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TECHNICAL SPECIFICATION

colour inside

Conductors for overhead lines – Fiber reinforced composite core used as supporting member material – Part 1: Polymeric matrix composite cores

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CONDUCTORS FOR OVERHEAD LINES – FIBER REINFORCED COMPOSITE CORE USED AS SUPPORTING MEMBER MATERIAL –

Part 1: Polymeric matrix composite cores

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IEC TS 62818-1 has been prepared by IEC technical committee 7: OVERHEAD ELECTRICAL CONDUCTORS. It is a Technical Specification.

The text of this Technical Specification is based on the following documents:

Draft	Report on voting
7/752/DTS	7/754/RVDTS

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 Technical Specification is English.

A list of all parts in the IEC 62818 series, published under the general title *Conductors for overhead lines – Fiber reinforced composite core used as supporting member material*, can be found on the IEC website.

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/publications.

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

- reconfirmed,
- withdrawn, or
- revised.

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INTRODUCTION

The first conductors using a composite core were installed in the early 2000s. Since then, they have been increasingly used by utilities worldwide. As a result, there is a need for an IEC publication to agree on tests methods to qualify these cores.

Because of the variety of products used for this purpose, this document does not set minima or maxima (usually provided by the manufacturer), but rather standardizes testing methods to ascertain the numerical values of the basic properties needed by the purchaser to choose the right supporting member material according to the properties of the overhead lines conductors. Future discussion items for review may include performance level and acceptance criteria, other ageing tests and criteria or other relevant tests.

In a future document, tests on the complete conductor which include the composite core will be covered in detail (for example salt fog, corrosion test, mechanical tests, thermal tests, flexural under tension, etc.).

CONDUCTORS FOR OVERHEAD LINES – FIBER REINFORCED COMPOSITE CORE USED AS SUPPORTING MEMBER MATERIAL –

Part 1: Polymeric matrix composite cores

1 Scope

This part of IEC 62818, which is a Technical Specification, establishes a system of fiber reinforced composite core used as supporting member material in conductors for overhead lines which may be used as the basis for specifications. This document is applicable to fiber reinforced composite core, with polymeric matrix, used as supporting member material in conductors for overhead lines.

This document gives guidance on:

– defining the common terms used for fiber reinforced composite core with polymeric matrix,
– prescribing common methods and recommendations to characterize the properties of fiber reinforced composite core based on single or multi-wires with PMC (Polymeric Matrix Composite) used as supporting member material in conductors,
– prescribing or recommending acceptance or failure criteria when applicable.

These tests, criteria and recommendations are intended to ensure a satisfactory use and quality under normal operating and environmental conditions.

This document does not apply to compliance criteria which may be required but indicative values could be given in Annexes for guidance.

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 60068-2-11:2021, *Environmental testing – Part 2-11: Tests – Test Ka: Salt mist*

IEC 60216-1:2013, *Electrical insulating materials – Thermal endurance properties – Part 1: Ageing procedures and evaluation of test results*

IEC 60468:1974, *Method of measurement of resistivity of metallic materials*

ISO 527-5:2021, *Plastics: Determination of tensile properties – Part 5: Test conditions for unidirectional fiber-reinforced plastic composites*

ISO 4892-2:2013, *Plastics: Methods of exposure to laboratory light sources – Part 2: Xenon-arc lamps*

ISO 11358-1:2022, *Plastics – Thermogravimetry (TG) of polymers – Part 1: General principles*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

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

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

3.1
polymer matrix composite
PMC
assembly of continuous fibers (such as carbon or glass fibers) embedded longitudinally in a polymer matrix (such as epoxy resin)

3.2
composite core
PMC single or multi-wires, including additional protection (metallic or non-metallic), if existing in the final application

3.3
external protective layer
outer layer made of metallic or non-metallic material applied onto the PMC for the purpose of protecting it against external aggressions (such as corrosion, oxidation, etc.) and also acting as a protection against galvanic corrosion, if any

Note 1 to entry: In case of a core based on an assembly of composite wires, this protective layer could be applied to:

- each individual wire,
- the assembly of wires.

Note 2 to entry: Individual wires could be protected with different materials. In this case, testing protocols shall be adapted in relation to the specific material.

3.4
fiber reinforcement
incorporation of continuous fibers within a polymeric matrix in order to increase its performance

Note 1 to entry: It is achieved through specific processes such as winding, moulding or pultrusion.

3.5
fiber
organic or inorganic bundle of filaments that is essentially continuous

3.6
resin
matrix component of PMC

Note 1 to entry: There are two types of resin, namely thermosetting resin and thermoplastic resin.

3.7
thermoplastic resin
type of resin made of long polymer chains with weak bonding between them, which, when the resin is heated, break in a reversible way and make the material shapeable

Note 1 to entry: This is classified into two types by array of polymer chain. One is semi-crystalline resin and the other is amorphous resin.

3.8
thermosetting resin
type of resin made of a network of cross linked polymer chains

Note 1 to entry: The network is created by heating monomers which polymerized under high temperature.

3.9
porosity
measurement of the void fraction in the material over the total volume

Note 1 to entry: It results from a lack of matrix impregnation or from matrix degradation. It distinguishes itself from composite crack or fracture by that it's a lack of matrix or matrix deficiency but not a matrix mechanical fracture.

3.10
glass transition temperature
T_g
temperature where the PMC properties transition from a hard, glassy state to a rubbery state

Note 1 to entry: T_g of PMC is related to T_g of the polymer matrix but it can be different, depending on each technology and specific product design.

3.11
glass transition temperature onset
$T_{g,onset}$
temperature corresponding to the onset of the transition from the glassy state as defined by the intercept of the two tangent of the storage (E') modulus curve (see Annex C)

3.12
glass transition temperature loss modulus
$T_{g,LossModulus}$
temperature corresponding to the peak (maximum) in the loss (E'') modulus curve (see Annex C)

3.13
thermolysis temperature
$T_{onset\ thermolysis}$
temperature corresponding to the start of the polymeric matrix thermolysis, an irreversible reaction that breaks structures of resin (e.g. main chain, cross-link, etc.) and affects the lifetime of PMC

3.14
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. A lot may consist of part or all of a purchased quantity

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

Note 2 to entry: If agreed between the manufacturer and the purchaser, for example for the Type tests, a Lot could be composed by only one Production unit.

3.15
production unit
coil, reel, spool or other package of individual composite core that represents a single usable length

3.16
sample
specimen(s) removed from a production unit(s) which is considered to have properties representative of a lot

3.17
specimen
length of composite core removed for test purposes

3.18
equivalent diameter
diameter of a circle which would have the same cross-sectional area as a given formed wire

4 Symbols and abbreviated terms

CTE coefficient of thermal expansion ($°C^{-1}$)
DC direct current (A)
DMA dynamic mechanical analysis
E_t tensile modulus (GPa)
F_c compressive load at break (N)
F_t tensile load at break (N)
K_c compressive stiffness ($K_c = F_c / \varepsilon_c$) (N)
RTS rated tensile strength (kN)
SEM scanning electron microscope
TGA thermo-gravimetric analysis
TMA thermo-mechanical analysis
$T_{C,CORE}$ maximum continuous temperature (°C) of the composite core
$T_{P,CORE}$ maximum peak-load temperature (°C) of the composite core
ε_c compressive strain at break (%)
ε_t elongation at break (%)
σ_t tensile stress at break (MPa)

5 Requirements

5.1 Composite core manufacturing

Composite core shall be produced according to the dimensional, mechanical and thermal properties agreed between purchaser and manufacturer, respecting the acceptance values and tolerances. These properties shall be uniform along the lot and every production unit shall be free of internal or external imperfections (e.g. high porosity, inclusions, scratches, scrape, notch, holes, cracks). Each composite wire shall be produced with a single assembly of continuous fibers; no fiber end-to-end joint is allowed, unless clearly agreed between both parts. The fiber splicing is accepted in the protective layer. The purchaser may be informed upon request that splicing was used for protective layer.

5.2 Composite core sampling and tests

5.2.1 General

Tests on composite core are described in Clause 7 and shall be classified as:

– Type test (T),
– Sample test (S),
– Routine test (R).

In order to ensure a satisfactory quality of the core and to properly characterize its properties, a list of type tests, sample tests and routine tests is provided in Table A.1, with a suggested sampling.

For a more detailed characterization of the core, additional/optional tests are also proposed in Table A.1 and described in Clause 8.