

IEEE Standard Test Code for High-Voltage Air Switches

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Abstract: Design test requirements for all high-voltage enclosed indoor and outdoor and non-enclosed indoor and outdoor air switches rated above 1000 V are specified. This includes requirements for such switches as disconnecting, selector, horn-gap, grounding, interrupter, etc., for manual and power operation, except for distribution-enclosed single-pole air switches and distribution cutouts fitted with disconnecting blades.

Keywords: corona, high-voltage air switches, ice breaking, indoor air switches, lightning impulse, mechanical operations, outdoor air switches, switching impulse

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Introduction

(This introduction is not a part of IEEE Std C37.34-1994, IEEE Standard Test Code for High-Voltage Air Switches.)

This publication is one of a series of seven standards (IEEE Std C37.30-1992 through IEEE C37.37-1979) on high-voltage air switches as follows:

IEEE Std C37.30-1992, IEEE Standard Requirements for High-Voltage Air Switches.

ANSI C37.32/D6/2-95, Schedules of Preferred Ratings, Construction Guidelines and Specifications for High-Voltage Air Disconnect Switches, Interrupter Switches, Fault Initiating Switches, Grounding Switches, Bus Supports, and Switch Accessories, Control Voltage Ranges.

ANSI C37.33-1987, High-Voltage Air Switches Rated Control Voltages and Their Ranges.

IEEE Std C37.34-1994, IEEE Standard Test Code for High-Voltage Air Switches.

IEEE Std C37.35-1976 (Reaff 1992), IEEE Guide for the Application, Installation, Operation, and Maintenance of High-Voltage Disconnecting and Load Interrupter Switches (ANSI).

IEEE Std C37.36b-1990, IEEE Guide to Current Interruption with Horn-Gap Air Switches (ANSI).

IEEE Std C37.37-1979 (Reaff 1993), IEEE Standard Loading Guide for AC High-Voltage Air Switches (in excess of 1000 volts) (ANSI).

This standard includes previously approved supplements that cover tests for ice breaking ability, mechanical operations, mechanical terminal loads, switching impulse, limits of corona and radio influence voltage as well as temperature limits for air switches.

This standard establishes a definition for corona, develops the concept of corona-free voltage, establishes the requirements for corona-free voltage, and the criteria for acceptance. The corona-free voltage is specified to be 1.10 times the line-to-neutral voltage equivalent of rated maximum voltage. Only visible corona is defined because this satisfies the majority of user requirements. Actual tests performed show satisfactory radio influence voltage (RIV) levels after the extinction of visible corona over the extremities of the device.

In the past, switches determined to be corona-free by the human eye accustomed to a darkened area have not been a source of radio or television interference. This standard, however, allows an alternate photographic corona test method where necessary.

Switch-mounting heights and proximity to other objects during tests have been limited so that they are representative of unfavorable operating conditions that could occur in a service location.

Tests require the switches to be free of visible corona at the corona extinction voltage because this voltage is lower than the corona starting voltage.

The specified ice tests are coordinated with IEC 129 (1984), which are intended for severe conditions of ice formation. The ice tests describe a method for natural environment (outdoor) testing. They establish criteria for acceptance, which are necessary to demonstrate compliance with the standard. Specific requirements have been added for manually-operated, power-operated, and fault-initiating switches.

The purpose of the mechanical operations test is to demonstrate the ability of a completely assembled switch to operate satisfactorily during its operating life expectancy.

Subclause 4.3 on the power frequency and lightning impulse open gap withstand voltage test has been revised to allow a bias test as an alternate to the standard test for switches rated 362 kV and above. Also, 4.4 on switching-impulse tests of extra-high voltage switches has been rewritten to utilize the test procedures contained in IEEE Std 4-1978 and IEC 129 (1984). The up-and-down method is used to establish phase-to-ground rated withstand voltage of the switch and the 3×9 test is used to verify the open gap withstand voltage. See annex A for background information.

The material was updated to conform with presently accepted standard conditions and switching-impulse wave shape. Also, the procedure for determining the maximum dispersion has been deleted, and a specific standard deviation is designated in case adequate test data is not available to determine the actual value.

To harmonize with IEC 129 (1984), the terms *peak withstand current* (formerly momentary current) and *short-time (symmetrical) withstand current* (formerly 3-s current) have been introduced. Also, a three-phase test is permitted on switches rated 48.3 kV and below to verify the peak withstand current rating of the switch.

Suggestions for improvement gained in the use of this standard will be welcome. They should be sent to the IEEE Standards Department.

The Standards Committee on Power Switchgear, C37, which reviewed and approved this standard, had the following personnel at the time of approval:

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IEEE Standard Test Code for High-Voltage Air Switches

1. Overview

1.1 Scope

This standard summarizes various design tests that shall be made on all types of high-voltage enclosed indoor or outdoor and non-enclosed indoor or outdoor air switches, and describes accepted methods used in making these tests.

For tests on apparatus insulators, see ANSI C29.1-1988.¹ High-voltage air switches in IEEE Std C37.20.2-1987, IEEE Std C37.20.3-1987, IEEE Std C37.71-1984, and ANSI C37.72-1987 are not covered by this standard.

1.2 References

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

Accredited Standards Committee C2-1993, National Electrical Safety Code (NESC).²

ANSI C29.1-1988, Test Methods for Electrical Power Insulators.³

ANSI C29.8-1985, Wet-Process Porcelain Insulators (Apparatus, Cap and Pin Type).

ANSI C29.9-1983, Wet-Process Porcelain Insulators (Apparatus, Post Type).

ANSI C37.32/D6/2-95, Schedules of Preferred Ratings, Construction Guidelines and Specifications for High-Voltage Air Disconnect Switches, Interrupter Switches, Fault Initiating Switches, Grounding Switches, Bus Supports, and Switch Accessories, Control Voltage Ranges.⁴

¹Information on references can be found in 1.2.

²The NESC is available from the Institute of Electrical and Electronics Engineers, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331, USA.

³ANSI publications are available from the Sales Department, American National Standards Institute, 11 West 42nd Street, 13th Floor, New York, NY 10036, USA.

⁴As this standard goes to press, ANSI C37.32/D6/2-95 was not published; however, the draft is available from the National Electrical Manufacturers Association (NEMA), 2101 L Street NW, Washington, DC 20037, USA.

ANSI C37.72-1987, Manually-Operated, Dead-Front Padmounted Switchgear with Load Interrupting Switches and Separable Connectors for Alternating-Current Systems.

ANSI C63.2-1987, American National Standard Electromagnetic Noise and Field Strength, 10 kHz to 40 GHz—Specifications.

IEEE Std 4-1978, IEEE Standard Techniques for High-Voltage Testing (ANSI).⁵

IEEE Std 119-1974, IEEE Recommended Practice for General Principles of Temperature Measurement as Applied to Electrical Apparatus.⁶

IEEE Std C37.09-1979 (Reaff 1988), IEEE Standard Test Procedure for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis (ANSI).

IEEE Std C37.20.2-1993, IEEE Standard for Metal-Clad and Station-Type Cubicle Switchgear (ANSI).⁷

IEEE Std C37.20.3-1987 (Reaff 1992), IEEE Standard for Metal-Enclosed Interrupter Switchgear (ANSI).

IEEE Std C37.30-1992, IEEE Standard Requirements for High-Voltage Air Switches (ANSI).

IEEE Std C37.34e-1979, IEEE Standard for Switching-Impulse Testing of Extra High-Voltage Switches, Supplement to IEEE Std C37.34-1971 (ANSI).

IEEE Std C37.71-1984 (Reaff 1990), IEEE Standard for Three-Phase Manually Operated Subsurface Load-Interrupting Switches for AC Systems (ANSI).

IEEE Std C37.100-1992, IEEE Standard Definitions for Power Switchgear (ANSI).

NEMA 107-1987, Methods of Measurement of Radio Influence Voltage (RIV) of High-Voltage Apparatus.

2. Definitions

The definitions of terms contained in this document, or in other standards referred to in this document, are not intended to embrace all legitimate meanings of the terms. They are applicable only to the subject treated in this standard. For additional definitions, see IEEE Std C37.100-1992.

2.1 lightning impulse dry withstand voltage: The crest value of a voltage impulse with a front duration from less than one to a few tens of microseconds that, under specified conditions, can be applied without causing flashover or puncture.

2.2 loadability (of an air switch): The ratio of allowable continuous current at 25° C ambient temperature to rated continuous current.

2.3 power frequency: The frequency at which a device or system is designed to operate.

2.4 peak withstand current (of an air switch): The crest value of the total current during the maximum cycle that a switch is required to carry at rated frequency.

2.5 short-time (symmetrical) withstand current (of an air switch): The current carried by a device, an assembly, or a bus for a specified short-time interval.

⁵IEEE Std 4-1978 has been withdrawn; however, copies can be obtained from the IEEE Standards Department, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331, USA.

⁶IEEE Std 119-1974 has been withdrawn; however, copies can be obtained from the IEEE Standards Department.

⁷IEEE publications are available from the Institute of Electrical and Electronics Engineers.

2.6 switching impulse withstand voltage: The crest value of a voltage impulse with a front duration from tens to thousands of microseconds that, under specified conditions, can be applied without causing flashover or puncture.

2.7 visible corona (as applies to an air switch): A luminous discharge due to ionization of the air surrounding an air switch, caused by a voltage gradient exceeding a certain critical value.

3. Design tests

Design tests are those made to determine the adequacy of the particular type, style, or model of equipment with its component parts to meet its assigned rating and to operate satisfactorily under normal service conditions or under special conditions, if specified.

Design tests are made only on representative apparatus to substantiate the ratings assigned to all other apparatus of the same basic design. These tests are not intended to be used as a part of normal production. The applicable portion of these design tests may also be used to evaluate modifications of a design and to assure that performance has not been adversely affected. Test data from previous similar designs may be used for current designs, where appropriate.

The following clauses establish physical and electrical conditions for tests and methods of determining test parameters.

4. Dielectric withstand voltage tests

Dielectric withstand voltage tests are performed to verify the voltage withstand capability of the switch with specified magnitudes and wave shapes of test voltage applied under specified test conditions. All test voltages are to be corrected to standard atmospheric conditions per IEEE Std 4-1978.

4.1 Power-frequency withstand voltage tests

4.1.1 Power-frequency dry withstand voltage test

The test voltage shall be the rated power-frequency dry withstand voltage and shall be applied to the specimen for 1 min without flashover and/or damage to the insulating material. Preferred ratings for all switches are given in ANSI C37.32/D6/2-95.

4.1.2 Power-frequency wet withstand voltage test

The test voltage shall be the rated power-frequency wet withstand voltage and shall be applied to the specimen for 10 s without flashover and/or damage to the insulating material. Preferred ratings are given in column 4 of table 1 in ANSI C37.32/D6/2-95 for non-enclosed outdoor switches.

4.1.3 Power-frequency dew withstand voltage test

The test voltage shall be the rated power-frequency dew withstand voltage and shall be applied to the specimen for 10 s without flashover and/or damage to the insulating material. Preferred ratings for all switches are given in ANSI C37.32/D6/2-95.

4.1.4 Voltage application for power-frequency dry and wet withstand voltage tests

Seventy-five percent of the rated power-frequency dry and wet withstand voltage may be applied in one step and gradually raised to the required value in neither less than 5 s nor more than 30 s.

4.1.5 Voltage application for power-frequency dew withstand voltage test

The voltage shall be raised rapidly to the rated power-frequency dew withstand test voltage in not more than 20 s.

4.1.6 Frequency and wave shape of the power-frequency withstand test voltage

The frequency of the test voltage shall be within $\pm 20\%$ of the rated frequency of the device being tested. A sine wave of acceptable shape shall be applied to the device. The test shall be made with alternating voltage having a crest value equal to 1.414 times the specified test voltage.

4.1.7 Mounting of specimen

The switch base shall be grounded or mounted on a grounded metal supporting structure.

4.1.8 Measurement of voltage

The voltage for dielectric tests shall be measured in accordance with IEEE Std 4-1978.

4.1.9 Points of application of voltage

Multi-pole switches mounted on a common base with or without barriers between poles, shall be tested as follows:

- a) With the switch closed and base grounded, simultaneously apply the test voltage to all terminals on one side of the switch.
- b) With the switch open and base grounded, apply voltage to one terminal of one pole with the other terminals grounded. Repeat the test using opposite terminal of the same pole. On non-enclosed three-pole or four-pole switches, the voltage shall be applied to an interior pole; however, on enclosed switches, each pole shall be tested.
- c) With the switch closed, apply voltage to one pole with the terminals of other poles and the base grounded. On three-pole or four-pole switches, the voltage shall be applied to an interior pole.

A multi-pole switch having separately mounted poles shall have tests performed only on a single pole, as follows:

- a) With the switch open, the test voltage shall be successively applied between each terminal and the grounded metal parts, including the base, with the other terminal connected to the ground.
- b) With the switch closed, the test voltage shall be applied between the live and the grounded metal parts, including the base.

4.1.10 Wet withstand voltage test standards, water resistivity, and rate of precipitation

Wet tests shall be made in accordance with IEEE Std 4-1978.

4.1.11 Dew withstand voltage test standards

The dew withstand voltage test, preparation of test specimen, and mounting arrangement shall be made in accordance with 4.6 of ANSI C29.1-1988.

4.2 Lightning impulse dry withstand voltage tests

4.2.1 Full wave voltage test

The test voltage shall be the rated $1.2 \times 50 \mu\text{s}$ full wave lightning impulse dry withstand voltage. Preferred ratings for all switches are given in column 2 of table 1 in ANSI C37.32/D6/2-95. Test voltages of positive and negative polarities