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INTERNATIONAL STANDARD

NORME INTERNATIONALE

Conductors for overhead lines – Aluminium and aluminium alloy wires for concentric lay stranded conductors

Conducteurs pour lignes aériennes – Fils d'aluminium et en alliage d'aluminium pour conducteurs toronnés à couches concentriques

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CONTENTS

FOREWORD 3
INTRODUCTION 5
1 Scope 6
2 Normative references 6
3 Terms and definitions 6
4 Material 8
5 Joints 8
6 Tests 8
6.1 General 8
6.2 Place of testing 8
6.3 Sampling rate 9
6.4 Test methods 9
6.4.1 Appearance 9
6.4.2 Wire diameter 9
6.4.3 Tensile strength 9
6.4.4 Elongation 9
6.4.5 Wrapping 10
6.4.6 Bending 10
6.4.7 Electrical resistivity 10
6.4.8 Thermal resistance 10
6.5 Acceptance and rejection 11
6.6 Certificate of compliance 11
7 Length and tolerance on length 11
Annex A (normative) Methods of securing formed wires 14
Annex B (informative) Thermal-resistant property 15
B.1 Thermal-resistant properties 15
B.2 Explanation of the Arrhenius plot 15
B.3 Continuous operation temperature 16
B.4 Duration and heating temperature 16
Bibliography 17

Figure A.1 – Methods of securing formed wires 14
Figure B.1 – Arrhenius plot (residual strength 90 %) 15

Table 1[a] – Designation and properties for calculation purposes[b] 11
Table 2 – Tolerance on wire diameter 12
Table 3 – Minimum mechanical properties for Ax and ALx wires 12
Table 4 – Minimum mechanical properties for ATx wires 13
Table 5 – Temperature and duration of heating 13
Table 6 – Parameters for bending test of aluminium alloy wires 13

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CONDUCTORS FOR OVERHEAD LINES – ALUMINIUM AND ALUMINIUM ALLOY WIRES FOR CONCENTRIC LAY STRANDED CONDUCTORS

FOREWORD

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IEC 62641 has been prepared by IEC technical committee 7: Overhead electrical conductors. It is an International Standard.

This first edition cancels and replaces the second edition of IEC 60104 published in 1987, the first edition of IEC 60121 published in 1960, the first edition of IEC 60889 published in 1987, and the first edition of IEC 62004 published in 2007. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous editions of IEC 60104, IEC 60121, IEC 60889 and IEC 62004:

a) designations of aluminium alloys are modified;
b) aluminium alloys A4, AL4 and AL5 are added;
c) wire diameter ranges for indicating mechanical properties are modified and extended;
d) test methods are merged.

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

Draft	Report on voting
7/713/FDIS	7/721/RVD

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

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/standardsdev/publications.

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INTRODUCTION

The purpose of this document is threefold.

First, it is to group together similar wire materials that share the same general characteristics and therefore the same test procedures and requirements. These wires are existing aluminium and aluminium alloy wires from IEC 60104, IEC 60121, IEC 60889 and IEC 62004 as well as from EN 50183.

Secondly, this format allows an easier standard maintenance, as multiple wire materials are covered by a single document instead of separate documents.

Thirdly, this document indicates the most used wire materials worldwide, based on the cooperation agreement between IEC and CENELEC, an IEC questionnaire in 2017 (7/672/Q, Annex A) and a CENELEC questionnaire (7X/SEC0056/CC). The standardized materials form a good basis which can be extended by others used in regions and countries.

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CONDUCTORS FOR OVERHEAD LINES – ALUMINIUM AND ALUMINIUM ALLOY WIRES FOR CONCENTRIC LAY STRANDED CONDUCTORS

1 Scope

This document specifies the mechanical and electrical properties of round and formed wires for equivalent diameters up to the values according to Table 3 for aluminium and aluminium alloys and according to Table 4 for thermal resistant alloys. This document is applicable to aluminium and aluminium alloy wires for the manufacture of concentric lay overhead electrical stranded conductors with or without gap(s) for power transmission purposes.

The various materials and their designations are listed in Table 1. For calculation purposes, the values listed in Table 1 are used.

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 (all parts), *International Electrotechnical Vocabulary (IEV)* (available at www.electropedia.org)

IEC 60468, *Method of measurement of resistivity of metallic materials*

IEC TR 61597, *Overhead electrical conductors – Calculation methods for stranded bare conductors*

ISO 6892-1, *Metallic materials – Tensile testing – Part 1: Method of test at room temperature*

ISO 7801, *Metallic materials – Wires – Reverse bend test*

ISO 7802, *Metallic materials – Wires – Wrapping test*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60050 (all parts) 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

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3.1
aluminium
metallic element forming the base of alumina, being white with a bluish tinge and remarkable for its resistance to oxidation and for its lightness

Note 1 to entry: See Ax and ALx in Table 1, 3.13 and Clause 4.

3.2
annealed aluminium
heat treated aluminium (A0 and AL0 in Table 1) resulting in its softest and most ductile state and maintaining its mechanical and electrical properties at temperatures up to 250 °C

3.3
equivalent diameter
diameter of a round wire, which would have the same cross section area as a given formed wire

3.4
formed wire
drawn or rolled metal wire having a constant non-circular cross-section

3.5
lot
group of production units of one type and size of wire, which was manufactured by the same manufacturer during the same time period under similar conditions of production

Note 1 to entry: A lot can consist of part or all of a purchased quantity.

3.6
nominal
value of a measurable property to which tolerance is applied

Note 1 to entry: Nominal values are target values.

3.7
production unit
coil, reel, spool, or other package of wire that represents a single usable length

3.8
residual strength ratio
ratio of the measured tensile strength at room temperature of a wire previously submitted to heating, to its measured tensile strength at room temperature prior to heating

Note 1 to entry: This ratio is applied only to thermal resistant aluminium alloys.

3.9
round wire
filament of drawn metal having a constant circular cross-section

3.10
sample
specimen or specimens removed from a production unit or units which are considered to have properties representative of a lot

3.11
specimen
length of wire removed for test purposes

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3.12
thermal resistance
capacity of a modified aluminium alloy to have a residual strength ratio of not les than 0,90 after heating

3.13
thermal resistant aluminium alloy
all types of aluminium alloys (ATx in Table 1) designed to operate at temperatures continuously higher than that of conventional aluminium alloy wires or hard-drawn aluminium wires with a maximum allowable continuous operation temperature indicated in Table 5

Note 1 to entry: According to CIGRE TB 643, conventional conductor systems (using aluminium alloy or hard-drawn aluminium wires) are traditionally rated at 75 °C continuous operation.

4 Material

The aluminium content of annealed and hard-drawn aluminium wires (A0, A1, AL0, AL1 in Table 1) shall not be less than 99,5 %, aluminium alloys (A2, A3, A4, AL2, AL3, AL4, AL5 in Table 1) shall be heat-treated aluminium-magnesium-silicon alloys, and thermal-resistant aluminium alloys (ATx in Table 1) shall be aluminium-zirconium alloys. The wires shall be of the required composition to achieve the mechanical, electrical and thermal-resistant (if required) properties specified hereinafter.

If required by the purchaser, the manufacturer shall provide a copy of the analysis certificate of the raw material.

5 Joints

Joints may be made in wires prior to final drawing. A joint may also be made in the finished wire provided:

– the weight of the production unit with a joint is at least 500 kg;
– there shall be no more than one joint in such production units made before final drawing;
– by lot, the amount of production units with joints is less than or equal to 10 % of the total amount of production units;
– when requested by the purchaser, the manufacturer shall provide evidence that the joints have a tensile strength of not less than 130 MPa for all wires except A0 joints which shall have not less than 60 MPa.

The production units containing a joint made in the finished wire shall be clearly identified.

6 Tests

6.1 General

Tests shall be made by the manufacturer on the wires to demonstrate their conformity to this document. All described tests are sample tests except the 400 h thermal resistance test which is a type test. The following test descriptions refer to non-stranded wires. In the case of formed wires, use the equivalent diameter instead of the diameter and secure the wire in the jaws according to Annex A.

6.2 Place of testing

Unless otherwise agreed between the purchaser and the manufacturer at time of ordering, all tests shall be carried out at the manufacturer's premises.

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6.3 Sampling rate

Specimens for tests specified in Clause 6 shall be taken by the manufacturer from samples of at least 10 % of each lot.

Alternatively, if a quality assessment procedure is in place and implemented, the sampling rate shall be subject to agreement between the manufacturer and purchaser.

6.4 Test methods

6.4.1 Appearance

The surface of the wire shall be visually examined to ensure that it is smooth and free from all imperfections including, but not limited to, cracks, unevenness, striation and inclusion (particularly copper particles) which can compromise the performance of the final product.

6.4.2 Wire diameter

6.4.2.1 General

The nominal diameter of wires shall be expressed in millimetres to two decimal places.

When tested in accordance with 6.4.2.2 or 6.4.2.3 the diameter shall not vary from its nominal value by more than the appropriate value indicated in Table 2.

6.4.2.2 Diameter for round wires

The diameter of a round wire shall be the mean of two direct measurements at right angle taken at the same cross-section. The measurement apparatus shall have an accuracy of at least 0,001 mm.

6.4.2.3 Diameter for formed wires

The equivalent diameter of a formed wire shall be obtained from weight measurements made on a sample not less than 1 m in length, and its density as defined in Table 1.

6.4.3 Tensile strength

One specimen cut from each of the samples taken under 6.3 shall be subjected to a tensile test in accordance with ISO 6892-1. The rate of separation of the jaws of the testing machine shall be not less than 25 mm/min and not greater than 100 mm/min.

When tested in accordance with 6.4.3, the tensile strength shall not be less than the appropriate value given in Table 3 or Table 4. Tensile strength for annealed aluminium wires shall not exceed 95 MPa. For nominal diameters outside the range given in Table 3 or Table 4, the requirements shall be agreed upon between the purchaser and the supplier.

6.4.4 Elongation

One specimen cut from each of the samples taken under 6.3 shall be subjected to a tensile test in accordance with ISO 6892-1. The rate of separation of the jaws of the testing machine shall be not less than 25 mm/min and not greater than 100 mm/min. The elongation after fracture of the wire shall be measured over a length of 250 mm between gauge marks on the wire itself, the fracture being between the marks. Upon agreement between purchaser and manufacturer, the elongation at break may be measured.

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When tested in accordance with 6.4.4, the elongation, expressed as a percentage of the original gauge length, shall not be less than the appropriate value given in Table 3 or Table 4. For nominal diameters outside the range given in Table 3 or Table 4, the requirements shall be agreed upon between the purchaser and the supplier. If the fracture occurs outside the gauge marks, or within 25 mm of either mark, and the required elongation is not obtained, another test shall be made.

6.4.5 Wrapping

No wrapping test is required for annealed aluminium wires.

For hard drawn aluminium, aluminium alloy and thermal resistant aluminium alloy wires, one specimen cut from each of the samples taken under 6.3 shall be subjected to a wrapping test in accordance with ISO 7802. The diameter of the mandrel shall be equivalent to the equivalent diameter of formed wire. Eight turns shall be wrapped around a mandrel of diameter equal to the wire diameter at a speed not exceeding 60 rev/min. For hard drawn aluminium wires only, six turns shall then be unwrapped and again closely wrapped.

When tested in accordance with 6.4.5, the wire shall not completely break.

6.4.6 Bending

No bending test is required for annealed aluminium wires.

For hard drawn aluminium, aluminium alloy and thermal resistant aluminium alloy wires, if agreed between the purchaser and manufacturer at time of ordering, one specimen cut from each of the samples taken under 6.3 shall be subjected to a bending test in accordance with ISO 7801. For aluminium alloy wires, the radius of cylindrical support and the number of bending cycles are given in Table 6.

When tested in accordance with 6.4.6, the sample shall show no cracks when examined with the naked eye or normal corrective glasses.

6.4.7 Electrical resistivity

The electrical resistivity of a specimen cut from each of the samples taken under 6.3 shall be determined by the method specified in IEC 60468.

When tested in accordance with 6.4.7, the resistivity at 20 °C shall not be greater than the value indicated in Table 1.

6.4.8 Thermal resistance

6.4.8.1 General

This test is applicable to all thermal-resistant alloy wire types only. The sampling rate of the 1 h test shall be in accordance with 6.3. The supplier shall submit reports of the 400 h test, made in accordance with 6.4.8.2 to demonstrate compliance with the requirements of 6.4.8.3. Information about thermal resistant properties is provided in Annex B.

6.4.8.2 Test method

Two specimens shall be secured from a continuous wire. One of the samples shall be kept in a suitable heater for the designated duration and temperature as given in Table 5 and subsequently tested at room temperature in accordance with 6.4.3. The other sample shall be tested in accordance with 6.4.3 without prior heating.

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