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(Revision and redesignation of
ANSI/IEEE Std 21-1976)

IEEE Standard General Requirements and Test Procedure for Outdoor Power Apparatus Bushings

Sponsor
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Abstract: Service conditions, rating, general requirements, and test procedures for outdoor apparatus bushings are set forth. They apply to outdoor power apparatus bushings that have basic impulse insulation levels of 110 kV and above for use as components of oil-filled transformers, oil-filled reactors, and oil circuit breakers. The following are not covered: high-voltage-cable terminations (potheads), bushings for instrument transformers, bushings for test transformers, bushings in which the internal insulation is provided by a gas, bushings applied with gaseous insulation (other than air at atmospheric pressure) external to the bushing, bushings for distribution-class circuit breakers and transformers, bushings for automatic circuit reclosures and line sectionalizers, and bushings for oil-less and oil-poor apparatus.

Keywords: apparatus bushings, bushings, oil circuit breakers, oil-filled reactors, oil-filled transformers

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- (1) Name of the manufacturer, identification number, type, year of manufacture, and serial number
- (2) Rated maximum line-to-ground voltage
- (3) Rated continuous current (see NOTE)

NOTE: Where bushings have a dual continuous current rating, the nameplate shall indicate the rating for

- (1) Oil circuit breaker application
- (2) Power transformer application
- (4) Rated full-wave lightning-impulse withstand voltage (BIL)
- (5) Capacitance C_1 and C_2 , on all bushings equipped with voltage taps, and C_1 on all bushings equipped with test taps
- (6) Power factor measured from conductor to tap, where applicable, at 10 kV or above and referred to 20 °C, by the Ungrounded Specimen Test (UST) method
- (7) Length of bushing below mounting surface (L)

7. Test Procedure

This test procedure summarizes the various tests that are made on power apparatus bushings, describes accepted methods used in making the tests, and specifies the tests that will demonstrate ratings in this standard. It does not preclude the use of other equivalent or more effective methods of demonstrating ratings. These tests are divided into the following classifications:

- (1) Design tests
- (2) Special tests
- (3) Routine tests

7.1 Test Conditions

7.1.1 General Requirements. Bushings shall be prepared for dielectric tests and measurements, and corrections for conditions shall be made in accordance with appropriate sections of this standard. The following shall be in accordance with applicable sections in IEEE Std 4-1978 [8]:

- (1) Definitions of tests
- (2) General test procedures
- (3) Characteristics and tolerance of waveshapes
- (4) Method of measurement
- (5) Standard atmospheric and precipitation conditions
- (6) Rate and duration of voltage application for low-frequency tests

7.1.2 Test Specimen Requirements. The test specimen shall comply with the following requirements:

- (1) Except for mechanical tests, bushings shall be mounted on a supporting structure and in the position approximating that for which they were designed and with their ends in the media of the type in which they are intended to operate.
- (2) Bushings shall be completely assembled with all elements normally considered essential parts of the bushings.
- (3) The bushing shall be dry (except for wet tests) and clean.
- (4) Voltage withstand tests shall be made with the following provisions: The bushing shall be mounted on a relatively flat metallic grounded mounting plate that extends outward from the bushing flange at least 25% of the porcelain height to prevent an arc from

striking any grounded object other than the grounded parts of the bushing or the mounting plate. The test connection to the bushing shall be made such that it does not affect the test results.

- (5) For partial discharge tests, suitable external shielding may be applied to eliminate external corona on the air-end terminal.

7.1.3 Test Conditions

7.1.3.1 Air Temperature. The ambient temperature at the time of test shall be between 10 °C and 40 °C (50 °F and 104 °F).

7.1.3.2 Humidity. The absolute humidity at the time of test should preferably be between 7.0 g/m³ and 15.0 g/m³. Refer to Fig 1.5 of IEEE Std 4-1978 [8] for determination of absolute humidity.

7.1.4 Correction Factors. When actual test conditions vary from standard test conditions as specified in IEEE Std 4-1978 [8], correction factors k_d for variation in relative air density and k_h for variation in humidity may be applied to correct applied withstand voltages to withstand voltages at standard conditions. Correction factors shall be determined in accordance with the rod-gap configuration of Table 1.3 of IEEE Std 4-1978 [8] and shall be applied as follows:

- (1) Dry 1 min low-frequency withstand tests: No corrections
- (2) Wet 10 s low-frequency withstand tests: Correction factor k_d may be applied
- (3) Full-wave lightning-impulse withstand tests: Correction factors k_d and k_h may be applied at either positive or negative polarity, but not at both
- (4) Chopped-wave lightning impulse test: No correction
- (5) Wet switching-impulse withstand tests: Correction factor k_d may be applied

7.1.5 Atmospheric Conditions and Correction Factors Used in Previous Tests. Retest of existing equipment designs that were previously tested in accordance with ANSI C68.1-1968 shall not be required as a result of minor changes in standard atmospheric conditions or correction factors now used in IEEE Std 4-1978 [8] (the revision of ANSI C68.1-1968).

7.2 Design Tests. Design tests are those made to determine the adequacy of the design of a particular type, style, or model of power apparatus bushing to meet its assigned ratings; to operate satisfactorily under usual service conditions, or under special conditions, if specified; and to demonstrate compliance with appropriate standards of the industry.

Design tests are made only on representative bushings to substantiate the ratings assigned to all other bushings of the same design. These tests are not intended to be made as a part of normal production. The applicable portions of these design tests may also be used to evaluate modifications of a previous design and to assure that performance has not been adversely affected. Test data from previous designs may be used for current designs where appropriate. Once made, the tests need not be repeated unless the design is changed so as to modify performance.

During these tests, the bushing will be stressed higher than usually encountered in service and the bushings must withstand these tests without evidence of partial or complete failure. Hidden damage that may occur during the dielectric withstand voltage tests can usually be detected by comparing values of certain electrical characteristics before and after the withstand voltage tests. The characteristics usually measured are capacitance, power factor, and RIV and/or apparent charge. These diagnostic tests may be associated with individual withstand tests or a group of withstand tests. The criteria for acceptance are given in Tables 9 and 10 of IEEE C57.19.01-1991 [5].