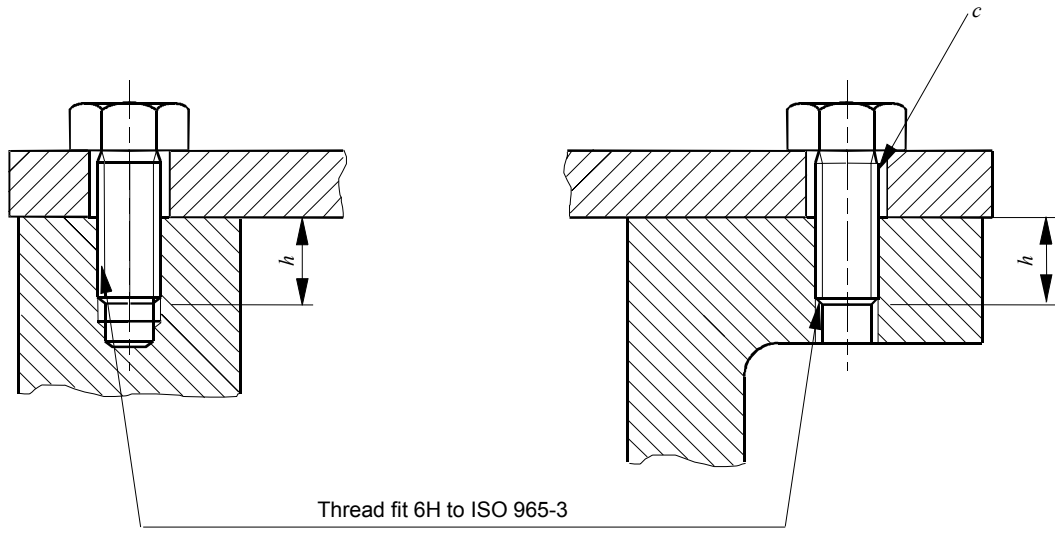
### 9.3.1 Thread engagement

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 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).



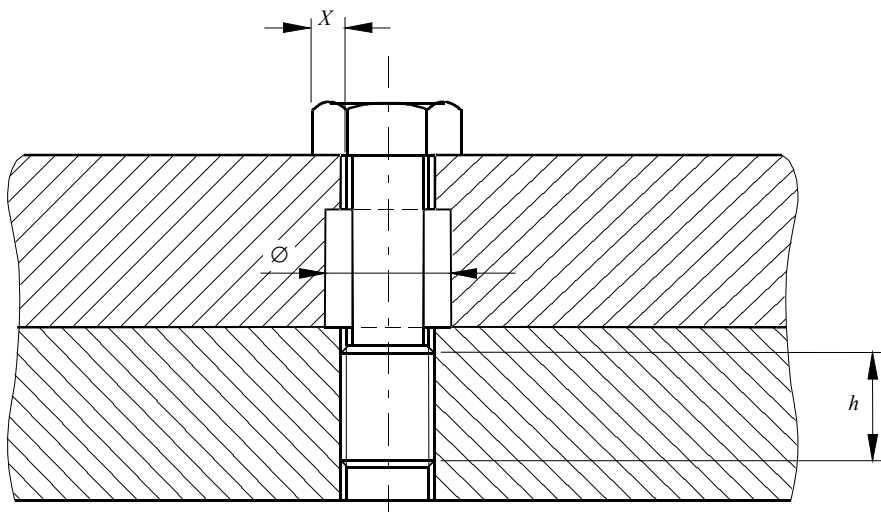
IEC 2864/03

**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**



IEC 2865/03

**Key**

$\varnothing$  Standard clearance hole appropriate to the thread form.

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

$X$  Contact dimension of a reduced shank fastener.

$X \geq$  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 fit 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 readily be defeated.

NOTE A screwdriver, pliers, or a similar tool are considered to be tools that will readily defeat an interlock.

## 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 safety depends, have a thermal stability adequate for the minimum and maximum temperatures to which they shall be subjected, within the rating of the electrical apparatus.

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 working temperature and at least 20 K above the maximum 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 apparatus which complies with the requirements of one or more of the types of protection listed in Clause 1.

### 13.2 Mounting internal to apparatus

Ex components may be mounted in the electrical apparatus:

- a) completely within an apparatus enclosure (for example, a type "e" terminal, ammeter, heater or indicator; a type "d" switch component or thermostat, a type "i" supply); or
- b) completely external to the apparatus enclosure (for example, a type "e" earth terminal, a type "i" sensor); or

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

Where the Ex component is mounted completely within the enclosure, the only parts that shall be tested or assessed, when used in an apparatus, are those parts which cannot be tested and/or assessed as a separate component (for example, test or assessment of surface temperature, creepage distance and clearance).

### **13.3 Mounting external to apparatus**

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 terminal compartments**

### **14.1 General**

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

### **14.2 Connection space**

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

### **14.3 Type of protection**

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

### **14.4 Creepage and clearance**

Terminal 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 Internal**

A connection facility for the connection of an earthing or equipotential bonding conductor shall be provided inside the electrical apparatus adjacent to the other connection facilities.

### **15.2 External**

An additional external connection facility for an earthing or equipotential bonding conductor shall be provided for electrical apparatus with a metallic enclosure, except for electrical apparatus 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.

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

### 15.3 Apparatus not requiring earthing

Where there is no requirement for earthing or bonding, for example, in some types of electrical apparatus 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 apparatus, while not presenting a risk of electrical shock, may need to be earthed or bonded to reduce the risk of ignition.

### 15.4 Size of conductor connection

Earthing or equipotential bonding connection facilities shall allow for the effective connection of at least one conductor with a cross-sectional area given in Table 5.

**Table 5 – Minimum cross-sectional area of protective conductors**

Cross-sectional area of phase conductors of the installation, $S$ mm <sup>2</sup>	Minimum cross-sectional area of the corresponding protective conductor, $S_p$ mm <sup>2</sup>
$S \leq 16$	$S$
$16 < S \leq 35$	16
$S > 35$	$0,5 S$

In addition, earthing or bonding connection facilities on the outside of electrical apparatus shall provide effective connection of a conductor with a cross-sectional area of at least 4 mm<sup>2</sup>.

### 15.5 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.

### 15.6 Secureness

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 apparatus 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 apparatus and the maximum number permitted. The thread form (for example, metric or NPT) of threaded entries shall be marked on the apparatus or shall appear in the installation instructions (see Clause 30).

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

### 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 apparatus 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 apparatus, i.e. one major element or part forms an inseparable part of the enclosure of the apparatus. In such cases, the glands shall be tested with the apparatus.

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

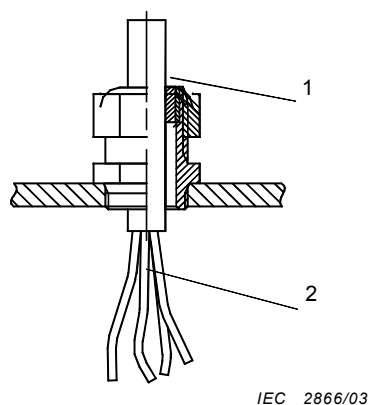
Cable glands, whether integral or separate, shall meet the relevant requirements of Annex A.

### 16.4 Blanking elements

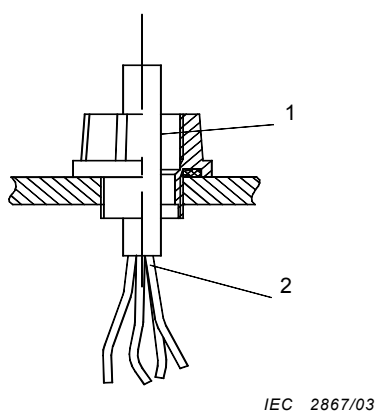
Blanking elements, intended to close unused openings in the enclosure walls of electrical apparatus, shall satisfy the requirements of the specific type of protection concerned. The blanking element shall only be removable with the aid of a tool.

### 16.5 Conductor temperature

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, the electrical apparatus shall be appropriately marked to provide guidance to the user on the proper selection of cable gland and cable or conductors.



**Figure 3a – Cable gland**



**Figure 3b – Conduit entry**

**Key**

- 1 Entry point
- 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 apparatus. 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 1 G $\Omega$ , measured in accordance with 26.13.

The thermal stability of non-metallic materials shall be considered adequate if the COT 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 °C.

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 apparatus only, be marked at a place near the actuator of the disconnector, with the operation under load marking given in item c) of 29.8.

## 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 29.8.

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 29.8.

## 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 apparatus shall be marked with the enclosure opening marking as required by item d) of 29.8.

## 20 Supplementary requirements for plugs and sockets

### 20.1 Interlocking

Plugs and sockets 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 are separated, or
- b) fixed together by means of special fasteners according to 9.2 and the apparatus marked with the separation marking as required by item d) of 29.8.

In the case where bolted types 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 29.8.

It is not necessary for plugs and sockets where the rated current does not exceed 10 A and rated voltage does not exceed either 250 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 such that the rated current flow ceases so no arc will occur on separation;
- the plug and socket 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.

### 20.2 Energized plugs

Plugs and components remaining energized when not engaged with a socket 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 with no individual opening greater than 2 500 mm<sup>2</sup>. If any opening size exceeds this, then the luminaire cover shall be tested as unguarded (see Table 8).

The light transmitting cover and, if provided, the guard, shall be capable of passing the relevant tests according to 26.4.2.

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

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 29.8.

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 29.8

## 21.3 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 and handlights

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

### 22.2 Group II caplights and handlights

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

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 connecting 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 Apparatus incorporating cells and batteries

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

### 23.1 Batteries

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

### 23.2 Cell types

Only cell types referred to in published IEC cell standards having known characteristics shall be used. Tables 6 and 7 below list cells for which suitable standards either exist or are to be produced.

**Table 6 – 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 <sub>2</sub> )	Non-aqueous inorganic	Lithium	3,6	3,9
F	Iron disulfide (FeS <sub>2</sub> )	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 <sub>2</sub> O)	Alkali metal hydroxide	Zinc	1,55	1,63
T	Silver oxide (AgO, Ag <sub>2</sub> O)	Alkali metal hydroxide	Zinc	1,55	1,87
<sup>a</sup>	Sulphur dioxide	Non-aqueous organic salt	Lithium	3,0	3,0
<sup>a</sup>	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.					
<sup>a</sup> May only be used if an IEC cell standard exists.					

**Table 7 – 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 IEC 61150	Nickel-cadmium	Potassium hydroxide (SG 1,3)	1,2	1,55
<sup>a</sup>	Nickel-iron	Potassium hydroxide (SG1,3)	Data awaited	1,6
<sup>a</sup>	Lithium	Non-aqueous organic salt	Data awaited	Data awaited
IEC 61436	Nickel metal hydride	Potassium hydroxide	1,2	1,5
<sup>a</sup> May only be used if an IEC cell standard exists.				

### 23.3 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.

### 23.4 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.

### 23.5 Mixture of cells

Batteries shall not contain a mixture of primary and secondary cells.

### 23.6 Interchangeability

Primary and secondary cells or batteries shall not be used inside the same apparatus 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 apparatus 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 apparatus and its orientation is important for safe operation, the correct orientation of the apparatus shall be indicated on the outside of the apparatus enclosure.

### **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 29.9, 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.

## **24 Documentation**

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

## **25 Compliance of prototype or sample with documents**

The prototype or sample of the electrical apparatus 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.

### **26.2 Test configuration**

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

### **26.3 Tests in explosive test mixtures**

The standard for the specific type of protection 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 of parts of enclosures

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

- the tests for resistance to impact (see 26.4.2);
- the drop test, if applicable (see 26.4.3);
- the 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.

#### 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 apparatus

The tests shall be made on samples as follows:

- Four samples all of which shall be submitted to the tests of thermal endurance to heat (see 26.8), then to tests of thermal endurance to cold (see 26.9), then to the tests for resistance to impact (see 26.4.2), then to the drop test if applicable (see 26.4.3), then to the tests for degrees of protection (IP) (see 26.4.5), with two used for the low-temperature test and the other two for the high-temperature test, and finally all four are subject to the appropriate tests specific to the type of protection concerned.

Alternatively, two samples shall be submitted to the tests of thermal endurance to heat (see 26.8), then to the tests of thermal endurance to cold (see 26.9), then to the tests for resistance to impact (see 26.4.2), then to the drop test if applicable (see 26.4.3), then to the tests for degrees of protection (IP) (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 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) (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) (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 electrical apparatus**

The tests shall be made on four samples all of which shall be submitted to the tests of thermal endurance to heat (see 26.8), then to tests of thermal endurance to cold (see 26.9), 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) (see 26.4.5), with two used for the low-temperature test and the other two for the high-temperature test, and finally all four are subject to the appropriate tests specific to the type of protection concerned.

Alternatively, the tests shall be made on two samples all of which shall be submitted to the tests of thermal endurance to heat (see 26.8), then to tests of thermal endurance to cold (see 26.9), 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) (see 26.4.5), and finally to the appropriate tests specific to the type of protection concerned. In this case, each sample is subjected to the tests for resistance to impact (see 26.4.2), then to the drop test if applicable (see 26.4.3), and finally the tests for degrees of protection (IP) (see 26.4.5).

#### **26.4.2 Resistance to impact**

The electrical apparatus 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 8 according to the application of the electrical apparatus. 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 apparatus 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 two samples, at two separate places on each sample. For enclosures or parts of enclosures made of non-metallic materials other than glass, the test shall first be made on two of the samples at the highest temperature, then on the other two samples at the lowest temperature, according to the tolerances given in 26.7.2.

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 apparatus 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 8 – Tests for resistance to impact**

Apparatus grouping	Drop height $h$ with 1 kg mass m			
	Group I		Group II	
	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 <sup>2</sup> to 2 500 mm <sup>2</sup> ; 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 <sup>2</sup> to 2 500 mm <sup>2</sup> reduces the risk of impact, but does not prevent impact.				

When an electrical apparatus is submitted to tests corresponding to the low risk of mechanical danger, it shall be marked with the symbol "X" to indicate this special condition of use in accordance with item i) of 29.2.

The test shall be carried out at an ambient temperature of  $(20 \pm 5) ^\circ\text{C}$ , 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 5 K to 10 K below the lowest temperature within the specified range.

When the electrical apparatus 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 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 apparatus or electrical apparatus 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.

For electrical apparatus with an enclosure which is not made of a non-metallic material, the test shall be carried out at a temperature of  $(20 \pm 5) ^\circ\text{C}$ , 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 5 K to 10 K below the lowest temperature within the specified range.

For electrical apparatus which has enclosures or parts of enclosures made of non-metallic material, the tests shall be carried out at the lower ambient 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 apparatus.

Superficial damage, chipping to paint work, breakage of cooling fins or other similar parts of the electrical apparatus 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 as specified in IEC 60529,
- the apparatus shall not be energized,
- where applicable, the dielectric test specified in IEC 60529 shall be carried out at  $[(2 U_n + 1\ 000) \pm 10\ %]$  V r.m.s. applied between 10 s and 12 s, where  $U_n$  is the maximum rated or internal voltage of the apparatus.

##### 26.4.5.2 Acceptance criteria

For electrical apparatus 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 their normal operating conditions.

For the purposes of acceptance criteria in accordance with IEC 60034-5, all dusts shall be considered to be conductive.

Where a standard for electrical apparatus for explosive gas 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

The thermal tests shall be made at the rating of the electrical apparatus, with the exception of the thermal test to determine the maximum surface temperature. The latter test is performed with the most adverse conditions at the most unfavourable voltage between 90 % to 110 % of the rated voltage of the electrical apparatus, unless the manufacturer can demonstrate that other standards prescribe other tolerances for equivalent industrial electrical apparatus.

The measured maximum surface temperature shall not exceed

- for Group I apparatus, those values as given in 5.3.2.1,
- for Group II apparatus subjected to routine testing for maximum surface temperature, the temperature or temperature class marked on the electrical apparatus,
- for Group II apparatus 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  $\leq 200$  °C), and less 10 K for temperature classes T2 and T1 (or marked temperatures  $> 200$  °C).

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 apparatus mounted in its normal service position.

For electrical apparatus which can normally be used in different positions, the temperature in each position shall be determined and the highest temperature shall be considered. When the temperature is determined for certain positions only, the electrical apparatus shall be marked with the symbol "X" to indicate this special condition of use according to item i) 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 apparatus.

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 7.2) shall be determined.

### 26.5.2 Thermal shock test

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

### 26.5.3 Small component ignition test

#### 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 5.5, 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 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 apparatus, the test shall be carried out with all such components at their maximum temperature.

The test shall be carried out with the component either

- mounted in the apparatus 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 apparatus 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 safety factor required by 5.4 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 T4 temperature classification, the mixture shall be either

- a) a homogeneous mixture of between 22,5 % and 23,5 % in 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 9.

**Table 9 – 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 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 Temperatures during tests

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 service 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  $(90 \pm 5)$  % relative humidity at a temperature of  $(20 \pm 2)$  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  $(95 \pm 2)$  °C and  $(90 \pm 5)$  % relative humidity followed by a period of two weeks in an air oven at a temperature of  $(20 \pm 2)$  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 Applicability

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 apparatus, the test applies only to luminaires.

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

### 26.10.2 Test procedure

The test shall be made on six test bars of standard size 50 mm × 6 mm × 4 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 apparatus.

The test shall be made in accordance with ISO 4892-1 in an exposure chamber using a xenon lamp and a sunlight simulating filter system, at a black panel temperature of  $(55 \pm 3)$  °C. The exposure time shall be 1 000 h.

Where preparations 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 apparatus.

### 26.10.3 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 apparatus

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

At the end of the test, the enclosure samples concerned shall be removed from the liquid bath, carefully wiped and then stored for  $(24 \pm 2)$  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 special condition of use according to item i) 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 ( $\text{CuZn}_{39}\text{Pb}_3$  or  $\text{CuZn}_{38}\text{Pb}_4$ ) 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 ( $\text{CuZn}_{39}\text{Pb}_3$  or  $\text{CuZn}_{38}\text{Pb}_4$ ) 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 ( $\pm 10$  %).

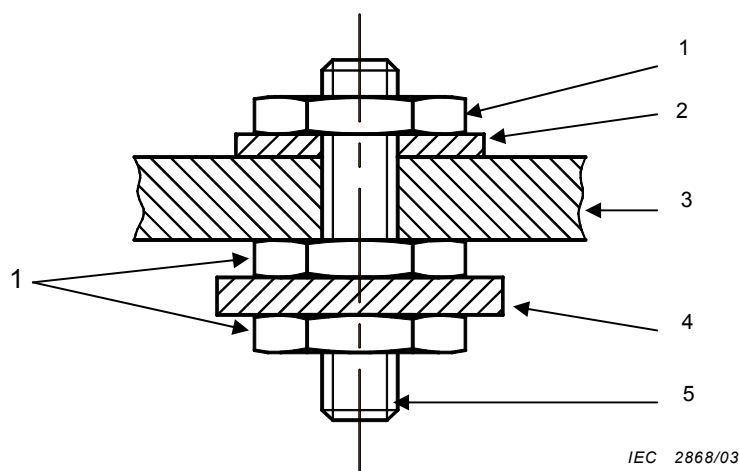
The hole in the wall (or part of the wall or the test sample) may be a plain through-hole or a tapped hole having a thread form compatible with the test bar.

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                                | 5 Test bar |
| 2 Earth plate                        | 6 Inside   |
| 3 Enclosure wall (non-metallic)      | 7 Outside  |
| 4 Earth plate or part of earth plate |            |

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

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

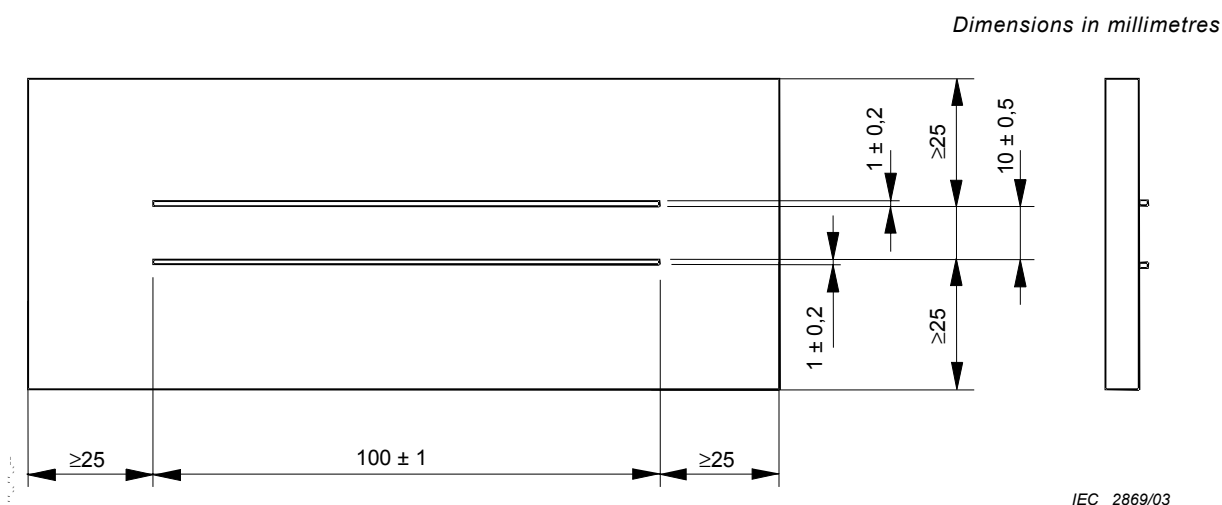
The surface resistance shall be tested on the parts of enclosures if size permits, or on a test piece comprising a rectangular plate with dimensions in accordance with Figure 5. The test piece shall have an intact clean surface. Two parallel electrodes are painted on the surface, using a conducting paint 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 24 h at the temperature and humidity according to 7.3. The test shall be carried out under the same ambient conditions.

The direct voltage applied for 1 min between the electrodes shall be  $(500 \pm 10) \text{ V}$ .

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 when the voltage has been applied for 1 min.



**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<sup>2</sup> flat sample of the non-metallic material from which the equipment is constructed.

The size of the flat sample is relevant because experimental evidence shows that 22 500 mm<sup>2</sup> 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 shall be kept to 30 % RH or less at  $(23 \pm 2) ^\circ\text{C}$  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 radius of 10 mm to 15 mm shall be 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 24 h at  $(23 \pm 2) ^\circ\text{C}$  and a relative humidity not higher than 30 %. 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). 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 spherical 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 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  $10^9 \Omega$ ;
- 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  $10^{10} \Omega$ );
- 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<sup>2</sup> 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  $(23 \pm 2) ^\circ\text{C}$  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 24 h at  $(23 \pm 2) ^\circ\text{C}$ .

### 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 rubbing it 10 times with the polyamide cloth. The last rub shall finish on the edge of the sample. Discharge the sample by slowly approaching the spherical electrode into a 0,1 µF or 0,01 µF capacitor (Figure 7) until a discharge occurs and measure the voltage on the voltmeter immediately after removing the spherical electrode from the sample (the voltage decreases with time due to the non infinity input resistance of the voltmeter). 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.

#### 26.14.6.2 Method B: Rubbing with a cotton cloth

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.

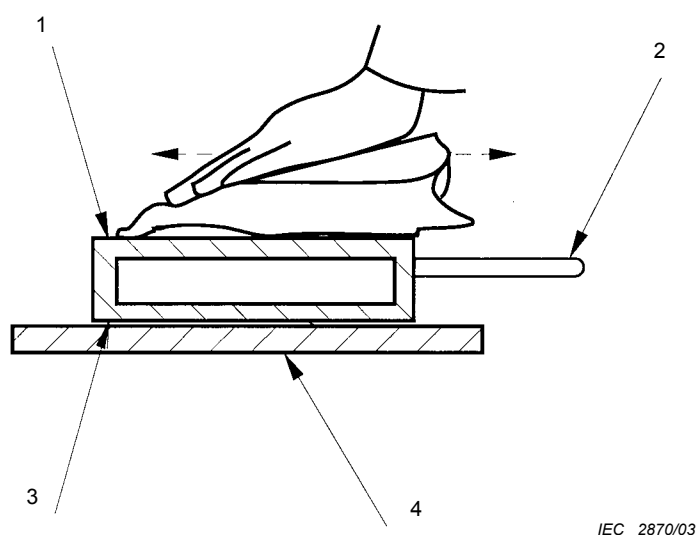
#### 26.14.6.3 Method C: Charging by influence with a d.c. high-voltage power supply (Figure 8)

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:

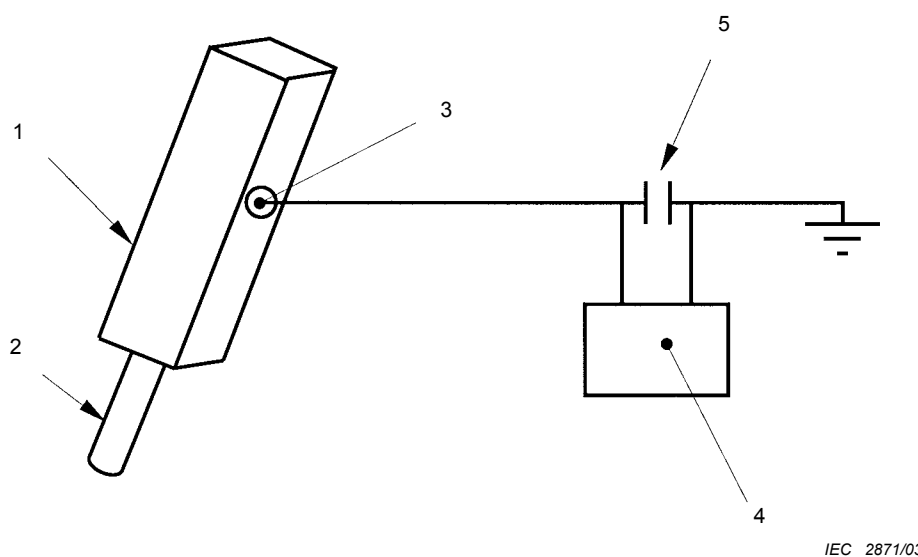
- 60 nC for Group I or IIA apparatus
- 30 nC for Group IIB apparatus
- 10 nC for Group IIC apparatus.



#### Components

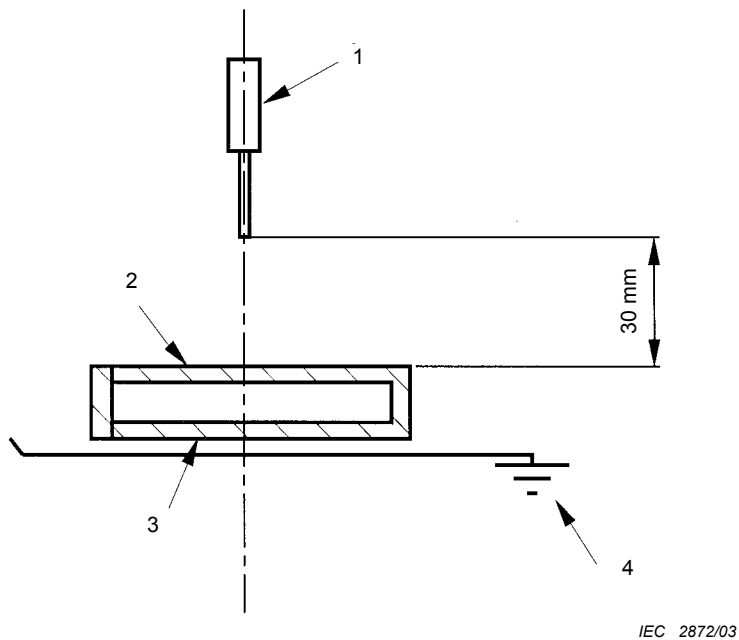
- |          |               |
|----------|---------------|
| 1 Face A | 3 PTFE handle |
| 3 Face B | 4 PTFE        |

Figure 6 – Rubbing with a pure nylon cloth

**Components**

- |                           |               |
|---------------------------|---------------|
| 1 Charged container       | 2 PTFE handle |
| 3 Sphere Ø,15 mm          | 4 Voltmeter   |
| 5 $C_M = 0,1 \mu\text{F}$ |               |

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

**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 apparatus. The samples shall be conditioned in a climatic conditioning chamber for at least 1 h at a temperature of  $(20 \pm 2)$  °C and a relative humidity between 30 % to 50 %. 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 apparatus shall be measured in the range 0 pF to 200 pF with an accuracy of  $\pm 5$  % 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 apparatus 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 apparatus 50 pF
- for Group IIA apparatus 50 pF
- for Group IIB apparatus 15 pF
- for Group IIC apparatus 5 pF.

## 27 Routine verifications and tests

The manufacturer shall carry out the routine verifications and tests necessary to ensure that the electrical apparatus produced complies with the documentation. The manufacturer shall also carry out any routine verifications and tests required by any of the standards listed in Clause 1 which were used for the examination and testing of the apparatus.

## 28 Manufacturer's responsibility

### 28.1 Certificate

The manufacturer shall prepare, or have prepared, a certificate confirming that the apparatus 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 apparatus or an Ex component.

### 28.2 Responsibility for marking

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

- the electrical apparatus has been constructed in accordance with the applicable requirements of the relevant standards in safety matters,
- the routine verifications and tests in Clause 27 have been successfully completed and that the product complies with the documentation.

## 29 Marking

In the interest of safety, it is essential that the system of marking indicated below shall only be applied to electrical apparatus which complies with the specific standard for the type of protection listed in Clause 1.

## 29.1 Location

The electrical apparatus shall be legibly marked on the main part of the apparatus.

## 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) the symbol Ex, which indicates that the electrical apparatus corresponds to one or more of the types of protection which are the subject of the specific standards listed in Clause 1;
- d) the symbol for each type of protection used:
  - "d": flameproof enclosure
  - "e": increased safety
  - "ia": intrinsic safety, level of protection "ia"
  - "ib": intrinsic safety, level of protection "ib"
  - "ma": encapsulation, level of protection "ma"
  - "mb": encapsulation, level of protection "mb"
  - "nA": Type n, method of protection "nA"
  - "nC": Type n, method of protection "nC"
  - "nL": Type n, method of protection "nL"
  - "nR": Type n, method of protection "nR"
  - "o": oil immersion
  - "px": pressurization, level of protection "px"
  - "py": pressurization, level of protection "py"
  - "pz": pressurization, level of protection "pz"
  - "q": powder filling.

For associated apparatus suitable for installation in a hazardous area, the symbols for the type of protection shall be enclosed within square brackets, for example, Ex d[ia] IIC T4.

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] IIC;

NOTE 1 For associated apparatus not suitable for installation in a hazardous area, a temperature class is not included.

NOTE 2 Electrical apparatus which does not fully comply with this standard and other relevant parts of IEC 60079 where equivalent safety is claimed, should be marked with the symbol "s".

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

The letters A, B, C shall be used if the specific standard for the type of protection concerned requires this, or if required for compliance with 6.3, 7.3.2 b), 7.3.2 c), 7.3.2 d), or 7.3.2 e).

When the electrical apparatus is for use only in a particular gas, the symbol II shall be followed by the chemical formula or the name of the gas in parentheses.

When the electrical apparatus is for use in a particular gas in addition to being suitable for use in a specific group of electrical apparatus, the chemical formula shall follow the group and be separated with the symbol “+”, for example, “IIB + H<sub>2</sub>”.

NOTE 3 Apparatus marked “IIB” is suitable for applications requiring Group IIA apparatus. Similarly, apparatus marked “IIC” is suitable for applications requiring Group IIA and Group IIB apparatus.

- f) for Group II electrical apparatus, 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 apparatus, 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 apparatus, 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 special condition of use according to item i) of 29.2.

Cable glands need not be marked with a temperature class or maximum surface temperature in degrees Celsius.

- g) a serial number, except for
- connection accessories (cable and conduit entries, blanking plates, adaptor plates, and bushings);
  - very small electrical apparatus on which there is limited space;
- (The batch number can be considered to be an alternative to the serial number.)
- h) 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 the serial number of the certificate in that year;
- i) if it is necessary to indicate special conditions for safe use, the symbol “X” shall be placed after the certificate reference. A warning marking may be marked on the apparatus as an alternative to the requirement for the “X” marking;

NOTE 4 The manufacturer should ensure that the requirements of the special conditions for safe use are passed to the purchaser together with any other relevant information.

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

NOTE 5 Additional marking may be required by the applicable industrial safety standards for construction of the electrical apparatus.

### 29.3 Different types of protection

Where different types of protection are used on different parts of an electrical apparatus, each respective part shall bear the symbol for the type of protection concerned.

Where more than one type of protection is used in an electrical apparatus, the symbols for the types of protection shall appear in alphabetical order, with or without separating spaces. When associated apparatus is used, the symbols for the type of protection shall follow those of the apparatus.

#### 29.4 Order of marking

The markings c) to f) according to 29.2 shall be placed in the order in which they are given in 29.2 and shall each be separated by a small space.

#### 29.5 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 apparatus of the Ex component;
- f) the name or mark of the issuer of the certificate, and the number of the certificate, if the Ex component has one to indicate it complies with this standard;
- 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 apparatus.

#### 29.6 Small apparatus and Ex components

On small electrical apparatus 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 apparatus 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 symbol Ex and the symbol of each type of protection;
- d) the name or mark of the issuer of the certificate, and the number of the certificate, if the Ex component has one to indicate it complies with this standard; and
- e) the symbol "X" or "U" (if appropriate).

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

#### 29.7 Extremely small apparatus and Ex components

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

#### 29.8 Warning markings

Where any of the following warning markings are required on the apparatus, the text as described in Table 10, following the word "WARNING," may be replaced by technically equivalent text. Multiple warnings may be combined into one equivalent warning.

**Table 10 – Text of warning markings**

	Reference	WARNING Marking
a)	6.3	WARNING – AFTER DE-ENERGIZING, DELAY <i>Y</i> MINUTES BEFORE OPENING ( <i>Y</i> 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)	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)	7.3.2 e)	WARNING – POTENTIAL ELECTROSTATIC CHARGING HAZARD – SEE INSTRUCTIONS
h)	18.4 2 21.2 2	WARNING – LIVE PARTS BEHIND COVER – DO NOT CONTACT

### 29.9 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.

### 29.10 Examples of marking<sup>3</sup>

Flameproof electrical apparatus for use in mines susceptible to firedamp:

BEDELLE S.A  
TYPE A B 5  
Ex d I  
No. 325  
ABC 02.12345  
.....  
.....

Ex component, flameproof with intrinsically safe output circuit, for places in explosive gas atmospheres other than in mines susceptible to firedamp, gas of subdivision C, manufactured by H. RIDSTONE and Co. Ltd. Type KW 369:

<sup>3</sup> Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

Ex d[ia] IIC  
DEF 02.536 U



Electrical apparatus, utilizing increased safety types of protection and pressurized enclosure "px", 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 special conditions for safe use indicated in the certificate.

H. ATHERINGTON Ltd  
TYPE 250 JG 1  
Ex epx II 125 °C (T4)  
No. 56732  
GHI 02.076 X

.....

.....

Electrical apparatus, utilizing flameproof enclosure and increased safety types of protection 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 de I  
Ex de IIB T3  
No. 5634  
JKL 02.521

.....

.....

Flameproof electrical apparatus for explosive gas atmospheres other than mines susceptible to firedamp on the basis of ammonia gas only.

WOKAITERT SARL  
TYPE NT 3  
Ex d II (NH3)  
No. 6549  
MNO 02.3102

.....

.....

## 30 Instructions

### 30.1 General

All electrical apparatus shall be accompanied by instructions, including the following particulars as a minimum:

- a recapitulation of the information with which the electrical apparatus 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 (servicing and emergency repair);
  - installation;
  - adjustment;
- where necessary, training instructions;
- details which allow a decision to be made as to whether the apparatus 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 necessary, 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 apparatus;
- a list of the standards, including the issue date, with which the apparatus is declared to comply. The certificate can be used to satisfy this requirement.

The instructions shall contain information necessary for the putting into service, maintenance, inspection, checking of correct operation and, where appropriate, repair of the apparatus, together with all useful instructions, in particular with regard to safety.

### **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)

### Ex cable glands

#### A.1 General

This annex specifies the general requirements for the construction, testing and marking of Ex cable glands and may be 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

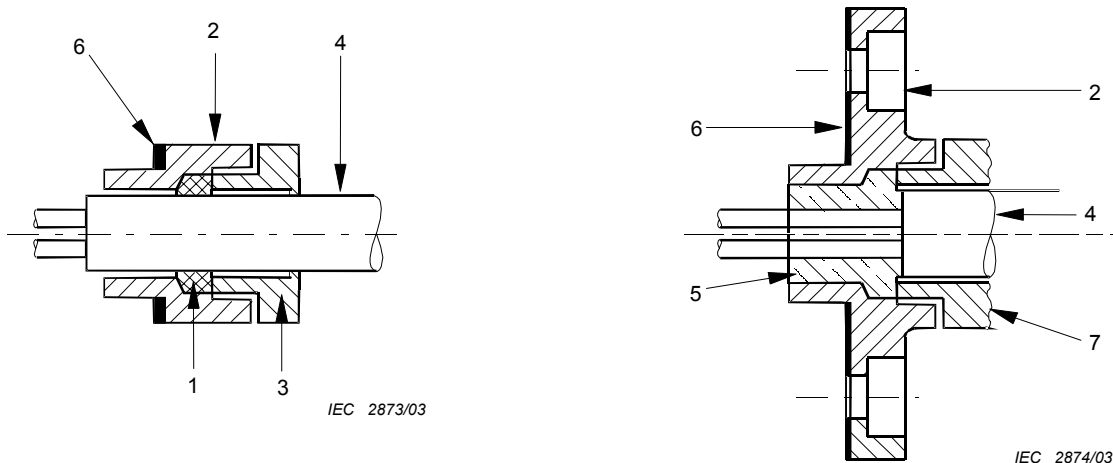
The cable sealing between the cable and the gland body shall be ensured by one of the following means (see Figure A.1):

- 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 2 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        | 4 Cable                      |
| 2 Gland body          | 5 Filling compound           |
| 3 Compression element | 6 Gasket (where required)    |
|                       | 7 Compound retaining element |

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

## **A.2.2 Materials**

### **A.2.2.1 Exposed parts**

The requirements relating to materials in 7.3 concerning electrostatic charges, apply only to exposed parts of cable glands.

### **A.2.2.2 Elastomeric sealing rings**

Elastomeric sealing rings shall be made of materials which satisfy the type test for resistance of ageing as defined in A.3.3.

### **A.2.2.3 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 cable glands**

Cable glands for Group II apparatus, 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 shall be used only for fixed installations of Group II apparatus and that the user shall ensure adequate clamping of the cable. Such cable glands shall be marked with the symbol "X" to indicate this special condition of use according to item i) of 29.2.

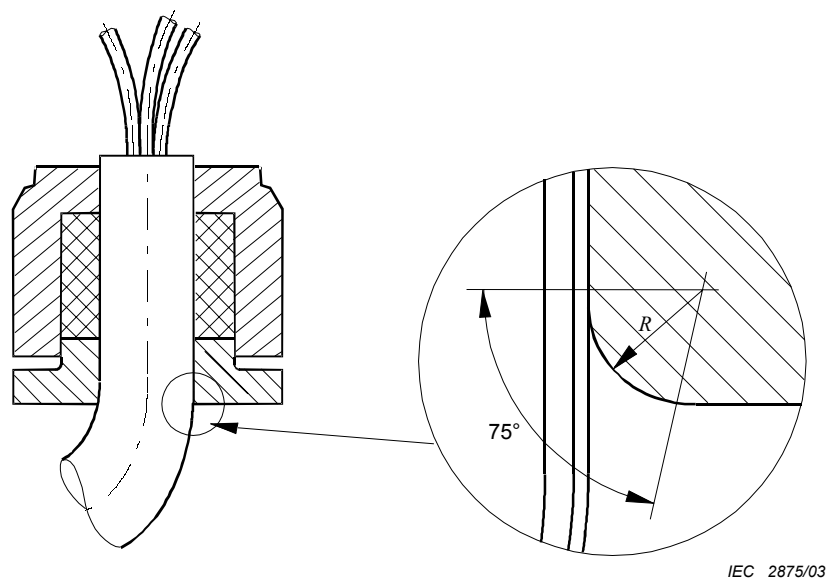
## **A.2.4 Lead-in of cable**

### **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 apparatus 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.3.5.

### **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 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  $1,6 \mu\text{m}$ ,  $R_a$ , 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 shall be mounted on a sample of dry, clean cable of dimensions equal to the size specified by the manufacturer of the cable gland.

For metallic sealing rings, each ring shall be mounted on a clean, dry, polished, cylindrical, metal mandrel, with a maximum surface roughness of  $1,6 \mu\text{m}$ ,  $R_a$ , 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 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 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 using two samples of clean, dry cable; 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 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 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 mounted on a tensile testing machine and 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  $(20 \pm 5) ^\circ\text{C}$ .

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 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 clamping device shall 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 apparatus, or
- 20 times the value in millimetres of the diameter of the cable over the armour for Group II apparatus.

NOTE 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 mounted on a tensile testing machine and a constant tensile force equal to that defined in A.3.2.1 shall be applied for  $(120 \pm 10)$  s. The test shall be carried out at an ambient temperature of  $(20 \pm 5)$  °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 Ageing test for material used for elastomeric sealing rings**

The material used for the manufacture of the sealing rings shall be prepared in the form of test pieces in accordance with ISO 48; the hardness shall be determined in accordance with this standard at ambient temperature.

The test pieces shall be placed in an oven in which the temperature shall be maintained at  $(100 \pm 5)$  °C for at least 168 h without interruption; they shall then be kept for at least 24 h at ambient temperature, before being placed in a refrigerator in which the temperature is maintained at  $(-20 \pm 2)$  °C for at least 48 h without interruption; they shall finally be kept for at least 24 h at ambient temperature. The hardness shall then be determined again.

At the end of the test procedure the variation in hardness, expressed in IRHD units, as specified in ISO 48, shall not exceed 20 % of the hardness before ageing.

Where a cable gland is intended to be used at a temperature above that foreseen in 16.5, the ageing test shall be carried out at a temperature  $(20 \pm 5) ^\circ\text{C}$  above the declared maximum operating temperature of the cable. Where a cable gland is intended to be used in an ambient temperature below  $-20 ^\circ\text{C}$ , the test in the refrigerator shall be carried out at the declared minimum ambient temperature with a tolerance of  $\pm 2 \text{ K}$ .

#### **A.3.4 Type test for resistance to impact**

The test shall be carried out by applying the appropriate requirements 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.3.1.5 or A.3.2.1, as appropriate.

#### **A.3.5 Test for degree of protection (IP) of cable glands**

The test shall be carried out in accordance with IEC 60529, using one cable-sealing ring of each of the different permitted sizes for each type of cable gland.

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  $1,6 \mu\text{m Ra}$ , 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 and, if a threaded entry, with the type and size of thread.

Where marking space is limited, the reduced marking requirements of 29.6 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 temperatures outside the range  $-20 ^\circ\text{C}$  to  $+80 ^\circ\text{C}$  and have been tested in accordance with A.3.3, 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.

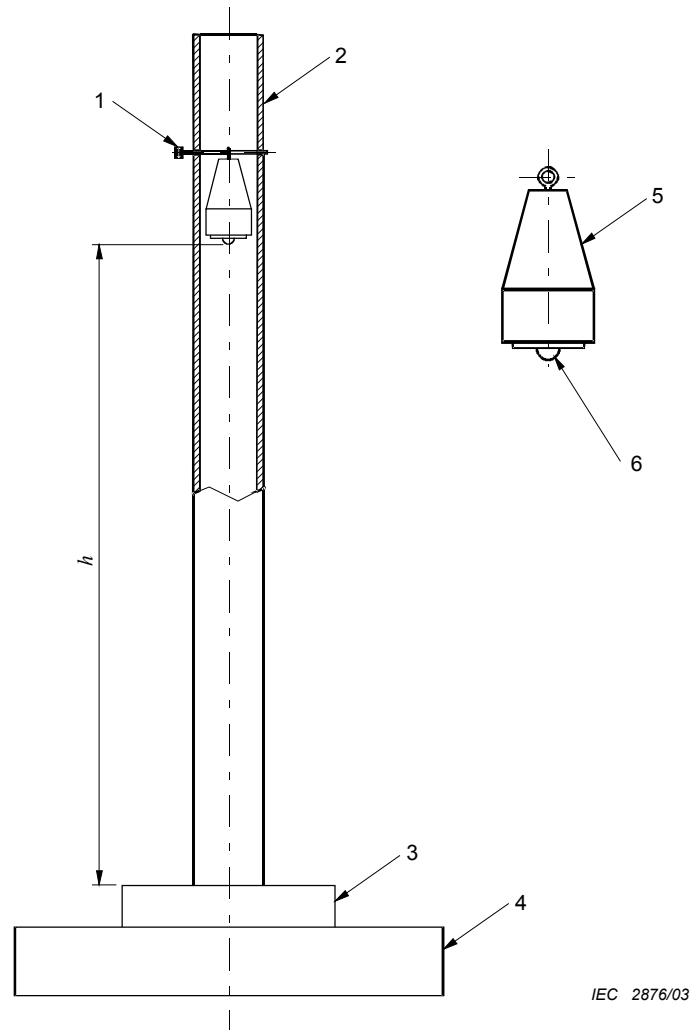
**Table B.1 – Clauses with which Ex components shall comply**

Clause or subclause	Applies (yes or no)	Remarks
1 to 4 (inclusive)	Yes	Except 4.2.2
5	No	Except that the operating temperature limits shall be specified
6.1	Yes	
6.3	No	
7.1	Yes	
7.2	Yes	See Note 1
7.3	Yes	If external (see Note 1)
7.4	Yes	If external (see Note 1)
8	Yes	
9.1	Yes	
9.2	Yes	But only if it is an apparatus enclosure
9.3	Yes	But only if it is an apparatus enclosure
10	Yes	
11	Yes	
12	Yes	
13	Yes	
14	Yes	Except that "X" marking is not necessary
15.1	Yes	But only if it is an apparatus enclosure
15.2	Yes	But only if it is an apparatus enclosure
15.3	Yes	
15.4	Yes	
15.5	Yes	
16	Yes	But only if it is an apparatus enclosure
17	No	Except for machine enclosures
18	Yes	
19	Yes	
20	Yes	
21	Yes	
22.1	Yes	
22.2	No	
23	Yes	
24	Yes	
25	Yes	
26.1	Yes	
26.2	No	
26.3	Yes	

Clause or subclause	Applies (yes or no)	Remarks
26.4	Yes	But only if it is an apparatus enclosure
26.5	Yes	But only if it is an apparatus enclosure
26.5.1	No	
26.5.2	Yes	Where the maximum temperature is specified
26.6	Yes	
26.7	Yes	Where the maximum temperature is specified
27	Yes	
28	Yes	
29	Yes	See Note 2
29.1	No	
29.2	No	
29.3	No	
29.4	No	
29.5	Yes	
29.6	Yes	
29.7	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



IEC 2876/03

#### 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 $\geq 20$ kg) |  |

**Figure C.1 – Example of rig for resistance to impact test**

## Bibliography

IEC 60079-12, *Electrical apparatus for explosive gas atmospheres – Part 12: Classification of mixtures of gases of 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, *Electrical apparatus for explosive gas atmospheres – Part 19: Repair and overhaul for apparatus used in explosive atmospheres (other than mines or explosives)*

IEC 60079-20, *Electrical apparatus for explosive gas atmospheres – Part 20: Data for flammable gases and vapours, relating to the use of electrical apparatus*

ISO/IEC DIS 17000, *Conformity assessment – General vocabulary*

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- certification
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- thesis
- manufacturing
- other.....

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