IEC 60840

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INTERNATIONAL STANDARD

AMENDMENT 1

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

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IEC 60840:2020-05/AMD1:2023-06(en)

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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

AMENDMENT 1

FOREWORD

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Amendment 1 to IEC 60840:2020 has been prepared by IEC technical committee 20: Electric cables.

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

Draft	Report on voting
20/2100/FDIS	20/2107/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 Amendment 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/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- withdrawn,
- replaced by a revised edition, or
- amended.

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2 Normative references

Add the following new references:

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IEC 60060-3, *High-voltage test techniques – Part 3: Definitions and requirements for on-site testing*

IEC 60137, *Insulated bushings for alternating voltages above 1 000 V*

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IEC 60332-1-3, *Tests on electric and optical fibre cables under fire conditions – Part 1-3: Test for vertical flame propagation for a single insulated wire or cable – Procedure for determination of flaming droplets/particles*

IEC 60754-3, *Test on gases evolved during combustion of materials from cables – Part 3: Measurement of low level of halogen content by ion chromatography*

IEC 62155, *Hollow pressurized and unpressurized ceramic and glass insulators for use in electrical equipment with rated voltages greater than 1 000 V*

3 Terms and definitions

3.2.4
prequalification test

Add **"PQ test"** *as a second preferred term.*

3.2.5
extension of prequalification test

Add **"EQ test"** *as a second preferred term.*

3.3.2
nominal electrical stress

In the existing Note 2 to entry, delete "Nominal".

3.3.8
joint with screen or metal sheath interruption

Replace the existing entry 3.3.8 with the following new entry 3.3.8:

3.3.8
maximum service pressure
MSP
highest difference between the maximum absolute internal pressure, when the equipment (of which a composite hollow insulator is a part) is carrying its rated normal current at maximum operational temperature and the normal outside pressure

Insert, between the existing entry 3.3.9 and entry 3.3.10 the following new entry 3.3.11:

3.3.11
joint with screen or metal sheath interruption
joint, where the metal screen/sheath and insulation screen of the cable are electrically interrupted

3.3.10
termination with sectionalizing insulation

Replace the existing entry 3.3.10 with the following new entry 3.3.10:

3.3.10
termination with an insulated screen
termination where the metal screen/sheath and insulation screen of the cable are electrically interrupted to the ground

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5 Precautions against water penetration in cables

Replace the existing first paragraph with the following new paragraph:

When cable systems are installed in water or in the ground, in locations with a risk of water ingress or corrosion, a radial water impermeable barrier is recommended.

6 Cable characteristics

Replace the existing text of list item c), excluding the NOTE, with the following new text:

c) Fire performance: if ST_1, ST_2 or ST_{12} oversheath material is used (see 4.4 and Table 2), then the subclauses of 12.5.14.3, if any, to which compliance is claimed, shall be declared.

Add, in list item n), after "d_{ii} is the declared nominal inner diameter of the insulation, in mm;" the following new text:

U_0 is the value in item b) above in kV;

7 Accessories characteristics

7.2 Composite insulators for outdoor cable terminations

Replace Subclause 7.2, including its title, with the following new Subclause 7.2:

7.2 Insulators for outdoor cable terminations

Insulators for outdoor cable terminations shall comply with the requirements given in Table 10 for Level I or II maximum cantilever operating load in service (or MML in the case of composite insulators). Level I refers to a normal load and shall be generally applied, unless a purchaser specifies a heavy load of Level II. Alternatively, a different value of maximum cantilever operating load or MML may be agreed between the purchaser and manufacturer. These tests are not applicable for cable terminations which are not subjected to cantilever stresses during operation, e.g. flexible terminations.

7.3 Accessory characteristics to be declared

Integrate the introductory sentence as part of list item a) as follows:

a) The following characteristics shall be declared by the manufacturer: cables used for testing accessories shall be correctly identified as in Clause 6;

Add, before the first bullet point of list item e), the following two new bullet points:

- design pressure for the outside of the termination insulator (see IEC 62271-209);
- type of insulating gas to be used in the cable connection enclosure (SF6 or details of alternative gas type).

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Add, at the end of the second bullet point of list item f), after "(MSP)", *the word* "value" *and add the following new list item g):*

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g) additional requirements for ceramic outdoor termination insulators:
- the maximum cantilever operating load in service;
- for insulators which will be pressurized in service, the design pressure.

8 Test conditions

8.3 Waveform of lightning impulse test voltages

Replace the existing paragraph with the following new paragraph:

The waveforms of lightning impulse tests shall be as given in IEC 60230.

Add, at the end of the existing Subclause 8.5, the following new Subclause 8.6:

8.6 Tests on gas immersed terminations

Electrical tests on gas immersed terminations shall be carried out in a cable connection enclosure with the diameter specified in IEC 62271-209 for the relevant value of rated voltage. The gas pressure requirements for electrical type tests given in IEC 62271-209 shall also be complied with.

9 Routine tests on cables and accessories

9.4 Electrical test on oversheath of the cable

Replace the existing paragraph with the following new paragraph:

Subject to agreement between the purchaser and manufacturer, the cable oversheath shall be subjected to the electrical test specified in Clause 3 of IEC 60229:2007.

10 Sample tests on cables

10.5 Measurement of electrical resistance of conductor and metal screen

Replace the existing second paragraph with the following new paragraph and bullet points:

The DC resistance of the conductor or metal screen/sheath shall be corrected to a temperature of 20 °C and a 1 km length of cable in accordance with the formulae and factors given in IEC 60228:

- for a conductor or metal screen/sheath of copper or aluminium, using the temperature coefficients given in IEC 60228 or
- for a metal screen/sheath other than copper or aluminium, using the temperature coefficients given in IEC 60287-1-1.

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10.7.2.3 Ring method

Replace the first two sentences of the first paragraph with the following new sentence:

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The measurements shall be made with a micrometer having ball noses of radii of approximately 3 mm.

10.12 lightning impulse voltage test

*Replace the fifth paragraph beginning with "*The lightning impulse voltage…" *with the following two new paragraphs:*

The lightning impulse voltage shall be applied, according to the procedure given in IEC 60230, after the completion of the 2 h heating and while the conductor temperature is within the limits stated above.

The cable shall withstand, without failure, 10 positive and 10 negative voltage impulses of the appropriate value given in Table 4, column 8.

10.14 Additional tests on components of cables with a longitudinally applied metal tape or foil, bonded to the oversheath

Replace the existing title with the following new title:

10.14 Tests on components of cables with a longitudinally applied metal tape or foil bonded to the oversheath

12 Type tests on cable systems

12.1 General

Delete the existing NOTE 1 and replace the existing NOTE 2 with the following new NOTE:

NOTE Tests on terminations under environmental conditions such as precipitation and/or pollution are not specified in this document.

12.2 Range of type approval

Replace, in the first paragraph, "conditions of a) to f)" *with* "conditions of a) to g)".

Add, at the end of list item g), the following new NOTE:

NOTE Clause H.6 gives requirements for approval of a gas immersed termination with an alternative type of gas.

12.3 Summary of type tests

Replace the existing second paragraph with the following new paragraph:

The non-electrical tests on cable components and complete cable are listed in Table 5 to Table 11, indicating which tests are applicable to each insulation and oversheath compound. The tests under fire conditions, as listed in Table 11, are only required if the manufacturer wishes to claim compliance with these tests as a special feature of the design of the cable.

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12.4.2 Tests and sequence of tests

Add, at the end of the paragraph in list item b) the following second sentence:

No bending test is required if a different sample is selected.

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12.4.3 Bending test

Replace, after list item 4), the definition of the symbol D_s with the following new definition:

D_s is the nominal diameter of the metal screen layer, in mm.

12.4.6 Heating cycle voltage test

Add, at the end of the last paragraph, the following new sentence:

Guidance concerning interruption of the test and the determination of valid heating cycles is given in Annex K.

12.4.7 Lightning impulse voltage test followed by a power frequency voltage test

Replace the existing second paragraph with the following new paragraph:

The conductor temperature shall be maintained within the stated temperature limits for at least 2 h before the first lightning impulse voltage is applied. The temperature shall be maintained within the above limits until the test is completed.

Replace the third paragraph with the following two new paragraphs:

If, for practical reasons, the test temperature cannot be reached, additional thermal insulation may be applied.

The lightning impulse voltage shall be applied, according to the procedure given in IEC 60230, after the completion of the 2 h heating and, while the conductor temperature is within the limits stated above.

12.5.5.4 Mechanical tests

Replace "IEC 60811-401" *with* "IEC 60811-501:2012 and IEC 60811-501:2012/AMD1:2018".

12.5.8 Test on PVC oversheaths (ST_1, ST_2) and LSHF oversheaths (ST_{12}) at low temperature

*Replace, in the existing title, "*Test on*…" with "*Test for*…" as follows:*

12.5.8 Test for PVC oversheaths (ST_1, ST_2) and LSHF oversheaths (ST_{12}) at low temperature

12.5.12 Measurement of density of HDPE insulation

*Replace, in the existing title, "…*density of*…" with* "…density for…" *as follows:*

12.5.12 Measurement of density for HDPE insulation

12.5.13 Measurement of carbon black content of black PE oversheaths (ST_3 and ST_7)

*Replace, in the existing title, "…*content of*…" with "…*content for*…" as follows:*

12.5.13 Measurement of carbon black content for black PE oversheaths (ST_3 and ST_7)

12.5.14 Test under fire conditions

Replace the contents of Subclause 12.5.14 with the following new Subclause 12.5.14:

12.5.14 Test under fire conditions

12.5.14.1 General

The tests in 12.5.14.2 shall be carried out on ST_{12} (LSHF) oversheath material.

The tests in 12.5.14.3 shall be carried out in accordance with the fire performance claimed for the cable, see Clause 6, item c).

12.5.14.2 Tests on gases evolved during combustion of ST_{12} (LSHF) oversheath

12.5.14.2.1 Determination of acidity (by pH measurement) and conductivity of gases evolved during combustion

The test according to IEC 60754-2 shall be carried out on the oversheath of the cable.

The results shall comply with the requirements given in Table 11.

12.5.14.2.2 Measurement of halogen content of gases evolved during combustion

The value for the oversheath, H_i, of the individual halogen content for each of the four halogens F, Cl, Br, and I, shall be determined by carrying out the test according to IEC 60754-3.

The values for each of the four individual halogens, H_i, and the sum of the values for the oversheath for the four halogens, i.e. $\sum H_i$, shall comply with the requirements given in Table 11.

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12.5.14.3 Fire performance tests for the cable

12.5.14.3.1 Vertical flame propagation test for single cable

The test under fire conditions in accordance with IEC 60332-1-2 shall be carried out on a sample of completed cable. During the test, the determination of flaming droplets and particles shall be carried out in accordance with IEC 60332-1-3.

The results for IEC 60332-1-2 shall comply with the requirements given in Table 11 and the filter paper (IEC 60332-1-3) shall not ignite during the test duration.

If a failure to meet the requirements of either standard is recorded, two more tests shall be carried out. If both tests result in passes, the cable shall be deemed to have passed the test.

12.5.14.3.2 Test for vertical flame spread of vertically-mounted cables

The test for vertical flame spread of vertically-mounted cables shall be carried out in accordance with IEC 60332-3-24, on samples of completed cable. The results shall comply with the requirements given in Table 11.

NOTE Higher performance to meet the requirements of IEC 60332-3-22 or IEC 60332-3-23 can be agreed between the purchaser and manufacturer. The fire performance level achieved depends on cable design as well as material performance.

12.5.14.3.3 Measurement of smoke density of cables burning under defined conditions

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The test for measurement of smoke density of cables burning under defined conditions shall be carried out in accordance with IEC 61034-2 on a sample of completed cable.

The results shall comply with the requirements given in Table 11.

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12.5.14.3.4 Determination of acidity (by pH measurement) and conductivity of gases evolved during combustion of the non-metallic materials in the cable

The test according to IEC 60754-2 shall be carried out on the non-metallic components of the cable. Non-metallic components with a mass less than or equal to 1 % of the total non-metallic mass need not be tested.

The weighted values of pH and conductivity of the non-metallic components of the cable shall be calculated according to IEC 60754-2 and shall comply with the requirements given in Table 11.

12.5.14.3.5 Measurement of halogen content of gases evolved during combustion of the non-metallic materials in the cable

The weighted value for the cable, $H_i^{'}$, for the four halogens F, Cl, Br, and I, shall be determined by carrying out the test according to IEC 60754-3 either:

- individually on each non-metallic component of the cable, and calculating the weighted value for the cable, for each halogen, as described in Annex L,
- or on a sample representative of the cable construction prepared as described in Annex L, in which case the result for each halogen shall be taken as the weighted value for the cable.

Non-metallic components with a mass less than or equal to 1 % of the total non-metallic mass need not be tested.

The weighted value for the cable, $H_i^{'}$, for each of the four individual halogens and the sum of the weighted values for the non-metallic components of the cable for the four halogens, i.e. $\sum H_i^{'}$, shall comply with the requirements given in Table 11.

12.5.16 Tests of components of cables with a longitudinally applied metal tape or foil, bonded to the oversheath

Replace the existing list item b) with the following new item b):

b) adhesion strength of the laminated metal tape or foil (see Clause G.2);

Add, after list item b), the following new item c):

c) peel strength of the laminated metal tape or foil (see Clause G.2).

12.5.17.1 Procedure

Replace the paragraph with the following new paragraph:

The shrinkage test shall be carried out on insulations of PE, HDPE and XLPE using the sampling and test procedure described in IEC 60811-502:2012, except in the case of 3 core cables where each of the 3 cores shall be tested to IEC 60811-502:2012 as if they were individual cables using the conditions specified in Table 8.

12.5.17.2 Requirements

Add, at the end of the existing sentence, the following new sentence:

In the case of 3 core cables the results for each core shall comply.

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13 Prequalification test of the cable system

13.1 General and range of prequalification test approval

Replace the contents of Subclause 13.1 with the following:

When a PQ test has been successfully performed on a cable system, it qualifies the manufacturer as a supplier of cable systems of the same family with the same or lower voltage ratings, as long as the calculated nominal electrical stresses at the cable insulation screen are equal to or lower than for the tested cable system.

The PQ test shall be performed on cable systems where the calculated nominal electrical stresses at the conductor screen are higher than 8,0 kV/mm and/or at the insulation screen higher than 4,0 kV/mm. The PQ test shall be performed except:

– if cable systems with the same construction and accessories of the same family have been prequalified for an equal or higher rated voltage;
– or if the manufacturer can demonstrate good service experience with cable systems with equal or higher calculated electrical stresses on the conductor and insulation screens, in the main insulation part(s) and in boundaries of the accessories and of accessories of the same family;
– or if the manufacturer has fulfilled the requirements of an equivalent long-term test on a cable system at an equal or higher voltage rating with the same construction and accessories of the same family, following a national or customer specification.