IEC 62067

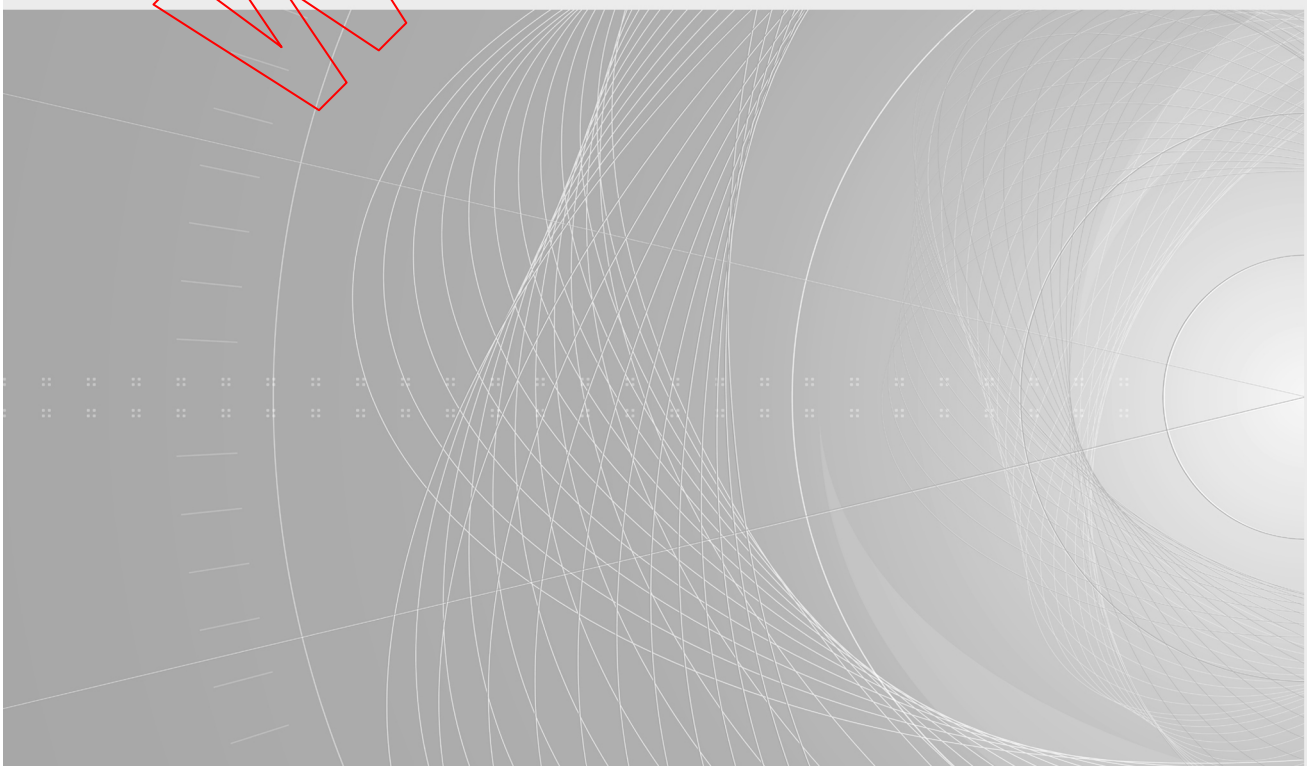
Edition 1.1 2006-03

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 prescriptions 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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This consolidated version of IEC 62067 consists of the first edition (2001) [documents 20/482/FDIS and 20/489/RVD] and its amendment 1 (2006) [documents 20/784/FDIS and 20/802/RVD].

The technical content is therefore identical to the base edition and its amendment and has been prepared for user convenience.

It bears the edition number 1.1.

A vertical line in the margin shows where the base publication has been modified by amendment 1.

Annexes A, B, C and D form an integral part of this standard.

The committee has decided that the contents of the base publication and its amendments will remain unchanged until the maintenance result 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- withdrawn,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 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 become 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 this new standard should also cover the 500 kV level. Thus, at its meeting in September 1996, CIGRE Study Committee 21 set up a 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 again taken into account by IEC in the preparation of this standard.

Compared with IEC 60840, first edition (1988), revised and published in 1999 as IEC 60840 edition 2, there is a major difference: CIGRE advised that, in order to gain some indication of the long term reliability of a cable system, it is necessary to carry out a long term accelerated ageing test. This test, known as the "prequalification test", is 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, given the task to study tests after installation on high-voltage extruded insulation cable systems, published its recommendations in Electra No 173 in August 1997. In the preparation of this International Standard, account has also been taken of these recommendations which state, among others, that d.c. tests should be avoided on the main insulation, as they are both ineffective and dangerous. On the other hand, d.c. tests are recommended on the oversheath.

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 referenced documents are indispensable for the application 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 60060-1:1989, *High-voltage test techniques – Part 1: General definitions and test requirements*

IEC 60183:1984, Guide to the selection of high-voltage cables

IEC 60228:1978, *Conductors of insulated cables*

IEC 60229:1982, *Tests on cable oversheaths which have a special protective function and are applied by extrusion*

IEC 60230:1966, *Impulse tests on cables and their accessories*

IEC 60332-1:1993, *Tests on electric cables under fire conditions – Part 1: Test on a single vertical insulated wire or cable*

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

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

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

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*

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

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

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*

IEC 60811-4-1:1985, *Common test methods for insulating and sheathing materials of electric cables – Part 4: Methods specific to polyethylene and polypropylene compounds – Section One: Resistance to environmental stress cracking – Wrapping test after thermal ageing in air – Measurement of the melt flow index – Carbon black and/or mineral content measurement in PE*

IEC 60840:2004, *Power cables with extruded insulation and their accessories for rated voltages above 30 kV (U_m = 36 kV) up to 150 kV (U_m = 170 kV) – Test methods and requirements.*

IEC 60885-3:1988, *Electrical test methods for electric cables – Part 3: Test methods for partial discharge measurements on lengths of extruded power cables*

3 Definitions

For the purpose of this International Standard, the following 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 the tests

3.2.1
routine tests
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 tests
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 tests
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. Once successfully completed, these tests need not be repeated, unless changes are made in the cable or accessory materials, or design or manufacturing process which might 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. The prequalification test need only be carried out once unless there is a substantial change in the cable system with respect to material, manufacturing process, design and design levels

NOTE A substantial change is defined as that which might adversely affect the performance of the cable system. The supplier should provide a detailed case, including test evidence, if modifications are introduced, which are claimed not to constitute a substantial change.

3.2.5
electrical tests after installation
tests made to demonstrate the integrity of the cable system as installed

3.3
cable system
cable with installed accessories

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, which 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 oversheathing materials

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

– ST_1 and ST_2 based on PVC;
– ST_3 and ST_7 based on polyethylene.

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

The maximum conductor temperatures in normal operation given in IEC 60840 apply to this standard.

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, either by agreement between the purchaser and the manufacturer or as recommended by the manufacturer, 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 and recording the tests described in this standard, the cable shall be identified. The following characteristics shall be known or declared.

6.1 Rated voltage: values shall be given for U_0, U, U_m (see 4.1 and 8.5).

6.2 Type of conductor, its material and nominal cross-sectional area, in square millimetres. 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 shall be declared.

6.3 Material and nominal thickness of insulation (see 4.2).

6.4 Type of manufacturing process for insulation system.

6.5 Presence, if any, and nature of watertightness measures in screening area.

6.6 Material and construction of metallic screen, e.g. number and diameter of wires, if any. Material, construction and nominal thickness of metallic sheath, if any. The d.c. resistance of the metallic screen shall be declared.

6.7 Material and nominal thickness of oversheath.

6.8 Nominal diameter over conductor (d).

6.9 Nominal diameter over complete cable (D).

6.10 Nominal capacitance between conductor and metallic screen/sheath.

7 Accessory characteristics

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

7.1 Conductor connectors used within the accessories shall be correctly identified with respect to

– assembly technique;
– tooling, dies and necessary setting;
– preparation of contact surfaces, if applicable;
– type, reference number and any other identification of the connector.

7.2 Accessories to be tested shall be correctly identified with respect to

– name of manufacturer;
– type, designation, manufacturing date or date code;
– rated voltage (see 6.1);
– installation instructions (reference and date).

8 Test conditions

8.1 Ambient temperature

Unless otherwise specified in the details for the particular test, tests shall be carried out at an ambient temperature of (20 ± 15) °C.

8.2 Frequency and waveform of power frequency test voltages

Unless otherwise indicated in this standard, the frequency of the alternating test voltages shall be in the range 49 Hz to 61 Hz. The waveform shall be substantially sinusoidal. The values quoted are r.m.s. values.

8.3 Waveform of lightning impulse test voltage

In accordance with IEC 60230, the front time of the standard lightning impulse voltage shall be between 1 µs and 5 µs. The time to half value shall be 50 µs ± 10 µs as specified in IEC 60060-1.

8.4 Waveform of switching impulse test voltage

In accordance with IEC 60060-1, the standard switching impulse voltage shall have a time to peak of 250 µs ± 50 µs and a time to half value of 2 500 µs ± 1 500 µs.

8.5 Relationship of test voltages to rated voltages

Where test voltages are specified in this standard as multiples of the rated voltage U_0, the value of U_0 for the determination of the test voltages shall be as specified in table 3.

For cables and accessories of rated voltage not shown in the table, the value of U_0 for determination of test voltages may be the same as for the nearest rated voltage which is given, provided that the value of U_m for the cable and accessory is not higher than the corresponding value in the table. Otherwise, and particularly if the rated voltage is not close to one of the values in the table, the value of U_0 on which the test voltages are based shall be the rated value, i.e. U divided by $\sqrt{3}$.

The test voltages in this standard are based on the assumption that the cables and accessories are used on systems of category A, as defined in IEC 60183.

9 Routine tests on cables and on the main insulation of prefabricated accessories

9.1 General

The following tests shall be carried out on each manufactured length of cable and on the main insulation of each prefabricated accessory, to check that the whole of each cable length and that the main insulation of each prefabricated accessory complies with the requirements.

The order in which these tests are carried out is at the discretion of the manufacturer.

a) Partial discharge test (see 9.2).

b) Voltage test (see 9.3).

c) Electrical test on oversheath of the cable, if required (see 9.4).

The applicability of the test on the oversheath of the cable, in item c) above, when the test is specified in the particular contract or order, depends upon the function of the oversheath in the installation (see IEC 60229). Therefore, this test shall only be carried out when required for the particular contract.

The main insulation of prefabricated accessories is required to undergo partial discharge and voltage routine tests according to alternative 1), 2) or 3) below:

1) on the main insulation of prefabricated accessories installed on cable;

2) by using a host accessory into which a component of an accessory is substituted for test;

3) by using a simulated accessory rig in which the electrical stress environment of a main insulation component is reproduced.

In cases 2) and 3), the test voltage shall be selected to obtain stresses at least the same as those on the component in a complete accessory when subjected to the test voltages specified in 9.2 and 9.3.

NOTE The main insulation of prefabricated accessories consists of the components that come in direct contact with the cable insulation and are necessary and essential to control the electrical field distribution in the accessory. Examples are premoulded or precast elastomer or filled epoxy resin insulating components that may be used singly or jointly to provide the necessary insulation or screening of accessories.

9.2 Partial discharge test

The partial discharge test shall be carried out in accordance with IEC 60885-3 for cables, except that the sensitivity as defined in IEC 60885-3 shall be 10 pC or better. Testing of accessories follow the same principles.

The test voltage shall be raised gradually to and held at 1,75 U_0 for 10 s and then slowly reduced to 1,5 U_0 (see table 3, column 5).

There shall be no detectable discharge from the test object at 1,5 U_0.

9.3 Voltage test

The voltage test shall be made at ambient temperature using an alternating test voltage at power frequency.

The test voltage shall be raised gradually to the specified value which shall then be held for the specified time between the conductor and metallic screen/sheath according to table 3, column 4.

No breakdown of the insulation shall occur.