American National Standard for Transformers —

Ventilated Dry-Type Network Transformers 2500 kVA and Below, Three-Phase, with High-Voltage 34 500 Volts and Below,Low-Voltage 216Y/125 and 480Y/277 Volts -Requirements

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The Institute of Electrical and Electronics Engineers, Inc.
3 Park Avenue, New York, NY 10016-5997, USA

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American National Standard

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Foreword

(This Foreword is not part of American National Standard C57.12.57-1987.)

A survey of the Edison Electric Institute (EEI) and National Electrical Manufacturers Association (NEMA) indicated a need for standards on ventilated dry-type network transformers.

This new standard was developed by a task-force working group consisting of EEI and NEMA delegates under the C57.12.4 Subcommittee on Underground and Secondary Networks.

This standard incorporates the technical requirements of ANSI C57.12.40-1982, Requirements for Secondary Network Transformers, Subway and Vault Types (Liquid Immersed), and ANSI/IEEE C57.12.01-1979, General Requirements for Dry-Type Distribution and Power Transformers, into a composite standard that serves the needs for dry-type network transformers. Since dry-type network units can operate with liquid network units, this standard incorporates the basic lightning impulse insulation level (BIL), impedance, voltage, and other technical requirements of ANSI C57.12.40-1982. It allows as alternates those technical characteristics and values associated with ANSI/IEEE C57.12.01-1979 and ANSI C57.12.51-1981, Requirements for Ventilated Dry-Type Power Transformers 501 kVA and Larger, Three-Phase with High-Voltage 601 to 34 500 Volts, Low-Voltage 208Y/120 to 4160 Volts, when specified or deemed more appropriate.

The applicable rules and procedures of ANSI for preparation and approval of voluntary consensus standards were followed. These rules specify procedures for voting, review, and attempted reconciliation of dissenting viewpoints, a 60-day public review period, and approval by ANSI's Board of Standards Review.

This American National Standard is a voluntary consensus standard. Its use becomes mandatory only when required by a duly constituted legal authority or when specified in a contractual relationship. To meet specialized needs and to allow innovation, specific changes are permissible when mutually determined by the user and the producer, provided such changes do not violate existing laws and are considered technically adequate for the function intended.

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

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. At the time it approved this standard, the C57 Committee had the following members:

John Nay, *Chair*
Charles H. White, *Secretary*
Ronald Chittim, *Cosecretary*

Organization Represented	Name of Representative
Bonneville Power Administration	(Representation Vacant)
Electric Light and Power Group	Roger Ensign
Institute of Electrical and Electronics Engineers	John C. Dutton
National Electrical Manufacturers Association	Roy E. Uptegraff, Jr
Naval Facilities	H.P. Stickley
Rural Electrification Administration	J.C. Arnold, Jr
Tennessee Valley Authority	L.R. Smith
Underwriters Laboratories	T. O'Grady
U.S. Bureau of Reclamation	F.W. Cook, Sr
U.S. Department of Energy	J.C. Arnold, Jr
Western Area Power Authority	D.R. Torgerson

Subcommittee C57.12.4 on Underground and Secondary Networks, which developed and approved this standard, had the following members:

C. R. Murray, *Chair*
R. Hansen , *Secretary*
J. J. Nay, *(Chair, Working Group C57.12.57)*

D.A. Barnard
E.A. Bertolini
J. DiDonato *(Alt)*
H. Ederegger
R.L. Evans
K. T. Ginthwain
C. E. Griffith
J. W. Howard
T. Massouda
C. R. Murray
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P. E. Orehek
F. Perri *(Alt)*
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CLAUSE PAGE

CLAUSE PAGE

Part II: Other Requirements or Alternatives That May Be Specified for Some Applications

American National Standard
for Transformers –

Ventilated Dry-Type Network Transformers 2500 kVA and Below, Three-Phase, with High-Voltage 34 500 Volts and Below, Low-Voltage 216Y/125 and 480Y/277 Volts - Requirements

1. Scope

1.1

This standard is intended to set forth characteristics relating to performance, limited electrical and mechanical interchangeability, and safety of the equipment described herein, and to assist in the proper selection of such equipment.

1.2

This standard describes certain electrical and mechanical characteristics and takes into consideration certain safety features of three-phase, 60-Hz, two-winding, ventilated dry-type network transformers generally used for step-down purposes, high-voltage 34 500 volts and below; low-voltage 216Y/125 and 480Y/277 volts with self-cooled ratings 2500 kVA and smaller. Forced-air ratings are listed in Part II.

1.3

This standard does not apply to other types of transformers, such as specialty, sealed dry-type, pad-mounted dry-type, liquid-immersed, instrument, regulating, furnace, mine, and rectifier transformers. Transformers with high voltage 600 volts or less are excluded.

1.4

As used in this standard, the word "shall" indicates mandatory requirements, and the words "should" and "may" refer to matters that are recommended and permissive, respectively, but not mandatory.

NOTE — The Foreword of this standard describes the circumstances under which the document may be used on a mandatory basis.

1.5

Part I of this standard describes electrical and mechanical requirements. Part II describes other requirements or alternatives that may be specified.

2. Referenced American National Standards

2.1 General

All requirements, definitions, and tests, except as specifically covered in this standard, shall be in accordance with the American National Standards listed below. Standards are identified by designation and year (for example, ANSI/IEEE C57.12.01-1979). When a referenced American National Standard is superseded by a revision approved by the American National Standards Institute, Inc, the revision shall apply.

ANSI B1.1-1982, Unified Inch Screw Threads (UN and UNR Thread Form)

ANSI C57.12.40-1982, Requirements for Secondary Network Transformers, Subway and Vault Types (Liquid Immersed)

ANSI C57.12.50-1981, Requirements for Ventilated Dry-Type Distribution Transformers 1 to 500 kVA, Single-Phase, and 15 to 500 kVA, Three-Phase, with High-Voltage 601 to 34 500 Volts, Low-Voltage 120 to 600 Volts

ANSI C57.12.51-1981, Requirements for Ventilated Dry-Type Power Transformers 501 kVA and Larger, Three-Phase, with High-Voltage 601 to 34 500 Volts, Low-Voltage 208Y/120 to 4160 Volts

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

ANSI C62.2-1981, Guide for the Application of Valve-Type Surge Arresters for Alternating-Current Systems

ANSI C84.1-1982, Voltage Ratings (60 Hz) for Electric Power Systems and Equipment

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

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

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

ANSI/IEEE C57.13-1978, Requirements for Instrument Transformers

ANSI/IEEE C57.94-1982, Recommended Practice for Installation, Application, Operation, and Maintenance of Dry-Type General Purpose Distribution and Power Transformers

ANSI/IEEE C57.105-1978, Guide for Application of Transformer Connections in Three-Phase Distribution Systems

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

2.2 Terminology

Transformers terminology as set forth in ANSI/IEEE C57.12.80-1978 shall apply. Other electrical terms are defined in ANSI/IEEE 100-1984.

Part I: Basic Electrical and Mechanical Requirements

(See Part II for other requirements or alternatives that may be specified.)

3. Usual Service Conditions

Service conditions shall be in accordance with those described in ANSI/IEEE C5.12.01-1979.

4. Ratings and Characteristics

4.1 Kilovolt-Ampere Ratings

Kilovolt-ampere ratings are continuous and based on not exceeding an 80°C average winding temperature rise, as measured by resistance, and the transformers shall be provided with a 150°C rise insulation system (220°C limiting temperature) as defined in ANSI/IEEE C57.12.01-1979.

Self-cooled (AA) kilovolt-ampere sizes shall be 300, 500, 750, 1000, 1500, 2000, and 2500 kVA.

4.2 Voltage Ratings and Tap Ratings

Preferred voltage ratings are shown in Table 1.

Tap ratings shall be in accordance with Table 1. All taps shall be at rated kVA.

Table 1— Preferred Voltage Ratings

Preferred Nominal System Voltage	Transformer High-Voltage				kVA Ratings for Low-Voltage Ratings of	
			Taps			
	Rating	kV Class	Above	Below	216Y/125	480Y/277
2 400/4 160Y	4 160	5	None	None	300–1000	500–1000
	4 160Y/2 400*	5	None	None	300–1000	500–1000
7 200	7 200	8.6	None	7 020/6 840/6 660/6 480	300–1000	–
12 000	12 000	15	None	11 700/11 400/11 100/10 800	300–1000	500–2500
			12 600/12 300	11 700/11 400	–	500–2500
13 200 or 7 620/13 200Y	13 200	15	None	12 870/12 540/12 210/11 880	300–1000	–
			13 860/13 530	12 870/12 540	–	500–2500
	13 200Y/7 620*	15	None	12 870/12 540/12 210/11 880	300–1000	–
			13 860/13 530	12 870/12 540	–	500–2500
14 400	14 400	15	None	14 040/13 680/13 320/12 960	300–1000	–
			15 120/14 760	14 040/13 680	–	500–2500
23 000	22 900	25	24 100/23 500	22 300/21 700	500–1000	500–2500
34 500	34 400	34.5	36 200/35 300	33 500/32 600	500–1000	500–2500

*High-voltage and low-voltage neutrals are internally connected by means of a removable link.

NOTES:

1 — All high-voltage windings are delta connected unless otherwise indicated.

2 — Unsymmetrical excitation or loading of wye-wye connected units may cause heating on their enclosure in excess of that which would be produced by balanced conditions. To reduce the probability of this enclosure heating, such units shall be provided with a construction that will not cause magnetic saturation when 33 percent zero sequence voltage is applied.

3 — Kilovolt-ampere ratings separated by a dash indicate that all intervening ratings covered in this standard are included.

4.3 Line Terminal Insulation Levels

High-voltage line terminal insulation levels shall be as shown in Table 2. Low-voltage line terminal insulation levels shall be as shown in Table 3.

Table 2— High-Voltage Line Terminal Insulation Levels

Rated Nominal High Voltage (volts)	kV Class	Basic Lightning Impulse Insulation Level (BIL) (kV)	Low-Frequency Voltage Insulation Level (kV, rms)
2400	2.5	45	15
4160	5	60	19
4800	5	60	19
6900	8.66	75	26
7200	8.66	75	26
12 000	15	95	34
13 200	15	95	34
13 800	15	95	34
23 000	25	125	40
34 500	34.5	150	50

NOTE — All voltages are delta unless otherwise indicated.

Table 3— Low-Voltage Line Terminal Insulation Levels

Rated Low Voltage (volts)	Basic Lightning Impulse Insulation Level (BIL) (kV)	Low-Frequency Voltage Insulation Level (kV, rms)
216Y/125	10	4
480Y/277	10	4

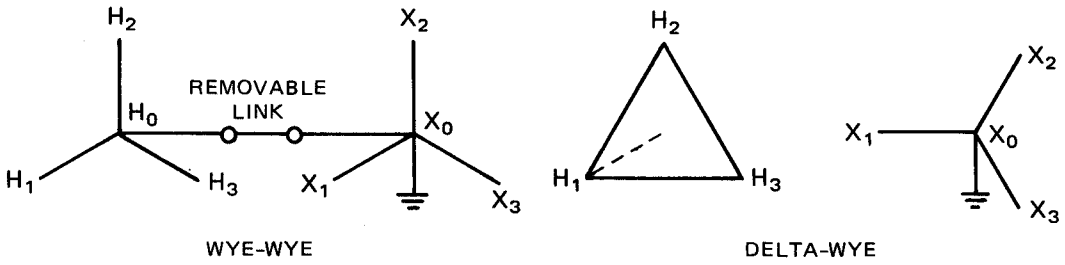
4.4 Angular Displacement and Terminal Markings

4.4.1 Angular Displacement

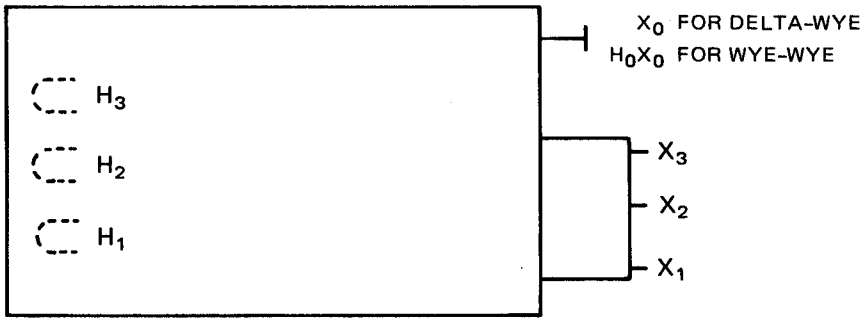
The angular displacement between high-voltage and low-voltage terminal voltages of three-phase transformers with delta-wye connections shall be 30 degrees, with the low voltage lagging the high voltage. The angular displacement between high-voltage and low-voltage terminal voltages of three-phase transformers with wye-wye connections shall be 0 degrees. Phasor relations shall be as shown in Figure 1.

4.4.2 Terminal Markings

Terminal markings shall be in accordance with Figure 1.



(a)
Angular Displacement



(b)
Terminal Markings

Figure 1— Angular Displacements and Terminal Markings

4.5 Percent Impedance

The percent impedance on the rated voltage connection shall be 5.0 percent for transformers 1000 kVA and smaller and 7.0 percent for transformers above 1000 kVA.

4.6 Audible Sound Levels

Transformers shall be designed so that the average sound level does not exceed the values given in Table 4 or Table 5, measured according to ANSI/IEEE C57.12.91-1979.

Table 4— Audible Sound Level Ratings up through 15 kV Class [Self-Cooled (AA)] *

Self-Cooled (AA) Ratings (kVA)	Average Sound Level (decibels)
300	55
500	56
750	57
1000	58
1500	60
2000	61
2500	62

*In view of the relatively little experience industry has had in building and applying dry-type transformers above 15 kV high voltage, no consensus regarding standard sound level values has yet been established. Such sound levels should be determined by discussion between users and manufacturers until experience is available to determine consensus values.

Table 5— Audible Sound Level Ratings up through 15 kV Class [Forced-Air-Cooled (AA/FA)]*

Self-Cooled (AA) Ratings (kVA)	Forced-Air-Cooled (AA)/(FA) Ratings (kVA)	Average Sound Level (decibels)
300	400	59
500	667	60
750	1000	61
1000	1333	62
1500	2000	65
2000	2667	66
2500	3333	67

*In view of the relatively little experience industry has had in building and applying dry-type transformers above 15 kV high voltage, no consensus regarding standard sound level values has yet been established. Such sound levels should be determined by discussion between users and manufacturers until experience is available to determine consensus values.

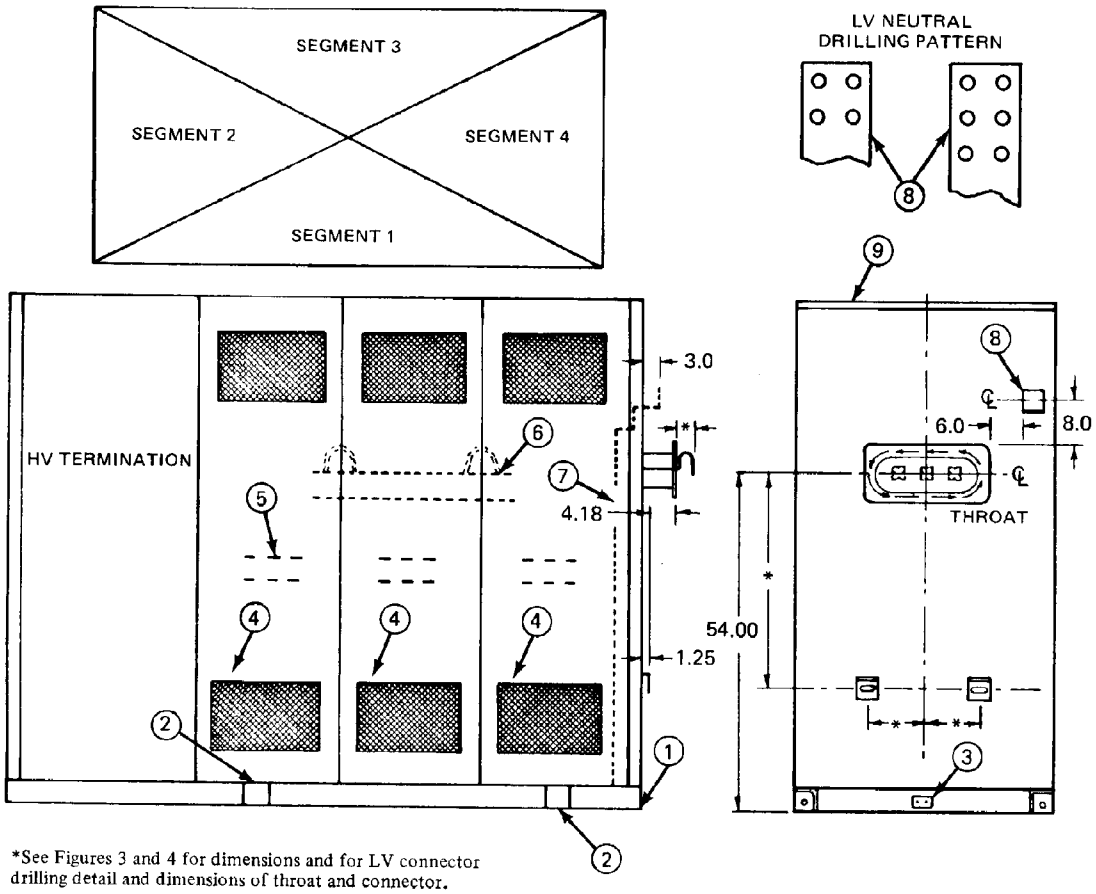
5. Construction (See Figure 2)

5.1 Insulation System

The insulation system of the transformer shall be suitable for operation at the limiting temperature associated with the kilovolt-ampere rating (see Section 4 or 9, as appropriate).

5.2 Accessory Location

Preferred locations of accessories, connections, compartments, and the like are given in Figure 2 and its referenced paragraphs.



*See Figures 3 and 4 for dimensions and for LV connector drilling detail and dimensions of throat and connector.

NOTE: Dimensions are in inches.

Item Number	Section Reference	Description
1	5.8.4	Transformer base designed for moving by rolling or skidding in either direction.
2	5.8	Lifting, jacking, and towing facilities shall be designed to provide a 5:1 safety factor. When lifting, a spreader bar shall be required to prevent enclosure damage.
3	5.9	Ground pads – One each on base centerline of Segments 2 and 4.
4	5.7	Removable panels for access to change voltage taps. The actual number of panels may vary.
5	4.2 (Table 1)	Voltage taps.
6	5.8.2.2	Internal lifting devices for core and coils.
7	5.6.1.2	Low-voltage neutral to base ground with provisions for being disconnected.
8	5.6.1.1	External neutral terminal (see drilling pattern above).
9	6.1	Drip-resistant top cover.

Figure 2— Dry-Type Network Transformer (LV Throat on End of Segment 4, HV on End of Segment 2)

5.3 Nameplate

A nameplate shall be provided in accordance with the requirements of ANSI/IEEE C57.12.01-1979, modified to include the words "network transformer." The nameplate shall be located on the front wall in segment 1.

5.4 High-Voltage Components

5.4.1 Location

All high-voltage components shall be located in segment 2 (see Figure 2).

NOTE: In view of the limited availability and experience industry has in building and applying high-voltage switches to dry-type network transformers, discussion between users and manufacturers in the application of switches is required until consensus develops.

5.4.2 High-Voltage Connections

Provisions for high-voltage connections shall be made on or near the top, and the type of termination shah be specified by the user.

5.5 Low-Voltage Components

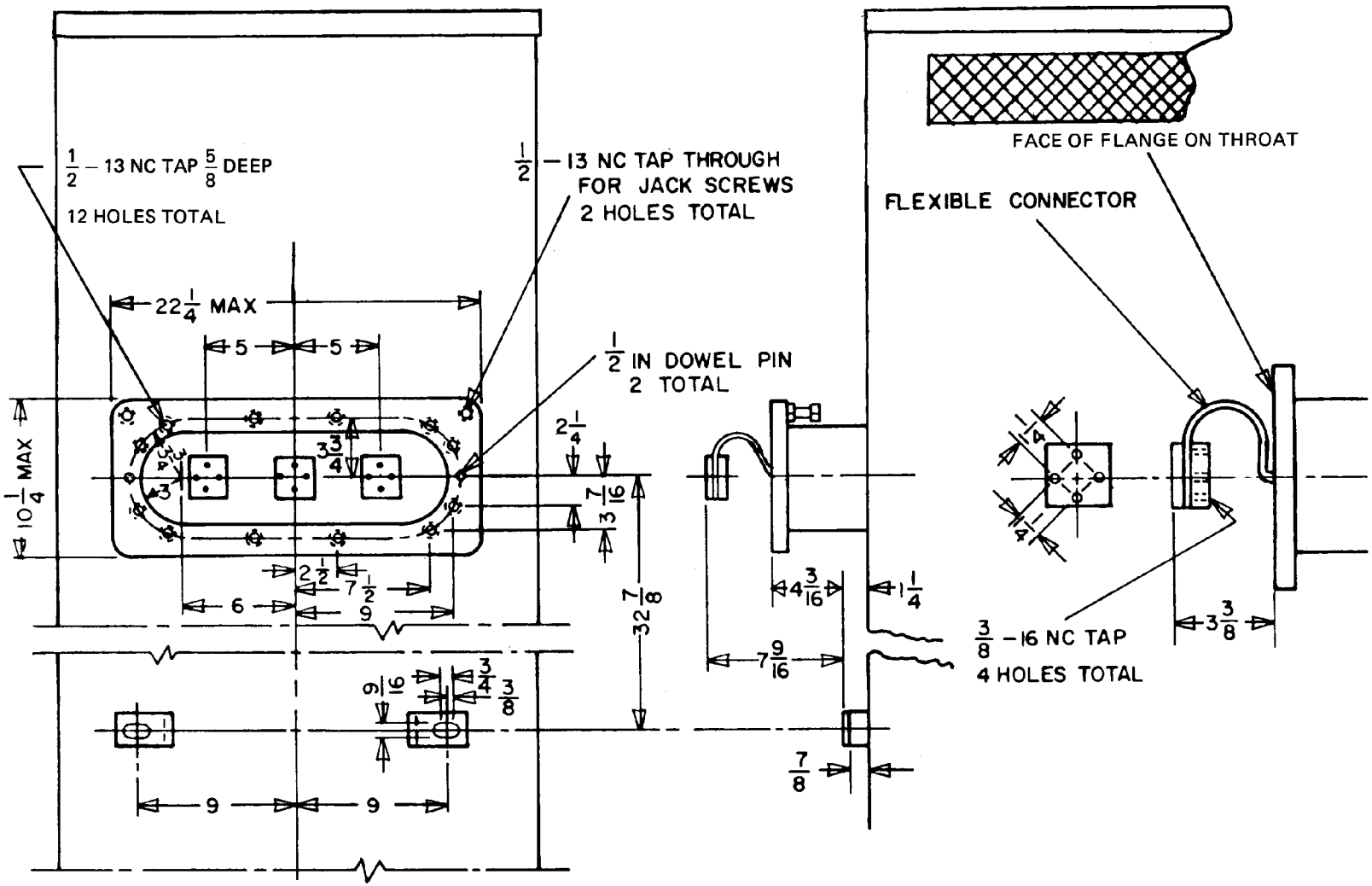
5.5.1 Location

All low-voltage components shall be located in segment 4 (see Figure 2).

5.5.2 Connections

5.5.2.1

Provisions shall be made for mounting, supporting, and making connections to a nonsubmersible network protector, with drillings according to Figure 3 or 4.



NOTE: All dimensions are in inches.

Figure 3— Transformer Throat for Mounting Network Protector
(Low-Voltage 216Y/125 Volts, 300–500 kVA; Low-Voltage 480Y/277 Volts, 500–1000 kVA)

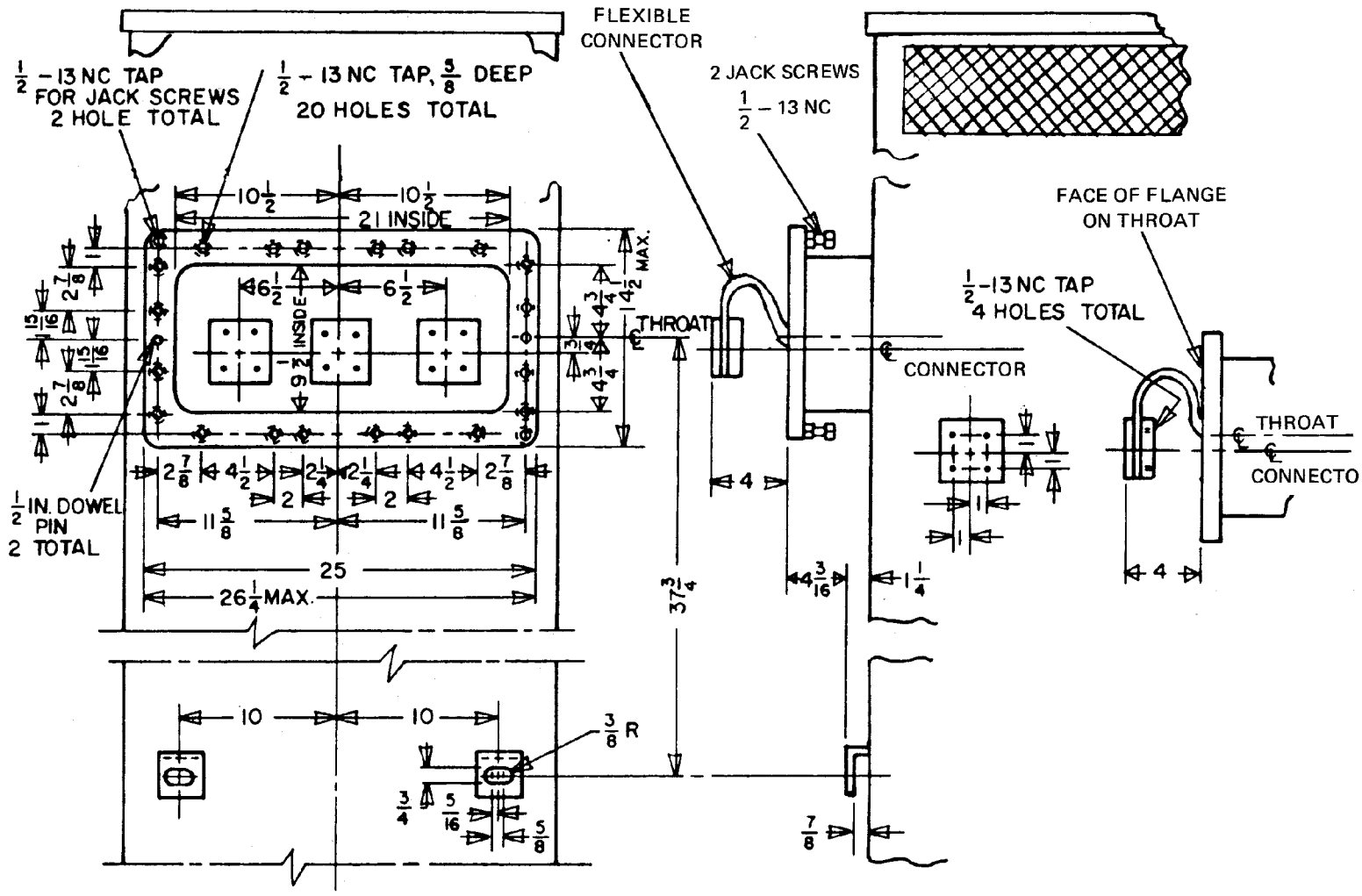


Figure 4— Transformer Throat for Mounting Network Protector
(Low-Voltage 216Y/125 Volts, 750–1000 kVA; Low-Voltage 480Y/277 Volts, 1500–2500 kVA)

5.5.2.2

Low-voltage connections shall be mounted in a flanged throat suitable for connecting to a network protector. Connection spacing, throat dimensions, terminal details and application shall be as follows:

Low-Voltage Ratings (kVA)		
216Y/125 Volts	**480Y/277 Volts**	**Figure Number**
300, 500	500, 750, 1000	3
750, 1000	1500, 2000, 2500	4

A gasket shall be provided for use between the throat and the protector.

5.5.2.3

Flexible connectors shall be provided.

5.5.3 Network Protector Mounting

The height of the centerline for the network protector throat shall be 54 inches above the floor.

5.6 Neutral Termination

5.6.1 Low-Voltage Neutral

5.6.1.1

The neutral shall be located as shown in Figure 2. The current rating of the neutral terminal shall be not less than that of the low-voltage phase connection. The terminal shall project upward and be provided with 9/16-inch holes with 1-3/4-inch centers as follows:

Low-Voltage Ratings (kVA)		
216Y/125 Volts	**480Y/277 Volts**	**Number of Holes**
300, 500, 750	500, 750, 1000, 1500	4
1000	2000, 2500	6

A provision shall be made for disconnecting the winding neutral at the neutral terminal.

5.6.1.2

The neutral of the low-voltage windings shall be connected to a ground pad on the inside base structure. An external ground pad shall be provided directly opposite the internal ground pad, as shown in Figure 2.

5.6.2 High-Voltage Neutral

Transformers having wye-connected high-voltage windings shall have the high-voltage neutral internally connected to the low-voltage neutral with provision for opening the connection for testing.

5.7 Tap Changing

Facilities shah be furnished for changing taps with the transformer de-energized and shall be either physically marked or described on the nameplate. Taps shall be accessible through a removable panel.

5.8 Lifting, Jacking, and Moving Facilities

5.8.1 Safety Factor

Lifting, jacking, and moving facilities shall be designed to provide a safety factor of five or more. The safety factor is the ratio of the ultimate stress of the material used to the working stress. The working stress is the maximum combined stress developed in the lifting, jacking, or moving facilities by the static load of the component being lifted or moved.

5.8.2 Lifting Facilities

5.8.2.1

Lifting points shall provide a balanced lift to prevent overturning. The bearing surfaces of lifting facilities shall be free from sharp edges and shall be provided with a hole having a minimum diameter of 2.0 inches.

NOTES:

1 — Depending on the design and the manufacturer's instructions, it may be necessary to have the cover in place when lifting, or it may be necessary to remove the cover to engage the lifting cables with the lifting facilities. The design shall be such that no transformer electrical wiring shall be removed for lifting or moving.

2 — A spreader bar shall be required to prevent enclosure damage if lifting from the base or side structure, as specified in the manufacturer's instructions.

5.8.2.2

A minimum of two lifting points shall be provided for lifting the core and coil assembly separately, using one lifting cable at each lifting point.

5.8.2.3

A minimum of four lifting points shall be provided for lifting the transformer assembly. Facilities shall be designed for lifting using one cable at each lifting point, with a maximum cable angle of 30 degrees with respect to the vertical.

5.8.3 Jacking Facilities

Jacking facilities shall be provided in the vicinity of the four corners of the base.

5.8.4 Base Structure

The base structure shall be designed for moving the transformer by rolling or skidding in either direction parallel to the centerlines of the transformer.

5.8.5 Tilting

The points of support shall be so located that the center of gravity of the transformer as prepared for shipment will not fall outside these points of support for a tilt of the base of 15 degrees or less from the horizontal.

5.9 Ground Pads

Grounding provisions shall consist of two external copper-faced-steel or stainless-steel pads with two holes horizontally spaced on 1-3/4-inch centers, drilled and tapped for 1/2-inch 13-UNC thread (see ANSI B1.1-1982). The minimum thickness of the copper facing shall be 0.015 inch. The minimum threaded depth of holes shall be 1/2 inch. The ground pads shall be welded to the base structure and shall be located at the centerlines of the high-voltage and low-voltage ends of the transformer in the respective segments. The ground pads shall be electrically bonded together. Thread protection for the ground pads shall be provided.

6. Transformer Enclosure

6.1 Enclosure

The enclosure shall be noncombustible, moisture resistant, protected against corrosion, and self. supporting, and all enclosure parts shall be fastened to other enclosure parts.

Panels of two sides of the enclosure shall be removable to permit inspection, cleaning, maintenance, and maintenance testing of the core and coil assembly.

6.2 Top Cover

The top cover of the enclosure shall be so constructed that the transformer operation is not impaired when the top cover is subjected to falling moisture or dirt.

6.3 Ventilating Opening

A ventilating opening in an enclosure shall prevent the insertion of a straight rod having a diameter of 0.500 inch, except that if the distance between the opening and the nearest not fully insulated live part is greater than indicated in Table 6, the opening may permit the entry of a rod having a diameter greater than 0.500 inch, but not greater than 0.750 inch. A barrier may be placed between an opening and live parts to comply with this requirement. If used, a barrier shall be so located that it intercepts all live parts from the line of sight through the opening protected.

Exception: An opening above the upper edge of the enclosure side wall, but under the overhang of the top, is acceptable if by means of its size, barrier, and the like, it will prevent a straight rod 0.500 inch in diameter from approaching any live part inside the enclosure by a distance not less than the clearance indicated in Table 6.

Table 6— Ventilation Opening Clearances

kV Class	Clearance (inches)
1.2	4
2.5	5
5	5.5
8.7	6.5
15	8
25	11
34.5	15

6.4 Low-Voltage Throat Barrier

A barrier shall be provided over the opening of the transformer enclosure and low-voltage throat.

7. Routine Tests

Routine tests shall be made in accordance with ANSI/IEEE C57.12.01-1979 and ANSI/IEEE C57.12.91-1979.

8. Tolerances

Tolerances on ratio, impedance, and losses shall be in accordance with ANSI/IEEE C57.12.01-1979.

Part II: Other Requirements or Alternatives That May Be Specified for Some Applications

(See Part I for basic electrical and mechanical requirements.)

NOTE — Certain specific applications have transformer requirements not covered in Part I. Part II comprises descriptions of the most frequently used requirements for such transformers. They shall be provided only when specified in conjunction with Part I requirements, or where applicable, as alternatives to Part I requirements.

9. Other Ratings and Characteristics

9.1 Forced-Air-Cooled Ratings

When specified, forced-air-cooled (AA/FA) kilovolt-ampere ratings for three-phase transformers shall be as shown in Table 5. Kilovolt-ampere ratings are continuous and based on not exceeding the specified winding temperature rise limits described in 4.1, 9.2, or 9.3.

WARNING NOTE: Maximum transformer rating may exceed maximum protector ampere rating.

9.2 40°C Average Ambient Temperature Conditions

When specified, the transformer shall be designed for operation in a location in which the maximum. temperature of the cooling air (ambient temperature) does not exceed 50°C at any time, and the average temperature of the cooling air for any 24-hour period does not exceed 40°C.

When this increased ambient temperature is specified, the kilovolt-ampere continuous rating of 4.1 shall be based on not exceeding a 70°C average winding rise, as measured by resistance (220°C limiting temperature).

9.3 Other Winding Temperature Rises and Insulation Systems

When specified, other winding temperature rises and insulation systems shall be provided (see ANSI/IEEE C57.12.01-1979).

9.4 Other Performance Characteristics

9.4.1 Percent Impedances

When specified, other percent impedances shall be provided.

9.4.2 Sound Levels

When specified, other audible sound levels for Class AA or AA/FA ratings shall be provided.

9.4.3 Other High-Voltage Ratings

9.4.3.1

When specified, other high-voltage ratings shall be provided in accordance with Table 7.

Table 7— Other Voltage Ratings

kV Class	Range of Other Voltage Ratings (line-to-Line) (volts)	kVA Ratings for Low-Voltage Ratings of 216Y/125	kVA Ratings for Low-Voltage Ratings of 480Y/277
2.5	2160–2500	300–750	500–750
5	2501–4800	300–1000	500–1000
8.66	4801–8600	300–1000	500–2500
15	8601–14 400	300–1000	500–2500
25	14 401–24 940	300–1000	500–2500
34.5	24 941–34 500	300–1000	500–2500

NOTES:

(1) All high-voltage voltages are delta.

(2) Voltages separated by a dash indicate that all intervening voltages are included.

(3) The high-voltage ratings in Table 2 may be specified without taps or with four rated kVA equally spaced voltage taps. The total tap range shall not exceed 10 percent or the total percent tap voltage range of the transformers of the same voltage class listed in Table 1, whichever is greater. The percent tap range shall be calculated as follows:

$$\text{Percent tap range} = \frac{(\text{Maximum tap voltage} - \text{Minimum tap voltage})\,100}{\text{Rated tap voltage}}$$

9.4.3.2

When specified, the high-voltage winding shall be furnished without taps.

9.4.4 Neutral Connections

9.4.4.1

When specified, for wye-wye connected units, the high-voltage neutral shall be brought out of the enclosure through a separate connection or bushing and grounded externally.

9.4.4.2

When specified, an insulated low-voltage neutral shall be provided. It shall be insulated for the low-voltage line terminal insulation level, as shown in Table 3.

9.4.5 Other Basic Lightning Impulse Insulation Levels (BILs)

When specified, other basic lightning impulse insulation levels shall be provided in accordance with ANSI/IEEE C57.12.01-1979.

9.5 High-Voltage Components

9.5.1 Location

When specified, high-voltage components shall be located in other segments (see Figure 2).

9.5.2 High-Voltage Switch

When specified, a high-voltage switch shall be provided.

9.5.3 High-Voltage Connections

When specified, provisions for high-voltage connections shall be located on the side or bottom.

9.6 Low-Voltage Components

9.6.1 Location

When specified, low-voltage components shall be located in other segments (see Figure 2).

9.6.2 Low-Voltage Connections

9.6.2.1

When specified, transformers shall be supplied without provisions for mounting, supporting, or making connections to a nonsubmersible network protector.

9.6.2.2

When specified, transformers shall be supplied with provisions for mounting, supporting, and making connections to a submersible network protector with drillings, according to Figure 3 or 4.

9.6.2.3

When specified, other low-voltage connections shall be provided.

10. Other Features

10.1 Surge Arresters

When specified, high-voltage or low-voltage surge arresters shall be connected to the base structure ground.

10.2 Temperature Devices

10.2.1 Winding Temperature Simulator or Hot-Spot Device

When specified, a calibrated winding temperature simulator or hot-spot device shall be furnished.

10.2.2 Contacts

When specified, fixed or adjustable nongrounded contacts shall be provided. The contacts rated at a minimum of 250 volts for devices (for example, alarms, instruments, and controls) shall be suitable for interrupting:

1) 0.02-ampere direct-current inductive load
2) 0.20-ampere direct-current noninductive load
3) 2.5-ampere alternating-current load (either non-inductive or inductive)

10.3 Forced-Air-Cooling

10.3.1

When specified, fans and equipment for automatic control of fans from a winding temperature simulator or hot-spot device shall be furnished. When fans and equipment are supplied, power and overcurrent protection for the fans and their circuits shall also be provided. Unless otherwise specified, the voltage for fan motors shall be 120 volts, single phase. The fan motors shall not utilize a centrifugal switch. The audible sound levels with forced-air-cooling shall not exceed the values stated in Table 5.

10.3.2

When specified, terminations shall be provided to accommodate power from an external, 120 volt, single-phase source.

10.4 Provisions for Future Forced-Air-Cooling

When specified, Class AA transformers shall be designed with provision for the future addition of fans to obtain the kilovolt-ampere ratings described in 9.1 and shall include a temperature device for control of fans.

10.5 Space Heaters

When specified, manually or automatically switched, or thermostatically controlled space heaters shall be provided. Power will be provided from an external source.

10.6 Terminal Blocks

When specified, enclosed terminal blocks for auxiliary equipment shall be provided.

10.7 Ventilation Opening

When specified, other types of ventilation openings shall be provided.

10.8 Network Protector Throat Heights

When specified, other network protector throat heights shall be provided.

10.9 Other Lifting Facilities

10.9.1

When specified, lifting provisions shall be at the top of the enclosure.

10.9.2

When specified, lifting provisions shall accommodate lifting the entire transformer assembly (for example, network protector, high-voltage switches, and other components).

11. Other Tests

When specified, other tests shall be in accordance with ANSI/IEEE C57.12.01-1979.