



IEEE Standard for Overhead-Type Distribution Transformers 500 kVA and Smaller; High Voltage, 34 500 V and Below; Low Voltage, 7970/13 800Y V and Below

IEEE Power and Energy Society

Developed by the
Transformers Committee

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STANDARDS

IEEE Standard for Overhead-Type Distribution Transformers 500 kVA and Smaller; High Voltage, 34 500 V and Below; Low Voltage, 7970/13 800Y V and Below

Sponsor

Transformers Committee
of the
IEEE Power and Energy Society

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Abstract: Certain electrical, dimensional, and mechanical characteristics and safety features of single- and three-phase, 60-Hz, liquid-immersed, self-cooled, overhead-type distribution transformers 500 kVA and smaller, high voltages 34 500 V and below, and low voltages 7970/13 800Y V and below are covered in this standard.

Keywords: distribution transformer, IEEE C57.12.20™, liquid, overhead, transformer

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Introduction

This introduction is not part of IEEE Std C57.12.20-2023, IEEE Standard for Overhead-Type Distribution Transformers 500 kVA and Smaller; High Voltage, 34 500 V and Below; Low Voltage, 7970/13 800Y V and Below.

In 1938 the Edison Electric Institute-National Electrical Manufacturers Association (EEI-NEMA) Joint Committee on Standards for Distribution Transformers was organized to develop standards for the various types of distribution transformers. For 23 years the continuous work of this Joint Committee was evidenced by a series of reports published jointly by the Edison Electric Institute (EEI) and the National Electrical Manufacturers Association (NEMA). The last report of overhead-type distribution transformers was the Seventh Report published in April 1961. The Joint Committee's last two reports on overhead-type distribution transformers were approved as American National Standards; the Seventh Report was reissued as ANSI C57.12.20-1962.

To avoid further duplication of effort and to simplify future revisions, the EEI-NEMA Joint Committee on Standards for Distribution Transformers was dissolved and replaced by new subcommittees of Accredited Standards Committee on Transformers, Regulators, and Reactors, C57. The work on standards for overhead-type distribution transformers was taken over by the Subcommittee on Distribution Transformers, Overhead and Pad-mounted, C57.12.2.

This standard was prepared by IEEE Subcommittee C57.12.2 on behalf of C57 and is a revision of IEEE Std C57.12.20™-2011. The 1981 edition included detailed requirements on relief of excessive pressure. The 1988 revision recognized the step-down and series-multiple designs in distribution transformers and omitted the platform-type—or station-type—transformer. In recognition of the dramatic reduction in catastrophic failures of overhead transformers since the formulation of NEMA Standards Proposal Number TR-P7-1975, the 1988 revision (i.e., ANSI C57.12.20-1988) included in Section 8, this updated NEMA proposal that was previously designated 2.02 of NEMA Standards Publication for Transformers, Regulators, and Reactors, NEMA TR 1-1980 [B6].⁶ Industry consensus is that transformers that are built in conformance with this standard and that have adequate overcurrent protection, and recognizing the limitations included therein, will provide for enclosures with reasonable withstand capability. The 2011 revision includes significant revisions to Clause 9. The 2017 revision includes the addition of low-voltage ratings of 346 V and 600 V. This revision also includes the addition of minimum impedance. The 2023 revision includes the addition of a 120 V low-voltage rating, three-phase T connection, and Annex B for cover dielectric tests. Clause 9 on the test for fault capability is removed, as that test is now part of IEEE Std C57.12.39™.

This standard was processed and approved for submittal to ANSI by Accredited Standards Committee on Transformers, Regulators, and Reactors, C57. Committee approval of the standard does not necessarily imply that all committee members voted for its approval.

⁶ The numbers in brackets correspond to the numbers of the bibliography in Annex C

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1. Overview

1.1 Scope

This standard covers certain electrical, dimensional, and mechanical characteristics and safety features of single- and three-phase, 60-Hz, liquid-immersed, self-cooled, overhead-type distribution transformers 500 kVA and smaller, high voltages 34 500 V and below, and low voltages 7970/13 800Y V and below.

1.2 Purpose

This standard is intended for use as a basis for determining the performance, interchangeability, and safety of overhead-type distribution transformers and to assist in the proper selection of this equipment.

1.3 Word usage

The word *shall* indicates mandatory requirements strictly to be followed in order to conform to the standard and from which no deviation is permitted (*shall* equals *is required to*).^{7,8}

The word *should* indicates that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others; or that a certain course of action is preferred but not necessarily required (*should* equals *is recommended that*).

The word *may* is used to indicate a course of action permissible within the limits of the standard (*may* equals *is permitted to*).

The word *can* is used for statements of possibility and capability, whether material, physical, or causal (*can* equals *is able to*).

⁷ The use of the word *must* is deprecated and cannot be used when stating mandatory requirements, *must* is used only to describe unavoidable situations.

⁸ The use of *will* is deprecated and cannot be used when stating mandatory requirements, *will* is only used in statements of fact.

2. Normative references

The following referenced documents are indispensable for the application of this document (i.e., they must be understood and used; therefore, each referenced document is cited in text and its relationship to this document is explained). For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments or corrigenda) applies.

IEEE Std C57.12.00™, IEEE Standard for General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers.^{9,10}

IEEE Std C57.12.30™, IEEE Standard for Pole-Mounted Equipment—Enclosure Integrity for Coastal Environments.

IEEE Std C57.12.31™, IEEE Standard for Pole-Mounted Equipment—Enclosure Integrity.

IEEE Std C57.12.39™, IEEE Standard for Requirements for Distribution Transformer Tank Pressure Coordination.

IEEE Std C57.12.70™, IEEE Standard for Standard Terminal Markings and Connections for Distribution and Power Transformers.

IEEE Std C57.12.80™, IEEE Standard Terminology for Power and Distribution Transformers.

IEEE Std C57.12.90™, IEEE Standard Test Code for Liquid-Immersed Distribution, Power, and Regulating Transformers.

IEEE Std C57.91™, IEEE Guide for Loading Mineral-Oil-Immersed Transformers and Step-Voltage Regulators.

3. Definitions

For the purposes of this document, the following terms and definitions apply. The *IEEE Standards Dictionary Online* and IEEE Std C57.12.80¹¹ should be consulted for terms not defined in this clause.¹²

There are no definitions in this standard.

4. Ratings

4.1 Kilovoltampere ratings

Kilovoltampere ratings are continuous and are based on not exceeding either a 65 °C average winding temperature rise or an 80 °C hottest-spot temperature rise. The temperature rise of the insulating liquid shall not exceed 65 °C when measured near the top of the tank. Kilovoltampere ratings for single-phase and three-phase transformers shall be as shown in Table 1. These ratings are based on the usual temperature and altitude service conditions specified in IEEE Std C57.12.00.

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¹⁰ IEEE publications are available from The Institute of Electrical and Electronics Engineers (<https://standards.ieee.org/>).

¹¹ Information on references can be found in Clause 2.

¹² *IEEE Standards Dictionary Online* is available at: <http://dictionary.ieee.org>. An IEEE account is required for access to the dictionary, and one can be created at no charge on the dictionary sign-in page.

4.2 Voltage ratings and tap ratings

Voltage ratings for single-phase and three-phase transformers shall be in accordance with Table 2, Table 3, and Table 4. No taps are to be provided unless otherwise specified.

When specified, tap ratings for single-phase and three-phase transformers shall be in accordance with Table 5. All tap ratings shall be at rated kilovoltamperes, except as otherwise indicated. Voltages in Table 2, Table 3, and Table 4 are without taps.

4.3 Minimum percent impedance voltage

For each transformer design, the manufacturer shall determine the nominal impedance. The impedance of individual transformers shall be within the tolerance on impedance as specified in IEEE Std C57.12.00. The minimum nominal impedance shall be in accordance with Table 11, which applies to all distribution transformers with low-voltage ratings of 600 V and below. Two winding distribution transformers with low-voltage ratings above 600 V should be designed to withstand short circuits limited only by the impedance of the transformer. There is no requirement for ratings not shown in Table 11. The user may specify impedance limits other than those shown in Table 11.

5. Basic lightning impulse insulation levels and dielectric test levels

5.1 Basic lightning impulse insulation levels

The high-voltage basic lightning impulse insulation level (BIL) shall be as shown in Table 2, Table 3, and Table 4. The low-voltage BIL shall be in accordance with the minimum BIL levels specified for distribution transformers in IEEE Std C57.12.00.

5.2 Dielectric test levels

Dielectric test levels shall be in accordance with the distribution levels specified in IEEE Std C57.12.00.

6. Tests

6.1 General

Except as specified in 6.2, tests shall be performed as specified in IEEE Std C57.12.00 and in IEEE Std C57.12.90.

6.2 Dielectric tests

For single-phase transformers with a high-voltage BIL of 150 kV or less that have one high-voltage bushing and a high-voltage terminal permanently connected to ground, no applied-voltage test is required. Induced-voltage tests shall be performed by applying between the terminals of one winding a voltage that shall be developed from the high-voltage line terminals to ground. This voltage shall be 1000 V plus 3.46 times the rated transformer winding voltage, but in no case shall the line-to-ground voltage developed exceed 40 000 V for 125 kV BIL or 50 000 V for 150 kV BIL. For this test, the neutral terminal shall be grounded. An applied voltage test shall be applied on the low-voltage winding.

7. Construction

All practical interchangeability regarding connections to external terminals is desirable. Emphasis should be given to interchangeability of the low-voltage connections. Therefore, for the purpose of this standard, two principal reference locations have been established, as shown in Figure 1, Figure 2, and Figure 3. The first of these is a horizontal plane that passes through the top of the bolt slot in the upper support lug. For the second, the transformer cover has been divided into four segments. The segments are numbered in a clockwise direction with the centerline of Segment 1 on the centerline of the low-voltage bushings, as shown in Figure 1 and Figure 2.

All dimensions contained in this standard are derived from US Customary equivalents. Unless otherwise noted, all dimensions shall have a tolerance of ± 2 mm (0.063 in).

7.1 Bushings and terminals

7.1.1 Bushings

Electrical characteristics of transformer bushings shall be as listed in Table 6.

The type, number, location, and arrangement of bushings for single-phase and three-phase transformers shall be as shown in Figure 4, Figure 7, Figure 8, Figure 9, Figure 10, Figure 11, Figure 12, Figure 13, and Figure 14, and Table 7. For single position mounting only, the centerline of the high-voltage bushings shall be located within the shaded areas. The positions of high-voltage bushings for three-phase transformers need not be symmetrical. All bushings shall be of the sidewall or cover type and shall be individually mounted.

Unless otherwise specified, the color of bushings shall match Light Gray Number 70, Munsell Notation 5BG 7.0/0.4 as described in IEEE Std C57.12.31.

7.1.2 High-voltage terminals

Terminal details shall be as shown in Figure 5. High-voltage bushings of transformers 200 kV BIL and below shall be equipped with tinned, copper-alloy solderless eyebolt connectors. High-voltage terminal sizes shall be as shown in Table 8.

7.1.3 Low-voltage terminals

Terminal details shall be as shown in Figure 5. Low-voltage terminal sizes shall be as shown in Table 9. Terminals of low-voltage windings 600 V and below shall be arranged for vertical takeoff.

External spacing between low-voltage bushing terminals shall be such as to provide the maximum clearance between live metal parts in the working area. For low-voltage ratings above 600 V, the electrical characteristics of the bushings determine the spacing. For low-voltage ratings 600 V and below, spacing shall be within the limits of Table 10.

7.1.4 Neutral termination

On single-phase transformers having one high-voltage bushing, the H2 end of the winding shall be securely connected internally to the grounded clamping structure or the tank. This connection shall be independent of all other electrical connections.

On three-phase transformers, a fully insulated low-voltage neutral bushing, X0, shall be provided when the low-voltage windings are wye connected.

On T-connected three-phase transformers, a fully insulated low-voltage neutral bushing, X0, shall be provided when required by Figure 4. A fully insulated low-voltage neutral bushing, X4, is optional and should be provided only when specified by the user.

On three-phase transformers, a fully insulated high-voltage neutral bushing, H0, and a fully insulated low-voltage neutral bushing X0, shall be provided where wye-connected high-voltage windings are rated 8320Y V and below and low-voltage windings are rated 600Y/346 V and below.

On three-phase transformers, a common fully insulated low-voltage type neutral bushing, H0X0, shall be provided where wye-connected high-voltage windings are rated above 8320Y V and low-voltage windings are rated 600Y/346 V and below. The high-voltage and low-voltage neutrals shall be connected internally by a link that is accessible and capable of reconnection.

7.2 Accessory equipment

7.2.1 General

Accessory equipment shall be provided and located as shown in Figure 7 through Figure 14.

7.2.2 Tap changer for de-energized operation

Refer to Item 3 in Figure 7, Figure 8, Figure 9, Figure 10, Figure 11, Figure 12, Figure 13, and Figure 14. An externally operated tap changer for de-energized operation shall be provided on tapped transformers. Each tap changer position and the tap voltage or percentage associated with it shall be clearly identifiable by reference to nameplate information. All positions of the de-energized tap changer shall be operative positions.

The handle of the externally operated de-energized tap changer shall be brought out through the side of the tank in or near Segment 3, as shown in Figure 7 Figure 8, Figure 9, Figure 10, Figure 11, Figure 12, Figure 13, and Figure 14. It shall be designed to help prevent accidental operation by requiring a preliminary step before the tap setting can be changed. Position numbers or letters corresponding to the nameplate shall be clearly identifiable near the handle. There shall be located on or adjacent to the operating mechanism a written caution statement to de-energize the transformer before operating.

7.2.3 Series-multiple connections

Refer to Item 14 in Figure 7, Figure 8, and Figure 11. The series-multiple voltage-changing device may be an internally mounted terminal board or externally operated switch, unless one or the other is specified. Either device is for de-energized operation.

Internal terminal boards with movable links shall have all studs identified on the board, and the nameplate shall show the connections to be made for each voltage.

The handle of the externally operated switch shall be brought out through the side of the tank in or near Segment 3, as shown in Figure 7, Figure 8, and Figure 11. It shall be designed to indicate voltage position and to help prevent accidental operation by requiring a preliminary step before the voltage setting can be changed. Actual voltages or position numbers corresponding to the nameplate shall be clearly identifiable near the handle. There shall be located on or adjacent to the operating mechanism a written caution statement to de-energize the transformer before operating.