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REDLINE VERSION

INTERNATIONAL STANDARD

colour inside

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

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EXPLOSIVE ATMOSPHERES –

Part 5: Equipment protection by powder filling “q”

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as “IEC Publication(s)”). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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This redline version of the official IEC Standard allows the user to identify the changes made to the previous edition. A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text.

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.

		Type		
Significant changes	**Clause/subclause**	**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

This 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” ~~may~~ 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. ~~For further information, see Annex A.~~

This standard supplements and modifies the general requirements of IEC 60079-0. Where a requirement of this standard conflicts with a requirement of 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.

IEC 60079-0~~:2004~~, *Explosive atmospheres – Part 0: Equipment – General requirements*

~~IEC 60079-1, *Electrical apparatus for explosive gas atmospheres – Part 1: Flameproof enclosure “d”*~~

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*

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 plates*

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

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
~~**distance through filling material**~~
~~shortest distance through a filling material between two conductive parts~~

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 ~~Enclosure~~ Containers

~~In addition to the enclosure requirements of IEC 60079-0, the following requirements apply.~~

4.1.1 Closing and sealing

4.1.1.1 General

~~Enclosures~~ 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 ~~Enclosures~~ Containers permanently sealed at the time of manufacture

The ~~enclosure~~ container shall be permanently sealed at the time of manufacture and shall not be capable of being opened without leaving visible evidence that the ~~enclosure~~ container has been opened. The ~~enclosure~~ 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 ~~Enclosures~~ 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 ~~enclosure~~ container when the equipment is repaired, re-filled, and re-sealed. The ~~enclosure~~ container shall be marked in accordance with Clause 6, item b).

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

4.1.2 Pressure test of ~~enclosure~~ 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 ~~enclosure~~ container

The ~~enclosure~~ 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 ~~enclosure~~ container is not hermetically sealed, the container shall be provided with a breathing device. The ~~enclosure~~ 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 ~~enclosure~~ container without the powder filling installed. At the end of any water ingress tests, no water shall be visible inside the ~~enclosure~~ container.

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

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

The ingress protection of ~~enclosures~~ 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. ~~These enclosures~~ The certificate number of this equipment shall include the ~~symbol~~ "X" suffix in accordance with ~~29.2 i)~~ the marking requirements of IEC 60079-0, 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 IEC 60079-0, this outer enclosure shall have a degree of protection of at least IP54. The IP rating of the inner ~~enclosure~~ 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 IEC 60079-0 do not generally apply to Ex Components intended to be mounted inside another enclosure complying with IEC 60079-0, as the external enclosure provides the protection against impact and drop.

The maximum gap of ~~an enclosure~~ 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 ~~Requirements~~ Material specification

The material shall be quartz or solid glass particles.

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

– 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.

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 ~~inner surface of the enclosure~~ container shall comply with Table 1 and Figure 1. This does not apply to conductors used for ~~external~~ field wiring connections which penetrate the wall of the ~~enclosure~~ container. ~~Such conductors shall comply with any requirements for the type of protection employed for the external connections.~~

Table 1 – Distances through the filling material

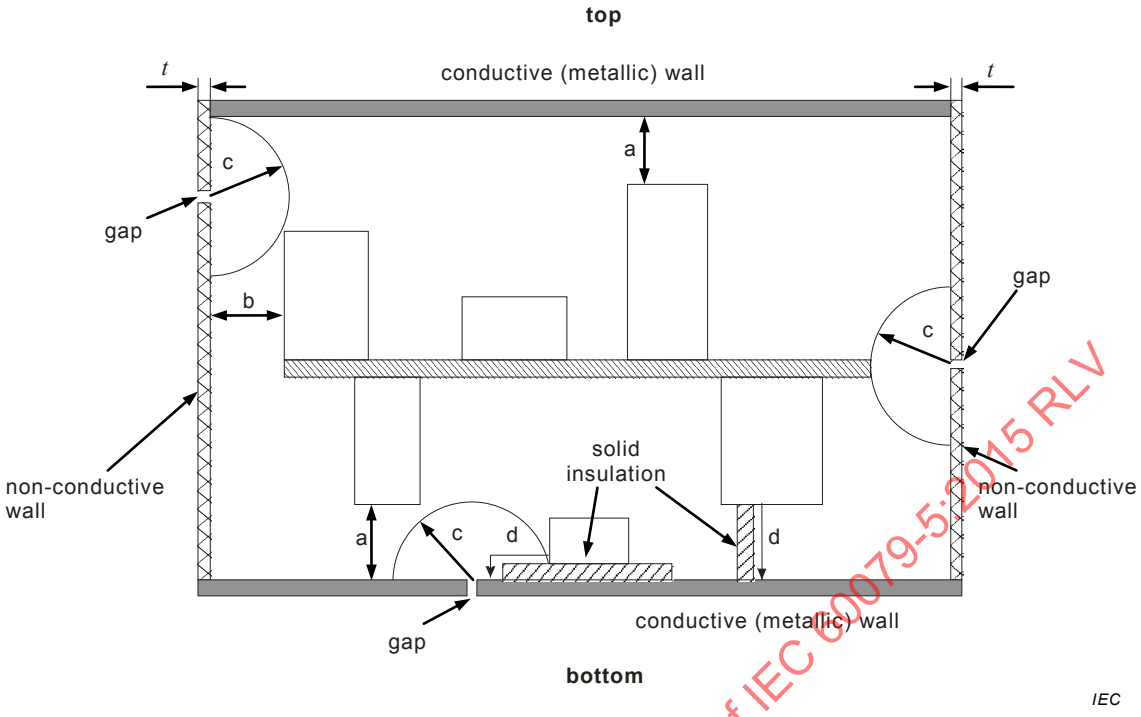
Voltage[a] a.c. r.m.s. or d.c. V	Minimum distance mm	Reduced distance [b] mm
$U \leq 80$	5	1,5
$U \leq 100$	5	2
$U \leq 125$	5	2
$U \leq 160$	5	2
$U \leq 200$	5	3
$U \leq 250$	5	3
$U \leq 400$	6,3	3
$U \leq 500$	8	3
$U \leq 800$	10	5
$U \leq 1\ 000$	14	5
$U \leq 1\ 600$	16	10
$U \leq 2\ 500$	25	10
$U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

~~NOTE Voltages shown are derived from IEC 60664-1 and are based on the rationalization of supply voltages given in Table 3b. When determining the required values for distance, the voltage value in the table may be increased by a factor of 1.1 in order to recognize the range of rated voltages in common use.~~

[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.



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

~~Fault~~ 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 ~~may~~ 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 ~~enclosure~~ 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 ~~enclosure~~ 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 ~~enclosure~~ container is not possible;

– the free volume~~s of more than~~ shall not exceed 30 cm^3 ~~are not permitted~~;

– the enclosure of the component shall resist the thermal and mechanical stresses to which it will be subjected even under ~~fault~~ 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 Materials used for support of energized parts**~~

~~Materials used between the electrically energized parts and the wall of the enclosure (except for the insulation of external wiring and the filling material) in the region specified in shall comply with the flammability requirements specified in .~~

~~**4.5 External field-wiring connections**~~

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

4.4 Connections

4.4.1 Equipment

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 IEC 60079-0 and shall not be capable of being removed without obvious damage to the powder filled "q" container.

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.

~~NOTE 2 Consideration shall be given to the effect that a release from the breather may have on the surrounding atmosphere.~~

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 ~~permissible limit temperature of the applicable~~ temperature class is not exceeded ~~at the wall of the enclosure and~~ inside the filling material ~~up to~~ at a depth of 5 mm from the wall of the ~~enclosure~~ 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.

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

4.8 Temperature limitations under ~~fault~~ malfunction conditions

4.8.1 General

The ~~enclosure~~ container shall not be damaged and the ~~limiting~~ temperature class shall not be exceeded even in the case of ~~faults~~ 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 ~~fault~~ malfunction which may cause either an overvoltage or overcurrent, for example:

– short-circuit of any component;

– open circuit due to any component failure;

– ~~fault~~ malfunction in the printed circuitry.

~~Over-current devices~~ 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 ~~fault~~ malfunction can lead to one or more subsequent ~~faults~~ malfunctions, for example overloading of a component, the primary and subsequent ~~faults~~ malfunctions are considered to be a single ~~fault~~ malfunction.

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 ~~fault~~ malfunction conditions and ~~fault~~ malfunction exclusions.

When the fuse is not integral to the electrical equipment or parts of electrical equipment, the ~~marking~~ certificate number shall include the ~~symbol~~ "X" suffix in accordance with ~~29.2 i)~~ the marking requirements of IEC 60079-0 and the Specific Conditions of Use listed on the certificate shall detail the required fuse.

When the fuse is not integral to an Ex component, the ~~marking~~ certificate number shall include the symbol "U" in accordance with ~~29.5 g) of~~ IEC 60079-0 and the schedule of limitations shall detail the required fuse.

4.8.3 ~~Fault~~ Malfunction exclusions

The following ~~faults~~ 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 ~~transformers which~~

– 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 ~~peak~~ voltages of the two circuits shall be considered as ~~peak~~ the voltage. The maximum ~~peak~~ voltage shall be assessed taking into account normal operating conditions (transients being disregarded) and ~~fault~~ malfunction conditions as specified in this standard.

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 1 – Creepage distances and distances through filling material

Voltage[a] **a.c. or d.c.** $U_{r.m.s.}$ ~~See Note~~ 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	~~175~~ 100	0,6	1,5
$U \leq 16$	1,6	~~175~~ 100	0,6	1,5
$U \leq 20$	1,6	~~175~~ 100	0,6	1,5
$U \leq 25$	1,7	~~175~~ 100	0,6	1,5
$U \leq 32$	1,8	~~175~~ 100	0,7	1,5
$U \leq 40$	3	~~175~~ 100	0,7	1,5
$U \leq 50$	3,4	~~175~~ 100	0,7	1,5
$U \leq 63$	3,4	~~175~~ 100	1	1,5
$U \leq 80$	3,6	~~175~~ 100	1	1,5
$U \leq 100$	3,8	~~175~~ 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
$U \leq 1\,000$	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

~~NOTE Voltages shown are derived from IEC 60664-1 and is based on the rationalization of supply voltages given in Table 3b. When determining the required values for creepage and clearance, the voltage value in the table may be increased by a factor of 1.1 in order to recognize the range of rated voltages in common use.~~

[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.

~~NOTE~~ [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" ~~and designed to be connected to an external source of supply not exceeding~~ 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 × 1,7 × I_n of the fuse;
– externally applied maximum voltage U_m;
– power rating 1,5 × (1,7 × I_n of the fuse)^2 × resistance of limiting device.

If the manufacturer does not provide a required short-circuit protective device, the certificate number for the electrical equipment or parts of electrical equipment shall include the ~~symbol~~ "X" suffix in accordance with ~~29.2 i)~~ the marking requirements of IEC 60079-0 and the Specific Conditions of Use listed on the certificate shall detail the short-circuit protective devices required.

5 Verifications and tests

5.1 Type verifications and tests

5.1.1 Pressure type test of ~~enclosure~~ container

The pressure tests shall be conducted on the samples subjected to the tests of enclosures in IEC 60079-0. Irrespective of its volume, the ~~enclosure~~ container samples shall be subjected to a pressure type test with an over-pressure of 50 kPa without the occurrence of permanent deformation exceeding 0,5 mm in any of its dimensions. The pressure shall be applied for at least 10 s.

For ~~enclosures~~ containers without breathing or degassing openings, which contain capacitors other than plastic foil, paper or ceramic type and where the volume of the filling material is lower than eight times the volume of the capacitors, the pressure type test with an overpressure of 1,5 MPa shall be applied for at least 10 s.

Where the reduced distances have been applied (4.3.1), the pressure test shall be conducted hydraulically. There shall be no drops of water to blotting paper placed under the sample from any of the joints of the sample not identified as a “gap” for the purposes of employing the reduced distances.

NOTE 1 The test samples used for this test normally have the “gaps” sealed to allow the evaluation of the joints without the drops of water expected to come from the “gaps”.

Tests ~~shall be carried out in normal conditions of the equipment, but~~ may be conducted without the filling material present.

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

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

5.1.2 Verification of the degree of protection of the enclosure

The degree of protection of the enclosure shall be verified in accordance with the method specified in IEC 60529. Any breathing devices shall be in place. This test shall be carried out after the pressure type test in 5.1.1 on any one of the samples.

NOTE 1 When the container is also the external enclosure, the tests of enclosures requirements of IEC 60079-0 apply.

NOTE 2 The impact and drop tests of enclosures from IEC 60079-0 do not generally apply to Ex Components intended to be mounted inside of another enclosure complying with IEC 60079-0, as the external enclosure provides the protection against impact and drop.

~~**5.1.3 Flammability of materials**~~

~~The flammability requirements for enclosures, or parts of enclosures made of plastics materials; of IEC 60079-1, shall be applied.~~

5.1.3 Dielectric strength test of the filling material

The insulating properties of the filling material shall be tested prior to the filling process using a sample of the filling material. For this purpose, the electrode arrangement shown in Figure 1 shall be used. The electrodes shall be covered by the filling material in all directions with a thickness of at least 10 mm.

The sample shall be conditioned for at least 24 h at a temperature of (23 ± 2) °C and relative humidity of between 45 % and 55 %. A test voltage of 1 000 V d.c. $^{+5}_{0}$ % shall then be applied to the electrodes.

The filling material complies with the requirements if the leakage current does not exceed 10^{-6} A. If the material fails to comply, further conditioning and retesting are not permitted.

5.1.4 Maximum temperatures

Where current dependent fuses in accordance with IEC 60127 are used as protective devices for temperature limitation, the maximum temperature under overload conditions shall be measured with a continuous current of at least 1,7 times the fuse rating. If other fuses are employed, the test current shall be based on the non-fusing current rating of the fuse.

Where items other than current dependent fuses are used as protective devices for temperature limitation, the equipment shall be tested to verify that the ~~limiting~~ temperature class is not exceeded when those protective devices operate.

When required by 4.8.3 to consider a malfunction, any malfunction which could increase heat dissipation but not cause a current dependant fuse to disconnect immediately shall be considered. (Malfunctions that will cause immediate rupture of the fuse do not need to be considered.) The malfunction assessed as most likely to affect the temperature class shall be simulated as closely as possible, particularly in respect of the spatial relationship between the container wall and the source of the heat.

NOTE 1 To simulate overload conditions or malfunctions which may cause higher temperatures than in normal operation, it ~~might be suitable~~ is often convenient to use power components mounted in the equipment and subject to the maximum available power. Such components ~~should be~~ are normally chosen and located in the equipment so that they are representative of the thermal characteristics of the components they represent.

NOTE 2 The term “overload” also applies to the situation where the Ex “q” equipment (or component – such as a solid state relay or a luminaire ballast) controls rather than consumes power and the temperature rise is, at least partly, related to the external load. In such cases, where the equipment is protected by a fuse rated at not more than 170 % of the maximum normal current, the external load is adjusted to achieve the maximum current through the fused circuit, but no more than 1,7 times the fuse rating. Internal malfunctions are not applied as they are not considered to result in an “overload”.

5.2 Routine verifications and tests

5.2.1 Routine pressure test of ~~enclosure~~ container

Each ~~enclosure~~ container having a volume greater than 100 cm^3 shall be subjected to a routine pressure test with an overpressure of 50 kPa or 1,5 MPa, as applicable (See 5.1.1) without the occurrence of permanent deformation exceeding 0,5 mm in any of its dimensions. The pressure shall be applied for at least 10 s.

Tests shall be carried out under normal conditions of the equipment, but may be done without the filling material present.

The routine pressure test may be waived where the ~~enclosure~~ container has passed a type test with four times the ~~reference~~ test pressure (50 kPA or 1,5 MPa) in 5.1.1.

The routine overpressure testing can be replaced by a batch test according to the following criteria based on ISO 2859-1:

- For a production batch up to 100, 8 samples need to be tested at 1,5 times the routine test pressure with no failures.
- For a production batch from 101 to 1 000, 32 samples need to be tested at 1,5 times the routine test pressure with no failures.
- For a production batch from 1 001 up to 10 000, 80 samples need to be tested at 1,5 times the routine test pressure with no failures.

Batches above 10 000 shall be subdivided into smaller batches.

In many cases, the routine pressure test cannot be conducted without modifying the container so significantly that it is no longer representative of the equipment and could no longer be completed as the equipment. In these cases, neither the type test nor the batch routine test provide reasonable alternatives. In some cases, the samples for the batch routine overpressure test also have to be significantly modified to be able to conduct the test. In these cases, the satisfactorily tested samples are discarded and only the remaining untested samples of the batch released.

5.2.2 Dielectric strength test of the filling material

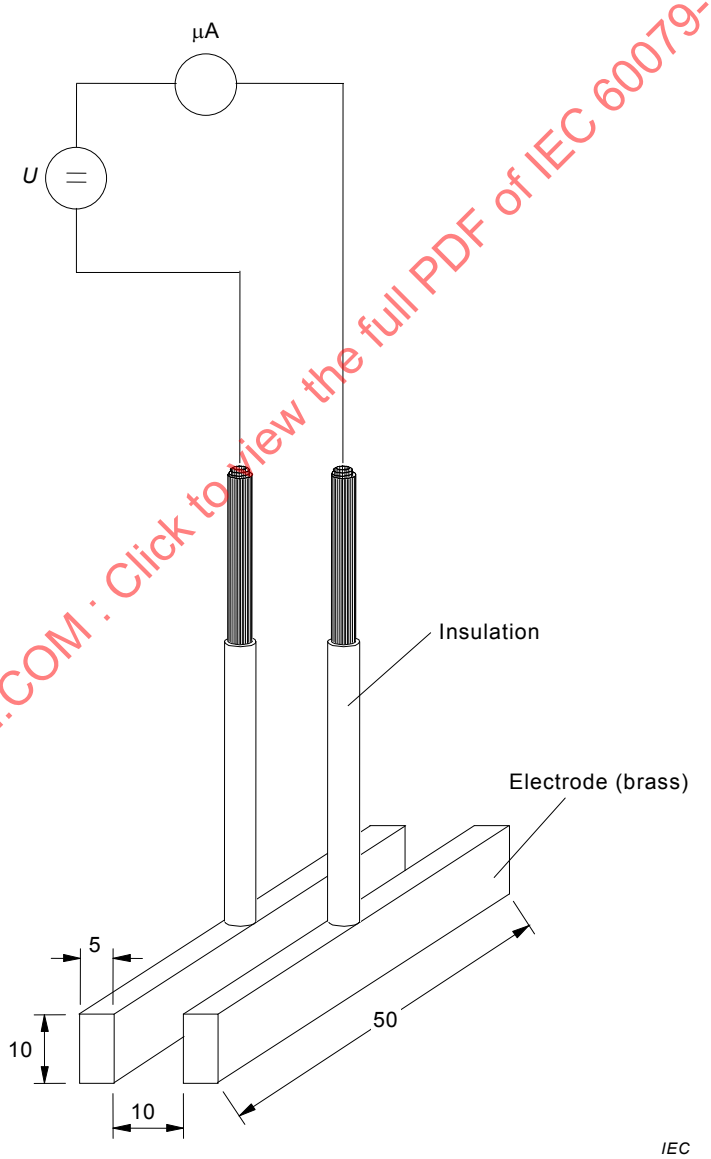
The insulating properties of each lot of the filling material shall be tested prior to the filling process using a sample of the filling material. For this purpose, the electrode arrangement shown in Figure ~~1~~ 2 shall be used. The electrodes shall be covered by the filling material in all directions with a thickness of at least 10 mm. The test voltage shall be 1 000 V d.c. $^{+5}_{0}$ % under the following climatic conditions:

– temperature (23 ± 2) °C;

– relative humidity 45 % to 55 %.

The filling material complies with the requirements if the leakage current does not exceed 10^{-6} A.

If the filling material does not initially comply with these requirements, the lot may be dried and retested.



Dimensions in millimetres with a tolerance of ±1,0 mm

Figure ~~1~~ 2 – Test arrangement for the dielectric strength test of the filling material

6 Marking

Electrical equipment, parts of electrical equipment, and Ex Components of powder filling "q" shall be marked in accordance with IEC 60079-0, with the following additional marking, as appropriate:

a) "This ~~enclosure~~ container has been permanently sealed and cannot be repaired".

b) "This ~~enclosure~~ container is factory sealed – consult manufacturer's instructions for repair".

c) Each connection facility for external connection shall be marked with an identification of rated voltage and rated current ("24 V d.c., 200 mA", "230 V, 100 mA").

d) External fuse data if the type of protection depends upon such a fuse, "Required external fuse: 315 mA";

e) Permitted prospective short-circuit current of the ~~external electrical~~ supply system if the equipment is designed for a short-circuit current less than 1 500 A, according to 4.8.5, for example "Permitted supply short-circuit current: 35 A".

f) Optionally, permitted prospective short-circuit current of the ~~external electrical~~ supply system if the equipment is designed for a short-circuit current of 1 500 A or more, according to 4.8.5, for example "Permitted supply short-circuit current: 3 500 A".

Any of these markings may be replaced by technically equivalent information.

7 Instructions

~~All powder filled "q" equipment shall be accompanied by instructions as required by IEC 60079-0, including the following additional particulars as a minimum~~

The instructions prepared in accordance with IEC 60079-0, shall also include the following:

– Where permitted by the manufacturer, details on the re-filling, re-sealing, and re-testing requirements for powder filled "q" equipment that has been opened for repair.

– Where the ~~enclosure~~ container is permanently sealed and repair is not permitted by the manufacturer, this shall be stated clearly in the instructions.

Annex A
(informative)

Introduction of an alternative risk assessment method encompassing "equipment protection levels" for Ex equipment

A.0 Introduction

This annex provides an explanation of the concept of a risk assessment method encompassing equipment protection levels (EPLs). These EPLs are introduced to enable an alternative approach to current methods of selecting Ex equipment.

A.1 Historical background

Historically, it has been acknowledged that not all types of protection provide the same level of assurance against the possibility of an incendive condition occurring. The installation standard, IEC 60079-14, allocates specific types of protection to specific zones, on the statistical basis that the more likely or frequent the occurrence of an explosive atmosphere, the greater the level of security required against the possibility of an ignition source being active.

Hazardous areas (with the normal exception of coal mining) are divided into zones according to the degree of hazard. The degree of hazard is defined according to the probability of the occurrence of explosive atmospheres. Generally, no account is taken of the potential consequences of an explosion, nor of other factors such as the toxicity of materials. A true risk assessment would consider all factors.

Acceptance of equipment into each zone is historically based on the type protection. In some cases the type of protection may be divided into different levels of protection which again historically correlate to zones. For example, intrinsic safety is divided into levels of protection ia and ib. The encapsulation "m" standard includes two levels of protection ''ma'' and ''mb''.

In the past, the equipment selection standard has provided a solid link between the type of protection for the equipment and the zone in which the equipment can be used. As noted earlier, nowhere in the IEC system of explosion protection is there any account taken of the potential consequences of an explosion, should it occur.

However, plant operators often make intuitive decisions on extending (or restricting) their zones in order to compensate for this omission. A typical example is the installation of "zone 1 type" navigation equipment in zone 2 areas of offshore oil production platforms, so that the navigation equipment can remain functional even in the presence of a totally unexpected prolonged gas release. In the other direction, it is reasonable for the owner of a remote, well secured, small pumping station to drive the pump with a "zone 2 type" motor, even in zone 1, if the total amount of gas available to explode is small and the risk to life and property from such an explosion can be discounted.

The situation became more complex with the publication of the first edition of IEC 60079-26 which introduced additional requirements to be applied for equipment intended to be used in zone 0. Prior to this, Ex ia was considered to be the only technique acceptable in zone 0.

It has been recognized that it is beneficial to identify and mark all products according to their inherent ignition risk. This would make equipment selection easier and provide the ability to better apply a risk assessment approach, where appropriate.

A.2 General

A risk assessment approach for the acceptance of Ex equipment has been introduced as an alternative method to the current prescriptive and relatively inflexible approach linking equipment to zones. To facilitate this, a system of equipment protection levels has been introduced to clearly indicate the inherent ignition risk of equipment, no matter what type of protection is used.

The system of designating these equipment protection levels is as follows.

A.2.1 Coal mining (group I)

A.2.1.1 EPL Ma

Equipment for installation in a coalmine, having a "very high" level of protection, which has sufficient security that it is unlikely to become an ignition source, even when left energized in the presence of an outbreak of gas.

NOTE Typically, communications circuits and gas detection equipment will be constructed to meet the Ma requirements – for example an Ex ia telephone circuit.

A.2.1.2 EPL Mb

Equipment for installation in a coal mine, having a "high" level of protection, which has sufficient security that it is unlikely to become a source of ignition in the time span between there being an outbreak of gas and the equipment being de-energized.

NOTE Typically, all the coal winning equipment will be constructed to meet the Mb requirements – for example Ex d motors and switchgear.

A.2.2 Gases (group II)

A.2.2.1 EPL Ga

Equipment for explosive gas atmospheres, having a "very high" level of protection, which is not a source of ignition in normal operation, expected faults or when subject to rare faults.

A.2.2.2 EPL Gb

Equipment for explosive gas atmospheres, having a "high" level of protection, which is not a source of ignition in normal operation or when subject to faults that may be expected, though not necessarily on a regular basis.

NOTE The majority of the standard protection concepts bring equipment within this equipment protection level.

A.2.2.3 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).

NOTE Typically, this will be Ex n equipment.

A.2.3 Dusts (group III)

A.2.3.1 EPL Da

Equipment for combustible dust atmospheres, having a "very high" level of protection, which is not a source of ignition in normal operation or when subject to rare faults.

~~A.2.3.2 EPL Db~~

~~Equipment for combustible dust atmospheres, having a "high" level of protection, which is not a source of ignition in normal operation or when subject to faults that may be expected, though not necessarily on a regular basis.~~

~~A.2.3.3 EPL Dc~~

~~Equipment for combustible dust atmospheres, having an "enhanced" level of protection, which is not a source of ignition in normal operation and which may have some additional protection to ensure that it remains inactive as an ignition source in the case of regular expected occurrences.~~

~~For the majority of situations, with typical potential consequences from a resultant explosion, it is intended that the following would apply for use of the equipment in zones (this is not directly applicable for coal mining, as the zone concept does not generally apply). See Table A.1.~~

~~**Table A.1 – Traditional relationship of EPLs to zones (no additional risk assessment)**~~

~~Equipment protection level~~	~~Zone~~
~~Ga~~	~~0~~
~~Gb~~	~~1~~
~~Gc~~	~~2~~
~~Da~~	~~20~~
~~Db~~	~~21~~
~~Dc~~	~~22~~

~~A.3 Risk of ignition protection afforded~~

~~The various levels of protection of equipment must be capable of functioning in conformity with the operational parameters established by the manufacturer to that level of protection. See Table A.2.~~

Table A.2 – Description of risk of ignition protection provided

Protection afforded	Equipment protection level Group	Performance of protection	Conditions of operation
Very high	Ma Group I	Two independent means of protection or safe even when two faults occur independently of each other	Equipment remains functioning when explosive atmosphere present
Very high	Ga Group II	Two independent means of protection or safe even when two faults occur independently of each other	Equipment remains functioning in zones 0,1 and 2
Very high	Da Group III	Two independent means of protection or safe even when two faults occur independently of each other	Equipment remains functioning in zones 20, 21 and 22
High	Mb Group I	Suitable for normal operation and severe operating conditions	Equipment de-energized when explosive atmosphere present
High	Gb Group II	Suitable for normal operation and frequently occurring disturbances or equipment where faults are normally taken into account	Equipment remains functioning in zones 1 and 2
High	Db Group III	Suitable for normal operation and frequently occurring disturbances or equipment where faults are normally taken into account	Equipment remains functioning in zones 21 and 22
Enhanced	Gc Group II	Suitable for normal operation	Equipment remains functioning in zone 2
Enhanced	Dc Group III	Suitable for normal operation	Equipment remains functioning in zone 22

A.4 Implementation

The fourth edition of IEC 60079-14 (encompassing the former requirements of IEC 61241-14) will introduce the EPLs to allow a system of "risk assessment" as an alternative method for the selection of equipment. Reference will also be included in the classification standards IEC 60079-10 and IEC 61241-10.

The additional marking and the correlation of the existing types of protection are being introduced into the revisions to the following IEC standards:

- IEC 60079-0 (encompassing the former requirements of IEC 61241-0)
- IEC 60079-1
- IEC 60079-2 (encompassing the former requirements of IEC 61241-4)
- IEC 60079-5
- IEC 60079-6
- IEC 60079-7
- IEC 60079-11 (encompassing the former requirements of IEC 61241-11)
- IEC 60079-15

- ~~IEC 60079-18 (encompassing the former requirements of IEC 61241-18)~~
- ~~IEC 60079-26~~
- ~~IEC 60079-28~~

~~For types of protection for explosive gas atmospheres the EPLs require additional marking. For explosive dust atmospheres, the present system of marking the zones on equipment is being replaced by marking the EPLs.~~

Bibliography

IEC 60050 (all parts), *International Electrotechnical Vocabulary* (available at http://www.electropedia.org)

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

IEC 60079 (all parts), *Explosive atmospheres*

IEC 60664-1:2007, *Insulation coordination for equipment within low-voltage systems – Part 1: Principles, requirements and tests*

IEC 60747-5-5, *Semiconductor devices – Discrete devices – Part 5-5: Optoelectronic devices – Photocouplers*

IEC 61140, *Protection against electric shock – Common aspects for installation and equipment*

IEC 60079-5

Edition 4.0 2015-02

INTERNATIONAL STANDARD

NORME INTERNATIONALE

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

Atmosphères explosives –
Partie 5: Protection du matériel par remplissage pulvérulent "q"

IEC 60079-5:2015-02(en-fr)

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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EXPLOSIVE ATMOSPHERES –

Part 5: Equipment protection by powder filling “q”

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as “IEC Publication(s)”). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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International Standard IEC 60079-5 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.

		Type		
Significant changes	**Clause/subclause**	**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.

EXPLOSIVE ATMOSPHERES –

Part 5: Equipment protection by powder filling “q”

1 Scope

This 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.

This standard supplements and modifies the general requirements of IEC 60079-0. Where a requirement of this standard conflicts with a requirement of 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.

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*

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*

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

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 IEC 60079-0 apply.

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 include the "X" suffix in accordance with the marking requirements of IEC 60079-0, 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 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 IEC 60079-0 do not generally apply to Ex Components intended to be mounted inside another enclosure complying with 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.

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.

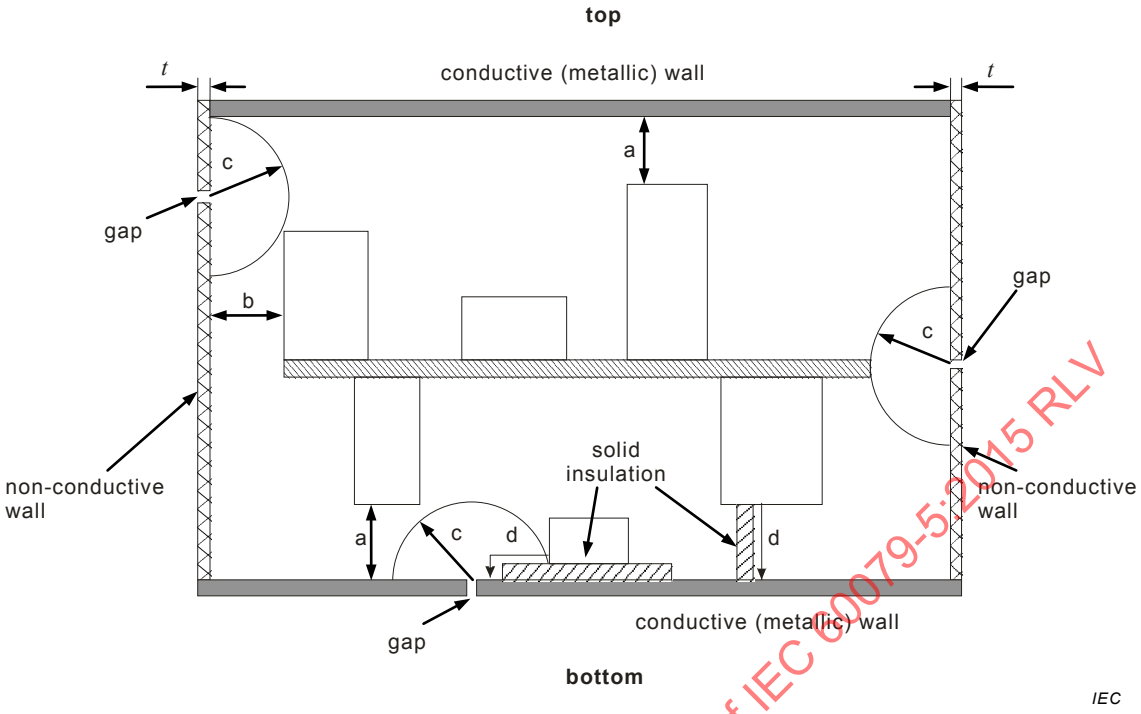
Table 1 – Distances through the filling material

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.



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

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

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 IEC 60079-0 and shall not be capable of being removed without obvious damage to the powder filled “q” container.

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.

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.

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.

When the fuse is not integral to the electrical equipment or parts of electrical equipment, the certificate number shall include the "X" suffix in accordance with the marking requirements of IEC 60079-0 and the Specific Conditions of Use listed on the certificate shall detail the required fuse.

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

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.

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
$U \leq 1\,000$	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 × 1,7 × I_n of the fuse;
– externally applied maximum voltage U_m;
– power rating 1,5 × (1,7 × I_n of the fuse)^2 × resistance of limiting device.

If the manufacturer does not provide a required short-circuit protective device, the certificate number for the electrical equipment or parts of electrical equipment shall include the "X" suffix in accordance with the marking requirements of IEC 60079-0 and the Specific Conditions of Use listed on the certificate shall detail the short-circuit protective devices required.

5 Verifications and tests

5.1 Type verifications and tests

5.1.1 Pressure type test of container

The pressure tests shall be conducted on the samples subjected to the tests of enclosures in IEC 60079-0. Irrespective of its volume, the container samples shall be subjected to a pressure type test with an over-pressure of 50 kPa without the occurrence of permanent deformation exceeding 0,5 mm in any of its dimensions. The pressure shall be applied for at least 10 s.

For containers without breathing or degassing openings, which contain capacitors other than plastic foil, paper or ceramic type and where the volume of the filling material is lower than eight times the volume of the capacitors, the pressure type test with an overpressure of 1,5 MPa shall be applied for at least 10 s.

Where the reduced distances have been applied (4.3.1), the pressure test shall be conducted hydraulically. There shall be no drops of water to blotting paper placed under the sample from any of the joints of the sample not identified as a “gap” for the purposes of employing the reduced distances.

NOTE 1 The test samples used for this test normally have the “gaps” sealed to allow the evaluation of the joints without the drops of water expected to come from the “gaps”.

Tests may be conducted without the filling material present.

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

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

5.1.2 Verification of the degree of protection of the enclosure

The degree of protection of the enclosure shall be verified in accordance with the method specified in IEC 60529. Any breathing devices shall be in place. This test shall be carried out after the pressure type test in 5.1.1 on any one of the samples.

NOTE 1 When the container is also the external enclosure, the tests of enclosures requirements of IEC 60079-0 apply.

NOTE 2 The impact and drop tests of enclosures from IEC 60079-0 do not generally apply to Ex Components intended to be mounted inside of another enclosure complying with IEC 60079-0, as the external enclosure provides the protection against impact and drop.

5.1.3 Dielectric strength test of the filling material

The insulating properties of the filling material shall be tested prior to the filling process using a sample of the filling material. For this purpose, the electrode arrangement shown in Figure 2 shall be used. The electrodes shall be covered by the filling material in all directions with a thickness of at least 10 mm.

The sample shall be conditioned for at least 24 h at a temperature of (23 ± 2) °C and relative humidity of between 45 % and 55 %. A test voltage of 1 000 V d.c. $^{+5}_{0}$ % shall then be applied to the electrodes.

The filling material complies with the requirements if the leakage current does not exceed 10^{-6} A. If the material fails to comply, further conditioning and retesting are not permitted.

5.1.4 Maximum temperatures

Where current dependent fuses in accordance with IEC 60127 are used as protective devices for temperature limitation, the maximum temperature under overload conditions shall be measured with a continuous current of at least 1,7 times the fuse rating. If other fuses are employed, the test current shall be based on the non-fusing current rating of the fuse.

Where items other than current dependent fuses are used as protective devices for temperature limitation, the equipment shall be tested to verify that the temperature class is not exceeded when those protective devices operate.

When required by 4.8.3 to consider a malfunction, any malfunction which could increase heat dissipation but not cause a current dependant fuse to disconnect immediately shall be considered. (Malfunctions that will cause immediate rupture of the fuse do not need to be considered.) The malfunction assessed as most likely to affect the temperature class shall be simulated as closely as possible, particularly in respect of the spatial relationship between the container wall and the source of the heat.

NOTE 1 To simulate overload conditions or malfunctions which may cause higher temperatures than in normal operation, it is often convenient to use power components mounted in the equipment and subject to the maximum available power. Such components are normally chosen and located in the equipment so that they are representative of the thermal characteristics of the components they represent.

NOTE 2 The term “overload” also applies to the situation where the Ex “q” equipment (or component – such as a solid state relay or a luminaire ballast) controls rather than consumes power and the temperature rise is, at least partly, related to the external load. In such cases, where the equipment is protected by a fuse rated at not more than 170 % of the maximum normal current, the external load is adjusted to achieve the maximum current through the fused circuit, but no more than 1,7 times the fuse rating. Internal malfunctions are not applied as they are not considered to result in an “overload”.

5.2 Routine verifications and tests

5.2.1 Routine pressure test of container

Each container having a volume greater than 100 cm^3 shall be subjected to a routine pressure test with an overpressure of 50 kPa or 1,5 MPa, as applicable (See 5.1.1) without the occurrence of permanent deformation exceeding 0,5 mm in any of its dimensions. The pressure shall be applied for at least 10 s.

Tests shall be carried out under normal conditions of the equipment, but may be done without the filling material present.

The routine pressure test may be waived where the container has passed a type test with four times the test pressure (50 kPA or 1,5 MPa) in 5.1.1.

The routine overpressure testing can be replaced by a batch test according to the following criteria based on ISO 2859-1:

- For a production batch up to 100, 8 samples need to be tested at 1,5 times the routine test pressure with no failures.
- For a production batch from 101 to 1 000, 32 samples need to be tested at 1,5 times the routine test pressure with no failures.
- For a production batch from 1 001 up to 10 000, 80 samples need to be tested at 1,5 times the routine test pressure with no failures.

Batches above 10 000 shall be subdivided into smaller batches.

In many cases, the routine pressure test cannot be conducted without modifying the container so significantly that it is no longer representative of the equipment and could no longer be completed as the equipment. In these cases, neither the type test nor the batch routine test provide reasonable alternatives. In some cases, the samples for the batch routine overpressure test also have to be significantly modified to be able to conduct the test. In these cases, the satisfactorily tested samples are discarded and only the remaining untested samples of the batch released.

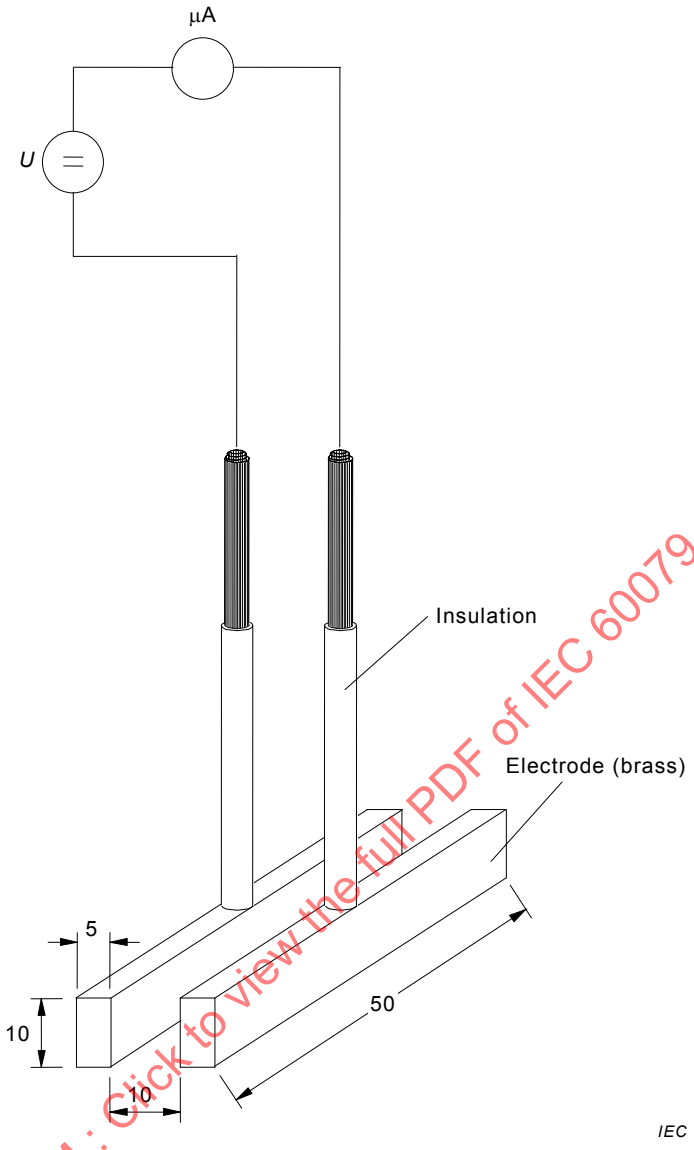
5.2.2 Dielectric strength test of the filling material

The insulating properties of each lot of the filling material shall be tested prior to the filling process using a sample of the filling material. For this purpose, the electrode arrangement shown in Figure 2 shall be used. The electrodes shall be covered by the filling material in all directions with a thickness of at least 10 mm. The test voltage shall be 1 000 V d.c. $^{+5}_{0}$ % under the following climatic conditions:

– temperature (23 ± 2) °C;
– relative humidity 45 % to 55 %.

The filling material complies with the requirements if the leakage current does not exceed 10^{-6} A.

If the filling material does not initially comply with these requirements, the lot may be dried and retested.



Dimensions in millimetres with a tolerance of ±1,0 mm

Figure 2 – Test arrangement for the dielectric strength test of the filling material

6 Marking

Electrical equipment, parts of electrical equipment, and Ex Components of powder filling "q" shall be marked in accordance with IEC 60079-0, with the following additional marking, as appropriate:

a) "This container has been permanently sealed and cannot be repaired".

b) "This container is factory sealed – consult manufacturer's instructions for repair".

c) Each connection facility for external connection shall be marked with an identification of rated voltage and rated current ("24 V d.c., 200 mA", "230 V, 100 mA").

d) External fuse data if the type of protection depends upon such a fuse, "Required external fuse: 315 mA";

e) Permitted prospective short-circuit current of the supply system if the equipment is designed for a short-circuit current less than 1 500 A, according to 4.8.5, for example "Permitted supply short-circuit current: 35 A".

f) Optionally, permitted prospective short-circuit current of the supply system if the equipment is designed for a short-circuit current of 1 500 A or more, according to 4.8.5, for example “Permitted supply short-circuit current: 3 500 A”.

Any of these markings may be replaced by technically equivalent information.

7 Instructions

The instructions prepared in accordance with IEC 60079-0, shall also include the following:

– Where permitted by the manufacturer, details on the re-filling, re-sealing, and re-testing requirements for powder filled “q” equipment that has been opened for repair.

– Where the container is permanently sealed and repair is not permitted by the manufacturer, this shall be stated clearly in the instructions.

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SOMMAIRE

COMMISSION ÉLECTROTECHNIQUE INTERNATIONALE

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ATMOSPHÈRES EXPLOSIVES –

Partie 5: Protection du matériel par remplissage pulvérulent “q”

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La Norme internationale IEC 60079-5 a été établie par le comité d'études 31 de l’IEC: Équipements pour atmosphères explosives.

Cette quatrième édition annule et remplace la troisième édition parue en 2007. Cette édition constitue une révision technique.

Cette édition inclut les modifications techniques majeures suivantes par rapport à l'édition précédente:

NOTE Les modifications techniques auxquelles il est fait référence comprennent les modifications techniques majeures par rapport à la norme IEC révisée, mais ne constituent pas une liste exhaustive de toutes les modifications apportées par rapport à la version précédente. Il est possible de trouver des précisions supplémentaires en se référant à la version en mode révision de la norme IEC, si elle est disponible.

		Type		
Modifications majeures	**Article / paragraphe**	**Modifications mineures et rédactionnelles**	**Extension**	**Modifications techniques majeures**
Les références spécifiques à l'IEC 60079-0 ont été reformulées pour qu'elles ne soient pas datées	4.1.3 4.8 4.8.3	X		
L'"enveloppe" contenant l'appareil à remplissage pulvérulent ou le Composant Ex a été redéfinie par le terme "conteneur" pour éviter la confusion avec les exigences relatives aux "enveloppes" de l'IEC 60079-0	4.1	X		
Un assouplissement des exigences a été introduit pour autoriser des distances réduites entre matériaux de remplissage, par exemple lorsqu'il n'y a pas d'interstice adjacent dans le conteneur	4.3.1		X	
Un assouplissement des exigences a été introduit pour autoriser l'utilisation des lignes de fuite selon l'IEC 60079-7 où l'IRC est meilleur que 175	4.8.3		X	
Une évaluation des joints utilisés en cas d'application des distances réduites selon le Tableau 1 a été ajoutée	5.1.1		X	
Le texte définissant la température maximale a été clarifié au sujet des surcharges et des dysfonctionnements	5.1.4	X		
Un essai individuel par lot a été introduit.	5.2.1		X	

Le texte de cette norme est issu des documents suivants:

FDIS	Rapport de vote
31/1156/FDIS	31/1171/RVD

Le rapport de vote indiqué dans le tableau ci-dessus donne toute information sur le vote ayant abouti à l'approbation de cette norme.

Cette publication a été rédigée selon les Directives ISO/IEC, Partie 2.

La liste de toutes les parties de la série IEC 60079, publiées sous le titre général *Atmosphères explosives*, peut être consultée sur le site web de l'IEC.

Le comité a décidé que le contenu de cette publication ne sera pas modifié avant la date de stabilité indiquée sur le site web de l'IEC sous "http://webstore.iec.ch" dans les données relatives à la publication recherchée. À cette date, la publication sera

- reconduite,
- supprimée,
- remplacée par une édition révisée, ou
- amendée.

ATMOSPHÈRES EXPLOSIVES –

Partie 5: Protection du matériel par remplissage pulvérulent “q”

1 Domaine d'application

La présente partie de l’IEC 60079 contient les exigences spécifiques de construction, d'essais et de marquage d'appareil électrique, des parties d'appareil électrique et des composants Ex à remplissage pulvérulent, mode de protection “q”, destinés à être utilisés dans des atmosphères explosives gazeuses.

NOTE 1 L'appareil électrique à remplissage pulvérulent, mode de protection “q” et les composants Ex peuvent contenir des circuits électroniques, des transformateurs, des fusibles de protection, des relais, des matériels électriques de sécurité intrinsèque, des matériels électriques associés, des interrupteurs, etc.

NOTE 2 Le mode de protection par remplissage pulvérulent “q” procure un Niveau de Protection du Matériel (EPL[1]) Gb ou Mb.

La présente norme complète et modifie les exigences générales de l’IEC 60079-0. Lorsqu’une exigence de la présente norme diverge d’une exigence de l’IEC 60079-0, l’exigence de cette norme prévaut.

La présente norme s'applique aux appareils électriques, aux parties d'appareil électrique et aux composants Ex avec:

– un courant assigné d'alimentation inférieur ou égal à 16 A;
– une tension assignée d'alimentation inférieure ou égale à 1 000 V;
– une puissance consommée assignée inférieure ou égale à 1 000 W.

2 Références normatives

Les documents suivants sont cités en référence de manière normative, en intégralité ou en partie, dans le présent document et sont indispensables pour son application. Pour les références datées, seule l’édition citée s’applique. Pour les références non datées, la dernière édition du document de référence s’applique (y compris les éventuels amendements).

IEC 60079-0, *Atmosphères explosives – Partie 0: Matériel – Exigences générales*

IEC 60079-7, *Atmosphères explosives – Partie 7: Protection de l'équipement par sécurité augmentée "e"*

IEC 60079-11, *Atmosphères explosives – Partie 11: Protection de l'équipement par sécurité intrinsèque "i"*

IEC 60127, (toutes les parties), *Coupe-circuit miniatures*

IEC 60529, *Degrés de protection procurés par les enveloppes (Code IP)*

IEC 61558-1, *Sécurité des transformateurs, alimentations, bobines d'inductance et produits analogues – Partie 1: Exigences générales et essais*

[1] EPL = *equipment protection level*

IEC 61558-2-6, *Sécurité des transformateurs, bobines d'inductance, blocs d'alimentation et produits analogues pour des tensions d'alimentation jusqu'à 1 100 V – Partie 2-6: Règles particulières et essais pour les transformateurs de sécurité et les blocs d'alimentation incorporant des transformateurs de sécurité*

ISO 2859-1, *Règles d'échantillonnage pour les contrôles par attributs – Partie 1: Procédures d'échantillonnage pour les contrôles lot par lot, indexés d'après le niveau de qualité acceptable (NQA)*

ISO 3310-1, *Tamis de contrôle – Exigences techniques et vérifications – Partie 1: Tamis de contrôle en tissus métalliques*

ISO 3310-2, *Tamis de contrôle – Exigences techniques et vérifications – Partie 2: Tamis de contrôle en tôles métalliques perforées*

ISO 2591-1, *Tamisage de contrôle – Partie 1: Modes opératoires utilisant des tamis de contrôle en tissus métalliques et en tôles métalliques perforées*

3 Termes et définitions

Pour les besoins du présent document, les termes et définitions donnés dans l'IEC 60079-0 ainsi que les suivants s'appliquent.

NOTE Des définitions supplémentaires applicables aux atmosphères explosives sont données dans l'IEC 60050-426.

3.1
remplissage pulvérulent "q"
mode de protection dans lequel les parties susceptibles d'enflammer une atmosphère explosive gazeuse sont en position fixe et sont complètement noyées dans un matériau de remplissage de telle sorte que l'inflammation d'une atmosphère explosive gazeuse environnante soit empêchée

Note 1 à l'article: Le mode de protection peut ne pas empêcher la pénétration de l'atmosphère explosive gazeuse environnante dans le matériel et les composants et l'inflammation par les circuits. Cependant, du fait des petits volumes libres dans le matériau de remplissage et du fait de l'extinction d'une flamme qui se propagerait à travers les cheminements dans le matériau de remplissage, une explosion externe est empêchée.

3.2
matériau de remplissage
particules de quartz ou de verre

3.3
conteneur (pour matériau de remplissage)
boîtier entourant immédiatement l'appareil électrique protégé par le matériau de remplissage et contenant celui-ci.

Note 1 à l'article: Le conteneur peut dans certains cas être l'enveloppe externe.

4 Exigences de construction

4.1 Conteneurs

4.1.1 Fermeture et scellement

4.1.1.1 Généralités

Les conteneurs des appareils électriques, des parties d'appareil électrique ou des composants Ex protégés par le remplissage pulvérulent "q" doivent être remplis et scellés lors

de leur fabrication. La fermeture et le scellement des conteneurs doivent être conformes aux méthodes de 4.1.1.2 ou 4.1.1.3.

4.1.1.2 Conteneurs scellés de façon permanente lors de la fabrication

Le conteneur doit être scellé de façon permanente lors de la fabrication et ne doit pas pouvoir être ouvert sans laisser des preuves visibles évidentes de son ouverture. Le conteneur doit être marqué conformément à l'Article 6, élément a).

NOTE Des techniques adaptées pour fournir des preuves visibles évidentes d'ouverture du conteneur sont par exemple, les joints soudés, brasés, scellés, les rivets, les vis scellées, ou les vis avec un fil de plombage.

4.1.1.3 Conteneurs destinés à être ouverts pour des réparations

Les appareils électriques, des parties d'appareil électrique ou des composants Ex qui sont conçus pour être réparés doivent posséder des méthodes de scellement capables d'être renouvelées sans dommage pour le conteneur quand l'appareil est réparé, rempli à nouveau et scellé à nouveau. Le conteneur doit être marqué conformément à l'Article 6, élément b).

4.1.2 Essai de pression du conteneur

Les appareils électriques, des parties d'appareil électrique ou des composants Ex protégés par remplissage pulvérulent "q" doivent respecter les exigences d'essai de pression spécifiée en 5.1.1.

4.1.3 Degré de protection du conteneur

Le conteneur de l'appareil électrique, les parties d'appareil électrique ou composants Ex protégés par remplissage pulvérulent "q", dans leurs conditions de fonctionnement normal, c'est-à-dire avec toutes leurs ouvertures fermées comme en usage normal, doivent être conformes au moins au degré de protection IP54 défini dans l'IEC 60529. Si le degré de protection est IP55 ou plus et que le conteneur n'est pas hermétiquement fermé, il doit être pourvu d'un dispositif de respiration. Le conteneur avec le dispositif de respiration en place doit répondre au degré de protection IP54 conformément à l'IEC 60529. L'essai doit être mené sur un conteneur vide sans le remplissage pulvérulent. À la fin de tous les essais de pénétration d'eau, aucune trace d'eau ne doit être visible à l'intérieur du conteneur.

NOTE 1 étant donné que le conteneur peut être détruit afin de déterminer le chemin d'entrée de l'eau ou de la poussière, deux échantillons distincts d'essai peuvent être nécessaires pour les deux essais de pénétration.

NOTE 2 Lorsque le conteneur est également l'enveloppe externe, les essais pour les exigences relatives aux enveloppes de l'IEC 60079-0 s'appliquent.

La protection contre la pénétration des conteneurs ou des parties d'appareil électrique protégés par remplissage pulvérulent "q", destinés à être utilisés exclusivement en salles propres et sèches, peut être réduite à un degré de protection IP43. Le numéro de certificat de cet appareil doit inclure le suffixe "X" conformément aux exigences de marquage de l'IEC 60079-0 et les Conditions Particulières d'Utilisation indiquées sur le certificat doivent détailler les restrictions d'utilisation.

Si des composants Ex protégés par remplissage pulvérulent "q" sont destinés à être montés à l'intérieur d'une autre enveloppe conforme à l'IEC 60079-0, cette enveloppe externe doit répondre au moins au degré de protection IP54. Le degré IP du conteneur interne n'a pas besoin d'être spécifié, si le composant Ex est monté dans une position où il est improbable qu'il soit contaminé par une faible quantité d'eau pouvant entrer dans l'enveloppe externe.

NOTE 3 Les essais de choc et de chute des enveloppes de l'IEC 60079-0 ne s'appliquent généralement pas aux Composants Ex destinés à être installés dans une autre enveloppe conforme à l'IEC 60079-0, puisque l'enveloppe externe assure une protection contre les chocs et les chutes.

L'interstice maximal du conteneur protégé par remplissage pulvérulent "q" doit être inférieur d'au moins 0,1 mm à la plus petite dimension du matériau de remplissage.

NOTE 4 La restriction concernant la taille de l'interstice a pour but d'empêcher que le matériau de remplissage puisse s'échapper.

4.1.4 Procédure de remplissage

Le remplissage doit être réalisé de manière à ne laisser subsister aucun vide à l'intérieur du matériau de remplissage (par exemple en le secouant). L'espace libre à l'intérieur de l'appareil électrique, des parties d'appareil électrique ou des composants Ex protégés par remplissage pulvérulent "q" doit être efficacement rempli par le matériau de remplissage (voir également 4.3.2).

4.1.5 Conteneurs n'étant pas des enveloppes externes

Le conteneur de l'appareil ou de composant Ex à mode de protection "q" installé ou destiné à être installé à l'intérieur d'une autre enveloppe est considéré de la même manière qu'un Composant Ex.

4.2 Matériau de remplissage

4.2.1 Spécification de matériau

Le matériau doit être constitué de particules de quartz ou de verre.

La spécification de matériau doit indiquer que lorsqu'elle est déterminée conformément à la procédure de l'ISO 2591-1 pour les matériaux secs, la taille des particules correspond aux dimensions de tamis suivantes:

– tamis d'ouverture nominale de 1 mm conformément à l'ISO 3310-1 ou à l'ISO 3310-2

– tamis d'ouverture nominale de 500 μm conformément à l'ISO 3310-1.

4.2.2 Documentation

Les documents présentés par le fabricant conformément à l'IEC 60079-0 doivent comprendre la spécification des particules du matériau, l'étendue granulométrique des particules de même que le procédé de remplissage et les mesures prises pour assurer un remplissage convenable.

NOTE La vérification de la conformité à la spécification des particules de matériau et de l'étendue granulométrique des particules n'est pas une exigence de la présente norme.

4.2.3 Essais

Le matériau de remplissage doit être soumis à l'essai de rigidité diélectrique spécifié en 5.1.3.

4.3 Distances

4.3.1 Distances au travers du matériau de remplissage

Sauf spécification contraire dans la présente norme, la distance minimale au travers du matériau de remplissage entre les parties électriquement conductrices de l'appareil, d'une part, et le conteneur, d'autre part, doit être conforme au Tableau 1 et à la Figure 1. Cela ne s'applique pas aux conducteurs utilisés pour les connexions de câblage sur site qui traversent la paroi du conteneur.