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**Power cables with cross-linked polyethylene insulation and
their accessories for rated voltage of 220 kV ($U_m=252$ kV) --**

Part 1: Test methods and requirements

额定电压 220 kV($U_m=252$ kV) 交联聚乙烯绝缘电力电缆及其附件

第 1 部分: 试验方法和要求

(IEC 62067:2011, 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, MOD)

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Power cables with cross-linked polyethylene insulation and their accessories for rated voltage of 220 kV ($U_m=252$ kV) --

Part 1: Test methods and requirements

1 Scope

This Part of GB/T 18890 specifies the test methods and requirements for fixedly-installed power cables with cross-linked polyethylene insulation, cable bodies and their accessories for rated voltage of 220 kV ($U_m=252$ kV).

This Part applies to single-core cables and their accessories used under normal installation and operating conditions. However, it does not apply to cables and their accessories used under special conditions, such as submarine cables. For these special-purpose cables and accessories, the tests in this standard may need to be modified or special test conditions may need to be established.

This Part does not include transition joints for connecting cross-linked polyethylene insulated cables 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.

GB/T 2951.11-2008, *Common test methods for insulating and sheathing materials of electric and optical cables -- Part 11: Methods for general application -- Measurement of thickness and overall dimensions -- Tests for determining the mechanical properties* (IEC 60811-1-1:2001, IDT)

GB/T 2951.12-2008, *Common test methods for insulating and sheathing materials of electric and optical cables -- Part 12: Methods for general application -- Thermal ageing methods* (IEC 60811-1-2:1985, IDT)

GB/T 2951.14-2008, *Common test methods for insulating and sheathing materials of electric and optical cables -- Part 14: Methods for general application -- Test at low temperature* (IEC 60811-1-4:1985, IDT)

GB/T 2951.21-2008, *Common test methods for insulating and sheathing materials of electric and optical cables -- Part 21: Methods specific to elastomeric compounds*

| *sheaths*

IEC 60183, *Guidance for the selection of high-voltage a.c. cable systems*

IEC 60229:2007, *Electric cables -- Tests on extruded over sheaths with a special protective function*

3 Terms and definitions

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

3.1 Definitions of dimensional values (thickness, cross-sectional area, etc.)

3.1.1 nominal value

A specified quantity and is often used in tables.

NOTE: In this Part, nominal values generally refer to values of quantities that have been verified by measurement taking into account stated tolerances.

3.1.2 median value

Arrange several measured values in ascending (or descending) order. If the number of values is odd, the middle value is the middle value. If the number of values is even, the average of the two middle values is the middle value.

3.2 Definitions for relevant tests

3.2.1 routine test

A test carried out by the manufacturer on components (all manufactured lengths of cable or all accessories) to check that they comply with specified requirements.

3.2.2 sample test

A test carried out by the manufacturer at a specified frequency on samples of finished cables or components taken from finished cables or accessories to verify that the finished cables or accessories meet the specified requirements.

3.2.3 type test

A test carried out before a cable system of the type covered by this Part is supplied on a normal industrial basis to demonstrate that it has satisfactory performance under the conditions of intended use.

NOTE: Once the type test is passed, it does not need to be repeated unless the material, manufacturing process, structure or design electric field strength of the cable or accessories are changed and such change may have an adverse effect on its performance.

3.2.4 prequalification test

A test carried out before a cable system of the type covered by this Part is supplied on a normal industrial production basis to demonstrate that the complete cable system has satisfactory long-term operating performance.

3.2.5 extension of prequalification test

A test in which before a cable system of a type covered by this Part is supplied on a general industrial production basis, the system cables and accessories have each passed a prequalification test to verify that the complete cable system has satisfactory long-term operating performance.

3.2.6 electrical test after installation

A test performed on a cable system to prove its integrity after installation.

3.3 Other definitions

3.3.1 cable system

Cables fitted with various accessories, including components for use only with terminals and connectors, to suppress the thermal-mechanical forces on the system.

3.3.2 nominal electrical stress

Electric field strength at U_0 calculated based on nominal size.

4 Voltage marking and materials

4.1 Rated voltage

This Part uses the symbols U_0 , U and U_m to indicate the rated voltage of cables and accessories. The meanings of these symbols are given by IEC 60183.

4.2 Cable insulation materials

This standard applies to cables with cross-linked polyethylene (XLPE) insulation. Table 1 specifies the maximum operating temperature of XLPE insulated cable conductors and the test conditions accordingly.

Table 1 -- Cross-linked polyethylene insulation compound for cables

Insulation mixture	Maximum conductor temperature/°C	
	Normal operation	Short circuit (maximum duration is 5 s)
Cross-linked polyethylene (XLPE)	90	250

5 Water blocking measures for cables

When the cable system is laid underground, in an underground passage prone to water accumulation, or in water, it is recommended to use a radially impermeable barrier layer to cover the cable.

NOTE: There is currently no radial water permeability test method.

To prevent the need to replace long lengths of cable once the cable is damaged and water ingress occurs, longitudinal water-blocking measures can also be adopted.

The longitudinal water penetration test is given in 12.5.14.

6 Cable characteristics

For the purpose of carrying out and recording the tests on cable systems or cables described in this standard, the cables shall be marked.

The following cable characteristics should be specified or stated:

- a) Manufacturer's name, model, designation, date of manufacture or date code.
- b) Rated voltage: the values of U_0 , U , and U_m should be given (see 4.1 and 8.4).
- c) Conductor type, material, and nominal cross-sectional area in square millimeters; conductor construction; measures to reduce skin effect (if any) and their nature; longitudinal water-blocking measures (if any) and their nature; if the nominal cross-sectional area does not conform to GB/T 3956, the DC resistance of the conductor converted to 1 km at 20°C.
- d) Insulation material and nominal thickness (see 4.2). Table 3 gives the $\tan\delta$ of cross-linked polyethylene insulation.
- e) Manufacturing process of the insulation system.
- f) Water-blocking measures (if any) and their nature for the shielding layer.
- g) Material and construction of the metal shield, such as the number and diameter of the metal wires. The DC resistance of the metal shield should be stated. Material, construction, and nominal thickness of the metal sheath, or the material, construction, and nominal thickness of the longitudinally wrapped metal tape or foil bonded to the outer sheath (if any).
- h) Material and nominal thickness of the outer sheath.
- i) Nominal conductor diameter (d).

- j) Nominal outer diameter of the finished cable (D).
- k) Nominal inner diameter of the insulation (d_{ii}) and calculated nominal outer diameter (D_{io}).
- l) Nominal capacitance per 1 km between the conductor and the metallic shield and/or metallic sheath.
- m) Calculated nominal electric field strength on the conductor shield (E_i) and nominal electric field strength on the insulation shield (E_o):

7 Accessory characteristics

For the purpose of carrying out and recording the tests on cable systems or accessories described in this standard, the accessories shall be marked.

The following characteristics should be identified or stated:

- a) Cables used for accessory tests shall be correctly marked in accordance with Chapter 6;
- b) Conductor connection fittings used in accessories should be correctly marked:
 - Installation process;
 - Tools, dies, and necessary assembly equipment;
 - Treatment of contact surfaces;

- Model, serial number, and other identification marks of the connecting fittings;
- Details of the type tests and approvals that the conductor connecting fittings have undergone, where applicable.

c) Accessories used for testing should be correctly marked with:

- Manufacturer's name;
- Model, name, date of manufacture or date code;
- Rated voltage [see Section 6, item b)];
- Installation instructions (number and date).

8 Test conditions

8.1 Ambient temperature

Unless otherwise specified for a particular test, the test shall be carried out at an ambient temperature of $(20 \pm 15)^\circ\text{C}$.

8.2 Frequency and waveform of power frequency test voltage

Unless otherwise specified in this standard, the frequency of the AC test voltage shall be between 49 Hz ~ 61 Hz. The waveform shall be essentially sinusoidal. The voltage value shall be expressed in root mean square (r.m.s.) terms.

8.3 Waveform of lightning impulse test voltage

According to GB/T 3048.13, the wavefront time of a standard lightning impulse voltage wave should be $1\ \mu\text{s} \sim 5\ \mu\text{s}$. According to GB/T 16927.1, the half-wave peak time should be $(50 \pm 10)\ \mu\text{s}$.

8.4 Relationship between test voltage and rated voltage

The test voltages specified in this standard are expressed as multiples of the rated voltage U_0 . To determine the test voltage U_0 value as 127 kV, the test voltage shall be as specified in Table 4.

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

8.5 Determination of cable conductor temperature

It is recommended that one of the test methods described in Annex A be used to determine the actual temperature of the conductor.

9 Routine tests on primary insulation of cables and prefabricated accessories

9.1 Overview

The following tests shall be carried out on each manufactured length of cable:

- a) Partial discharge test (see 9.2);
- b) Voltage test (see 9.3);
- c) Electrical test on the outer sheath (see 9.4).

The order of these tests is left to the discretion of the manufacturer.

The main insulation of each prefabricated accessory shall be subjected to the partial discharge test (see 9.2) and the voltage test (see 9.3). The test may be carried out according to the following 1), 2) or 3) methods:

- 1) Test conducted on an accessory installed on the cable;
- 2) Test conducted on the main insulating component installed on an accessory specifically designed for testing;
- 3) Test conducted using a simulated accessory device so that the electric field strength experienced by the main insulating component replicates actual electric

field conditions.

In cases 2) and 3) above, the test voltage should be selected so that the electric field strength produced is at least the same as the electric field strength produced in the accessory product when the test voltage specified in 9.2 and 9.3 is applied to the component.

NOTE: The primary insulation of prefabricated accessories includes components that are in direct contact with the cable insulation and are essential and fundamental to controlling the electric field distribution in the accessory, such as molded or precast prefabricated rubber insulation or epoxy insulation with filler. They can be used alone or in combination to provide the necessary insulation and shielding for the accessory.

9.2 Partial discharge test

Cable partial discharge tests should be conducted in accordance with GB/T 3048.12. The detection sensitivity should be 10 pC or better. Accessory tests should follow the same principles. The detection sensitivity should be 5 pC or better.

The test voltage shall be gradually increased to $1.75 U_0$ and maintained for 10 s, then slowly decreased to $1.5 U_0$ (see Table 4, column 5).

At $1.5 U_0$, the test object shall have no detectable discharge exceeding the declared sensitivity.

9.3 Voltage test

The voltage test should be carried out at ambient temperature using industrial frequency AC voltage.

The test voltage shall be applied between the conductor and the metal shield and/or metal sleeve, gradually increasing to $2.5 U_0$ (see Table 4), and then maintained for 30 min.

There should be no insulation breakdown.

9.4 Electrical test on outer sheath

The electrical test specified in Chapter 3 of IEC 60229:2007 shall be carried out. Apply a DC voltage of 25 kV between the metal shield and/or metal sheath and the conductive layer on the surface of the outer sheath with the metal sheath connected to the negative pole for 1 min.

The outer sheath should not be punctured.

10 Sample test of cables

10.1 Overview

The following tests shall be carried out on a sample of cable representing the delivery batch. For tests b) and g), the sample may be a whole reel of cable.

- a) Conductor inspection (see 10.4);
- b) Conductor resistance and metallic screen and/or metallic sheath resistance measurement (see 10.5);
- c) Insulation and outer sheath thickness measurement (see 10.6);
- d) Metal sheath thickness measurement (see 10.7);
- e) Diameter measurement, where required (see 10.8);
- f) XLPE insulation thermal expansion test (see 10.9);
- g) Capacitance measurement (see 10.10);
- h) Lightning impulse voltage test (see 10.11);
- i) Water penetration test, where applicable (see 10.12);
- j) Testing of cable components with longitudinally wrapped metal tape or foil bonded to the outer sheath (see 10.13).

10.2 Test frequency

The sample test items a) ~ g) and j) in 10.1 shall be conducted on one specimen taken from each batch (production series) of cables of the same model and conductor cross-sectional area, but shall not exceed 10% of the total number of cables in any contract. Round to the nearest integer.

The sampling frequency for items h) ~ i) in 10.1 shall be in accordance with the agreed quality control method. In the absence of such an agreement, contracts with cable lengths between 4 km~20 km shall be subject to a single test. Contracts with cable lengths exceeding 20 km shall be subject to a second test.

10.3 Retest

If a specimen from any cable fails any of the tests in 10.1, two more specimens shall be taken from the same batch of cables and tested for the failed items. If both of the additional cables pass the test, the remaining cables in the batch from which the two specimens were taken shall be considered to meet the requirements. If any of the additional cables fails the test, the entire batch of cables shall be considered to fail the

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