

# INTERNATIONAL STANDARD

## NORME INTERNATIONALE

Live working – Insulating foam-filled tubes and solid rods –  
Part 1: Tubes and rods of a circular cross-section  
(standards.iteh.ai)

Travaux sous tension – Tubes isolants remplis de mousse et tiges isolantes  
pleines –  
Partie 1: Tubes et tiges de section circulaire

<https://standards.iteh.ai/catalog/standards/sist/6d61ac74-32c5-466b-a7c7-401b09000000/iec-60855-1-2016>



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Partie 1: Tubes et tiges de section circulaire

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**LIVE WORKING – INSULATING FOAM-FILLED TUBES AND SOLID RODS –****Part 1: Tubes and rods of a circular cross-section**

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International Standard IEC 60855-1 has been prepared by technical committee 78: Live working.

This second edition cancels and replaces the first edition published in 2009. This edition constitutes a technical revision.

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

- reintroduction of specific diameters of foam-filled tubes and solid rods of circular cross-section with its tolerances;
- reintroduction of the dielectric tests before and after exposure to humidity, as included in IEC 60855-1:2009;
- specification of an alternative test (after exposure to immersion) in case of foam-filled tubes and solid rods having completed the production phase;
- review of phase angle maximum specified values;

- review of the wet test procedure and the improvement of the associated test arrangement.

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

FDIS	Report on voting
78/1147/FDIS	78/1156/RVD

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

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

A list of all parts in the IEC 60855 series, published under the general title *Live working – Insulating foam-filled tubes and solid rods*, can be found on the IEC website.

Terms defined in Clause 3 are given in *italic* print throughout this standard.

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

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## INTRODUCTION

This part of IEC 60855 has been prepared in accordance with the requirements of IEC 61477.

The product covered by this part of IEC 60855 may have an impact on the environment during some or all stages of its life cycle. These impacts can range from slight to significant, be short-term or long-term, and occur at the global, regional or local level.

This part of IEC 60855 does not include requirements and test provisions for the manufacturers of the product, or recommendations to the users of the product for environmental improvement. However, all parties intervening in its design, manufacture, packaging, distribution, use, maintenance, repair, reuse, recovery and disposal are invited to take account of environmental considerations.

Technical committee 78 is considering the preparation of IEC 60855-2, which would cover foam-filled tubes and solid rods of cross-section other than circular.

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# LIVE WORKING – INSULATING FOAM-FILLED TUBES AND SOLID RODS –

## Part 1: Tubes and rods of a circular cross-section

### 1 Scope

This part of IEC 60855 is applicable to *insulating foam-filled tubes* and solid rods, of a circular cross-section, made of synthetic materials with reinforced fibreglass and intended to be used in the manufacture and construction of tools, devices and equipment for carrying out live working on electrical systems operating at voltages above 1 kV.

Foam-filled tubes and solid rods of cross-section other than circular and/or made with material other than synthetic materials with reinforced fibreglass are not covered by this part of IEC 60855.

### 2 Normative references

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

IEC 60060-1, *High-voltage test techniques – Part 1: General definitions and test requirements*

IEC 60060-2, *High-voltage test techniques – Part 2: Measuring systems*

IEC 60212:2010, *Standard conditions for use prior to and during the testing of solid electrical insulating materials*

IEC 61318, *Live working – Conformity assessment applicable to tools, devices and equipment*

### 3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 61318 and the following apply.

#### 3.1 foam

insulating material composed of closed cells, generally made of polyurethane, used to prevent the ingress and migration of moisture

Note 1 to entry: *Foam* is the inner support to manufacture the *foam*-filled tubes covered by this part of IEC 60855.

[SOURCE: IEC 60050-651:2014, 651-22-03, modified – The note has been changed to refer specifically to the *foam* filled tubes covered by this part of IEC 60855.]

#### 3.2 insulating foam-filled tube foam-filled tube

tube of uniform circular cross-section supplied in straight lengths, manufactured on a *foam* and constructed or formed of synthetic insulating rigid material with reinforced fibreglass

### 3.3 insulating solid rod solid rod

solid product of uniform circular cross-section supplied in straight lengths, constructed or formed of synthetic insulating rigid reinforced material

[SOURCE: IEC 60050-651:2014, 651-22-04, modified – The term and its definition have been changed to refer specifically to *insulating solid rods* covered by this part of IEC 60855.]

## 4 Requirements

### 4.1 Materials and design

*Foam*-filled tubes and solid rods shall be made of synthetic insulating material with reinforced fibreglass.

NOTE Yellow, orange and red are the preferred colours to indicate that the material has insulating properties.

If any coating is applied, it may be transparent or coloured.

The *foam* filling shall be bonded to the wall of the insulating tube, and neither the *foam* nor the bond shall be deteriorated during the tests, other than those tests which lead to destruction of the parts. The *foam* filling shall be free of voids, separations, cracks or other defects.

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### 4.2 Electrical requirements (standards.iteh.ai)

The material and the design of *foam*-filled tubes and solid rods shall have insulating properties.

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The external surface of the *foam*-filled tubes and solid rods shall have hydrophobic properties.

### 4.3 Mechanical requirements

The material and the design of *foam*-filled tubes and solid rods shall have mechanical resistance properties.

### 4.4 Diameters of foam-filled tubes and solid rods

All measured diameters shall fall within the tolerance limits specified in Table 1.

Table 1 – Specified diameters

Item	External nominal diameter mm	Tolerance on external diameter mm
Solid rod	10	± 1
	15	± 1
Foam-filled tube	32	± 1
	39	± 1,1
	51	± 1,2
	64	± 1,3
	77	± 1,5

## 4.5 Marking

Embossed marking is prohibited.

The marking of each *foam*-filled tube and solid rod shall include the following information as a minimum:

- name or trademark of the manufacturer;
- external nominal diameter;
- date of manufacture (month and year) and identification number when available;
- number of the relevant IEC standard (IEC 60855-1).

Other characteristics or information not needed at the work location, like the year of publication of the standard, shall be associated to the product item by other means, such as coded information (bar codes, microchips, etc.) on the product or on its packaging.

The marking shall be clearly legible to a person with normal or corrected vision, without additional magnification. The marking shall be durable and shall not affect the electrical performance of *foam*-filled tubes and solid rods.

## 4.6 Packaging

The marking of each pack shall include the following information as a minimum:

- name or trademark of the manufacturer;
- external nominal diameter; (standards.iteh.ai)
- date of manufacture (month and year) and identification number when available;
- number of the relevant IEC standard (IEC 60855-1)

The packaging should reduce abrasive or direct contact with other *foam*-filled tubes or solid rods or any surface that could damage the polished surface.

## 5 Tests

### 5.1 General

This part of IEC 60855 provides testing provisions to demonstrate that the *foam*-filled tubes and solid rods comply with the requirements of Clause 4. These testing provisions are primarily intended to be used for type testing for validation of the design input. Where relevant, alternative means (calculation, examination, tests, etc.), are specified within the test subclauses for the purpose of foam-filled tubes and solid rods having completed the production phase (see Annex B).

### 5.2 Type test conditions

#### 5.2.1 General

To comply with this part of IEC 60855, the design of the product shall fulfil all the type tests listed in Table A.1.

The type tests shall be carried out following the order given in Table A.1.

Each test shall be carried out on each separate test piece in the relevant group.

Any test piece failing to pass any one of the tests mentioned in Annex A shall result in the design being rejected.

For all type tests, environmental conditions in the test room shall comply with the normal atmospheric conditions provided in Table 2 of IEC 60212:2010, at a temperature of between 15 °C and 35 °C, with a relative humidity between 25 % and 75 % (taking into account Note 4 of Table 2 of IEC 60212:2010).

Nevertheless, for the electrical test the atmospheric conditions shall be at temperature between 18 °C and 28 °C, with a relative humidity between 45 % and 75 %.

This part of IEC 60855 covers foam-filled tubes and solid rods for use at temperatures between –25 °C and +55 °C and at a relative humidity between 20 % and 93 %. For foam-filled tubes and solid rods intended to be used in unusual atmospheric conditions (higher or lower temperatures, higher relative humidity), the tests should be more restricting and be carried out in appropriate conditions.

Unless otherwise specified, for all type tests, the tolerance on the dimensions shall be  $\pm 0,5$  %.

When a visual check is specified, it shall be understood to be a visual check by a person with normal or corrected vision without additional magnification.

## 5.2.2 Groups and test pieces

The manufacturer shall supply lengths of foam-filled tubes and solid rods to provide the following groups of test pieces. For each test piece of every group the corresponding length shall be cut at least to 0,1 m from the end of the initial length of solid rod or foam-filled tube provided by the manufacturer.

- Group 1: three test pieces of 0,3 m.
- Group 2: three test pieces of 1,2 m. [IEC 60855-1:2016](https://standards.iteh.ai/catalog/standards/sist/6d61ac74-32c5-466b-a7c7-d0d98dcb49c9/iec-60855-1-2016)
- Group 3: three test pieces of 2,5 m in case of foam-filled tube and 2 m in case of solid rod. <https://standards.iteh.ai/catalog/standards/sist/6d61ac74-32c5-466b-a7c7-d0d98dcb49c9/iec-60855-1-2016>
- Group 4: three test pieces of 1,2 m.
- Group 5: (for foam-filled tubes only): three test pieces of length equal to three times the external diameter  $\pm 5$  %.
- Group 6: three test pieces of 2,5 m.
- Group 7: three test pieces of  $(100 \pm 5)$  mm.

One length of 2 m shall be kept as a reference specimen.

The equipment used to cut the test pieces shall not leave any trace of overheating on the cross-section. The cut shall be clean, showing no signs of tearing of the fibres and shall be made perpendicular to the axis of the foam-filled tube and solid rod.

## 5.3 Visual and dimensional checks

### 5.3.1 General

These checks shall be carried out to ensure that the general requirements are fulfilled and that the dimensions comply with the specifications.

### 5.3.2 Visual check

Initial lengths and test pieces shall be checked visually to verify the elements of marking, the packaging and to detect constructional defects.

There are two levels of inspection to detect constructional defects:

- a) A first visual check shall be carried out on each of the initial lengths of foam-filled tube and solid rod provided by the manufacturer before the test pieces are cut from them. This is to detect any surface defects such as obviously faulty bonding between the fibre and the resin, voids underneath the varnish, foreign bodies, protrusions, dirt, bumps or scratches and absence of marks. Any defect shall result in rejection of the initial length.
- b) A second visual check shall be carried out on each of the test pieces after they have been cut. This is to detect any internal defects around the visible part of the cross-section, and more particularly, any signs of detachment between the *foam* and the resin, and *foam* of poor quality (voids, cracks). Any such defect shall result in rejection of the test piece.

### 5.3.3 Dimensional check

The purpose of the dimensional check is to verify that diameters comply with the marking, and the tolerances comply with the requirements of 4.4.

The dimensional check shall be carried out on each of the initial lengths, before the test pieces are cut from them, at both ends and in the middle. The difference between any two measured diameters of a given length shall be less than 0,5 mm.

## 5.4 Electrical tests

### 5.4.1 General

Unless otherwise stated, tests shall be carried out using an AC power source at power frequency in accordance with the requirements given in IEC 60060-1. Measuring systems shall comply with IEC 60060-2 unless otherwise specified.

### 5.4.2 Dielectric test before and after exposure to humidity

#### 5.4.2.1 Type test

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#### 5.4.2.1.1 General test conditions

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Before the test, each test piece of 300 mm length shall be prepared by cleaning with isopropanol ( $\text{CH}_3\text{-CH(OH)-CH}_3$ ) and then dried in air at room temperature for a period of not less than 15 min.

NOTE It is not the purpose of this part of IEC 60855 to ensure that any relevant legislation and any specific safety instructions regarding the use of isopropanol are fully observed.

The test pieces shall be lightly wiped with a clean dry lint-free cloth and the ends of the test pieces shall be covered with conductive adhesive tape.

Conditioning in a humid atmosphere is carried out in accordance with IEC 60212.

#### 5.4.2.1.2 Measurements

The test assembly shall comply with Figures 1, 2, 3 and 4. The measuring apparatus shall not be less than 2 m from the high voltage source. All measuring leads, the shunt and the optional protective gap shall be shielded and earthed. The test piece shall be mounted at a minimum height of 1 m from the ground on an insulating support. A voltage of 100 kV rms at power frequency shall be applied between the electrodes for 1 min. The AC voltage shall be initially applied at a low value and gradually increased at a constant rate-of-rise of approximately 5 kV/s until the test voltage level is reached. The test period shall be considered to start at the instant the specified voltage is reached.

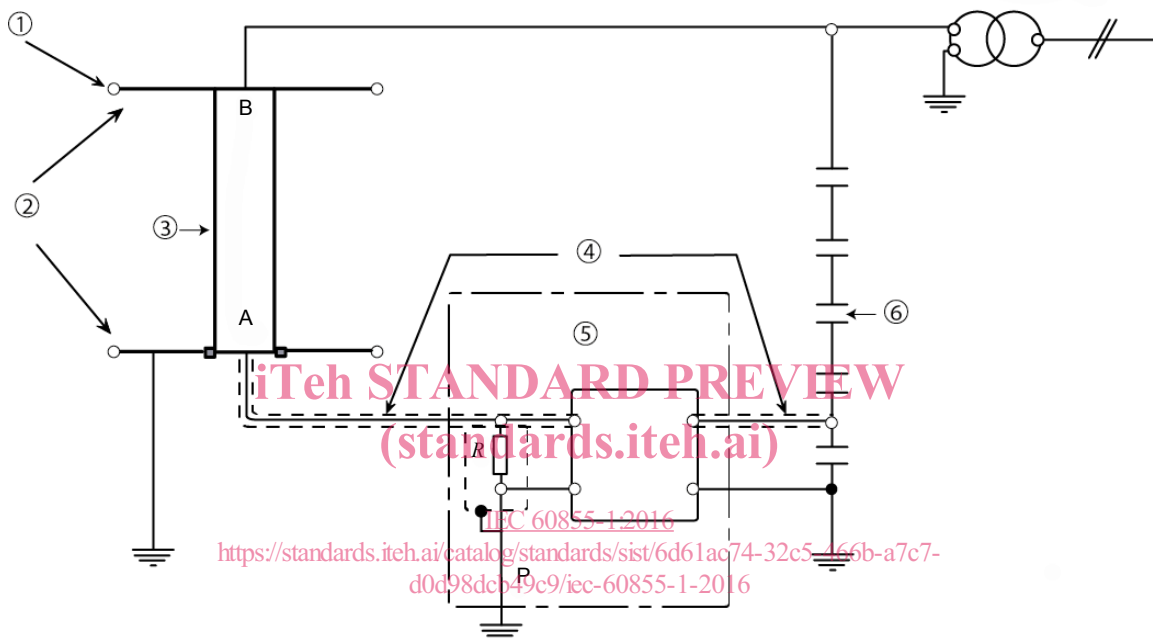
The current passing through the test piece shall be measured (the guard electrode on the earth side is directly connected to earth). The maximum current recorded during the test is called *I*.

The phase difference between current and voltage shall be measured as follows:

- current (earth end), by passing it through a known impedance;
- voltage (line end), by means of an appropriate divider.

The minimum phase angle recorded during the test is called  $\varphi$ .

Before installing the test piece in the test set-up, reference measurements with no test piece present shall be taken and the current and phase angle values recorded. The phase angle value shall be higher than  $88^\circ$ . This blank test will help verify the quality of the test set-up.



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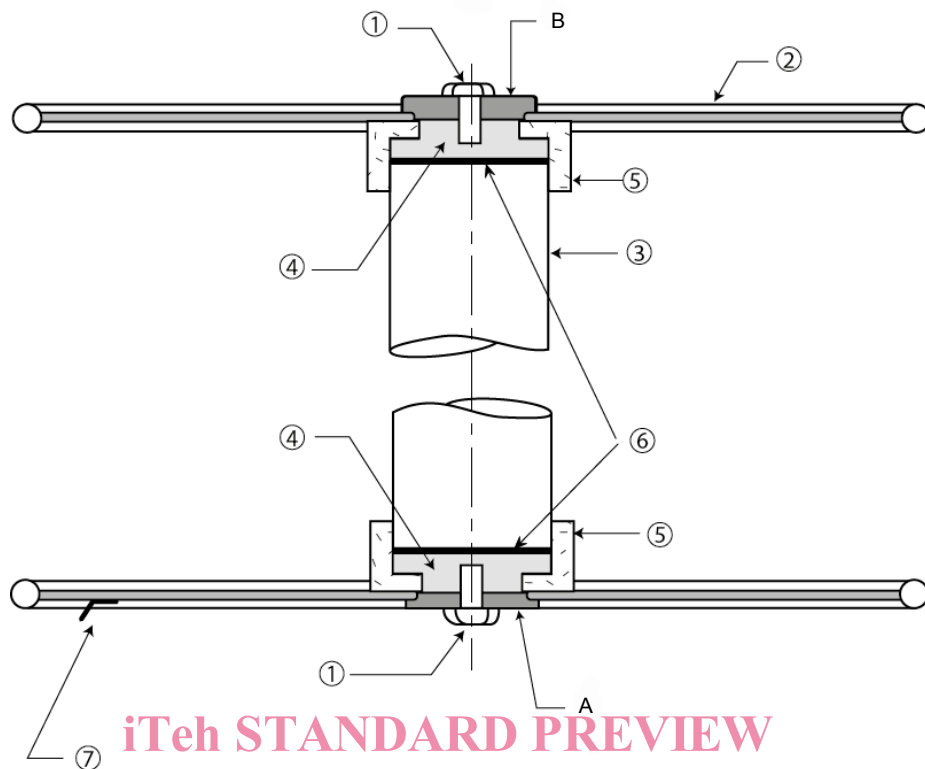
- |   |                        |   |                                   |
|---|------------------------|---|-----------------------------------|
| 1 | continuous welded tube | 4 | screened leads                    |
| 2 | guard electrodes       | 5 | measuring equipment               |
| 3 | test piece             | 6 | capacitive (or resistive) divider |

A and B See Figure 2.

R resistance between points A and P:  $R \leq 10\,000\ \Omega$

The measurement zone is situated at least 2 m away from any high voltage source.

**Figure 1 – Typical dielectric test arrangement**



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**Key**

- |   |   |   |   |
|---|---|---|---|
| A | insulating material                       | B | brass   |
| 1 | socket for $\varnothing$ 4 mm banana plug | 5 | insulating support  |
| 2 | guard electrode                           | 6 | contact maintained by conductive adhesive tape                        |
| 3 | test piece of 300 mm length               | 7 | socket for $\varnothing$ 4 mm banana plug soldered on guard electrode |
| 4 | brass electrode                           |   |   |

Banana plugs may be replaced by other suitable electrical connectors.

**Figure 2 – Assembly set-up of the test piece to the guard electrodes**