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INTERNATIONAL STANDARD

NORME INTERNATIONALE

Power cables with extruded insulation and their accessories for rated voltages above 150 kV (U_m = 170 kV) up to 500 kV (U_m = 550 kV) – Test methods and requirements

Câbles d'énergie à isolation extrudée et leurs accessoires pour des tensions assignées supérieures à 150 kV (U_m = 170 kV) et jusqu'à 500 kV (U_m = 550 kV) – Méthodes et exigences d'essai

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POWER CABLES WITH EXTRUDED INSULATION AND THEIR ACCESSORIES FOR RATED VOLTAGES ABOVE 150 kV (U_m = 170 kV) UP TO 500 kV (U_m = 550 kV) – TEST METHODS AND REQUIREMENTS

FOREWORD

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International Standard IEC 62067 has been prepared by IEC technical committee 20: Electric cables.

This second edition of IEC 62067 cancels and replaces the first edition, published in 2001, and its Amendment 1 (2006), and constitutes a technical revision.

The significant technical changes with respect to the previous edition are as follows:

– addition of the extension of prequalification test, requiring significant less time to be completed compared with the full prequalification test;
– during the routine tests on the main insulation of prefabricated accessories the required sensitivity level for the partial discharge test is reduced from 10 pC to 5 pC.

NOTE For a more detailed history of events leading up to this second edition, see the Introduction.

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

FDIS	Report on voting
20/1268/FDIS	20/1278A/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.

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

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- withdrawn,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

INTRODUCTION

As a result of major developments in cable systems with extruded insulation for voltages above 150 kV, CIGRE Study Committee (SC) 21 set up Working Group (WG) 21.03 in 1990. The terms of reference of WG 21.03 were "*to prepare recommendations for electrical type tests, sample and routine tests, based on extending IEC 60840:1988 up to 400 kV and to make proposals for prequalification/development tests which, as a minimum, should be performed*".

WG 21.03 reported that the extension of IEC 60840 to voltages above 150 kV needed extra consideration because of the following factors:

– such cables form part of the backbone of the transmission system and, therefore, reliability considerations are of the highest priority;

– these cables and their accessories operate with higher electrical stresses than cables up to 150 kV and, as a result, have a smaller safety margin with respect to the intrinsic performance boundaries of the cable system;

– such cables and accessories have a thicker insulation wall than those up to 150 kV and, as a result, are subjected to greater thermomechanical effects;

– the design and coordination of the cables and accessories becomes more difficult with increasing system voltage levels.

The recommendations of the WG 21.03 were published in Electra No. 151 in December 1993 and taken into account by IEC in 1995 in the preparation of this standard for cable systems with extruded insulation for voltages above 150 kV. IEC considered that the new standard should also cover the 500 kV level. Thus, at its meeting in September 1996, CIGRE SC 21 set up task force 21.18 to study the extension of the initial recommendations to the 500 kV level. The updated recommendations were cited in Electra No. 193 in December 2000 and thus were also taken into account by IEC Technical Committee (TC) 20 in the preparation of the first edition of this standard.

On the advice of CIGRE, a long term accelerated ageing test was introduced in the first edition, in order to gain some indication of the long term reliability of a cable system. This test, known as the "prequalification test", was to be performed on the complete system comprising the cable, joints and terminations in order to demonstrate the performance of the system.

In addition, CIGRE WG 21.09, published recommendations for “tests after installation on high-voltage extruded insulation cable systems” in Electra No 173 in August 1997. These recommendations (which state, amongst other things, that d.c. tests should be avoided on the main insulation, as they are both ineffective and potentially damaging) were also taken into account in the first edition of this standard.

At its meeting in November 2004, TC 20 concluded that the next revision of IEC 62067 should include the recommendation for testing of HV and EHV extruded cables that was under preparation by the CIGRE SC B1 (previously SC 21) WG B1.06. This was made available as a CIGRE Technical Brochure 303 before the meeting of TC 20 in October 2006, which confirmed this view. Therefore Technical Brochure 303 has been considered by TC 20 and major parts implemented in this standard. This has resulted in some modifications to the prequalification test requirements, a major change being the addition of the extension of prequalification test. The latter test requires approximately one quarter of the time to complete when compared with the full prequalification test.

A list of relevant CIGRE references is given in the bibliography.

POWER CABLES WITH EXTRUDED INSULATION AND THEIR ACCESSORIES FOR RATED VOLTAGES ABOVE 150 kV (U_m = 170 kV) UP TO 500 kV (U_m = 550 kV) – TEST METHODS AND REQUIREMENTS

1 Scope

This International Standard specifies test methods and requirements for power cable systems, cables with extruded insulation and their accessories for fixed installations, for rated voltages above 150 kV (U_m = 170 kV) up to and including 500 kV (U_m = 550 kV).

The requirements apply to single-core cables and to their accessories for usual conditions of installation and operation, but not to special cables and their accessories, such as submarine cables, for which modifications to the standard tests may be necessary or special test conditions may need to be devised.

This standard does not cover transition joints between cables with extruded insulation and paper insulated cables.

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.

NOTE The IEC 60811 series is currently undergoing a revision, which will lead to a restructuring of its parts. A description of this, as well as a cross-reference table between the current and planned parts will be given in IEC 60811-100.

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

IEC 60183, *Guide to the selection of high-voltage cables*

IEC 60228, *Conductors of insulated cables*

IEC 60229:2007, *Electric cables – Tests on extruded oversheaths with a special protective function*

IEC 60230, *Impulse tests on cables and their accessories*

IEC 60287-1-1:2006, *Electric cables – Calculation of the current rating – Part 1-1: Current rating equations (100 % load factor) and calculation of losses – General*

IEC 60332-1-2, *Tests on electric and optical fibre cables under fire conditions – Part 1-2: Test for vertical flame propagation for a single insulated wire or cable – Procedure for 1 kW pre-mixed flame*

IEC 60811-1-1:1993, *Common test methods for insulating and sheathing materials of electric cables and optical cables – Section 1-1: Methods for general application – Measurement of thickness and overall dimensions – Tests for determining the mechanical properties*
Amendment 1 (2001)

IEC 60811-1-2:1985, *Common test methods for insulating and sheathing materials of electric cables – Part 1: Methods for general application – Section Two: Thermal ageing methods*
Amendment 1 (1989)
Amendment 2 (2000)

IEC 60811-1-3:1993, *Common test methods for insulating and sheathing materials of electric cables – Part 1-3: General application – Methods for determining the density – Water absorption tests – Shrinkage test*
Amendment 1 (2001)

IEC 60811-1-4:1985, *Common test methods for insulating and sheathing materials of electric cables – Part 1: Methods for general application – Section Four: Tests at low temperature*
Amendment 1 (1993)
Amendment 2 (2001)

IEC 60811-2-1:1998, *Common test methods for insulating and sheathing materials of electric and optical cables – Part 2-1: Methods specific to elastomeric compounds – Ozone resistance, hot set and mineral oil immersion tests*
Amendment 1 (2001)

IEC 60811-3-1:1985, *Common test methods for insulating and sheathing materials of electric cables – Part 3: Methods specific to PVC compounds – Section 1: Pressure test at high temperature – Tests for resistance to cracking*
Amendment 1 (1994)
Amendment 2 (2001)

IEC 60811-3-2:1985, *Common test methods for insulating and sheathing materials of electric cables – Part 3: Methods specific to PVC compounds – Section two: Loss of mass test – Thermal stability test*
Amendment 1 (1993)
Amendment 2 (2003)

IEC 60811-4-1:2004, *Insulating and sheathing materials of electric and optical cables – Common test methods – Part 4-1: Methods specific to polyethylene and polypropylene compounds – Resistance to environmental stress cracking –Measurement of the melt flow index – Carbon black and/or mineral filler content measurement in polyethylene by direct combustion – Measurement of carbon black content by thermogravimetric analysis (TGA) – Assessment of carbon black dispersion in polyethylene using a microscope*

IEC 60885-3, *Electrical test methods for electric cables – Part 3: Test methods for partial discharge measurements on lengths of extruded power cables*

3 Terms and definitions

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

3.1 Definitions of dimensional values (thicknesses, cross-sections, etc.)

3.1.1
nominal value
value by which a quantity is designated and which is often used in tables

NOTE Usually, in this standard, nominal values give rise to values to be checked by measurements taking into account specified tolerances.

3.1.2
median value
when several test results have been obtained and ordered in an increasing (or decreasing) succession, middle value if the number of available values is odd, and mean of the two middle values if the number is even

3.2 Definitions concerning tests

3.2.1
routine test
tests made by the manufacturer on each manufactured component (length of cable or accessory) to check that the component meets the specified requirements

3.2.2
sample test
tests made by the manufacturer on samples of complete cable, or components taken from a complete cable or accessory, at a specified frequency, so as to verify that the finished product meets the specified requirements

3.2.3
type test
tests made before supplying, on a general commercial basis, a type of cable system covered by this standard, in order to demonstrate satisfactory performance characteristics to meet the intended application

NOTE Once successfully completed, these tests need not be repeated, unless changes are made in the cable or accessory with respect to materials, manufacturing process, design or design electrical stress levels, which might adversely change the performance characteristics.

3.2.4
prequalification test
test made before supplying, on a general commercial basis, a type of cable system covered by this standard, in order to demonstrate satisfactory long term performance of the complete cable system

3.2.5
extension of prequalification test
tests made before supplying, on a general commercial basis, a type of cable system covered by this standard, in order to demonstrate satisfactory long term performance of the complete cable system, taking into account an already prequalified cable system

3.2.6
electrical test after installation
tests made to demonstrate the integrity of the cable system as installed

3.3 Other definitions

3.3.1
cable system
cable with installed accessories including components used for thermomechanical restraint of systems limited to those used for terminations and joints only

3.3.2
nominal electrical stress
electrical stress calculated at U_0 using nominal dimensions

4 Voltage designations and materials

4.1 Rated voltages

In this standard, the symbols U_0, U and U_m are used to designate the rated voltages of cables and accessories where these symbols have the meanings given in IEC 60183.

4.2 Cable insulating materials

This standard applies to cables insulated with the materials listed in Table 1. It also specifies, for cables with each type of insulating compound, the maximum operating conductor temperatures on which the specified test conditions are based.

4.3 Cable metal screens/sheaths

This standard applies to the various designs in use. It covers designs providing a radial water tightness and other designs.

Designs that provide radial watertightness mainly consist of

- metal sheaths,
- longitudinally applied metal tapes or foils bonded to the oversheath,
- composite screens, involving a bunch of wires and, in addition, either a metal sheath or a metal tape or foil bonded to the oversheath, acting as a radial water impermeable barrier (see Clause 5),

and other designs such as

- bunch of metal wires only.

NOTE In all cases the metal screen/sheath should be able to carry the total fault current.

4.4 Cable oversheathing materials

Tests are specified for four types of oversheath, as follows:

– ST_1 and ST_2 based on polyvinyl chloride (PVC);
– ST_3 and ST_7 based on polyethylene (PE).

The choice of the type of oversheath will depend on the design of the cable and the mechanical and thermal and fire constraints during operation.

The maximum conductor temperatures in normal operation for different types of oversheathing materials covered by this standard are given in Table 2.

NOTE For some applications, the oversheath may be covered by a functional layer (e.g. semi-conductive).

5 Precautions against water penetration in cables

When cable systems are installed in the ground, in easily flooded galleries or in water, a radial water impermeable barrier around the cable is recommended.

NOTE A test for radial water penetration is not currently available.

Longitudinal water barriers may also be applied in order to avoid the need to replace long sections of cable in case of damage in the presence of water.

A test for longitudinal water penetration is given in 12.5.14.

6 Cable characteristics

For the purpose of carrying out the cable system tests described in this standard and recording the results, the cable shall be identified. The following characteristics shall be known or declared:

a) Name of manufacturer, type, designation and manufacturing date or date code.

b) Rated voltage: values shall be given for U_0, U, U_m (see 4.1 and 8.4).

c) Type of conductor, its material and nominal cross-sectional area, in square millimetres; conductor construction; presence, if any, and nature of measures taken to reduce skin effect; presence, if any, and nature of measures taken to achieve longitudinal watertightness. If the nominal cross-sectional area is not in accordance with IEC 60228, the d.c. conductor resistance corrected to 1 km length and to 20 °C shall be declared ;

d) Material and nominal thickness of insulation (t_n) (see 4.2);

e) Type of manufacturing process for insulation system;

f) Presence, if any, and nature of watertightness measures in the screening area;

g) Material and construction of metal screen, e.g. number and diameter of wires. (The d.c. resistance of the metal screen shall be declared.) Material, construction and nominal thickness of metal sheath, or longitudinally applied metal tape or foil bonded to the oversheath, if any;

h) Material and nominal thickness of oversheath;

i) Nominal diameter of the conductor (d);

j) Nominal overall diameter of the cable (D);

k) Nominal inner diameter (d_{ii}) and calculated nominal outer diameter (D_{io}) of the insulation;

l) Nominal capacitance, corrected to 1 km length, between conductor and metal screen/sheath;

m) Calculated nominal electrical stress at conductor screen (E_i) and at insulation screen (E_o):

$$E_i = \frac{2U_0}{d_{ii} \times \ln(D_{io} / d_{ii})}$$

$$E_o = \frac{2U_0}{D_{io} \times \ln(D_{io} / d_{ii})}$$

where

$D_{io} = d_{ii} + 2t_n$;

d_{ii} is the declared nominal inner diameter of the insulation;

D_{io} is the calculated nominal outer diameter of the insulation;

t_n is the declared nominal insulation thickness.

The value of U_0 is given in Table 4;

7 Accessory characteristics

For the purpose of carrying out the cable system or accessory tests described in this standard and recording the results, the accessory shall be identified.

The following characteristics shall be known or declared:

a) cables used for testing accessories shall be correctly identified as in Clause 6;

b) conductor connections used within the accessories shall be correctly identified, where applicable, with respect to