

American National Standard for Transformers — Used in Unit Installations, Including Unit Substations—Conformance Standard

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American National Standards Institute, Inc.

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Foreword

(This Foreword is not part of American National Standard C57.12.55-1987.)

The High Voltage Apparatus Coordinating Committee (HVACC) was established July 24, 1972 by the Electrical and Electronic Technical Advisory Board (now superseded by the Electrical and Electronic Standards Management Board) of the American National Standards Institute. The responsibility assigned to HVACC was to review and evaluate existing American National Standards and other related standards for the purpose of developing a “Draft Standard” for unit substations and to develop recommendations for (1) correlating requirements of these standards and (2) adding requirements to these standards appropriate for product evaluation.

This standard results from the evaluation of existing American National Standards and the need to add requirements to these standards for the evaluation and conformance certification of dry-type transformers. This document refers to the proposed revision of American National Standard for Dry-Type Transformers, ANSI/IEEE C57.12.01-1979 (now in preparation).

This document includes Appendixes A and B, outlining procedures recommended for qualifying insulation systems; related material is covered in American National Standard Test for Thermal Evaluation of Insulation Systems for Ventilated Dry-Type Power and Distribution Transformers, ANSI/IEEE C57.12.56-1984.

This standard is not intended to cover application, installation, or operation of dry-type transformers.

Transformers certified under this standard may contain accessories necessary for installation. For the conformance requirements for such accessories, reference should be made to the American National Standard for each specific accessory involved. Typical accessories of a pad-mounted installation are fuses, lightning arresters, circuit breakers, motor starter controls, and the like.

Suggestions for improvement of this standard will be welcome. They should be sent to the National Electrical Manufacturers Association, 2101 L Street, NW, Suite 300, Washington, DC 20037.

This standard was processed and approved for submittal to ANSI by the 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. At the time it approved this standard, the C57 Committee had the following members:

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C. R. Willmore, *Secretary*

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American National Standard for Transformers —

Dry-Type Transformers Used in Unit Installations, Including Unit Substations — Conformance Standard

1. Scope and Purpose

1.1 Scope

This standard describes certain electrical, mechanical, and safety requirements and conformance tests for dry-type distribution and power transformers and for autotransformers. These transformers may be either single-phase or polyphase, with ventilated, nonventilated, or sealed enclosures.

Such transformers may be remotely or integrally associated with primary or secondary switchgear or substations, or both. The range of transformers is 601 volts through 34 500 volts (either primary or secondary) in sizes of 1 kVA through 2 500 kVA. Such transformers are intended to be installed in accordance with the American National Standard National Electrical Code (ANSI/NFPA 70-1987). All manufacturers seeking certification under this standard should demonstrate that performance requirements have been met by performing the tests herein, by submitting data from earlier tests, by exhibiting proof of satisfactory field service, or by an appropriate combination of these methods. Families of insulation systems may be certified on the basis of tests performed on one representative model.

1.2 Exceptions

This standard applies to all dry type transformers except the following:

- 1) Instrument transformers
- 2) Step-voltage and induction voltage regulators
- 3) Current regulators
- 4) Arc furnace transformers
- 5) Rectifier transformers
- 6) Specialty transformers
- 7) Mine transformers
- 8) Motor starting reactors and transformers
- 9) Transformers utilizing insulation systems other than conventional varnish impregnated systems

This standard excludes transformers under the exclusive control of electrical utilities and used for communication, metering, generation, control, transformation, transmission, and distribution of electric energy regardless of whether such transformers are located indoors in buildings and rooms used exclusively by utilities for such purposes, or outdoors on property owned or leased, established rights on private property, or on public rights of way (highways, streets, roads, and the like).

2. Referenced Standards

2.1 American National Standards

This standard is intended to be used in conjunction with the following American National Standards. When these standards are superseded by a revision approved by the American National Standards Institute, Inc, the revision shall apply.

ANSI C57.12.70-1978, Terminal Markings and Connections for Distribution and Power Transformers

ANSI/IEEE C57.12.01-1979, General Requirements for Dry-Type Distribution and Power Transformers

ANSI/IEEE C57.12.56-1984, Test for Thermal Evaluation of Insulation Systems for Ventilated Dry-Type Power and Distribution Transformers

ANSI/IEEE C57.12.80-1978 (R1986), Terminology for Power and Distribution Transformers

ANSI/IEEE C57.12.91-1979, Test Code for Dry-Type Distribution and Power Transformers

ANSI/IEEE 99-1980, Preparation of Test Procedures for the Thermal Evaluation of Insulation Systems for Electric Equipment

ANSI/IEEE 100-1984 Dictionary of Electrical and Electronics Terms

ANSI/NEMA MG2-1977, Safety Standard for Construction and Guide for Selection, Installation, and Use of Electric Motors and Generators

ANSI/NFPA 70-1987, National Electrical Code

ANSI/UL 347-1985, High Voltage Industrial Control Equipment

2.2 Other Standards

This standard is also intended to be used in conjunction with the following publications:

NEMA TR 1-1980, Transformers, Regulators, and Reactors

MIL-STD-209C-1968, Swinging Eyes and Attachments for Lifting and Tying Down Military Equipment

3. Transformer Requirements

The requirements for dry-type transformers that are used in unit substations or that are pad mounted shall be in accordance with ANSI/IEEE C57.12.01-1979 and ANSI/IEEE C57.12.91-1979.

The recommended procedure for thermal evaluation of the insulation system is covered by ANSI/IEEE C57.12.56-1984 and Appendixes A and B of this standard.

4. Enclosures

4.1 Definition

An enclosure is a surrounding case or housing used to provide a degree of protection to conductors or equipment and to provide a degree of protection to persons against contacting live parts.

4.2 Categories

The categories of indoor and outdoor enclosures shall be as follows:

4.2.1 Category “A” Indoor or Outdoor Enclosures: Category “A” indoor or outdoor enclosures are intended (1) for ground level use in installations subject to deliberate, unauthorized acts by members of the unsupervised general

public and (2) primarily to provide a degree of protection against contact with the enclosed equipment. These enclosures shall meet the requirements given for Category A enclosures in Table 1.

4.2.2 Category “B” Indoor or Outdoor Enclosures: Category “B” indoor or outdoor enclosures are intended (1) for use in installations not subject to deliberate, unauthorized acts by members of the unsupervised general public and (2) primarily to provide a degree of protection to unauthorized and untrained personnel against incidental contact with the enclosed equipment. These enclosures shall meet the requirements given for Category B enclosures in Table 1.

4.2.3 Category “C” Indoor or Outdoor Enclosures: Category “C” indoor or outdoor enclosures are intended (1) for use in installations in secured areas generally inaccessible to unauthorized and untrained persons and (2) to provide a degree of protection against contact with the enclosed equipment. These enclosures shall meet the requirements given for Category C enclosures in Table 1.

4.2.4 Sealed Enclosures: Sealed enclosures shall be in accordance with ANSI C57.12.01-1979.

Table 1— Requirements for Category A, B, and C Enclosures

Feature	Reference Sections	Required for Categories		
		A	B	C
All Enclosures				
Enclosure security	5.3	Yes	Not Applicable	Not Applicable
Basic enclosures requirements	5	Yes	Yes	Yes
Rigidity (sheet metal)	5.1.1; 5.2.3	Yes	Yes	Not Applicable
Exposed live parts permissible	5.1.9	No	No	Yes
Operating handles	5.1.16	Locked Cover	No	No
Operating handles - height	5.1.16	78 inches Maximum	78 inches Maximum	78 inches Maximum
Vent openings - “line of sight” restriction	5.1.10; 5.1.11	Not Applicable	Yes	No
Doors (if supplied)	5.1.4	Yes	Yes	Yes
Doors - handles lockable	5.1.4	Yes	Yes*	No
Doors - captive fasteners	5.1.4	Not Applicable	Yes*	No
Hinge pins - no removable door	5.1.4	Yes	No	No
Lifting provisions	5.1.2	Yes	Yes	Yes
Gages, valves, etc - locked cover	5.1.18	Yes	No	No
Guards for exposed fan blades	5.1.19	Not Applicable	Yes	Not Applicable
Caution and warning signs	8	Yes	Yes	Yes
Outdoor Enclosures				
Material	6.1	Yes	Yes	Yes
Hinges	6.1	Yes	Yes	Yes
Gaskets	6.1	Yes	Yes	Yes
Doorstop	6.1	Yes	Yes	Yes
Types and design tests	6.2	Yes	Yes	Yes
Tests				
Spray test	7.1	All Types	All Types	All Types
Dust test	7.2	Types 103, 103S, 104	Types 103, 103S, 104	Types 103, 103S, 104
External-icing (sleet) test	7.3	All Types	All Types	AllTypes
Hosedown	7.4	Type 104	Type 104	Type 104
Corrosion resistance	7.5	Types 103, 103S,104	Types 103, 103S,104	Types 103, 103S,104

*Either lockable handles or captive fasteners, but not both, are required.

5. Enclosures — Basic Requirements

5.1 Construction

5.1.1 General

If of metal, enclosures shall be suitably supported, constructed, and assembled so that they will have the strength and rigidity necessary to resist the abuses to which they are likely to be subjected, without total or partial collapse that may result in an increased fire hazard due to reduction of spacings, loosening or displacement of parts, or other serious defects. Nonmetallic materials may be used as all or part of an enclosure if found suitable for the application and shall otherwise comply with 5.1.1. Among the factors to be taken into consideration when a nonmetallic material is being judged for acceptability are the following: (1) physical strength, (2) resistance to impact, (3) moisture-absorptive properties, (4) combustibility, (5) ground plane between high voltage and enclosure, and (6) resistance to distortion at temperatures to which it may be subjected under conditions of normal and abnormal use. These factors are considered with respect to thermal aging. The enclosure shall be capable of withstanding the tests specified in this standard that are applicable to the location and environmental conditions to which it will be exposed.

5.1.2 Lifting Provisions

Lifting provisions shall provide a distributed balanced lift in a vertical direction for the assembled transformer and shall be designed to provide a safety factor of five or more. The safety factor of five is the ratio of the ultimate stress of material used to the working stress.¹ The working stress is the maximum combined stress developed in the lifting provisions by the static load of the completely assembled transformer.²

A spreader bar may be required to lift the complete unit.

If lifted from the core and coil by removing the top cover, the maximum angle of lift (measured from vertical) shall be 30 degrees.

5.1.3 Protection of Inside and Outside Surfaces

Unless the enclosure is of a material that will resist corrosion, both inside and outside surfaces shall be suitably protected by painting, galvanizing, plating, or other equivalent means.

5.1.4 Covers and Doors

If an enclosure cover is not of the drawout construction type but gives access to fuses or any other overload-protective devices the normal functioning of which requires renewal, or if it is necessary to open the cover in connection with the normal operation of the device, the cover shall be hinged.

Exception: Fuses for instrument transformers, internal fans, and the like may be behind bolted covers.

A part of the enclosure such as a door, cover, or panel giving access to the inside of the enclosure shall be provided with fasteners for firmly securing it in place. Such fasteners shall be so located or used in multiple so as to hold the door or cover closed over its entire length. A hinged cover more than 48 inches (1219 millimeters) long on the hinged side shall have at least a two-point latch operated by a single knob or handle or shall have at least two captive fasteners.

¹Taken from American National Standard Safety Standard for Construction and Guide for Selection, Installation, and Use of Electric Motors and Generators, ANSI/NEMA MG2-1977, paragraph MC 2-2-03, Lifting Means.

²Taken from Specification MIL-STD-209C, Swinging Eyes and Attachments for Lifting and Tying Down Military Equipment, August I, 1968. MIL publications are available from the Navy Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120.

The opening handles for doors in Category A and B enclosures shall be lockable. However, captive fasteners are permitted on Category B enclosures. Exposed hinge pins shall be nonremovable on doors of Category A enclosures or, as an alternative, the door shall be nonremovable in the closed position.

A door or cover shall shut closely against a 1/4-inch (6.4-millimeter) rabbet (as shown in Figure 1) or the equivalent, or shall have a minimum overlap of 1/2 inch, or shall have flanges for the full length of the four edges. Flanges on a door or cover shall fit closely with the outside walls of the enclosure proper and shall not be less than 7/16 inch (11.1 millimeters) in depth. A suitable combination of flange and rabbet is acceptable. Figure 2 illustrates typical constructions that are considered to comply with this requirement. Other constructions may be suitable.

Cover plates intended to be removed for inspection and maintenance of energized parts and wiring shall not exceed 12 square feet (1.11 square meters) in area or 60 pounds (27.2 kilograms) in weight unless they are equipped with lifting means or hinges.

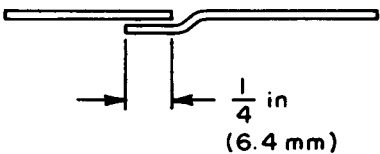


Figure 1 —Rabbet

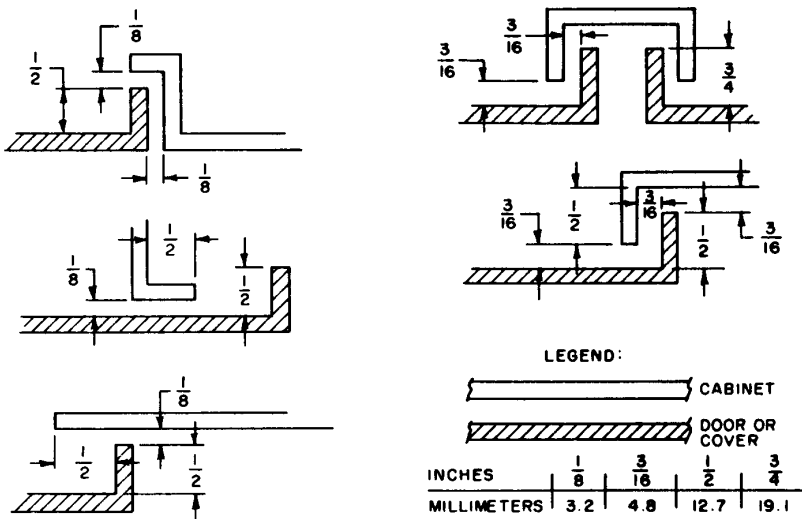


Figure 2 —Typical Constructions

5.1.5 Cast-Metal Enclosures

An enclosure of cast metal shall be at least 1/8 inch (3.2 millimeters) thick at every point, greater than 1/8 inch (3.2 millimeters) thick at reinforcing ribs and door edges, and not less than 1/4 inch (6.4 millimeters) thick at tapped holes for conduit.

Exception: At other than plain or threaded conduit holes, die-cast metal shall be:

- 1) Not less than 3/32 inch (2.4 millimeters) thick for an area greater than 24 square inches (0.015 square meters) or having any dimensions greater than 6 inches (152 millimeters).
- 2) Not less than 1/16 inch (1.6 millimeters) thick for an area of 24 square inches (0.015 square meters) or less and having no dimensions greater than 6 inches (152 millimeters). The area limitation may be obtained by the provision of suitable reinforcing ribs subdividing a larger area.

5.1.6 Sheet-Metal Enclosures

The thickness of a sheet-metal enclosure shall not be less than that indicated in Tables 2 and 3 except (1) that uncoated steel shall not be less than 0.032 inch (0.81 millimeter) thick, zinc-coated steel shall not be less than 0.034 inch (0.86 millimeter) thick, and nonferrous metal shall not be less than 0.045 inch (1.14 millimeter) thick at points at which a wiring system is to be connected, and (2) as indicated in 5.2.1 and 5.2.3.

Tables 2 and 3 are based on a uniform deflection of the enclosure surface for any given load concentrated at the center of the surface regardless of metal thickness.

Table 2— Minimum Thickness of Sheet Metal for Enclosures of Carbon Steel or Stainless Steel

Without Supporting Frame*		With Supporting Frame or or equivalent Reinforcing*		Minimum Thickness in Inches (millimeters)	
Maximum Width [†] in Inches (millimeters)	Maximum Length [‡] in Inches (millimeters)	Maximum Width [†] in Inches (millimeters)	Maximum Length [‡] in Inches (millimeters)	Uncoated	Zinc-Coated
4.0 (101)	Not limited**	6.25 (159)	Not limited**	0.020 ^{††} (0.51) ^{††}	0.023 ^{††} (0.058) ^{††}
4.75 (121)	5.75 (146)	6.75 (171)	8.25 (210)		
6.0 (152)	Not limited	9.5 (241)	Not limited	0.026 ^{††} (0.66) ^{††}	0.029 ^{††} (0.74) ^{††}
7.0 (178)	8.75 (222)	10.0 (254)	12.5 (318)		
8.0 (203)	Not limited	12.0 (305)	Not limited	0.032 (0.81)	0.034 (0.86)
9.0 (229)	11.5 (292)	13.0 (330)	16.0 (406)		
12.5 (318)	Not limited	19.5 (495)	Not limited	0.042 (1.07)	0.045 (1.14)
14.0 (356)	18.0 (457)	21.0 (533)	25.0 (635)		
18.0 (457)	Not limited	27.0 (686)	Not limited	0.053 (1.35)	0.056 (1.42)
20.0 (508)	25.0 (635)	29.0 (737)	36.0 (914)		
22.0 (559)	Not limited	33.0 (838)	Not limited	0.060 (1.52)	0.063 (1.60)
25.0 (635)	31.0 (787)	35.0 (889)	43.0 (1092)		
25.0 (635)	Not limited	39.0 (991)	Not limited	0.067 (1.70)	0.070 (1.78)
29.0 (737)	36.0 (914)	41.0 (1041)	51.0 (1295)		
33.0 (838)	Not limited	51.0 (1295)	Not limited	0.080 (2.03)	0.084 (2.13)
38.0 (965)	47.0 (1194)	54.0 (1372)	66.0 (1676)		
42.0 (1067)	Not limited	64.0 (1626)	Not limited	0.093 (2.36)	0.097 (2.46)
47.0 (1194)	59.0 (1499)	68.0 (1727)	84.0 (2134)		
52.0 (1321)	Not limited	80.0 (2032)	Not limited	0.108 (2.74)	0.111 (2.82)
60.0 (1524)	74.0 (1880)	84.0 (2134)	103.0 (2616)		
63.0 (1600)	Not limited	97.0 (2464)	Not limited	0.123 (3.12)	0.126 (3.20)
73.0 (1854)	90.0 (2286)	103.0 (2616)	127.0 (3226)		

*See 5.1.7 for supporting frame.

[†]The width is the smaller dimension of a rectangular sheet metal piece that is part of an enclosure. Adjacent surfaces of an enclosure may have supports in common and be made from a single sheet.

[‡]For panels that are not supported along one side (for example, side panel of boxes) the length of the unsupported side shall be limited to the dimensions specified.

***"Not limited" applies only if the edge of the surface is flanged at least 1/2 inch (12.7 mm) or fastened to adjacent surfaces not normally removed in use.

^{††}Sheet steel for an enclosure for outdoor use (rainproof or raintight) is required to be not less than 0.034 inch (0.86 mm) in thickness if zinc-coated and not less than 0.032 inch (0.81 mm) in thickness if uncoated.