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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

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This Consolidated version of IEC 61340-4-4 bears the edition number 2.1. It consists of the second edition (2012-01) [documents 101/346/FDIS and 101/353/RVD] and its amendment 1 (2014-11) [documents 101/421/CDV and 101/447/RVC]. The technical content is identical to the base edition and its amendment.

In this Redline version, a vertical line in the margin shows where the technical content is modified by amendment 1. Additions and deletions are displayed in red, with deletions being struck through. A separate Final version with all changes accepted is available in this publication.

This publication has been prepared for user convenience.

International Standard IEC 61340-4-4 has been prepared by IEC technical committee 101: Electrostatics, in cooperation with ISO subcommittee 3: Performance requirements and tests for means of packaging, packages and unit loads, of ISO technical committee 122: Packaging.

The main changes with respect to the first edition of this standrad are listed below:

a) Adoption of a type classification system for FIBC based on four types: A, B, C and D.

b) Guidance for safe use of FIBC in relation to hazardous areas and hazardous zones defined in IEC 60079-10-1 and IEC 60079-10-2 is added.

c) Resistance to groundable points and electrical breakdown voltage measurements on FIBC shall be measured at low humidity only.

d) Requirements for labelling FIBC are changed to improve clarity and ease of recognition by end users.

e) Classification, performance requirements and guidance for safe use of inner liners in combination with FIBC are added.

f) An informative annex giving guidance on test methods for quality control and inspection testing is added.

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

A list of all the 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 the base publication and its amendment will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

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- withdrawn,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

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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, e.g. 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 standard 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 standard 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 be created by the contents in the FIBC or may 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 and inner liner;
- design and performance requirements for FIBC and inner liners;
- 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 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 be used for manufacturing quality control is given in Annex C.

The requirements of this standard 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 standard 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 minimum ignition energy of a typical Group IIB gas or vapour. 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.

Compliance with the requirements specified in this standard does not necessarily ensure that hazardous electrostatic discharges, e.g. 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 standard does not mitigate the need for full risk assessment. For example, metal and other conductive powders and toner powders may require additional precautions to prevent hazardous discharges from the powders.

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

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1 Figures in square brackets refer to the bibliography.

Test methods included in this standard may 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 standard.

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

2 Normative references

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

IEC 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 dust atmospheres*

IEC 60243-1:1998, *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 7000:2004, *Graphical symbols for use on equipment – Index and synopsis*

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 following terms and definitions, as well as those given in IEC 60079-10-1, IEC 60079-10-2 and ISO 21898, apply.

3.1
quenching
effect of solid objects acting as heat sinks in close proximity to gas

3.2
critical quenching distance
maximum separation distance between opposing electrodes below which quenching prevents ignition at a specified energy

NOTE For ignitions to take place, the gap between electrodes should be greater than the critical quenching distance.

3.3
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

3.4
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

3.5
hazardous explosive atmosphere
explosive atmosphere present in such quantities that precautions against ignition are required

3.6
minimum ignition energy
least electrical energy of a purely capacitive spark (i.e. no added inductance) required to ignite a dust, gas or vapour

3.7
charging current
quantity of charge per unit time flowing into FIBC

3.8
cone discharge
electrostatic discharge running outwards across the surface from the top of highly charged, insulating powder heaps in large containers

3.9
brush discharge
electrostatic discharge from a non-conductive, solid or liquid surface

3.10
spark
electrostatic discharge from an electrically isolated conductive object or surface

3.11
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 break down voltage with the two surfaces highly charged to opposite polarity

3.12
inner liner
integral or removable container which fits into the FIBC (synonymous with liner)

3.13
surface resistivity
equivalent to the surface resistance of a square area of material, having electrodes at two opposite sides

3.14
volume resistivity
equivalent to the volume resistance of a cube of material with unit length, having the electrodes at two opposite surfaces

3.15
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

3.16
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

3.17
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 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 be simultaneously classified as both Type B and Type D, or as Type CD.

4.1.1 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.

4.1.2 Type B

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

4.1.3 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 filling and emptying operations.

4.1.4 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 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.

4.2.2 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.

4.2.3 Type L1

Type L1 inner liners are made from materials with surface resistivity on at least one surface less than or equal to $1{,}0 \times 10^7\ \Omega$ (see Annex F), measured under the conditions specified in 8.2. of this standard. 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 $1{,}0 \times 10^{12}\ \Omega$, 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 L1 inner liners are summarized in Table 1.

Table 1 – Permissible configurations and requirements for Type L1 inner liners

Configuration	Parameters			
	Resistivity of inside surface ρ_I	Resistivity of outside surface ρ_O	Breakdown voltage V_B	Thickness d
1	$\rho_I \leq 1{,}0 \times 10^7\ \Omega$	$\rho_O \leq 1{,}0 \times 10^7\ \Omega$	No measurement required	No limit
2A	$\rho_I \leq 1{,}0 \times 10^7\ \Omega$	$\rho_O \leq 1{,}0 \times 10^{12}\ \Omega$	No measurement required	No limit
2B	$\rho_I \leq 1{,}0 \times 10^{12}\ \Omega$	$\rho_O \leq 1{,}0 \times 10^7\ \Omega$	No measurement required	No limit
3	$\rho_I \leq 1{,}0 \times 10^7\ \Omega$	$\rho_O > 1{,}0 \times 10^{12}\ \Omega$	$V_B < 4$ kV	No limit
4	$\rho_I > 1{,}0 \times 10^{12}\ \Omega$	$\rho_O \leq 1{,}0 \times 10^7\ \Omega$	$V_B < 4$ kV	d <700 μm

4.2.4 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.