

IEEE Standard Test Procedures and Requirements for Alternating- Current Cable Terminations 2.5 kV Through 765 kV

Sponsor

**Insulated Conductors Committee
of the
IEEE Power Engineering Society**

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Abstract: All indoor and outdoor cable terminations used on alternating-current cables having laminated or extruded insulation rated 2.5 kV through 765 kV are covered, except for separable insulated connectors, which are covered by IEEE Std 386-1995.

Keywords: accelerated contamination testing, correction factors, dielectric field tests, environmental exposure, nonstandard service conditions, rating, solar radiation, standard service conditions, test requirements, ultraviolet light

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Introduction

(This introduction is not part of IEEE Std 48-1996, IEEE Standard Test Procedures and Requirements for Alternating-Current Cable Terminations 2.5 kV Through 765 kV.)

This standard supersedes IEEE Std 48-1990, IEEE Standard Test Procedures and Requirements for High-Voltage Alternating-Current Cable Terminations.

Several definitions have been added to reflect use of polymeric designs and to differentiate between various environments encountered. To clarify test procedures, Class 1 terminations have been divided into three classes: Class 1A for extruded dielectric cable, Class 1B for laminated dielectric cable, and Class 1C for pressure-type systems.

Partial discharge requirements for laminated cable terminations have been replaced by ionization test requirements, which are more applicable for laminated cable constructions. Retesting is not intended now as the partial discharge is more difficult. Reflecting cable voltage trends, table 1 contains test requirements up to 765 kV for laminated dielectric terminations and 230 kV for solid dielectric cable terminations.

Clause 9 has been expanded to include a pollution severity guide to assist the user to define a particular environment and help determine type and creepage length needed. Effects of solar radiation are addressed and test methods are recommended. The user is also advised to refer to the manufacturer for contamination testing, particularly if difficult environments are encountered.

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1. Scope

This standard covers all indoor and outdoor cable terminations used on alternating-current cables having laminated or extruded insulation rated 2.5 kV through 765 kV, except separable insulated connectors, which are covered by IEEE Std 386-1995, IEEE Standard for Separable Insulated Connector Systems for Power Distribution Systems Above 600 V [B16].¹

Cable terminations and component parts shall be capable of withstanding the tests specified in this standard.

2. References

This standard shall be used in conjunction with the following standards. When the following standards are superseded by an approved revision, the revision shall apply.

IEC 270-1981, Partial Discharge Measurements.²

IEEE Std 4-1995, IEEE Standard Techniques for High-Voltage Testing (ANSI).³

IEEE Std 82-1994, IEEE Standard Test Procedure for Impulse Voltage Tests on Insulated Conductors (ANSI).

IEEE Std 835-1994, IEEE Standard Power Cable Ampacity Tables (ANSI).

¹The numbers in brackets correspond to those of the bibliography in clause 10.

²IEC publications are available from IEC Sales Department, Case Postale 131, 3, rue de Varembe, CH-1211, Genève 20, Switzerland/Suisse. IEC publications are also available in the United States from the Sales Department, American National Standards Institute, 11 West 42nd Street, 13th Floor, New York, NY 10036, USA.

³IEEE publications are available from the Institute of Electrical and Electronics Engineers, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331, USA.

3. Definitions

The definitions and terminology used herein apply specifically to cable terminations treated in this standard. For additional definitions, see [B15].

3.1 apparatus termination: A termination designed for use in sealed enclosures where the external dielectric strength is dependent upon liquid or special gaseous dielectric and where the ambient temperature of the medium immediately surrounding the termination may reach 55 °C.

3.2 breakdown: A disruptive discharge occurring through a dielectric.

3.3 chalking: The powdered surface on the polymeric insulator consisting of particles of filler resulting from ultraviolet exposure or leakage current activity.

3.4 cracking: Rupture of the polymeric insulator material to depths equal to or greater than 0.1 mm.

3.5 crazing: Surface microfractures of the insulator material to depths less than 0.1 mm resulting from ultraviolet exposure.

3.6 design tests: Tests made by the manufacturer to obtain data for design or application, or to obtain information on the performance of each type of high-voltage cable termination.

3.7 external connector (aerial lug): A connector that joins the external conductor to the current-carrying parts of a cable termination.

3.8 field tests: Tests that may be made on a cable system (including the high-voltage cable terminations) by the user after installation, as an acceptance or proof test.

3.9 flashover: A disruptive discharge around or over the surface of an insulating member, between parts of different potential or polarity, produced by the application of voltage wherein the breakdown path becomes sufficiently ionized to maintain an electric arc.

3.10 high-voltage cable termination: A device used for terminating alternating-current power cables having laminated or extruded insulation rated 2.5 kV and above, which are classified according to the following:

- a) Class 1 termination: Provides electric stress control for the cable insulation shield terminus; provides complete external leakage insulation between the cable conductor(s) and ground; and provides a seal to the end of the cable against the entrance of the external environment and maintains the operating design pressure, if any, of the cable system. This class is divided into three types:
 - Class 1A: For use on extruded dielectric cable
 - Class 1B: For use on laminated dielectric cable
 - Class 1C: Expressly for pressure-type cable systems
- b) Class 2 termination: Provides electric stress control for the cable insulation shield terminus, and provides complete external leakage insulation between the cable conductor(s) and ground.
- c) Class 3 termination: Provides electric stress control for the cable insulation shield terminus.

NOTE—Some cables below 15 kV do not have an insulation shield. Terminations for such cables would not be required to provide electric stress control. In such cases, this provision would not be part of the definition.

3.11 indoor termination—dry: A termination intended for use where it is protected from solar radiation and precipitation and not subject to periodic condensation, or other excessive humidity (90% RH or more). May be installed in air conditioned or heated areas.

3.12 indoor termination—wet: A termination intended for use where it is protected from direct exposure to both solar radiation and precipitation, but is subjected to climatic conditions that can cause condensation onto the termination surfaces.

3.13 outdoor termination: A termination intended for use where it is not protected from direct exposure to either solar radiation or precipitation. These are Class 1A, 1B, or 1C terminations. Class 2 terminations may also qualify.

3.14 outdoor termination—polluted: A termination intended for use where it is not protected from direct exposure to either solar radiation or precipitation, and is exposed to nonstandard (unusual) service conditions such as extreme seacoast salt deposits, solid precipitates, etc. Often requires extra maintenance such as washing or extra creepage length.

3.15 partial discharge (corona) extinction voltage: The voltage at which partial discharge (corona) is no longer detectable on instrumentation adjusted to a specified sensitivity, following the application of a specified higher voltage.

3.16 pressure-type termination: A Class 1C termination intended for use on positive pressure cable systems.

- Single pressure zone termination: A pressure-type termination intended to operate with one pressure zone.
- Multipressure zone termination: A pressure-type termination intended to operate with two or more pressure zones.

3.17 radio influence voltage (RIV): The radio noise appearing on conductors of electric equipment or circuits, as measured using a radio-noise meter as a two-terminal voltmeter in accordance with specified methods.

3.18 routine tests: Tests made on each high-voltage cable termination or upon a representative number of devices, or parts thereof, during production for purposes of quality control.

3.19 termination insulator: An insulator used to protect each cable conductor passing through the device and provide complete external leakage insulation between the cable conductor(s) and ground.

3.20 weathersheds: The external part of the termination insulator that protects the core and provides the wet electrical strength and leakage distance.

3.21 withstand test voltage: The voltage that the device must withstand without flashover, disruptive discharge, puncture, or other electrical failure when voltage is applied under specified conditions.

NOTE—For power frequency voltages, the values specified are RMS values and for a specified time. For lightning or switching impulse voltages, the values specified are crest values of a specified wave. For direct voltages, the values specified are average values and for a specified time.

4. Service conditions

4.1 Standard service conditions

Devices conforming to this standard shall be capable of successful operation under the following service conditions. Refer to [B14] for more information.

4.1.1 Physical conditions

- a) Temperature
 - 1) The temperature of the medium in direct contact with the termination shall not be less than $-30\text{ }^{\circ}\text{C}$, nor more than $+40\text{ }^{\circ}\text{C}$.
 - 2) For apparatus terminations, the temperature of the medium in direct contact with the termination (ambient inside enclosure) shall not exceed $55\text{ }^{\circ}\text{C}$. The devices designed for this service will be connected to the equipment bus which may, at full load, reach a maximum temperature of $85\text{ }^{\circ}\text{C}$.
- b) The altitude shall not exceed 1000 m (3300 ft) where atmospheric air is part of the thermal or dielectric system or both.

4.1.2 System conditions

The nominal power system frequency is not less than 48 Hz nor more than 62 Hz.

4.2 Nonstandard service conditions

The following service conditions may require special consideration in design or application of the cable terminations, and should be called to the attention of the manufacturer.

4.2.1 Physical conditions

- a) Temperature of the surrounding medium (ambient temperature) less than $-30\text{ }^{\circ}\text{C}$ and more than $+40\text{ }^{\circ}\text{C}$
- b) Altitude exceeding 1000 m (3300 ft) where atmospheric air is part of the thermal or dielectric system or both (see clause 9)
- c) Damaging fumes or vapors, excessive or abrasive dust, explosive mixtures of dust or gases, steam, salt spray, excessive moisture or dripping water, salt on roadways, etc.
- d) Unusual mechanical conditions such as vibration, shock, cantilever loading, wind loading, icing, etc.
- e) Unusual transportation or storage conditions
- f) Unusual space limitations
- g) Unusual internal pressures
- h) Unusual maintenance difficulties

4.2.2 Electrical conditions

- Power frequencies less than 48 Hz or greater than 62 Hz

5. Rating

The rating of a high-voltage cable termination shall include the following items, where applicable:

- a) *BIL (basic lightning impulse insulation level)*. The crest value of a lightning impulse voltage of a specified wave shape, which the high-voltage cable termination is required to withstand under specified conditions.