IEC 60079-0

Edition 6.0 2011-06
REDLINE VERSION

INTERNATIONAL STANDARD

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Explosive atmospheres –
Part 0: Equipment – General requirements

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IEC 60079-0:2011-06 RLV(en)

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Explosive atmospheres –
Part 0: Equipment – General requirements

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Atmosphères explosives – Partie 0: Matériel – Exigences générales

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TC 31/Publication 60079-0 (2011), sixth edition/I-SH 01

EXPLOSIVE ATMOSPHERES –

Part 0: Equipment – General requirements

INTERPRETATION SHEET 1

This interpretation sheet has been prepared by technical committee 31: Equipment for explosive atmospheres, of IEC.

The text of this interpretation sheet is based on the following documents:

ISH	Report on voting
31/1085/ISH	31/1095/RVD

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

Interpretation of Annex A

Questions:

Is the torque used for the tensile test of A.3.1.4 required to be the same torque as the initial torque determined in A.3.1.1?

At what point in the testing sequence is the thermal endurance to heat test conducted?

Interpretation:

In A.3.1.1, a torque is applied to either the screws of a flanged compression element or the nut of a screwed compression element to compress the sealing ring to secure the mandrel. A tensile force is then applied to the mandrel to confirm the securement. The tensile force is applied for not less than 6 h. The test is carried out at an ambient temperature of (20 ± 5) °C. The torque value needed for clamping to be assured by the sealing ring is acceptable if the slippage of the mandrel or cable sample as a result of the tensile force is not more than 6 mm.

Subsequently, either the complete cable gland and mandrel assembly used for the determination described above, or a new sample prepared using the same torque values, is then to be subjected to the thermal endurance tests. The maximum service temperature is considered to be 75 °C unless otherwise specified by the manufacturer.

NOTE 1 The 75 °C service temperature is the median of the branching point and entry point temperatures.

NOTE 2 Cable glands employing only metallic sealing rings and metallic parts do not require thermal endurance tests.

The subsequent test conditions and acceptance criteria are given in A.3.1.4. Prior to the application of the tensile force, the gland may be re-tightened in accordance with the manufacturer's instructions.

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NOTE The torque applied to the screws or nut during retightening is not required to be the same as the initial torque applied in A.3.1.1.

In A.3.1.5, the “value needed to prevent slipping” is the torque required for A.3.1.4.

It is intended that this interpretation will be introduced in IEC 60079-0 Edition 7 and therefore an Interpretation Sheet will not be required for this or future editions.

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EXPLOSIVE ATMOSPHERES –

Part 0: Equipment – General requirements

INTERPRETATION SHEET 2

This interpretation sheet has been prepared by IEC technical committee 31: Equipment for explosive atmospheres.

The text of this interpretation sheet is based on the following documents:

ISH	Report on voting
31/1132/ISH	31/1153/RVISH

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

Following decision No 16 of the TC 31 meeting in Melbourne in 2011, the issuing of an Interpretation Sheet for IEC 60079-0:2011 (6th edition) was requested, in order to clarify the significance of the changes with respect to the 5th edition.

Question

What are the minor editorial, extensions, and major technical changes of the 6th edition with respect to the 5th edition?

Answer

The following table shows the significance of the changes.

The significance of the changes between IEC Standard, IEC 60079-0, Edition 5, 2007-10 (Including Corrigendum No.1 and Interpretation Sheet I-SH 01) and IEC 60079-0, Edition 6, 2011-06 are as listed below:

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		Type		
Explanation of the significance of the changes	**Clause**	**Minor and editorial changes**	**Extension**	**Major technical changes**
Expansion of material specification data for plastics and elastomers, including UV resistance	7.1.2		x	
Addition of alternative qualification for O-rings	7.2.3		x	
Addition of alternative criteria for surface resistance	7.4.2 a)		x	
Addition of alternative breakdown voltage limit for non-metallic layers applied to metallic enclosures	7.4.2 c)		x	
Expansion of "X" marking options for non-metallic enclosure materials not meeting basic electrostatic requirements	7.4.2 d) 7.4.2 e)		x	
Clarification that non-metallic enclosure requirements also apply to painted or coated metal enclosures	7.4.3		x	
Clarification of test to determine capacitance of accessible metal parts with reduction in acceptable capacitance	7.5 Table 9			C1
Addition of limits on zirconium content for Group III and Group II (Gb only) enclosures	8.3 8.4		x	
Introduction of "X" marking for Group III enclosures not complying with basic material requirements, similar to that existing for Group II	8.4	x		
Addition of button-head cap screws to permitted "Special Fasteners"	9.2		x	
Reference for protective earthing (PE) requirements for electrical machines to IEC 60034 1	15.3	x		
Addition of requirements for ventilating fans	17.1.5			C2
Addition of requirement for temperature rating of bearing lubricants	17.2	x		
Addition of alternative construction for disconnectors	18.2		x	
Removal of voltage limits on plugs and sockets	20.2		x	
Addition of test requirements for arc-quenching test on plugs and sockets	20.2			C3
Additional information on cell voltages	23.3 Table 12			C4
Revision to impact test of glass parts	26.4.2	x		
Revision to impact test procedure to address "bounce" of impact head	26.4.2		x	
Clarification of the test requirements for "service" and "surface" temperature	26.5.1.2 26.5.1.3	x		
Clarification of temperature rise tests for converter-fed motors	26.5.1.3		x	
Addition of alternative test method for thermal endurance	26.8 Table 15		x	
Removal of "charging test" and addition of note providing guidance	Formerly 26.14			C5
Clarification of test for the measurement of capacitance, revision of maximum capacitance	26.14			C6
Addition of tests for ventilating fans	26.15			C2
Addition of alternative o-ring testing	26.16		x	
Addition of a "Schedule of Limitations" to	28.2	x		

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		Type		
Explanation of the significance of the changes	**Clause**	**Minor and editorial changes**	**Extension**	**Major technical changes**
certificates for Ex Components				
Clarification of the marking for multiple temperature classes	29.4 d) 29.5 d)	x		
Addition of marking for converter-fed motors	29.15		x	
Removal of IP marking for Group III	29.5	x		
Addition of specific instructions for electrical machines and for ventilating fans	30.3 30.4		x	

NOTE The technical changes referred to include the significance of technical changes in the revised IEC Standard, but they do not form an exhaustive list of all modifications from the previous version. More guidance may be found by referring to the Redline Version of the standard.

Explanation of the Types of Changes:

A) Definitions

1. Minor and editorial changes:

- Clarification
- Decrease of technical requirements
- Minor technical change
- Editorial corrections

These are changes which modify requirements in an editorial or a minor technical way. They include changes of the wording to clarify technical requirements without any technical change, or a reduction in level of existing requirement.

2. Extension: Addition of technical options

These are changes which add new or modify existing technical requirements, in a way that new options are given, but without increasing requirements for equipment that was fully compliant with the previous standard. Therefore, these will not have to be considered for products in conformity with the preceding edition.

3. Major technical changes:

- addition of technical requirements
- increase of technical requirements

These are changes to technical requirements (addition, increase of the level or removal) made in a way that a product in conformity with the preceding edition will not always be able to fulfil the requirements given in the later edition. These changes have to be considered for products in conformity with the preceding edition. For these changes additional information is provided in clause B) below.

NOTE These changes represent current technological knowledge. However, these changes should not normally have an influence on equipment already placed on the market.

B) Information about the background of 'Major technical changes'

C1 – The values in the table have been significantly reduced based on information that is intended to be published in IEC TS 60079-32-1 (currently in preparation).

C2 – The requirements for fans was added at the request of the IECEx International Product Certification Scheme.

C3 – The test has been introduced for all disconnectors as an alternative to the voltage and current restrictions in the previous standard which were considered to be arbitrary.

C4 – There has been a slight increase in some cell voltages. This is a minor change for most protection concepts but should be regarded as a major change for equipment having a type of protection relying on energy limitation, e.g. IEC 60079-11

C5 – The charging test was removed as it had been found to be not repeatable. Guidance will be given in IEC TS 60079-32-1 (currently in preparation).

C6 – The limits for capacitance have been decreased based on technical information in CLC/TR 50404.

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EXPLOSIVE ATMOSPHERES –

Part 0: Equipment – General requirements

INTERPRETATION SHEET 3

Withdrawn

This interpretation sheet has been prepared by IEC technical committee 31: Equipment for explosive atmospheres.

The text of this interpretation sheet is based on the following documents:

FDIS	Report on voting
31/1376/FDIS	31/1386/RVD

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

Question:

How shall marking be shown for equipment covered by both the electrical and non-electrical standards (IEC 60079 and ISO 80079 series)?

Answer:

Equipment which includes both an electrical part and a non-electrical part shall have combined marking. For example:

Ex db h IIA T4 Gb

Ex h tb IIIC T135 °C Db

It will be clearer for the user that the combined risk of the electrical part and the non-electrical part, covered by a single certificate, has been assessed for the complete equipment, stating one EPL, one equipment Group and one temperature class for Gas and the same for Dust (but showing a maximum surface temperature instead of a temperature class). It is also noted that Ex Components are not marked with either a temperature class (Group II) or a maximum surface temperature (Group III).

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For equipment where separate certificates have been prepared, with one for the electrical parts, and one for the non-electrical parts, it is appropriate to have separate electrical and non-electrical marking strings, each with its own associated certificate number.

NOTE Additional guidance on the marking of assemblies is given in IEC TS 60079-46.

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EXPLOSIVE ATMOSPHERES –

Part 0: Equipment – General requirements

INTERPRETATION SHEET 4

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This interpretation sheet has been prepared by IEC technical committee 31: Equipment for explosive atmospheres.

The text of this interpretation sheet is based on the following documents:

DISH	Report on voting
31/1454/DISH	31/1465/RVDISH

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

Interpretation sheet of Subclause 16.6 of IEC 60079-0:2011

The TC 31/CAG requested (Resolution 2 of 2018-04-19) that WG 22 prepare an interpretation sheet based on IECEx Decision Sheet DS2018/002 addressing the assignment of entry point and branching point temperatures of electrical rotating machines.

This interpretation is made available for Edition 6 of this standard due to the current use of that standard by manufacturers, conformity assessment schemes and national bodies by means of this “Interpretation Sheet” as follows:

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Details of interpretation:

IEC 60079-0:2011 (Ed. 6), *Explosive atmospheres – Part 0: Equipment – General requirements*

Interpretation of Subclause 16.6, Temperature at branching point and entry point:

Question: Subclause 16.6 of IEC 60079-0:2011 (Ed. 6) states "When the temperature under rated conditions is higher than 70 °C at the entry point or 80 °C at the branching point of the conductors, information shall be marked on the equipment exterior to provide guidance to the user on the proper selection of cable and cable gland or conductors in conduit."

It is not normal practice for electrical rotating machines to be tested with the cable entry devices and cables that might be used in an actual installation, but with the cables available at the manufacturer's test area. In many cases, there will be no formal entry device as the cables will enter via the space reserved for fixing of a gland plate.

How shall the relevant entry point and branching point temperatures be determined?

Interpretation: *The use of the maximum internal air space temperature to represent the maximum service temperature of terminal box gaskets and seals, the cable branching point temperature, and the entry point temperature reflects the normal practice of testing electrical rotating machines without prior knowledge of the actual glands and cables to be used for installation. The production of heat from the electrical rotating machine connections is generally insignificant with respect to the production of heat from the machine windings and core.*

Further amplification:

1) The entry point of the cable where the temperature is measured should be sealed so far as possible to ensure that there is minimum air-circulation which can reduce the measured temperature.
2) This is not intended to apply to any gasket between the terminal box and the frame of the electrical rotating machine, where higher temperatures may be recorded, but only to the gasket between the terminal box and its lid.

Although written in the context of electrical rotating machines, there may be other types of equipment where an equivalent approach is applicable.

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International Standard IEC 60079-0 has been prepared by IEC technical committee 31: Equipment for explosive atmospheres.

This sixth edition cancels and replaces the fifth edition, published in 2007, and constitutes a full technical revision.

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

- Relocation of definitions for energy limitation parameters to IEC 60079-11
- Addition of note to clarify that the non-metallic "enclosure" requirements are applied to other than "enclosures" by some of the subparts
- Expansion of material specification data for plastics and elastomers, including UV resistance
- Addition of alternative qualification for O-rings
- Addition of alternative criteria for surface resistance

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- Addition of breakdown voltage limit for non-metallic layers applied to metallic enclosures
- Expansion of “X” marking options for non-metallic enclosure materials not meeting basic electrostatic requirements
- Clarification that non-metallic enclosure requirements also apply to painted or coated metal enclosures
- Clarification of test to determine capacitance of accessible metal parts with reduction in acceptable capacitance
- Addition of limits on zirconium content for Group III and Group II (Gb only) enclosures
- Introduction of “X” marking for Group III enclosures not complying with basic material requirements, similar to that existing for Group II
- Addition of button-head cap screws to permitted “Special Fasteners”
- Reference for protective earthing (PE) requirements for electrical machines to IEC 60034-1
- Clarification of terminology for cable glands, blanking elements, and thread adapters
- Addition of requirements for ventilating fans
- Addition of alternative construction for disconnectors
- Removal of voltage limits on plugs and sockets
- Addition of test requirements for arc-quenching test on plugs and sockets
- Update of cell and battery information to reflect latest standards
- Revision to impact test of glass parts
- Revision to impact test procedure to address “bounce” of impact head
- Clarification of the test requirements for “service” and “surface” temperature
- Addition of temperature rise tests for converter-fed motors
- Addition of alternative test method for thermal endurance
- Removal of “charging test” and addition of note providing guidance
- Clarification of test for the measurement of capacitance
- Addition of a “Schedule of Limitations” to certificates for Ex Components
- Clarification of the marking for multiple temperature classes
- Addition of marking for converter-fed motors
- Removal of IP marking for Group III
- Addition of specific instructions for electrical machines
- Addition of specific instructions for ventilating fans
- Update to informative Annex D on converter-fed motors
- Update to informative Annex E on temperature testing of motors
- Addition of informative Annex F, flowchart for testing of non-metallic enclosures and non-metallic parts of enclosures

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

FDIS	Report on voting
31/922/FDIS	31/939/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.

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A list of all parts of the IEC 60079 series, under the general title *Explosive atmospheres,* can be found on the IEC website.

Future standards in this series will carry the new general title as cited above. Titles of existing standards in this series will be updated at the time of a new edition.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

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

The contents of the corrigenda of November 2012 and December 2013, and the interpretation sheets of November 2013, October 2014, June 2018 and April 2019 have been included in this copy.

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EXPLOSIVE ATMOSPHERES –

Part 0: Equipment – General requirements

1 Scope

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

The standard atmospheric conditions (relating to the explosion characteristics of the atmosphere) under which it may be assumed that electrical equipment can be operated are:

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

This standard and other standards supplementing this standard specify additional test requirements for equipment operating outside the standard temperature range, but further additional consideration and additional testing may be required for equipment operating outside the standard atmospheric pressure range and standard oxygen content, particularly with respect to types of protection that depend on quenching of a flame such as 'flameproof enclosure "d"' (IEC 60079-1) or limitation of energy, 'intrinsic safety "i"' (IEC 60079-11).

NOTE 1 Although the standard atmospheric conditions above give a temperature range for the atmosphere of -20 °C to +60 °C, the normal ambient temperature range for the equipment is –20 °C to +40 °C, unless otherwise specified and marked. See 5.1.1. It is considered that –20 °C to +40 °C is appropriate for most equipment and that to manufacture all equipment to be suitable for a standard atmosphere upper ambient temperature of +60 °C would place unnecessary design constraints.

NOTE 2 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, mechanical impacts resulting in thermite reactions, electrical arcing and static electric discharge in normal industrial environments.

NOTE 3 It is acknowledged that, with developments in technology, it may be possible to achieve the objectives of the IEC 60079 series of standards in respect of explosion prevention by methods that are not yet fully defined. Where a manufacturer wishes to take advantage of such developments, this International Standard, as well as other standards in the IEC 60079 series, may be applied in part. It is intended that the manufacturer prepare documentation that clearly defines how the IEC 60079 series of standards has been applied, together with a full explanation of the additional techniques employed. The designation "Ex s" has been reserved to indicate special protection. A standard for special protection "s", IEC 60079-33, is in preparation.

NOTE 4 Where an explosive gas atmosphere and a combustible dust atmosphere are, or may be, present at the same time, the simultaneous presence of both should be considered and may require additional protective measures.

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

NOTE 5 Such equipment should be subjected to a hazard analysis that identifies and lists all of the potential sources of ignition by the electrical equipment and the measures to be applied to prevent them becoming effective.

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

– IEC 60079-1: Gas – Flameproof enclosures "d";
– IEC 60079-2: Gas – Pressurized enclosures "p";

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– IEC 60079-5: Gas – Powder filling "q";
– IEC 60079-6: Gas – Oil immersion "o";
– IEC 60079-7: Gas – Increased safety "e";
– IEC 60079-11: Gas – Intrinsic safety "i";
– IEC 60079-15: Gas – Type of protection “n”;
– IEC 60079-18: Gas and dust – Encapsulation "m";
– IEC 60079-31: Dust – Protection by enclosure “t”
– IEC 61241-4: Dust – Pressurization “pD”.

NOTE 6 Additional information on types of protection for non-electrical equipment can be found in ISO/IEC 80079-36 (to be published).

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

IEC 60079-13: Explosive atmospheres – Part 13: Equipment protection by pressurized room “p”

IEC 60079-25: Explosive atmospheres – Part 25: Intrinsically safe electrical systems

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

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

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

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

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

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

2 Normative references

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

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

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

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

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

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

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

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

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

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

IEC 60079-15, *Explosive atmospheres – Part 15: Equipment protection by type of protection "n"*

IEC 60079-18, *Explosive atmospheres – Part 18: Equipment protection by encapsulation "m"*

IEC 60079-20-1, *Explosive Atmosphere – Part 20-1: Material characteristics for gas and vapour classification, test methods and data*

IEC 60079-25: *Explosive atmospheres – Part 25: Intrinsically safe systems*

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

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

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

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

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

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

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

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

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

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

IEC 60254 (all parts), *Lead-acid traction batteries*

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

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

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

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

IEC 60662, *High-pressure sodium vapour lamps*

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

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

IEC 60896-11, *Stationary lead-acid batteries – Part 11: Vented types – General requirements and methods of tests*

IEC 60896-21, *Stationary lead-acid batteries – Part 21: Valve regulated types – Methods of test*

IEC 60952 (all parts), *Aircraft batteries*

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

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

IEC 61427, *Secondary cells and batteries for photovoltaic energy systems (PVES) – General requirements and methods of test*

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

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

IEC 61960, *Secondary cells and batteries containing alkaline or other non-acid electrolytes – Secondary lithium cells and batteries for portable applications*

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

ISO 178, *Plastics – Determination of flexural properties*

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

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

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

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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 3601-1, *Fluid power systems – O-rings – Part 1: Inside diameters, cross-sections, tolerances and designation codes*

ISO 3601-2, *Fluid power systems – O-rings – Part 2: Housing dimensions for general applications*

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 4892-2, *Plastics – Methods of exposure to laboratory light sources – Part 2: Xenon-arc lamps*

ISO 7380, *Hexagon socket button head screws*

ISO 14583, *Hexalobular socket pan head screws*

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

ANSI/UL 746C, *Polymeric Materials – Used in Electrical Equipment Evaluations*

3 Terms and definitions

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

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

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

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

3.2
area, hazardous
area in which an explosive atmosphere is present, or may be expected to be present, in quantities such as to require special precautions for the construction, installation and use of electrical apparatus

3.3
area, non-hazardous
area in which an explosive atmosphere is not expected to be present in quantities such as to require special precautions for the construction, installation and use of electrical apparatus

3.4
associated apparatus
electrical apparatus which contains both energy-limited and non-energy-limited circuits and is constructed so that the non-energy-limited circuits cannot adversely affect the energy-limited circuits

NOTE Associated apparatus may be either:

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

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

3.5
cells and batteries

3.5.1
battery
assembly of two or more cells electrically connected to each other to increase the voltage or capacity

3.5.2
capacity
quantity of electricity or electric charge, which a fully charged battery can deliver under specified conditions

3.5.3
cell
assembly of electrodes and electrolyte which constitutes the smallest electrical unit of a battery

3.5.4
charging
act of forcing current through a secondary cell or battery in the opposite direction to the normal flow to restore the energy

3.5.5
deep discharge
event which reduces a cell voltage below that recommended by the cell or battery manufacturer

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3.5.6
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 11 and 12 which show the maximum open-circuit voltage for acceptable cells.

3.5.7
nominal voltage
(of a cell or battery) is that specified by the manufacturer

3.5.8
vented cell or battery
secondary cell, or battery, having a cover provided with an opening through which gaseous products may escape

3.5.9
primary cell or battery
electrochemical system capable of producing electrical energy by chemical reaction

3.5.10
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

3.5.11
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.

3.5.12
sealed valve-regulated cell or battery
cell or battery which is closed under normal conditions but which has an arrangement which allows the escape of gas if the internal pressure exceeds a pre-determined value. The cell cannot normally receive an addition to the electrolyte

3.5.13
secondary cell or battery
electrically rechargeable electrochemical system capable of storing electrical energy and delivering it by chemical reaction

3.5.14
container (battery)
enclosure to contain the battery

NOTE The cover is a part of the battery container.

3.6
bushing
insulating device carrying one or more conductors through an internal or external wall of an enclosure

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3.7
cable gland
device permitting the introduction of one or more electric and/or fibre optic cables into an electrical equipment so as to maintain the relevant type of protection

3.7.1
clamping device
element of a cable gland for preventing tension or torsion in the cable from being transmitted to the connections

3.7.2
compression element
element of a cable gland acting on the sealing ring to enable the latter to fulfil its function

3.7.3
sealing ring
ring used in a cable gland to ensure the sealing between the cable gland and the cable

3.7.4
Ex Equipment cable gland
cable gland tested separately from the equipment enclosure but certified as equipment and which can be fitted to the equipment enclosure during installation.

3.7.5
cable transit device
an entry device, intended for one or more cables, with a seal made up of one or more separate elastomeric modules or parts of modules (modular internal seal), which are compressed together when the device is assembled and mounted as intended.

NOTE Cable transit devices can also serve as Ex blanking Elements when the elastomeric modules provided allow for this function.

3.8
certificate
document that assures the conformity of a product, process, system, person, or organization with specified requirements

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

3.8.1
Ex Component Certificate
a certificate prepared for an Ex Component. See 3.28.

3.8.2
Equipment Certificate
A certificate prepared for equipment other than an Ex Component. Such equipment may include Ex Components, but additional evaluation is always required as part of their incorporation into equipment. See 3.7.4, 3.25, 3.27, 3.28, and 3.29.

3.9
compound (for encapsulation)
any thermosetting, thermoplastic, epoxy resin or elastomeric materials with or without fillers and/or additives, in their solid state; used for encapsulation

3.10
conduit entry
means of introducing a conduit into electrical equipment so as to maintain the relevant type of protection

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3.11
connection facilities
terminals, screws or other parts, used for the electrical connection of conductors of external circuits

3.12
connections, factory
terminations intended for connection during a manufacturing process under controlled conditions

3.13
connections, field-wiring
terminations intended for connection by the installer in the field

3.14
continuous operating temperature
COT
temperature range which ensures the stability and integrity of the material for the expected life of the equipment, or part, in its intended application

3.15
converter (for use with electrical machines)
unit for electronic power conversion, changing one or more electrical characteristics and comprising one or more electronic switching devices and associated components, such as transformers, filters, commutation aids, controls, protections, and auxiliaries, if any

NOTE A Converter may also be known as a frequency converter, a converter drive, an inverter drive, a variable speed drive, or a variable frequency drive.

3.16
converter, soft-start
converter which limits the input current to the electrical machine during the starting process.

NOTE It is intended that the soft-start converter is used only during the starting process and is then isolated from the power system when the electrical machine is running.

3.17
degree of protection of enclosure
IP
numerical classification according to IEC 60529 preceded by the symbol IP applied to the enclosure of electrical equipment to provide

– protection of persons against contact with, or approach to, live parts and against contact with moving parts (other than smooth rotating shafts and the like) inside the enclosure,
– protection of the electrical equipment against ingress of solid foreign objects, and
– where indicated by the classification, protection of the electrical equipment against harmful ingress of water

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

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

3.18
dust
generic term including both combustible dust and combustible flyings

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3.18.1
combustible dust
finely divided solid particles, 500 μm or less in nominal size, which may be suspended in air, may settle out of the atmosphere under their own weight, may burn or glow in air, and may form explosive mixtures with air at atmospheric pressure and normal temperatures

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

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

3.18.1.1
conductive dust
combustible dust with electrical resistivity equal to or less than 10^3 Ω·m

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

3.18.1.2
non-conductive dust
combustible dust with electrical resistivity greater than 10^3 Ω·m

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

3.18.2
combustible flyings
solid particles, including fibres, greater than 500 μm in nominal size which may be suspended in air and could settle out of the atmosphere under their own weight

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

3.19
dust-tight enclosure
enclosure capable of excluding the ingress of observable dust particle deposits

3.20
dust-protected enclosure
enclosure in which the ingress of dust is not totally excluded, but is unlikely to enter in sufficient quantity to interfere with the safe operation of the equipment and does not accumulate in a position within the enclosure where it is liable to cause an ignition hazard

3.21
elastomer
a macromolecular material which returns rapidly to approximately its initial dimensions and shape after substantial deformation by a weak stress and release of the stress (IEV 212-04-05)

NOTE The definition applies to room temperature test conditions.

3.22
electrical equipment
items applied as a whole or in part for the utilization of electrical energy

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

3.23
encapsulation
process of applying a compound to enclose an electrical device(s) by suitable means

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3.24
enclosure
all the walls, doors, covers, cable glands, rods, spindles, shafts, etc. which contribute to the type of protection and/or the degree of protection IP of the electrical equipment

3.25
equipment (for explosive atmospheres)
general term including apparatus, fittings, devices, components, and the like used as a part of, or in connection with, an electrical installation in an explosive atmosphere

3.26
equipment protection level
EPL
level of protection assigned to equipment based on its likelihood of becoming a source of ignition and distinguishing the differences between explosive gas atmospheres, explosive dust atmospheres, and the explosive atmospheres in mines susceptible to firedamp

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

3.26.1
EPL Ma
equipment for installation in a mine susceptible to firedamp, having a "very high" level of protection, which has sufficient security that it is unlikely to become an ignition source in normal operation, during expected malfunctions or during rare malfunctions, even when left energized in the presence of an outbreak of gas

3.26.2
EPL Mb
equipment for installation in a mine susceptible to firedamp, having a "high" level of protection, which has sufficient security that it is unlikely to become a source of ignition in normal operation or during expected malfunctions in the time span between there being an outbreak of gas and the equipment being de-energized

3.26.3
EPL Ga
equipment for explosive gas atmospheres, having a "very high" level of protection, which is not a source of ignition in normal operation, during expected malfunctions or during rare malfunctions

3.26.4
EPL Gb
equipment for explosive gas atmospheres, having a "high" level of protection, which is not a source of ignition in normal operation or during expected malfunctions

3.26.5
EPL Gc
equipment for explosive gas atmospheres, having an "enhanced" level of protection, which is not a source of ignition in normal operation and which may have some additional protection to ensure that it remains inactive as an ignition source in the case of regular expected occurrences (for example failure of a lamp)

3.26.6
EPL Da
equipment for explosive dust atmospheres, having a "very high" level of protection, which is not a source of ignition in normal operation, during expected malfunctions, or during rare malfunctions

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3.26.7
EPL Db
equipment for explosive dust atmospheres, having a "high" level of protection, which is not a source of ignition in normal operation or during expected malfunctions

3.26.8
EPL Dc
equipment for explosive dust atmospheres, having an "enhanced" level of protection, which is not a source of ignition in normal operation and which may have some additional protection to ensure that it remains inactive as an ignition source in the case of regular expected occurrences (for example failure of a lamp)

3.27
Ex blanking element
threaded blanking element tested separately from the equipment enclosure but having an equipment certificate and which is intended to be fitted to the equipment enclosure without further consideration

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

NOTE 2 Non-threaded blanking elements are not equipment.

3.28
Ex Component
part of electrical equipment or a module, marked with the symbol "U", which is not intended to be used alone and requires additional consideration when incorporated into electrical equipment or systems for use in explosive atmospheres

3.29
Ex thread adapter
thread adapter tested separately from the enclosure but having an equipment certificate and which is intended to be fitted to the equipment enclosure without further consideration

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

3.30
explosive atmosphere
mixture with air, under atmospheric conditions, of flammable substances in the form of gas, vapour, dust, fibres, or flyings which, after ignition, permits self-sustaining propagation

3.31
explosive dust atmosphere
mixture with air, under atmospheric conditions, of flammable substances in the form of dust, fibres, or flyings which, after ignition, permits self-sustaining propagation

3.32
explosive gas atmosphere
mixture with air, under atmospheric conditions, of flammable substances in the form of gas or vapour, which, after ignition, permits self-sustaining flame propagation

3.33
explosive test mixture
specified explosive mixture used for the testing of electrical equipment for explosive gas atmospheres

3.34
firedamp
flammable mixture of gases naturally occurring in a mine

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NOTE Firedamp consists mainly of methane, but always contains small quantities of other gases, such as nitrogen, carbon dioxide, and hydrogen, and sometimes ethane and carbon monoxide. The terms firedamp and methane are used frequently in mining practice as synonyms.

3.35
free space
intentionally created space surrounding components or space inside components

3.36
galvanic isolation
arrangement within equipment which permits the transfer of signals or power between two circuits without any direct electrical connection between the two

NOTE Galvanic isolation frequently utilizes either magnetic (transformer or relay) or opto-coupled elements.

3.37
ignition temperature of an explosive gas atmosphere
lowest temperature of a heated surface which, under specified conditions according to IEC 60079-20-1, will ignite a flammable substance in the form of a gas or vapour mixture with air

3.38
ignition temperature of a dust layer
lowest temperature of a hot surface at which ignition occurs in a dust layer of specified thickness on a hot surface

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

3.39
ignition temperature of a dust cloud
lowest temperature of the hot inner wall of a furnace at which ignition occurs in a dust cloud in air contained therein

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

3.40
limiting temperature
maximum permissible temperature for equipment or parts of equipment equal to the lower of the two temperatures determined by:

a) the danger of ignition of the explosive atmosphere;

b) the thermal stability of the materials used

3.41
malfunction
equipment or components which do not perform their intended function with respect to explosion protection

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

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

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

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

– disturbance of the power supply or other services;

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

3.41.1
expected malfunction
disturbances or equipment malfunctions which normally occur in practice

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3.41.2
rare malfunction
type of malfunction, which may happen, but only in rare instances. Two independent expected malfunctions which, separately, would not create a source of ignition, but which, in combination, do create a source of ignition, are regarded as a single rare malfunction

3.42
maximum surface temperature
highest temperature which is attained in service under the most adverse conditions (but within the specified tolerances) by any part or surface of electrical equipment

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

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

3.43
normal operation
operation of equipment conforming electrically and mechanically with its design specification and used within the limits specified by the manufacturer

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

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

3.44
level of protection
subdivision of a Type of Protection, correlating with the Equipment Protection Level, that differentiates the likelihood of the equipment becoming a source of ignition

NOTE For example, Type of Protection intrinsic safety "i" is subdivided into Levels of Protection "ia", "ib", and "ic; which correlate with Equipment Protection Levels Ga, Gb, and Gc (for explosive gas atmospheres).

3.45
plastic
a material which contains as an essential ingredient a high polymer and which at some stage in its processing into finished products can be shaped by flow

[IEV 212-04-02]

NOTE Elastomers, which are also shaped by flow, are not considered as plastics.

3.46
radio frequency
electromagnetic waves from 9 kHz to 60 GHz

3.46.1
continuous transmission
transmission where the duration of the pulse is greater than the half of the thermal initiation time

3.46.2
pulsed transmission
transmission where the duration of the pulse is shorter than the half of the thermal initiation time, but the time between two consecutive pulses, however, is longer than three times the thermal initiation time

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3.46.3
thermal initiation time
time (over which the threshold power is averaged) during which energy deposited by the spark accumulates in a small volume of gas around it without significant thermal dissipation

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

3.46.4
threshold energy
Z_{th}
for a pulsed radio-frequency discharge, the maximum energy of the single pulse which can be extracted from the receiving body

3.46.5
threshold power
P_{th}
product of the effective output power of the transmitter multiplied by the antenna gain

NOTE The gain is produced by an antenna concentrating radiation in a particular direction and is always related to a specified reference antenna

3.47
rated value
quantity value, assigned generally by the manufacturer, for a specified operating condition of a component, device or apparatus

3.48
rating
set of rated values and operating conditions

3.49
replaceable battery pack
assembly consisting of one or more interconnected cells, along with any integrated protective components, which form a complete replaceable battery

3.50
service temperature
maximum or minimum temperature reached at specific points of the equipment when the equipment is operating at rated conditions, including ambient temperature and any external sources of heating or cooling. See 5.2

NOTE Equipment may reach different service temperatures in different parts.

3.51
spacings, electrical
separation distances between conductive parts at different electrical potentials

3.51.1
clearance
shortest distance in air between two conductive parts

3.51.2
creepage distance
shortest distance along the surface of a solid insulating material between two conductive parts

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3.51.3
distance through casting compound
shortest distance through a casting compound between two conductive parts

3.51.4
distance through solid insulation
shortest distance through solid insulation between two conductive parts

3.51.5
distance under coating
shortest distance between conductive parts along the surface of an insulating medium covered with insulating coating

3.52
symbol "U"
symbol used to denote an Ex Component

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

3.53
symbol "X"
symbol used to denote specific conditions of use

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

3.54
termination compartment
separate compartment, or part of a main enclosure, communicating or not with the main enclosure, and containing connection facilities

3.55
test, routine
test to which each individual device is subjected during or after manufacture to ascertain whether it complies with certain criteria

3.56
test, type
test of one or more devices made to a certain design to show that the design meets certain specifications

3.57
type of protection
specific measures applied to electrical equipment to avoid ignition of a surrounding explosive atmosphere

3.58
void
unintentional space created as a consequence of the encapsulation process

3.59
working voltage
highest r.m.s. value of the a.c. or d.c. voltage across any particular insulation which can occur when the equipment is supplied at rated voltage

NOTE 1 Transients are disregarded.

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

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4 Equipment grouping

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

4.1 Group I

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

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

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

4.2 Group II

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

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

Group II subdivisions

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

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

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

4.3 Group III

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

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

Group III subdivisions:

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

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

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4.4 Equipment for a particular explosive atmosphere

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

5 Temperatures

5.1 Environmental influences

5.1.1 Ambient temperature

Electrical equipment designed for use in a normal ambient temperature range of –20 °C to +40 °C does not require marking of the ambient temperature range. However, electrical equipment designed for use in other than this normal ambient temperature range is considered to be special. The marking shall then include either the symbol T_a or T_{amb} together with both the upper and lower ambient temperatures or, if this is impracticable, the symbol "X" shall be used to indicate specific conditions of use that include the upper and lower ambient temperatures. See item e) of 29.3 and Table 1.

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

Table 1 – Ambient temperatures in service and additional marking

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

5.1.2 External source of heating or cooling

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

NOTE 1 The external source of heating or cooling is frequently referred to as the "process temperature".

NOTE 2 The way in which these ratings are expressed will vary according to the nature of the source. For sources generally larger than the equipment, the maximum or minimum temperature will usually be sufficient. For sources generally smaller than the equipment, or for heat conduction through thermal insulation, the rate of heat flow may be appropriate.

NOTE 3 The influence of radiated heat may need to be considered on the final installation. See IEC 60079-14.

5.2 Service temperature

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

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

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5.3 Maximum surface temperature

5.3.1 Determination of maximum surface temperature

Maximum surface temperature shall be determined according to 26.5.1 considering the maximum ambient temperature and, where relevant, the maximum rated external source of heating.

5.3.2 Limitation of maximum surface temperature

5.3.2.1 Group I electrical equipment

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

This maximum surface temperature shall not exceed

– 150 °C on any surface where coal dust can form a layer,
– 450 °C where coal dust is not likely to form a layer (i.e., inside of a dust-protected enclosure).

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

5.3.2.2 Group II electrical equipment

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

– the temperature class assigned (see Table 2), or
– the maximum surface temperature assigned, or
– if appropriate, the ignition temperature of the specific gas for which it is intended.

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

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

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

5.3.2.3 Group III electrical equipment

5.3.2.3.1 Maximum surface temperature determined without a dust layer

The maximum surface temperature determined (see 26.5.1) shall not exceed the maximum surface temperature assigned.

5.3.2.3.2 Maximum surface temperature with respect to dust layers

In addition to the maximum surface temperature required in 5.3.2.3.1, the maximum surface temperature may also be determined for a given depth of layer, T_L, of dust surrounding all sides of the equipment, unless otherwise specified in the documentation, and marked with the symbol “X” to indicate this specific condition of use in accordance with item d) of 29.5.

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

NOTE 2 Additional information on the application of equipment where dust layers up to 50 mm may accumulate on the equipment is given in IEC 60079-14.

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

NOTE There is both theoretical and practical evidence to show that the smaller the heated surface, the higher the surface temperature required to ignite a given explosive atmosphere.

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

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

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

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

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

Total surface area excluding lead wires	Equipment Group II With temperature class T4		Equipment Group I Dust excluded	
	Maximum surface temperature	Maximum power dissipation	Maximum surface temperature	Maximum power dissipation
	°C	W	°C	W
<20 mm^2	275		950	
≥20 mm^2 ≤1 000 mm^2	200, or	1,3		3,3
>1 000 mm^2		1,3		3,3

Table 3b – Assessment of temperature classification Component surface area ≥ 20 mm^2 Variation in maximum power dissipation with ambient temperature

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

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

For surface areas of not more than 1 000 mm^2, the surface temperature may exceed that for the temperature class marked on the Group II electrical equipment or the corresponding

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maximum surface temperature for Group I electrical equipment, if there is no risk of ignition from these surfaces, with a safety margin of

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

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

NOTE During the tests, the safety margin may be provided by increasing the ambient temperature or by increasing the power dissipation of the component. For methane, the second option is recommended.

6 Requirements for all electrical equipment

6.1 General

Electrical equipment and Ex Components shall

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

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

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

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

NOTE 3 It is not a requirement of this standard that compliance with these industrial standards be verified.

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

6.2 Mechanical strength of equipment

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

6.3 Opening times

Enclosures which can be opened more quickly than

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

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

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

shall be marked with one of the following warning markings:

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– an enclosure opening delay marking as specified in item a) of 29.12; or
– an enclosure opening marking as specified in item b) of 29.12.

6.4 Circulating currents in enclosures (e.g. of large electrical machines)

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

NOTE 1 Stray magnetic fields can result in significant currents flowing both within and between bolted sections of multi-section enclosures often employed for large rotating electrical machines. This is most likely to occur during the starting of motors. It is important to avoid sparking from intermittent interruption of these currents.

NOTE 2 Although primarily a concern with large rotating machines, the same situation can occur in other equipment with large stray magnetic fields interacting with bolted sections of multi-section enclosures.

NOTE 3 Examples of precautions that can be taken include:

– the provision of equipotential bonding; or

– the provision of an adequate quantity of fasteners.

Where equipotential bonding conductors are employed, they shall be adequately rated for the anticipated currents and they shall be arranged to ensure reliable current transfer without the risk of sparking under adverse operating conditions, such as vibration or corrosion. The bonds shall be protected against corrosion and loosening in accordance with 15.4 and 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 between parts. The insulation of such parts shall be capable of withstanding a voltage of 100 V r.m.s for 1 min. However, provision shall be made for adequate earthing of isolated exposed conductive parts.

6.5 Gasket retention

Where the degree of protection provided by the enclosure depends on a gasketed joint which is intended to be opened for installation or maintenance purposes, gaskets shall be attached or secured to one of the mating faces to prevent loss, damage or incorrect assembly. The gasket material shall not itself adhere to the other joint face. When the joint is opened and re-closed prior to the tests for degree of protection by enclosure, it shall be verified that the gasket material has not adhered to the other joint face. (See 26.4.1.2).

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

6.6 Electromagnetic and ultrasonic energy radiating equipment

The energy levels shall not exceed the values given below.

NOTE Additional information on the application of higher power radiating sources can be found, for Group I and Group II, in CLC/TR50427. The results of the TR are based on far field conditions.

6.6.1 Radio frequency sources

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

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Table 4 – Radio frequency power thresholds

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

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

Table 5 – Radio-frequency energy thresholds

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

NOTE 1 In Tables 4 and 5, the same values are applied for Ma, Mb, Ga, Gb, Gc, Da, Db, or Dc equipment due to the large safety factors involved.

NOTE 2 In Tables 4 and 5, the values for Group III are adopted from Group I and not based on experimental results.

NOTE 3 In Tables 4 and 5; the values apply in normal operation, provided that the user of the equipment does not have access to adjust the equipment to give higher values. It is not necessary to consider possible increases in power caused by faults, due to the large safety margins involved and the strong likelihood that RF amplifiers will rapidly fail if a fault occurs that significantly increases the output power.

6.6.2 Lasers or other continuous wave sources

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

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

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

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

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

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

- 10 mW/mm^2 or 35 mW for continuous wave lasers and other continuous wave sources, and

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- 0,5 mJ/mm^2 for pulse lasers or pulse light sources.

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

6.6.3 Ultrasonic sources

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

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

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

7.1 General

7.1.1 Applicability

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

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

NOTE 2 Some of the subparts of this standard may make the “non-metallic parts of enclosures” requirements given in this clause applicable to parts, which are not enclosures, but on which the type of protection depends, e.g. “d” bushings, “e” terminals.

7.1.2 Specification of materials

7.1.2.1 General

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

7.1.2.2 Plastic materials

The specification for plastic materials shall include the following:

a) the name or registered trademark of the resin manufacturer or compounder;

b) the identification of the material, including its colour, type and percentage of fillers and 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) may be determined in accordance with ANSI/UL 746B.

e) when applicable, data supporting compliance with 7.3 (resistance to ultraviolet light).

The source of the test data for these characteristics shall be identified.

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

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7.1.2.3 Elastomers

The specification for elastomers shall include the following:

a) the name or registered trademark of the resin manufacturer or compounder;
b) the identification of the material, including its
   – type designation,
   – colour,
   – type and percentage of fillers and other additives, if used;
c) the possible surface treatments, such as varnishes, etc.;
d) the continuous operating temperature (COT);
e) when applicable, data supporting compliance with 7.3 (resistance to ultraviolet light).

The source of the test data for these characteristics shall be identified.

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

7.2 Thermal endurance

7.2.1 Tests for thermal endurance

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

7.2.2 Material selection

The plastic materials shall have a temperature index "TI" or RTI – mechanical (according to 7.1.2) of at least 20 K greater than the maximum service temperature of the enclosure or the part of the enclosure (see 26.5.1).

The elastomers shall have a continuous operating temperature (COT) range that includes a minimum temperature that is below, or equal to, the minimum service temperature and a maximum temperature that is at least 20 K above the maximum service temperature.

NOTE Equipment may have different service temperatures on different parts of the equipment. Selection and testing of individual materials is based on the specific service temperature of that part, but may alternatively be based on the maximum (or minimum) service temperature of the complete equipment.

7.2.3 Alternative qualification of elastomeric sealing O-rings

Elastomeric sealing O-rings are normally qualified as a part of the complete equipment enclosure when the ingress protection of the enclosure (IP) is required by the type of protection. Alternatively, a metal enclosure incorporating elastomeric sealing O-rings, according to ISO 3601-1, used in defined mounting conditions according to ISO 3601-2, is permitted to be evaluated using a test fixture instead of testing the O-ring assembled in the complete equipment enclosure. The test fixture shall replicate the dimensions of the complete equipment enclosure O-ring mounting. The tests shall be conducted according 26.16**.** The O-ring is then mounted in the complete equipment enclosure and subjected to the required IP tests of 26.4.5.

NOTE The compression set value determined after the tests of 26.16 is necessary for subsequent comparison to O-rings of alternative materials for the same application.

For the qualification of additional O-ring materials, the IP tests are not required if, subsequent to the tests of 26.16, the compression set of the alternative O-ring is less than or equal to that of the originally tested O-ring.

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7.3 Resistance to light

The resistance to light of the enclosures, or parts of enclosures, of non-metallic materials shall be satisfactory (see 26.10). Materials meeting the ultraviolet light exposure requirements (f1) in ANSI/UL 746C are considered satisfactory.

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

If the equipment is protected from light (for example, daylight or light from luminaires) when installed, and, in consequence, the test is not carried out, the equipment shall be marked by the symbol "X" to indicate this specific condition of use according to item e) of 29.3.

NOTE 1 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.

NOTE 2 The tests for resistance to light are conducted on special test bars and not on the enclosure. Therefore, the special test bars are not required to be subjected to the tests of enclosures (26.4) prior to the tests for resistance to light.

7.4 Electrostatic charges on external non-metallic materials

7.4.1 Applicability

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

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

NOTE 1 Non-metallic paints, films, foils, and plates are typically attached to external surfaces of enclosures to provide additional environmental protection. Their ability to store an electrostatic charge is addressed by this clause.

NOTE 2 It is generally acknowledged that glass is not susceptible to storing an electrostatic charge.

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

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

a) by suitable selection of the material so that surface resistance complies with either of the limits given below when measured in accordance with 26.13;

   10^9 Ω measured at (50 ± 5) % relative humidity; or

   10^{11}Ω measured at (30 ± 5) % relative humidity

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

   The surface area is defined as follows:

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

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

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Alternatively, for long parts with non-metallic surfaces, such as tubes, bars, or ropes, the surface area need not be considered, but the diameters or widths shall not exceed the values shown in Table 7. Cables for connection of external circuits are not considered to fall under this requirement. See 16.7.

c) by limitation of a non-metallic layer bonded to a conductive surface. The thickness of the non-metallic layer shall not exceed the values shown in Table 8 or the breakdown voltage shall be ≤4 kV (measured across the thickness of the insulating material according to the method described in IEC 60243-1);

d) by provision of a conductive coating. Non-metallic surfaces may be covered with a bonded durable conductive coating. The resistance between coating and either the point of bond (in the case of equipment for fixed installations) or the farthest point of potential contact with the enclosure (in the case of portable equipment) shall not exceed 10^9 Ω. The resistance shall be measured in accordance with 26.13 but using a 100 mm^2 electrode at the worst case position of the surface and either the bond or the farthest point of potential contact. The equipment shall be marked "X" in accordance with item e) of 29.3 and the documentation shall provide guidance on the use of the bonding connection (for fixed equipment) and provide information to enable the user to decide on the durability of the coating material with respect to the environmental conditions;

NOTE 1 The environmental conditions that have an effect on the coating material may include influences from small particles in an air stream, solvent vapours, and the like.

e) for fixed installations where the installation is intended to minimize the risk from electrostatic discharge, by marking the equipment X" in accordance with item e) of 29.3. . The instructions shall provide guidance for the user to minimize the risk from electrostatic discharge. Where practicable, the equipment shall also be marked with the electrostatic charge warning given in item g) of 29.12.

NOTE 2 Guidance on the risk of ignition from electrostatic discharge can be found in EN TR50404 and future IEC/TS 60079-32.

NOTE 3 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 4 When selecting electrical insulating materials, attention should be paid to maintaining a minimum insulation resistance to avoid problems arising from touching exposed non-metallic parts that are in contact with live parts.

Table 6 – Limitation of surface areas

Maximum surface area mm²				
Group I equipment	**Group II equipment**			
	Equipment protection level	**Group IIA**	**Group IIB**	**Group IIC**
10 000	EPL Ga	5 000	2 500	400
	EPL Gb	10 000	10 000	2 000
	EPL Gc	10 000	10 000	2 000

Table 7 – Maximum diameter or width

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

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