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INTERNATIONAL STANDARD

Electrostatics –
Part 4-4: Standard test methods for specific applications – Electrostatic classification of flexible intermediate bulk containers (FIBC)

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ELECTROSTATICS –

Part 4-4: Standard test methods for specific applications – Electrostatic classification of flexible intermediate bulk containers (FIBC)

FOREWORD

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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 61340-4-4 has been prepared by IEC technical committee 101: Electrostatics.

This third edition cancels and replaces the second edition, published in 2012, and Amendment 1:2014. This edition constitutes a technical revision.

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

a) in light of experimental evidence, the maximum resistance to ground limit for Type C FIBC, and corresponding resistance limits for inner liners used in Type C FIBC has been increased from 1,0 × 10^7 Ω to 1,0 × 10^8 Ω;
b) the classification of Type L1 inner liners has been revised and extended to include Type L1C inner liners made from multi-layer materials with a conductive internal layer;
c) a labelling requirement to include a reference to IEC TS 60079-32-1 for guidance on earthing has been added.

The text of this International Standard is based on the following documents:

FDIS	Report on voting
101/546/FDIS	101/555/RVD

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

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

A list of all parts in the IEC 61340 series, published under the general title *Electrostatics*, can be found on the IEC website.

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

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- withdrawn,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

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INTRODUCTION

Flexible intermediate bulk containers (FIBC) are widely used for the storage, transportation and handling of powdered, flaked or granular material. Typically, they are constructed from woven polypropylene fabric in the form of cubic bags of about 1 m^3 volume, although they can vary in shape and in size from 0,25 m^3 to 3 m^3. The fabric used may be a single layer, a multi-layer laminate, or a coated fabric. Untreated polypropylene is an electrical insulator, as is often the case with the products placed in FIBC. There is ample opportunity for the generation of electrostatic charge during filling and emptying operations and in unprotected FIBC high levels of charge can quickly build up. In such cases, electrostatic discharges are inevitable and can be a severe problem when FIBC are used in hazardous explosive atmospheres.

A hazardous explosive atmosphere can be generated when handling fine powders that create dust clouds or thin layers of powder, both of which can be ignited by electrostatic discharges. A hazardous explosive atmosphere can also be generated when using gases or volatile solvents. In these industrial situations, there is clearly a need to eliminate incendive electrostatic discharges.

As with any industrial equipment, a thorough risk assessment should always be conducted before using FIBC in potentially hazardous situations. This part of IEC 61340 describes a system of classification, test methods, performance and design requirements and safe use procedures that can be used by manufacturers, specifiers and end-users as part of a risk assessment of any FIBC intended for use within a hazardous explosive atmosphere. However, it does not include procedures for evaluating the specific risks of electrostatic discharges arising from products within FIBC, for example cone discharges, from personnel or from equipment used near FIBC. Information on risks associated with cone discharges is given in Annex E.

CAUTION: The test methods specified in this document involve the use of high voltage power supplies and flammable gases that may present hazards if handled incorrectly, particularly by unqualified or inexperienced personnel. Users of this document are encouraged to carry out proper risk assessments and pay due regard to local regulations before undertaking any of the test procedures.

ELECTROSTATICS –

Part 4-4: Standard test methods for specific applications – Electrostatic classification of flexible intermediate bulk containers (FIBC)

1 Scope

This part of IEC 61340 specifies requirements for flexible intermediate bulk containers (FIBC) between 0,25 m^3 and 3 m^3 in volume, intended for use in hazardous explosive atmospheres. The explosive atmosphere ~~may~~ can be created by the contents in the FIBC or ~~may~~ can exist outside the FIBC.

The requirements include:

- classification and labelling of FIBC;
- classification of inner liners;
- specification of test methods for each type of FIBC, inner liner, labels and document pockets;
- design and performance requirements for FIBC, inner liners, labels and document pockets;
- safe use of FIBC (including those with inner liners) within different zones defined for explosion endangered environments, described for areas where combustible dusts are, or ~~may~~ can be, present (IEC 60079-10-2), and for explosive gas atmospheres (IEC 60079-10-1);
- procedures for type qualification and certification of FIBC, including the safe use of inner liners.

NOTE 1 Guidance on test methods that ~~may~~ can be used for manufacturing quality control is given in Annex C.

The requirements of this document are applicable to all types of FIBC and inner liners, tested as manufactured, prior to use and intended for use in hazardous explosive atmospheres: Zones 1 and 2 (Groups IIA and IIB only) and Zones 21 and 22 (see Annex D for classification of hazardous areas and explosion groups). For some types of FIBC, the requirements of this document apply only to use in hazardous explosive atmospheres with minimum ignition energy of 0,14 mJ or greater and where charging currents do not exceed 3,0 µA.

NOTE 2 0,14 mJ ~~is the~~ represents a realistic minimum ignition energy ~~of~~ for a ~~typical~~ Group IIB gas or vapour atmosphere. Although more sensitive materials exist, 0,14 mJ is the lowest minimum ignition energy of any material that is likely to be present when FIBC are emptied. 3,0 µA is the highest charging current likely to be found in common industrial processes. This combination of minimum ignition energy and charging current represents the most severe conditions that might be expected in practice.

FIBC are not normally used in Zone 0 or Zone 20. If FIBC are used in Zone 0 or Zone 20, the requirements of this document are applicable, together with additional requirements that are beyond the scope of this document to define.

The volume contained within FIBC can be designated as Zone 20, in which case the requirements of this document are applicable.

Solids containing residual solvent can result in a hazardous explosive atmosphere within FIBC, possibly resulting in the volume being designated as Zone 1 or Zone 2; in which case the requirements of this document are applicable.

Compliance with the requirements specified in this document does not necessarily ensure that hazardous electrostatic discharges, for example cone discharges, will not be generated by the contents in FIBC. Information on the risks associated with cone discharges is given in Annex E.

Compliance with the requirements of this document does not mitigate the need for full risk assessment. For example, metal and other conductive powders and toner powders ~~may~~ can require additional precautions to prevent hazardous discharges from the powders.

NOTE 3 In the examples mentioned in the paragraph above, additional precautions ~~may~~ can be necessary in the case of metal or other conductive powder because if the powder is isolated and becomes charged, incendiary sparks ~~may~~ can occur, and in the case of toner powders, incendiary discharges ~~may~~ can occur during rapid filling and emptying operations. IEC TS 60079-32-1 [1] [1] gives guidance on additional precautions that ~~may~~ can be necessary.

Test methods included in this document ~~may~~ can be used in association with other performance requirements, for example when a risk assessment has shown the minimum ignition energy of concern is less than 0,14 mJ, charging currents are greater than 3,0 μA, or the ambient conditions are outside of the range specified in this document.

Compliance with the requirements specified in this document does not necessarily ensure that electric shocks to personnel will not occur from FIBC during normal use.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60079-10-1, *Explosive atmospheres – Part 10-1: Classification of areas – Explosive gas atmospheres*

IEC 60079-10-2, *Explosive atmospheres – Part 10-2: Classification of areas – ~~Combustible~~ Explosive dust atmospheres*

IEC 60243-1:~~1998~~ 2013, *Electric strength of insulating materials – Test methods – Part 1: Tests at power frequencies*

IEC 60243-2, *Electric strength of insulating materials – Test methods – Part 2: Additional requirements for tests using direct voltage*

IEC 60417~~-5019:2006~~, *Graphical symbols for use on equipment* (available at: http://www.graphical-symbols.info/equipment)

~~IEC 61241-2-3, *Electrical apparatus for use in the presence of combustible dust – Part 2: Test methods – Section 3: Method for determining minimum ignition energy of dust/air mixtures*~~

IEC 61340-2-3, *Electrostatics – Part 2-3: Methods of test for determining the resistance and resistivity of solid ~~planar~~ materials used to avoid electrostatic charge accumulation*

ISO/IEC 80079-20-2, *Explosive atmospheres – Part 20-2: Material characteristics – Combustible dusts test methods*

ISO 7000~~:2004~~, *Graphical symbols for use on equipment – ~~Index and synopsis~~ Registered symbols* (available at: http://www.graphical-symbols.info/equipment)

1 Numbers in square brackets refer to the Bibliography.

ISO 21898, *Packaging – Flexible intermediate bulk containers (FIBCs) for non-dangerous goods*

ASTM E582, *Standard test method for minimum ignition energy and quenching distance in gaseous mixtures*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60079-10-1, IEC 60079-10-2 and ISO 21898 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1
multi-layer material
material comprised of more than one layer, the combination of which can be formed by coextrusion, coating, laminating or any other process that permanently bonds all layers together

3.2
quenching
effect of solid objects acting as heat sinks in close proximity to gas

3.3
critical quenching distance
maximum separation distance between opposing electrodes below which quenching prevents ignition at a specified energy

Note 1 to entry: For ignitions to take place, the gap between electrodes ~~should be~~ is greater than the critical quenching distance.

3.4
flammable substance
substance in the form of gas, vapour, liquid, solid, or mixture of these, capable of propagating combustion when subjected to an ignition source

3.5
explosive atmosphere
mixture with air, under atmospheric conditions, of flammable substances in the form of gases, vapours, mists or dusts in which, after ignition has occurred, combustion spreads to the entire unburned mixture

3.6
hazardous explosive atmosphere
explosive atmosphere present in such quantities that precautions against ignition are required

3.7
minimum ignition energy
MIE
least electrical energy of a purely capacitive spark (i.e. no added inductance) required to ignite a dust, gas or vapour

3.8
charging current
quantity of charge per unit time flowing into FIBC

3.9
cone discharge
electrostatic discharge running outwards across the surface from the top of highly charged, insulating powder heaps in large containers

3.10
brush discharge
electrostatic discharge from a non-conductive, solid or liquid surface

3.11
spark
electrostatic discharge from an electrically isolated conductive object or surface

3.12
propagating brush discharge
highly energetic discharge from an insulating sheet, layer or coating on a conductive surface, or a material of high resistivity and high breakdown voltage with the two surfaces highly charged to opposite polarity

3.13
inner liner
liner
integral or removable container which fits into the FIBC

3.14
surface resistivity
resistivity equivalent to the surface resistance of a square area of material having electrodes at two opposite sides

3.15
volume resistivity
resistivity equivalent to the volume resistance of a cube of material with unit length, having the electrodes at two opposite surfaces

3.16
type qualification testing
testing used to determine the type of FIBC as specified in 4.1 and to demonstrate that FIBC meet the requirements of Clause 7

3.17
quality control testing
testing designed to provide manufacturers and users with information that demonstrates all FIBC produced and delivered are substantially the same as the sample FIBC used to qualify the FIBC design

3.18
groundable point
point on FIBC designated by the manufacturer as a location to attach a grounding or earth bonding cable or other means of earthing FIBC

~~NOTE There may be one or more groundable points on each FIBC. Lift loops may also be designated as groundable points, but fortuitous earthing via lifting hooks should not be relied as these may be painted/coated, or covered with powder etc., and so may not guarantee an adequate earth path.~~

4 Classification

4.1 Classification for FIBC

4.1.1 Principles of classification ~~for FIBC~~

FIBC are classified according to one of four types: Type A, Type B, Type C and Type D. The types are defined by the construction of the FIBC, the nature of their intended operation and associated performance requirements.

An individual design of FIBC may only be classified as one single type; for example one FIBC ~~cannot~~ shall not be simultaneously classified as both Type B and Type D, or as both Type B and Type C, or as Type CD.

4.1.2 Type A

Type A FIBC are made from fabric or plastic sheet without any measures against the build up of static electricity. Any FIBC that does not meet the requirements specified in Clause 7, or which has not been tested against the requirements is classified as Type A.

4.1.3 Type B

Type B FIBC are made from fabric or plastic sheet designed to prevent the occurrence of sparks and propagating brush discharges.

Conductive materials, as used in the manufacture of Type C FIBC for example, shall not be used in the manufacture of Type B FIBC.

NOTE Type B FIBC are not normally connected to earth. Conductive material that is not connected to earth creates a risk of incendiary sparks.

4.1.4 Type C

Type C FIBC are made from conductive fabric or plastic sheet, or interwoven with conductive threads or filaments and designed to prevent the occurrence of incendiary sparks, brush discharges and propagating brush discharges. Type C FIBC are designed to be connected to earth ~~during~~ before the commencement of filling and emptying operations and remain connected to earth during these operations.

4.1.5 Type D

Type D FIBC are made from static protective fabric designed to prevent the occurrence of incendiary sparks, brush discharges and propagating brush discharges, without the need for a connection from the FIBC to earth.

4.2 Principles of classification and requirements for inner liners

4.2.1 Components of inner liners

Materials used for inner liners can be single layer, or multi-layered materials. In the latter case, the layers are typically permanently bonded together. Examples of FIBC with a single layer inner liner and with a multi-layer inner liner are shown in Figure 1.

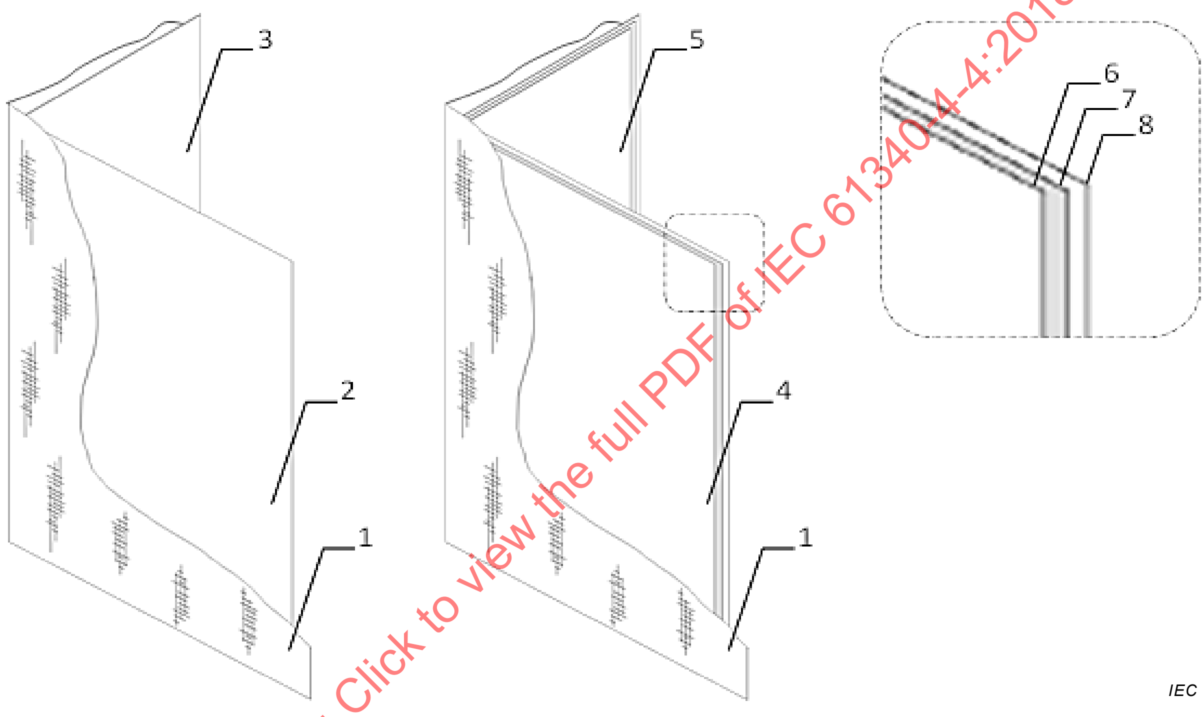
For the purposes of this document, and for both single layer inner liners and multi-layer inner liners, the outside surface of the inner liner is the surface that physically contacts the FIBC, and the inside surface of the inner liner is the surface that physically contacts the product with which the FIBC is filled.

In Figure 1, the multi-layer inner liner is shown as comprising of three layers. In practice, more than three layers can be used. For the purposes of this document, an internal layer is any layer of a multi-layer liner that does not physically contact either the FIBC or the product with which the FIBC is filled.

The electrical properties of the outside surface of a single layer or multi-layer inner liner can be the same as the inside surface, or they can be different. For example, one of the surfaces can be treated with a topical finish to reduce surface resistivity.

With multi-layer inner liners, there are many possible combinations of layers with similar or different electrical properties.

Notwithstanding the many possible combinations of materials for inner liners, for the purposes of this document it is the electrical properties of the outside surface and inside surface of inner liners that are of interest, together with the presence of any conductive internal layers.



Key

1 FIBC
2 outside surface of single layer inner liner
3 inside surface of single layer inner liner
4 outside surface of multi-layer inner liner
5 inside surface of multi-layer inner liner
6 external layer of multi-layer inner liner
7 internal layer of multi-layer inner liner
8 external layer of multi-layer inner liner

NOTE For illustrative purposes, the layers of the multi-layer inner liner are shown separated. In practice, they are typically permanently bonded together.

Figure 1 – Examples of inner liners in FIBC

4.2.2 Surface resistivity measurements for inner liners

Surface resistivity shall be measured according to IEC 61340-2-3. A minimum of ten measurements shall be made at points evenly distributed over the inner liner surface. All measurements shall be within the limits specified for the type of inner liner being tested.

4.2.3 Breakdown voltage measurements for inner liners

Breakdown voltage shall be measured according to 9.2 under the conditions specified in 8.2. The measured breakdown voltage is highly dependent on the thickness of the insulating material and its electrical resistivity. As even minor changes can affect the breakdown voltage, the result only applies to the configuration of liner tested (including the thickness of the individual layers for co-extruded liners, in addition to the overall thickness).

When measuring breakdown voltage between an insulating layer and an internal conductive layer, a means of making electrical contact with the conductive layer is required. If an electrical connection is present, for example the earth bonding point on a finished liner, this can be used. When measuring films without earth bonding points, electrical contact with the conductive layer can be made using a staple inserted through the film, or by partially removing the insulating layer from an area at least 100 mm from the edge of the area where the electrode will be applied to the insulating layer. In the latter cases, either at least two staples shall be inserted, or at least two areas of insulating film shall be removed so that electrical connection to the conductive layer can be checked by measuring the resistance between staples or exposed conductive areas.

~~4.2.2 Special cases~~

~~Inner liners made from materials that contain a conductive layer sandwiched between two insulating layers shall not be used in Type B or Type D FIBC. If such an inner liner is used in Type C FIBC, the conductive layer shall be securely bonded to earth. The thickness of the insulating layers shall be less than 700 µm, and the breakdown voltage measured between an electrode placed on each surface in turn and the conductive layer shall be less than 4 kV, measured according to 9.1 under the conditions specified in 8.2.~~

~~NOTE In order to avoid incendiary brush discharge, the thickness of any exposed insulating layers in contact with non-insulating layers is limited to a maximum of 700 µm.~~

4.2.4 Type L1

Type L1 inner liners are made from materials with surface resistivity on at least one surface less than or equal to 1,0 x ~~10^7~~ 10^8 Ω (see Annex F), measured under the conditions specified in 8.2. Type L1 shall not include internal conductive layers; such inner liners are classified as Type L1C (see 4.2.5). Type L1 inner liners may be used in Type C FIBC.

~~If the material is multi-layered, or~~ If the material has one surface with surface resistivity greater than 1,0 x 10^{12} Ω, the breakdown voltage through the material shall be less than 4 kV, measured according to 9.2 under the conditions specified in 8.2.

Fortuitous contact between the inner liner and the inside of the FIBC cannot be relied upon to ensure proper earthing of the inner liner. Therefore, the surface with resistivity less than 1,0 x 10^8 Ω shall be securely connected to the earth bonding system of the FIBC via specific connections. The connections to the earth bonding system of the FIBC shall be sufficiently strong to withstand the stresses present during filling, transport and emptying operations and maintain electrical continuity.

The total thickness of any layer(s) with surface resistivity greater than 1,0 x 10^{12} Ω on the inside (product side) of the inner liner material shall be less than 700 µm.

Permissible configurations and requirements for Type L1 inner liners are summarized in Table 1.

Table 1 – Permissible configurations and requirements for Type L1 inner liners (without conductive internal layers)

Configuration	Parameters			
	Resistivity of inside surface ρ_I	Resistivity of outside surface ρ_O	Breakdown voltage V_B	Thickness d
1	$\rho_I \leq 1{,}0 \text{ x } \cancel{10^7}\ 10^8\ \Omega$	$\rho_O \leq 1{,}0 \text{ x } \cancel{10^7}\ 10^8\ \Omega$	No measurement required	No limit
2A	$\rho_I \leq 1{,}0 \text{ x } \cancel{10^7}\ 10^8\ \Omega$	$\rho_O \leq 1{,}0 \text{ x } 10^{12}\ \Omega$	No measurement required	No limit
2B	$\rho_I \leq 1{,}0 \text{ x } 10^{12}\ \Omega$	$\rho_O \leq 1{,}0 \text{ x } \cancel{10^7}\ 10^8\ \Omega$	No measurement required	No limit
3	$\rho_I \leq 1{,}0 \text{ x } \cancel{10^7}\ 10^8\ \Omega$	$\rho_O > 1{,}0 \text{ x } 10^{12}\ \Omega$	V_B < 4 kV	No limit
4	$\rho_I > 1{,}0 \text{ x } 10^{12}\ \Omega$	$\rho_O \leq 1{,}0 \text{ x } \cancel{10^7}\ 10^8\ \Omega$	V_B < 4 kV	d < 700 µm
All layers with surface resistivity less than $1{,}0 \times 10^8\ \Omega$ shall be securely bonded to earth when installed in FIBC.				

4.2.5 Type L1C

Type L1C inner liners are made from multi-layered materials with an internal layer of surface resistivity less than or equal to $1{,}0 \times 10^8\ \Omega$ (see Annex F). Type L1C inner liners may be used in Type C FIBC.

The breakdown voltage between any surface with resistivity greater than $1{,}0 \times 10^{12}\ \Omega$ and the conductive internal layer shall be less than 4 kV, measured according to 9.2 under the conditions specified in 8.2.

The total thickness of any layer(s) with surface resistivity greater than $1{,}0 \times 10^{12}\ \Omega$ on the inside (product side) of the inner liner material shall be less than 700 µm.

All layers with surface resistivity less than $1{,}0 \times 10^8\ \Omega$ shall be securely connected to the earth bonding system of the FIBC via specific connections. The connections to the earth bonding system of the FIBC shall be sufficiently strong to withstand the stresses present during filling, transport and emptying operations and maintain electrical continuity.

Even if the surface of the inner liner in contact with the inside of the FIBC has a surface resistivity less than $1{,}0 \times 10^8\ \Omega$, fortuitous contact between the inner liner and the inside of the FIBC cannot be relied upon to ensure proper earthing of the inner liner, and specific earth bonding connections are still required.

Permissible configurations and requirements for Type L1C inner liners are summarized in Table 2.

Table 2 – Permissible configurations and requirements for Type L1C inner liners (with conductive internal layers[a])

Configuration	Parameters			
	Resistivity of inside surface ρ_I	Resistivity of outside surface ρ_O	Breakdown voltage V_B	Thickness d
1	$\rho_I \leq 1{,}0 \times 10^{12}\ \Omega$	$\rho_O \leq 1{,}0 \times 10^{12}\ \Omega$	No measurement required	No limit
2	$\rho_I \leq 1{,}0 \times 10^{12}\ \Omega$	$\rho_O > 1{,}0 \times 10^{12}\ \Omega$	V_B < 4 kV[b]	No limit
3	$\rho_I > 1{,}0 \times 10^{12}\ \Omega$	$\rho_O \leq 1{,}0 \times 10^{12}\ \Omega$	V_B < 4 kV[b]	d < 700 µm
4	$\rho_I > 1{,}0 \times 10^{12}\ \Omega$	$\rho_O > 1{,}0 \times 10^{12}\ \Omega$	V_B < 4 kV[b]	d < 700 µm

[a] All layers with surface resistivity less than $1{,}0 \times 10^8\ \Omega$ shall be securely bonded to earth when installed in FIBC.

[b] Breakdown voltage is measured between the surface with resistivity > $1{,}0 \times 10^{12}\ \Omega$ and the conductive internal layer.

4.2.6 Type L2

Type L2 inner liners are made from materials with surface resistivity on at least one surface between $1{,}0 \times 10^9\ \Omega$ and $1{,}0 \times 10^{12}\ \Omega$ (see Annex F), measured under the conditions specified in 8.3. Type L2 inner liners may be used in Type B, Type C and Type D FIBC.

~~If Type L2 inner liners are used in Type C FIBC, the charging current shall not exceed 3 µA.~~

Materials with surface resistivity less than $1{,}0 \times 10^8\ \Omega$ shall not be used in any layer within Type L2 inner liners.

If Type L2 inner liners are used in Type C FIBC, fortuitous contact between the inner liner and the inside of the FIBC cannot be relied upon to ensure proper earthing of the inner liner. Therefore, the surface with resistivity between $1{,}0 \times 10^9\ \Omega$ and $1{,}0 \times 10^{12}\ \Omega$ shall be securely connected to the earth bonding system of the FIBC via specific connections. The connections to the earth bonding system of the FIBC shall be sufficiently strong to withstand the stresses present during filling, transport and emptying operations and maintain electrical continuity.

~~If the material is multi-layered, or~~ If the material has one surface with surface resistivity greater than $1{,}0 \times 10^{12}\ \Omega$, the breakdown voltage through the material shall be less than 4 kV, measured according to 9.1 under the conditions specified in 8.2.

The thickness of any layer with surface resistivity greater than $1{,}0 \times 10^{12}\ \Omega$ on the inside (product side) of the inner liner material shall be less than 700 µm.

Permissible configurations and requirements for Type L2 inner liners are summarized in Table 3.

Table 3 – Permissible configurations and requirements for Type L2 inner liners

Configuration	Parameters			
	Resistivity of inside surface ρ_I	Resistivity of outside surface ρ_O	Breakdown voltage V_B	Thickness d
1	$1{,}0 \times 10^9\ \Omega \leq \rho_I \leq 1{,}0 \times 10^{12}\ \Omega$	$1{,}0 \times 10^9\ \Omega \leq \rho_O \leq 1{,}0 \times 10^{12}\ \Omega$	No measurement required	No limit
2	$1{,}0 \times 10^9\ \Omega \leq \rho_I \leq 1{,}0 \times 10^{12}\ \Omega$	$\rho_O > 1{,}0 \times 10^{12}\ \Omega$	$V_B < 4$ kV[a]	No limit
3	$\rho_I > 1{,}0 \times 10^{12}\ \Omega$	$1{,}0 \times 10^9\ \Omega \leq \rho_O \leq 1{,}0 \times 10^{12}\ \Omega$	$V_B < 4$ kV[a]	~~$d < 700$ µm~~

[a] Breakdown voltage less than 4 kV cannot always be achieved if the thickness of the layer with resistivity greater than $1{,}0 \times 10^{12}\ \Omega$ exceeds 20 µm.

4.2.7 Type L3

Type L3 inner liners are made from materials with surface resistivity of greater than $1{,}0 \times 10^{12}\ \Omega$, measured under the conditions specified in 8.2. Type L3 inner liners may be used in Type B FIBC.

Materials with surface resistivity less than $1{,}0 \times 10^8\ \Omega$ shall not be used in any layer within Type L3 inner liners.

The breakdown voltage through the material shall be less than 4 kV, measured according to 9.1 under the conditions specified in 8.2.

Permissible configurations and requirements for Type L3 inner liners are summarized in Table 4.

Table 4 – Permissible configurations and requirements for Type L3 inner liners

Configuration	Parameters			
	Resistivity of inside surface ρ_I	Resistivity of outside surface ρ_O	Breakdown voltage V_B	Thickness d
1	$\rho_I > 1{,}0 \times 10^{12}\ \Omega$	$\rho_O > 1{,}0 \times 10^{12}\ \Omega$	$V_B < 4$ kV	No limit

4.3 Combination of FIBC and inner liners

When inner liners are used in FIBC, the inner liners and FIBC shall comply separately with their respective requirements, i.e. 4.2 for inner liners and Clause 7 for FIBC, and shall comply with all requirements specified for the combination, including the earthing requirements for Type C FIBC/Type L1/L1C/L2 inner liner combinations and ignition testing requirements for Type D FIBC/Type L2 inner liner combinations. The inclusion of an inner liner in FIBC does not change the type classification of the FIBC. For example, Type A FIBC with Type L1 inner liners are still Type A FIBC and are subject to all the restrictions on use of Type A FIBC.

The requirements for breakdown voltage for FIBC and inner liners shall be applied separately. For Type B, Type C and Type D FIBC with inner liners for which there is a breakdown voltage requirement, two sets of breakdown voltage measurement shall be required: one set on the FIBC material and one set on the inner liner material. For example, if a Type B FIBC is fitted with a Type L3 inner liner, the breakdown voltage of the FIBC material shall be measured on its own and shall be less than 6 kV, and a separate breakdown voltage measurement shall be made on the inner liner material and it shall be less than 4 kV.

5 Safe use of FIBC

The requirements and specifications that FIBC ~~must~~ shall meet and the ways in which they are used depend on the nature and sensitivity of any explosive atmosphere present during filling and emptying. The final goal for the construction of FIBC is to exclude incendiary discharges from the FIBC fabric during their intended use. FIBC constructed in compliance with the requirements specified in this document do not necessarily ensure that hazardous electrostatic discharges, for example cone discharges or spark discharges from charged conductive products, will not be generated by the contents in FIBC. Information on the risks associated with cone discharges is given in Annex E.

The igniting ability of electrostatic discharges, i.e. sparks, brush discharges and propagating brush discharges, is different for each type of discharge. The necessity of their exclusion and thus the requirements and specifications for FIBC depend on the intended use of the FIBC. The conditions in which each type of FIBC shall be used is shown in Table 5.

Table 5 – Use of different types of FIBC

Bulk product in FIBC	**Surroundings**		
MIE of dust[a]	**Non-flammable atmosphere**	**Dust zones 21-22[b] (1 000 mJ ≥ MIE > 3 mJ)[a]**	**Gas zones 1-2[b] (explosion groups IIA/IIB)[b] or dust zones 21-22[b] (MIE ≤ 3 mJ)[a]**
MIE > 1 000 mJ	A,B,C,D	B,C,D	C,D[c]
1 000 mJ ≥ MIE > 3 mJ	B,C,D	B,C,D	C,D[c]
MIE ≤ 3 mJ[d]	C,D	C,D	C,D[c]

~~NOTE~~ Additional precautions are usually necessary when a flammable gas or vapour atmosphere is present inside the FIBC, e.g. in the case of solvent wet powders.

NOTE Non-flammable atmosphere includes dusts having MIE > 1 000 mJ.

[a] Measured in accordance with ~~IEC 61241-2-3~~ ISO/IEC 80079-20-2, capacitive discharge circuit (no added inductance).

[b] See Annex D for explanation of hazardous areas, zones and explosion groups.

[c] Use of Type D shall be limited to explosion groups IIA/IIB with MIE ≥ 0,14 mJ.

[d] See Annex E for explanation of the 3 mJ limit in relation to cone discharges.

The ability to safely use FIBC in hazardous explosive atmospheres may change if an inner liner is installed in the FIBC. Combinations of FIBC and inner liner that can be used safely in hazardous explosive atmospheres are shown in Table 6. In addition to the separate requirements for FIBC and inner liners, there are requirements that certain combinations of FIBC and inner liner shall meet. These requirements are also shown in Table 6.

Table 6 – Inner liners and FIBC: combinations that are permissible and not permissible in hazardous explosive atmospheres

FIBC	Inner liner			
	Type L1	Type L1C	Type L2	Type L3
Type B	Not permissible	Not permissible	Permissible	Permissible
Type C	Permissible[a]	Permissible[b]	Permissible[c]	Not permissible
Type D	Not permissible	Not permissible	Permissible[d]	Not permissible

~~Additional~~ Precautions:

Type A FIBC shall not be used in hazardous explosive atmospheres, irrespective of the type of liner used.

Liners shall not be removed from emptied FIBC in hazardous explosive atmospheres.

[a] To ensure the inner liner is properly earthed, the resistance from at least one side of the inner liner to the groundable points on the FIBC shall be less than 1,0 x ~~10^7~~ 10^8 Ω, measured according to 9.4 under the conditions specified in 8.2.

[b] To ensure the inner liner is properly earthed, the resistance from any conductive layer of the inner liner to the groundable points on the FIBC shall be less than 1,0 x 10^8 Ω, measured according to 9.4 under the conditions specified in 8.2.

[c] To ensure the inner liner is properly earthed, the resistance from any dissipative layer of the inner liner to the groundable points on the FIBC shall be less than 1,0 x 10^{12} Ω, measured according to 9.4 under the conditions specified in 8.2.

[d] Combination of FIBC and liner shall meet the requirements of 7.3.2 tested under the conditions specified in 8.4.

Isolated conductive objects (e.g. tools, bolts, clips~~, etc.~~) ~~should~~ shall not be stored on, attached to, or even temporarily placed on any type of FIBC during filling and emptying operations. Even with Type C FIBC, the rough nature of some FIBC materials may prevent conductive objects placed on the FIBC from contacting the conductive elements in the fabric of the FIBC, in which case the conductive object will remain isolated from earth.

In accordance with general safety guidance (see IEC TS 60079-32-1 [1]), all conductive objects, including personnel, Type C FIBC and any conductive contents of FIBC, within a hazardous explosive atmosphere, shall be properly earthed. Type D FIBC are not considered to be conductive objects and are not required to be earthed.

Precautions should be taken to prevent the contamination of any FIBC with substances (e.g. water, rust, oil, grease~~, etc.~~) that might create an ignition hazard or impair charge dissipation.

6 Labelling

FIBC for which claims of compliance with this document are made, shall be durably marked by means of a permanently attached label, or other means, with at least the following information:

a) the number of this document, i.e. IEC 61340-4-4;

b) the type of FIBC, i.e. Type B, Type C or Type D (the type designation shall be emphasized so that it is easily readable at a glance);

~~NOTE Type A FIBC are not required to be labelled.~~

c) the symbol ISO 7000-2415:2004-01 on Type B, Type C and Type D to indicate protection from static electricity;

d) for Type B, the phrase "permitted in dust zones 21-22 with MIE $>$ 3 mJ";

e) for Type C, the phrase "permitted in dust zones 21-22 and gas zones 1-2 (explosion groups IIA/IIB)";

f) for Type D the phrase "permitted in dust zones 21-22 and gas zones 1-2 (explosion groups IIA/IIB with MIE $\geq$ 0,14 mJ) and where charging currents $\leq$ 3 μA";

g) for Type C the phrase "FIBC shall be properly earthed according to manufacturer's instructions";

h) for Type D, the phrase "FIBC does not require earthing";

i) for Type B, Type C and Type D the phrase "electrical properties may be affected by general usage, contamination and reconditioning";

j) for Type B, Type C and Type D the phrase "all conductive objects ~~within 1 m distance~~, including personnel shall be ~~connected to~~ earthed during FIBC filling and emptying operations (see IEC TS 60079-32-1 for guidance on earthing)";

k) certifying authority and certificate number (only for FIBC certified by independent certifying authorities).

Type A FIBC are not required to be labelled.

Yellow is preferred for the background colour for labels or marking, but other colours may be used. Conductive black material may be used for labels for Type C FIBC, but shall not be used for labels for Type B or Type D FIBC.

The designated earth bonding points on Type C FIBC shall be labelled or marked with the earth symbol (IEC 60417-5019:2006-08), as shown for example in Figure 5. The background colour for labels or marking shall be yellow and the lettering shall be black, or the background colour shall be black and the lettering shall be yellow. The label or marking may be incorporated into another label or marking as may be required for other purposes.

Examples of suitable labels for each type of FIBC are shown in Figures 2 to 4.

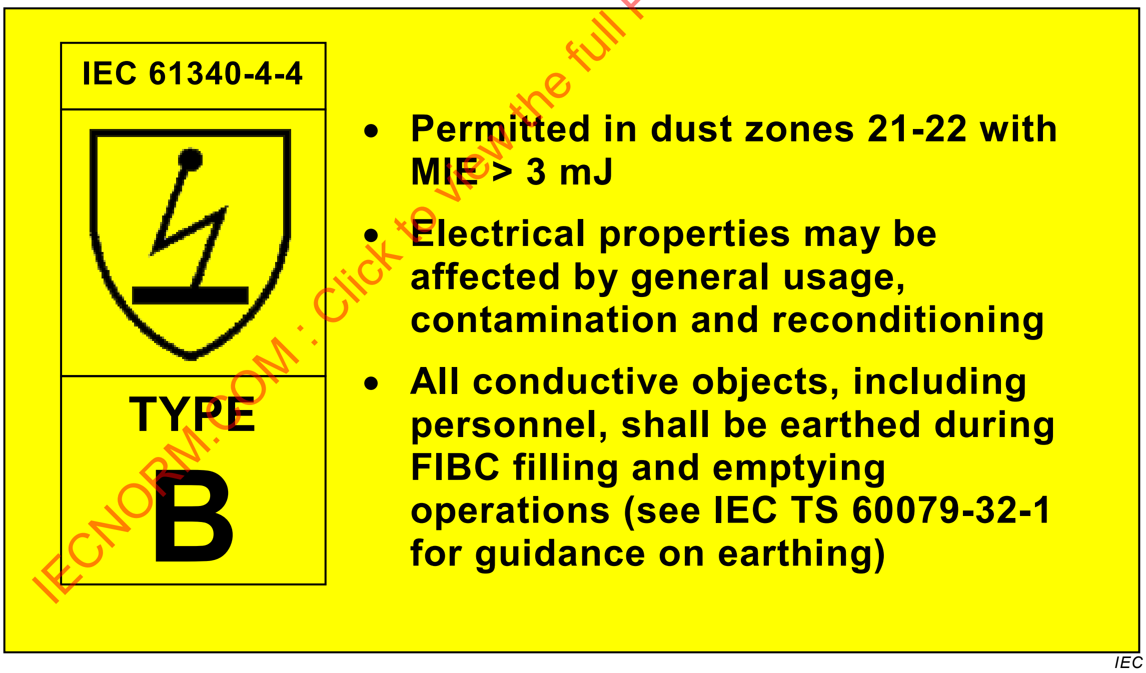


Figure 2 – Example of a label for Type B FIBC

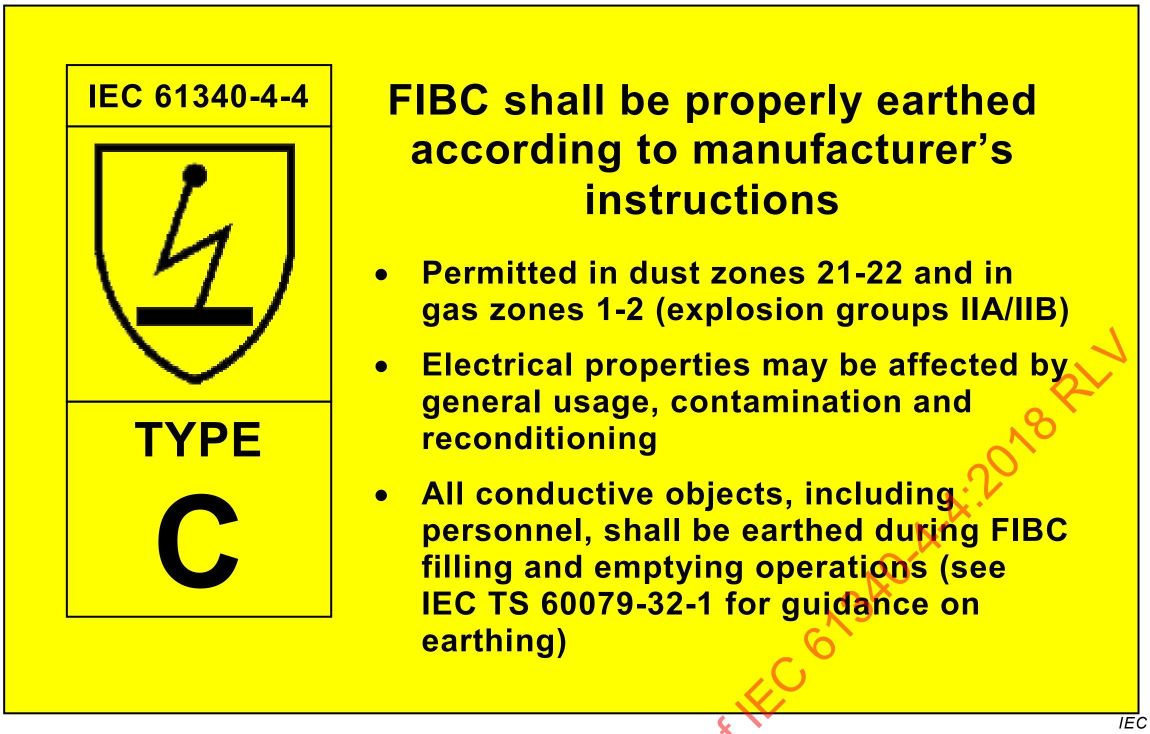


Figure 3 – Example of a label for Type C FIBC

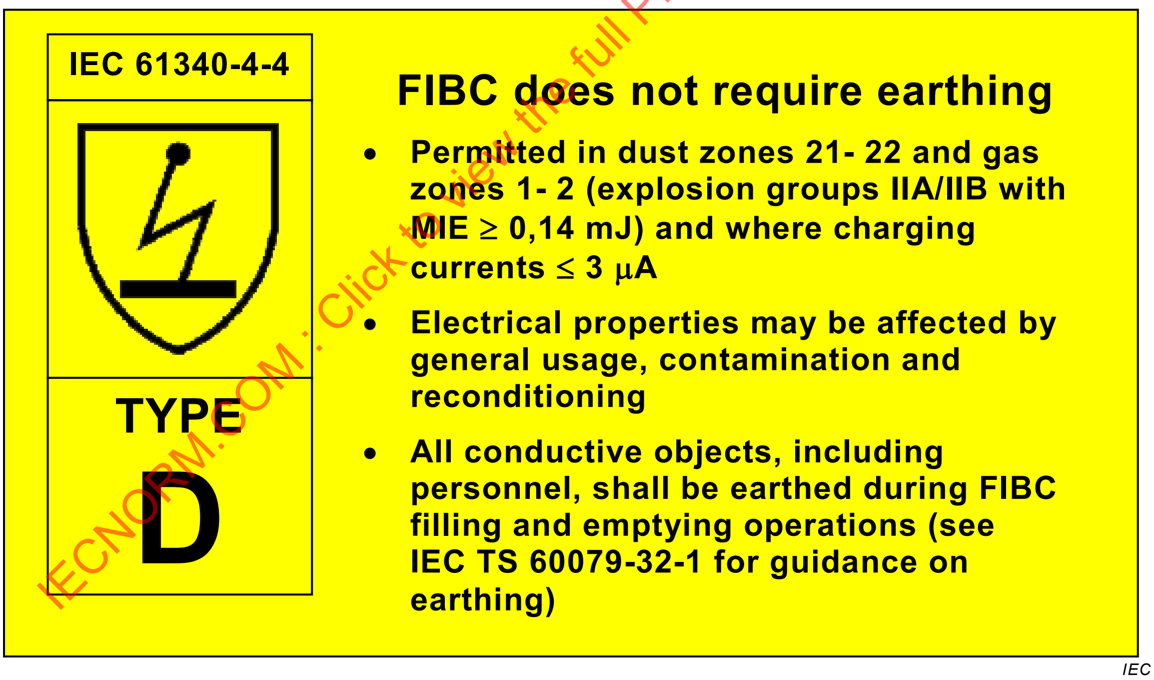
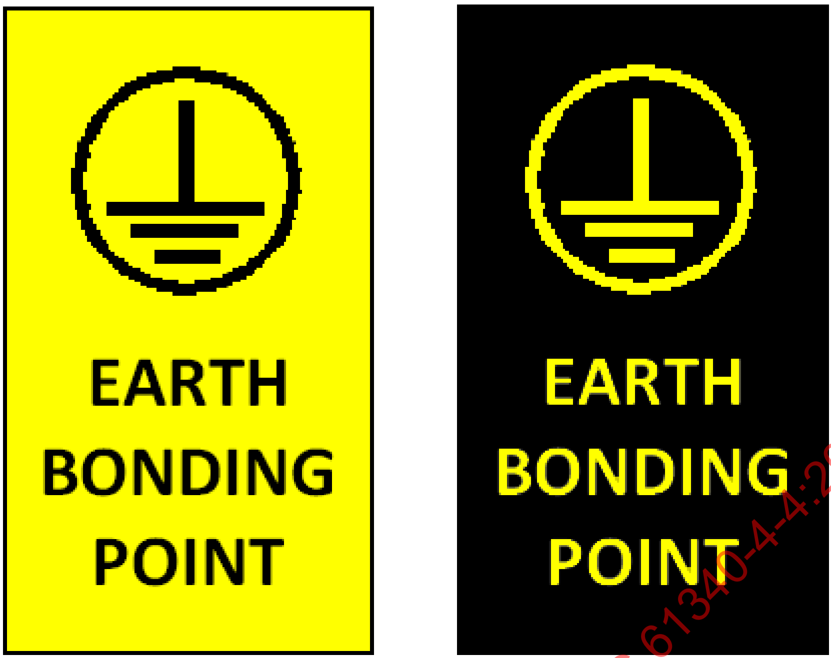


Figure 4 – Example of a label for Type D FIBC



IEC

Figure 5 – Example of labels for Type C FIBC designated earth bonding points

FIBC shall not be labelled or marked in any way that conflicts with the requirements of this document, or in any way that could cause confusion as to its classification or use restrictions (e.g. "Type CD" is not permitted). No additional lettering or symbols shall be appended to the type designation (e.g. "Type D+" is not permitted).

It is the responsibility of FIBC manufacturers to ensure the sample(s) tested are representative of the production FIBC to which labels shall be attached.

Type B FIBC labels shall not be made from material with surface resistivity less than 1,0 x 10^9 Ω, measured according to IEC 61340-2-3 under the conditions specified in 8.3 b).

~~Type C FIBC labels greater than 100 cm^2 in area, or greater than or equal to 700 μm in thickness shall not be made from material with surface resistivity greater than 1,0 × 10^{12} Ω, measured according to IEC 61340-2-3 under the conditions specified in 8.2.~~ Type C FIBC labels made from materials with surface resistivity less than 1,0 x ~~10^7~~ 10^8 Ω, measured according to IEC 61340-2-3 under the conditions specified in 8.2, can be used, provided the resistance to groundable point measured according to 9.4 is less than the limit specified in 7.3.1.

Type C FIBC labels made from materials with surface resistivity between 1,0 x 10^9 Ω and 1,0 x 10^{12} Ω, measured according to IEC 61340-2-3 under the conditions specified in 8.3, can be used.

Type C FIBC labels with surface resistivity greater than 1,0 x 10^{12} Ω, measured according to IEC 61340-2-3 under the conditions specified in 8.2, shall not be greater than 100 cm^2 in area, or greater than or equal to 700 μm in thickness.

Type D FIBC labels greater than 100 cm^2 shall be subjected to ignition testing according to 9.2 and shall meet the requirements specified in 7.3.2.

Printing ink can modify the surface electrical properties of labels. Therefore, measurements made to verify compliance with the requirements of Clause 6 shall be made on printed labels.

Printed and unprinted surfaces of labels shall comply with the surface resistivity requirements of Clause 6.

7 Requirements for FIBC

7.1 General remarks

An FIBC intended for use in the presence of a flammable material or in a hazardous explosive atmosphere shall not itself produce incendiary discharges. The absence of incendiary discharges shall be verified for at least the smallest and largest sizes of FIBC of a particular design by meeting one of the requirements listed in 7.2 and 7.3 when tested as manufactured, prior to usage.

For FIBC manufactured from multiple layers of materials that are not permanently and intimately bonded together over the entire surface area, the material requirements listed in 7.2 and 7.3 shall be applied separately to each layer of material.

Quality control test methods described in Annex C shall not be used as a substitute for type qualification test methods specified in Clause 9.

Where it is intended that FIBC be used for multiple fill/clean/empty cycles, it is recommended that tests be conducted according to Clause 9 to verify that FIBC comply with the requirements of Clause 7 after the required number of use cycles.

NOTE It is possible that compliance with the requirements of this document ~~may~~ does not extend to FIBC that have been contaminated or degraded through use, or are used contrary to manufacturers' recommendations.

Type qualification certificates based on this document shall be supported by a test report including the information specified in Clause 10. Unless otherwise specified or agreed by interested parties, a type qualification certificate for an FIBC design shall be valid for a period of three years from the date of issue.

7.2 Requirements for dust environments with ignition energies greater than 3 mJ (apply to Type B FIBC, Type C FIBC and Type D FIBC)

To ensure propagating brush discharges cannot occur across the walls of an FIBC intended for use in the presence of combustible dusts but in the absence of flammable vapours or gases, it shall be constructed from materials having an electrical breakdown voltage of less than or equal to 6 kV when tested according to 9.2. The materials used to construct inner baffles, other than mesh or net baffles, shall also meet these requirements.

Although conductive materials can be used to achieve an electrical breakdown voltage of less than 6 kV, such materials shall not be used in the manufacture of Type B FIBC because there is a risk of incendiary sparks if such materials are not connected to earth.

7.3 Requirements for vapour and gas atmospheres and for dust environments with ignition energies of 3 mJ or less

7.3.1 Type C FIBC

A Type C FIBC intended for use in the presence of flammable vapours or gases, or combustible dusts with ignition energies of 3 mJ or less (see Annex E) shall have a resistance to groundable point of less than $1,0 \times \cancel{10^{7}}\ 10^{8}\ \Omega$ (see Annex F) when tested according to 9.4. Additionally, the FIBC shall be constructed entirely from conductive material or at least shall contain fully inter-connected conductive threads or tapes with a maximum spacing of 20 mm if the threads or tapes are in a stripe pattern, or 50 mm if they are in a grid pattern.

For FIBC constructed of multi-layer materials, the inside or outside surface of the FIBC shall have a resistance to groundable point of less than $1,0 \times \cancel{10^{7}}\ 10^{8}\ \Omega$ when tested according to

9.4. If the inside layer does not have a resistance to groundable point of less than 1,0 x ~~10^7~~ 10^8 Ω, then the material shall also meet the requirements specified in 7.2. All layers of multi-layer materials shall remain in firm contact during filling and emptying operations.

The materials used to construct inner baffles, other than mesh or net baffles, shall also meet these requirements and shall be included in the tests conducted according to 9.3.

One or more groundable points shall be permanently attached to Type C FIBC. Earth bonding cables shall be attached to the groundable points during all filling and emptying operations.

Any lift loops attached to Type C FIBC shall be made from conductive material or shall at least contain conductive threads or tapes with a maximum spacing of 20 mm.

Lift loops may be designated as groundable points, but fortuitous earthing via lifting hooks cannot be relied upon as these may be painted/coated, or covered with powder etc., and so cannot guarantee an adequate earth path. Therefore, earth bonding cables shall be attached to lift loops if they are designated as groundable points.

7.3.2 Type D FIBC

A Type D FIBC intended for use in the presence of flammable vapours or gases, or combustible dusts with ignition energies of 3 mJ or less (see Annex E) shall not cause any ignition when tested according to 9.3.

Additionally, for Type D FIBC made from material that has an insulating layer (e.g. coating film or lamination) on the inside of the container, the material shall meet the requirements specified in 7.2. All layers of multi-layer materials shall remain in firm contact during filling and emptying operations.

For the purposes of type qualification testing where a range of outlet sizes are available for a particular design, ignition testing according to 9.3 shall be carried out on test FIBC with an outlet size that is the smaller of a) 400 mm, or b) the maximum outlet size for the design under test.

The materials used to construct inner baffles, other than mesh or net baffles, shall be the same as the materials used to construct the major panels of the FIBC.

When inner liners are used with Type D FIBC, the combination of FIBC and inner liner shall not cause any ignition when tested according to 9.3.

8 Atmosphere for conditioning, calibrating and testing

8.1 Conditioning time

Conditioning time shall be at least 12 h prior to testing and test samples shall be free hanging to allow sufficient air circulation. When tests are to be conducted in accordance with 9.3, pellets shall be circulated at intervals during this period to ensure adequate conditioning.

8.2 Electrical breakdown voltage, surface resistivity and resistance to groundable point testing

Test samples and apparatus shall be conditioned, calibrated and tested under conditions of (23 ± 2) °C and (20 ± 5) % relative humidity.

8.3 Surface resistivity testing

Test samples and apparatus shall be conditioned, calibrated and tested under conditions of

a) (23 ± 2) °C and (20 ± 5) % relative humidity;

b) (23 ± 2) °C and (60 ± 5) % relative humidity.

8.4 Ignition testing

Test samples and apparatus shall be conditioned, calibrated and tested under conditions of

a) (23 ± 2) °C and (20 ± 5) % relative humidity;

b) (23 ± 2) °C and (60 ± 10) % relative humidity.

9 Test procedures

9.1 Sampling

For qualification purposes, test samples shall be representative of production FIBC and FIBC/inner liner combinations as supplied. The following elements, and any others not listed here, shall be identical between test samples and supplied products:

- labels;
- document pockets, placards;
- inner liners (type, shape and size);
- inner liner attachment;
- design of FIBC (type, shape, size, attachments).

9.2 Electrical breakdown voltage

Breakdown voltage shall be determined in accordance with IEC 60243-1 and IEC 60243-2. The method used is specified in 10.1 of IEC 60243-1:~~1998~~ 2013, the short-time (rapid-rise) test. The test shall be conducted with unequal electrodes under the application of direct voltage at a rate of rise of 300 V/s. The maximum output current of the DC power supply shall be 1 mA.

For multi-layer materials, all layers shall be tested together and the test specimens shall be positioned so that the high-voltage electrode is in contact with the surface of the material that is normally on the inside of the FIBC.

An example of a voltage/time graph for materials showing distinct breakdown is shown in Figure A.1. For certain materials used in the construction of FIBC, there ~~may~~ can be some conductivity which will prevent a sudden breakdown occurring. Typically, such materials will cause a reduction in the rate of voltage rise as charge leaks through the material. An example is shown in Figure A.2. Materials of this nature will not give rise to propagating brush discharges and shall be deemed to meet the requirements of 7.2.

If the output current of the DC power supply reaches 1 mA before the electrode voltage reaches 6 kV, the material under test shall be deemed to meet the requirements of 7.2.

9.3 Ignition testing

9.3.1 Apparatus

9.3.1.1 General

Apparatus other than that specified below may be used, provided that it satisfies the same functional requirements and is shown to give the same results.

9.3.1.2 Ignition probe

The ignition probe is a cylinder made from rigid non-conductive material, such as polycarbonate or acrylic, with an internal diameter of (70 ± 5) mm and an internal length of (100 ± 5) mm (see Figure 6). The material used for constructing the probe shall be of sufficient thickness and strength to withstand repeated ignition without cracking, distorting or otherwise failing.

One end of the cylinder is closed apart from a central port to allow the inflow of the flammable gas. The size of the inlet port is not critical but shall be large enough to allow the required flow rate to be achieved without excessive pressure build-up. A suitable flame arrestor shall be installed in the gas supply line as close as possible to the ignition probe.

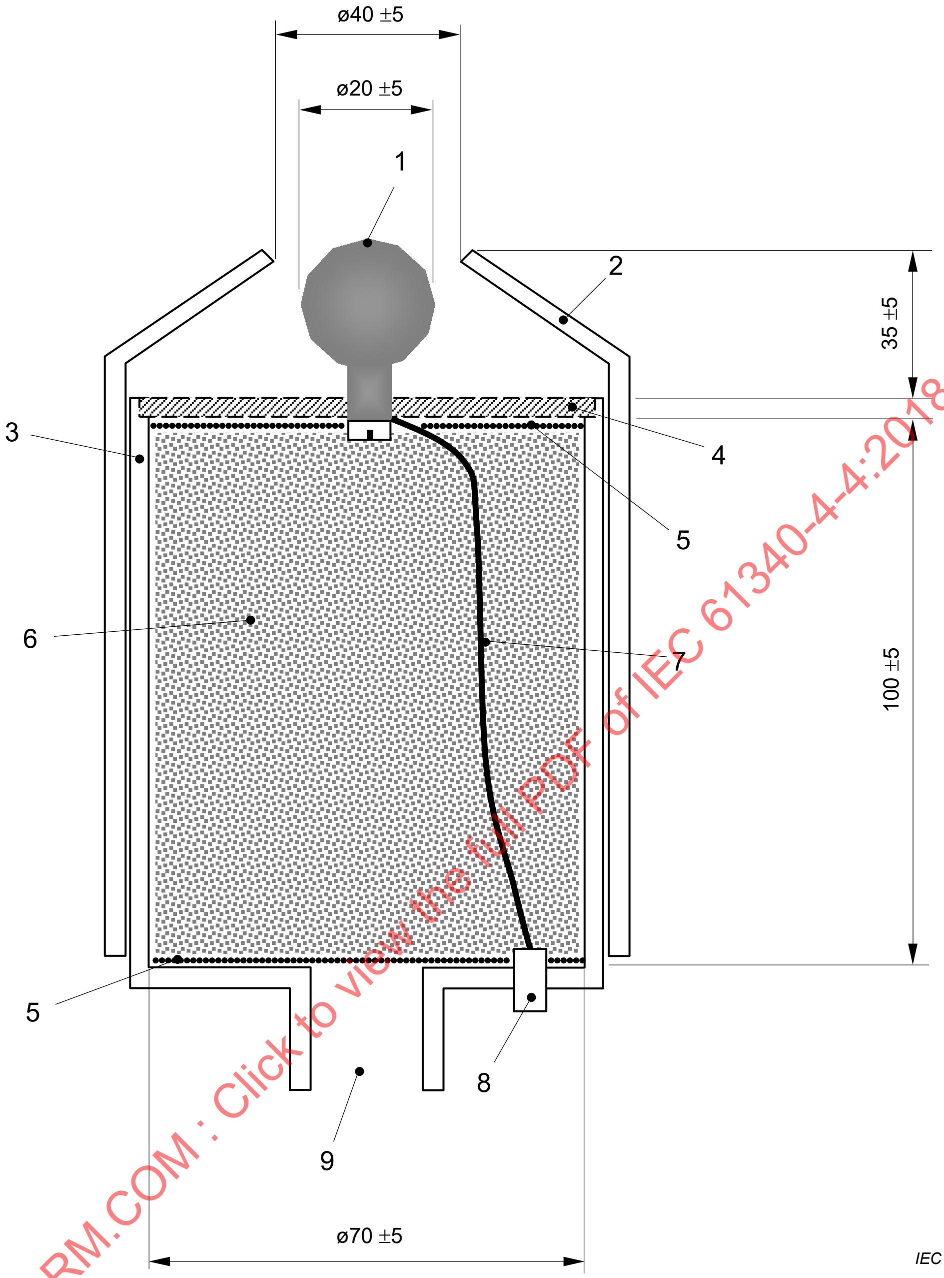
A metal plate is fitted to the other end of the cylinder to form a fixing base for the discharge electrode (see Figure 7). The metal plate is drilled with holes, (5 ± 1) mm in diameter, to allow the uniform flow of gas through it and around the discharge electrode.

A spherical metal electrode of diameter (20 ± 5) mm is mounted centrally to the metal plate. The electrode, metal plate and any other metal or conductive material in the ignition probe are connected to a common point earth via a low impedance (< 10 Ω) connection. The earth point shall be the common point earth for local structures and equipment to the FIBC such as conductive parts of the FIBC test rig. The common earth point may be connected to the electricity supply earth. The connection between the electrode, the metal plate and the earth connector shall be sufficiently robust to withstand physical and thermal impacts. The electrical continuity between the discharge electrode and the earth connector shall be checked prior to use.

The ignition probe is filled with glass or porcelain beads, nominally 1 mm to 2 mm in diameter, which are retained by a fine metal gauze or mesh at either end of the main cylinder. The beads assist in the mixing of the gases and also contribute to preventing propagation of any flame back through the probe.

An adjustable shroud made from insulating material is fitted to the cylinder to direct gas over the discharge electrode and into the region in front of the discharge electrode where electrostatic discharges take place. The opening in this shroud is (40 ± 5) mm.

Dimensions in millimetres

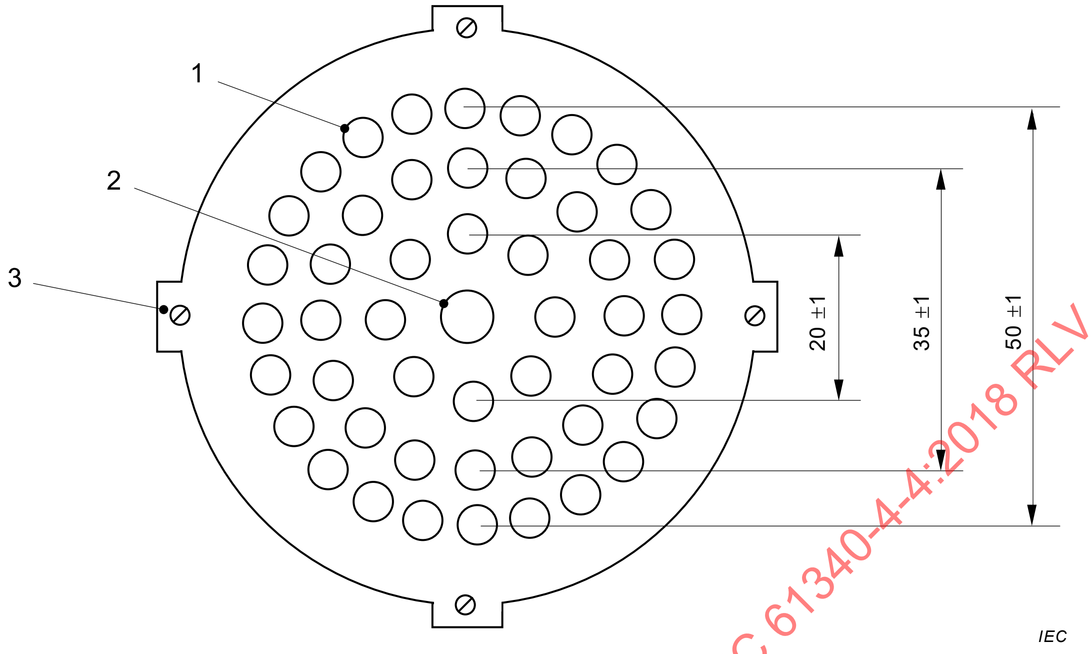


Key

1 discharge electrode
2 adjustable shroud made from insulating material (e.g. polycarbonate or acrylic)
3 cylinder made from insulating material (e.g. polycarbonate or acrylic)
4 perforated metal plate (2 mm nominal thickness)
5 fine metal mesh or gauze (e.g. copper)
6 beads (e.g. glass or porcelain), 1 mm to 2 mm diameter (nominal)
7 robust earth connection
8 earth connector
9 inlet port for flammable gas

Figure 6 – Ignition probe

Dimensions in millimetres



Key

1 perforation (5 ± 1) mm diameter

2 mounting hole for discharge electrode

3 screw for securing plate to body of ignition probe

Figure 7 – Perforated metal plate for use in ignition probe

9.3.1.3 Gas control and mixing apparatus

The flammable gas is generated by mixing ethylene (minimum 99,5 % purity) with air. The air used shall contain (21,0 ± 0,5) % oxygen and (79,0 ± 0,5) % nitrogen. The gas control and mixing apparatus is used to direct the gas in the appropriate proportions to the ignition probe (see Figure 8).

The volume concentrations of gas used are shown in Table 7.

Table 7 – Volume concentrations of flammable gas mixture

Gas	Composition	Volume concentration %	Minimum ignition energy mJ	Critical quenching distance mm
Ethylene	≥ 99,5 % C_2H_4	5,4 ± 0,1	0,14 ± 0,01	1,8 ± 0,1
Air	(21,0 ± 0,5) % O_2 (79,0 ± 0,5) % N_2	94,6 ± 0,1		

The control of the gas mixture within the specified tolerances shall be checked using, for example, an infra-red ethylene gas analyser sampling the gas mixture supply line.

If a gas mixture other than that specified in Table 7 is used, the minimum ignition energy of the gas mixture shall be verified using the ASTM E582 method to be (0,14 ± 0,01) mJ.

NOTE 1 If a gas other than ethylene is used, the critical quenching distance ~~may~~ can be different to that specified in Table 7.

It is convenient to use compressed gas cylinders for the gas supply, but other sources of supply may be used. A pre-mixed cylinder of (21,0 ± 0,5) % oxygen and (79,0 ± 0,5) %

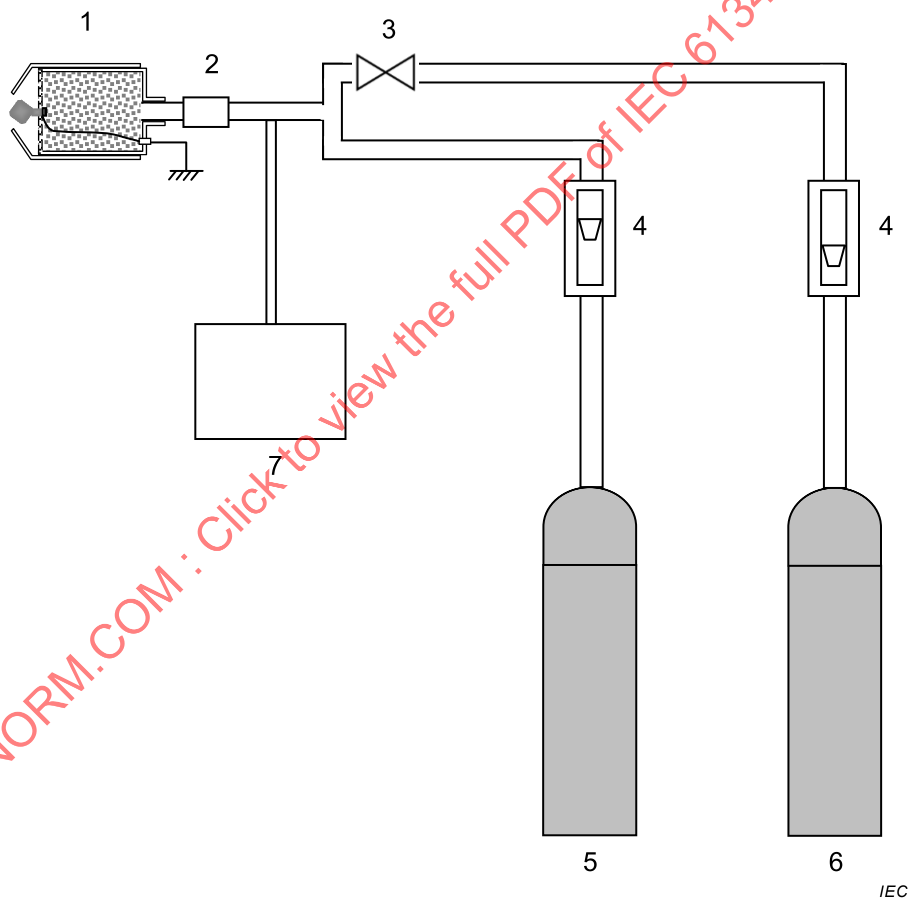
nitrogen may be used in place of air. If necessary, molecular sieve filters shall be used to ensure the gases have low moisture content. This is particularly important, for example, when using air directly from a compressor. Gases of at least 99,5 % purity shall be used.

"Breathing air", i.e. compressed air with low moisture and oil content, has a wider tolerance of oxygen concentration than is specified in Table 7 and ~~should~~ shall not be used unless analysis shows that it meets the composition limits in Table 7.

NOTE 2 Some molecular sieves ~~may~~ can absorb ethylene, so it is important to position the sieve filter before the gas reaches monitoring equipment.

Each gas supply is controlled and monitored using flowmeters and valves. The combined flow-rate of all gases through the ignition probe shall be (0,21 ± 0,04) l/s.

A fast action shut-off valve is used to stop the flow of ethylene when ignition occurs. The shut-off valve shall stop the supply of ethylene whilst leaving the air to flow freely to provide cooling and drying of the ignition probe after ignition has occurred. The type and location of the shut-off valve shall be selected as appropriate to the specific design of the overall apparatus.



Key

1 ignition probe

2 flame arrestor

3 ethylene shut-off valve

4 flowmeters

5 air or oxygen/nitrogen mixture

6 ethylene

7 ethylene analyser

Figure 8 – Gas control and mixing apparatus (schematic)

9.3.1.4 Re-circulating FIBC filling rig

A rigid steel framework, or other suitable support, is used to hold test FIBC so that they can be filled with charged product (see Figure 9). To minimize the influence of the steel framework on the electrostatic fields associated with the charged FIBC, any support framework around the sides of the FIBC shall be at least 1 m away from it.

Test FIBC are filled with polypropylene pellets (see Annex B) with a volume resistivity of at least 1,0 x 10^{12} Ωm. The pellets shall be homopolymer without fillers, pigments, antistatic additives, etc. Other materials may be used only after it has been determined that they produce equivalent results and do not generate cone discharges.

NOTE One way of checking the equivalence of different pellet materials is to carry out the procedures specified in 9.3.2 to establish that the voltage applied to the corona charging unit generates the same charging current.

One means of circulating pellets is to position a hopper immediately below the test FIBC to collect the pellets and feed them to a conveyor where they are transported to the filling chute and loaded back into the test FIBC. Other means of circulating pellets may be equally suitable. The filling rate shall be (1,1 ± 0,1) kg of product per second.

The polypropylene pellets will naturally become charged by triboelectric action, but additional charge shall be injected by the incorporation of high-voltage corona points inside the filling pipe (see Figure 10). The size, number and geometry of corona points may vary, but shall be designed to ensure efficient charging of the pellets, which shall be verfied using the procedure specified in 9.3.2. An insulating shroud surrounding the corona-charging unit prevents direct contact with the FIBC. A high-voltage DC power supply is used to control the corona-charging unit, which shall maintain the average charging current at (3,0 ± 0,2) µA with the instantaneous maximum not exceeding 4,0 µA and the instantaneous minimum not less than 2,0 µA. The polarity of charge shall be negative. The corona charging unit shall not introduce charge into the FIBC under test when no pellets are flowing.

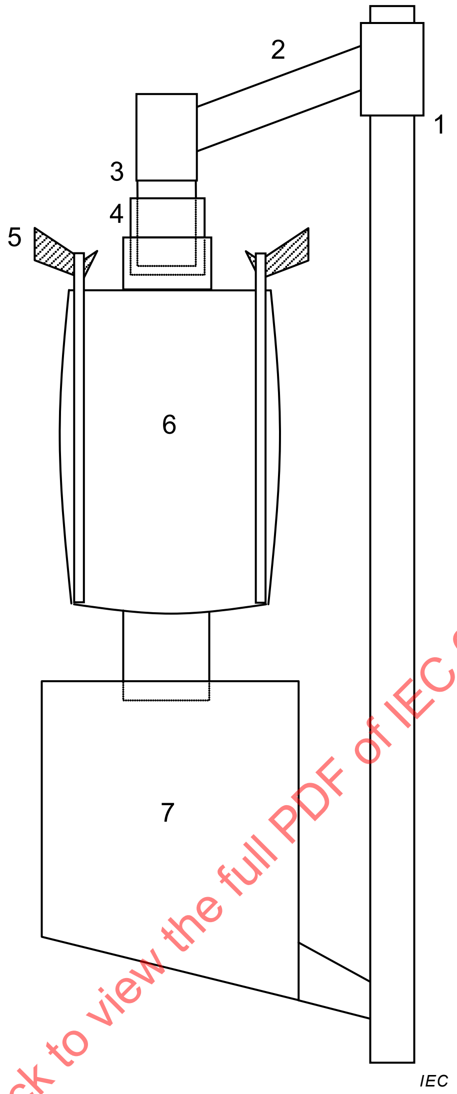
~~NOTE~~ It is recommended that pellets be changed regularly. It is not possible to specify intervals for changing pellets, but as a guide they should be changed whenever there are obvious signs of contamination, physical degradation, when the level of tribocharging is significantly reduced, or when there is an obvious build-up of fines.

All sections of the test FIBC, including the discharging spout, shall be accessible for approach with the ignition probe.

Depending on the design of the filling rig and its location, it may be necessary to provide a working platform to support the test apparatus and personnel.

For FIBC that are not required to be earthed during normal use, insulation shall be inserted between the lifting loops and the support points on the metal framework, such that the resistance to earth shall be at least 1,0 x 10^{12} Ω.

All metal support framework, working platforms and any other conductors, including personnel, within 1 m of the test FIBC, shall be earthed, irrespective of the type of FIBC being tested.



Key

1 means of conveying pellets

2 transfer pipe

3 corona charging unit

4 insulating shroud

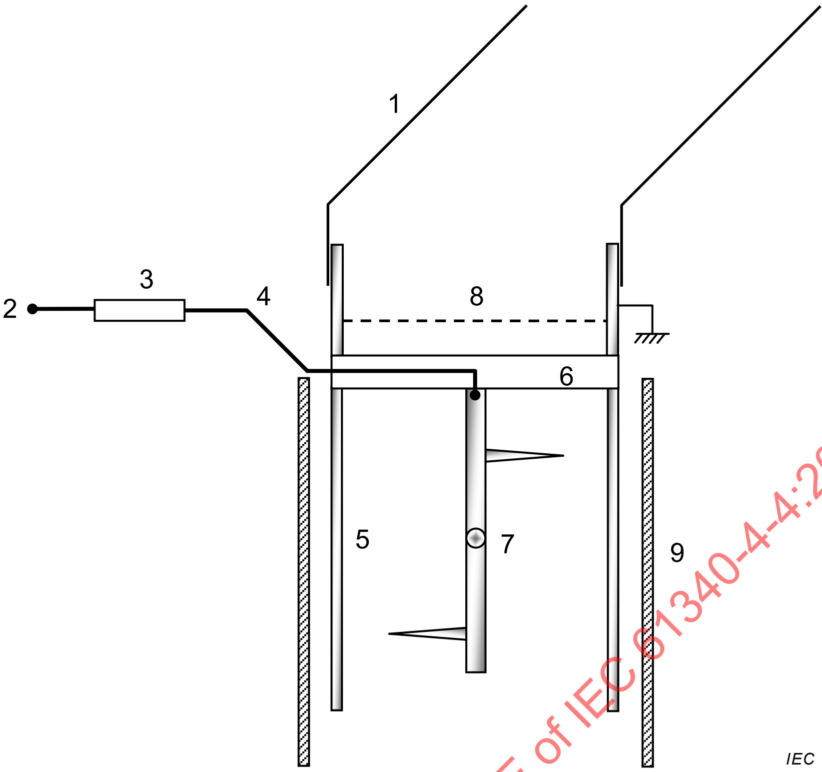
5 means of supporting FIBC

6 FIBC

7 collecting hopper

NOTE This figure shows an example of a rig for FIBC with four lifting loops; other designs ~~may~~ can be required when testing, for example, single-point liftable FIBC.

Figure 9 – FIBC filling rig (schematic)



Key

1 transfer pipe

2 input from high-voltage DC power supply (negative polarity)

3 decoupling resistor ~ 10^7 Ω

4 insulated high-voltage connecting lead

5 earthed metal cylinder

6 insulating rod (e.g. PTFE)

7 metal rod carrying an array of pointed corona electrodes

8 earthed metal mesh to prevent damage to the corona array from large objects (mesh size > pellet size)

9 insulating shroud to prevent FIBC contacting corona charging unit

Figure 10 – Corona charging unit (schematic)

9.3.1.5 Charge measuring apparatus

The charge measuring apparatus comprises two main parts: a Faraday pail for collecting charged pellets and a means of measuring the charge flowing into the Faraday pail. It is convenient to use a conductive FIBC as a Faraday pail. The FIBC shall be constructed entirely from conductive material or at least shall contain fully inter-connected conductive threads or tapes with a maximum spacing of 20 mm, if the threads or tapes are in a stripe pattern, or 50 mm if they are in a grid pattern. The resistance to groundable point of the FIBC shall be less than 1,0 x ~~10^7~~ 10^8 Ω when measured according to 9.4.

An electrometer is used to measure the charge flowing into the conductive FIBC. The electrometer shall either have an average, minimum and maximum function or shall have a suitable signal output from which the average, minimum and maximum charging current can be determined by means of a suitable instrument (e.g. digital multimeter, oscilloscope, data logger~~, etc.~~).

9.3.2 Establishing correct charging current

Mount the conductive FIBC (9.3.1.5) in the filling rig (9.3.1.4) ensuring that the resistance from the conductive FIBC to the filling rig, or from the conductive FIBC to any other earth connection, is at least 1,0 x 10^{12} Ω.

Connect the electrometer (9.3.1.5) to the groundable point on the conductive FIBC and connect the electrometer to ground. If a separate averaging instrument (9.3.1.5) is to be used, connect it to the electrometer.

Begin pellet flow of (1,1 ± 0,1) kg/s into the FIBC and apply desired voltage to the corona charging unit.

Once the bottom of the FIBC is filled with pellets and a consistent cone of pellets has been formed, proceed with performing average measurements.

Using the average function on the electrometer or the separate averaging instrument, perform 1 min data samples three times and record the average charging current for each 1 min period. Average the three 1 min averages and record the average charging current with the voltage applied to the corona charging unit.

Repeat the procedure until the voltage level applied to the corona charging unit to produce (3,0 ± 0,2) µA is determined. For subsequent testing, this voltage level shall be applied to the corona charging unit.

9.3.3 Ignition tests

9.3.3.1 General

Ignition tests are carried out by bringing the ignition probe (9.3.1.2) up to the wall of the charged test FIBC with the flammable gas mixture flowing through the probe. The following test sequence is designed to produce at least 200 ignition tests on the test FIBC. The test sequence may be terminated at any time after a single verifiable ignition has occurred, the test FIBC having failed to meet the requirements specified in 7.3.2.

It may be necessary to fill and empty the test FIBC several times in order to complete the required number of ignition attempts. For FIBC without an outlet, a suitable size cut shall be made in the base. In this case, it may be necessary to use several FIBC of the same design and size in order to complete the full test sequence.

The whole sequence of ignition attempts shall be made at locations distributed evenly on each of the four walls of the test FIBC (50 ignition attempts on each wall). For FIBC that do not have four clearly defined sides, 200 ignition attempts shall be made at locations distributed evenly over the area of the FIBC. Additional ignition attempts (10 on each panel) shall be made on any panel attached to the test FIBC (e.g. flaps covering spouts), on any panel that differs substantially in its construction compared to the rest of the test FIBC and on any label or document pouch greater than 100 cm^2 in area. Labels and document pouches less than 100 cm^2 and lifting straps do not need to be tested.

By arrangement between interested parties, ignition attempts may be made at other locations in addition to those specified in this document. In such cases, the position of additional measurement points shall be described in the test report. Any verifiable ignition (see 9.3.3.4) that occurs during such testing shall result in the FIBC under test failing to meet the requirements of 7.3.2.

9.3.3.2 Procedure

With the discharging spout of the FIBC closed, start the flow of pellets at (1,1 ± 0,1) kg/s and apply the voltage determined in 9.3.2 to the corona charging unit. Allow the pellets to fill the base of the FIBC. When the fill level has started to move up the walls of the FIBC, start the gas mixture flowing through the ignition probe and allow it to flow for at least 30 s before any ignition attempt is made.

An ignition attempt is made by bringing the ignition probe up to one wall of the FIBC at a point at least 100 mm below the fill level. The speed of approach of the probe shall be (0,75 ± 0,25) m/s. Too slow an approach may cause corona to reduce local charge levels. Too fast an approach may cause quenching of the nascent flame kernel.

~~NOTE~~ The occurrence of cone discharges is avoided during this test procedure by bringing the ignition probe up to the FIBC at least 100 mm below the fill level.

9.3.3.3 No probe ignition

If no ignition occurs, remove the ignition probe and wait 10 s to 15 s before approaching the probe toward the next measurement point and continue with the ignition testing procedure.

Make as many attempts as possible at different points on the wall of the FIBC, including edge seams, until the FIBC is three-quarters full.

Visual checks shall be made after every 10 attempts to ensure the voltage supplied to the corona charging unit is as determined in 9.3.2, and the gas flow rates and ethylene concentration are as specified in 9.3.1.3. If necessary, adjust the test apparatus so that all parameters are within the specified ranges before continuing ignition testing and discount the previous 10 attempts.

When the FIBC is three-quarters full, stop the inflow of pellets and the corona charging. If the FIBC has an outlet, open the outlet and, as pellets flow out of the FIBC, make as many ignition attempts as possible alternating between the wall and, if fitted, the discharging spout. The time between each successive ignition attempt while the FIBC is emptying shall not be greater than 2 s. If the FIBC is a full open base design, it may only be possible to make one ignition attempt, which shall be made just before the FIBC completely empties.

If the FIBC is fitted with an inner liner and the discharge spout of the inner liner protrudes outside the discharge spout of the FIBC while emptying, additional ignition attempts shall be directed at the discharge spout of the inner liner.

If the FIBC is not fitted with an outlet and is designed to be emptied by vacuum or by tipping, it is not necessary to carry out ignition testing whilst emptying the FIBC.

If the FIBC is not fitted with an outlet and is designed to be emptied by cutting the base or by dropping the FIBC on to a spike, then a cut shall be made in the base that is similar in size to that made in practice, and as many ignition attempts as possible shall be made while the FIBC is emptying.

If, having completed at least 200 verified ignition attempts, no ignition has occurred, the test FIBC has met the requirements specified in 7.3.2.

9.3.3.4 Probe ignition

If ignition occurs, remove the ignition probe and make sure the flame is fully extinguished by shutting off the supply of flammable gas. Immediately verify that the concentration of ethylene, the air flow rate and the charging current are within the specified ranges. If all parameters are within tolerance, the ignition is recorded, the test FIBC fails to meet the requirements specified in 7.3.2 and the ignition testing may be stopped.

If the ethylene concentration, air flow rate or charging current are not within tolerance, the ignition is discounted, as well as all attempts since the last time the test parameters were verified. Adjust the test apparatus as necessary so that all parameters are within the specified ranges and recommence ignition testing.

If verified ignition occurs, and the option of further testing is chosen for additional information needs, allow air (or oxygen/nitrogen) only to flow for at least 60 s to cool and dry the ignition probe, re-start the flammable gas flow and wait at least 30 s before approaching the probe toward the next measurement point and continue with the ignition testing procedure.

Visual checks shall be made after every 10 attempts to ensure the voltage supplied to the corona charging unit is as determined in 9.3.2, and the gas flow rates and ethylene concentration are as specified in 9.3.1.3. If necessary, adjust the test apparatus so that all parameters are within the specified ranges before continuing ignition testing and discount the previous 10 attempts.

When the FIBC is three-quarters full, stop the inflow of pellets and the corona charging. If the FIBC has an outlet, open the outlet and, as pellets flow out of the FIBC, make as many ignition attempts as possible alternating between the wall and, if fitted, the discharging spout. The time between each successive ignition attempt while the FIBC is emptying shall not be greater than 2 s. If the FIBC is a full open base design, it may only be possible to make one ignition attempt, which shall be made just before the FIBC completely empties.

If the FIBC is fitted with an inner liner and the discharge spout of the inner liner protrudes outside the discharge spout of the FIBC while emptying, additional ignition attempts shall be directed at the discharge spout of the inner liner.

If the FIBC is not fitted with an outlet and is designed to be emptied by vacuum or by tipping, it is not necessary to carry out ignition testing whilst emptying the FIBC.

If the FIBC is not fitted with an outlet and is designed to be emptied by cutting the base or by dropping the FIBC on to a spike, then a cut shall be made in the base that is similar in size to that made in practice, and as many ignition attempts as possible shall be made while the FIBC is emptying.

9.3.3.5 Recording results

Record the total number of acceptable ignition attempts and the number that result in verifiable ignition of the flammable gas mixture.

The test FIBC shall be considered to meet the requirements of 7.3.2 if no verifiable ignition occurred and the total number of ignitions attempts under the correct test conditions is at least 200.

If one or more ignitions are discounted because of incorrect test conditions (see 9.3.3.4), the FIBC shall only be considered to meet the requirements of 7.3.2 if subsequent testing on the same FIBC produced no verifiable ignitions and the total number of ignitions attempts under the correct test conditions is at least 200.

The test FIBC shall be considered to fail the requirements of 7.3.2 if one or more verifiable ignitions occur.

9.4 Resistance to groundable point

9.4.1 Apparatus

9.4.1.1 Resistance-measuring apparatus

9.4.1.1.1 General

A self-contained resistance meter (ohmmeter) or power supply and current meter in the appropriate configuration for resistance measurement, with a ±10 % accuracy, and capable of the requirements described in 9.4.1.1.2 and 9.4.1.1.3.

9.4.1.1.2 For laboratory evaluations

The apparatus shall have a circuit voltage while under load of (10 ± 0,5) V for resistance below 1,0 × 10^6 Ω, (100 ± 5) V for a resistance between 1,0 × 10^6 Ω and 1,0 × 10^{11} Ω, and (500 ± 25) V for a resistance above 1,0 × 10^{11} Ω. The measuring range of the apparatus shall be at least one order of magnitude either side of the expected range of resistance being measured. The apparatus shall be used in a manner that ensures unintended ground paths do not influence measurements.

9.4.1.1.3 For acceptance testing

A laboratory evaluation apparatus (see 9.4.1.1.2) shall be used for acceptance testing, or the following.

The apparatus shall have an open circuit voltage of (10 ± 0,5) V for a resistance below 1,0 x 10^6 Ω, (100 ± 5) V for a resistance between 1,0 x 10^6 Ω and 1,0 x 10^{11} Ω, and (500 ± 25) V for a resistance above 1,0 x 10^{11} Ω. The measuring range of the apparatus shall be at least one order of magnitude either side of the expected range of resistance being measured. The apparatus shall be used in a manner that ensures unintended ground paths do not influence measurements.

In case of dispute, laboratory evaluation apparatus shall be used.

9.4.1.2 Measuring electrodes

9.4.1.2.1 Materials without conducting threads

The measuring electrode for materials without conducting threads shall consist of a metal plate or block with a contact area of (25 ± 1) mm × (25 ± 1) mm. The electrode is faced with a soft conductive rubber (nominal Shore A durometer hardness of 30 and volume resistivity less than 1,0 x 10^4 Ωm) with the same size contact area. Alternatively, non-conductive rubber or foam may be used with an aluminium foil covering to provide electrical contact to the metal plate or block.

9.4.1.2.2 Material with conducting threads

The measuring electrode for materials with conducting threads shall be a sharp metal point with a radius of curvature of (0,25 ± 0,05) mm, a cone angle at the tip of (20 ± 1)° and a major diameter of (1,5 ± 0,5) mm.

9.4.2 Test procedure

Suspend the FIBC under test by its lifting loops so that it hangs freely with no part of the main bag touching the floor or any other structure. The resistance between any part of the FIBC and earth shall be at least 1,0 x 10^{12} Ω.

For FIBC containing conducting elements within their lifting loops, insulation shall be inserted between the lifting loops and the support points on the metal framework, such that the resistance to earth shall be at least 1,0 x 10^{12} Ω.

Connect one test lead from the resistance-measuring apparatus to a groundable point on the FIBC using a clip that assures good electrical contact.

Connect the other test lead from the resistance measuring apparatus to the measuring electrode.

For materials without conducting threads, hold the soft-faced electrode (see 9.4.1.2.1) against the surface of the FIBC under test. It may be necessary to insert some insulating material into the FIBC of sufficient weight to keep the sides of the FIBC in tension during measurements.

For materials with conducting threads, select a single thread and ensure the pointed electrode (see 9.4.1.2.2) makes contact. In some cases, the fabric structure or a coating may cover a conducting thread. A sharp point enables the electrode to penetrate the fabric or coating to make contact with the conducting thread.

Starting with the voltage set to 10 V, take a reading of the resistance (15 ± 2) s after applying the test voltage. If the value exceeds 1,0 x 10^6 Ω, select 100 V and repeat the measurement. If the value for this second measurement exceeds 1,0 x 10^{11} Ω, select 500 V and make a final measurement. Record the reading, which matches the voltage and resistance range specified in 9.4.1.1, unless either of the following situations occurs:

a) the measured resistance at 10 V is greater than 1,0 × 10^6 Ω and the measured resistance at 100 V is less than 1,0 × 10^6 Ω; or
b) the measured resistance at 100 V is greater than 1,0 × 10^{11} Ω and the measured resistance at 500 V is less than 1,0 × 10^{11} Ω;

in which case the resistance measurement made at the higher voltage level shall be recorded.

At least 10 measurements shall be made at locations distributed evenly on each panel in the FIBC, including top and bottom panels, internal reinforcements, discharge and filling spouts, skirts, etc., and the full series of measurements shall be repeated for each groundable point, including lifting loops if they are designated as such. If the FIBC under test contains conducting threads, the 10 measurements made on each panel shall be made on different threads.

Additional measurements shall be made on any label or other attachment made from materials with surface resistivity less than 1,0 × 10^9 Ω, measured according to IEC 61340-2-3 under the conditions specified in 8.2.

For FIBC that do not have four clearly defined sides, at least 40 measurements shall be made at locations distributed evenly over the area of the FIBC.

A careful visual inspection shall be carried out of the entire FIBC to identify any area that appears to differ in any way from the rest of the FIBC. If the FIBC under test contains conducting threads, a visual inspection shall be used to identify possible break points, missing or damaged threads. Additional resistance measurements shall be carried out on all areas identified during the visual inspection.

10 Test report

10.1 General

The test report shall include at least the information in 10.2 to 10.7.

10.2 For all types of testing

a) reference to this document;

b) date of testing;

c) details of equipment calibration;

d) atmosphere for conditioning and testing;

e) description of test samples (for FIBC description shall be as defined in Table 8 below);

f) details of any pre-treatment;

g) for each FIBC sample tested, a statement as to whether or not it meets the requirements specified in Clause 7;

h) for each inner liner tested, a statement as to whether or not it meets the requirements specified in 4.2;

i) details of any deviations from this document.

10.3 For electrical breakdown voltage testing

a) the maximum electrical breakdown voltage measured for each material in the FIBC or inner liner; or

b) a statement indicating that electrical breakdown voltage cannot be determined because of conductivity within the material.

10.4 For ignition testing

a) whether FIBC are isolated or earthed during testing, and how the FIBC are earthed, including the resistance to earth;

b) volume concentrations of gas mixture;

c) minimum ignition energy of gas mixture;

d) for each sample tested, the number of ignition attempts made;

e) for each sample tested, the location of any additional measurement points;

f) for each sample tested, the number of ignitions achieved.

10.5 For resistance to groundable point testing

a) the maximum resistance to a groundable point;

b) the applied test voltage.

10.6 For surface resistivity testing of inner liners, labels and document pockets

a) the minimum and maximum surface resistivity on each side of the sample;

b) the applied test voltage.

10.7 For test reports issued by accredited testing authorities

a) the accreditation number of the testing authority;

b) a unique certificate or test report number.

Table 8 – Example of full sample description to be included in the test report

Detail	Notes
FIBC description	Code and trade name
Manufacturer's name and address	
Method of construction	
Nominal load (kg)	
Material type and grade	
Tare mass (kg)	
Number of plies	
Grammage of material per square metre (g/m^2)	
Fabric (warp/weft), tapes per 100 mm	
Coating material, thickness (µm), weight (g/m^2)	
Liner material, thickness (µm)	
Design drawing	
Dimensions (mm)	
Filling aperture	Position, design, internal diameter (mm), closure material and grammage (g/m^2)
Discharge aperture	Position, design, internal diameter (mm), closure material and grammage (g/m^2)
Sewing	Type, constructive thread
Conductive thread or dissipative yarns, tapes or coatings	Type, distance between threads (mm), position of earth bonding points
Form of liner attachment	
Filler cord	
Adhesive type	

Annex A
(~~normative~~ informative)

Electrical breakdown voltage – Typical voltage/time graphs

Figures A.1 and A.2 show representations of voltage/time graphs for electrical breakdown voltage measurements made by the method specified in 9.2.

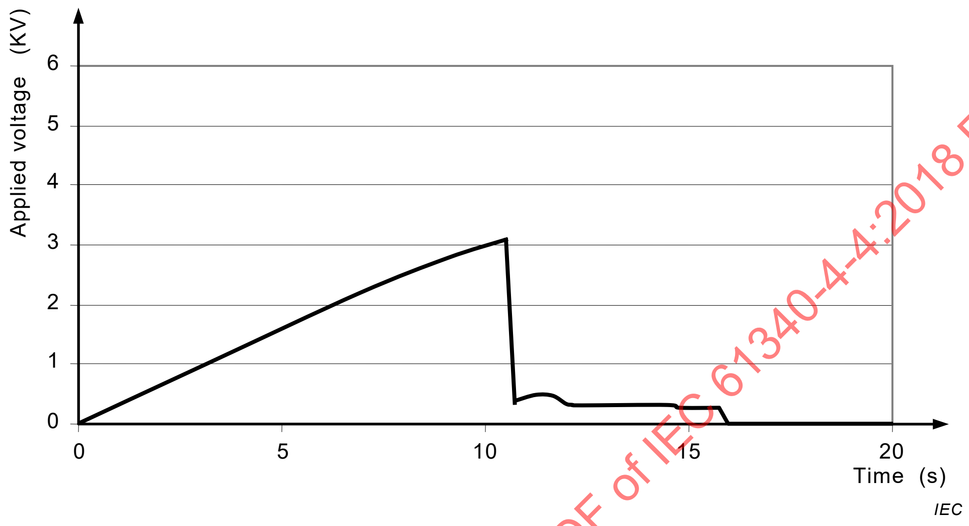


Figure A.1 – Example of voltage/time graph for material showing distinct breakdown

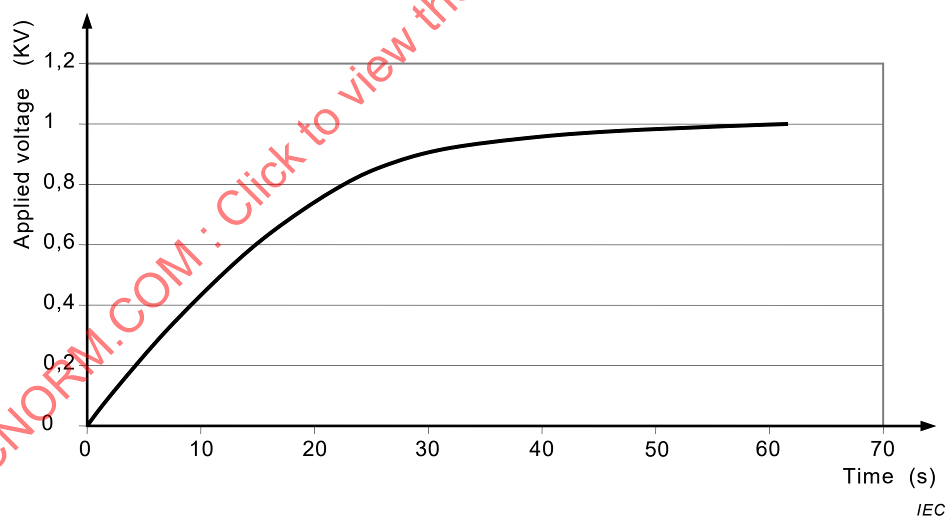


Figure A.2 – Example of voltage/time graph for material showing reduction in rate of voltage rise because of conduction within the test material

Annex B
(normative)

Polypropylene pellets for ignition testing

The particle size distribution of nominally spherical polypropylene pellets suitable for use in ignition testing (see 9.3) is shown in Table B.1.

Table B.1 – Particle size distribution of polypropylene pellets

	Particle size distribution									**Total mass**
Sieve size	4	4 x 5	5 x 6	6 x 8	8 x 12	12 x 16	16 x 30	30 x 40	PAN	
Mean opening (mm)		4,38	3,68	2,87	2,03	1,44	0,89	0,51		
Mass (g)	0,00	1,22	15,28	86,94	124,47	52,64	2,46	0,02	0,01	283,04
Mass fraction (%)	0,00	0,43	5,40	30,72	43,98	18,60	0,87	0,01	0,00	
Mean particle diameter: 2,27 mm.										

Annex C
(informative)

Guidance on test methods for manufacturing quality control

C.1 Introductory remarks

Quality control testing is carried out by manufacturers to ensure that FIBC are within manufacturing specification before leaving the factory. Similar test procedures may also be carried out by users who wish to check that FIBC meet their requirements before accepting them for use in their facilities.

As quality control testing may be carried out on a daily basis, often on multiple samples, it is preferable for test methods and procedures to be simple and quick to perform at an acceptable cost. The test procedures specified in Clause 9 can be used for quality control testing, but for many manufacturers and users they may be too complex, too time consuming or too expensive.

In contrast to type qualification testing, where FIBC are evaluated against standard acceptance criteria, quality control testing allows manufacturers and users to evaluate FIBC against acceptance criteria that they specify and which are often only valid for a specific design of FIBC or application. For this reason, quality control test methods and acceptance criteria used by one manufacturer or user may not be appropriate for evaluating FIBC from other manufacturers or FIBC intended for other specific uses.

The test methods described in Clause C.2 may be useful for quality control testing. The list of test methods is not comprehensive and there may be other test methods that are equally suitable. Manufacturers or users should ensure that quality control testing is suitable for their own needs.

Quality control testing should be designed to provide manufacturers and users with information that demonstrates all FIBC produced and delivered are substantially the same as the sample FIBC used to qualify the FIBC design. Quality control test methods, other than those specified in Clause 9, if used for this purpose, should not be used as a substitute for type qualification test methods, and should not be used by manufacturers to promote their FIBC in a way that might conflict with the requirements specified in Clause 7.

C.2 Test methods

C.2.1 Resistance measurements

Resistance measuring apparatus other than that specified in 9.4.1.1 may be used for quality control testing. Simple resistance meters or multimeters that are widely available at low cost may be used in place of more expensive laboratory grade apparatus for quickly checking the electrical continuity between panels in Type C FIBC. Measurements may also be made on materials to ensure that they are sufficiently conducting for use in Type C FIBC.

For convenience, resistance measurements for quality control testing may be carried out on FIBC whilst they are on an inspection table, for example. Care should be taken to avoid creating electrical connections between panels that may not be present during normal FIBC filling and emptying operations.

Resistance measurements may be used for quality control testing for some designs of Type D FIBC. The test procedures specified in 9.4 or other procedures may be used to check that the resistance of materials is neither too low nor too high.

C.2.2 Charge decay measurements

IEC 61340-2-1 [4] specifies test methods for measuring the ability of materials and products to dissipate static electric charge. The apparatus specified in 4.3 may be useful for quality control testing of some materials used in the construction of Type D FIBC.

The point at which timing is started and stopped, as well as the acceptable charge decay time, should be selected by manufacturers or users in accordance with their own requirements. A very short decay time may indicate that the material under test is too conductive and may give rise to sparks. An excessively long decay time may indicate that the material under test does not have the ability to dissipate charge at the rate required for Type D FIBC and may give rise to brush discharges. As a general guide, decay time constants between 500 ms and 30 s may be acceptable. It should be noted, however, that some materials used in the construction of Type D FIBC may have charge decay times outside of these limits.

C.2.3 Charge transfer measurements

The principle of charge transfer measurements is to provoke an electrostatic discharge to an electrode connected to a measuring system to determine the quantity of charge transferred in the discharge.

Charging of FIBC should be carried out using the re-circulating FIBC filling rig described in 9.3.1.4. To charge materials and FIBC where the use of a re-circulating FIBC filling rig is not available, or practical, alternative charging methods can be employed, such as rubbing with other materials, which, in combination with the FIBC material, have a high electrostatic charging propensity, or by spraying with charge generated by a high-voltage corona array.

IEC 60079-32-2 [2] describes test apparatus and procedures that may be used to charge materials and make charge transfer measurements. The specified rubbing materials may not be appropriate for charging all types of FIBC, in which case they may be substituted for other, more suitable materials.

The maximum charge transfer limits shown in IEC TS 60079-32-1 [1] are based on electrostatic discharges from homogeneous, non-conductive materials. The nature of electrostatic discharges from some static protective FIBC may differ in both spatial and temporal characteristics to the type of discharge used to derive the data shown in IEC TS 60079-32-1 [1]. For quality control testing, manufacturers or users should establish maximum charge transfer limits applicable to their own products or applications.

Annex D
(normative)

Classification of hazardous areas and zones

Tables D.1 and D.2 describe the classification of hazardous areas, explosion groups and hazardous zones defined in IEC 60079-10-1 and IEC 60079-10-2.

Table D.1 – Classification of hazardous areas in IEC 60079-10-1 and IEC 60079-10-2

Classification	Description of the area	
I	Mines susceptible to firedamp	
II	Places with an explosive gas atmosphere other than mines, consisting of	
	A	Normal incendive gases and vapours, e.g. hexane, methane, acetone
	B	Highly incendive gases and vapours, e.g. diethyl ether, ethylene, cyclopentane
	C	Very highly incendive gases and vapours, e.g. hydrogen, ethyne, carbon disulphide
III	Places with an explosive dust atmosphere other than mines, consisting of	
	A	Combustible flyings
	B	Non-conductive dust
	C	Conductive dust
NOTE 1 A substance classified with a specific explosion group produces an area of the same explosion group in its vicinity. NOTE 2 The ignition hazard increases from A to C.		

Table D.2 – Classification of zones in IEC 60079-10-1 and IEC 60079-10-2

Zone	Description of the zone
0	Place in which an explosive atmosphere consisting of a mixture with air of flammable substances in the form of gas, vapour or mist is present continuously or for long periods, or frequently.
1	Place in which an explosive atmosphere consisting of a mixture with air of flammable substances in the form of gas, vapour or mist is likely to occur in normal operation occasionally.
2	Place in which an explosive atmosphere consisting of a mixture with air of flammable substances in the form of gas, vapour or mist is not likely to occur in normal operation but, if it does occur, will persist for a short period only.
20	Place in which an explosive atmosphere, in the form of a cloud of combustible dust in air, is present continuously, or for long periods or frequently for short periods. NOTE Places where piles of dust are present but where dust clouds are not present continuously, or for a long period, or frequently are not included in this zone.
21	Place in which an explosive atmosphere, in the form of a cloud of combustible dust in air, is likely to occur occasionally in normal operation.
22	Place in which an explosive atmosphere, in the form of a cloud of combustible dust in air, is not likely to occur in normal operation but, if it does occur, will persist for a short period only.

Annex E
(informative)

Risks associated with cone discharges

This document describes procedures for evaluating the ignition risk presented by electrostatic discharges related to the construction, fabric and all parts of the FIBC itself in flammable or explosive environments.

It ~~must~~ should however be kept in mind that filling charged, high resistivity powder into containers may generate a region of very high space charge density within the heap of bulked powder. This leads to high electrical fields at the top of the heap. Under those circumstances, large discharges running (radially, in the case of cylindrical containers) along the surface have been observed. These discharges are related to the charge retained on the product. They occur independently of the type of FIBC being filled. They occur as well in an earthed metal container.

The conditions necessary for this type of discharge are complex; the influencing factors are resistivity of bulked powder, charging current, volume and geometry of bulked powder and particle size. It has been reported that atmospheres of flammable gases and vapours as well as atmospheres of sensitive combustible powders can be ignited by this type of discharge. The average energy released in cone discharges depends on the container diameter and the particle size (median) of the products forming the powder heap.

The MIE limit of 3 mJ specified in Table 5 is based on the incendivity of cone discharges. Cone discharges may have a much higher energy in Type B FIBC than in Type C or D FIBC because the walls of Type C or D FIBC will be at close to zero potential. Based on this fact, the internal field distribution will be such that in Type C or D FIBC, cone discharges will at most only jump across half the diameter of the FIBC, but in Type B FIBC cone discharges may jump across the full diameter of the FIBC. Energy calculations predict that in Type B FIBC, cone discharges may be incendiary to powders with MIE of up to 3 mJ, whereas in Type C and Type D FIBC, calculations for the same powders predict cone discharge energy below the powder MIE.

More information about cone discharges is given in IEC TS 60079-32-1 [1].

Annex F
(informative)

Explanation for resistance and resistivity limits, and thickness limits for insulating layers of inner liners

F.1 Resistance to groundable point limit for Type C FIBC

The maximum permitted resistance between a conductor and earth is determined by the charging current. Hazardous sparks from conductors can be eliminated by connecting the conductor to earth through a resistance that is no greater than the value obtained by dividing the spark onset potential by the charging current. The resistance to groundable point limit of 1,0 x ~~10^7~~ 10^8 is such that a charging current significantly greater than ~~10~~ 30 μA is required to generate hazardous potentials on Type C FIBC (Yamaguma *et al*, 2015 [8]). Such high charging currents are not generated during normal FIBC filling and emptying operations. Therefore, by setting the resistance to groundable point limit at 1,0 x ~~10^7~~ 10^8 Ω, Type C FIBC can be used without further consideration of charging current.

F.2 Resistivity of inner liners

The upper resistivity limit for Type L1 inner liners is set at 1,0 x ~~10^7~~ 10^8 Ω so that they are compatible with the requirements for Type C FIBC as explained in Clause F.1.

Empirical evidence (e.g. Butterworth *et al*, 1983 [6]; Salmela *et al*, 2005 [7]) indicates that electrostatic discharges from isolated materials with resistivity between the order of 10^9 Ω and 10^{12} Ω present minimum risk of igniting explosive atmospheres.

Isolated materials with resistivity significantly less than 10^9 Ω tend to produce spark-like discharges. One characteristic of sparks is that they release a large proportion of the electrical energy stored on a charged material. For metals and other very low resistivity materials, virtually all the stored electrical energy is released into the spark gap and is available to cause ignition. Materials with greater resistivity absorb some energy as charge moves through them, leaving less energy in the spark gap to cause ignition. At some point, the amount of energy absorbed by the material is so great that the energy transferred to the spark gap is not enough to cause ignition.

Materials with resistivity significantly greater than 10^{12} Ω are considered to be insulating and do not allow the free movement of charge. Localized areas on insulators can acquire very high surface charge densities, which can result in brush discharges that release enough energy to cause ignition.

Type L2 inner liners may be used in Type B and Type D FIBC, in which case they will normally be isolated from earth. Therefore, the resistivity of Type L2 inner liners shall not be less than 1,0 x 10^9 Ω, otherwise hazardous sparks may occur. To avoid hazardous brush discharges, the upper limit of resistivity permitted for Type L2 inner liners is set at 1,0 x 10^{12} Ω.

Further information on earthing requirements, sparks and brush discharges is given in IEC TR 61340-1 [3] and IEC TS 60079-32-1 [1].

F.3 Thickness of insulating layers of inner liners

The external field from any charge that builds up on the surface of a thin insulating material backed by a conductive or dissipative layer is attenuated by the backing layer, which reduces the risk of incendiary brush discharges from the material. The degree of attenuation diminishes as the thickness of the insulating material increases. If the thickness of the insulating material exceeds 700 µm, the risk of incendiary brush discharges becomes significant. Therefore, the thickness of any insulating layer of an inner liner that contacts the product is limited to less than 700 µm.

Bibliography

[1] IEC TS 60079-32-1, *Explosive atmospheres – Part 32-1: Electrostatic~~s~~ hazards, guidance*~~[2]~~

[2] IEC 60079-32-2, *Explosive atmospheres – Part 32-2: Electrostatics hazards – Tests*

[3] IEC TR 61340-1, *Electrostatics – Part 1: Electrostatic phenomena – Principles and measurements*~~[3]~~

[4] IEC 61340-2-1, *Electrostatics – Part 2-1: Measurement methods – Ability of materials and products to dissipate static electric charge*

[5] CLC/TR 50404, *Electrostatics – Code of practice for the avoidance of hazards due to static electricity*

[6] BUTTERWORTH, G.J., CHUBB, J.N. and PAUL, E.S., *A study of the incendivity of electrical discharges between planar resistive electrodes*, Inst. Phys. Conf. Ser. No. 66, 1983

[7] SALMELA, H., PAASI, J., KALLIOHAKA, T. and FAST, L., *Measurements of air discharges from insulating, electrostatic dissipative and conductive materials with different ESD probes*, J. Electrostat. 63 (6-10), 2005

[8] YAMAGUMA, M., GOTO, K., KOKUBUN, A., *A study on resistance of anti-electrostatic flexible intermediate bulk containers*, J. Chem. Eng. Jap. Vol. 8 No. 8 (708-714), 2015

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~~2 At the time of writing, IEC/TS 60079-32-1 is in the early stages of development. It is expected to be published within the stability period of this standard. The guidance given in future IEC/TS 60079-32-1 is derived from CLC/TR 50404, which is expected to be withdrawn and superseded by IEC/TS 60079-32-1.~~

~~3 Under consideration.~~

IEC 61340-4-4

Edition 3.0 2018-01

INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Electrostatics –
Part 4-4: Standard test methods for specific applications – Electrostatic classification of flexible intermediate bulk containers (FIBC)

Électrostatique –
Partie 4-4: Méthodes d'essai normalisées pour des applications spécifiques – Classification électrostatique des grands récipients pour vrac souples (GRVS)

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

ELECTROSTATICS –

Part 4-4: Standard test methods for specific applications – Electrostatic classification of flexible intermediate bulk containers (FIBC)

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 61340-4-4 has been prepared by IEC technical committee 101: Electrostatics.

This third edition cancels and replaces the second edition, published in 2012, and Amendment 1:2014. This edition constitutes a technical revision.

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

a) in light of experimental evidence, the maximum resistance to ground limit for Type C FIBC, and corresponding resistance limits for inner liners used in Type C FIBC has been increased from $1,0 \times 10^7\ \Omega$ to $1,0 \times 10^8\ \Omega$;
b) the classification of Type L1 inner liners has been revised and extended to include Type L1C inner liners made from multi-layer materials with a conductive internal layer;

c) a labelling requirement to include a reference to IEC TS 60079-32-1 for guidance on earthing has been added.

The text of this International Standard is based on the following documents:

FDIS	Report on voting
101/546/FDIS	101/555/RVD

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

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

A list of all parts in the IEC 61340 series, published under the general title *Electrostatics*, can be found on the IEC website.

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

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

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

INTRODUCTION

Flexible intermediate bulk containers (FIBC) are widely used for the storage, transportation and handling of powdered, flaked or granular material. Typically, they are constructed from woven polypropylene fabric in the form of cubic bags of about 1 m^3 volume, although they can vary in shape and in size from 0,25 m^3 to 3 m^3. The fabric used may be a single layer, a multi-layer laminate, or a coated fabric. Untreated polypropylene is an electrical insulator, as is often the case with the products placed in FIBC. There is ample opportunity for the generation of electrostatic charge during filling and emptying operations and in unprotected FIBC high levels of charge can quickly build up. In such cases, electrostatic discharges are inevitable and can be a severe problem when FIBC are used in hazardous explosive atmospheres.

A hazardous explosive atmosphere can be generated when handling fine powders that create dust clouds or thin layers of powder, both of which can be ignited by electrostatic discharges. A hazardous explosive atmosphere can also be generated when using gases or volatile solvents. In these industrial situations, there is clearly a need to eliminate incendive electrostatic discharges.

As with any industrial equipment, a thorough risk assessment should always be conducted before using FIBC in potentially hazardous situations. This part of IEC 61340 describes a system of classification, test methods, performance and design requirements and safe use procedures that can be used by manufacturers, specifiers and end-users as part of a risk assessment of any FIBC intended for use within a hazardous explosive atmosphere. However, it does not include procedures for evaluating the specific risks of electrostatic discharges arising from products within FIBC, for example cone discharges, from personnel or from equipment used near FIBC. Information on risks associated with cone discharges is given in Annex E.

CAUTION: The test methods specified in this document involve the use of high voltage power supplies and flammable gases that may present hazards if handled incorrectly, particularly by unqualified or inexperienced personnel. Users of this document are encouraged to carry out proper risk assessments and pay due regard to local regulations before undertaking any of the test procedures.

ELECTROSTATICS –

Part 4-4: Standard test methods for specific applications – Electrostatic classification of flexible intermediate bulk containers (FIBC)

1 Scope

This part of IEC 61340 specifies requirements for flexible intermediate bulk containers (FIBC) between 0,25 m^3 and 3 m^3 in volume, intended for use in hazardous explosive atmospheres. The explosive atmosphere can be created by the contents in the FIBC or can exist outside the FIBC.

The requirements include:

– classification and labelling of FIBC;
– classification of inner liners;
– specification of test methods for each type of FIBC, inner liner, labels and document pockets;
– design and performance requirements for FIBC, inner liners, labels and document pockets;
– safe use of FIBC (including those with inner liners) within different zones defined for explosion endangered environments, described for areas where combustible dusts are, or can be, present (IEC 60079-10-2), and for explosive gas atmospheres (IEC 60079-10-1);
– procedures for type qualification and certification of FIBC, including the safe use of inner liners.

NOTE 1 Guidance on test methods that can be used for manufacturing quality control is given in Annex C.

The requirements of this document are applicable to all types of FIBC and inner liners, tested as manufactured, prior to use and intended for use in hazardous explosive atmospheres: Zones 1 and 2 (Groups IIA and IIB only) and Zones 21 and 22 (see Annex D for classification of hazardous areas and explosion groups). For some types of FIBC, the requirements of this document apply only to use in hazardous explosive atmospheres with minimum ignition energy of 0,14 mJ or greater and where charging currents do not exceed 3,0 µA.

NOTE 2

0,14 mJ represents a realistic minimum ignition energy for a Group IIB gas or vapour atmosphere. Although more sensitive materials exist, 0,14 mJ is the lowest minimum ignition energy of any material that is likely to be present when FIBC are emptied. 3,0 µA is the highest charging current likely to be found in common industrial processes. This combination of minimum ignition energy and charging current represents the most severe conditions that might be expected in practice.

FIBC are not normally used in Zone 0 or Zone 20. If FIBC are used in Zone 0 or Zone 20, the requirements of this document are applicable, together with additional requirements that are beyond the scope of this document to define.

The volume contained within FIBC can be designated as Zone 20, in which case the requirements of this document are applicable.

Solids containing residual solvent can result in a hazardous explosive atmosphere within FIBC, possibly resulting in the volume being designated as Zone 1 or Zone 2; in which case the requirements of this document are applicable.

Compliance with the requirements specified in this document does not necessarily ensure that hazardous electrostatic discharges, for example cone discharges, will not be generated by the contents in FIBC. Information on the risks associated with cone discharges is given in Annex E.

Compliance with the requirements of this document does not mitigate the need for full risk assessment. For example, metal and other conductive powders and toner powders can require additional precautions to prevent hazardous discharges from the powders.

NOTE 3 In the examples mentioned in the paragraph above, additional precautions can be necessary in the case of metal or other conductive powder because if the powder is isolated and becomes charged, incendiary sparks can occur, and in the case of toner powders, incendiary discharges can occur during rapid filling and emptying operations. IEC TS 60079-32-1 [1][1] gives guidance on additional precautions that can be necessary.

Test methods included in this document can be used in association with other performance requirements, for example when a risk assessment has shown the minimum ignition energy of concern is less than 0,14 mJ, charging currents are greater than 3,0 μA, or the ambient conditions are outside of the range specified in this document.

Compliance with the requirements specified in this document does not necessarily ensure that electric shocks to personnel will not occur from FIBC during normal use.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60079-10-1, *Explosive atmospheres – Part 10-1: Classification of areas – Explosive gas atmospheres*

IEC 60079-10-2, *Explosive atmospheres – Part 10-2: Classification of areas – Explosive dust atmospheres*

IEC 60243-1:2013, *Electric strength of insulating materials – Test methods – Part 1: Tests at power frequencies*

IEC 60243-2, *Electric strength of insulating materials – Test methods – Part 2: Additional requirements for tests using direct voltage*

IEC 60417, *Graphical symbols for use on equipment* (available at: http://www.graphical-symbols.info/equipment)

IEC 61340-2-3, *Electrostatics – Part 2-3: Methods of test for determining the resistance and resistivity of solid materials used to avoid electrostatic charge accumulation*

ISO/IEC 80079-20-2, *Explosive atmospheres – Part 20-2: Material characteristics – Combustible dusts test methods*

ISO 7000, *Graphical symbols for use on equipment – Registered symbols* (available at: http://www.graphical-symbols.info/equipment)

ISO 21898, *Packaging – Flexible intermediate bulk containers (FIBCs) for non-dangerous goods*

1 Numbers in square brackets refer to the Bibliography.

ASTM E582, *Standard test method for minimum ignition energy and quenching distance in gaseous mixtures*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60079-10-1, IEC 60079-10-2 and ISO 21898 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1
multi-layer material
material comprised of more than one layer, the combination of which can be formed by coextrusion, coating, laminating or any other process that permanently bonds all layers together

3.2
quenching
effect of solid objects acting as heat sinks in close proximity to gas

3.3
critical quenching distance
maximum separation distance between opposing electrodes below which quenching prevents ignition at a specified energy

Note 1 to entry: For ignitions to take place, the gap between electrodes is greater than the critical quenching distance.

3.4
flammable substance
substance in the form of gas, vapour, liquid, solid, or mixture of these, capable of propagating combustion when subjected to an ignition source

3.5
explosive atmosphere
mixture with air, under atmospheric conditions, of flammable substances in the form of gases, vapours, mists or dusts in which, after ignition has occurred, combustion spreads to the entire unburned mixture

3.6
hazardous explosive atmosphere
explosive atmosphere present in such quantities that precautions against ignition are required

3.7
minimum ignition energy
MIE
least electrical energy of a purely capacitive spark (i.e. no added inductance) required to ignite a dust, gas or vapour

3.8
charging current
quantity of charge per unit time flowing into FIBC

3.9
cone discharge
electrostatic discharge running outwards across the surface from the top of highly charged, insulating powder heaps in large containers

3.10
brush discharge
electrostatic discharge from a non-conductive, solid or liquid surface

3.11
spark
electrostatic discharge from an electrically isolated conductive object or surface

3.12
propagating brush discharge
highly energetic discharge from an insulating sheet, layer or coating on a conductive surface, or a material of high resistivity and high breakdown voltage with the two surfaces highly charged to opposite polarity

3.13
inner liner
liner
integral or removable container which fits into the FIBC

3.14
surface resistivity
resistivity equivalent to the surface resistance of a square area of material having electrodes at two opposite sides

3.15
volume resistivity
resistivity equivalent to the volume resistance of a cube of material with unit length, having the electrodes at two opposite surfaces

3.16
type qualification testing
testing used to determine the type of FIBC as specified in 4.1 and to demonstrate that FIBC meet the requirements of Clause 7

3.17
quality control testing
testing designed to provide manufacturers and users with information that demonstrates all FIBC produced and delivered are substantially the same as the sample FIBC used to qualify the FIBC design

3.18
groundable point
point on FIBC designated by the manufacturer as a location to attach a grounding or earth bonding cable or other means of earthing FIBC

4 Classification

4.1 Classification for FIBC

4.1.1 Principles of classification

FIBC are classified according to one of four types: Type A, Type B, Type C and Type D. The types are defined by the construction of the FIBC, the nature of their intended operation and associated performance requirements.

An individual design of FIBC may only be classified as one single type; for example one FIBC shall not be simultaneously classified as both Type B and Type D, or as both Type B and Type C, or as Type CD.

4.1.2 Type A

Type A FIBC are made from fabric or plastic sheet without any measures against the build up of static electricity. Any FIBC that does not meet the requirements specified in Clause 7, or which has not been tested against the requirements is classified as Type A.

4.1.3 Type B

Type B FIBC are made from fabric or plastic sheet designed to prevent the occurrence of sparks and propagating brush discharges.

Conductive materials, as used in the manufacture of Type C FIBC for example, shall not be used in the manufacture of Type B FIBC.

NOTE Type B FIBC are not normally connected to earth. Conductive material that is not connected to earth creates a risk of incendiary sparks.

4.1.4 Type C

Type C FIBC are made from conductive fabric or plastic sheet, or interwoven with conductive threads or filaments and designed to prevent the occurrence of incendiary sparks, brush discharges and propagating brush discharges. Type C FIBC are designed to be connected to earth before the commencement of filling and emptying operations and remain connected to earth during these operations.

4.1.5 Type D

Type D FIBC are made from static protective fabric designed to prevent the occurrence of incendiary sparks, brush discharges and propagating brush discharges, without the need for a connection from the FIBC to earth.

4.2 Principles of classification and requirements for inner liners

4.2.1 Components of inner liners

Materials used for inner liners can be single layer, or multi-layered materials. In the latter case, the layers are typically permanently bonded together. Examples of FIBC with a single layer inner liner and with a multi-layer inner liner are shown in Figure 1.

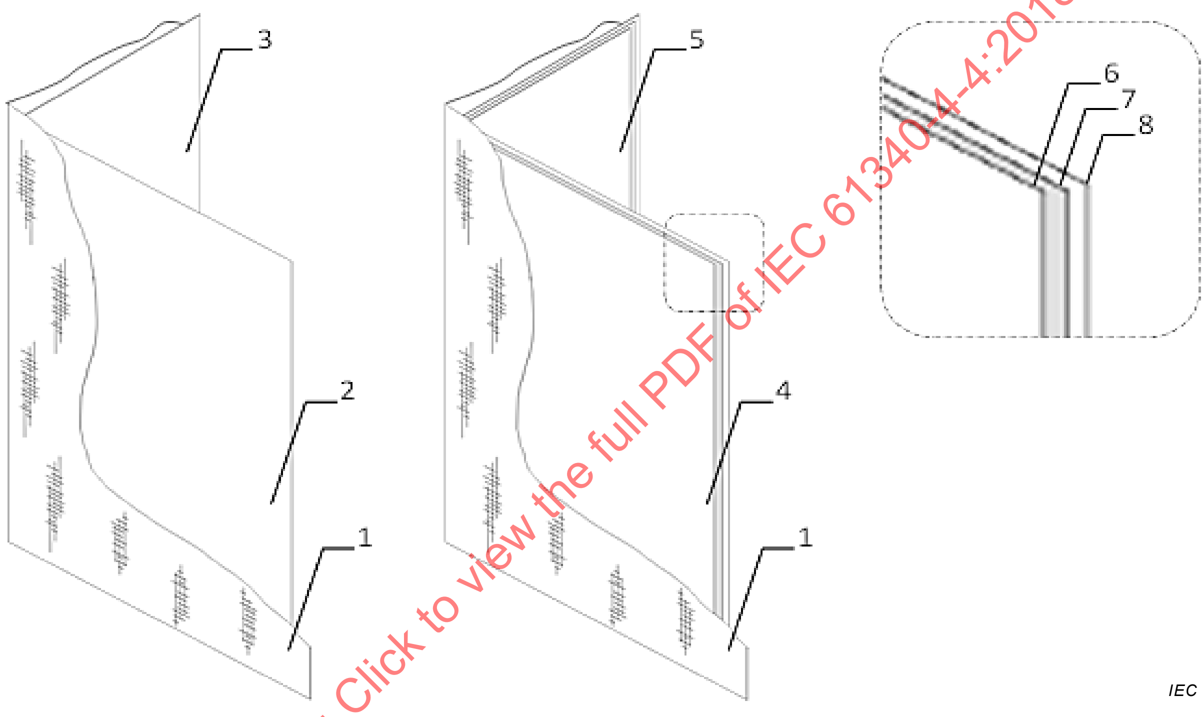
For the purposes of this document, and for both single layer inner liners and multi-layer inner liners, the outside surface of the inner liner is the surface that physically contacts the FIBC, and the inside surface of the inner liner is the surface that physically contacts the product with which the FIBC is filled.

In Figure 1, the multi-layer inner liner is shown as comprising of three layers. In practice, more than three layers can be used. For the purposes of this document, an internal layer is any layer of a multi-layer liner that does not physically contact either the FIBC or the product with which the FIBC is filled.

The electrical properties of the outside surface of a single layer or multi-layer inner liner can be the same as the inside surface, or they can be different. For example, one of the surfaces can be treated with a topical finish to reduce surface resistivity.

With multi-layer inner liners, there are many possible combinations of layers with similar or different electrical properties.

Notwithstanding the many possible combinations of materials for inner liners, for the purposes of this document it is the electrical properties of the outside surface and inside surface of inner liners that are of interest, together with the presence of any conductive internal layers.



Key

1 FIBC
2 outside surface of single layer inner liner
3 inside surface of single layer inner liner
4 outside surface of multi-layer inner liner
5 inside surface of multi-layer inner liner
6 external layer of multi-layer inner liner
7 internal layer of multi-layer inner liner
8 external layer of multi-layer inner liner

NOTE For illustrative purposes, the layers of the multi-layer inner liner are shown separated. In practice, they are typically permanently bonded together.

Figure 1 – Examples of inner liners in FIBC

4.2.2 Surface resistivity measurements for inner liners

Surface resistivity shall be measured according to IEC 61340-2-3. A minimum of ten measurements shall be made at points evenly distributed over the inner liner surface. All measurements shall be within the limits specified for the type of inner liner being tested.

4.2.3 Breakdown voltage measurements for inner liners

Breakdown voltage shall be measured according to 9.2 under the conditions specified in 8.2. The measured breakdown voltage is highly dependent on the thickness of the insulating material and its electrical resistivity. As even minor changes can affect the breakdown voltage, the result only applies to the configuration of liner tested (including the thickness of the individual layers for co-extruded liners, in addition to the overall thickness).

When measuring breakdown voltage between an insulating layer and an internal conductive layer, a means of making electrical contact with the conductive layer is required. If an electrical connection is present, for example the earth bonding point on a finished liner, this can be used. When measuring films without earth bonding points, electrical contact with the conductive layer can be made using a staple inserted through the film, or by partially removing the insulating layer from an area at least 100 mm from the edge of the area where the electrode will be applied to the insulating layer. In the latter cases, either at least two staples shall be inserted, or at least two areas of insulating film shall be removed so that electrical connection to the conductive layer can be checked by measuring the resistance between staples or exposed conductive areas.

4.2.4 Type L1

Type L1 inner liners are made from materials with surface resistivity on at least one surface less than or equal to 1,0 x 10^8 Ω (see Annex F), measured under the conditions specified in 8.2. Type L1 shall not include internal conductive layers; such inner liners are classified as Type L1C (see 4.2.5). Type L1 inner liners may be used in Type C FIBC.

If the material has one surface with surface resistivity greater than 1,0 x 10^{12} Ω, the breakdown voltage through the material shall be less than 4 kV, measured according to 9.2 under the conditions specified in 8.2.

Fortuitous contact between the inner liner and the inside of the FIBC cannot be relied upon to ensure proper earthing of the inner liner. Therefore, the surface with resistivity less than 1,0 x 10^8 Ω shall be securely connected to the earth bonding system of the FIBC via specific connections. The connections to the earth bonding system of the FIBC shall be sufficiently strong to withstand the stresses present during filling, transport and emptying operations and maintain electrical continuity.

The total thickness of any layer(s) with surface resistivity greater than 1,0 x 10^{12} Ω on the inside (product side) of the inner liner material shall be less than 700 μm.

Permissible configurations and requirements for Type L1 inner liners are summarized in Table 1.

Table 1 – Permissible configurations and requirements for Type L1 inner liners (without conductive internal layers)

Configuration	**Parameters**			
	Resistivity of inside surface ρ_I	**Resistivity of outside surface** ρ_O	**Breakdown voltage** V_B	**Thickness** d
1	$\rho_I \leq 1{,}0 \times 10^8\ \Omega$	$\rho_O \leq 1{,}0 \times 10^8\ \Omega$	No measurement required	No limit
2A	$\rho_I \leq 1{,}0 \times 10^8\ \Omega$	$\rho_O \leq 1{,}0 \times 10^{12}\ \Omega$	No measurement required	No limit
2B	$\rho_I \leq 1{,}0 \times 10^{12}\ \Omega$	$\rho_O \leq 1{,}0 \times 10^8\ \Omega$	No measurement required	No limit
3	$\rho_I \leq 1{,}0 \times 10^8\ \Omega$	$\rho_O > 1{,}0 \times 10^{12}\ \Omega$	V_B < 4 kV	No limit
4	$\rho_I > 1{,}0 \times 10^{12}\ \Omega$	$\rho_O \leq 1{,}0 \times 10^8\ \Omega$	V_B < 4 kV	d < 700 μm
All layers with surface resistivity less than 1,0 × 10^8 Ω shall be securely bonded to earth when installed in FIBC.				

4.2.5 Type L1C

Type L1C inner liners are made from multi-layered materials with an internal layer of surface resistivity less than or equal to $1{,}0 \times 10^8\ \Omega$ (see Annex F). Type L1C inner liners may be used in Type C FIBC.

The breakdown voltage between any surface with resistivity greater than $1{,}0 \times 10^{12}\ \Omega$ and the conductive internal layer shall be less than 4 kV, measured according to 9.2 under the conditions specified in 8.2.

The total thickness of any layer(s) with surface resistivity greater than $1{,}0 \times 10^{12}\ \Omega$ on the inside (product side) of the inner liner material shall be less than 700 µm.

All layers with surface resistivity less than $1{,}0 \times 10^8\ \Omega$ shall be securely connected to the earth bonding system of the FIBC via specific connections. The connections to the earth bonding system of the FIBC shall be sufficiently strong to withstand the stresses present during filling, transport and emptying operations and maintain electrical continuity.

Even if the surface of the inner liner in contact with the inside of the FIBC has a surface resistivity less than $1{,}0 \times 10^8\ \Omega$, fortuitous contact between the inner liner and the inside of the FIBC cannot be relied upon to ensure proper earthing of the inner liner, and specific earth bonding connections are still required.

Permissible configurations and requirements for Type L1C inner liners are summarized in Table 2.

Table 2 – Permissible configurations and requirements for Type L1C inner liners (with conductive internal layers[a])

Configuration	Parameters			
	Resistivity of inside surface ρ_I	Resistivity of outside surface ρ_O	Breakdown voltage V_B	Thickness d
1	$\rho_I \leq 1{,}0 \times 10^{12}\ \Omega$	$\rho_O \leq 1{,}0 \times 10^{12}\ \Omega$	No measurement required	No limit
2	$\rho_I \leq 1{,}0 \times 10^{12}\ \Omega$	$\rho_O > 1{,}0 \times 10^{12}\ \Omega$	V_B < 4 kV[b]	No limit
3	$\rho_I > 1{,}0 \times 10^{12}\ \Omega$	$\rho_O \leq 1{,}0 \times 10^{12}\ \Omega$	V_B < 4 kV[b]	d < 700 µm
4	$\rho_I > 1{,}0 \times 10^{12}\ \Omega$	$\rho_O > 1{,}0 \times 10^{12}\ \Omega$	V_B < 4 kV[b]	d < 700 µm

[a] All layers with surface resistivity less than $1{,}0 \times 10^8\ \Omega$ shall be securely bonded to earth when installed in FIBC.

[b] Breakdown voltage is measured between the surface with resistivity > $1{,}0 \times 10^{12}\ \Omega$ and the conductive internal layer.

4.2.6 Type L2

Type L2 inner liners are made from materials with surface resistivity on at least one surface between $1{,}0 \times 10^9\ \Omega$ and $1{,}0 \times 10^{12}\ \Omega$ (see Annex F), measured under the conditions specified in 8.3. Type L2 inner liners may be used in Type B, Type C and Type D FIBC.

Materials with surface resistivity less than $1{,}0 \times 10^8\ \Omega$ shall not be used in any layer within Type L2 inner liners.

If Type L2 inner liners are used in Type C FIBC, fortuitous contact between the inner liner and the inside of the FIBC cannot be relied upon to ensure proper earthing of the inner liner. Therefore, the surface with resistivity between $1{,}0 \times 10^{9}\ \Omega$ and $1{,}0 \times 10^{12}\ \Omega$ shall be securely connected to the earth bonding system of the FIBC via specific connections. The connections to the earth bonding system of the FIBC shall be sufficiently strong to withstand the stresses present during filling, transport and emptying operations and maintain electrical continuity.

If the material has one surface with surface resistivity greater than $1{,}0 \times 10^{12}\ \Omega$, the breakdown voltage through the material shall be less than 4 kV, measured according to 9.1 under the conditions specified in 8.2.

The thickness of any layer with surface resistivity greater than $1{,}0 \times 10^{12}\ \Omega$ on the inside (product side) of the inner liner material shall be less than 700 µm.

Permissible configurations and requirements for Type L2 inner liners are summarized in Table 3.

Table 3 – Permissible configurations and requirements for Type L2 inner liners

Configuration	Parameters			
	Resistivity of inside surface ρ_I	**Resistivity of outside surface** ρ_O	**Breakdown voltage** V_B	**Thickness** d
1	$1{,}0 \times 10^{9}\ \Omega \leq \rho_I \leq 1{,}0 \times 10^{12}\ \Omega$	$1{,}0 \times 10^{9}\ \Omega \leq \rho_O \leq 1{,}0 \times 10^{12}\ \Omega$	No measurement required	No limit
2	$1{,}0 \times 10^{9}\ \Omega \leq \rho_I \leq 1{,}0 \times 10^{12}\ \Omega$	$\rho_O > 1{,}0 \times 10^{12}\ \Omega$	V_B < 4 kV[a]	No limit
3	$\rho_I > 1{,}0 \times 10^{12}\ \Omega$	$1{,}0 \times 10^{9}\ \Omega \leq \rho_O \leq 1{,}0 \times 10^{12}\ \Omega$	V_B < 4 kV[a]	d < 700 µm

[a] Breakdown voltage less than 4 kV cannot always be achieved if the thickness of the layer with resistivity greater than $1{,}0 \times 10^{12}\ \Omega$ exceeds 20 µm.

4.2.7 Type L3

Type L3 inner liners are made from materials with surface resistivity of greater than $1{,}0 \times 10^{12}\ \Omega$, measured under the conditions specified in 8.2. Type L3 inner liners may be used in Type B FIBC.

Materials with surface resistivity less than $1{,}0 \times 10^{8}\ \Omega$ shall not be used in any layer within Type L3 inner liners.

The breakdown voltage through the material shall be less than 4 kV, measured according to 9.1 under the conditions specified in 8.2.

Permissible configurations and requirements for Type L3 inner liners are summarized in Table 4.

Table 4 – Permissible configurations and requirements for Type L3 inner liners

Configuration	Parameters			
	Resistivity of inside surface ρ_I	Resistivity of outside surface ρ_O	Breakdown voltage V_B	Thickness d
1	$\rho_I > 1{,}0 \times 10^{12}\ \Omega$	$\rho_O > 1{,}0 \times 10^{12}\ \Omega$	$V_B < 4$ kV	No limit

4.3 Combination of FIBC and inner liners

When inner liners are used in FIBC, the inner liners and FIBC shall comply separately with their respective requirements, i.e. 4.2 for inner liners and Clause 7 for FIBC, and shall comply with all requirements specified for the combination, including the earthing requirements for Type C FIBC/Type L1/L1C/L2 inner liner combinations and ignition testing requirements for Type D FIBC/Type L2 inner liner combinations. The inclusion of an inner liner in FIBC does not change the type classification of the FIBC. For example, Type A FIBC with Type L1 inner liners are still Type A FIBC and are subject to all the restrictions on use of Type A FIBC.

The requirements for breakdown voltage for FIBC and inner liners shall be applied separately. For Type B, Type C and Type D FIBC with inner liners for which there is a breakdown voltage requirement, two sets of breakdown voltage measurement shall be required: one set on the FIBC material and one set on the inner liner material. For example, if a Type B FIBC is fitted with a Type L3 inner liner, the breakdown voltage of the FIBC material shall be measured on its own and shall be less than 6 kV, and a separate breakdown voltage measurement shall be made on the inner liner material and it shall be less than 4 kV.

5 Safe use of FIBC

The requirements and specifications that FIBC shall meet and the ways in which they are used depend on the nature and sensitivity of any explosive atmosphere present during filling and emptying. The final goal for the construction of FIBC is to exclude incendiary discharges from the FIBC fabric during their intended use. FIBC constructed in compliance with the requirements specified in this document do not necessarily ensure that hazardous electrostatic discharges, for example cone discharges or spark discharges from charged conductive products, will not be generated by the contents in FIBC. Information on the risks associated with cone discharges is given in Annex E.

The igniting ability of electrostatic discharges, i.e. sparks, brush discharges and propagating brush discharges, is different for each type of discharge. The necessity of their exclusion and thus the requirements and specifications for FIBC depend on the intended use of the FIBC. The conditions in which each type of FIBC shall be used is shown in Table 5.

Table 5 – Use of different types of FIBC

Bulk product in FIBC	Surroundings		
MIE of dust[a]	Non-flammable atmosphere	Dust zones 21-22[b] (1 000 mJ ≥ MIE > 3 mJ)[a]	Gas zones 1-2[b] (explosion groups IIA/IIB)[b] or dust zones 21-22[b] (MIE ≤ 3 mJ)[a]
MIE > 1 000 mJ	A,B,C,D	B,C,D	C,D[c]
1 000 mJ ≥ MIE > 3 mJ	B,C,D	B,C,D	C,D[c]
MIE ≤ 3 mJ[d]	C,D	C,D	C,D[c]

Additional precautions are usually necessary when a flammable gas or vapour atmosphere is present inside the FIBC, e.g. in the case of solvent wet powders.

NOTE Non-flammable atmosphere includes dusts having MIE > 1 000 mJ.

[a] Measured in accordance with ISO/IEC 80079-20-2, capacitive discharge circuit (no added inductance).

[b] See Annex D for explanation of hazardous areas, zones and explosion groups.

[c] Use of Type D shall be limited to explosion groups IIA/IIB with MIE ≥ 0,14 mJ.

[d] See Annex E for explanation of the 3 mJ limit in relation to cone discharges.

The ability to safely use FIBC in hazardous explosive atmospheres may change if an inner liner is installed in the FIBC. Combinations of FIBC and inner liner that can be used safely in hazardous explosive atmospheres are shown in Table 6. In addition to the separate requirements for FIBC and inner liners, there are requirements that certain combinations of FIBC and inner liner shall meet. These requirements are also shown in Table 6.

Table 6 – Inner liners and FIBC: combinations that are permissible and not permissible in hazardous explosive atmospheres

FIBC	**Inner liner**			
	Type L1	**Type L1C**	**Type L2**	**Type L3**
Type B	Not permissible	Not permissible	Permissible	Permissible
Type C	Permissible[a]	Permissible[b]	Permissible[c]	Not permissible
Type D	Not permissible	Not permissible	Permissible[d]	Not permissible

Precautions:

Type A FIBC shall not be used in hazardous explosive atmospheres, irrespective of the type of liner used.

Liners shall not be removed from emptied FIBC in hazardous explosive atmospheres.

[a] To ensure the inner liner is properly earthed, the resistance from at least one side of the inner liner to the groundable points on the FIBC shall be less than 1,0 x 10^8 Ω, measured according to 9.4 under the conditions specified in 8.2.

[b] To ensure the inner liner is properly earthed, the resistance from any conductive layer of the inner liner to the groundable points on the FIBC shall be less than 1,0 x 10^8 Ω, measured according to 9.4 under the conditions specified in 8.2.

[c] To ensure the inner liner is properly earthed, the resistance from any dissipative layer of the inner liner to the groundable points on the FIBC shall be less than 1,0 x 10^{12} Ω, measured according to 9.4 under the conditions specified in 8.2.

[d] Combination of FIBC and liner shall meet the requirements of 7.3.2 tested under the conditions specified in 8.4.

Isolated conductive objects (e.g. tools, bolts, clips) shall not be stored on, attached to, or even temporarily placed on any type of FIBC during filling and emptying operations. Even with Type C FIBC, the rough nature of some FIBC materials may prevent conductive objects placed on the FIBC from contacting the conductive elements in the fabric of the FIBC, in which case the conductive object will remain isolated from earth.

In accordance with general safety guidance (see IEC TS 60079-32-1 [1]), all conductive objects, including personnel, Type C FIBC and any conductive contents of FIBC, within a hazardous explosive atmosphere, shall be properly earthed. Type D FIBC are not considered to be conductive objects and are not required to be earthed.

Precautions should be taken to prevent the contamination of any FIBC with substances (e.g. water, rust, oil, grease) that might create an ignition hazard or impair charge dissipation.

6 Labelling

FIBC for which claims of compliance with this document are made, shall be durably marked by means of a permanently attached label, or other means, with at least the following information:

a) the number of this document, i.e. IEC 61340-4-4;

b) the type of FIBC, i.e. Type B, Type C or Type D (the type designation shall be emphasized so that it is easily readable at a glance);

c) the symbol ISO 7000-2415:2004-01 on Type B, Type C and Type D to indicate protection from static electricity;

d) for Type B, the phrase "permitted in dust zones 21-22 with MIE > 3 mJ";

e) for Type C, the phrase "permitted in dust zones 21-22 and gas zones 1-2 (explosion groups IIA/IIB)";

f) for Type D the phrase "permitted in dust zones 21-22 and gas zones 1-2 (explosion groups IIA/IIB with MIE ≥ 0,14 mJ) and where charging currents ≤ 3 μA";

g) for Type C the phrase "FIBC shall be properly earthed according to manufacturer's instructions";

h) for Type D, the phrase "FIBC does not require earthing";

i) for Type B, Type C and Type D the phrase "electrical properties may be affected by general usage, contamination and reconditioning";

j) for Type B, Type C and Type D the phrase "all conductive objects, including personnel shall be earthed during FIBC filling and emptying operations (see IEC TS 60079-32-1 for guidance on earthing)";

k) certifying authority and certificate number (only for FIBC certified by independent certifying authorities).

Type A FIBC are not required to be labelled.

Yellow is preferred for the background colour for labels or marking, but other colours may be used. Conductive black material may be used for labels for Type C FIBC, but shall not be used for labels for Type B or Type D FIBC.

The designated earth bonding points on Type C FIBC shall be labelled or marked with the earth symbol (IEC 60417-5019:2006-08), as shown for example in Figure 5. The background colour for labels or marking shall be yellow and the lettering shall be black, or the background colour shall be black and the lettering shall be yellow. The label or marking may be incorporated into another label or marking as may be required for other purposes.

Examples of suitable labels for each type of FIBC are shown in Figures 2 to 4.

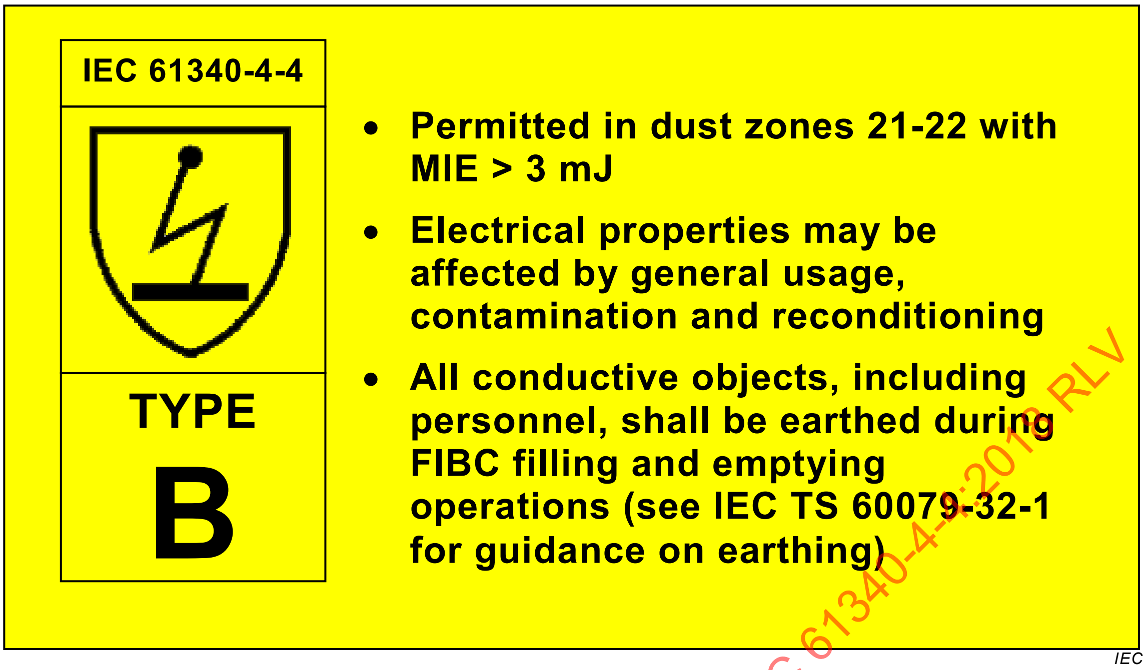


Figure 2 – Example of a label for Type B FIBC

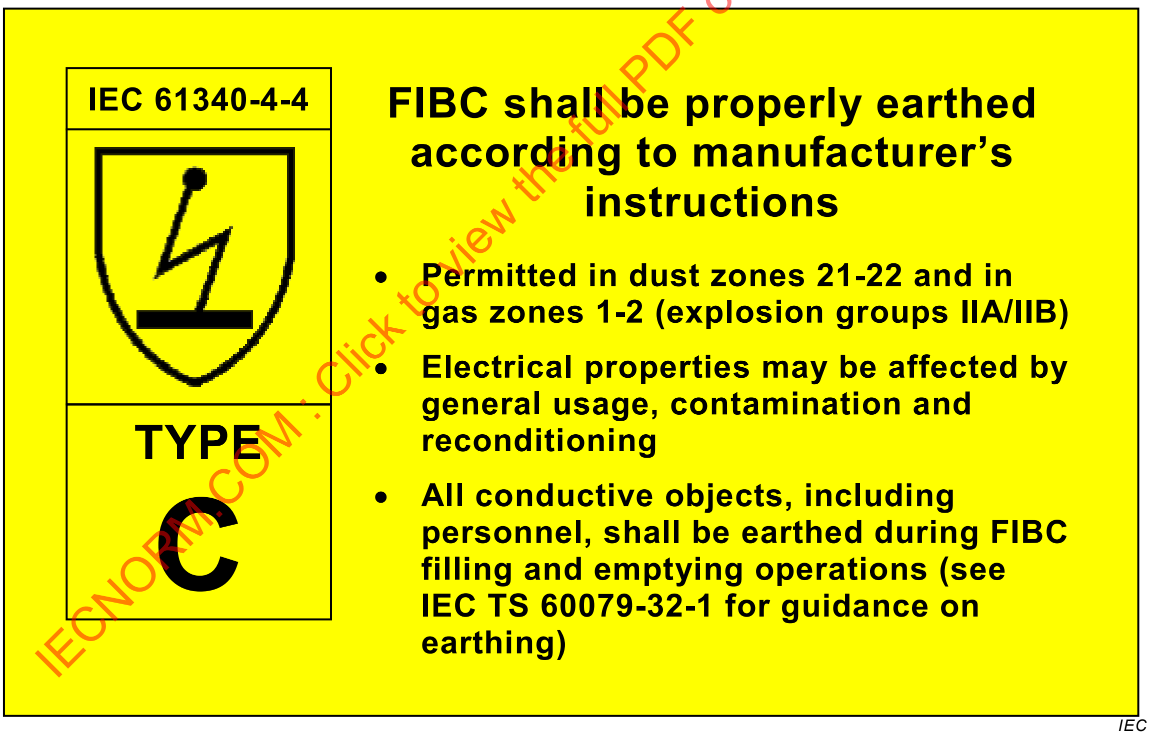


Figure 3 – Example of a label for Type C FIBC

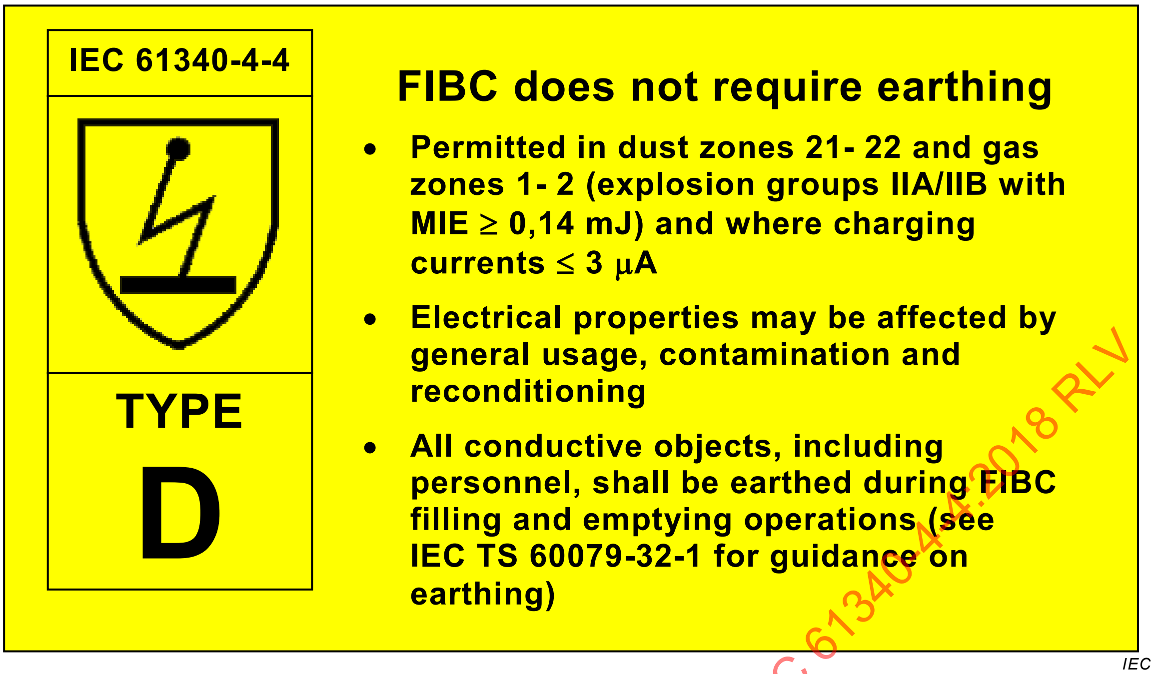


Figure 4 – Example of a label for Type D FIBC

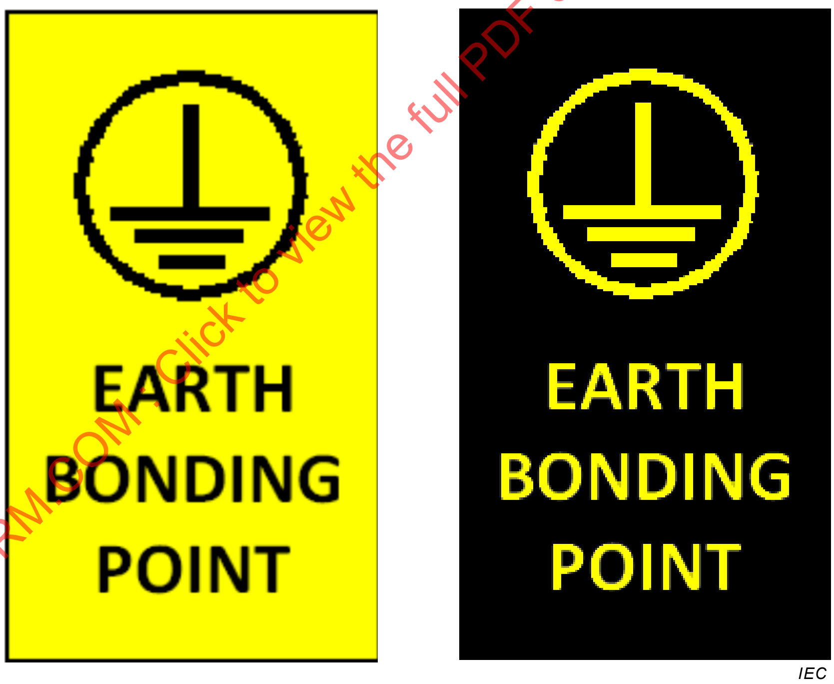


Figure 5 – Example of labels for Type C FIBC designated earth bonding points

FIBC shall not be labelled or marked in any way that conflicts with the requirements of this document, or in any way that could cause confusion as to its classification or use restrictions (e.g. "Type CD" is not permitted). No additional lettering or symbols shall be appended to the type designation (e.g. "Type D+" is not permitted).

It is the responsibility of FIBC manufacturers to ensure the sample(s) tested are representative of the production FIBC to which labels shall be attached.

Type B FIBC labels shall not be made from material with surface resistivity less than 1,0 x 10^9 Ω, measured according to IEC 61340-2-3 under the conditions specified in 8.3 b).

Type C FIBC labels made from materials with surface resistivity less than 1,0 x 10^8 Ω, measured according to IEC 61340-2-3 under the conditions specified in 8.2, can be used, provided the resistance to groundable point measured according to 9.4 is less than the limit specified in 7.3.1.

Type C FIBC labels made from materials with surface resistivity between 1,0 x 10^9 Ω and 1,0 x 10^{12} Ω, measured according to IEC 61340-2-3 under the conditions specified in 8.3, can be used.

Type C FIBC labels with surface resistivity greater than 1,0 x 10^{12} Ω, measured according to IEC 61340-2-3 under the conditions specified in 8.2 ,shall not be greater than 100 cm^2 in area, or greater than or equal to 700 μm in thickness.

Type D FIBC labels greater than 100 cm^2 shall be subjected to ignition testing according to 9.2 and shall meet the requirements specified in 7.3.2.

Printing ink can modify the surface electrical properties of labels. Therefore, measurements made to verify compliance with the requirements of Clause 6 shall be made on printed labels. Printed and unprinted surfaces of labels shall comply with the surface resistivity requirements of Clause 6.

7 Requirements for FIBC

7.1 General remarks

An FIBC intended for use in the presence of a flammable material or in a hazardous explosive atmosphere shall not itself produce incendiary discharges. The absence of incendiary discharges shall be verified for at least the smallest and largest sizes of FIBC of a particular design by meeting one of the requirements listed in 7.2 and 7.3 when tested as manufactured, prior to usage.

For FIBC manufactured from multiple layers of materials that are not permanently and intimately bonded together over the entire surface area, the material requirements listed in 7.2 and 7.3 shall be applied separately to each layer of material.

Quality control test methods described in Annex C shall not be used as a substitute for type qualification test methods specified in Clause 9.

Where it is intended that FIBC be used for multiple fill/clean/empty cycles, it is recommended that tests be conducted according to Clause 9 to verify that FIBC comply with the requirements of Clause 7 after the required number of use cycles.

NOTE It is possible that compliance with the requirements of this document does not extend to FIBC that have been contaminated or degraded through use, or are used contrary to manufacturers' recommendations.

Type qualification certificates based on this document shall be supported by a test report including the information specified in Clause 10. Unless otherwise specified or agreed by interested parties, a type qualification certificate for an FIBC design shall be valid for a period of three years from the date of issue.

7.2 Requirements for dust environments with ignition energies greater than 3 mJ (apply to Type B FIBC, Type C FIBC and Type D FIBC)

To ensure propagating brush discharges cannot occur across the walls of an FIBC intended for use in the presence of combustible dusts but in the absence of flammable vapours or gases, it shall be constructed from materials having an electrical breakdown voltage of less than or equal to 6 kV when tested according to 9.2. The materials used to construct inner baffles, other than mesh or net baffles, shall also meet these requirements.

Although conductive materials can be used to achieve an electrical breakdown voltage of less than 6 kV, such materials shall not be used in the manufacture of Type B FIBC because there is a risk of incendiary sparks if such materials are not connected to earth.

7.3 Requirements for vapour and gas atmospheres and for dust environments with ignition energies of 3 mJ or less

7.3.1 Type C FIBC

A Type C FIBC intended for use in the presence of flammable vapours or gases, or combustible dusts with ignition energies of 3 mJ or less (see Annex E) shall have a resistance to groundable point of less than $1,0 \times 10^8\ \Omega$ (see Annex F) when tested according to 9.4. Additionally, the FIBC shall be constructed entirely from conductive material or at least shall contain fully inter-connected conductive threads or tapes with a maximum spacing of 20 mm if the threads or tapes are in a stripe pattern, or 50 mm if they are in a grid pattern.

For FIBC constructed of multi-layer materials, the inside or outside surface of the FIBC shall have a resistance to groundable point of less than $1,0 \times 10^8\ \Omega$ when tested according to 9.4. If the inside layer does not have a resistance to groundable point of less than $1,0 \times 10^8\ \Omega$, then the material shall also meet the requirements specified in 7.2. All layers of multi-layer materials shall remain in firm contact during filling and emptying operations.

The materials used to construct inner baffles, other than mesh or net baffles, shall also meet these requirements and shall be included in the tests conducted according to 9.3.

One or more groundable points shall be permanently attached to Type C FIBC. Earth bonding cables shall be attached to the groundable points during all filling and emptying operations.

Any lift loops attached to Type C FIBC shall be made from conductive material or shall at least contain conductive threads or tapes with a maximum spacing of 20 mm.

Lift loops may be designated as groundable points, but fortuitous earthing via lifting hooks cannot be relied upon as these may be painted/coated, or covered with powder etc., and so cannot guarantee an adequate earth path. Therefore, earth bonding cables shall be attached to lift loops if they are designated as groundable points.

7.3.2 Type D FIBC

A Type D FIBC intended for use in the presence of flammable vapours or gases, or combustible dusts with ignition energies of 3 mJ or less (see Annex E) shall not cause any ignition when tested according to 9.3.

Additionally, for Type D FIBC made from material that has an insulating layer (e.g. coating film or lamination) on the inside of the container, the material shall meet the requirements specified in 7.2. All layers of multi-layer materials shall remain in firm contact during filling and emptying operations.

For the purposes of type qualification testing where a range of outlet sizes are available for a particular design, ignition testing according to 9.3 shall be carried out on test FIBC with an outlet size that is the smaller of a) 400 mm, or b) the maximum outlet size for the design under test.

The materials used to construct inner baffles, other than mesh or net baffles, shall be the same as the materials used to construct the major panels of the FIBC.

When inner liners are used with Type D FIBC, the combination of FIBC and inner liner shall not cause any ignition when tested according to 9.3.

8 Atmosphere for conditioning, calibrating and testing

8.1 Conditioning time

Conditioning time shall be at least 12 h prior to testing and test samples shall be free hanging to allow sufficient air circulation. When tests are to be conducted in accordance with 9.3, pellets shall be circulated at intervals during this period to ensure adequate conditioning.

8.2 Electrical breakdown voltage, surface resistivity and resistance to groundable point testing

Test samples and apparatus shall be conditioned, calibrated and tested under conditions of (23 ± 2) °C and (20 ± 5) % relative humidity.

8.3 Surface resistivity testing

Test samples and apparatus shall be conditioned, calibrated and tested under conditions of

a) (23 ± 2) °C and (20 ± 5) % relative humidity;
b) (23 ± 2) °C and (60 ± 5) % relative humidity.

8.4 Ignition testing

Test samples and apparatus shall be conditioned, calibrated and tested under conditions of

a) (23 ± 2) °C and (20 ± 5) % relative humidity;
b) (23 ± 2) °C and (60 ± 10) % relative humidity.

9 Test procedures

9.1 Sampling

For qualification purposes, test samples shall be representative of production FIBC and FIBC/inner liner combinations as supplied. The following elements, and any others not listed here, shall be identical between test samples and supplied products:

- labels;
- document pockets, placards;
- inner liners (type, shape and size);
- inner liner attachment;
- design of FIBC (type, shape, size, attachments).

9.2 Electrical breakdown voltage

Breakdown voltage shall be determined in accordance with IEC 60243-1 and IEC 60243-2. The method used is specified in 10.1 of IEC 60243-1:2013, the short-time (rapid-rise) test. The test shall be conducted with unequal electrodes under the application of direct voltage at a rate of rise of 300 V/s. The maximum output current of the DC power supply shall be 1 mA.

For multi-layer materials, all layers shall be tested together and the test specimens shall be positioned so that the high-voltage electrode is in contact with the surface of the material that is normally on the inside of the FIBC.

An example of a voltage/time graph for materials showing distinct breakdown is shown in Figure A.1. For certain materials used in the construction of FIBC, there can be some conductivity which will prevent a sudden breakdown occurring. Typically, such materials will cause a reduction in the rate of voltage rise as charge leaks through the material. An example is shown in Figure A.2. Materials of this nature will not give rise to propagating brush discharges and shall be deemed to meet the requirements of 7.2.

If the output current of the DC power supply reaches 1 mA before the electrode voltage reaches 6 kV, the material under test shall be deemed to meet the requirements of 7.2.

9.3 Ignition testing

9.3.1 Apparatus

9.3.1.1 General

Apparatus other than that specified below may be used, provided that it satisfies the same functional requirements and is shown to give the same results.

9.3.1.2 Ignition probe

The ignition probe is a cylinder made from rigid non-conductive material, such as polycarbonate or acrylic, with an internal diameter of (70 ± 5) mm and an internal length of (100 ± 5) mm (see Figure 6). The material used for constructing the probe shall be of sufficient thickness and strength to withstand repeated ignition without cracking, distorting or otherwise failing.

One end of the cylinder is closed apart from a central port to allow the inflow of the flammable gas. The size of the inlet port is not critical but shall be large enough to allow the required flow rate to be achieved without excessive pressure build-up. A suitable flame arrestor shall be installed in the gas supply line as close as possible to the ignition probe.

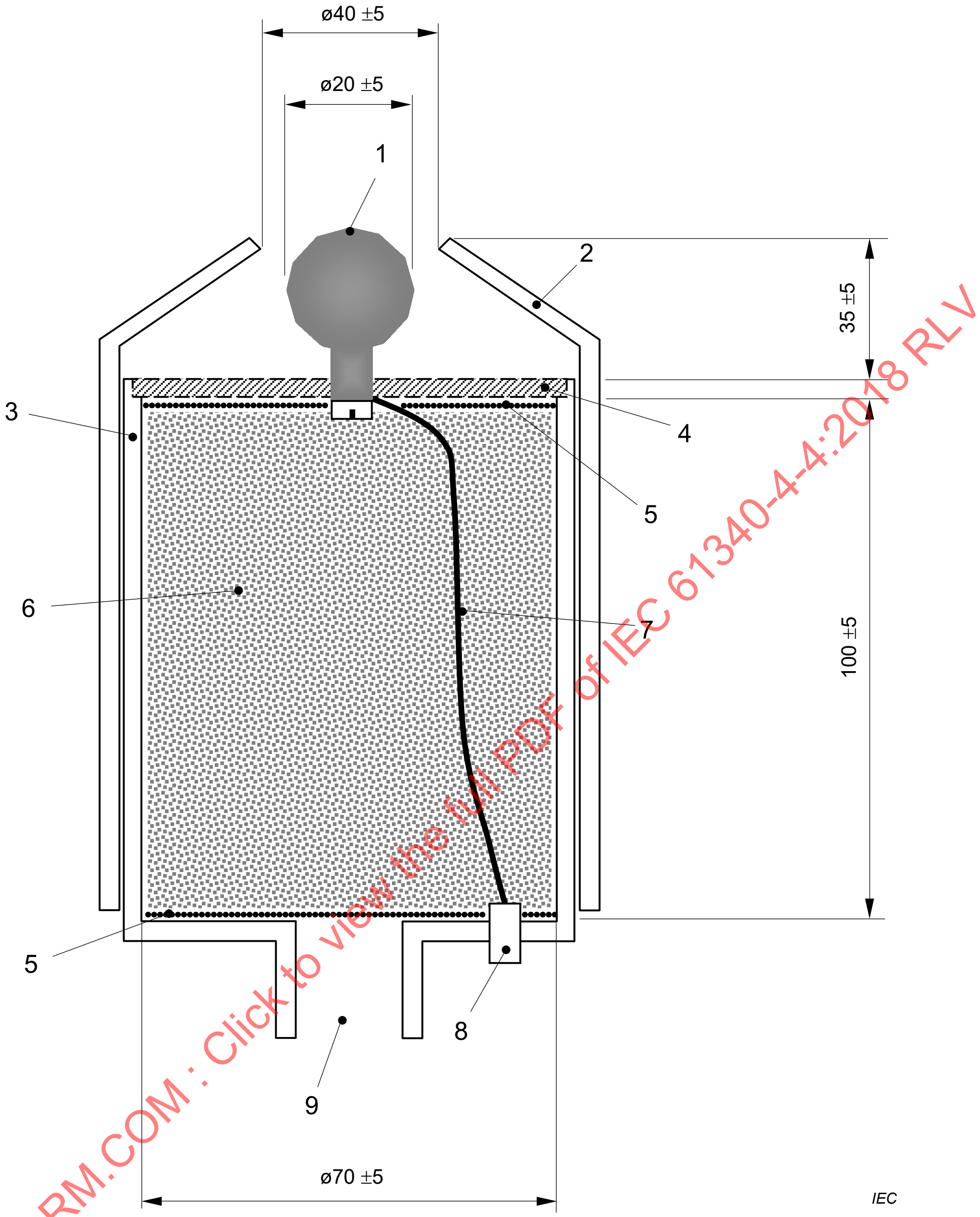
A metal plate is fitted to the other end of the cylinder to form a fixing base for the discharge electrode (see Figure 7). The metal plate is drilled with holes, (5 ± 1) mm in diameter, to allow the uniform flow of gas through it and around the discharge electrode.

A spherical metal electrode of diameter (20 ± 5) mm is mounted centrally to the metal plate. The electrode, metal plate and any other metal or conductive material in the ignition probe are connected to a common point earth via a low impedance (< 10 Ω) connection. The earth point shall be the common point earth for local structures and equipment to the FIBC such as conductive parts of the FIBC test rig. The common earth point may be connected to the electricity supply earth. The connection between the electrode, the metal plate and the earth connector shall be sufficiently robust to withstand physical and thermal impacts. The electrical continuity between the discharge electrode and the earth connector shall be checked prior to use.

The ignition probe is filled with glass or porcelain beads, nominally 1 mm to 2 mm in diameter, which are retained by a fine metal gauze or mesh at either end of the main cylinder. The beads assist in the mixing of the gases and also contribute to preventing propagation of any flame back through the probe.

An adjustable shroud made from insulating material is fitted to the cylinder to direct gas over the discharge electrode and into the region in front of the discharge electrode where electrostatic discharges take place. The opening in this shroud is (40 ± 5) mm.

Dimensions in millimetres

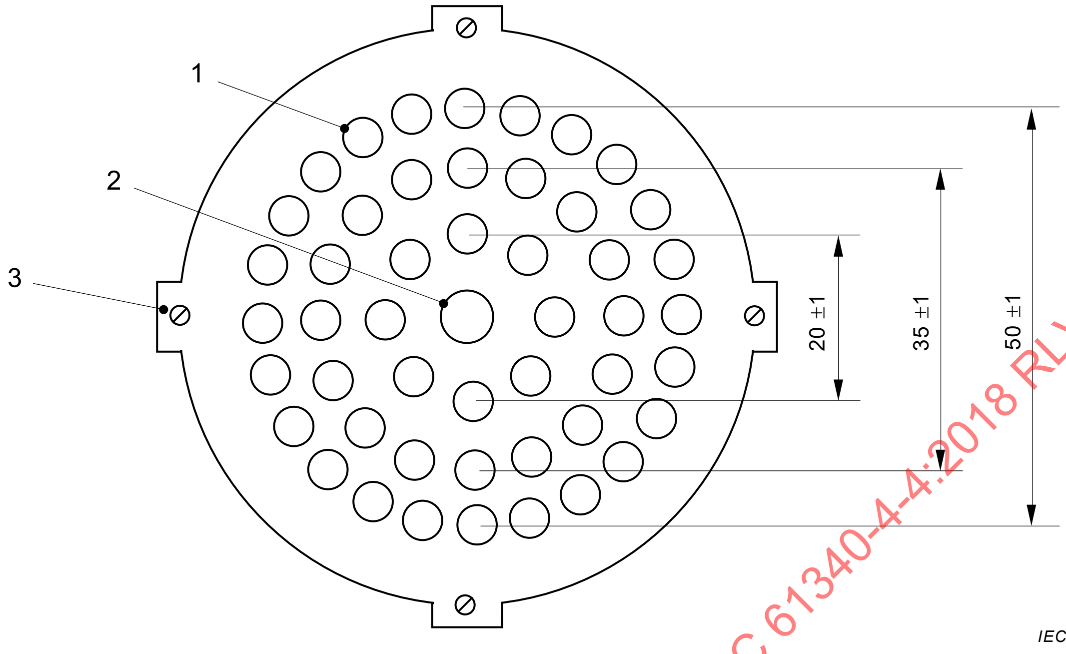


Key

1 discharge electrode
2 adjustable shroud made from insulating material (e.g. polycarbonate or acrylic)
3 cylinder made from insulating material (e.g. polycarbonate or acrylic)
4 perforated metal plate (2 mm nominal thickness)
5 fine metal mesh or gauze (e.g. copper)
6 beads (e.g. glass or porcelain), 1 mm to 2 mm diameter (nominal)
7 robust earth connection
8 earth connector
9 inlet port for flammable gas

Figure 6 – Ignition probe

Dimensions in millimetres



Key

1 perforation (5 ± 1) mm diameter

2 mounting hole for discharge electrode

3 screw for securing plate to body of ignition probe

Figure 7 – Perforated metal plate for use in ignition probe

9.3.1.3 Gas control and mixing apparatus

The flammable gas is generated by mixing ethylene (minimum 99,5 % purity) with air. The air used shall contain (21,0 ± 0,5) % oxygen and (79,0 ± 0,5) % nitrogen. The gas control and mixing apparatus is used to direct the gas in the appropriate proportions to the ignition probe (see Figure 8).

The volume concentrations of gas used are shown in Table 7.

Table 7 – Volume concentrations of flammable gas mixture

Gas	Composition	Volume concentration %	Minimum ignition energy mJ	Critical quenching distance mm
Ethylene	≥ 99,5 % C_2H_4	5,4 ± 0,1	0,14 ± 0,01	1,8 ± 0,1
Air	(21,0 ± 0,5) % O_2 (79,0 ± 0,5) % N_2	94,6 ± 0,1		

The control of the gas mixture within the specified tolerances shall be checked using, for example, an infra-red ethylene gas analyser sampling the gas mixture supply line.

If a gas mixture other than that specified in Table 7 is used, the minimum ignition energy of the gas mixture shall be verified using the ASTM E582 method to be (0,14 ± 0,01) mJ.

NOTE 1 If a gas other than ethylene is used, the critical quenching distance can be different to that specified in Table 7.

It is convenient to use compressed gas cylinders for the gas supply, but other sources of supply may be used. A pre-mixed cylinder of (21,0 ± 0,5) % oxygen and (79,0 ± 0,5) %

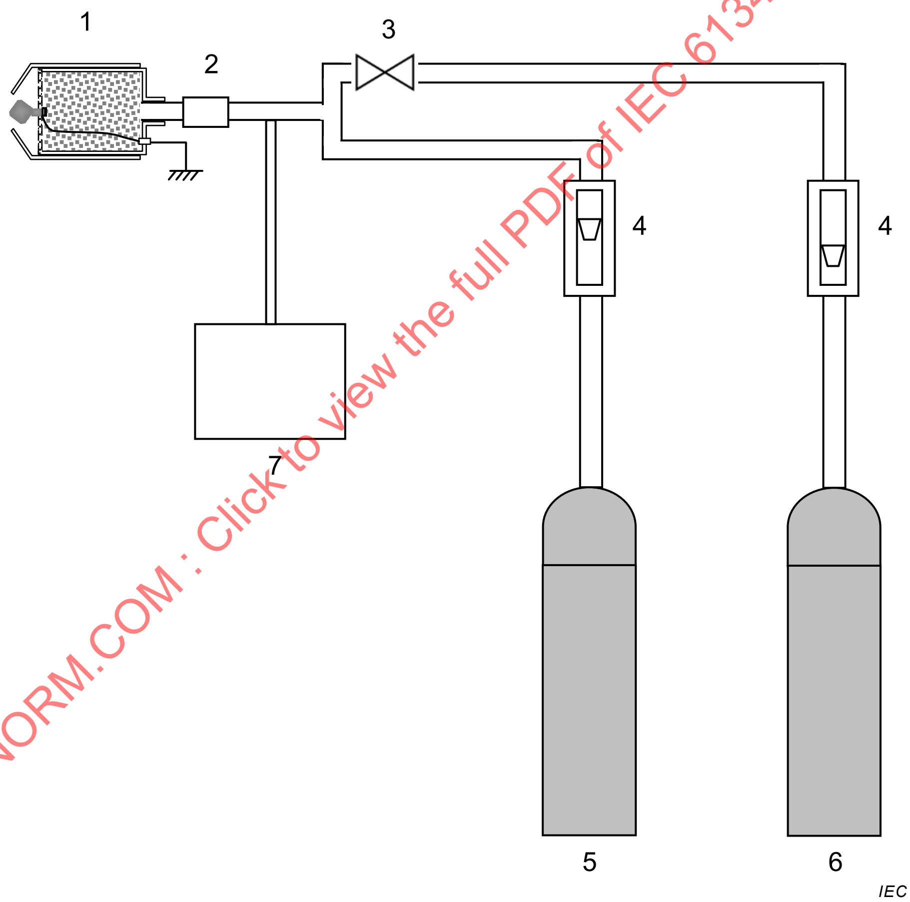
nitrogen may be used in place of air. If necessary, molecular sieve filters shall be used to ensure the gases have low moisture content. This is particularly important, for example, when using air directly from a compressor. Gases of at least 99,5 % purity shall be used.

"Breathing air", i.e. compressed air with low moisture and oil content, has a wider tolerance of oxygen concentration than is specified in Table 7 and shall not be used unless analysis shows that it meets the composition limits in Table 7.

NOTE 2 Some molecular sieves can absorb ethylene, so it is important to position the sieve filter before the gas reaches monitoring equipment.

Each gas supply is controlled and monitored using flowmeters and valves. The combined flow-rate of all gases through the ignition probe shall be (0,21 ± 0,04) l/s.

A fast action shut-off valve is used to stop the flow of ethylene when ignition occurs. The shut-off valve shall stop the supply of ethylene whilst leaving the air to flow freely to provide cooling and drying of the ignition probe after ignition has occurred. The type and location of the shut-off valve shall be selected as appropriate to the specific design of the overall apparatus.



Key

1 ignition probe

2 flame arrestor

3 ethylene shut-off valve

4 flowmeters

5 air or oxygen/nitrogen mixture

6 ethylene

7 ethylene analyser

Figure 8 – Gas control and mixing apparatus (schematic)

9.3.1.4 Re-circulating FIBC filling rig

A rigid steel framework, or other suitable support, is used to hold test FIBC so that they can be filled with charged product (see Figure 9). To minimize the influence of the steel framework on the electrostatic fields associated with the charged FIBC, any support framework around the sides of the FIBC shall be at least 1 m away from it.

Test FIBC are filled with polypropylene pellets (see Annex B) with a volume resistivity of at least 1,0 x 10^{12} Ωm. The pellets shall be homopolymer without fillers, pigments, antistatic additives, etc. Other materials may be used only after it has been determined that they produce equivalent results and do not generate cone discharges.

NOTE One way of checking the equivalence of different pellet materials is to carry out the procedures specified in 9.3.2 to establish that the voltage applied to the corona charging unit generates the same charging current.

One means of circulating pellets is to position a hopper immediately below the test FIBC to collect the pellets and feed them to a conveyor where they are transported to the filling chute and loaded back into the test FIBC. Other means of circulating pellets may be equally suitable. The filling rate shall be (1,1 ± 0,1) kg of product per second.

The polypropylene pellets will naturally become charged by triboelectric action, but additional charge shall be injected by the incorporation of high-voltage corona points inside the filling pipe (see Figure 10). The size, number and geometry of corona points may vary, but shall be designed to ensure efficient charging of the pellets, which shall be verfied using the procedure specified in 9.3.2. An insulating shroud surrounding the corona-charging unit prevents direct contact with the FIBC. A high-voltage DC power supply is used to control the corona-charging unit, which shall maintain the average charging current at (3,0 ± 0,2) μA with the instantaneous maximum not exceeding 4,0 μA and the instantaneous minimum not less than 2,0 μA. The polarity of charge shall be negative. The corona charging unit shall not introduce charge into the FIBC under test when no pellets are flowing.

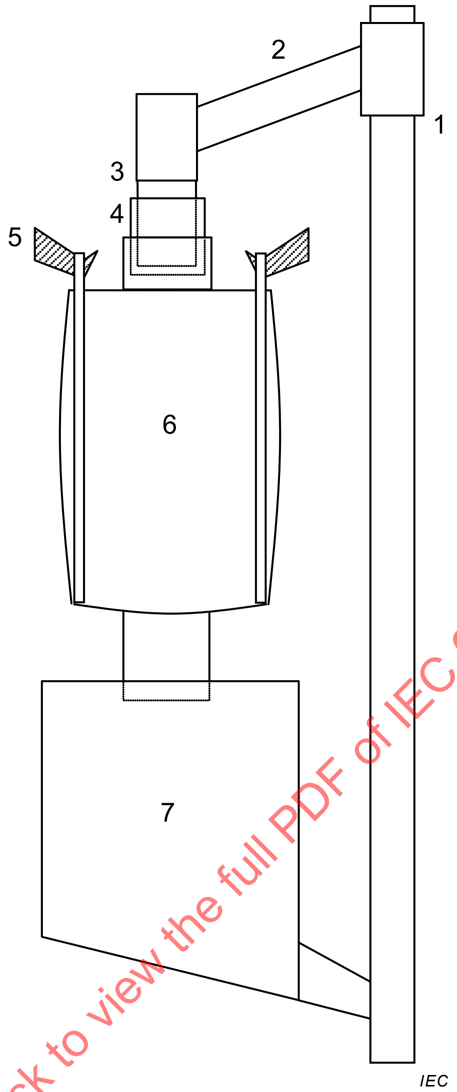
It is recommended that pellets be changed regularly. It is not possible to specify intervals for changing pellets, but as a guide they should be changed whenever there are obvious signs of contamination, physical degradation, when the level of tribocharging is significantly reduced, or when there is an obvious build-up of fines.

All sections of the test FIBC, including the discharging spout, shall be accessible for approach with the ignition probe.

Depending on the design of the filling rig and its location, it may be necessary to provide a working platform to support the test apparatus and personnel.

For FIBC that are not required to be earthed during normal use, insulation shall be inserted between the lifting loops and the support points on the metal framework, such that the resistance to earth shall be at least 1,0 x 10^{12} Ω.

All metal support framework, working platforms and any other conductors, including personnel, within 1 m of the test FIBC, shall be earthed, irrespective of the type of FIBC being tested.



Key

1 means of conveying pellets

2 transfer pipe

3 corona charging unit

4 insulating shroud

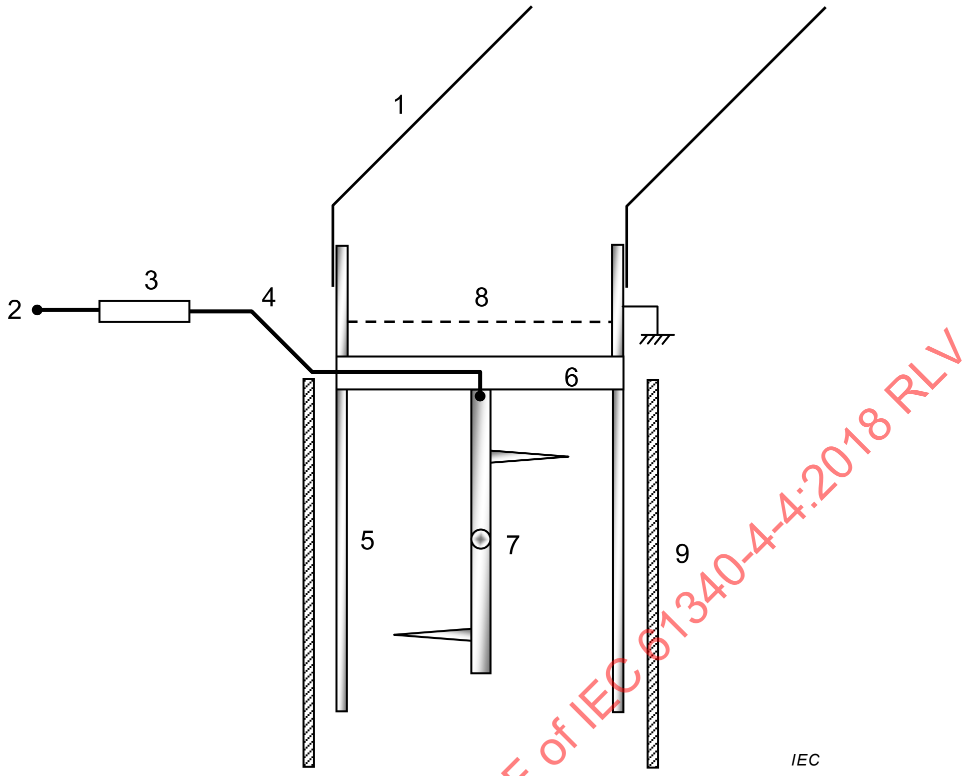
5 means of supporting FIBC

6 FIBC

7 collecting hopper

NOTE This figure shows an example of a rig for FIBC with four lifting loops; other designs can be required when testing, for example, single-point liftable FIBC.

Figure 9 – FIBC filling rig (schematic)



Key

1 transfer pipe

2 input from high-voltage DC power supply (negative polarity)

3 decoupling resistor ~ 10^7 Ω

4 insulated high-voltage connecting lead

5 earthed metal cylinder

6 insulating rod (e.g. PTFE)

7 metal rod carrying an array of pointed corona electrodes

8 earthed metal mesh to prevent damage to the corona array from large objects (mesh size > pellet size)

9 insulating shroud to prevent FIBC contacting corona charging unit

Figure 10 – Corona charging unit (schematic)

9.3.1.5 Charge measuring apparatus

The charge measuring apparatus comprises two main parts: a Faraday pail for collecting charged pellets and a means of measuring the charge flowing into the Faraday pail. It is convenient to use a conductive FIBC as a Faraday pail. The FIBC shall be constructed entirely from conductive material or at least shall contain fully inter-connected conductive threads or tapes with a maximum spacing of 20 mm, if the threads or tapes are in a stripe pattern, or 50 mm if they are in a grid pattern. The resistance to groundable point of the FIBC shall be less than 1,0 x 10^8 Ω when measured according to 9.4.

An electrometer is used to measure the charge flowing into the conductive FIBC. The electrometer shall either have an average, minimum and maximum function or shall have a suitable signal output from which the average, minimum and maximum charging current can be determined by means of a suitable instrument (e.g. digital multimeter, oscilloscope, data logger).

9.3.2 Establishing correct charging current

Mount the conductive FIBC (9.3.1.5) in the filling rig (9.3.1.4) ensuring that the resistance from the conductive FIBC to the filling rig, or from the conductive FIBC to any other earth connection, is at least 1,0 x 10^{12} Ω.

Connect the electrometer (9.3.1.5) to the groundable point on the conductive FIBC and connect the electrometer to ground. If a separate averaging instrument (9.3.1.5) is to be used, connect it to the electrometer.

Begin pellet flow of (1,1 ± 0,1) kg/s into the FIBC and apply desired voltage to the corona charging unit.

Once the bottom of the FIBC is filled with pellets and a consistent cone of pellets has been formed, proceed with performing average measurements.

Using the average function on the electrometer or the separate averaging instrument, perform 1 min data samples three times and record the average charging current for each 1 min period. Average the three 1 min averages and record the average charging current with the voltage applied to the corona charging unit.

Repeat the procedure until the voltage level applied to the corona charging unit to produce (3,0 ± 0,2) µA is determined. For subsequent testing, this voltage level shall be applied to the corona charging unit.

9.3.3 Ignition tests

9.3.3.1 General

Ignition tests are carried out by bringing the ignition probe (9.3.1.2) up to the wall of the charged test FIBC with the flammable gas mixture flowing through the probe. The following test sequence is designed to produce at least 200 ignition tests on the test FIBC. The test sequence may be terminated at any time after a single verifiable ignition has occurred, the test FIBC having failed to meet the requirements specified in 7.3.2.

It may be necessary to fill and empty the test FIBC several times in order to complete the required number of ignition attempts. For FIBC without an outlet, a suitable size cut shall be made in the base. In this case, it may be necessary to use several FIBC of the same design and size in order to complete the full test sequence.

The whole sequence of ignition attempts shall be made at locations distributed evenly on each of the four walls of the test FIBC (50 ignition attempts on each wall). For FIBC that do not have four clearly defined sides, 200 ignition attempts shall be made at locations distributed evenly over the area of the FIBC. Additional ignition attempts (10 on each panel) shall be made on any panel attached to the test FIBC (e.g. flaps covering spouts), on any panel that differs substantially in its construction compared to the rest of the test FIBC and on any label or document pouch greater than 100 cm² in area. Labels and document pouches less than 100 cm² and lifting straps do not need to be tested.

By arrangement between interested parties, ignition attempts may be made at other locations in addition to those specified in this document. In such cases, the position of additional measurement points shall be described in the test report. Any verifiable ignition (see 9.3.3.4) that occurs during such testing shall result in the FIBC under test failing to meet the requirements of 7.3.2.

9.3.3.2 Procedure

With the discharging spout of the FIBC closed, start the flow of pellets at (1,1 ± 0,1) kg/s and apply the voltage determined in 9.3.2 to the corona charging unit. Allow the pellets to fill the base of the FIBC. When the fill level has started to move up the walls of the FIBC, start the gas mixture flowing through the ignition probe and allow it to flow for at least 30 s before any ignition attempt is made.

An ignition attempt is made by bringing the ignition probe up to one wall of the FIBC at a point at least 100 mm below the fill level. The speed of approach of the probe shall be (0,75 ± 0,25) m/s. Too slow an approach may cause corona to reduce local charge levels. Too fast an approach may cause quenching of the nascent flame kernel.

The occurrence of cone discharges is avoided during this test procedure by bringing the ignition probe up to the FIBC at least 100 mm below the fill level.

9.3.3.3 No probe ignition

If no ignition occurs, remove the ignition probe and wait 10 s to 15 s before approaching the probe toward the next measurement point and continue with the ignition testing procedure.

Make as many attempts as possible at different points on the wall of the FIBC, including edge seams, until the FIBC is three-quarters full.

Visual checks shall be made after every 10 attempts to ensure the voltage supplied to the corona charging unit is as determined in 9.3.2, and the gas flow rates and ethylene concentration are as specified in 9.3.1.3. If necessary, adjust the test apparatus so that all parameters are within the specified ranges before continuing ignition testing and discount the previous 10 attempts.

When the FIBC is three-quarters full, stop the inflow of pellets and the corona charging. If the FIBC has an outlet, open the outlet and, as pellets flow out of the FIBC, make as many ignition attempts as possible alternating between the wall and, if fitted, the discharging spout. The time between each successive ignition attempt while the FIBC is emptying shall not be greater than 2 s. If the FIBC is a full open base design, it may only be possible to make one ignition attempt, which shall be made just before the FIBC completely empties.

If the FIBC is fitted with an inner liner and the discharge spout of the inner liner protrudes outside the discharge spout of the FIBC while emptying, additional ignition attempts shall be directed at the discharge spout of the inner liner.

If the FIBC is not fitted with an outlet and is designed to be emptied by vacuum or by tipping, it is not necessary to carry out ignition testing whilst emptying the FIBC.

If the FIBC is not fitted with an outlet and is designed to be emptied by cutting the base or by dropping the FIBC on to a spike, then a cut shall be made in the base that is similar in size to that made in practice, and as many ignition attempts as possible shall be made while the FIBC is emptying.

If, having completed at least 200 verified ignition attempts, no ignition has occurred, the test FIBC has met the requirements specified in 7.3.2.

9.3.3.4 Probe ignition

If ignition occurs, remove the ignition probe and make sure the flame is fully extinguished by shutting off the supply of flammable gas. Immediately verify that the concentration of ethylene, the air flow rate and the charging current are within the specified ranges. If all parameters are within tolerance, the ignition is recorded, the test FIBC fails to meet the requirements specified in 7.3.2 and the ignition testing may be stopped.

If the ethylene concentration, air flow rate or charging current are not within tolerance, the ignition is discounted, as well as all attempts since the last time the test parameters were verified. Adjust the test apparatus as necessary so that all parameters are within the specified ranges and recommence ignition testing.

If verified ignition occurs, and the option of further testing is chosen for additional information needs, allow air (or oxygen/nitrogen) only to flow for at least 60 s to cool and dry the ignition probe, re-start the flammable gas flow and wait at least 30 s before approaching the probe toward the next measurement point and continue with the ignition testing procedure.

Visual checks shall be made after every 10 attempts to ensure the voltage supplied to the corona charging unit is as determined in 9.3.2, and the gas flow rates and ethylene concentration are as specified in 9.3.1.3. If necessary, adjust the test apparatus so that all parameters are within the specified ranges before continuing ignition testing and discount the previous 10 attempts.

When the FIBC is three-quarters full, stop the inflow of pellets and the corona charging. If the FIBC has an outlet, open the outlet and, as pellets flow out of the FIBC, make as many ignition attempts as possible alternating between the wall and, if fitted, the discharging spout. The time between each successive ignition attempt while the FIBC is emptying shall not be greater than 2 s. If the FIBC is a full open base design, it may only be possible to make one ignition attempt, which shall be made just before the FIBC completely empties.

If the FIBC is fitted with an inner liner and the discharge spout of the inner liner protrudes outside the discharge spout of the FIBC while emptying, additional ignition attempts shall be directed at the discharge spout of the inner liner.

If the FIBC is not fitted with an outlet and is designed to be emptied by vacuum or by tipping, it is not necessary to carry out ignition testing whilst emptying the FIBC.

If the FIBC is not fitted with an outlet and is designed to be emptied by cutting the base or by dropping the FIBC on to a spike, then a cut shall be made in the base that is similar in size to that made in practice, and as many ignition attempts as possible shall be made while the FIBC is emptying.

9.3.3.5 Recording results

Record the total number of acceptable ignition attempts and the number that result in verifiable ignition of the flammable gas mixture.

The test FIBC shall be considered to meet the requirements of 7.3.2 if no verifiable ignition occurred and the total number of ignitions attempts under the correct test conditions is at least 200.

If one or more ignitions are discounted because of incorrect test conditions (see 9.3.3.4), the FIBC shall only be considered to meet the requirements of 7.3.2 if subsequent testing on the same FIBC produced no verifiable ignitions and the total number of ignitions attempts under the correct test conditions is at least 200.

The test FIBC shall be considered to fail the requirements of 7.3.2 if one or more verifiable ignitions occur.

9.4 Resistance to groundable point

9.4.1 Apparatus

9.4.1.1 Resistance-measuring apparatus

9.4.1.1.1 General

A self-contained resistance meter (ohmmeter) or power supply and current meter in the appropriate configuration for resistance measurement, with a ±10 % accuracy, and capable of the requirements described in 9.4.1.1.2 and 9.4.1.1.3.

9.4.1.1.2 For laboratory evaluations

The apparatus shall have a circuit voltage while under load of (10 ± 0,5) V for resistance below $1,0 \times 10^6$ Ω, (100 ± 5) V for a resistance between $1,0 \times 10^6$ Ω and $1,0 \times 10^{11}$ Ω, and (500 ± 25) V for a resistance above $1,0 \times 10^{11}$ Ω. The measuring range of the apparatus shall be at least one order of magnitude either side of the expected range of resistance being measured. The apparatus shall be used in a manner that ensures unintended ground paths do not influence measurements.

9.4.1.1.3 For acceptance testing

A laboratory evaluation apparatus (see 9.4.1.1.2) shall be used for acceptance testing, or the following.

The apparatus shall have an open circuit voltage of (10 ± 0,5) V for a resistance below $1,0 \text{ x } 10^6$ Ω, (100 ± 5) V for a resistance between $1,0 \text{ x } 10^6$ Ω and $1,0 \text{ x } 10^{11}$ Ω, and (500 ± 25) V for a resistance above $1,0 \text{ x } 10^{11}$ Ω. The measuring range of the apparatus shall be at least one order of magnitude either side of the expected range of resistance being measured. The apparatus shall be used in a manner that ensures unintended ground paths do not influence measurements.

In case of dispute, laboratory evaluation apparatus shall be used.

9.4.1.2 Measuring electrodes

9.4.1.2.1 Materials without conducting threads

The measuring electrode for materials without conducting threads shall consist of a metal plate or block with a contact area of (25 ± 1) mm × (25 ± 1) mm. The electrode is faced with a soft conductive rubber (nominal Shore A durometer hardness of 30 and volume resistivity less than $1,0 \text{ x } 10^4$ Ωm) with the same size contact area. Alternatively, non-conductive rubber or foam may be used with an aluminium foil covering to provide electrical contact to the metal plate or block.

9.4.1.2.2 Material with conducting threads

The measuring electrode for materials with conducting threads shall be a sharp metal point with a radius of curvature of (0,25 ± 0,05) mm, a cone angle at the tip of (20 ± 1)° and a major diameter of (1,5 ± 0,5) mm.

9.4.2 Test procedure

Suspend the FIBC under test by its lifting loops so that it hangs freely with no part of the main bag touching the floor or any other structure. The resistance between any part of the FIBC and earth shall be at least $1,0 \text{ x } 10^{12}$ Ω.

For FIBC containing conducting elements within their lifting loops, insulation shall be inserted between the lifting loops and the support points on the metal framework, such that the resistance to earth shall be at least 1,0 x 10^{12} Ω.

Connect one test lead from the resistance-measuring apparatus to a groundable point on the FIBC using a clip that assures good electrical contact.

Connect the other test lead from the resistance measuring apparatus to the measuring electrode.

For materials without conducting threads, hold the soft-faced electrode (see 9.4.1.2.1) against the surface of the FIBC under test. It may be necessary to insert some insulating material into the FIBC of sufficient weight to keep the sides of the FIBC in tension during measurements.

For materials with conducting threads, select a single thread and ensure the pointed electrode (see 9.4.1.2.2) makes contact. In some cases, the fabric structure or a coating may cover a conducting thread. A sharp point enables the electrode to penetrate the fabric or coating to make contact with the conducting thread.

Starting with the voltage set to 10 V, take a reading of the resistance (15 ± 2) s after applying the test voltage. If the value exceeds 1,0 x 10^6 Ω, select 100 V and repeat the measurement. If the value for this second measurement exceeds 1,0 x 10^{11} Ω, select 500 V and make a final measurement. Record the reading, which matches the voltage and resistance range specified in 9.4.1.1, unless either of the following situations occurs:

a) the measured resistance at 10 V is greater than 1,0 × 10^6 Ω and the measured resistance at 100 V is less than 1,0 × 10^6 Ω; or
b) the measured resistance at 100 V is greater than 1,0 × 10^{11} Ω and the measured resistance at 500 V is less than 1,0 × 10^{11} Ω;

in which case the resistance measurement made at the higher voltage level shall be recorded.

At least 10 measurements shall be made at locations distributed evenly on each panel in the FIBC, including top and bottom panels, internal reinforcements, discharge and filling spouts, skirts, etc., and the full series of measurements shall be repeated for each groundable point, including lifting loops if they are designated as such. If the FIBC under test contains conducting threads, the 10 measurements made on each panel shall be made on different threads.

Additional measurements shall be made on any label or other attachment made from materials with surface resistivity less than 1,0 × 10^9 Ω, measured according to IEC 61340-2-3 under the conditions specified in 8.2.

For FIBC that do not have four clearly defined sides, at least 40 measurements shall be made at locations distributed evenly over the area of the FIBC.

A careful visual inspection shall be carried out of the entire FIBC to identify any area that appears to differ in any way from the rest of the FIBC. If the FIBC under test contains conducting threads, a visual inspection shall be used to identify possible break points, missing or damaged threads. Additional resistance measurements shall be carried out on all areas identified during the visual inspection.

10 Test report

10.1 General

The test report shall include at least the information in 10.2 to 10.7.

10.2 For all types of testing

a) reference to this document;
b) date of testing;
c) details of equipment calibration;
d) atmosphere for conditioning and testing;
e) description of test samples (for FIBC description shall be as defined in Table 8 below);
f) details of any pre-treatment;
g) for each FIBC sample tested, a statement as to whether or not it meets the requirements specified in Clause 7;
h) for each inner liner tested, a statement as to whether or not it meets the requirements specified in 4.2;
i) details of any deviations from this document.

10.3 For electrical breakdown voltage testing

a) the maximum electrical breakdown voltage measured for each material in the FIBC or inner liner; or
b) a statement indicating that electrical breakdown voltage cannot be determined because of conductivity within the material.

10.4 For ignition testing

a) whether FIBC are isolated or earthed during testing, and how the FIBC are earthed, including the resistance to earth;
b) volume concentrations of gas mixture;
c) minimum ignition energy of gas mixture;
d) for each sample tested, the number of ignition attempts made;
e) for each sample tested, the location of any additional measurement points;
f) for each sample tested, the number of ignitions achieved.

10.5 For resistance to groundable point testing

a) the maximum resistance to a groundable point;
b) the applied test voltage.

10.6 For surface resistivity testing of inner liners, labels and document pockets

a) the minimum and maximum surface resistivity on each side of the sample;
b) the applied test voltage.

10.7 For test reports issued by accredited testing authorities

a) the accreditation number of the testing authority;
b) a unique certificate or test report number.

Table 8 – Example of full sample description to be included in the test report

Detail	Notes
FIBC description	Code and trade name
Manufacturer's name and address	
Method of construction	
Nominal load (kg)	
Material type and grade	
Tare mass (kg)	
Number of plies	
Grammage of material per square metre (g/m^2)	
Fabric (warp/weft), tapes per 100 mm	
Coating material, thickness (μm), weight (g/m^2)	
Liner material, thickness (μm)	
Design drawing	
Dimensions (mm)	
Filling aperture	Position, design, internal diameter (mm), closure material and grammage (g/m^2)
Discharge aperture	Position, design, internal diameter (mm), closure material and grammage (g/m^2)
Sewing	Type, constructive thread
Conductive thread or dissipative yarns, tapes or coatings	Type, distance between threads (mm), position of earth bonding points
Form of liner attachment	
Filler cord	
Adhesive type	

Annex A
(informative)

Electrical breakdown voltage – Typical voltage/time graphs

Figures A.1 and A.2 show representations of voltage/time graphs for electrical breakdown voltage measurements made by the method specified in 9.2.

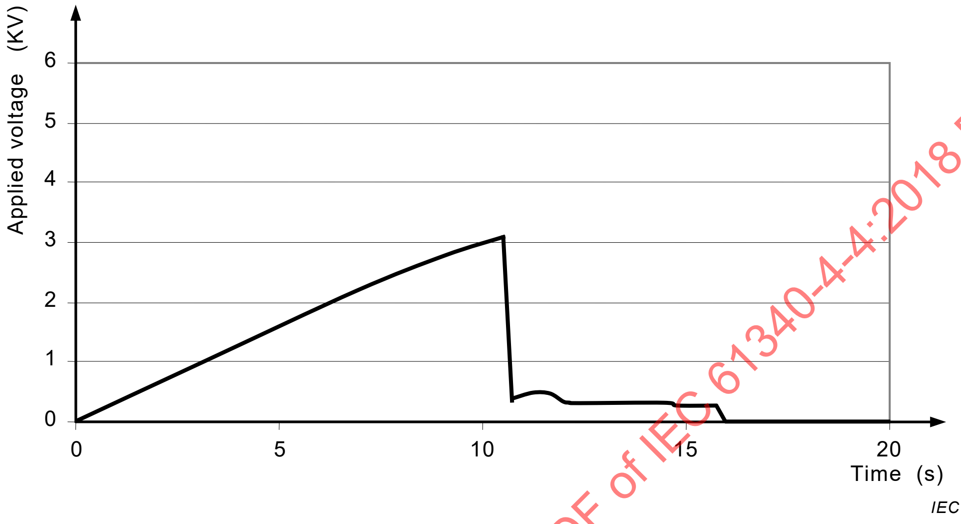


Figure A.1 – Example of voltage/time graph for material showing distinct breakdown

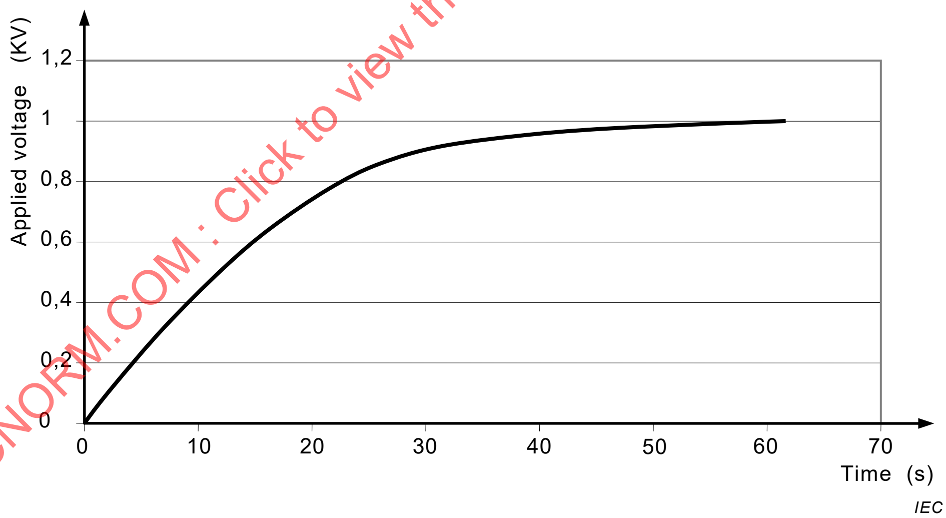


Figure A.2 – Example of voltage/time graph for material showing reduction in rate of voltage rise because of conduction within the test material

Annex B
(normative)

Polypropylene pellets for ignition testing

The particle size distribution of nominally spherical polypropylene pellets suitable for use in ignition testing (see 9.3) is shown in Table B.1.

Table B.1 – Particle size distribution of polypropylene pellets

	Particle size distribution									**Total mass**
Sieve size	4	4 x 5	5 x 6	6 x 8	8 x 12	12 x 16	16 x 30	30 x 40	PAN	
Mean opening (mm)		4,38	3,68	2,87	2,03	1,44	0,89	0,51		
Mass (g)	0,00	1,22	15,28	86,94	124,47	52,64	2,46	0,02	0,01	283,04
Mass fraction (%)	0,00	0,43	5,40	30,72	43,98	18,60	0,87	0,01	0,00	
Mean particle diameter: 2,27 mm.										

Annex C
(informative)

Guidance on test methods for manufacturing quality control

C.1 Introductory remarks

Quality control testing is carried out by manufacturers to ensure that FIBC are within manufacturing specification before leaving the factory. Similar test procedures may also be carried out by users who wish to check that FIBC meet their requirements before accepting them for use in their facilities.

As quality control testing may be carried out on a daily basis, often on multiple samples, it is preferable for test methods and procedures to be simple and quick to perform at an acceptable cost. The test procedures specified in Clause 9 can be used for quality control testing, but for many manufacturers and users they may be too complex, too time consuming or too expensive.

In contrast to type qualification testing, where FIBC are evaluated against standard acceptance criteria, quality control testing allows manufacturers and users to evaluate FIBC against acceptance criteria that they specify and which are often only valid for a specific design of FIBC or application. For this reason, quality control test methods and acceptance criteria used by one manufacturer or user may not be appropriate for evaluating FIBC from other manufacturers or FIBC intended for other specific uses.

The test methods described in Clause C.2 may be useful for quality control testing. The list of test methods is not comprehensive and there may be other test methods that are equally suitable. Manufacturers or users should ensure that quality control testing is suitable for their own needs.

Quality control testing should be designed to provide manufacturers and users with information that demonstrates all FIBC produced and delivered are substantially the same as the sample FIBC used to qualify the FIBC design. Quality control test methods, other than those specified in Clause 9, if used for this purpose, should not be used as a substitute for type qualification test methods, and should not be used by manufacturers to promote their FIBC in a way that might conflict with the requirements specified in Clause 7.

C.2 Test methods

C.2.1 Resistance measurements

Resistance measuring apparatus other than that specified in 9.4.1.1 may be used for quality control testing. Simple resistance meters or multimeters that are widely available at low cost may be used in place of more expensive laboratory grade apparatus for quickly checking the electrical continuity between panels in Type C FIBC. Measurements may also be made on materials to ensure that they are sufficiently conducting for use in Type C FIBC.

For convenience, resistance measurements for quality control testing may be carried out on FIBC whilst they are on an inspection table, for example. Care should be taken to avoid creating electrical connections between panels that may not be present during normal FIBC filling and emptying operations.

Resistance measurements may be used for quality control testing for some designs of Type D FIBC. The test procedures specified in 9.4 or other procedures may be used to check that the resistance of materials is neither too low nor too high.

C.2.2 Charge decay measurements

IEC 61340-2-1 [4] specifies test methods for measuring the ability of materials and products to dissipate static electric charge. The apparatus specified in 4.3 may be useful for quality control testing of some materials used in the construction of Type D FIBC.

The point at which timing is started and stopped, as well as the acceptable charge decay time, should be selected by manufacturers or users in accordance with their own requirements. A very short decay time may indicate that the material under test is too conductive and may give rise to sparks. An excessively long decay time may indicate that the material under test does not have the ability to dissipate charge at the rate required for Type D FIBC and may give rise to brush discharges. As a general guide, decay time constants between 500 ms and 30 s may be acceptable. It should be noted, however, that some materials used in the construction of Type D FIBC may have charge decay times outside of these limits.

C.2.3 Charge transfer measurements

The principle of charge transfer measurements is to provoke an electrostatic discharge to an electrode connected to a measuring system to determine the quantity of charge transferred in the discharge.

Charging of FIBC should be carried out using the re-circulating FIBC filling rig described in 9.3.1.4. To charge materials and FIBC where the use of a re-circulating FIBC filling rig is not available, or practical, alternative charging methods can be employed, such as rubbing with other materials, which, in combination with the FIBC material, have a high electrostatic charging propensity, or by spraying with charge generated by a high-voltage corona array.

IEC 60079-32-2 [2] describes test apparatus and procedures that may be used to charge materials and make charge transfer measurements. The specified rubbing materials may not be appropriate for charging all types of FIBC, in which case they may be substituted for other, more suitable materials.

The maximum charge transfer limits shown in IEC TS 60079-32-1 [1] are based on electrostatic discharges from homogeneous, non-conductive materials. The nature of electrostatic discharges from some static protective FIBC may differ in both spatial and temporal characteristics to the type of discharge used to derive the data shown in IEC TS 60079-32-1 [1]. For quality control testing, manufacturers or users should establish maximum charge transfer limits applicable to their own products or applications.

Annex D
(normative)

Classification of hazardous areas and zones

Tables D.1 and D.2 describe the classification of hazardous areas, explosion groups and hazardous zones defined in IEC 60079-10-1 and IEC 60079-10-2.

Table D.1 – Classification of hazardous areas in IEC 60079-10-1 and IEC 60079-10-2

Classification		Description of the area
I	Mines susceptible to firedamp	
II	Places with an explosive gas atmosphere other than mines, consisting of	
	A	Normal incendive gases and vapours, e.g. hexane, methane, acetone
	B	Highly incendive gases and vapours, e.g. diethyl ether, ethylene, cyclopentane
	C	Very highly incendive gases and vapours, e.g. hydrogen, ethyne, carbon disulphide
III	Places with an explosive dust atmosphere other than mines, consisting of	
	A	Combustible flyings
	B	Non-conductive dust
	C	Conductive dust

NOTE 1 A substance classified with a specific explosion group produces an area of the same explosion group in its vicinity.

NOTE 2 The ignition hazard increases from A to C.

Table D.2 – Classification of zones in IEC 60079-10-1 and IEC 60079-10-2

Zone	Description of the zone
0	Place in which an explosive atmosphere consisting of a mixture with air of flammable substances in the form of gas, vapour or mist is present continuously or for long periods, or frequently.
1	Place in which an explosive atmosphere consisting of a mixture with air of flammable substances in the form of gas, vapour or mist is likely to occur in normal operation occasionally.
2	Place in which an explosive atmosphere consisting of a mixture with air of flammable substances in the form of gas, vapour or mist is not likely to occur in normal operation but, if it does occur, will persist for a short period only.
20	Place in which an explosive atmosphere, in the form of a cloud of combustible dust in air, is present continuously, or for long periods or frequently for short periods. NOTE Places where piles of dust are present but where dust clouds are not present continuously, or for a long period, or frequently are not included in this zone.
21	Place in which an explosive atmosphere, in the form of a cloud of combustible dust in air, is likely to occur occasionally in normal operation.
22	Place in which an explosive atmosphere, in the form of a cloud of combustible dust in air, is not likely to occur in normal operation but, if it does occur, will persist for a short period only.

Annex E
(informative)

Risks associated with cone discharges

This document describes procedures for evaluating the ignition risk presented by electrostatic discharges related to the construction, fabric and all parts of the FIBC itself in flammable or explosive environments.

It should however be kept in mind that filling charged, high resistivity powder into containers may generate a region of very high space charge density within the heap of bulked powder. This leads to high electrical fields at the top of the heap. Under those circumstances, large discharges running (radially, in the case of cylindrical containers) along the surface have been observed. These discharges are related to the charge retained on the product. They occur independently of the type of FIBC being filled. They occur as well in an earthed metal container.

The conditions necessary for this type of discharge are complex; the influencing factors are resistivity of bulked powder, charging current, volume and geometry of bulked powder and particle size. It has been reported that atmospheres of flammable gases and vapours as well as atmospheres of sensitive combustible powders can be ignited by this type of discharge. The average energy released in cone discharges depends on the container diameter and the particle size (median) of the products forming the powder heap.

The MIE limit of 3 mJ specified in Table 5 is based on the incendivity of cone discharges. Cone discharges may have a much higher energy in Type B FIBC than in Type C or D FIBC because the walls of Type C or D FIBC will be at close to zero potential. Based on this fact, the internal field distribution will be such that in Type C or D FIBC, cone discharges will at most only jump across half the diameter of the FIBC, but in Type B FIBC cone discharges may jump across the full diameter of the FIBC. Energy calculations predict that in Type B FIBC, cone discharges may be incendiary to powders with MIE of up to 3 mJ, whereas in Type C and Type D FIBC, calculations for the same powders predict cone discharge energy below the powder MIE.

More information about cone discharges is given in IEC TS 60079-32-1 [1].

Annex F
(informative)

Explanation for resistance and resistivity limits, and thickness limits for insulating layers of inner liners

F.1 Resistance to groundable point limit for Type C FIBC

The maximum permitted resistance between a conductor and earth is determined by the charging current. Hazardous sparks from conductors can be eliminated by connecting the conductor to earth through a resistance that is no greater than the value obtained by dividing the spark onset potential by the charging current. The resistance to groundable point limit of 1,0 x 10^8 is such that a charging current significantly greater than 30 μA is required to generate hazardous potentials on Type C FIBC (Yamaguma *et al*, 2015 [8]). Such high charging currents are not generated during normal FIBC filling and emptying operations. Therefore, by setting the resistance to groundable point limit at 1,0 x 10^8 Ω, Type C FIBC can be used without further consideration of charging current.

F.2 Resistivity of inner liners

The upper resistivity limit for Type L1 inner liners is set at 1,0 x 10^8 Ω so that they are compatible with the requirements for Type C FIBC as explained in Clause F.1.

Empirical evidence (e.g. Butterworth *et al*, 1983[6]; Salmela *et al*, 2005[7]) indicates that electrostatic discharges from isolated materials with resistivity between the order of 10^9 Ω and 10^{12} Ω present minimum risk of igniting explosive atmospheres.

Isolated materials with resistivity significantly less than 10^9 Ω tend to produce spark-like discharges. One characteristic of sparks is that they release a large proportion of the electrical energy stored on a charged material. For metals and other very low resistivity materials, virtually all the stored electrical energy is released into the spark gap and is available to cause ignition. Materials with greater resistivity absorb some energy as charge moves through them, leaving less energy in the spark gap to cause ignition. At some point, the amount of energy absorbed by the material is so great that the energy transferred to the spark gap is not enough to cause ignition.

Materials with resistivity significantly greater than 10^{12} Ω are considered to be insulating and do not allow the free movement of charge. Localized areas on insulators can acquire very high surface charge densities, which can result in brush discharges that release enough energy to cause ignition.

Type L2 inner liners may be used in Type B and Type D FIBC, in which case they will normally be isolated from earth. Therefore, the resistivity of Type L2 inner liners shall not be less than 1,0 x 10^9 Ω, otherwise hazardous sparks may occur. To avoid hazardous brush discharges, the upper limit of resistivity permitted for Type L2 inner liners is set at 1,0 x 10^{12} Ω.

Further information on earthing requirements, sparks and brush discharges is given in IEC TR 61340-1 [3] and IEC TS 60079-32-1 [1].

F.3 Thickness of insulating layers of inner liners

The external field from any charge that builds up on the surface of a thin insulating material backed by a conductive or dissipative layer is attenuated by the backing layer, which reduces the risk of incendiary brush discharges from the material. The degree of attenuation diminishes as the thickness of the insulating material increases. If the thickness of the insulating material exceeds 700 µm, the risk of incendiary brush discharges becomes significant. Therefore, the thickness of any insulating layer of an inner liner that contacts the product is limited to less than 700 µm.

Bibliography

[1] IEC TS 60079-32-1, *Explosive atmospheres – Part 32-1: Electrostatic hazards, guidance*

[2] IEC 60079-32-2, *Explosive atmospheres – Part 32-2: Electrostatics hazards – Tests*

[3] IEC TR 61340-1, *Electrostatics – Part 1: Electrostatic phenomena – Principles and measurements*

[4] IEC 61340-2-1, *Electrostatics – Part 2-1: Measurement methods – Ability of materials and products to dissipate static electric charge*

[5] CLC/TR 50404, *Electrostatics – Code of practice for the avoidance of hazards due to static electricity*

[6] BUTTERWORTH, G.J., CHUBB, J.N. and PAUL, E.S., *A study of the incendivity of electrical discharges between planar resistive electrodes*, Inst. Phys. Conf. Ser. No. 66, 1983

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SOMMAIRE

COMMISSION ÉLECTROTECHNIQUE INTERNATIONALE

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ÉLECTROSTATIQUE –

Partie 4-4: Méthodes d'essai normalisées pour des applications spécifiques – Classification électrostatique des grands récipients pour vrac souples (GRVS)

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9) L'attention est attirée sur le fait que certains des éléments de la présente Publication de l'IEC peuvent faire l'objet de droits de brevet. L'IEC ne saurait être tenue pour responsable de ne pas avoir identifié de tels droits de brevets et de ne pas avoir signalé leur existence.

La Norme internationale IEC 61340-4-4 a été établie par le comité d'études 101 de l'IEC: Électrostatique.

Cette troisième édition annule et remplace la deuxième édition, parue en 2012, et l'Amendement 1:2014. Cette édition constitue une révision technique.

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

a) au vu des preuves expérimentales, la limite maximale de résistance de mise à la terre pour les GRVS de Type C, et les limites de résistance associées des revêtements protecteurs intérieurs utilisés dans les GRVS de Type C ont été augmentées de $1,0 \times 10^7\ \Omega$ à $1,0 \times 10^8\ \Omega$;

b) la classification des revêtements protecteurs intérieurs de Type L1 a été révisée et étendue aux revêtements protecteurs intérieurs de Type L1C fabriqués à partir de matériaux multicouches ayant une couche interne conductrice;

c) une exigence relative à l'étiquetage permettant d'inclure une référence à l'IEC TS 60079-32-1 concernant les recommandations relatives à la mise à la terre a été ajoutée.

Le texte de cette Norme internationale est issu des documents suivants:

FDIS	Rapport de vote
101/546/FDIS	101/555/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 internationale.

Ce document a été rédigé selon les Directives ISO/IEC, Partie 2.

Une liste de toutes les parties de la série IEC 61340, publiées sous le titre général *Électrostatique*, peut être trouvée sur le site web de l'IEC.

Le comité a décidé que le contenu de ce document 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 au document recherché. À cette date, le document sera

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INTRODUCTION

Des grands récipients pour vrac souples (GRVS) sont largement utilisés pour le stockage, le transport et la manipulation des matériaux sous forme de poudres, de paillettes ou granuleux. Ils sont généralement réalisés en toile de polypropylène sous forme de sacs cubiques d'environ 1 m^3 de volume, bien que leur forme puisse varier et que leurs dimensions puissent varier entre 0,25 m^3 et 3 m^3. La toile utilisée peut être à une seule couche, un stratifié multicouche ou une toile enduite. Le polypropylène non traité est un isolant électrique, comme c'est souvent le cas avec les produits mis dans les GRVS. Il existe un risque important de génération de charges électrostatiques au cours des opérations de remplissage et de vidage et dans les GRVS non protégés, des niveaux élevés de charge peuvent rapidement s'accumuler. Dans de tels cas, les décharges électrostatiques sont inévitables et peuvent constituer un problème grave lorsque les GRVS sont utilisés dans des atmosphères explosives dangereuses.

Une atmosphère explosive dangereuse peut être générée lors de manipulations de poudres fines qui créent des nuages de poussière, ou des couches minces de poudre, qui les uns et les autres peuvent être enflammés par des décharges électrostatiques. Une atmosphère explosive dangereuse peut également être générée lors de l'utilisation de gaz ou de solvants volatils. Dans ces situations de type industriel, il y a clairement nécessité d'éliminer les décharges électrostatiques d'inflammation.

Comme avec tout matériel industriel, il convient d'effectuer une appréciation approfondie du risque avant d'utiliser des GRVS dans des situations potentiellement dangereuses. L'objet de la présente partie de l'IEC 61340 est de décrire un système de classification, les méthodes d'essai, les exigences de performance et de conception et les procédures d'utilisation sécurisées qui peuvent être utilisés par les fabricants, les rédacteurs de spécifications et les utilisateurs finaux, en tant que partie intégrante d'une appréciation du risque de tout GRVS destiné à être utilisé dans une atmosphère explosive dangereuse. Cependant, elle ne comprend pas les procédures pour l'évaluation des risques spécifiques des décharges électrostatiques provenant de produits à l'intérieur des GRVS, par exemple les décharges de cônes, du personnel ou de matériels utilisés à proximité des GRVS. Des informations relatives aux risques associés aux décharges de cônes sont données à l'Annexe E.

ATTENTION: Les méthodes d'essai spécifiées dans le présent document impliquent l'utilisation d'alimentations électriques à haute tension et de gaz inflammables qui peuvent présenter des dangers s'ils sont manipulés de manière incorrecte, en particulier par du personnel non qualifié ou inexpérimenté. Les utilisateurs du présent document sont encouragés à effectuer les appréciations de risque appropriées et à tenir compte des réglementations locales avant d'entreprendre une quelconque procédure d'essai.

ÉLECTROSTATIQUE –

Partie 4-4: Méthodes d'essai normalisées pour des applications spécifiques – Classification électrostatique des grands récipients pour vrac souples (GRVS)

1 Domaine d'application

La présente partie de l'IEC 61340 spécifie les exigences relatives aux grands récipients pour vrac souples (GRVS) dont le volume est compris entre 0,25 m^3 et 3 m^3, destinés à être utilisés dans des atmosphères explosives dangereuses. L'atmosphère explosive peut être créée par le contenu du GRVS ou peut exister à l'extérieur du GRVS.

Les exigences comportent:

– la classification et l'étiquetage des GRVS;
– la classification des revêtements protecteurs intérieurs;
– la spécification des méthodes d'essai pour chaque type de GRVS, du revêtement protecteur intérieur, des étiquettes et des pochettes de documents;
– les exigences de conception et de performance des GRVS, des revêtements protecteurs intérieurs, des étiquettes et des pochettes de documents;
– l'utilisation sécurisée des GRVS (incluant ceux qui comportent des revêtements protecteurs intérieurs) dans des zones différentes définies pour des environnements présentant un danger d'explosion, décrite pour des zones où des poussières combustibles sont présentes ou peuvent être présentes (IEC 60079-10-2) et pour des atmosphères explosives gazeuses (IEC 60079-10-1);
– les procédures de qualification de type et de certification des GRVS, incluant l'utilisation sécurisée des revêtements protecteurs intérieurs.

NOTE 1 Des recommandations relatives aux méthodes d'essai pouvant être utilisées pour le contrôle de la qualité de fabrication sont données à l'Annexe C.

Les exigences du présent document sont applicables à tous les types de GRVS et de revêtements protecteurs intérieurs, testés dans leurs conditions de fabrication, avant utilisation, et destinés à être utilisés dans des atmosphères explosives dangereuses: Zones 1 et 2 (Groupes IIA et IIB seulement) et zones 21 et 22 (voir la classification des zones dangereuses et des groupes d'explosion à l'Annexe D). Pour certains types de GRVS, les exigences du présent document s'appliquent uniquement à une utilisation dans des atmosphères explosives dangereuses avec une énergie d'allumage minimale de 0,14 mJ ou plus et/ou les courants de charge ne dépassent pas 3,0 µA.

NOTE 2 0,14 mJ représente l'énergie d'allumage minimale réaliste pour un gaz ou une atmosphère vapeur du Groupe IIB. Bien qu'il existe des matériaux plus sensibles, 0,14 mJ est l'énergie d'allumage minimale la plus faible de tout matériau qui est susceptible d'être présent lorsque les GRVS sont vidés. 3,0 µA est le courant de charge le plus élevé que susceptible d'être rencontré dans des processus industriels communs. Cette combinaison d'énergie d'allumage minimale et de courant de charge représente les conditions les plus sévères auxquelles il est possible de s'attendre en pratique.

Les GRVS ne sont normalement pas utilisés en Zone 0 ou en Zone 20. S'ils sont utilisés en Zone 0 ou en Zone 20, les exigences du présent document s'appliquent, ainsi que des exigences complémentaires qui dépassent le domaine d'application du présent document.

Le volume contenu dans les GRVS peut être désigné comme zone 20, auquel cas les exigences du présent document s'appliquent.

Les solides contenant des résidus de solvant peuvent générer une atmosphère explosive dangereuse à l'intérieur du GRVS, ce qui peut entraîner la désignation du volume en Zone 1 ou en Zone 2; dans ce cas les exigences du présent document sont applicables.

La conformité aux exigences spécifiées dans le présent document ne garantit pas nécessairement que des décharges électrostatiques dangereuses, par exemple des décharges de cônes, ne seront pas générées par le contenu des GRVS. Des informations relatives aux risques associés aux décharges de cônes sont données à l'Annexe E.

La conformité aux exigences du présent document ne réduit pas la nécessité d'une appréciation complète du risque. Par exemple, les poudres conductrices et les poudres de toner peuvent nécessiter des précautions supplémentaires pour empêcher des décharges dangereuses des poudres.

NOTE 3 Dans les exemples mentionnés dans l'alinéa ci-dessus, des précautions supplémentaires peuvent être nécessaires dans le cas d'une poudre métallique, car si la poudre est isolée et se charge, des étincelles incendiaires peuvent apparaître, et dans le cas des poudres de toner, des décharges incendiaires peuvent apparaître au cours d'opérations de remplissage et de déconditionnement rapide. L'IEC TS 60079-32-1 [1] [1] donne des recommandations relatives aux précautions supplémentaires pouvant être nécessaires.

Les méthodes d'essai comprises dans le présent document peuvent être utilisées en association avec d'autres exigences de performance; par exemple, lorsqu'une appréciation du risque a indiqué que l'énergie d'allumage minimale concernée est inférieure à 0,14 mJ, que des courants de charge sont supérieurs à 3,0 μA ou que les conditions ambiantes sont à l'extérieur de la plage spécifiée par le présent document.

La conformité aux exigences spécifiées dans le présent document ne garantit pas nécessairement que des chocs électriques sur le personnel ne se produiront pas à partir du GRVS au cours d'une utilisation normale.

2 Références normatives

Les documents suivants cités dans le texte constituent, pour tout ou partie de leur contenu, des exigences du présent document. 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 60079-10-1, *Atmosphères explosives – Partie 10-1: Classement des emplacements – Atmosphères explosives gazeuses*

IEC 60079-10-2, *Atmosphères explosives – Partie 10-2: Classement des emplacements – Atmosphères explosives poussiéreuses*

IEC 60243-1:2013, *Rigidité diélectrique des matériaux isolants – Méthodes d'essai – Partie 1: Essais aux fréquences industrielles*

IEC 60243-2, *Rigidité diélectrique des matériaux isolants – Méthodes d'essai – Partie 2: Exigences supplémentaires pour les essais à tension continue*

IEC 60417, *Symboles graphiques utilisables sur le matériel* (disponible à l'adresse: http://www.graphical-symbols.info/equipment)

IEC 61340-2-3, *Électrostatique – Partie 2-3: Méthodes d'essais pour la détermination de la résistance et de la résistivité des matériaux solides destinés à éviter les charges électrostatiques*

1 Les chiffres entre crochets se réfèrent à la Bibliographie.

ISO/IEC 80079-20-2, *Atmosphères explosives – Partie 20-2: Caractéristiques des produits – Méthodes d'essai des poussières combustibles*

ISO 7000, *Symboles graphiques utilisables sur le matériel – Symboles enregistrés* (disponible à l'adresse: http://www.graphical-symbols.info/equipment)

ISO 21898, *Emballages – Grands récipients vrac souples (GRVS) pour matières non dangereuses*

ASTM E582, *Standard test method for minimum ignition energy and quenching distance in gaseous mixtures*

3 Termes et définitions

Pour les besoins du présent document, les termes et définitions de l'IEC 60079-10-1, l'IEC 60079-10-2 et l'ISO 21898, ainsi que les suivants, s'appliquent.

L'ISO et l'IEC tiennent à jour des bases de données terminologiques destinées à être utilisées en normalisation, consultables aux adresses suivantes:

- IEC Electropedia: disponible à l'adresse http://www.electropedia.org/
- ISO Online browsing platform: disponible à l'adresse http://www.iso.org/obp

3.1
matériau multicouche
matériau se composant de plus d'une couche, dont la combinaison peut se faire par coextrusion, revêtement, stratification ou par tout autre procédé permettant de lier de façon permanente les couches entre elles

3.2
étouffement de flamme
effet d'objets solides servant de dissipateur à forte proximité du gaz

3.3
distance d'étouffement critique
distance de séparation maximale entre des électrodes opposées en deçà de laquelle le refroidissement prévient l'inflammation à une énergie spécifiée

Note 1 à l'article: Les inflammations ont lieu si l'espace entre les électrodes est supérieur à la distance d'étouffement critique.

3.4
substance inflammable
substance sous forme de gaz, de vapeur, solide ou d'un mélange de ceux-ci, capable de propager la combustion lorsqu'elle est soumise à une source d'inflammation

3.5
atmosphère explosive
mélange avec l'air, sous conditions atmosphériques, de substances inflammables sous forme de gaz, vapeurs, aérosols ou poussières, dans lesquelles, après que l'inflammation a eu lieu, la combustion s'étend sur toute la surface non brûlée

3.6
atmosphère explosive dangereuse
atmosphère explosive présente dans des quantités telles que des précautions contre l'inflammation sont requises

3.7
énergie minimale d'inflammation
EMI
énergie électrique la plus faible d'une étincelle purement capacitive (c'est-à-dire sans inductance supplémentaire) exigée pour enflammer de la poussière, des gaz ou de la vapeur

3.8
courant de charge
quantité de charge par temps unitaire circulant dans le GRVS

3.9
décharge de cônes
décharge électrostatique s'écoulant vers l'extérieur en traversant la surface depuis le dessus de tas de poudre hautement chargés, non conducteurs dans de grands récipients

3.10
décharge en aigrette
décharge électrostatique provenant d'une surface solide ou liquide non conductrice

3.11
étincelle
décharge électrostatique provenant d'un objet ou d'une surface de nature conductrice mais se trouvant isolés

3.12
décharge glissante de surface
décharge hautement énergétique provenant d'une feuille, d'une couche ou d'un revêtement sur une surface conductrice ou d'un matériau de haute résistivité présentant une tension de claquage élevée, les deux surfaces étant fortement chargées mais de polarité opposée

3.13
revêtement protecteur intérieur
revêtement protecteur
récipient intégré ou amovible s'ajustant dans le GRVS

3.14
résistivité superficielle
résistivité équivalente à la résistance superficielle d'une surface carrée de matériau comportant des électrodes sur deux côtés opposés

3.15
résistivité volumique
résistivité équivalente à la résistance volumique d'un cube de matériau de longueur unitaire comportant des électrodes sur deux faces opposées

3.16
essai de qualification de type
essai utilisé pour déterminer le type de GRVS tel que spécifié en 4.1 et pour démontrer que le GRVS satisfait aux exigences de l'Article 7

3.17
essai de contrôle qualité
essai conçu pour fournir aux fabricants et aux utilisateurs des informations qui prouvent que tous les GRVS fabriqués et délivrés sont sensiblement identiques à l'échantillon de GRVS utilisé pour qualifier la conception du GRVS

3.18
point de mise à la terre
point du GRVS désigné par le fabricant comme un emplacement pour fixer un câble de connexion à la terre ou d'autres moyens de mise à la terre d'un GRVS

4 Classification

4.1 Classification des GRVS

4.1.1 Principes de classification

Les GRVS sont classés dans l'un des quatre types suivants: Type A, Type B, Type C et Type D. Les types sont définis par la construction du GRVS, la nature de leur fonctionnement prévu et les exigences de performance associées.

Une conception individuelle de GRVS ne peut être classée que dans un seul type. Par exemple, un GRVS ne doit pas être classé simultanément comme Type B et Type D, ou comme Type B et Type C, ni comme Type CD.

4.1.2 Type A

Les GRVS de Type A sont constitués de toiles tissées ou de plastique sans aucune mesure contre le développement de charges électrostatiques. Les GRVS qui ne satisfont pas aux exigences spécifiées à l'Article 7 ou dont les exigences n'ont pas été vérifiées sont classés dans le Type A.

4.1.3 Type B

Les GRVS de Type B sont constitués de toiles tissées ou de plastique conçu pour empêcher l'apparition d'étincelles et de décharges glissantes de surface.

Les matériaux conducteurs, par exemple ceux utilisés pour la fabrication des GRVS de Type C, ne doivent pas être utilisés pour la fabrication des GRVS de Type B.

NOTE Les GRVS de Type B ne sont normalement pas reliés à la terre. Le matériau conducteur qui n'est pas relié à la terre représente un risque d'étincelles incendiaires.

4.1.4 Type C

Les GRVS de Type C sont constitués d'une feuille conductrice de toile ou de plastique ou entrelacée avec des fils conducteurs ou des filaments et conçus pour empêcher l'apparition d'étincelles incendiaires, de décharge en aigrette et de décharges glissantes de surface. Les GRVS de Type C sont conçus pour être reliés à la terre avant le début des opérations de remplissage et de vidange et doivent restés reliés à la terre durant ces opérations.

4.1.5 Type D

Les GRVS de Type D sont constitués de toile protégée contre l'électricité statique conçue pour empêcher l'apparition d'étincelles incendiaires, de décharge en aigrette et de décharges glissantes de surface, sans nécessiter une connexion du GRVS à la terre.

4.2 Principes de classification et exigences pour les revêtements protecteurs intérieurs

4.2.1 Composants des revêtements protecteurs intérieurs

Les matériaux utilisés pour les revêtements protecteurs intérieurs peuvent être monocouches ou multicouches. Dans le cas des matériaux multicouches, les couches sont généralement liées entre elles de façon permanente. Des exemples de GRVS à revêtement protecteur intérieur monocouche et multicouche sont représentés à la Figure 1.

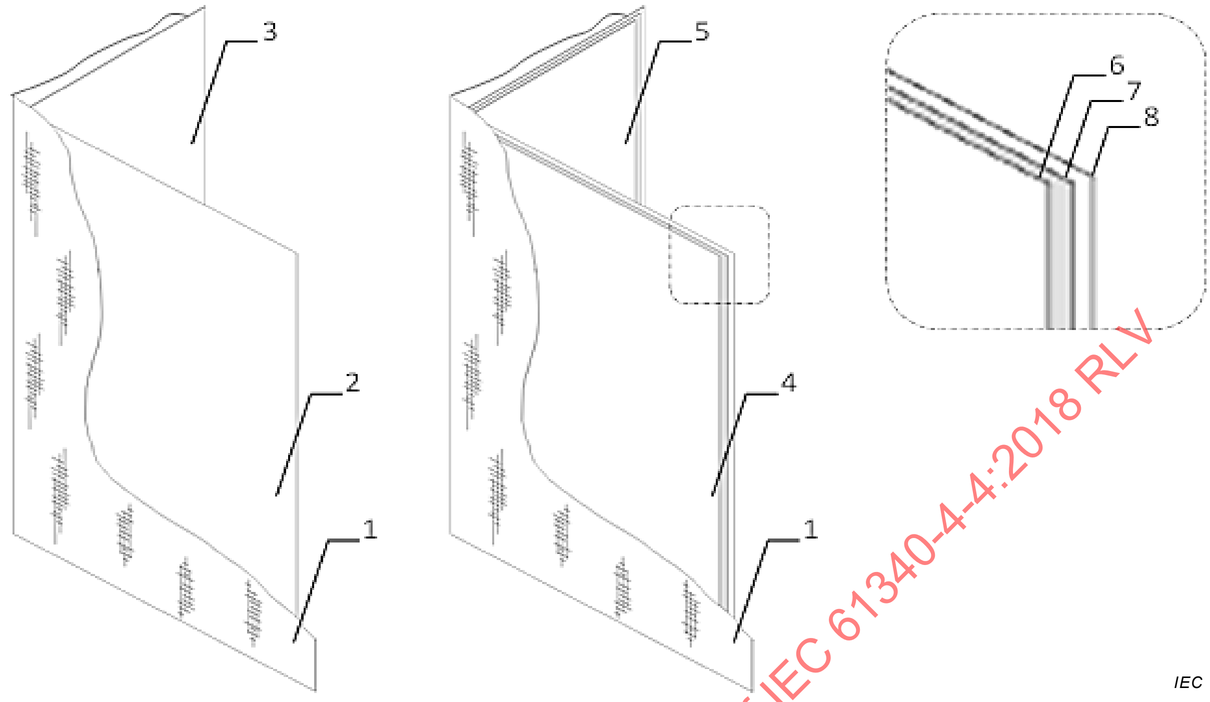
Pour les besoins du présent document, et pour les revêtements protecteurs intérieurs monocouches et multicouches, la surface extérieure du revêtement protecteur intérieur représente la surface en contact physique avec le GRVS, et la surface intérieure du revêtement protecteur intérieur représente la surface en contact physique avec le produit dont est rempli le GRVS.

À la Figure 1, le revêtement protecteur intérieur multicouche représenté comporte trois couches. En pratique, il est possible d'utiliser plus de trois couches. Pour les besoins du présent document, une couche interne représente toute couche d'un revêtement multicouche qui n'entre en contact physique ni avec le GRVS, ni avec le produit dont est rempli le GRVS.

Les propriétés électriques de la surface extérieure d'un revêtement protecteur intérieur monocouche ou multicouche peuvent être identiques ou différentes de celles de la surface intérieure. Par exemple, l'une des surfaces peut être traitée avec une finition locale afin de réduire la résistivité superficielle.

Plusieurs combinaisons de couches aux propriétés électriques différentes ou analogues sont possibles avec les revêtements protecteurs intérieurs multicouches.

Bien qu'il soit possible de combiner plusieurs matériaux pour les revêtements protecteurs intérieurs, pour les besoins du présent document ce sont les propriétés électriques des surfaces extérieures et intérieures des revêtements protecteurs intérieurs qui présentent un intérêt, conjointement avec la présence de couches internes conductrices.



Légende

1 GRVS
2 surface extérieure d'un revêtement protecteur intérieur monocouche
3 surface intérieure d'un revêtement protecteur intérieur monocouche
4 surface extérieure d'un revêtement protecteur intérieur multicouche
5 surface intérieure d'un revêtement protecteur intérieur multicouche
6 surface externe d'un revêtement protecteur intérieur multicouche
7 surface interne d'un revêtement protecteur intérieur multicouche
8 surface externe d'un revêtement protecteur intérieur multicouche

NOTE À titre indicatif, les couches du revêtement protecteur intérieur multicouche sont représentées séparément. En pratique, elles sont liées entre elles de façon permanente.

Figure 1 – Exemples de revêtements protecteurs intérieurs de GRVS

4.2.2 Mesures de la résistivité de surface pour les revêtements protecteurs intérieurs

La résistivité superficielle doit être mesurée selon l'IEC 61340-2-3. Un minimum de dix mesures doit être effectué aux points uniformément répartis à la surface du revêtement intérieur. Toutes les mesures doivent être dans les limites indiquées pour le type du revêtement intérieur soumis à l'essai.

4.2.3 Mesures de la tension de claquage pour les revêtements protecteurs intérieurs

La tension de claquage doit être mesurée selon 9.2 dans les conditions spécifiées en 8.2. La tension de claquage mesurée dépend fortement de l'épaisseur du matériau isolant et de sa résistivité électrique. Même si des modifications mineures peuvent affecter la tension de claquage, le résultat s'applique uniquement à la configuration du revêtement soumis à l'essai (y compris l'épaisseur des couches individuelles des revêtements coextrudés, en plus de l'épaisseur générale du revêtement).

Lors de la mesure de la tension de claquage entre une couche isolante et une couche interne conductrice, il est exigé d'effectuer un contact électrique avec la couche conductrice. Si une connexion électrique est présente, par exemple le point de mise à la terre sur un revêtement fini, elle peut être utilisée. Lors de la mesure des films sans point de mise à la terre, le contact électrique avec la couche conductrice peut se faire en insérant une agrafe à travers le film, ou en enlevant partiellement la couche conductrice sur une zone d'au moins 100 mm qui va du bord de la zone d'application de l'électrode à la couche isolante. Dans ces cas, au moins deux agrafes doivent être insérées ou au moins deux zones de film isolant doivent être retirées afin que la liaison électrique à la couche conductrice puisse être vérifiée par mesure de la résistance entre les agrafes ou les zones conductrices exposées.

4.2.4 Type L1

Les revêtements protecteurs intérieurs de Type L1 sont constitués de matériaux ayant au moins une surface avec une résistivité superficielle inférieure ou égale à $1{,}0 \times 10^8\ \Omega$ (voir l'Annexe F), mesurée dans les conditions spécifiées en 8.2. Les revêtements de Type L1 ne doivent pas comporter de couche interne conductrice; ces revêtements protecteurs intérieurs sont classés en Type L1C (voir 4.2.5). Les revêtements protecteurs intérieurs de Type L1 peuvent être utilisés dans les GRVS de Type C.

Si le matériau comporte une surface d'une résistivité superficielle supérieure à $1{,}0 \times 10^{12}\ \Omega$, la tension de claquage à travers le matériau doit être inférieure à 4 kV, mesurée selon 9.2 dans les conditions spécifiées en 8.2.

Le contact fortuit entre le revêtement protecteur intérieur et l'intérieur du GRVS ne peut assurer la bonne mise à la terre du revêtement protecteur intérieur. Par conséquent, la surface ayant une résistivité inférieure à $1{,}0 \times 10^8\ \Omega$ doit être solidement reliée au système de mise à la terre du GRVS via des connexions spécifiques. Les connexions au système de mise à la terre du GRVS doivent être suffisamment robustes pour résister aux contraintes lors des opérations de remplissage, de transport et de vidage et pour maintenir une continuité électrique.

L'épaisseur totale d'une couche quelconque ayant une résistivité superficielle supérieure à $1{,}0 \times 10^{12}\ \Omega$ à l'intérieur (côté produit) du matériau du revêtement protecteur intérieur doit être inférieure à 700 µm.

Les configurations admissibles et les exigences des revêtements protecteurs intérieurs de Type L1 sont résumées dans le Tableau 1.

Tableau 1 – Configurations admissibles et exigences des revêtements protecteurs intérieurs de Type L1 (sans couche conductrice interne)

Configuration	Paramètres			
	Résistivité de la surface intérieure ρ_I	Résistivité de la surface extérieure ρ_O	Tensions de claquage V_B	Épaisseur d
1	$\rho_I \leq 1{,}0 \times 10^8\ \Omega$	$\rho_O \leq 1{,}0 \times 10^8\ \Omega$	Aucune mesure exigée	Aucune limite
2A	$\rho_I \leq 1{,}0 \times 10^8\ \Omega$	$\rho_O \leq 1{,}0 \times 10^{12}\ \Omega$	Aucune mesure exigée	Aucune limite
2B	$\rho_I \leq 1{,}0 \times 10^{12}\ \Omega$	$\rho_O \leq 1{,}0 \times 10^8\ \Omega$	Aucune mesure exigée	Aucune limite
3	$\rho_I \leq 1{,}0 \times 10^8\ \Omega$	$\rho_O \leq 1{,}0 \times 10^{12}\ \Omega$	$V_B < 4$ kV	Aucune limite
4	$\rho_I \leq 1{,}0 \times 10^{12}\ \Omega$	$\rho_O \leq 1{,}0 \times 10^8\ \Omega$	$V_B < 4$ kV	$d < 700$ µm
Toutes les couches ayant une résistivité superficielle inférieure à $1{,}0 \times 10^8\ \Omega$ doivent être solidement reliées à la terre lorsqu'elles sont installées dans le GRVS.				

4.2.5 Type L1C

Les revêtements protecteurs intérieurs de Type L1C sont constitués de matériaux multicouches et ont une couche interne d'une résistivité superficielle inférieure ou égale à $1,0 \times 10^{8}\ \Omega$ (voir l'Annexe F). Les revêtements protecteurs intérieurs de Type L1C peuvent être utilisés dans les GRVS de Type C.

La tension de claquage entre une surface quelconque ayant une résistivité superficielle supérieure à $1,0 \times 10^{12}\ \Omega$ et la couche conductrice interne doit être inférieure à 4 kV, mesurée selon 9.2 dans les conditions spécifiées en 8.2.

L'épaisseur totale d'une couche quelconque ayant une résistivité superficielle supérieure à $1,0 \times 10^{12}\ \Omega$ à l'intérieur (côté produit) du matériau du revêtement protecteur intérieur doit être inférieure à 700 μm.

Toutes les couches ayant une résistivité inférieure à $1,0 \times 10^{8}\ \Omega$ doivent être solidement reliées au système de mise à la terre du GRVS via des connexions spécifiques. Les connexions au système de mise à la terre du GRVS doivent être suffisamment robustes pour résister aux contraintes lors des opérations de remplissage, de transport et de vidage et pour maintenir une continuité électrique.

Même si la surface du revêtement protecteur intérieur en contact avec l'intérieur du GRVS a une résistivité superficielle inférieure à $1,0 \times 10^{8}\ \Omega$, le contact fortuit entre le revêtement protecteur intérieur et l'intérieur du GRVS ne peut assurer la bonne mise à la terre du revêtement protecteur intérieur. De plus, des connexions spécifiques de mise à la terre sont toujours exigées.

Les configurations admissibles et les exigences des revêtements protecteurs intérieurs de Type L1C sont résumées dans le Tableau 2.

Tableau 2 – Configurations admissibles et exigences des revêtements protecteurs intérieurs de Type L1C (avec couche conductrice interne[a])

Configuration	Paramètres			
	Résistivité de la surface intérieure ρ_I	Résistivité de la surface extérieure ρ_O	Tensions de claquage V_B	Épaisseur d
1	$\rho_I \leq 1,0 \times 10^{12}\ \Omega$	$\rho_O \leq 1,0 \times 10^{12}\ \Omega$	Aucune mesure exigée	Aucune limite
2	$\rho_I \leq 1,0 \times 10^{12}\ \Omega$	$\rho_O \leq 1,0 \times 10^{12}\ \Omega$	V_B < 4 kV[b]	Aucune limite
3	$\rho_I \leq 1,0 \times 10^{12}\ \Omega$	$\rho_O \leq 1,0 \times 10^{12}\ \Omega$	V_B < 4 kV[b]	d < 700 μm
4	$\rho_I \leq 1,0 \times 10^{12}\ \Omega$	$\rho_O \leq 1,0 \times 10^{12}\ \Omega$	V_B < 4 kV[b]	d < 700 μm

[a] Toutes les couches ayant une résistivité superficielle inférieure à $1,0 \times 10^{8}\ \Omega$ doivent être solidement reliées à la terre lorsqu'elles sont installées dans le GRVS.

[b] La tension de claquage est mesurée entre la surface ayant une résistivité > $1,0 \times 10^{12}\ \Omega$ et la couche interne conductrice.

4.2.6 Type L2

Les revêtements protecteurs intérieurs de Type L2 sont constitués de matériaux ayant au moins une surface avec une résistivité superficielle comprise entre $1,0 \times 10^{9}\ \Omega$ et $1,0 \times 10^{12}\ \Omega$ (voir l'Annexe F), mesurée dans les conditions spécifiées en 8.3. Les revêtements protecteurs intérieurs de Type L2 peuvent être utilisés dans les GRVS de Type B, de Type C et de Type D.

Les matériaux ayant une résistivité superficielle inférieure à $1,0 \times 10^8$ Ω ne doivent être utilisés dans aucune couche des revêtements protecteurs intérieurs de Type L2.

Si les revêtements protecteurs intérieurs de Type L2 sont utilisés avec les GRVS de Type C, le contact fortuit entre le revêtement protecteur intérieur et l'intérieur du GRVS ne peut assurer la bonne mise à la terre du revêtement protecteur intérieur. Par conséquent, la surface ayant une résistivité comprise entre $1,0 \times 10^9$ Ω et $1,0 \times 1\,0^{12}$ Ω doit être solidement reliée au système de mise à la terre du GRVS via des connexions spécifiques. Les connexions au système de mise à la terre du GRVS doivent être suffisamment robustes pour résister aux contraintes lors des opérations de remplissage, de transport et de vidage et pour maintenir une continuité électrique.

Si le matériau comporte une surface d'une résistivité superficielle supérieure à $1,0 \times 10^{12}$ Ω, la tension de claquage à travers le matériau doit être inférieure à 4 kV, mesurée selon 9.1 dans les conditions spécifiées en 8.2.

L'épaisseur totale d'une couche quelconque ayant une résistivité superficielle supérieure à $1,0 \times 10^{12}$ Ω à l'intérieur (côté produit) du matériau du revêtement protecteur intérieur doit être inférieure à 700 μm.

Les configurations admissibles et les exigences des revêtements protecteurs intérieurs de Type L2 sont résumées dans le Tableau 3.

Tableau 3 – Configurations admissibles et exigences des revêtements protecteurs intérieurs de Type L2

Configuration	Paramètres			
	Résistivité de la surface intérieure ρ_I	Résistivité de la surface extérieure ρ_O	Tensions de claquage V_B	Épaisseur d
1	$1,0 \times 10^9\ \Omega \le \rho_I \le 1,0 \times 10^{12}\ \Omega$	$1,0 \times 10^9\ \Omega \le \rho_O \le 1,0 \times 10^{12}\ \Omega$	Aucune mesure exigée	Aucune limite
2	$1,0 \times 10^9\ \Omega \le \rho_I \le 1,0 \times 10^{12}\ \Omega$	$\rho_O > 1,0 \times 10^{12}\ \Omega$	V_B < 4 kV[a]	Aucune limite
3	$\rho_I > 1,0 \times 10^{12}\ \Omega$	$1,0 \times 10^9\ \Omega \le \rho_O \le 1,0 \times 10^{12}\ \Omega$	V_B < 4 kV[a]	d < 700 μm

[a] La tension de claquage inférieure à 4 kV ne peut pas toujours être atteinte si l'épaisseur de la couche ayant une résistivité supérieure à $1,0 \times 10^{12}$ Ω dépasse 20 µm.

4.2.7 Type L3

Les revêtements protecteurs intérieurs de Type L3 sont constitués de matériaux ayant une résistivité superficielle supérieure à $1,0 \times 10^{12}$ Ω, mesurée dans les conditions spécifiées en 8.2. Les revêtements protecteurs intérieurs de Type L3 peuvent être utilisés dans les GRVS de Type B.

Les matériaux ayant une résistivité superficielle inférieure à $1,0 \times 10^8$ Ω ne doivent être utilisés dans aucune couche des revêtements protecteurs intérieurs de Type L3.

La tension de claquage à travers le matériau doit être inférieure à 4 kV, mesurée selon 9.1 dans les conditions spécifiées en 8.2.

Les configurations admissibles et les exigences des revêtements protecteurs intérieurs de Type L3 sont résumées dans le Tableau 4.

Tableau 4 – Configurations admissibles et exigences des revêtements protecteurs intérieurs de Type L3

Configuration	Paramètres			
	Résistivité de la surface intérieure ρ_I	Résistivité de la surface extérieure ρ_O	Tensions de claquage V_B	Épaisseur d
1	$\rho_I > 1{,}0 \times 10^{12}\ \Omega$	$\rho_O > 1{,}0 \times 10^{12}\ \Omega$	$V_B < 4$ kV	Aucune limite

4.3 Combinaison de GRVS et de revêtements protecteurs intérieurs

Lorsque des revêtements protecteurs intérieurs sont utilisés dans des GRVS, les revêtements protecteurs intérieurs et le GRVS doivent être conformes à leurs exigences respectives, c'est-à-dire 4.2 pour les revêtements protecteurs intérieurs et l'Article 7 pour les GRVS, et doivent être conformes à toutes les exigences spécifiées pour les combinaisons, y compris les exigences de mise à la terre pour les combinaisons de revêtements protecteurs intérieurs des GRVS de Type C/Type L1/LC1/L2, et aux exigences d'essais d'allumage pour les combinaisons de revêtements protecteurs intérieurs des GRVS de Type D et de Type L2. L'inclusion d'un revêtement protecteur intérieur dans un GRVS ne change pas le type dans lequel est classé le GRVS. Par exemple, des GRVS de Type A avec des revêtements protecteurs intérieurs de Type L1 sont toujours des GRVS de Type A et sont soumis à toutes les restrictions d'utilisation des GRVS de Type A.

Les exigences relatives à la tension de claquage des GRVS et des revêtements protecteurs intérieurs doivent être appliquées séparément. Pour les GRVS de Type B, de Type C et de Type D avec des revêtements protecteurs intérieurs pour lesquels existe une exigence de tension de claquage, deux ensembles de mesures de tension de claquage doivent être exigés: une série sur le matériau du GRVS et une série sur le matériau du revêtement protecteur intérieur. Si, par exemple, un GRVS de Type B est équipé d'un revêtement protecteur intérieur de Type L3, la tension de claquage du matériau du GRVS doit être mesurée séparément et doit être inférieure à 6 kV, et une mesure de tension de claquage séparée doit être effectuée sur le matériau du revêtement protecteur intérieur et celle-ci doit être inférieure à 4 kV.

5 Utilisation sécurisée des GRVS

Les exigences et les spécifications auxquelles doivent satisfaire les GRVS et les façons dont ils sont utilisés dépendent de la nature et de la sensibilité de toute atmosphère explosive présente pendant le remplissage et le vidage. Le but ultime de la construction des GRVS est d'exclure les décharges incendiaires provenant de la toile du GRVS pendant l'utilisation qui en est prévue. Les GRVS fabriqués en conformité avec les exigences spécifiées dans le présent document ne garantissent pas nécessairement que des décharges électrostatiques dangereuses, par exemple des décharges de cônes ou des décharges par étincelle de produits conducteurs chargés, ne seront pas générées par le contenu des GRVS. Des informations relatives aux risques associés aux décharges de cônes sont données à l'Annexe E.

La capacité d'allumage des décharges électrostatiques, c'est-à-dire des étincelles, des décharges en aigrette et des décharges glissantes de surface, est différente pour chaque type de décharge. La nécessité de les exclure et ainsi les exigences et les spécifications des GRVS dépendent de l'utilisation prévue du GRVS. Les conditions dans lesquelles chaque type de GRVS doit être utilisé sont présentées dans le Tableau 5.

Tableau 5 – Utilisation des différents types de GRVS

Produit en vrac dans le GRVS	Environnement		
EMI de la poussière[a]	**Atmosphère non inflammable**	**Zones de poussière 21 et 22[b] (1 000 mJ ≥ EMI > 3 mJ)[a]**	**Zones de gaz 1-2[b] (groupes d'explosion IIA/IIB)[b] ou zones de poussière 21 et 22[b] (EMI ≤ 3 mJ)[a]**
EMI > 1 000 mJ	A,B,C,D	B,C,D	C,D[c]
1 000 mJ ≥ EMI > 3 mJ	B,C,D	B,C,D	C,D[c]
EMI ≤ 3 mJ[d]	C,D	C,D	C,D[c]

Des précautions supplémentaires sont habituellement nécessaires lorsqu'un gaz ou une atmosphère de vapeur inflammable est présent à l'intérieur du GRVS, par exemple dans le cas de poudres mouillées avec un solvant.

NOTE Une atmosphère non inflammable comporte des poussières ayant une EMI > 1 000 mJ.

[a] Mesurée selon l'ISO/IEC 80079-20-2, circuit de décharge capacitive (sans ajout d'inductance).

[b] Voir l'explication des régions, zones et groupes d'explosion dangereux à l'Annexe D.

[c] L'utilisation du Type D doit être limitée aux groupes d'explosion IIA/IIB avec une EMI ≥ 0,14 mJ.

[d] Voir l'Annexe E pour l'explication de la limite de 3 mJ en relation avec les décharges de cônes.

L'aptitude à une utilisation sécurisée des GRVS dans des atmosphères explosives dangereuses peut varier si un revêtement protecteur intérieur est installé dans le GRVS. Des combinaisons de GRVS et de revêtement protecteur intérieur pouvant être utilisées en toute sécurité dans des atmosphères explosives dangereuses sont présentées dans le Tableau 6. En plus des exigences séparées pour les GRVS et les revêtements protecteurs intérieurs, il existe des exigences qui doivent être satisfaites par certaines combinaisons de GRVS et de revêtement protecteur intérieur. Ces exigences sont également présentées dans le Tableau 6.

Tableau 6 – Combinaisons de revêtement protecteurs intérieurs et de GRVS admissibles et non admissibles dans des atmosphères explosives dangereuses

GRVS	Revêtement protecteur intérieur			
	Type L1	**Type L1C**	**Type L2**	**Type L3**
Type B	Non admissible	Non admissible	Admissible	Admissible
Type C	Admissible[a]	Admissible[b]	Admissible[c]	Non admissible
Type D	Non admissible	Non admissible	Admissible[d]	Non admissible

Précautions:

Un GRVS de Type A ne doit pas être utilisé dans des atmosphères explosives dangereuses, quel que soit le type de revêtement protecteur intérieur utilisé.

Les revêtements protecteurs ne doivent pas être retirés des GRVS dans des atmosphères explosives dangereuses.

[a] Pour garantir une bonne mise à la terre du revêtement protecteur intérieur, la résistance entre au moins une face du revêtement protecteur intérieur et les points de mise à la terre sur le GRVS doit être inférieure à $1{,}0 \times 10^8\ \Omega$, la mesure étant effectuée selon 9.4 dans les conditions spécifiées en 8.2.

[b] Pour garantir une bonne mise à la terre du revêtement protecteur intérieur, la résistance entre une couche conductrice quelconque du revêtement protecteur intérieur et les points de mise à la terre sur le GRVS doit être inférieure à $1{,}0 \times 10^8\ \Omega$, la mesure étant effectuée selon 9.4 dans les conditions spécifiées en 8.2.

[c] Pour garantir une bonne mise à la terre du revêtement protecteur intérieur, la résistance entre une couche dissipatrice quelconque du revêtement protecteur intérieur et les points de mise à la terre sur le GRVS doit être inférieure à $1{,}0 \times 10^{12}\ \Omega$, la mesure étant effectuée selon 9.4 dans les conditions spécifiées en 8.2.

[d] La combinaison du GRVS et du revêtement protecteur intérieur doit satisfaire aux exigences de 7.3.2 lorsque l'essai est effectué dans les conditions spécifiées en 8.2.

Des objets conducteurs isolés (par exemple, des outils, des boulons, des attaches, etc.) ne doivent pas être stockés, fixés à ou même placés temporairement sur tout type de GRVS pendant les opérations de remplissage et de vidage. Même avec un GRVS de Type C, la nature grossière de certains matériaux de GRVS peut empêcher des objets conducteurs placés sur le GRVS de toucher les éléments conducteurs situés dans le tissu du GRVS, auquel cas l'objet conducteur reste isolé de la terre.

Conformément aux recommandations générales de sécurité (voir l'IEC TS 60079-32-1[1]), tous les objets conducteurs, y compris le personnel, le GRVS de Type C et le contenu conducteur du GRVS, situés dans une atmosphère explosive dangereuse doivent être convenablement mis à la terre. Les GRVS de Type D ne sont pas considérés comme des objets conducteurs et il n'est pas nécessaire qu'ils soient mis à la terre.

Il convient de prendre des précautions pour empêcher la contamination de tout GRVS par des substances (par exemple, de l'eau, de la rouille, de l'huile, de la graisse) pouvant créer un danger d'allumage ou entraver la dissipation des charges.

6 Étiquetage

Les GRVS pour lesquels les déclarations de conformité au présent document sont effectuées doivent porter un marquage durable par le biais d'une étiquette fixée en permanence ou d'autres moyens, comportant au moins les informations suivantes:

a) le numéro de ce document, c'est-à-dire IEC 61340-4-4;

b) le type de GRVS, c'est-à-dire Type B, Type C ou Type D (la désignation du type doit être mise en évidence de façon qu'elle soit facilement visible d'un simple coup d'œil);

c) le symbole ISO 7000-2415:2004-01 sur le Type B, le Type C et le Type D pour indiquer la protection contre l'électricité statique;

d) pour le Type B, la phrase "autorisé en zone de poussières 21 et 22 avec EMI > 3 mJ";

e) pour le Type C, la phrase "autorisé en zones de poussières 21 et 22 et en zones de gaz 1 et 2 (groupes d'explosion IIA/IIB)";

f) pour le Type D, la phrase "autorisé en zones de poussières 21 et 22 et en zones de gaz 1 et 2 (groupes d'explosion IIA/IIB) avec EMI $\geq$ 0,14 mJ) et avec des courants de charge $\leq$ 3 μA";

g) pour le Type C, la phrase "le GRVS doit être convenablement relié à la terre selon les instructions du fabricant";

h) pour le Type D, la phrase "le GRVS ne nécessite pas de mise à la terre";

i) pour le Type B, le Type C et le Type D, la phrase "les propriétés électriques peuvent être affectées par l'utilisation générale, la contamination et le reconditionnement";

j) pour le Type B, le Type C et le Type D, la phrase "tous les objets conducteurs, y compris le personnel, doivent être mis à la terre pendant les opérations de remplissage et de vidage du GRVS (voir l'IEC TS 60079-32-1 pour des recommandations relatives à la mise à la terre)";

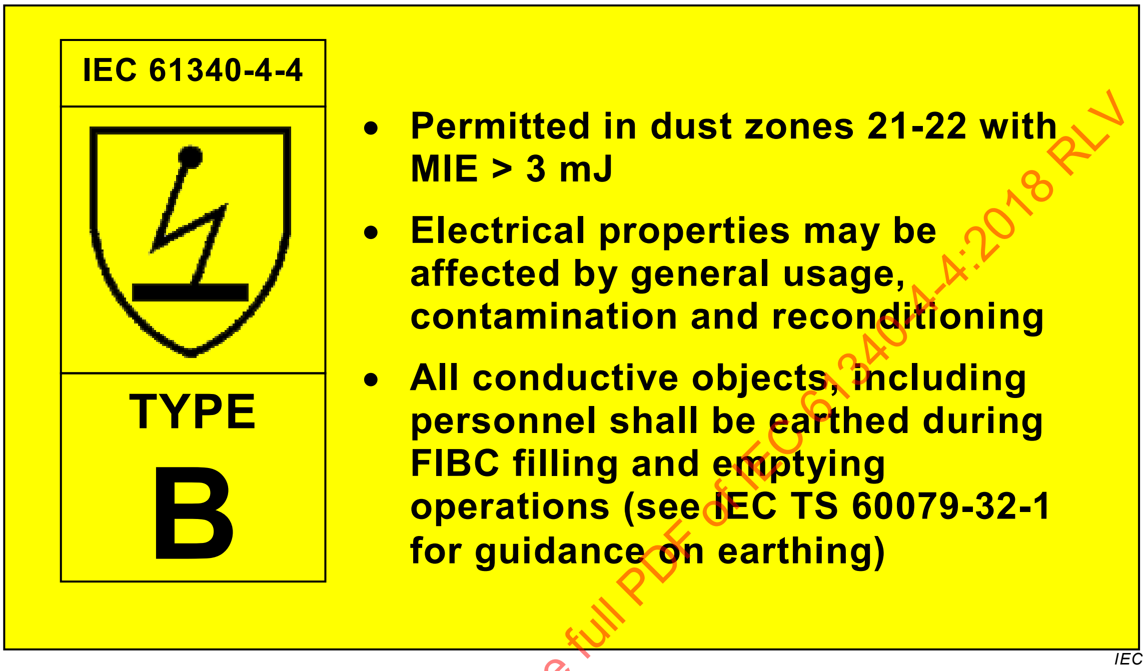
k) l'autorité de certification et le numéro de certificat (seulement pour les GRVS certifiés par des autorités de certification indépendantes).

Il n'est pas exigé d'étiqueter les GRVS de Type A.

Il est préférable d'utiliser le jaune en couleur de fond des étiquettes et marquage, mais d'autres couleurs peuvent également être utilisées. Les matériaux noirs conducteurs peuvent être utilisés pour les étiquettes des GRVS de Type C, mais ne doivent pas être utilisés avec les GRVS de Type B ou de Type D.

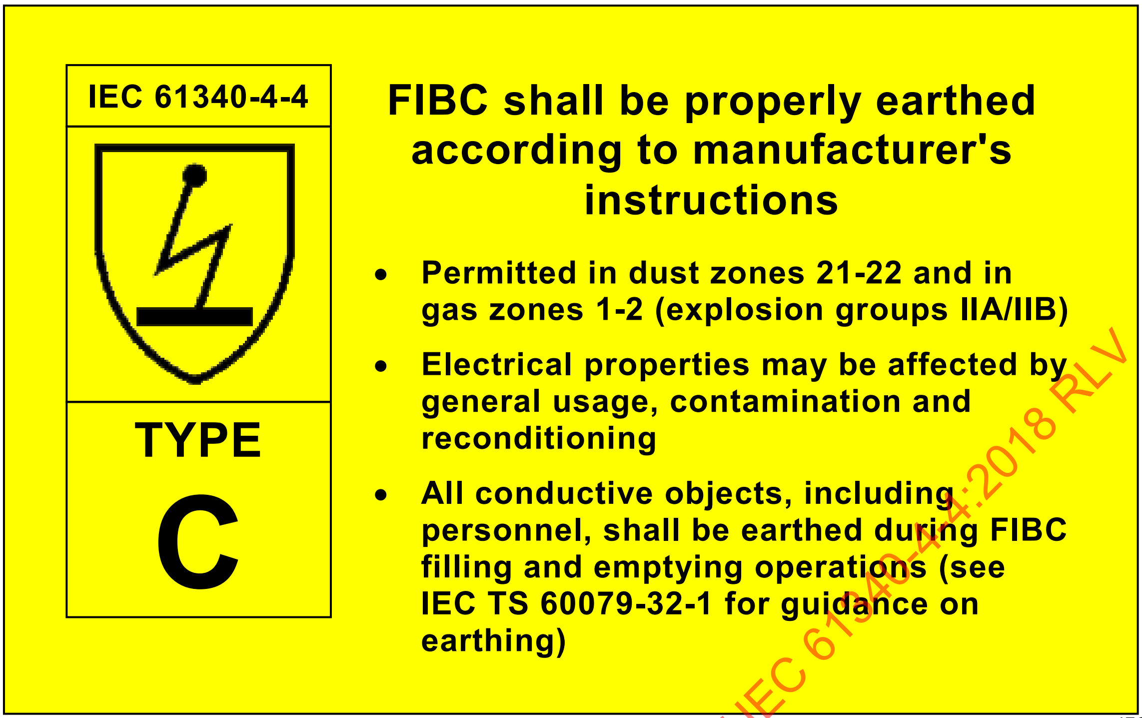
Les points de mise à la terre désignés sur les GRVS de Type C doivent être étiquetés ou marqués avec le symbole de terre (IEC 60417-5019:2006-08), comme indiqué par exemple à la Figure 5. La couleur de fond des étiquettes ou du marquage doit être jaune et les lettres doivent être noires, ou la couleur de fond doit être noire et les lettres doivent être jaunes. L'étiquette ou le marquage peut être incorporé dans une autre étiquette ou marquage comme pouvant être exigé pour d'autres buts.

Des exemples d'étiquettes convenables pour chaque type de GRVS sont présentés aux Figures 2 à 4.



Anglais	Français
Permitted in dust zones 21-22 with MIE > 3 mJ	Autorisé en zones de poussières 21 et 22 avec EMI > 3 mJ
Electrical properties may be affected by general usage, contamination and reconditioning	Les propriétés électriques peuvent être affectées par l'utilisation générale, la contamination et le reconditionnement
All conductive objects, including personnel shall be earthed during FIBC filling and emptying operations (see IEC TS 60079-32-1 for guidance on earthing)	Tous les objets conducteurs, y compris le personnel, doivent être mis à la terre pendant les opérations de remplissage et de vidage du GRVS (voir l'IEC TS 60079-32-1 pour des recommandations relatives à la mise à la terre)

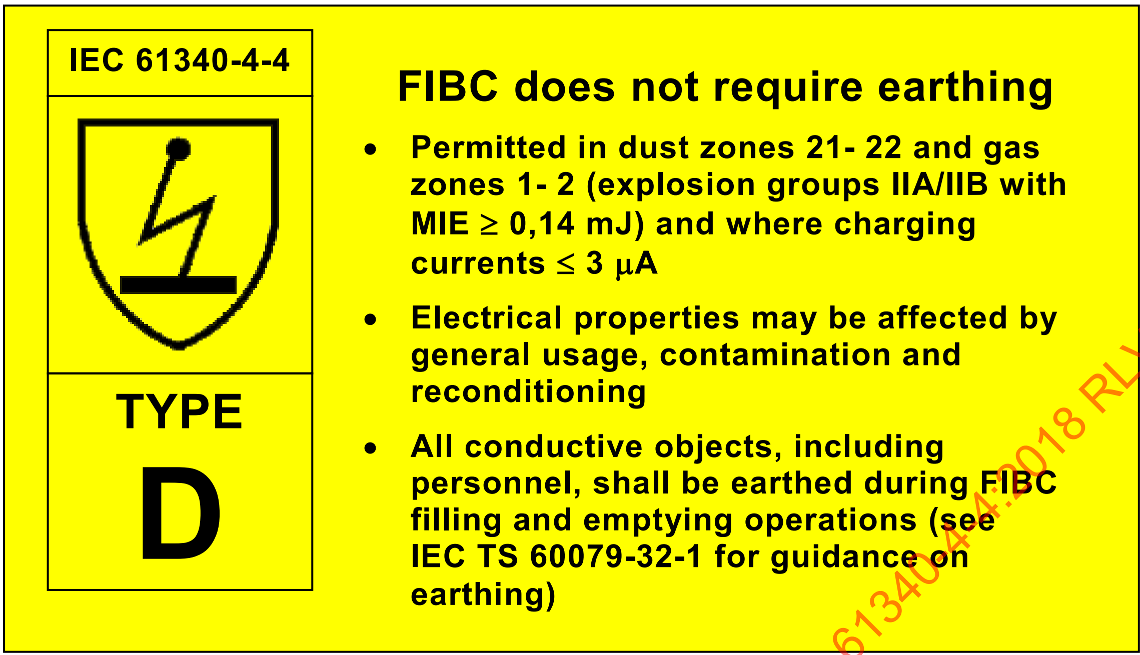
Figure 2 – Exemple d'étiquette pour un GRVS de Type B



IEC

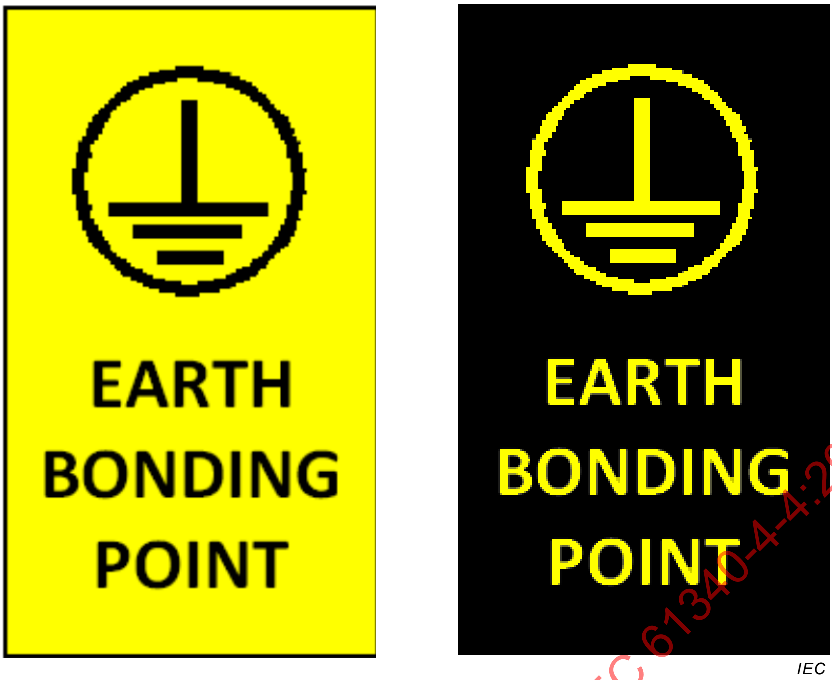
Anglais	Français
FIBC shall be properly earthed according to manufacturer's instructions	Le GRVS doit être convenablement mis à la terre selon les instructions du fabricant
Permitted in dust zones 21-22 and in gas zones 1-2 (explosion groups IIA/IIB)	Autorisé en zones de poussières 21 et 22 et en zones de gaz 1 et 2 (groupes d'explosion IIA/IIB)
Electrical properties may be affected by general usage, contamination and reconditioning	Les propriétés électriques peuvent être affectées par l'utilisation générale, la contamination et le reconditionnement
All conductive objects, including personnel shall be earthed during FIBC filling and emptying operations (see IEC TS 60079-32-1 for guidance on earthing)	Tous les objets conducteurs, y compris le personnel, doivent être mis à la terre pendant les opérations de remplissage et de vidage du GRVS (voir l'IEC TS 60079-32-1 pour des recommandations relatives à la mise à la terre)

Figure 3 – Exemple d'étiquette pour un GRVS de Type C



Anglais	Français
FIBC does not require earthing	Le GRVS ne nécessite pas de mise à la terre
Permitted in dust zones 21- 22 and gas zones 1- 2 (explosion groups IIA/IIB with MIE ≥ 0,14 mJ) and where charging currents ≤ 3 μA	Autorisé en zones de poussières 21 et 22 et en zones de gaz 1 et 2 (groupes d'explosion IIA/IIB) avec EMI ≥ 0,14 mJ) et avec des courants de charge ≤ 3 μA
Electrical properties may be affected by general usage, contamination and reconditioning	Les propriétés électriques peuvent être affectées par l'utilisation générale, la contamination et le reconditionnement
All conductive objects, including personnel shall be earthed during FIBC filling and emptying operations (see IEC TS 60079-32-1 for guidance on earthing)	Tous les objets conducteurs, y compris le personnel, doivent être mis à la terre pendant les opérations de remplissage et de vidage du GRVS (voir l'IEC TS 60079-32-1 pour des recommandations relatives à la mise à la terre)

Figure 4 – Exemple d'étiquette pour un GRVS de Type D



Anglais	Français
Earth bonding point	Point de mise à la terre

Figure 5 – Exemple d'étiquettes pour des points de mise à la terre désignés des GRVS de Type C

Les GRVS ne doivent pas être étiquetés ou marqués dans le cas où cela entrerait en conflit avec les exigences du présent document ou en cas de confusion relative à leur classification ou à leurs restrictions d'utilisation ("Type CD", par exemple, n'est pas autorisé). Aucune lettre ou aucun symbole supplémentaire ne doit être ajouté à la désignation du type (par exemple, "Type D+" n'est pas autorisé).

Il incombe aux fabricants de GRVS de s'assurer que l'échantillon ou les échantillons soumis à l'essai sont représentatifs des GRVS de production auxquels des étiquettes doivent être fixées.

Les étiquettes des GRVS de Type B ne doivent pas être constituées de matériaux ayant une résistivité superficielle inférieure à 1,0 x 10^9 Ω, mesurée selon l'IEC 61340-2-3 dans les conditions spécifiées en 8.3 b).

Les étiquettes de GRVS de Type C constituées de matériaux ayant une résistivité superficielle inférieure à $1{,}0 \times 10^8$ Ω, mesurée selon l'IEC 61340-2-3 dans les conditions spécifiées en 8.2, peuvent être utilisées à condition que la résistance au point de mise à la terre mesurée selon 9.4 soit inférieure à la limite spécifiée en 7.3.1.

Les étiquettes de GRVS de Type C constituées de matériaux ayant une résistivité superficielle comprise entre $1{,}0 \times 10^9$ Ω et $1{,}0 \times 10^{12}$ Ω, mesurée selon l'IEC 61340-2-3 dans les conditions spécifiées en 8.3, peuvent être utilisées.

Les étiquettes de GRVS de Type C ayant une résistivité superficielle supérieure à $1{,}0 \times 10^{12}$ Ω, mesurée selon l'IEC 61340-2-3 dans les conditions spécifiées en 8.2, ne doivent pas avoir une surface supérieure à 100 cm^2, ou une épaisseur supérieure ou égale à 700 µm.

Les étiquettes de GRVS de Type D supérieures à 100 cm^2 doivent être soumises à un essai d'allumage selon 9.2 et doivent satisfaire aux exigences spécifiées en 7.3.2.