UL 60079-5

STANDARD FOR SAFETY

Explosive Atmospheres – Part 5: Equipment protection by powder filling "q"

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UL Standard for Safety for Explosive Atmospheres – Part 5: Equipment protection by powder filling "q", UL 60079-5

Fourth Edition, Dated April 29, 2016

Summary of Topics

This revision of ANSI/UL 60079-5 dated August 14, 2020 is being issued to update the title page to reflect the reaffirmation of its ANSI approval. No changes in requirements have been made.

This standard is an adoption of IEC 60079-5, Explosive Atmospheres – Part 5: Equipment Protection by Powder Filling "q" (fourth edition issued by IEC February 2015) with US National Differences.

Text that has been changed in any manner or impacted by UL's electronic publishing system is marked with a vertical line in the margin.

The requirements are substantially in accordance with Proposal(s) on this subject dated June 5, 2020.

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APRIL 29, 2016
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ANSI/UL 60079-5-2016 (R2020)

UL 60079-5

Standard for Explosive atmospheres – Part 5: Equipment protection by powder filling "q"

First Edition – December, 2002
Second Edition – March, 2007
Third Edition – July, 2009

Fourth Edition

April 29, 2016

This ANSI/UL Standard for Safety consists of the Fourth Edition including revisions through August 14, 2020.

The most recent designation of ANSI/UL 60079-5 as a Reaffirmed American National Standard (ANS) occurred on July 31, 2020. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, Title Page, or Preface. The National Difference Page and IEC Foreword are also excluded from the ANSI approval of IEC-based standards.

Comments or proposals for revisions on any part of the Standard may be submitted to UL at any time. Proposals should be submitted via a Proposal Request in UL's On-Line Collaborative Standards Development System (CSDS) at https://csds.ul.com.

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Preface (UL)

This UL Standard is based on IEC Publication 60079-5: fourth edition Explosive atmospheres – Part 5: Equipment protection by powder filling “q”. IEC publication 60079-5 is copyrighted by the IEC.

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Note – Although the intended primary application of this standard is stated in its scope, it is important to note that it remains the responsibility of the users of the standard to judge its suitability for their particular purpose.

The following people served as members of STP 60079 and participated in the review of this standard:

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National Differences

National Differences from the text of International Electrotechnical Commission (IEC) Publication 60079-5, Explosive Atmospheres – Part 5: Equipment protection by powder Filling "q" copyright 2015 are indicated by notations (differences) and are presented within the body of the UL printed standard in bold text with legislative mark-ups (strike-out and underline).

There are five types of National Differences as noted below. The difference type is noted on the first line of the National Difference in the standard. The standard may not include all types of these National Differences.

D1 – These are National Differences which are based on **basic safety principles and requirements**, elimination of which would compromise safety for consumers and users of products.

D2 – These are National Differences from IEC requirements based on existing **safety practices**. These requirements reflect national safety practices, where empirical substantiation (for the IEC or national requirement) is not available or the text has not been included in the IEC standard.

DC – These are National Differences based on the **component standards** and will not be deleted until a particular component standard is harmonized with the IEC component standard.

DE – These are National Differences based on **editorial comments or corrections**.

DR – These are National Differences based on the **national regulatory requirements**.

Each national difference contains a description of what the national difference entails. Typically one of the following words is used to explain how the text of the national difference is to be applied to the base IEC text:

Addition / Add - An addition entails adding a complete new numbered clause, subclause, table, figure, or annex. Addition is not meant to include adding select words to the base IEC text.

Deletion / Delete - A deletion entails complete deletion of an entire numbered clause, subclause, table, figure, or annex without any replacement text.

Modification / Modify - A modification is an altering of the existing base IEC text such as the addition, replacement or deletion of certain words or the replacement of an entire clause, subclause, table, figure, or annex of the base IEC text.

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FOREWORD

INTERNATIONAL ELECTROTECHNICAL COMMISSION

EXPLOSIVE ATMOSPHERES – Part 5: Equipment protection by powder filling “q”

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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8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.

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

International Standard IEC 60079-5 has been prepared by IEC technical committee 31: Equipment for explosive atmospheres.

This fourth edition cancels and replaces the third edition, published in 2007, and constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

NOTE The technical changes referred to include the significant technical changes in the revised IEC standard, but they do not form an exhaustive list of all modifications from the previous edition. More guidance may be found by referring to the redline version of the IEC standard, if available.

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Significant changes	Clause/ subclause	Type		
		Minor and editorial changes	Extension	Major technical changes
Specific references to IEC 60079-0 have been reworded so the references to IEC 60079-0 can be non-dated references	4.1.3 4.8 4.8.3	X		
The “housing” surrounding the powder filled equipment or Ex Component has been redefined as a “container” to avoid confusion with the “enclosure” requirements of IEC 60079-0	4.1	X		
A relaxation has been introduced to permit reduced distances through filling material for instances where there is no adjacent gap in the container	4.3.1		X	
A relaxation has been introduced to permit the use of creepage dimensions per IEC 60079-7 where CTI is better than 175	4.8.3		X	
An evaluation of joints employed when the reduced distances according to Table 1 are applied, has been added.	5.1.1		X	
Text for determination of maximum temperature clarified with respect to overloads and malfunctions	5.1.4	X		
A batch routine test has been introduced	5.2.1		X	

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

FDIS	Report on voting
31/1156/FDIS	31/1171/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 list of all parts of IEC 60079 series, under the general title *Explosive atmospheres*, can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC website 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.

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EXPLOSIVE ATMOSPHERES – Part 5: Equipment protection by powder filling “q”

1 Scope

1DV.1 DE *Modification of Clause 1, first paragraph to replace with the following:*

1DV.1.1 This standard ~~part of IEC 60079~~ contains specific requirements for the construction, testing and marking of electrical equipment, parts of electrical equipment and Ex components in the type of protection powder filling “q”, intended for use in explosive gas atmospheres.

NOTE 1 Electrical equipment and Ex components protected by powder filling “q” can contain electronic circuits, transformers, protection fuses, relays, intrinsically safe electrical apparatus, associated electrical apparatus, switches, etc.

NOTE 2 Type of protection powder filling “q” provides Equipment Protection Level (EPL) Gb or Mb.

1DV.2 DR *Modification of Clause 1, second paragraph to replace with the following:*

1DV.2.1 This standard supplements and modifies the general requirements of UL 60079-0 ~~IEC 60079-0~~. Where a requirement of this standard conflicts with a requirement of UL 60079-0 ~~IEC 60079-0~~, the requirement of this standard takes precedence.

This standard applies to electrical equipment, parts of electrical equipment and Ex components with:

– a rated supply current less than or equal to 16 A;

– a rated supply voltage less than or equal to 1 000 V;

– a rated power consumption less than or equal to 1 000 W.

2 Normative references

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

2DV DR *Modification of Clause 2 references to replace with the following:*

~~IEC 60079-0, Explosive atmospheres – Part 0: Equipment – General requirements~~

~~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 60127 (all parts), *Miniature fuses*

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

IEC 61558-1, *Safety of power transformers, power supplies, reactors and similar products – Part 1: General requirements and tests*

IEC 61558-2-6, *Safety of transformers, reactors, power supply units and similar products for supply voltages up to 1 100 V – Part 2-6: Particular requirements and tests for safety isolating transformers and power supply units incorporating safety isolating transformers*

ISO 2859-1, *Sampling procedures for inspection by attributes – Part 1: Sampling schemes indexed by acceptance quality limit (AQL) for lot-by-lot inspection*

ISO 3310-1, *Test sieves – Technical requirements and testing – Part 1: Test sieves of metal wire cloth*

ISO 3310-2, *Test sieves – Technical requirements and testing – Part 2: Test sieves of perforated metal plate*

ISO 2591-1, *Test sieving – Methods using test sieves of woven wire cloth and perforated metal plate*

UL 2225, *Cables and Cable-Fittings for Use in Hazardous (Classified) Locations*

UL 60079-0, *Explosive Atmospheres Part 0: Equipment – General Requirements*

UL 60079-7, *Explosive Atmospheres – Part 7: Equipment Protection by Increased Safety "e"*

UL 60079-11, *Explosive Atmospheres – Part 11: Equipment Protection by Intrinsic Safety "i"*

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3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60079-0 as well as the following apply.

NOTE Additional definitions applicable to explosive atmospheres can be found in IEC 60050-426.

3.1 **POWDER FILLING "q"** type of protection in which the parts capable of igniting an explosive gas atmosphere are fixed in position and completely surrounded by filling material to prevent the ignition of an external explosive gas atmosphere

Note 1 to entry: The type of protection may not prevent the surrounding explosive gas atmosphere from penetrating into the equipment and components and being ignited by the circuits. However, due to the small free volumes in the filling material and due to the quenching of a flame which may propagate through the paths in the filling material, an external explosion is prevented.

3.2 **FILLING MATERIAL** solid quartz or solid glass particles

3.3 **CONTAINER (FOR FILLING MATERIAL)** housing immediately surrounding the electrical equipment protected by and containing the filling material

Note 1 to entry: The container may, in some cases, also be the external enclosure.

4 Constructional requirements

4.1 Containers

4.1.1 Closing and sealing

4.1.1.1 General

Containers of electrical equipment, parts of electrical equipment or Ex components protected by powder filling ”q” shall be filled and sealed at the time of manufacture. The closing and sealing shall be the methods of 4.1.1.2 or 4.1.1.3.

4.1.1.2 Containers permanently sealed at the time of manufacture

The container shall be permanently sealed at the time of manufacture and shall not be capable of being opened without leaving visible evidence that the container has been opened. The container shall be marked in accordance with Clause 6, item a).

NOTE Suitable techniques that can provide visible evidence of containers being opened are, for example, welding, soldering, cemented joints, rivets, cementing of screws, or lead-seal safety-wiring of screws.

4.1.1.3 Containers intended to be opened for repair

Electrical equipment, parts of electrical equipment, or Ex components that are designed to be repaired shall incorporate sealing methods that are capable of being renewed without damage to the container when the equipment is repaired, re-filled, and re-sealed. The container shall be marked in accordance with Clause 6, item b).

4.1.2 Pressure test of container

The electrical equipment, parts of electrical equipment or Ex components protected by powder filling “q” shall meet the pressure test requirements specified in 5.1.1.

4.1.3 Degree of protection of the container

4.1.3DV DR *Modification of Clause 4.1.3 to replace with the following:*

The container of the electrical equipment, parts of electrical equipment, or Ex components protected by powder filling “q”, in their normal service condition, i. e. with all openings closed as in normal use, shall comply at least with the degree of protection IP54 as defined in IEC 60529. If the degree of protection is IP55 or higher, and the container is not hermetically sealed, the container shall be provided with a breathing device. The container with the breathing device in place shall comply at least with the degree of protection IP54 according to IEC 60529. The test shall be conducted on an empty container without the powder filling installed. At the end of any water ingress tests, no water shall be visible inside the container.

NOTE 1 As the container may need to be destroyed in order to determine the entrance of dust or water, two separate test samples could be required for the two ingress tests.

NOTE 2 When the container is also the external enclosure, the tests of enclosures requirements of UL 60079-0 ~~IEC 60079-0~~ apply.

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The ingress protection of containers or parts of electrical equipment protected by powder filling "q", intended for use only in clean, dry rooms, may be reduced to degree of protection IP43. The ~~certificate number of this~~ equipment shall be marked ~~include the "X" suffix~~ in accordance with ~~the marking requirements of~~ UL 60079-0 ~~IEC 60079-0~~ to indicate that there are Specific Conditions of Use, and the Specific Conditions of Use listed on the certificate shall detail the restrictions of use.

When Ex components protected by powder filling "q" are intended to be mounted inside another enclosure complying with UL 60079-0 ~~IEC 60079-0~~, this outer enclosure shall have a degree of protection of at least IP54. The IP rating of the inner container does not need to be specified provided that the Ex component is mounted in a position where it is unlikely to be contaminated by any small amounts of water that may enter the outer enclosure.

NOTE 3 The impact and drop tests of enclosures from UL 60079-0 ~~IEC 60079-0~~ do not generally apply to Ex Components intended to be mounted inside another enclosure complying with UL 60079-0 ~~IEC 60079-0~~, as the external enclosure provides the protection against impact and drop.

The maximum gap of a container protected by powder filling "q" shall be at least 0,1 mm smaller than the specified smallest dimension of the filling material.

NOTE 4 The restriction on the size of the gap is intended to reduce the escape of filling material.

4.1.4 Filling procedure

Filling shall be carried out so as not to leave any void within the filling material (for example by shaking down). The free space within electrical equipment, parts of electrical equipment or Ex components protected by powder filling "q" shall be effectively filled with filling material (see also 4.3.2).

4.1.5 Containers that are not external enclosures

The container of type of protection "q" equipment or Ex Component that is installed or intended to be installed internal to another enclosure is considered the same as that of an Ex Component.

4.2 Filling material

4.2.1 Material specification

The material shall be quartz or solid glass particles.

The material specification shall state that, determined in accordance with the ISO 2591-1 procedure for dry materials, the size of particles are within the following sieve sizes:

– 1 mm nominal aperture sieve in accordance with ISO 3310-1 or ISO 3310-2

– 500 µm nominal aperture sieve in accordance with ISO 3310-1.

4.2.2 Documentation

The documents prepared by the manufacturer in accordance with IEC 60079-0 shall include the specification of the particle material, the size range of the particles, as well as the filling process and the measures taken to ensure proper filling.

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NOTE It is not a requirement of this standard that conformity to the specification of the particle material and size range of the particles needs to be verified.

4.2.3 Testing

The filling material shall be subjected to the dielectric strength test specified in 5.1.3.

4.3 Distances

4.3.1 Distances through filling material

Except where specified otherwise in this standard, the minimum distance through the filling material between electrically conducting parts of the equipment and the container shall comply with Table 1 and Figure 1. This does not apply to conductors used for field wiring connections which penetrate the wall of the container.

Table 1
Distances through the filling material

Voltage[a] a.c. r.m.s. or d.c. V	Minimum distance mm	Reduced distance [b] mm
$U \leq 80$	5	1,5
$U \leq 100$	5	2
$U \leq 125$	5	2
$U \leq 160$	5	2
$U \leq 200$	5	3
$U \leq 250$	5	3
$U \leq 400$	6,3	3
$U \leq 500$	8	3
$U \leq 800$	10	5
$U \leq 1\,000$	14	5
$U \leq 1\,600$	16	10
$U \leq 2\,500$	25	10
$U \leq 3\,200$	32	10
$U \leq 4\,000$	40	14
$U \leq 5\,000$	50	14
$U \leq 6\,300$	63	25
$U \leq 8\,000$	80	25
$U \leq 10\,000$	100	40

[a] When determining the required values for creepage and distance, the working voltage may be higher than the voltage in the table by a factor of 1,1 (see Note).

NOTE The factor of 1,1 recognizes that at many places in a circuit, the working voltage equals the rated voltage and that there are a number of rated voltages in common use that can be accommodated by the 1,1 factor.

[b] To ensure that there is a sufficient path length through the filling material to provide quenching of a flame from the inside to the outside of the container, the reduced distances shown are permitted only when there is no adjacent gap in the container that could permit a flame to exit. See Figure 1.

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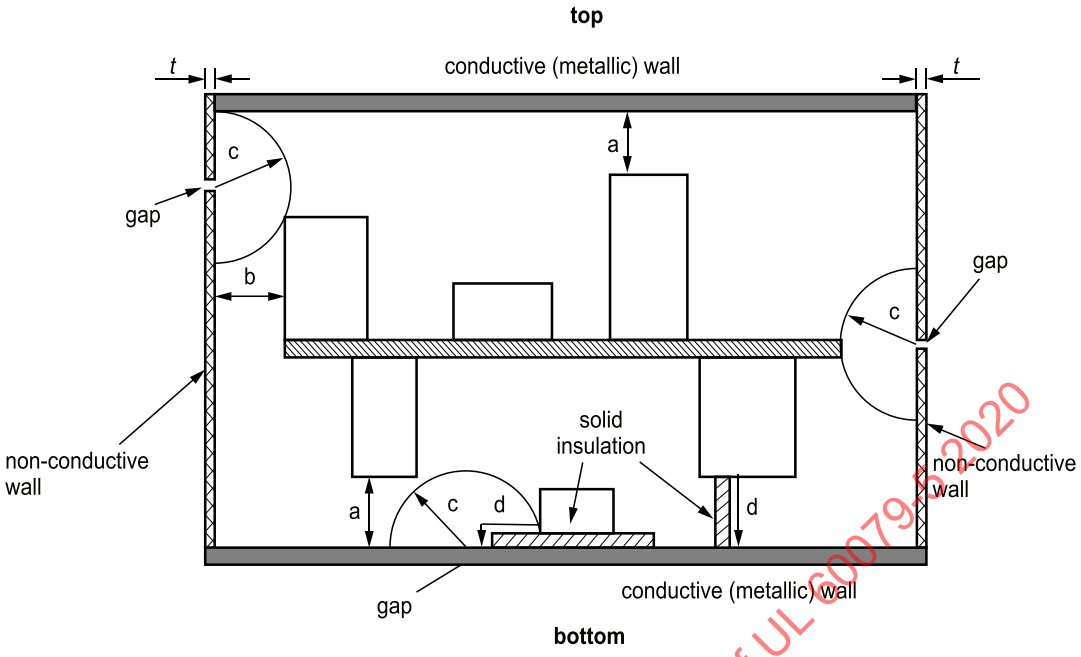

Key

[a] distance to conductive wall according Table 1, reduced distance

[b] distance to non conductive wall with thickness *t*; $b \geq$ (distance according Table 1) – *t*

[c] distance to gap, minimum radius according Table 1, no reduced distance

[d] creepage distance according Table 2

Figure 1

Distances through filling material

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Malfunction conditions according to 4.8 shall be considered when determining the working voltage.

NOTE While this standard is applicable to equipment with a rated supply voltage not exceeding 1 000 V, Table 1 takes into account working voltages greater than 1 000 V which can be developed or generated within the equipment or Ex Component. A typical example is a fluorescent luminaire ballast with a rated voltage of 240 V, but with an arc initiation voltage of approximately 2 000 V.

4.3.2 Distances surrounding free space

If electrical equipment contains components which have an enclosed free space not filled with the filling material (e.g. a relay), the following requirements apply:

– if the enclosed free space of the component is less than 3 cm^3, the minimum distance through the filling material between the component wall and the inner surface of the container shall comply with Table 1. The reduced distances are not permitted;

– if the enclosed free space of the component is between 3 cm^3 and 30 cm^3, the minimum distance through the filling material between the component wall and the inner surface of the container shall comply with Table 1 but with a minimum of 15 mm;

– the component shall be fixed, so that movement nearer to the wall of the container is not possible;

– the free volume shall not exceed 30 cm^3;

– the enclosure of the component shall resist the thermal and mechanical stresses to which it will be subjected even under malfunction conditions according to 4.8. There shall be no damage or distortion which could reduce the protection provided by the filling material.

4.4 Connections

4.4.1 Equipment

4.4.1DV DR *Modification of Clause 4.4.1 to replace with the following:*

Cables used for the entry of electrical conductors into a powder filled "q" container shall be an integral part of the equipment and shall be protected and sealed as specified in 4.1.1. The clamping means shall comply with the cable gland requirements of UL 60079-0 ~~IEC 60079-0~~ and shall not be capable of being removed without obvious damage to the powder filled "q" container.

NOTE This construction is only practical with a factory-installed cable and in most cases, a factory-installed cable gland. A flameproof "d" cable gland in accordance with UL 2225 may be required as the increased safety "e" cable gland in accordance with UL 2225 may not provide adequate pressure sealing (see 5.1.1) of the powder filled "q" enclosure.

4.4.2 Ex Components

Connection to powder filled "q" Ex Components shall comply with the connection facilities and termination compartments requirements of IEC 60079-0.

4.5 Capacitors

The total stored energy of all capacitors in an enclosure of electrical equipment, part of electrical equipment or Ex component protected by powder filling "q" shall not exceed 20 J in normal operation.

4.6 Cells and batteries

Enclosures for powder filled "q" electrical equipment, parts of electrical equipment or Ex components that contain cells or batteries shall incorporate a breathing device to the surrounding atmosphere (see 4.1.3) unless the batteries or cells:

a) have a capacity of 1,5 Ah or less, or

b) do not release gas under normal operating conditions, and comply with the requirements for primary and secondary batteries with a capacity up to 25 Ah, of IEC 60079-7, for level of protection "eb".

NOTE Sealed gas-tight cells do not release gas under normal operating conditions.

4.7 Temperature limitations under overload conditions

Each electrical equipment, part of electrical equipment or Ex component protected by powder filling "q" shall be protected against overload prescribed in the relevant product standard specified by the manufacturer so that the temperature class is not exceeded inside the filling material at a depth of 5 mm from the wall of the container. If the reduced dimension of Table 1 has been applied and results in a distance less than 5 mm, the reduced distance shall be used in place of the 5 mm shown. The effectiveness of the protection shall be confirmed by the test of 5.1.4.

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NOTE It is often difficult to limit the temperatures with only a fuse, and an internal thermal protective device is often necessary to comply with the maximum temperature requirements of 5.1.4.

4.8 Temperature limitations under malfunction conditions

4.8.1 General

The container shall not be damaged and the temperature class shall not be exceeded even in the case of malfunctions as detailed in 4.8. The effectiveness of the temperature protection shall be confirmed by the test in 5.1.4.

4.8.2 Fuse

Unless the equipment supply is protected by a fuse rated at not more than 170 % of the maximum normal current, the equipment shall be subjected to any single internal electrical malfunction which may cause either an overvoltage or overcurrent, for example:

– short-circuit of any component;

– open circuit due to any component failure;

– malfunction in the printed circuitry.

Fuses, if employed, shall have a voltage rating not less than that of the circuit and shall have a breaking capacity not less than the prospective fault current of the circuit.

If a malfunction can lead to one or more subsequent malfunctions, for example overloading of a component, the primary and subsequent malfunctions are considered to be a single malfunction.

4.8.2DV.1 D1 ***Delete the fourth paragraph of Clause 4.8.2. It does not apply.***

~~**Where there is no product standard, the overloads to be considered are those specified by the manufacturer.**~~

The voltage U_n shall be assumed to be applied to the supply terminals when considering malfunction conditions and malfunction exclusions.

4.8.2DV.2 DR ***Modification of Clause 4.8.2, sixth and seventh paragraphs to replace with the following:***

4.8.2DV.2.1 When the fuse is not integral to the electrical equipment or parts of electrical equipment, the equipment ~~certificate number~~ shall be marked ~~include the "X" suffix~~ in accordance with ~~the marking requirements of~~ UL 60079-0 ~~IEC 60079-0~~ to indicate that there are Specific Conditions of Use and the Specific Conditions of Use listed on the certificate shall detail the required fuse.

4.8.2DV.2.2 When the fuse is not integral to an Ex component, the instructions ~~certificate number shall include the symbol "U" in accordance with IEC 60079-0 and the schedule of limitations~~ shall detail the required fuse.

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4.8.3 Malfunction exclusions

The following malfunctions need not be considered.

a) Resistance values lower than the rated values for:

– film type resistors,

– wire wound resistors and coils with a single layer in helical form,

when they are used at no more than 2/3 of their rated voltage and rated power at the maximum service temperature as specified by the manufacturer of the respective components.

b) Short-circuit conditions for:

– plastic foil capacitors,

– ceramic capacitors,

– paper capacitors,

when they are used at no more than 2/3 of their rated voltage as specified by the manufacturer of the respective components.

c) Insulation failure of:

– galvanically separating components (e.g. optocouplers and relays) designed for segregation of different circuits,

when the sum *U* of the r.m.s. values of the maximum voltages of the two circuits is not more than 1 000 V and the rated voltage of the component between the two different circuits is at least 1,5 times *U*.

NOTE Galvanically separating components providing double or reinforced insulation according to a product standard are considered to meet the requirements of IEC 61140, e.g. IEC 60747-5-5 for photo coupler.

d) Transformers, coils and windings, which:

– comply with Level of Protection “eb” in IEC 60079-7, or

– comply with the requirements for mains transformers, Level of Protection “ia” or “ib”, in IEC 60079-11, or

– comply with IEC 61558-2-6, or

– provide a double or reinforced insulation between the circuit per IEC 61558-1.

It is not necessary to consider the possibility of a short circuit if the distances or creepage distances between bare live parts or printed tracks are at least equal to the values of Table 2 (for methods of measuring creepage distances see IEC 60079-7 and IEC 60079-11).

The maximum voltage between the parts shall be used to determine the distances according to Table 2. If the parts are electrically isolated, the sum of the maximum voltages of the two circuits shall be considered as the voltage. The maximum voltage shall be assessed taking into account normal operating conditions (transients being disregarded) and malfunction conditions as specified in this standard.

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For distance under a coating according to Table 2, the following conditions apply:

– a conformal coating shall have the effect of sealing the conductors in question against ingress of moisture;

– it shall adhere to the conductive parts and to the insulation material;

– if the conformal coating is applied by spraying, then two separate coats are to be applied;

– other methods of application require only one coat, for example, dip coating, brushing, vacuum impregnating, but the intention is to achieve an effective, lasting, unbroken seal;

– a solder mask is considered as one of the two coatings, provided it is not damaged during soldering.

Conductive parts protruding from the insulation (including soldered component pins) shall not be considered as coated unless special measures have been applied to obtain an effective unbroken seal.

Where bare parts of energized circuits emerge from the coating, the comparative tracking index (CTI) in Table 2 applies to both insulation and conformal coating.

Table 2
Creepage distances and distances through filling material

Voltage[a] a.c. or d.c. $U_{r.m.s.}$ V	Creepage distance[b] mm	Minimum value CTI	Distance under coating mm	Distance through filling material mm
$U \leq 10$	1,6	–[c]	0,6	1,5
$U \leq 12,5$	1,6	100	0,6	1,5
$U \leq 16$	1,6	100	0,6	1,5
$U \leq 20$	1,6	100	0,6	1,5
$U \leq 25$	1,7	100	0,6	1,5
$U \leq 32$	1,8	100	0,7	1,5
$U \leq 40$	3	100	0,7	1,5
$U \leq 50$	3,4	100	0,7	1,5
$U \leq 63$	3,4	100	1	1,5
$U \leq 80$	3,6	100	1	1,5
$U \leq 100$	3,8	100	1,3	2
$U \leq 125$	4	175	1,3	2
$U \leq 160$	5	175	1,3	2
$U \leq 200$	6,3	175	2,6	3
$U \leq 250$	8	175	2,6	3
$U \leq 320$	10	175	2,6	3
$U \leq 400$	12,5	175	3,3	3
$U \leq 500$	16	175	5	3
$U \leq 630$	20	175	6	5
$U \leq 800$	25	175	6	5

Table 2 Continued on Next Page

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Table 2 Continued

Voltage[a] a.c. or d.c. $U_{r.m.s.}$ V	Creepage distance[b] mm	Minimum value CTI	Distance under coating mm	Distance through filling material mm
$U \leq 1\,000$	32	175	8,3	5
$U \leq 1\,250$	32	175	12	10
$U \leq 1\,600$	32	175	13,3	10
$U \leq 2\,000$	32	175	13,3	10
$U \leq 2\,500$	40	175	13,3	10
$U \leq 3\,200$	50	175	16	14
$U \leq 4\,000$	63	175	21	14
$U \leq 5\,000$	80	175	27	14
$U \leq 6\,300$	100	175	33	25
$U \leq 8\,000$	125	175	41	25
$U \leq 10\,000$	160	175	55	40

[a] When determining the required values for creepage and distance, the working voltage may be higher than the voltage in the table by a factor of 1,1 (see Note).

NOTE The factor of 1,1 recognizes that at many places in a circuit, the working voltage equals the rated voltage and that there are a number of rated voltages in common use that can be accommodated by the 1,1 factor.

[b] If material with higher CTI value is used, the use of the Level of Protection "eb" creepage distances given for that CTI in IEC 60079-7 is permitted.

[c] At 10 V and below, the value of CTI is not relevant.

4.8.4 Protective devices for temperature limitation

Temperature limitation may be achieved by an internal or external, electrical or thermal, protective device. The device shall not be self-resetting.

Where integral fuses are used as protective devices, the fusing element shall be of the enclosed type, for example, in glass or ceramic.

Over-current devices shall have a voltage rating not less than that of the circuit and shall have a breaking capacity not less than the prospective fault current of the circuit.

4.8.5 Power supply prospective short-circuit current

Electrical equipment, parts of electrical equipment and Ex components protected by powder filling "q", with a rated voltage of not greater than 250 V a.c., shall be suitable for operation from a supply system with a prospective short-circuit current of 1 500 A unless the marking includes the value of the permitted prospective short-circuit current. Higher prospective currents than 1 500 A could be present in some installations, for example at higher voltages.

If a current limiting device is necessary to limit the prospective short-circuit current to a value not greater than the rated breaking capacity of the fuse, this device shall be a resistor according to 4.8.3 a) and the rated values shall be:

– current rating $1,5 \times 1,7 \times I_n$ of the fuse;

– externally applied maximum voltage U_m;

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