

# REDLINE VERSION



---

## Overhead lines – Requirements and tests for spacers

INTERNATIONAL  
ELECTROTECHNICAL  
COMMISSION

---

ICS 29.240.20

ISBN 978-2-8322-7900-7

**Warning! Make sure that you obtained this publication from an authorized distributor.**

## CONTENTS

|   |    |
|---|----|
| FOREWORD .....  | 4  |
| 1 Scope .....   | 6  |
| 2 Normative references .....  | 6  |
| 3 Terms and definitions .....   | 8  |
| 4 General requirements .....  | 8  |
| 4.1 Design .....  | 8  |
| 4.2 Materials .....   | 9  |
| 4.2.1 General .....   | 9  |
| 4.2.2 Non-metallic materials .....  | 9  |
| 4.3 Mass, dimensions and tolerances .....   | 9  |
| 4.4 Protection against corrosion .....  | 9  |
| 4.5 Manufacturing appearance and finish .....   | 9  |
| 4.6 Marking .....   | 10 |
| 4.7 Installation instructions .....   | 10 |
| 4.8 Specimen .....  | 10 |
| 5 Quality assurance .....   | 10 |
| 6 Classification of tests .....   | 10 |
| 6.1 Type tests .....  | 10 |
| 6.1.1 General .....   | 10 |
| 6.1.2 Application .....   | 10 |
| 6.2 Sample tests .....  | 11 |
| 6.2.1 General .....   | 11 |
| 6.2.2 Application .....   | 11 |
| 6.2.3 Sampling and acceptance criteria .....  | 11 |
| 6.3 Routine tests .....   | 11 |
| 6.3.1 General .....   | 11 |
| 6.3.2 Application and acceptance criteria .....   | 11 |
| 6.4 Table of tests to be applied .....  | 11 |
| 7 Test methods .....  | 14 |
| 7.1 Visual examination .....  | 14 |
| 7.2 Verification of dimensions, materials and mass .....  | 14 |
| 7.3 Corrosion protection test .....   | 14 |
| 7.3.1 Hot dip galvanized components (other than stranded galvanized steel wires) .....            | 14 |
| 7.3.2 Ferrous components protected from corrosion by methods other than hot dip galvanizing ..... | 15 |
| 7.3.3 Stranded galvanized steel wires .....   | 15 |
| 7.3.4 Corrosion caused by non-metallic components .....   | 15 |
| 7.4 Non-destructive tests .....   | 15 |
| 7.5 Mechanical tests .....  | 15 |
| 7.5.1 Clamp slip tests .....  | 15 |
| 7.5.2 Tests on bolt sets .....  | 23 |
| 7.5.3 Simulated short-circuit current test and compression and tension tests .....                | 26 |
| 7.5.4 Characterisation of the elastic and damping properties .....                                | 33 |
| 7.5.5 Flexibility tests .....   | 37 |
| 7.5.6 Fatigue tests .....   | 40 |

|  |   |    |
|--|---|----|
| 7.6  | Tests to characterise elastomers .....                                | 45 |
| 7.6.1  | General .....   | 45 |
| 7.6.2  | Tests .....   | 45 |
| 7.6.3  | Ozone resistance test .....   | 45 |
| 7.7  | Electrical tests .....  | 47 |
| 7.7.1  | Corona and radio interference voltage (RIV) tests.....                | 47 |
| 7.7.2  | Electrical resistance test.....                                       | 48 |
| 7.8  | Verification of vibration behaviour of the bundle/spacer system ..... | 49 |
| Annex A (normative) Minimum technical details to be agreed between purchaser and supplier.....                 |   | 50 |
| Annex B (informative) Compressive forces in the simulated short-circuit current test .....                     |   | 51 |
| Annex C (informative) Characterisation of the elastic and damping properties<br>Stiffness-Damping Method ..... |   | 52 |
| Annex D (informative) Verification of vibration behaviour of the bundle/spacer system.....                     |   | 54 |
| D.1  | General.....  | 54 |
| D.2  | Aeolian vibration .....   | 54 |
| D.3  | Subspan oscillation.....  | 55 |
| Annex E (informative) Description of HT conductors as given in<br>CIGRE TB 695-2017 [7] .....                  |   | 56 |
| Bibliography.....  |   | 57 |
|  |   |    |
| Figure 1 – Test arrangements for longitudinal slip tests .....   |   | 18 |
| Figure 2 – Test arrangement for torsional slip tests.....  |   | 22 |
| Figure 3 – Test arrangement for the spring force test at room temperature .....                                |   | 24 |
| Figure 4 – Test arrangement for permanent load test on conical washers .....                                   |   | 25 |
| Figure 5 – Test arrangements for simulated short-circuit current tests .....                                   |   | 30 |
| Figure 6 – Test arrangements for compression and tension test.....   |   | 32 |
| Figure 7 – Typical logarithmic decrement graph.....  |   | 36 |
| Figure 8 – Sketch of longitudinal displacement test.....   |   | 38 |
| Figure 9 – Sketch of vertical displacement test .....  |   | 39 |
| Figure 10 – Sketch of conical displacement test.....   |   | 39 |
| Figure 11 – Sketch of transverse horizontal displacement test .....  |   | 40 |
| Figure 12 – Test arrangements for subspan oscillation tests .....  |   | 43 |
| Figure 13 – Test arrangement for aeolian vibration test .....  |   | 45 |
| Figure C.1 – Rotation of spacer arm around the centre of the hinge.....  |   | 52 |
| Figure C.2 – Vector representation of formula C.2 .....  |   | 53 |
|  |   |    |
| Table 1 – Tests on spacers.....  |   | 13 |
| Table 2 – Tests on elastomers .....  |   | 47 |

## INTERNATIONAL ELECTROTECHNICAL COMMISSION

---

**OVERHEAD LINES –  
REQUIREMENTS AND TESTS FOR SPACERS****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.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

**DISCLAIMER**

**This Redline version is not an official Standard and is intended to provide the user with an indication of what changes have been made to the previous version. Only the IEC International Standard provided in this package is to be considered the official Standard.**

**This Redline version provides you with a quick and easy way to compare all the changes between this standard and its 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 61854 has been prepared by IEC technical committee 11: Overhead lines.

This second edition cancels and replaces the first edition published in 1998. This edition constitutes a technical revision.

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

- a) Consider the application of spacers on high temperature conductors specifying additional high temperature tests in clamp slip tests and for the characterization of elastic and damping properties;
- b) Specify as far as possible test parameters and acceptance values;
- c) Avoid as far as possible the alternative procedures for the same test;
- d) Introduce a simpler test device for the simulated short circuit current test;
- e) Introduce test at low temperature on fastener components such as break away bolts and conical spring washers;
- f) Prescribe a different procedure for subspan oscillation tests on spacers equipped with clamps having rod attachments;
- g) Modify the test procedure for the aeolian vibration tests;
- h) Prescribe a different procedure for aeolian vibration tests on spacers equipped with clamps having rod attachments;
- i) Re-edit all the figures in order to make them more clear and homogeneous;
- j) Introduce an additional test device for the simulated short circuit current test.

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

| FDIS        | Report on voting |
|-------------|------------------|
| 11/265/FDIS | 11/272/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 document has been drafted in accordance with the ISO/IEC Directives, Part 2.

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.**

## OVERHEAD LINES – REQUIREMENTS AND TESTS FOR SPACERS

### 1 Scope

This document applies to spacers for conductor bundles of overhead lines. It covers rigid spacers, flexible spacers and spacer dampers.

It does not apply to interphase spacers, hoop spacers and bonding spacers.

NOTE This document is written to cover the line design practices and spacers most commonly used at the time of writing. There may be other spacers available for which the specific tests reported in this document may not be applicable.

In ~~many~~ some cases, test procedures and test values are left to agreement between purchaser and supplier and are stated in the procurement contract. The purchaser is best able to evaluate the intended service conditions, which should be the basis for establishing the test severity.

In Annex A, the minimum technical details to be agreed between purchaser and supplier are listed.

### 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 60050(466):1990, *International Electrotechnical vocabulary (IEV) – Chapter 466: Overhead lines*

IEC 60888:1987, *Zinc-coated steel wires for stranded conductors*

IEC 61284:1997, *Overhead lines – Requirements and tests for fittings*

ISO 34-1:~~1994~~2015, *Rubber, vulcanized or thermoplastic – Determination of tear strength – Part 1: Trouser, angle and crescent test pieces*

ISO 34-2:~~1996~~2015, *Rubber, vulcanized or thermoplastic – Determination of tear strength – Part 2: Small (Delft) test pieces*

ISO 37:~~1994~~2017, *Rubber, vulcanized or thermoplastic – Determination of tensile stress-strain properties*

ISO 188:~~1982~~2011, *Rubber, vulcanized or thermoplastic – Accelerated ageing or heat resistance tests*

ISO 812:~~1991~~2017, *Rubber, vulcanized or thermoplastic – Determination of low-temperature brittleness*

~~ISO 815:1991, Rubber, vulcanized or thermoplastic – Determination of compression set at ambient, elevated or low temperatures~~

ISO 815-1:2014, *Rubber, vulcanized or thermoplastic – Determination of compression set – Part 1: At ambient or elevated temperatures*

ISO 815-2:2014, *Rubber, vulcanized or thermoplastic – Determination of compression set – Part 2: At low temperatures*

ISO 868:~~1985~~2003, *Plastics and ebonite – Determination of indentation hardness by means of a durometer (Shore hardness)*

~~ISO 1183:1987, *Plastics – Methods for determining the density and relative density of non-cellular plastics*~~

ISO 1183-1:2019, *Plastics — Methods for determining the density of non-cellular plastics — Part 1: Immersion method, liquid pycnometer method and titration method*

ISO 1431-1:~~1989~~2012, *Rubber, vulcanized or thermoplastic – Resistance to ozone cracking – Part 1: Static and dynamic strain testing*

ISO 1461:2009, *Hot dip galvanized coatings on fabricated ~~ferrous products~~ iron and steel articles – Specifications and test methods<sup>1)</sup>*

ISO 1817:~~1985~~2015, *Rubber, vulcanized or thermoplastic – Determination of the effect of liquids*

ISO 2781:~~1988~~2018, *Rubber, vulcanized or thermoplastic – Determination of density*

ISO 2859-1:~~1989~~1999/AMD1:2011, *Sampling procedures for inspection by attributes – Part 1: Sampling ~~plans~~ schemes indexed by acceptable quality ~~level~~ limit (AQL) for lot-by-lot inspection*

ISO 2859-2:1985, *Sampling procedures for inspection by attributes – Part 2: Sampling plans indexed by limiting quality level (LQ) for isolated lot inspection*

ISO 2921:~~1982~~2011, *Rubber, vulcanized – Determination of low-temperature ~~characteristics~~ retraction (TR test) — ~~Temperature retraction procedure (TR test)~~*

~~ISO 3417:1991, *Rubber – Measurement of vulcanization characteristics with the oscillating disc curemeter*~~

~~ISO 3951:1989, *Sampling procedures and charts for inspection by variables for percent nonconforming*~~

ISO 3951-1:2013, *Sampling procedures for inspection by variables -- Part 1: Specification for single sampling plans indexed by acceptance quality limit (AQL) for lot-by-lot inspection for a single quality characteristic and a single AQL*

ISO 3951-2:2013, *Sampling procedures for inspection by variables -- Part 2: General specification for single sampling plans indexed by acceptance quality limit (AQL) for lot-by-lot inspection of independent quality characteristics*

ISO 4649:~~1985~~2017, *Rubber, vulcanized or thermoplastic – Determination of abrasion resistance using a rotating cylindrical drum device*

---

<sup>1)</sup>~~To be published.~~

ISO 4662:~~1986~~2017, *Rubber, vulcanized or thermoplastic – Determination of rebound resilience of vulcanizates*

ISO 6502-2:2018, *Rubber – Measurement of vulcanization characteristics using curemeters – Part 2: Oscillating disc curemeter*

ISO 9001:2015, *Quality management systems – Requirements*



# INTERNATIONAL STANDARD

# NORME INTERNATIONALE



---

**Overhead lines – Requirements and tests for spacers**

**Lignes aériennes – Exigences et essais applicables aux entretoises**

## CONTENTS

|   |    |
|---|----|
| FOREWORD .....  | 4  |
| 1 Scope .....   | 6  |
| 2 Normative references .....  | 6  |
| 3 Terms and definitions .....   | 7  |
| 4 General requirements .....  | 8  |
| 4.1 Design .....  | 8  |
| 4.2 Materials .....   | 9  |
| 4.2.1 General .....   | 9  |
| 4.2.2 Non-metallic materials .....  | 9  |
| 4.3 Mass, dimensions and tolerances .....   | 9  |
| 4.4 Protection against corrosion .....  | 9  |
| 4.5 Manufacturing appearance and finish .....   | 9  |
| 4.6 Marking .....   | 9  |
| 4.7 Installation instructions .....   | 9  |
| 4.8 Specimen .....  | 9  |
| 5 Quality assurance .....   | 10 |
| 6 Classification of tests .....   | 10 |
| 6.1 Type tests .....  | 10 |
| 6.1.1 General .....   | 10 |
| 6.1.2 Application .....   | 10 |
| 6.2 Sample tests .....  | 10 |
| 6.2.1 General .....   | 10 |
| 6.2.2 Application .....   | 10 |
| 6.2.3 Sampling and acceptance criteria .....  | 11 |
| 6.3 Routine tests .....   | 11 |
| 6.3.1 General .....   | 11 |
| 6.3.2 Application and acceptance criteria .....   | 11 |
| 6.4 Table of tests to be applied .....  | 11 |
| 7 Test methods .....  | 13 |
| 7.1 Visual examination .....  | 13 |
| 7.2 Verification of dimensions, materials and mass .....  | 13 |
| 7.3 Corrosion protection test .....   | 13 |
| 7.3.1 Hot dip galvanized components (other than stranded galvanized steel wires) .....            | 13 |
| 7.3.2 Ferrous components protected from corrosion by methods other than hot dip galvanizing ..... | 14 |
| 7.3.3 Stranded galvanized steel wires .....   | 14 |
| 7.3.4 Corrosion caused by non-metallic components .....   | 14 |
| 7.4 Non-destructive tests .....   | 14 |
| 7.5 Mechanical tests .....  | 14 |
| 7.5.1 Clamp slip tests .....  | 14 |
| 7.5.2 Tests on bolt sets .....  | 19 |
| 7.5.3 Simulated short-circuit current test and compression and tension tests .....                | 21 |
| 7.5.4 Characterisation of the elastic and damping properties .....                                | 27 |
| 7.5.5 Flexibility tests .....   | 31 |
| 7.5.6 Fatigue tests .....   | 33 |

|  |   |    |
|--|---|----|
| 7.6  | Tests to characterise elastomers .....                                | 36 |
| 7.6.1  | General .....   | 36 |
| 7.6.2  | Tests .....   | 36 |
| 7.6.3  | Ozone resistance test .....   | 36 |
| 7.7  | Electrical tests .....  | 38 |
| 7.7.1  | Corona and radio interference voltage (RIV) tests.....                | 38 |
| 7.7.2  | Electrical resistance test.....                                       | 38 |
| 7.8  | Verification of vibration behaviour of the bundle/spacer system ..... | 39 |
| Annex A (normative) Minimum technical details to be agreed between purchaser and supplier.....                 |   | 40 |
| Annex B (informative) Compressive forces in the simulated short-circuit current test .....                     |   | 41 |
| Annex C (informative) Characterisation of the elastic and damping properties<br>Stiffness-Damping Method ..... |   | 42 |
| Annex D (informative) Verification of vibration behaviour of the bundle/spacer system.....                     |   | 44 |
| D.1  | General.....  | 44 |
| D.2  | Aeolian vibration .....   | 44 |
| D.3  | Subspan oscillation.....  | 45 |
| Annex E (informative) Description of HT conductors as given in<br>CIGRE TB 695-2017 [7] .....                  |   | 46 |
| Bibliography.....  |   | 47 |
|  |   |    |
| Figure 1 – Test arrangements for longitudinal slip tests .....   |   | 16 |
| Figure 2 – Test arrangement for torsional slip tests.....  |   | 19 |
| Figure 3 – Test arrangement for the spring force test at room temperature .....                                |   | 20 |
| Figure 4 – Test arrangement for permanent load test on conical washers .....                                   |   | 21 |
| Figure 5 – Test arrangements for simulated short-circuit current tests .....                                   |   | 25 |
| Figure 6 – Test arrangements for compression and tension test.....   |   | 26 |
| Figure 7 – Typical logarithmic decrement graph.....  |   | 30 |
| Figure 8 – Sketch of longitudinal displacement test.....   |   | 32 |
| Figure 9 – Sketch of vertical displacement test .....  |   | 32 |
| Figure 10 – Sketch of conical displacement test.....   |   | 32 |
| Figure 11 – Sketch of transverse horizontal displacement test .....  |   | 33 |
| Figure 12 – Test arrangements for subspan oscillation tests .....  |   | 34 |
| Figure 13 – Test arrangement for aeolian vibration test .....  |   | 36 |
| Figure C.1 – Rotation of spacer arm around the centre of the hinge.....  |   | 42 |
| Figure C.2 – Vector representation of formula C.2 .....  |   | 43 |
|  |   |    |
| Table 1 – Tests on spacers.....  |   | 12 |
| Table 2 – Tests on elastomers .....  |   | 37 |

# INTERNATIONAL ELECTROTECHNICAL COMMISSION

---

## OVERHEAD LINES – REQUIREMENTS AND TESTS FOR SPACERS

### 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.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 61854 has been prepared by IEC technical committee 11: Overhead lines.

This second edition cancels and replaces the first edition published in 1998. This edition constitutes a technical revision.

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

- a) Consider the application of spacers on high temperature conductors specifying additional high temperature tests in clamp slip tests and for the characterization of elastic and damping properties;
- b) Specify as far as possible test parameters and acceptance values;
- c) Avoid as far as possible the alternative procedures for the same test;
- d) Introduce a simpler test device for the simulated short circuit current test;
- e) Introduce test at low temperature on fastener components such as break away bolts and conical spring washers;

- f) Prescribe a different procedure for subspan oscillation tests on spacers equipped with clamps having rod attachments;
- g) Modify the test procedure for the aeolian vibration tests;
- h) Prescribe a different procedure for aeolian vibration tests on spacers equipped with clamps having rod attachments;
- i) Re-edit all the figures in order to make them more clear and homogeneous;
- j) Introduce an additional test device for the simulated short circuit current test.

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

|             |                  |
|-------------|------------------|
| FDIS        | Report on voting |
| 11/265/FDIS | 11/272/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 document has been drafted in accordance with the ISO/IEC Directives, Part 2.

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.**

## OVERHEAD LINES – REQUIREMENTS AND TESTS FOR SPACERS

### 1 Scope

This document applies to spacers for conductor bundles of overhead lines. It covers rigid spacers, flexible spacers and spacer dampers.

It does not apply to interphase spacers, hoop spacers and bonding spacers.

NOTE This document is written to cover the line design practices and spacers most commonly used at the time of writing. There may be other spacers available for which the specific tests reported in this document may not be applicable.

In some cases, test procedures and test values are left to agreement between purchaser and supplier and are stated in the procurement contract. The purchaser is best able to evaluate the intended service conditions, which should be the basis for establishing the test severity.

In Annex A, the minimum technical details to be agreed between purchaser and supplier are listed.

### 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 60050(466):1990, *International Electrotechnical vocabulary (IEV) – Chapter 466: Overhead lines*

IEC 60888:1987, *Zinc-coated steel wires for stranded conductors*

IEC 61284:1997, *Overhead lines – Requirements and tests for fittings*

ISO 34-1:2015, *Rubber, vulcanized or thermoplastic – Determination of tear strength – Part 1: Trouser, angle and crescent test pieces*

ISO 34-2:2015, *Rubber, vulcanized or thermoplastic – Determination of tear strength – Part 2: Small (Delft) test pieces*

ISO 37:2017, *Rubber, vulcanized or thermoplastic – Determination of tensile stress-strain properties*

ISO 188:2011, *Rubber, vulcanized or thermoplastic – Accelerated ageing or heat resistance tests*

ISO 812:2017, *Rubber, vulcanized or thermoplastic – Determination of low-temperature brittleness*

ISO 815-1:2014, *Rubber, vulcanized or thermoplastic – Determination of compression set – Part 1: At ambient or elevated temperatures*

ISO 815-2:2014, *Rubber, vulcanized or thermoplastic – Determination of compression set – Part 2: At low temperatures*

ISO 868:2003, *Plastics and ebonite – Determination of indentation hardness by means of a durometer (Shore hardness)*

ISO 1183-1: 2019, *Plastics — Methods for determining the density of non-cellular plastics — Part 1: Immersion method, liquid pycnometer method and titration method*

ISO 1431-1:2012, *Rubber, vulcanized or thermoplastic – Resistance to ozone cracking – Part 1: Static and dynamic strain testing*

ISO 1461:2009, *Hot dip galvanized coatings on fabricated iron and steel articles – Specifications and test methods*

ISO 1817:2015, *Rubber, vulcanized or thermoplastic – Determination of the effect of liquids*

ISO 2781:2018, *Rubber, vulcanized or thermoplastic – Determination of density*

ISO 2859-1:1999/AMD1: 2011, *Sampling procedures for inspection by attributes – Part 1: Sampling schemes indexed by acceptable quality limit (AQL) for lot-by-lot inspection*

ISO 2859-2:1985, *Sampling procedures for inspection by attributes – Part 2: Sampling plans indexed by limiting quality level (LQ) for isolated lot inspection*

ISO 2921:2011, *Rubber, vulcanized – Determination of low-temperature retraction (TR test)*

ISO 3951-1:2013, *Sampling procedures for inspection by variables -- Part 1: Specification for single sampling plans indexed by acceptance quality limit (AQL) for lot-by-lot inspection for a single quality characteristic and a single AQL*

ISO 3951-2:2013, *Sampling procedures for inspection by variables -- Part 2: General specification for single sampling plans indexed by acceptance quality limit (AQL) for lot-by-lot inspection of independent quality characteristics*

ISO 4649:2017, *Rubber, vulcanized or thermoplastic – Determination of abrasion resistance using a rotating cylindrical drum device*

ISO 4662:2017, *Rubber, vulcanized or thermoplastic – Determination of rebound resilience*

ISO 6502-2:2018, *Rubber – Measurement of vulcanization characteristics using curemeters – Part 2: Oscillating disc curemeter*

ISO 9001:2015, *Quality management systems – Requirements*

## SOMMAIRE

|  |    |
|--|----|
| AVANT-PROPOS .....   | 50 |
| 1 Domaine d'application .....  | 52 |
| 2 Références normatives .....  | 52 |
| 3 Termes et définitions .....  | 54 |
| 4 Exigences générales .....  | 54 |
| 4.1 Conception .....   | 54 |
| 4.2 Matériaux.....   | 55 |
| 4.2.1 Généralités .....  | 55 |
| 4.2.2 Matériaux non métalliques .....  | 55 |
| 4.3 Masse, dimensions et tolérances .....  | 55 |
| 4.4 Protection contre la corrosion .....   | 55 |
| 4.5 Aspect et finition de fabrication .....  | 56 |
| 4.6 Marquage .....   | 56 |
| 4.7 Instructions d'installation.....   | 56 |
| 4.8 Echantillons .....   | 56 |
| 5 Assurance qualité .....  | 56 |
| 6 Classification des essais .....  | 56 |
| 6.1 Essais de type .....   | 56 |
| 6.1.1 Généralités .....  | 56 |
| 6.1.2 Application.....   | 56 |
| 6.2 Essais sur échantillon .....   | 57 |
| 6.2.1 Généralités .....  | 57 |
| 6.2.2 Application.....   | 57 |
| 6.2.3 Echantillonnage et critères de réception .....   | 57 |
| 6.3 Essais individuels de série .....  | 57 |
| 6.3.1 Généralités .....  | 57 |
| 6.3.2 Application et critères de réception .....   | 57 |
| 6.4 Tableau des essais à effectuer .....   | 58 |
| 7 Méthodes d'essai.....  | 60 |
| 7.1 Examen visuel .....  | 60 |
| 7.2 Vérification des dimensions, des matériaux et de la masse .....  | 60 |
| 7.3 Essai de protection contre la corrosion .....  | 60 |
| 7.3.1 Composants revêtus par galvanisation à chaud (autres que les fils en acier galvanisé câblés) .....       | 60 |
| 7.3.2 Produits ferreux protégés contre la corrosion par des méthodes autres que la galvanisation à chaud ..... | 61 |
| 7.3.3 Fils en acier galvanisé câblés .....   | 61 |
| 7.3.4 Corrosion causée par des composants non métalliques .....  | 61 |
| 7.4 Essais non destructifs .....   | 61 |
| 7.5 Essais mécaniques .....  | 62 |
| 7.5.1 Essais de glissement des pinces .....  | 62 |
| 7.5.2 Essais sur ensembles de boulons .....  | 67 |
| 7.5.3 Essais de courant de court-circuit simulé et essais de compression et de traction .....                  | 69 |
| 7.5.4 Caractérisation des propriétés élastiques et d'amortissement .....                                       | 75 |
| 7.5.5 Essais de flexibilité .....  | 80 |



|  |  |    |
|--|--|----|
| 7.5.6  | Essais de fatigue .....  | 82 |
| 7.6  | Essais de caractérisation des élastomères.....                                 | 86 |
| 7.6.1  | Généralités .....  | 86 |
| 7.6.2  | Essais .....   | 86 |
| 7.6.3  | Essai de résistance à l'ozone.....   | 86 |
| 7.7  | Essais électriques.....  | 88 |
| 7.7.1  | Essais d'effet couronne et de tension perturbatrice radioélectrique (RIV)..... | 88 |
| 7.7.2  | Essai de résistance électrique .....   | 88 |
| 7.8  | Vérification du comportement vibratoire du système faisceau/entretoise .....   | 89 |
| Annexe A (normative) Informations techniques minimales à convenir entre l'acheteur et le fournisseur.....  |  | 90 |
| Annexe B (informative) Forces de compression dans l'essai de courant de court-circuit simulé.....  |  | 91 |
| Annexe C (informative) Caractérisation des propriétés élastiques et d'amortissement<br>Méthode de détermination de la rigidité et de l'amortissement ..... |  | 92 |
| Annexe D (informative) Vérification du comportement vibratoire du système faisceau/entretoise .....  |  | 94 |
| D.1  | Généralités .....  | 94 |
| D.2  | Vibrations éoliennes .....   | 94 |
| D.3  | Oscillation de sous-portée .....   | 95 |
| Annexe E (informative) Description des conducteurs HT donnée dans la brochure technique CIGRE 695-2017 [7] .....   |  | 97 |
| Bibliographie.....   |  | 98 |
| Figure 1 – Montages d'essai pour les essais de glissement longitudinal.....  |  | 63 |
| Figure 2 – Montage d'essai pour les essais de glissement en torsion.....   |  | 67 |
| Figure 3 – Montage d'essai pour l'essai de force du ressort à température ambiante .....   |  | 68 |
| Figure 4 – Montage d'essai pour l'essai de charge permanente sur rondelles coniques .....  |  | 69 |
| Figure 5 – Montages d'essai pour les essais de courant de court-circuit simulé .....   |  | 73 |
| Figure 6 – Montages d'essai pour l'essai de compression et de traction.....  |  | 75 |
| Figure 7 – Courbe de décroissement logarithmique type .....  |  | 79 |
| Figure 8 – Exemple d'essai de déplacement longitudinal.....  |  | 81 |
| Figure 9 – Exemple d'essai de déplacement vertical .....   |  | 81 |
| Figure 10 – Exemple d'essai de déplacement conique .....   |  | 81 |
| Figure 11 – Exemple d'essai de déplacement horizontal transversal .....  |  | 82 |
| Figure 12 – Montages d'essai pour les essais d'oscillation de sous-portée.....   |  | 84 |
| Figure 13 – Montage d'essai pour l'essai de vibrations éoliennes.....  |  | 85 |
| Figure C.1 – Rotation du bras de l'entretoise autour du centre de l'articulation .....   |  | 92 |
| Figure C.2 – Représentation vectorielle de la formule C.2.....   |  | 93 |
| Tableau 1 – Essais sur les entretoises.....  |  | 59 |
| Tableau 2 – Essais sur les élastomères .....   |  | 87 |

## COMMISSION ÉLECTROTECHNIQUE INTERNATIONALE

---

### LIGNES AÉRIENNES – EXIGENCES ET ESSAIS APPLICABLES AUX ENTRETOISES

#### AVANT-PROPOS

- 1) La Commission Electrotechnique Internationale (IEC) est une organisation mondiale de normalisation composée de l'ensemble des comités électrotechniques nationaux (Comités nationaux de l'IEC). L'IEC a pour objet de favoriser la coopération internationale pour toutes les questions de normalisation dans les domaines de l'électricité et de l'électronique. A cet effet, l'IEC – entre autres activités – publie des Normes internationales, des Spécifications techniques, des Rapports techniques, des Spécifications accessibles au public (PAS) et des Guides (ci-après dénommés "Publication(s) de l'IEC"). Leur élaboration est confiée à des comités d'études, aux travaux desquels tout Comité national intéressé par le sujet traité peut participer. Les organisations internationales, gouvernementales et non gouvernementales, en liaison avec l'IEC, participent également aux travaux. L'IEC collabore étroitement avec l'Organisation Internationale de Normalisation (ISO), selon des conditions fixées par accord entre les deux organisations.
- 2) Les décisions ou accords officiels de l'IEC concernant les questions techniques représentent, dans la mesure du possible, un accord international sur les sujets étudiés, étant donné que les Comités nationaux de l'IEC intéressés sont représentés dans chaque comité d'études.
- 3) Les Publications de l'IEC se présentent sous la forme de recommandations internationales et sont agréées comme telles par les Comités nationaux de l'IEC.
- 4) Dans le but d'encourager l'uniformité internationale, les Comités nationaux de l'IEC s'engagent, dans toute la mesure possible, à appliquer de façon transparente les Publications de l'IEC dans leurs publications nationales et régionales. Toutes divergences entre toutes Publications de l'IEC et toutes publications nationales ou régionales correspondantes doivent être indiquées en termes clairs dans ces dernières.
- 5) L'IEC elle-même ne fournit aucune attestation de conformité. Des organismes de certification indépendants fournissent des services d'évaluation de conformité et, dans certains secteurs, accèdent aux marques de conformité de l'IEC. L'IEC n'est responsable d'aucun des services effectués par les organismes de certification indépendants.
- 6) Tous les utilisateurs doivent s'assurer qu'ils sont en possession de la dernière édition de cette publication.
- 7) Aucune responsabilité ne doit être imputée à l'IEC, à ses administrateurs, employés, auxiliaires ou mandataires, y compris ses experts particuliers et les membres de ses comités d'études et des Comités nationaux de l'IEC, pour tout préjudice causé en cas de dommages corporels et matériels, ou de tout autre dommage de quelque nature que ce soit, directe ou indirecte, ou pour supporter les coûts (y compris les frais de justice) et les dépenses découlant de la publication ou de l'utilisation de cette Publication de l'IEC ou de toute autre Publication de l'IEC, ou au crédit qui lui est accordé.
- 8) L'attention est attirée sur les références normatives citées dans cette publication. L'utilisation de publications référencées est obligatoire pour une application correcte de la présente publication.
- 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 61854 a été établie par le comité d'études 11 de l'IEC: Lignes aériennes.

Cette deuxième édition annule et remplace la première édition parue en 1998. Cette édition constitue une révision technique.

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

- a) prise en compte de l'application des entretoises sur des conducteurs haute température, avec la spécification d'essais à haute température supplémentaires dans le cadre des essais de glissement des pinces et la caractérisation des propriétés élastiques et d'amortissement;
- b) spécification la plus large possible des paramètres d'essai et des valeurs de réception associées;
- c) affranchissement, dans la mesure du possible, par rapport aux procédures alternatives pour le même essai;

- d) introduction d'un dispositif d'essai plus simple pour l'essai de courant de court-circuit simulé;
- e) introduction d'un essai à basse température sur les composants de fixation tels que les boulons fusibles et les rondelles élastiques coniques;
- f) prescription d'une procédure différente pour les essais d'oscillation de sous-portée sur les entretoises équipées de pinces avec garnitures;
- g) modification de la procédure d'essai pour les essais de vibrations éoliennes;
- h) prescription d'une procédure différente pour les essais de vibrations éoliennes sur les entretoises équipées de pinces avec garnitures;
- i) reprise de l'ensemble des figures afin de les rendre plus claires et homogènes;
- j) introduction d'un dispositif d'essai supplémentaire pour l'essai de courant de court-circuit simulé.

Le texte de cette norme est issu des documents suivants:

| FDIS        | Rapport de vote |
|-------------|-----------------|
| 11/265/FDIS | 11/272/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.

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

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. A cette date, le document sera

- reconduit,
- supprimé,
- remplacé par une édition révisée, ou
- amendé.

**IMPORTANT – Le logo "*colour inside*" qui se trouve sur la page de couverture de cette publication indique qu'elle contient des couleurs qui sont considérées comme utiles à une bonne compréhension de son contenu. Les utilisateurs devraient, par conséquent, imprimer cette publication en utilisant une imprimante couleur.**

## **LIGNES AÉRIENNES – EXIGENCES ET ESSAIS APPLICABLES AUX ENTRETOISES**

### **1 Domaine d'application**

Le présent document s'applique aux entretoises destinées aux faisceaux de conducteurs de lignes aériennes. Il couvre les entretoises rigides, les entretoises souples et les entretoises amortisseuses.

Il ne s'applique pas aux espaceurs, aux écarteurs à anneaux et aux entretoises de mise à la terre.

NOTE Le présent document a été élaboré pour couvrir les pratiques de conception de lignes, ainsi que les entretoises les plus couramment utilisées au moment de sa rédaction. Il peut exister d'autres entretoises pour lesquelles les essais spécifiques décrits dans le présent document peuvent ne pas s'appliquer.

Dans certains cas, les procédures d'essai et les valeurs d'essai sont convenues entre l'acheteur et le fournisseur et sont indiquées dans le contrat d'approvisionnement. L'acheteur est le mieux à même d'évaluer les conditions de service prévues, qu'il convient d'utiliser comme base pour la définition de la sévérité des essais.

L'Annexe A répertorie les informations techniques minimales à convenir entre l'acheteur et le fournisseur.

### **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 60050(466):1990, *Vocabulaire Electrotechnique International (IEV) – Chapitre 466: Lignes électriques*

IEC 60888:1987, *Fils en acier zingué pour conducteurs câblés*

IEC 61284:1997, *Lignes aériennes – Exigences et essais pour le matériel d'équipement*

ISO 34-1:2015, *Caoutchouc vulcanisé ou thermoplastique – Détermination de la résistance au déchirement – Partie 1: Eprouvettes pantalon, angulaire et croissant*

ISO 34-2:2015, *Caoutchouc vulcanisé ou thermoplastique – Détermination de la résistance au déchirement – Partie 2: Petites éprouvettes (épreuves de Delft)*

ISO 37:2017, *Caoutchouc vulcanisé ou thermoplastique – Détermination des caractéristiques de contrainte-déformation en traction*

ISO 188:2011, *Caoutchouc vulcanisé ou thermoplastique – Essais de résistance au vieillissement accéléré et à la chaleur*

ISO 812:2017, *Caoutchouc vulcanisé ou thermoplastique – Détermination de la fragilité à basse température*

ISO 815-1:2014, *Caoutchouc vulcanisé ou thermoplastique – Détermination de la déformation rémanente après compression – Partie 1: A températures ambiantes ou élevées*

ISO 815-2:2014, *Caoutchouc vulcanisé ou thermoplastique – Détermination de la déformation rémanente après compression – Partie 2: A basses températures*

ISO 868:2003, *Plastiques et ébonite – Détermination de la dureté par pénétration au moyen d'un duromètre (dureté Shore)*

ISO 1183-1: 2019, *Plastics — Methods for determining the density of non-cellular plastics — Part 1: Immersion method, liquid pycnometer method and titration method* (disponible en anglais uniquement)

ISO 1183-1:2012, *Plastiques – Méthodes de détermination de la masse volumique des plastiques non alvéolaires*

ISO 1431-1:2012, *Caoutchouc vulcanisé ou thermoplastique – Résistance au craquelage par l'ozone – Partie 1: Essais sous allongement statique et dynamique*

ISO 1461:2009, *Revêtements par galvanisation à chaud sur produits finis en fonte et en acier – Spécifications et méthodes d'essai*

ISO 1817:2015, *Caoutchouc vulcanisé ou thermoplastique – Détermination de l'action des liquides*

ISO 2781:2018, *Caoutchouc vulcanisé ou thermoplastique – Détermination de la masse volumique*

ISO 2859-1:1999/AMD1: 2011, *Règles d'échantillonnage pour les contrôles par attributs – Partie 1: Procédures d'échantillonnage pour les contrôles lot par lot, indexés d'après le niveau de qualité acceptable (NQA)*

ISO 2859-2:1985, *Règles d'échantillonnage pour les contrôles par attributs – Partie 2: Plans d'échantillonnage pour les contrôles de lots isolés, indexés d'après la qualité limite (QL)*

ISO 2921:2011, *Caoutchouc vulcanisé – Détermination du retrait à basse température (essai TR)*

ISO 3951-1:2013, *Règles d'échantillonnage pour les contrôles par mesures – Partie 1: Spécification pour les plans d'échantillonnage simples indexés d'après une limite de qualité acceptable (LQA) pour un contrôle lot par lot pour une caractéristique qualité unique et une LQA unique*

ISO 3951-2:2013, *Règles d'échantillonnage pour les contrôles par mesures – Partie 2: Spécification générale pour les plans d'échantillonnage simples indexés d'après une limite de qualité acceptable (LQA) pour le contrôle lot par lot de caractéristiques qualité indépendantes*

ISO 4649:2017, *Caoutchouc vulcanisé ou thermoplastique – Détermination de la résistance à l'abrasion à l'aide d'un dispositif à tambour tournant*

ISO 4662:2017, *Caoutchouc vulcanisé ou thermoplastique – Détermination de la résilience de rebondissement*

ISO 6502-2:2018, *Caoutchouc – Mesure des caractéristiques de vulcanisation à l'aide de rhéomètres – Partie 2: Rhéomètre à disque oscillant*

ISO 9001:2015, *Systèmes de management de la qualité – Exigences*