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IEEE Standards

C57.12.34™

IEEE Standard Requirements for Pad-Mounted, Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers (2500 kVA and Smaller)—High-Voltage: 34 500 GrdY/19 920 Volts and Below; Low-Voltage: 480 Volts and Below

IEEE Power Engineering Society

Sponsored by the
Transformers Committee

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Transformers Committee
of the
IEEE Power Engineering Society

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Abstract: Certain electrical, dimensional, and mechanical characteristics are set forth as well as certain safety features of three-phase, 60 Hz, mineral-oil-immersed, self-cooled, pad-mounted, compartmental-type distribution transformers. These transformers are rated 2500 kVA and smaller, with high-voltages of 34 500 GrdY / 19 920 volts and below, and with low-voltages of 480 volts and below. This standard covers the connector, bushing and terminal arrangements for radial or loop feed systems. This standard does not cover the electrical and mechanical requirements of any accessory devices that may be supplied with the transformer.
Keywords: compartmental, connector arrangements, loop, pad mounted, radial, three phase, three-phase pad-mounted distribution transformers, transformer

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Introduction

This introduction in not part of IEEE Std C57.12.34-2004, IEEE Standard Requirements for Pad-Mounted Comparmental-Type, Self-Cooled, Three-Phase, Distribution Transformers (2500 kVA and Smaller)—High-Voltage: 34 500 GrdY/19 920 Volts and Below; Low-Voltage: 480 Volts and Below.

The Accredited Standards Committee on Transformers, Regulators, and Reactors, C57 has for many years been developing standards on transformers, regulators, and reactors. The data has been obtained from many sources, including the standards of the Institute of Electrical and Electronics Engineers (IEEE) and the National Electrical Manufactures Association (NEMA), reports of committees of the Edison Electrical Institute, and others.

This standard was prepared by the Working Group of the Subcommittee on Distribution Transormers, Three Phase, Pad-Mounted, and is a revision and combination of IEEE Std C57.12.22-1987 and IEEE Std C57.12.26-1992.

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At the time this standard was completed. The Three-Phase Pad-Mounted Distribution Transformer Working Group.

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Stephen Shull, *Vice-Chair*

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Sam Michael
Dan Mulkey
Robert Olen
Tim Olson
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Donnie Trivitt
Alan Wilks
William Wimmer

The following members of the individual balloting committee voted on this standard. Balloters may have voted for approval, disapproval, or abstention.

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Edward Bertolini
Wallace Binder
Alain Bolliger
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Peter Clarke
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1. Overview

1.1 Purpose

This standard is intended for use as a basis for determining performance, interchangeability, and safety of the equipment covered, and to assist in the proper selection of such equipment.

1.2 Scope

This standard covers certain electrical, dimensional, and mechanical characteristics and takes into consideration certain safety features of three-phase, 60 Hz, mineral-oil-immersed, self-cooled, pad-mounted, compartmental-type distribution transformers. These transformers are rated 2500 kVA and smaller, with high-voltages of 34 500 GrdY/ 19 920 volts and below, and with low-voltages of 480 volts and below. These transformers are generally used for step-down purposes from an underground primary cable supply. This standard covers the connector, bushing and terminal arrangements for radial or loop feed systems. Either certain minimum dimensions (see Figures 1, 2, 3, 7, 8, and 11) or certain specific dimensions (see Figures 4, 5, 6, 9, 10, and 12) shall be specified. This standard does not cover the electrical and mechanical requirements of any accessory devices that may be supplied with the transformer.

NOTE—Refer to latest USA federal regulations concerning PCB contamination in transformers.[1]

[1] Notes in text, tables, and figures are given for information only and do not contain requirements needed to implement this standard.

2. Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments or corrigenda) applies.

ANSI C57.12.20, American National Standard for Overhead-Type Distribution Transformers, 500 kVA and Smaller: High-Voltage, 34 500 Volts and Below; Low-Voltage, 7970/13 800Y Volts and Below.[2]

ANSI 57.12.28, American National Standard—Pad-Mounted Equipment—Enclosure Integrity.

IEEE Std 386™, IEEE Standard for Separable Insulated Connector Systems for Power Distribution Systems above 600 V.[3, 4]

IEEE Std C57.12.00™, IEEE Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers.

IEEE Std C57.12.70™, IEEE Standard for 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.

3. Definitions

For the purposes of this standard, the following terms and definitions apply. IEEE 100, *The Authoritative Dictionary of IEEE Standards Terms*, Seventh Edition, should be referenced for terms not defined in this clause.

3.1 safety factor: The ratio of the ultimate stress of the material used in the lifting provisions to the working stress.

3.2 working stress: The maximum combined stress developed in the lifting provisions by the static load of the completely assembled transformer.

4. Ratings

4.1 Kilovolt-ampere ratings

Kilovolt-ampere ratings are for continuous operation and based on not exceeding either a 65°C average winding temperature rise or an 80 °C hot-spot conductor temperature rise. The temperature rise of the insulating oil shall not exceed 65°C when measured near the top of the tank. These kilovolt-ampere ratings

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are based on the usual temperature and altitude service conditions specified in IEEE Std C57.12.00.[5] The kilovolt-ampere ratings shall be as follows:

Kilovolt-ampere ratings	
75	750
112.5	1000
150	1500
225	2000
300	2500
500	--------

4.2 Voltage ratings

Voltage ratings shall be in accordance with Table 1 of this standard.

4.3 Tap ratings

When specified, high-voltage taps shall be as given in Table 2 of this standard. The tap changer handle or the area next to the handle in the terminating compartment shall be marked indicating suitability for de-energized operation only.

5. Basic lightning impulse insulation levels

Basic lightning impulse insulation levels (BILs) shall be in accordance with Table 1, Table 3, and Table 4 of this standard.

6. Dielectric test levels

Dielectric test levels shall be in accordance with the distribution levels in Table 5 of IEEE Std C57.12.00.

7. Impedance voltage

7.1 Nominal percent impedance voltage

The percent impedance voltage, as measured on the rated voltage connection, shall be as follows:

Rating (kVA)	Impedance Voltage (%)
75	1.10 – 5.75 [a]
112.5 – 300	1.40 – 5.75 [a]
500	1.70 – 5.75 [a]
750 – 2500	5.75 nominal

[a] The minimum impedance listed above may produce available fault currents greater than the interrupting rating of down line equipment.

[5] Information on references can be found in Clause 2.

7.2 Tolerance on impedance voltage

The tolerance on nominal impedance voltages shall be as specified in 9.2 of IEEE Std C57.12.00.

7.3 Tolerance on impedance voltage on a tap

The percent departure of the tested impedance voltage on any tap from the tested impedance voltage at rated voltage shall not be greater than the total tap voltage range and shall be expressed as a percentage of the rated voltage.

8. Tests

8.1 General

Except as specified in 8.2 of this standard, tests shall be performed as specified in IEEE Std C57.12.00 and IEEE Std C57.12.90.

8.2 Dielectric tests

For wye-wye connected transformers, no applied voltage test is required on the high-voltage winding. An induced voltage test shall be performed as specified in IEEE Std C57.12.90. The voltage induced between the high-voltage line terminals and ground shall be the lower of the following values:

a) 3.46 times the rated high-voltage winding voltage plus 1000 volts, or

b) The applied voltage test values provided in IEEE Std C57.12.00, Table 5.

9. Construction

9.1 General

A pad-mounted, compartmental-type transformer shall consist of a tank with high-voltage and low-voltage cable terminating compartments, as shown in Figures 3 and 6 or Figures 8 and 10 of this standard. The compartment shall be separated by a barrier of metal or other rigid material.

9.2 Compartment configuration

The high-voltage and low-voltage compartments shall be located side-by-side on one side of the transformer tank. When viewed from the front, the low-voltage compartment shall be on the right.

9.3 Access

Each compartment shall have a door so constructed as to provide access to the high-voltage compartment only after the door to the low-voltage compartment has been opened. There shall be one or more additional captive fastening devices that must be disengaged before the high-voltage door can be opened. Where the low-voltage compartment door is of a flat panel design, the door shall have three-point latching with a handle provided for a locking device. The compartment doors shall be of sufficient size to provide adequate operating and working space when removed or open. The doors shall either be equipped for latching in the open position or designed for manual removal.

9.4 Enclosure security and coating system

The transformer tank and compartment shall conform to ANSI C57.12.28 and be so constructed as to limit disassembly, breakage, and prying open of any doors, panels, and sills when the doors are in the closed and locked position.

9.5 Pad attachment

The bottom edges of the compartments shall be so constructed as to provide for the use of hold-down devices which are accessible only from the inside the compartments.

9.6 Lifting

The construction of the unit shall be such that it can be lifted, skidded, or slid, or any combination of these, into place on the mounting surface without disturbing the high-voltage or low-voltage cables.

a) Jack bosses or jacking facilities shall be provided on the tank. The vertical clearance for a jack shall be 38 mm (1.5 inches) minimum, 165 mm (6.5 inches) maximum.

b) The transformer shall be arranged for rolling in two directions; parallel to and at right angles to one side of the transformer.

c) The transformer shall be provided with lifting provisions permanently attached and arranged on the tank to provide a distributed balanced lift in a vertical direction for the completely assembled transformer and shall be designed to provide a safety factor of five.

9.7 Connectors, bushings and terminals

9.7.1 Electrical characteristics

The electrical characteristics of the completely assembled high-voltage connectors, high-voltage bushings and low-voltage terminals shall be as shown in Tables 3 and 4 of this standard.

9.7.2 High-voltage terminals

9.7.2.1 General

The number, location, and arrangement of the high-voltage terminals shall be as shown in Figures 1, 2, 3, 4A, 4B, 5A, 5B, 5C, 6, 7, 8, 9, or 10.

9.7.2.2 Repairability

The high-voltage terminals, whether bushing wells and bushing inserts, integral bushings, or bushings, shall be externally replaceable. The inside terminal connections shall be externally removable through the connector’s opening in the transformer tank, or accessible through a hand hole to permit removal and replacement.

9.7.2.3 High-voltage terminals using separable insulated high-voltage connectors

The high-voltage connectors shall consist of either bushing wells and bushing inserts, or integral bushings, as specified. Cable accessory parking stands shall be provided. For specific details concerning high-voltage separable connectors and cable accessory parking stands, refer to IEEE Std 386. Separable insulated high-voltage connectors that are designed for operation after the transformer is in place shall be located so that they can be operated with hot-line tools.

9.7.2.4 High-voltage terminals using high-voltage bushings

High-voltage bushings shall have tin plated copper alloy clamp-type connectors arranged for vertical take-off. The clamp connectors shall accommodate No. 6 AWG solid to 250 kcmil stranded conductors.

9.7.2.5 High-voltage neutral terminal

When provided, the high-voltage neutral bushing may be two insulation classes below that of the phase bushings.

9.7.3 Low-voltage terminals

9.7.3.1 General

The low-voltage phase and neutral terminals shall be in accordance with Figures 3, 6, 8, 10, 11(a), 11(b), 12(a) or 12(b) of this standard and arranged for vertical take-off. Terminal dimensions shall be as shown in Figures 13(a) of this standard or, if specified, 13(b) of this standard.

9.7.3.2 Support

Low-voltage terminals equipped with ten hole spades shall be furnished with additional support. A manufacturer designed support shall be attached at the end that is the farthest from the tank wall and mounted in such a way that it will not interfere with the use of any of the ten holes of the spade.

9.7.3.3 Repairability

The low-voltage bushings shall be externally replaceable. The inside terminal connections shall be externally removable through the connector’s opening in the transformer tank, or accessible through a hand hole to permit removal and replacement.

9.7.3.4 Low-voltage neutral terminal

The low-voltage neutral shall be either a blade connected directly to the tank or a fully insulated terminal. If a fully insulated terminal is used, a ground pad shall be provided on the outer surface of the tank. One or more removable ground straps suitably sized for the short-circuit rating of the transformer as defined in IEEE Std C57.12.00 shall be provided and connected between the low-voltage neutral terminal and the ground pad. For wye-wye connected units, the high-voltage neutral shall be connected to the low-voltage neutral internally with provisions for opening this connection for testing.

9.7.4 Designations

Connector, bushing, and terminal designations shall be as defined in IEEE Std C57.12.70.

9.8 Instruction nameplate

9.8.1 Location

The instruction nameplate shall be located in the low-voltage compartment and shall be readable with the cables in place. When the nameplate is mounted on a removable part, the manufacturer's name and transformer serial number shall be permanently affixed to a non-removable part.

9.8.2 Information

The nameplate information shall conform to IEEE Std C57.12.00; nameplate A for 500 kVA or below; nameplate B for all other ratings. The high-voltage BIL, angular displacement as shown in Figure 14 of this standard, and identification of the bushing and terminal connections as shown in the applicable figures of this standard shall be displayed on the nameplate.

9.9 Oil preservation

9.9.1 Tank construction

The transformer shall be of sealed-tank construction. The transformer shall remain effectively sealed for a top-oil temperature of –5 °C to +105 °C continuous and under operating conditions as described in IEEE Std C57.91.

9.9.2 Pressure relief

A replaceable valve shall be provided to relieve pressures that build up slowly in excess of normal operating pressures. These excess pressures may be due to overloads, high ambient temperatures, external secondary faults, and incipient faults in the low-voltage winding. When relieving these excess pressures, the valve shall emit only a negligible amount of oil. The valve shall be furnished in the low-voltage compartment on the tank wall above the 140°C top oil level, by the manufacturer's calculation, and shall be located so as not to interfere with use of the low-voltage terminals or the operating handle of the low-voltage circuit breaker. The inlet port shall be ¼ inch or larger NPT (or NF thread with gasket), sized for a specified minimum flow rate. Exposed parts shall be of weather and corrosion-resistant materials. Gaskets and O-rings shall withstand oil vapor and a 105°C temperature continuous under operating conditions as described in IEEE Std C57.91, without seizing or deteriorating, for the life of the transformer. The valve shall have a pull ring for manually reducing pressure to the atmosphere using a standard hook-stick and shall be capable of withstanding a static pull force of 112 newtons (25 lb.) for one minute without permanent deformation. The valve shall withstand a static force of 445 newtons (100 lb.) for one minute applied normal to its longitudinal axis at the outermost extremity of the body. When specified, the venting port, on the outward side of the valve head set, shall be protected to prevent entry of dust, moisture, and insects before and after the valve has actuated; or a weather-cap-type indicator shall be provided, which will remain attached to the valve and provide positive indication to an observer that the valve has operated. Venting and sealing characteristics shall be as follows:

Cracking pressure: 69 kPa(gage) ±13 kPa(gage) (10 psig ± 2 psig)

Resealing pressure: 42 kPa(gage) (6 psig) minimum

Zero leakage from resealing pressure to –56 kPa(gage) (–8 psig)

Flow at 103 kPa (gage): 16.5 L/s minimum of air at a standard temperature and pressure. Standard temperature is 21°C and standard pressure is 101 kPa (absolute) (Flow at 15 psig: 35 SCFM minimum where SCFM is flow at cubic feet per minute, corrected for an air pressure of 14.7 psi and an air temperature of 21°C.)

9.10 Tanks

9.10.1 Strength

The tank shall be of sufficient strength to withstand a gage pressure of 50 kPa (7 psig) without permanent distortion; and 103 kPa (15 psig) without rupturing or affecting cabinet security as described in ANSI C57.12.28.

9.10.2 Pressure testing and oil access

A 1-inch NPT upper plug (or cap) for filling and pressure testing shall be provided in the low-voltage compartment. A 1-inch NPT drain plug (or cap) for transformers rated 75-500 kVA and a 1-inch NPT drain valve with built-in sampling device for transformers rated 750-2500 kVA shall be provided in the low-voltage compartment. Suitable means for indicating the correct liquid level at 25°C shall be provided.

9.10.3 Removable covers

If a removable cover or handhole covers are exposed, they shall be secured in such a way as to conform to ANSI C57.12.28.

9.11 Grounding provisions

9.11.1 500 kVA and below

Two steel pads, each with a ½ inch - 13 UNC tapped hole and a minimum thread depth of 11 mm (0.44 inches) shall be provided.

9.11.2 Above 500 kVA

Two unpainted, copper-faced steel or stainless steel pads, 51 x 89 mm (2.0 x 3.5 inches) each with two holes spaced on 44 mm (1.75 inch) centers and tapped for ½ inch - 13 UNC thread shall be provided. The minimum thickness of the copper facing shall be 0.5 mm (0.02 inch). Minimum thread depth of the holes shall be 13 mm (0.5 inch).

9.11.3 Location

The ground pads described in 9.11.1 and 9.11.2 shall be welded on or near the transformer base, one in the high-voltage compartment and one in the low-voltage compartment. In cases where the transformer tank and compartments are separate, these pads shall be electrically bonded.

9.11.4 Lightning arrester attachment

When designed in accordance with Figure 7 or 9 of this standard, mounting provisions for surge arresters shall consist of six steel pads with ½ inch - 13 UNC tapped holes 11 mm (0.44 inch) deep, or ½ inch - 13 UNC studs, 25 mm (1.0 inch) long, located in the high-voltage compartment.

9.12 Components for loop primary cable systems

The minimum current-carrying capabilities of components for looped primary systems shall be 200 amperes (continuous current rating) and 10,000 amperes rms symmetrical for 0.17 second (short-time current rating) for transformers with or without high-voltage switching.

10. Storage

The transformer shall be stored in a vertical position on its base and shall remain essentially in that position at all times, including transport to the site and during installations.

11. Installation

Equipment manufactured to this specification may be installed in areas where environmental and climatic conditions make operation at varying angles of tilt from the horizontal an important consideration. Under these circumstances, the users may wish to make a particular "angle of tilt" part of their specifications.

12. Other requirements that may be specified for some applications

Certain specific applications call for transformer requirements not covered in Clause 4 through Clause 11. They shall be met only when specified in conjunction with the requirements of Clause 4 through Clause 11. These specific requirements may change the dimensions in Figures 4A, 4B, 5A, 5B, 5C, 6, 9, 10 and 12 of this standard. They are not included in this standard in order to avoid the implication of great or lesser availability by listing some and omitting others.

Table 1—Range of kVA and voltage ratings

High-voltage rating Delta or wye [a] (V)	Minimum BIL (kV)	Rating (kVA)	
		For low-voltage rating 208Y/120 [a] or 240 volts	For low-voltage rating 480Y/277 [a] or 480 volts
2 400	45	75– 750	75 – 750
4 160 [c]	60	75 – 1000	75 – 1500
4 800 [c]	60	75– 1000	75 – 2000
7 200 [c]	75	75– 1000	75 – 2500
12 000	95	75 –1000	75 – 2500
12 470	95	75– 1000	775 – 2500
13 200	95	75 – 1000	75 – 2500
13 800	95	75 – 1000	75 – 2500
16 340	95	75 – 1000	75 – 2500
Grounded wye [a]			
22 860GrdY/13 200	125	75 – 1000	75 – 2500
23 900GrdY/13 800	125	75 – 1000	75 – 2500
24 940GrdY/ 14 400	125	75 – 1000	75 – 2500
34 500GrdY/19 920 [b]	150	75 – 1000	75 – 2500

NOTE —Kilovolt-ampere ratings separated by a dash indicate that all ratings covered in this range as shown in 4.1 of this standard are included.

[a] Unsymmetrical excitation or loading of Y-Y connected units may cause heating of their tanks in excess of that which would be produced by balanced conditions. To reduce the probability of tank heating, such units shall be provided with a core construction that will not saturate when 33% zero-sequence voltage is applied.

[b] When specifying 125 kV BIL, adequate grounding and surge protection studies should be made.

[c] IEEE Std 386 should be consulted for complete connector ratings.

Table 2—High-voltage taps

75 –500 kVA		High-voltage rating (V)	750 – 2500 kVA
For low-voltage rating 208Y/120, 240 [a] 480Y/277, or 480 volts			For low-voltage rating 208Y/120, 240 480Y/277, or 480 volts
Above high-voltage rating	Below high-voltage rating		
2 @ 2.5% each	2 @ 2.5% each	2 400	2 520 / 2 460 / 2 340 / 2 280
		4 160	4 370 / 4 265 / 4 055 / 3 950
		4 800	5 040 / 4 920 / 4 680 / 4 560
		7 200	7 560 / 7 380 / 7 020 / 6 840
		12 000	12 600 / 12 300 / 11 700 / 11 400
		12 470	13 090 / 12 780 / 12 160 / 11850
		13 200	13 860 / 13 530 / 12 870 / 12 540
14 400 / 14 100 / 13 500 / 13 200		13 800	14 400 / 14 100 / 13 500 / 13 200
17 200 / 16 770 / 15 910 / 15 480		16 340	17 200 / 16 770 / 15 910 / 15 480
2 @ 2.5% each	2 @ 2.5% each	22 860GrdY/13 200	24 010 / 23 430 / 22 290 / 21 720
		23 900GrdY/13 800	25 100 / 24 500 / 23 300 / 22 710
		24 940GrdY/14 400	26 190 / 25 570 / 24 320 / 23 690
		34 500GrdY/ 19 920	36 230 / 35 370 / 33 640 / 32 780
NOTE —Kilovolt-ampere ratings separated by a dash indicate that all ratings covered in this range as shown in 4.1 of this standard are included.			

[a] Transformers with a 208Y/120 low-voltage rating may be specified with 4 – 2.5% taps below the high-voltage rating.

Table 3—Electrical characteristics and minimum electrical clearances of high-voltage bushings and low-voltage terminals

Transformer voltage	BIL [b,c] (kV)	60-Hz Dry-one-minute withstand [b,c] (kV)	Minimum clearance – live parts [a]		
			Phase to Ground [c]	Phase to Phase [c]	Phase to Nonhygrosocopic Insulating Barrier
208Y/120, 240	30	10	25 (1.0)	25 (1.0)	
480Y/277, 480	30	10	25 (1.0)	25 (1.0)	
2 400	45	15	51 (2.0)	51 (2.0)	
4 160 to 4 800	60	21	64 (2.5)	64 (2.5)	
7 200	75	27	89 (3.5)	102 (4.0)	76 (3.0)
12 000 to 16 340	95	35	127 (5.0)	140 (5.5)	76 (3.0)
22 860 GrdY to 24 940 GrdY	125	42	146 (5.75)	159 (6.25)	76 (3.0)
34 500 Grd Y [b]	150	70	203 (8.0)	229 (9.0)	102 (4.0)
NOTE —All dimensions are in millimeters (inches).					

[a] These dimensions should be increased wherever possible to allow for ease in making connections by the user.

[b] The use of barriers shall not reduce these electrical characteristics.

[c] Where clearances are less than those shown, an adequate nonhygroscopic insulating barrier shall be provided.

Table 4—Electrical characteristics and ratings of high-voltage connectors

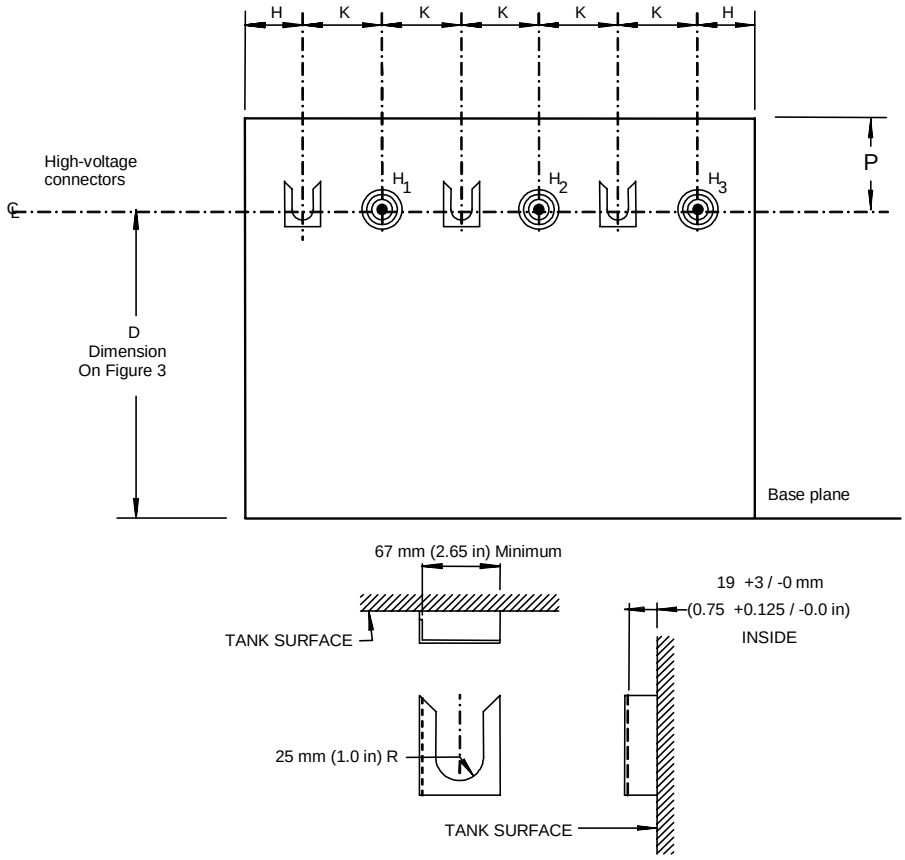
Transformer		Electrical characteristics of completely assembled high-voltage connectors [a]			
High-voltage ratings (V)	BIL (kV)	High-voltage ratings		BIL (kV)	60-Hz Dry-one-minute withstand (kV)
		Phase to ground (kV)	Phase to ground / Phase to phase (kV)		
2 400	45	8.3	8.3 / 14.4	95	34
4 160 to 4 800	60	8.3	8.3 / 14.4	95	34
7 200	75	8.3	8.3 / 14.4	95	34
12 000 to 16 340 [b]	95	8.3 or 15.2	8.3 / 14.4 or 15.2 / 26.3	95 or 125	34 or 40
22 860 GrdY to 24 940 GrdY	125	15.2	15.2 / 26.3	125	40
34 500 Grd Y [c]	150	21.1	21.1 / 36.6	150	50

NOTE —IEEE Std 386 should be consulted for complete connector ratings.

[a] For complete connector rating, refer to IEEE Std 386.

[b] The required connector rating should be specified.

[c] When specifying 125 kV BIL, adequate grounding and surge protection studies should be made.



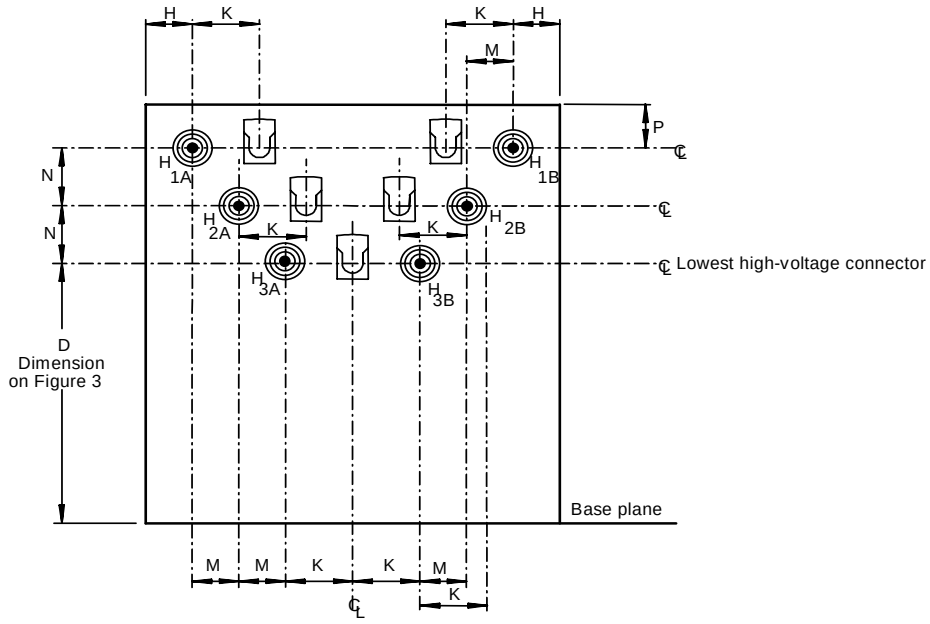
Cable accessory parking stand

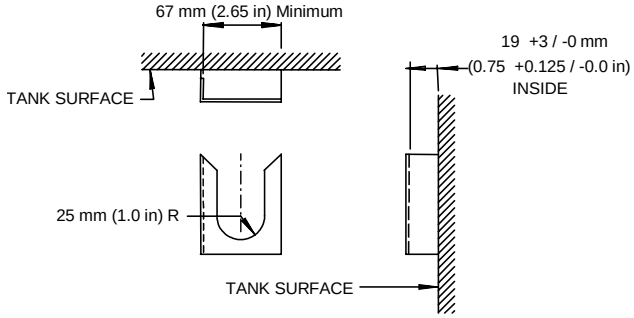
Separable insulated connectors with high-voltage ratings as follows:									
kVA Ratings	8.3 and 8.3/14.4 kV			15.2 and 15.2/26.3 kV			21.1 and 21.1/36.6 kV [a]		
	H	K	P	H	K	P	H	K	P
75–150 without bails	58(2.3)	102 (4.0)	114 (4.5)	74 (2.9)	102 (4.0)	114 (4.5)	102 (4.0)	152 (6.0)	191 (7.5)
75–150 with bails	58(2.3)	102 (4.0)	279 (11.0)	74 (2.9)	102 (4.0)	356 (14.0)	102 (4.0)	152 (6.0)	432 (17.0)
225– 500 without bails	76 (3.0)	102 (4.0)	114 (4.5)	76 (3.0)	102 (4.0)	114 (4.5)	102 (4.0)	152 (6.0)	191 (7.5)
225 – 500 with bails	76 (3.0)	102 (4.0)	279 (11.0)	76 (3.0)	102 (4.0)	356 (14.0)	102 (4.0)	152 (6.0)	432 (17.0)
750 – 2500 without bails	81 (3.2)	102 (4.0)	114 (4.5)	81 (3.2)	102 (4.0)	114 (4.5)	102 (4.0)	152 (6.0)	191 (7.5)
750 – 2500 with bails	81 (3.2)	102 (4.0)	279 (11.0)	81 (3.2)	102 (4.0)	356 (14.0)	102 (4.0)	152 (6.0)	432 (17.0)

NOTES
1—All dimensions are in millimeters (inches) and are minimums.
2—Kilovolt-ampere ratings separated by a dash indicate that all ratings covered in this range as shown in 4.1 of this standard are included.
3—The above minimum dimensions do not provide for all types of parking-stand mounted devices.

[a] The configuration of the 21.1 / 36.6 kV connectors is based on IEEE Std 386, Figure 7.

Figure 1—Minimum dimensions for radial-feed transformers with high-voltage connectors





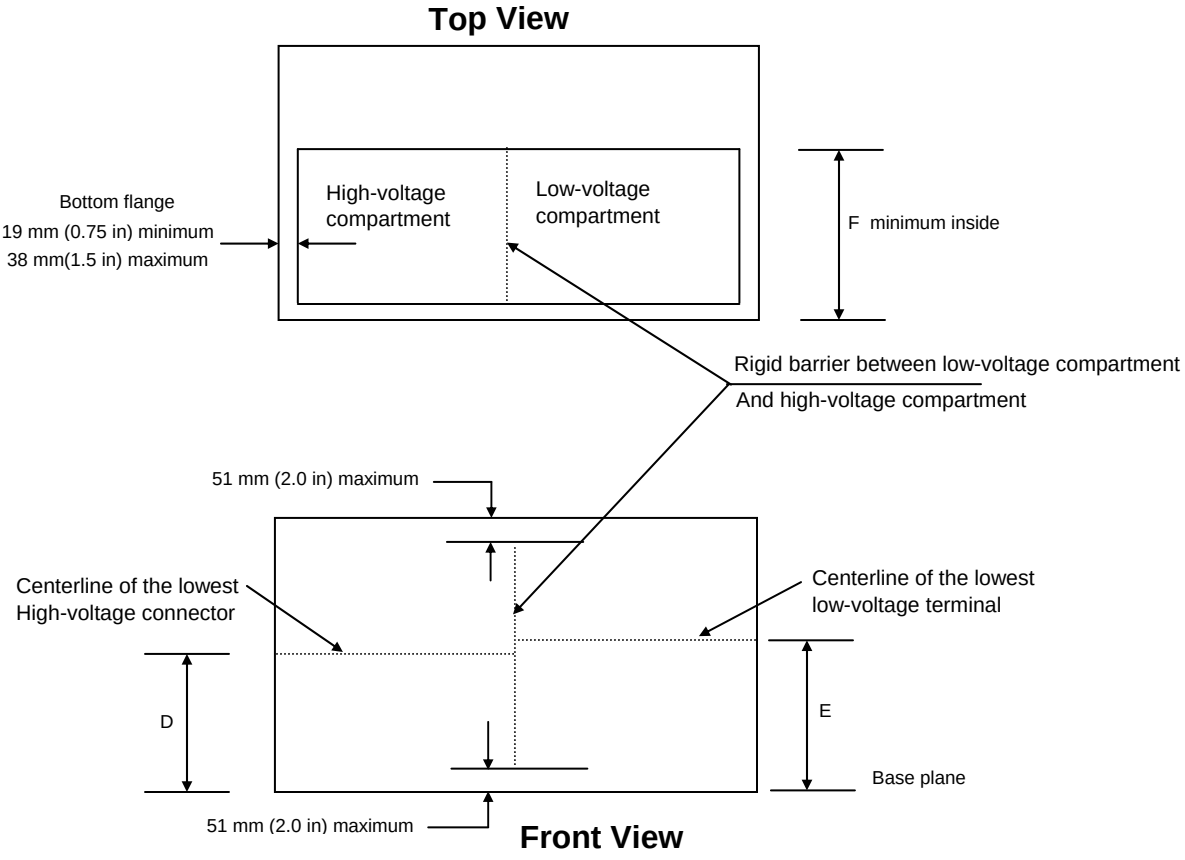
Cable accessory parking stand

Separable insulated connectors with high-voltage ratings as follows:															
kVA	8.3 and 8.3/14.4 kV					15.2 and 15.2/26.3 kV					21.1 and 21.1/36.6 kV [a]				
Ratings	H	N	M	K	P	H	N	M	K	P	H	N	M	K	P
75 – 2500 without bails	76 (3.0)	102 (4.0)	76 (3.0)	102 (4.0)	114 (4.5)	76 (3.0)	102 (4.0)	89 (3.5)	114 (4.5)	114 (4.5)	102 (4.0)	102 (4.0)	95 (3.75)	152 (6.0)	191 (7.5)
75 – 2500 with bails	76 (3.0)	102 (4.0)	76 (3.0)	102 (4.0)	279 (11.0)	76 (3.0)	102 (4.0)	89 (3.5)	114 (4.5)	356 (14.0)	102 (4.0)	102 (4.0)	95 (3.75)	152 (6.0)	432 (17.0)

NOTES
1—All dimensions are in millimeters (inches) and are minimums.
2—Kilovolt-ampere ratings separated by a dash indicate that all ratings covered in this range as shown in 4.1 of this standard are included.
3—The above minimum dimensions do not provide for all types of parking-stand-mounted devices.

[a] The configuration of the 21.1 / 36.6 kV connectors is based on IEEE Std 386, Figure 7.

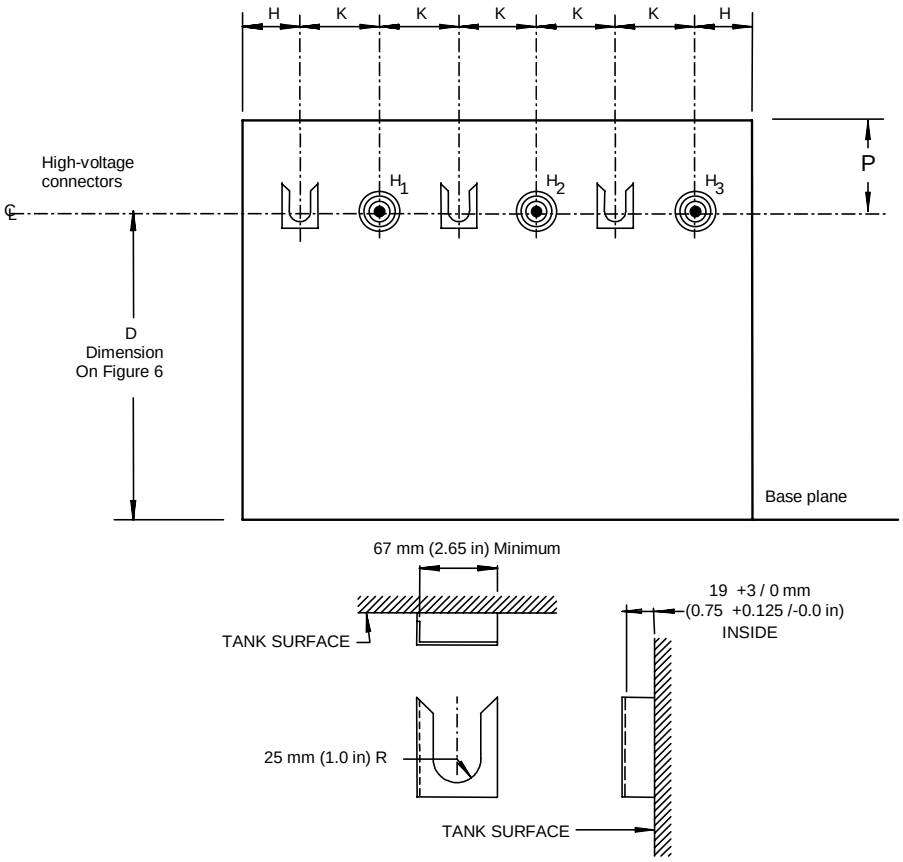
Figure 2—Minimum dimensions for loop-feed transformers with high-voltage connectors



Separable insulated connectors with high-voltage ratings as follows:						
kVA Ratings	8.3 or 15.2 kV			21.1 and 21.1/36.6 kV		
	D	E	F	D	E	F
75 – 500	533 (21.0)	508 (20.0)	457 (18.0)	533 (21.0)	508 (20.0)	533 (21.0)
750 –2500	686 (27.0)	686 (27.0)	457 (18.0)	686 (27.0)	686 (27.0)	533 (21.0)

NOTES
1—All dimensions are in millimeters (inches) and are minimums.
2—Kilovolt-ampere ratings separated by a dash indicate that all ratings covered in this range as shown in 4.1 of this standard are included.

Figure 3—Compartment designations and minimum dimensions for loop-feed or radial-feed transformers with high-voltage connectors



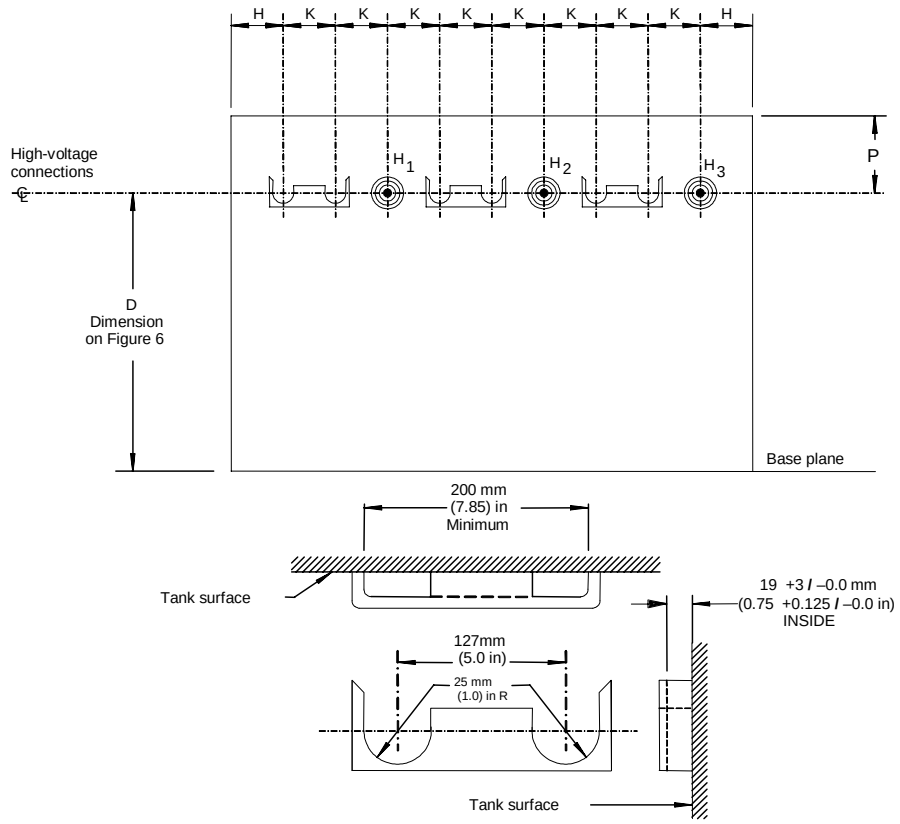
Cable accessory parking stand

Separable insulated connectors with high-voltage ratings as follows:									
	8.3 or 8.3/14.4 kV			15.2 and 15.2/26.3 kV			21.1 and 21.1/36.6 kV [a]		
Tolerances	**Min.**	**± 6.0 (± 0.25)**	**Min.**	**Min.**	**± 6.0 (± 0.25)**	**Min.**	**Min.**	**± 6.0 (± 0.25)**	**Min.**
KVA Ratings	**H**	**K**	**P**	**H**	**K**	**P**	**H**	**K**	**P**
75 – 2500 without bails	89 (3.5)	127 or 165 (5.0 or 6.5)	114 (4.5)	114 (4.5)	165 (6.5)	114 (4.5)	127 (5.0)	178 (7.0)	191 (7.5)
75 – 2500 with bails	89 (3.5)	127 or 165 (5.0 or 6.5)	279 (11.0)	114 (4.5)	165 (6.5)	356 (14.0)	127 (5.0)	178 (7.0)	432 (17.0)

NOTES
1—All dimensions are in millimeters (inches).
2—Kilovolt-ampere ratings separated by a dash indicate that all ratings covered in this range as shown in 4.1 of this standard are included.
3—The above minimum dimensions do not provide for all types of parking-stand mounted devices.

[a] The configuration of the 21.1 / 36.6 kV connectors is based on IEEE Std 386, Figure 7.

Figure 4(a)—Specific dimensions for radial-feed transformers with high-voltage connectors



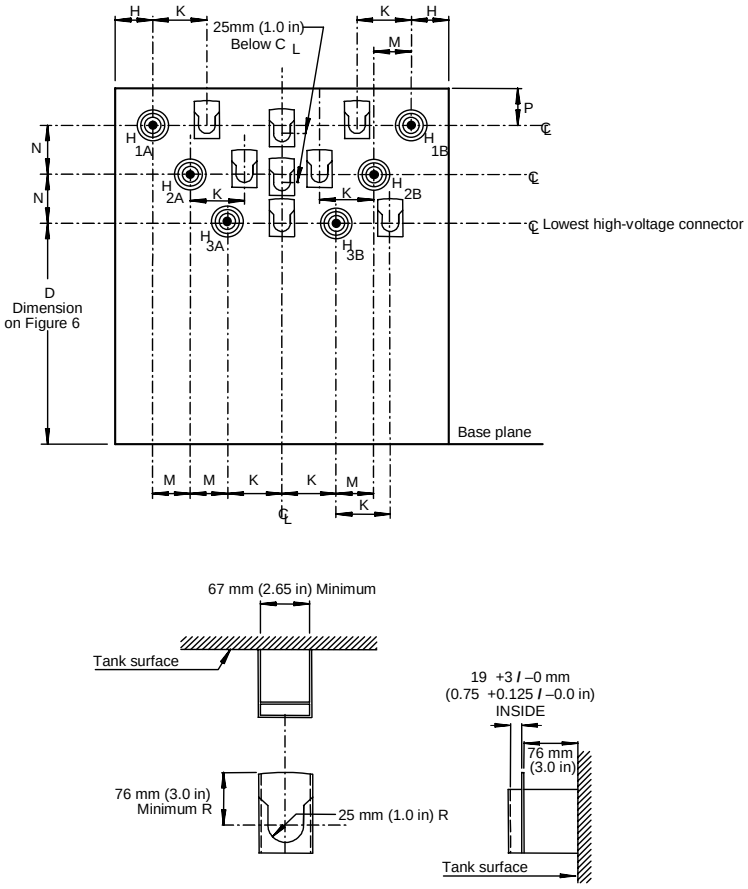
Cable accessory parking stand

Separable insulated connectors with high-voltage ratings as follows:			
	21.1 and 21.1 / 36.6 kV [a]		
Tolerances	Min	± 6.0 (± 0.25)	Min
KVA Ratings	H	K	P
75 – 2500 without bails	127 (5.0)	127 (5.0)	191 (7.5)
75 – 2500 with bails	127 (5.0)	127 (5.0)	508 (20.0)

NOTES
1—All dimensions are in millimeters (inches).
2—Kilovolt-ampere ratings separated by a dash indicate that all ratings covered in this range as shown in 4.1 of this standard are included.

[a] The configuration of the 21.1 / 36.6 kV connectors is based on IEEE Std 386, Figure 7.

Figure 4(b)—Specific dimensions for radial-feed transformers with high-voltage connectors

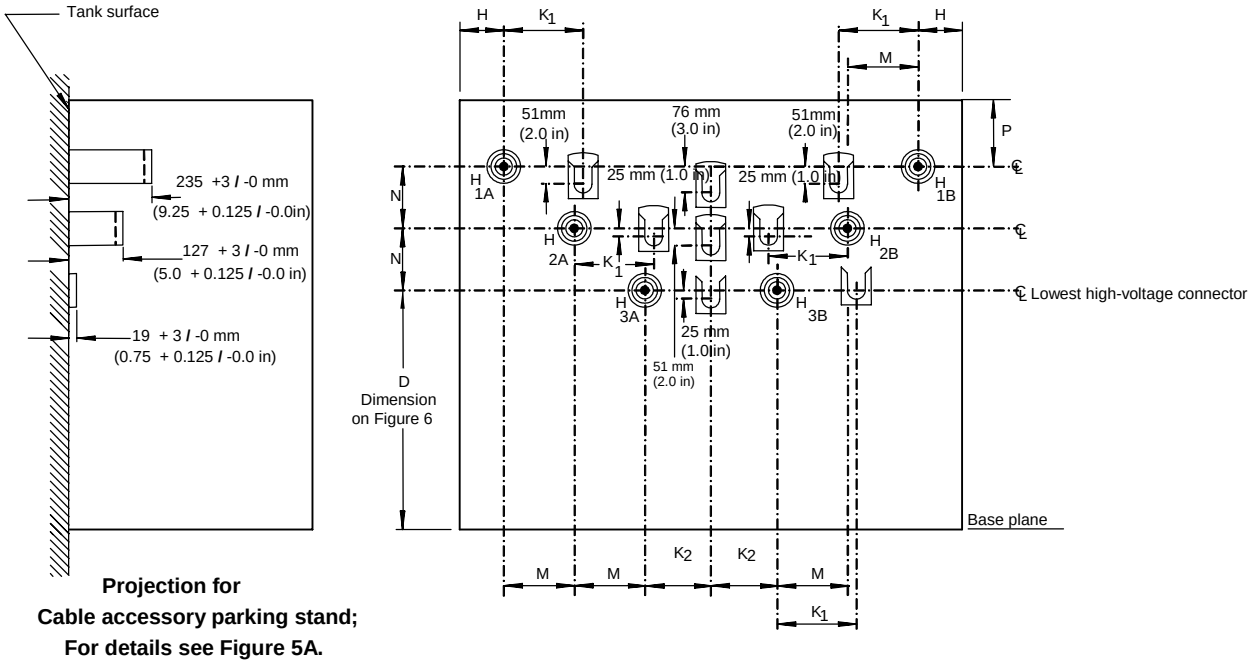


Cable accessory parking stand

Separable insulated connectors with high-voltage ratings as follows:										
	8.3 and 8.3 / 14.4 kV					15.2 and 15.2 / 26.3 kV				
Tolerances	Min.	± 6.0 (± 0.25)	± 6.0 (± 0.25)	± 6.0 (± 0.25)	Min.	Min.	± 6.0 (± 0.25)	± 6.0 (± 0.25)	± 6.0 (± 0.25)	Min.
KVA Ratings	H	M	N	K	P	H	M	N	K	P
75 – 2500 without bails	89 (3.5)	114 (4.5)	152 (6.0)	127 or 165 (5.0 or 6.5)	114 (4.5)	114 (4.5)	114 (4.5)	152 (6.0)	165 (6.5)	114 (4.5)
75 –2500 with bails	89 (3.5)	114 (4.5)	152 (6.0)	127 or 165 (5.0 or 6.5)	279 (11.0)	114 (4.5)	114 (4.5)	152 (6.0)	165 (6.5)	356 (14.0)

NOTES
1—All dimensions are in millimeters (inches).
2—Kilovolt-ampere ratings separated by a dash indicate that all ratings covered in this range as shown in 4.1 of this standard are included.
3—The above minimum dimensions do not provide for all types of parking-stand mounted devices.

Figure 5(a)—Specific dimensions for loop-feed transformers with high-voltage connectors

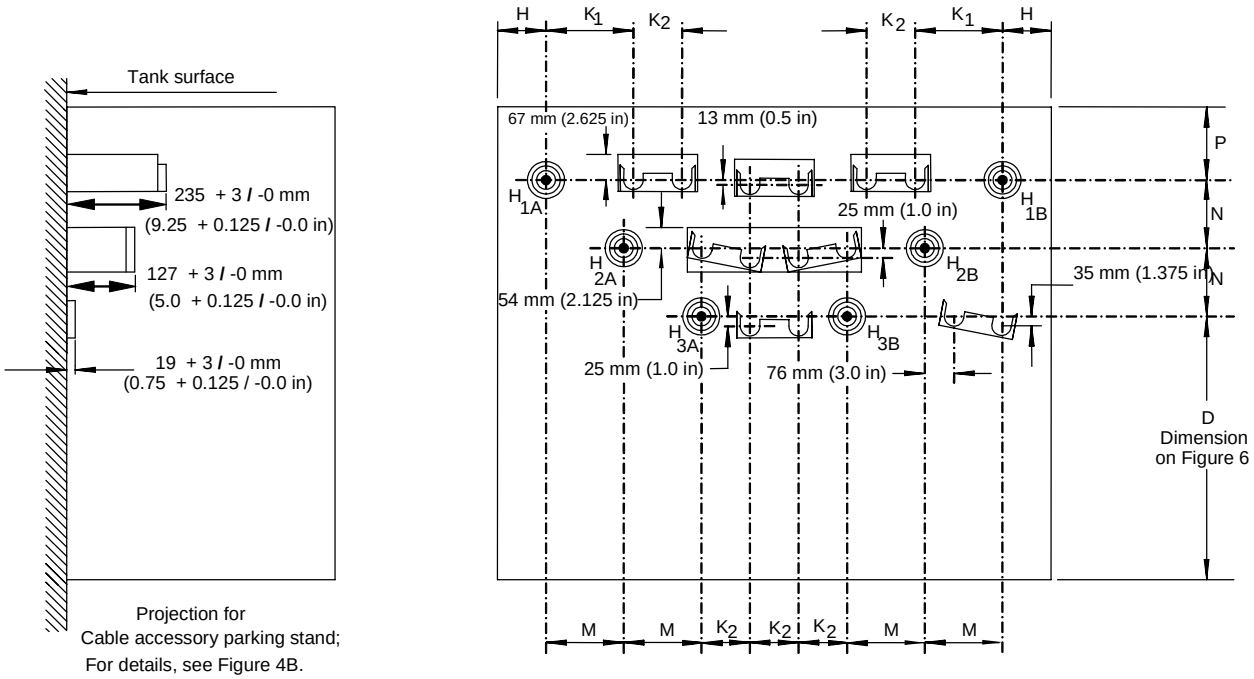


Separable insulated connectors with high-voltage ratings as follows:						
	21.1 and 21.1 / 36.6 kV [a]					
Tolerance	**Min.**	**± 6.0 (± 0.25)**	**± 6.0 (± 0.25)**	**± 6.0 (± 0.25)**	**± 6.0 (± 0.25)**	**Min.**
KVA Ratings	**H**	**M**	**N**	**K_1**	**K_2**	**P**
75 – 2500 without bails	127 (5.0)	178 (7.0)	203 (8.0)	229 (9.0)	191 (7.5)	191 (7.5)
75 – 2500 with bails	127 (5.0)	178 (7.0)	203 (8.0)	229 (9.0)	191 (7.5)	432 (17.0)

NOTES
1—All dimensions are in millimeters (inches).
2—Kilovolt-ampere ratings separated by a dash indicate that all ratings covered in this range as shown in 4.1 of this standard are included.

[a] The configuration of the 21.1 / 36.6 kV connectors is based on IEEE Std 386, Figure 7.

Figure 5(b)—Specific dimensions for loop-feed transformers with high-voltage connectors

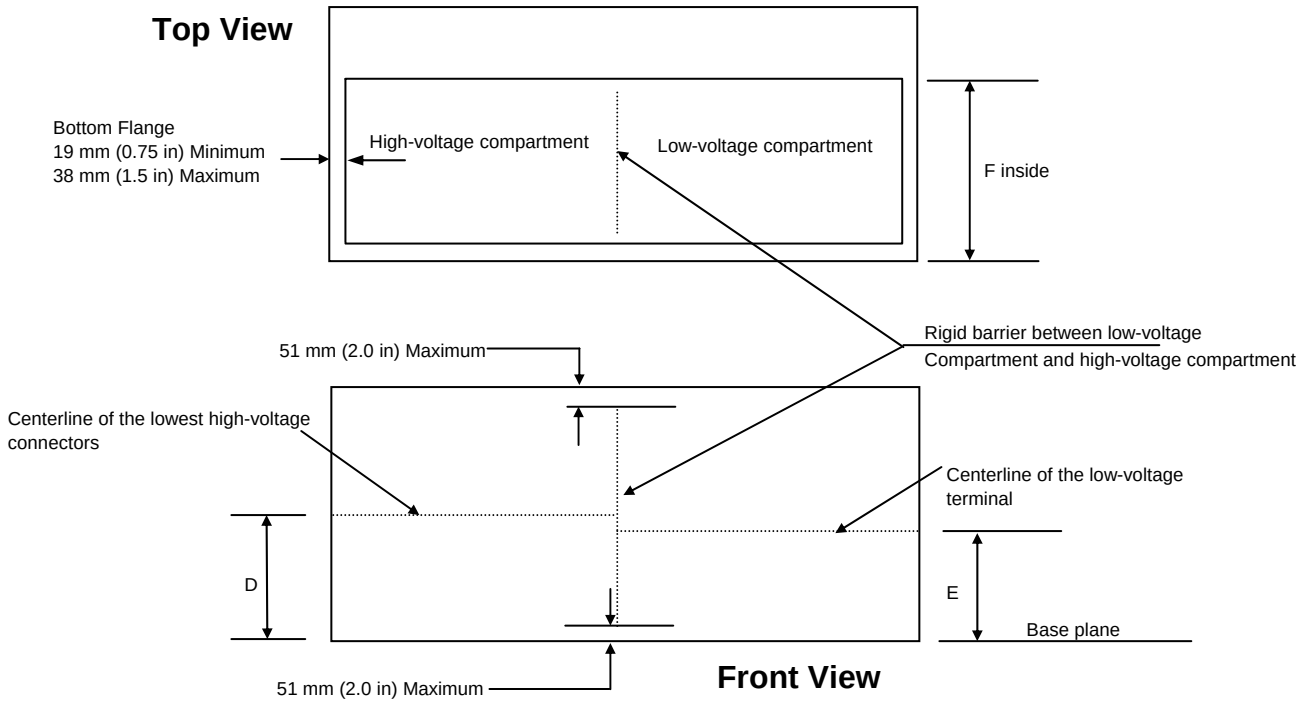


Separable insulated connectors with high-voltage ratings as follows:						
	21.1 and 21.1 / 36.6 kV [a]					
Tolerance	**Min**	**± 6 (± 0.25)**	**± 6 (± 0.25)**	**± 6 (± 0.25)**	**± 6 (± 0.25)**	**Min**
KVA Ratings	**H**	**M**	**N**	**K_1**	**K_2**	**P**
75 – 2500 without bails	127 (5.0)	178 (7.0)	203 (8.0)	203 (8.0)	127 (5.0)	203 (8.0)
75 – 2500 with bails	127 (5.0)	178 (7.0)	203 (8.0)	203 (8.0)	127 (5.0)	508 (20.0)

NOTES
1—All dimensions are in millimeters (inches).
2—Kilovolt-ampere ratings separated by a dash indicate that all ratings covered in this range as shown in 4.1 of this standard are included.

[a] The configuration of the 21.1 / 36.6 kV connectors is based on IEEE Std 386, Figure 8.

Figure 5(c)—Specific dimensions for loop-feed transformers



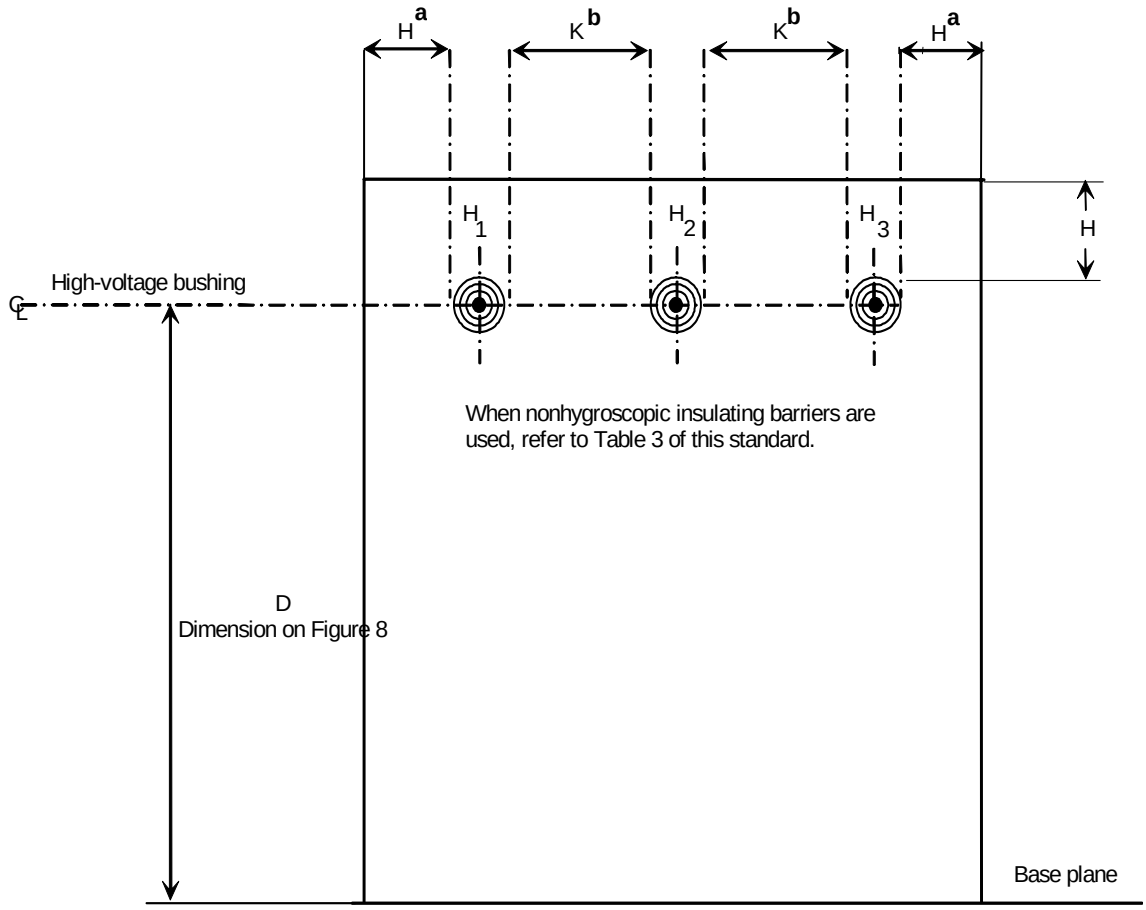
Separable insulated connectors with high voltage ratings as follows:								
	8.3 or 15.2 kV				21.1 and 21.1/36.6 kV			
Tolerance	± 13 (±0.5)	± 13 (± 0.5)	Min.	Min.	± 13 (±0.5)	± 13 (± 0.5)	Min.	Min.
KVA Ratings	D	E	F	F [a]	D Fig.8	E	F [b] Fig.7	F [b]
75 –150	686 (27.0) (19.0)	686 (27.0)	457 (18.0)	483	686 (27.0)	686 (27.0)	610 (24.0)	762 (30.0)
225 – 500	686 (27.0) (19.0)	787 (31.0)	457 (18.0)	483	686 (27.0)	787 (31.0)	610 (24.0)	762 (30.0)
750 – 2500	686 (27.0) (19.0)	1168 (46.0)	457 (18.0)	483	686 (27.0)	1168 (46.0)	610 (24.0)	762 (30.0)

NOTES
1—All dimensions are in millimeters (inches).
2—Kilovolt-ampere ratings separated by a dash indicate that all ratings covered in this range as shown in 4.1 of this standard are included.

[a] This dimension is the minimum depth at the elevation of the parking stands and applies to transformers that conform to Figure 5 of this standard and utilizing 15.2 kV connectors.

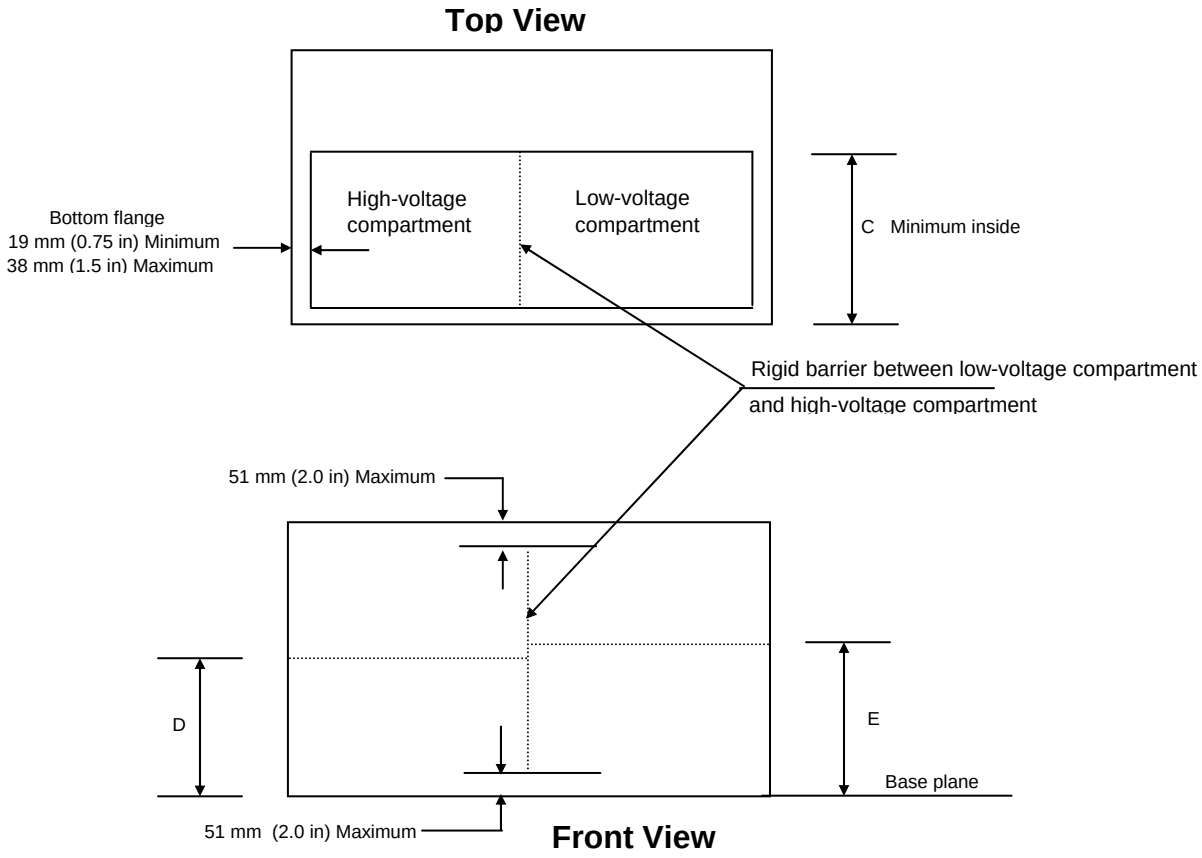
[b] The configuration of the 21.1 / 36.6 kV connectors is based on IEEE Std 386, Figure 7 and 8, "Designation interface for separable insulated connectors".

Figure 6—Compartment designations and specific dimensions for loop-feed or radial-feed transformers with high-voltage connectors



[a] H is the minimum phase to ground clearance as specified in Table 3 of this standard.
[b] K is the minimum phase to phase clearance as specified in Table 3 of this standard.

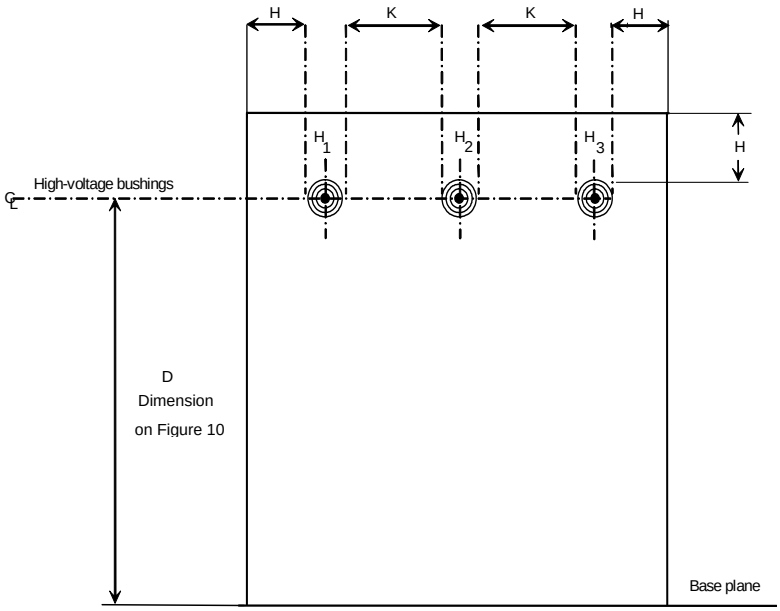
Figure 7—Minimum dimensions for radial-feed transformers with high-voltage bushings



kVA Ratings	C			D			E
	95 kV BIL and Less	125kV BIL	150kV BIL	95 kV BIL and Less	125kV BIL	150kV BIL	30 kV BIL
75 – 500	406 (16.0)	457 (18.0)	483 (19.0)	610 (24.0)	610 (24.0)	610 (24.0)	508 (20.0)
750 – 2500	406 (16.0)	457 (18.0)	533 (21.0)	914 (36.0)	914 (36.0)	914 (36.0)	686 (27.0)

NOTES
1—All dimensions are in millimeters (inches) and are minimum unless otherwise indicated.
2—The BIL is shown for transformer high-voltage ratings included, refer to Table 1 of this standard.
3—Kilovolt-ampere ratings separated by a dash indicate that all ratings covered in this range as shown in 4.1 of this standard are included.

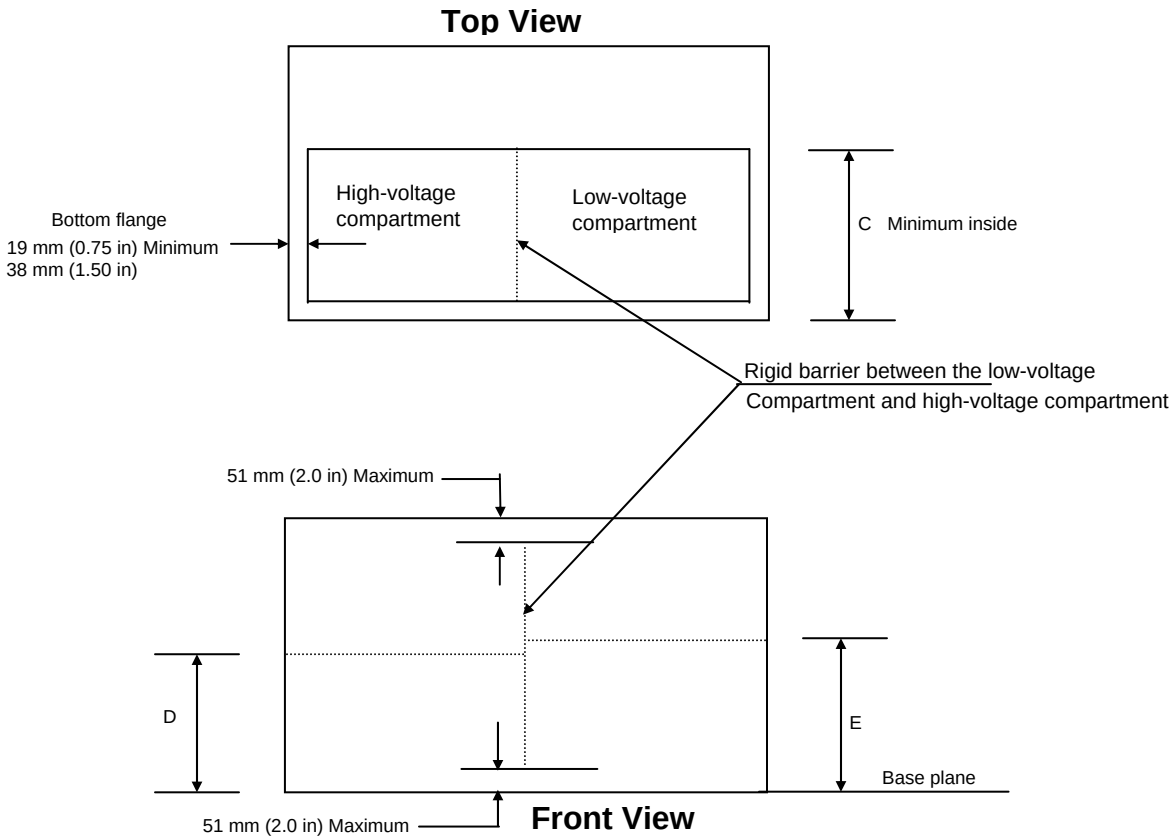
Figure 8—Compartment designations and minimum dimensions for radial-feed transformers with high-voltage bushings



Tolarance	Minimum	+25 / -0 (+1.0 / - 0.0)
BIL [a] (kV)	H [b]	K [c]
95 and below	140 (5.5)	165 (6.5)
125	152 (6.0)	178 (7.0)
150	203 (8.0)	229 (9.0)
NOTE—All dimensions are in millimeters (inches).		

[a] For transformer high-voltage ratings, refer to Table 1 of this standard.
[b] This dimension is minimum clearance for live parts, phase to ground.
[c] This dimension is minimum clearance for live parts, phase to phase.

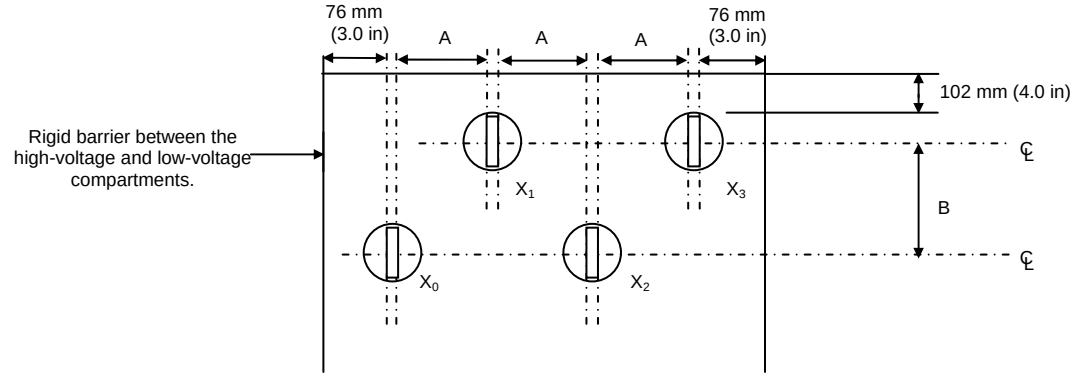
Figure 9—Specific dimensions for radial-feed transformers with high-voltage bushings



	C			D			E
Tolerance	**Minimum**			**± 6 (±0.25)**			**± 6 (±0.25)**
kVA Ratings	**95 kV BIL and Less**	**125kV BIL**	**150kV BIL**	**95 kV BIL and Less**	**125kV BIL**	**150kV BIL**	**30 kV BIL**
75 – 150	457 (18.0)	610 (24.0)	610 (24.0)	762 (30.0)	762 (30.0)	1067 (42.0)	686 (27.0)
225 – 500	457 (18.0)	610 (24.0)	610 (24.0)	914 (36.0)	914 (36.0)	1219 (48.0)	787 (31.0)
750 – 2500	457 (18.0)	610 (24.0)	610 (24.0)	1270 (50.0)	1270 (50.0)	1372 (54.0)	1168 (46.0)

NOTES
1—All dimensions are in millimeters (inches).
2—The BIL is shown for transformer high-voltage ratings included, refer to Table 1.
3—Kilovolt-ampere ratings separated by a dash indicate that all ratings covered in this range as shown in 4.1 of this standard are included.

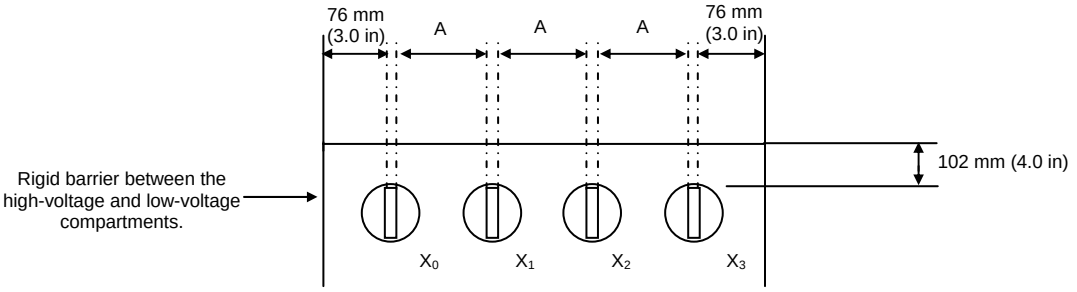
Figure 10—Compartment designations and specific dimensions for radial-feed transformers with high-voltage bushings



kVA Ratings	A	B
75 – 150	76 (3.0)	152 (6.0)
225 – 500	102 (4.0)	203 (8.0)
750 – 2500	127 (5.0)	203 (8.0)

NOTES
1—All dimensions are in millimeters (inches) and are minimums.
2—Kilovolt-ampere ratings separated by a dash indicate that all ratings covered in this range as shown in 4.1 of this standard are included.

(a) Staggered low-voltage terminal arrangement

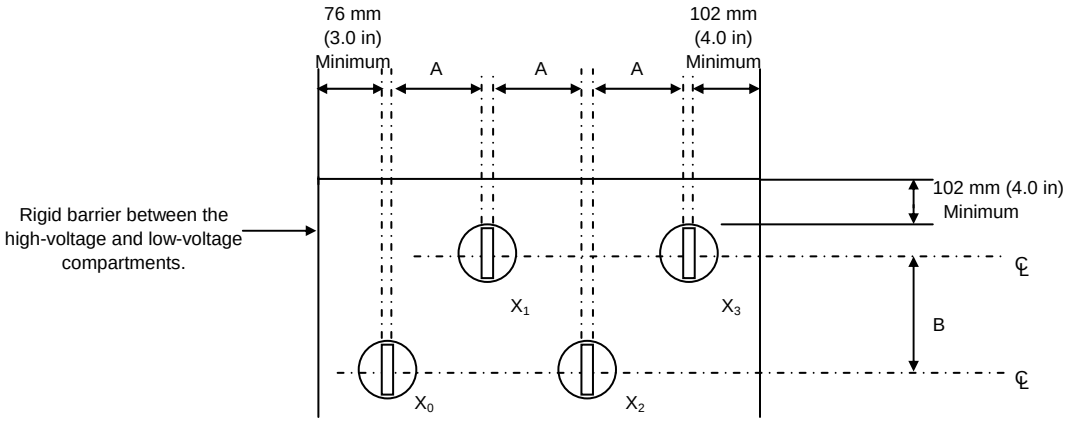


kVA Ratings	A
75 – 150	127 (5.0)
225 – 2500	127 (5.0)

NOTES
1—All dimensions are in millimeters (inches) and are minimums.
2—Kilovolt-ampere ratings separated by a dash indicate that all ratings covered in this range as shown in 4.1 of this standard are included.

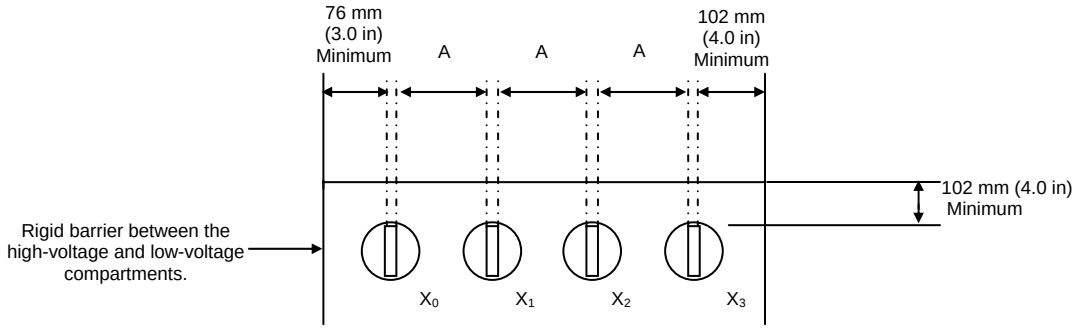
(b) In-line low-voltage terminal arrangement

Figure 11—Low-voltage terminal arrangements with minimum dimensions



Tolerance	± 6 (±0.25)	± 6 (±0.25)
kVA Ratings	A	B
75 – 150	127 (5.0)	152 (6.0)
225 – 2500	152 (6.0)	203 (8.0)
NOTE – All dimensions are in millimeters (inches). Kilovolt-ampere ratings separated by a dash indicate that all ratings covered in this range as shown in 4.1 of this standard are included.		

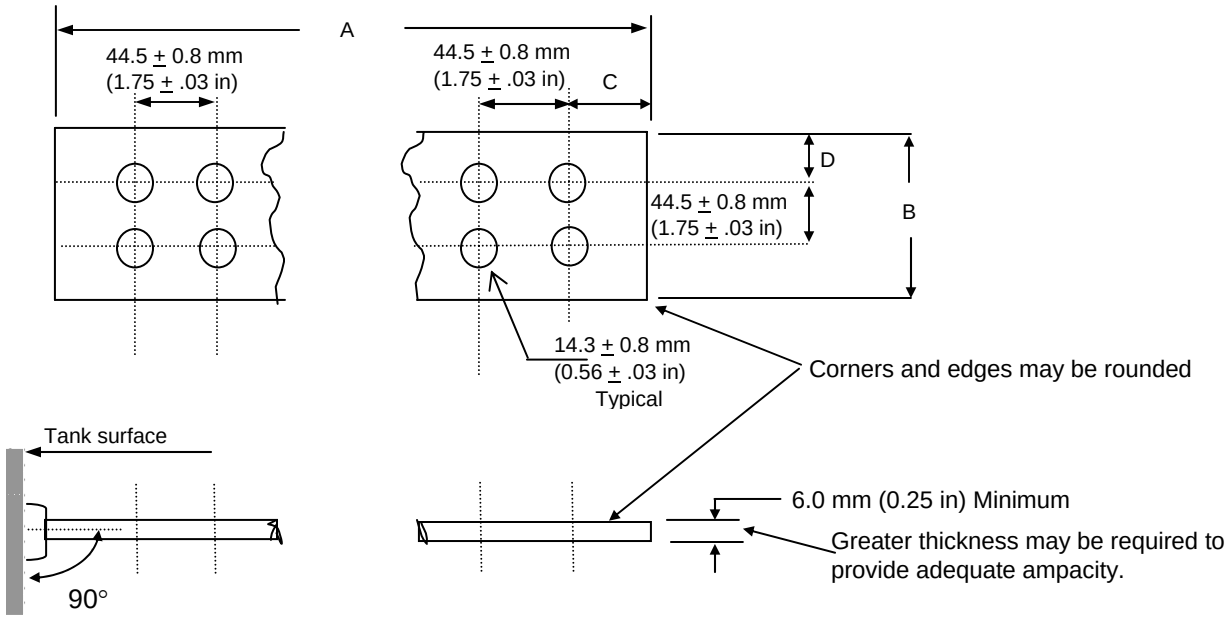
(a) Staggered low-voltage terminal arrangement



Tolerance	± 6 (±0.25)
kVA Ratings	A
75 – 150	152 (6.0)
225 – 2500	152 (6.0)
NOTE – All dimensions are in millimeters (inches). Kilovolt-ampere ratings separated by a dash indicate that all ratings covered in this range as shown in 4.1 of this standard are included.	

(b) In-line low-voltage terminal arrangement

Figure 12—Low-voltage terminal arrangements with specific dimensions

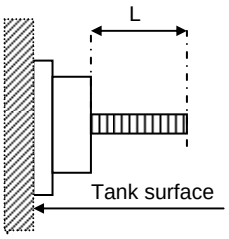


Low-voltage Ratings — Dimensions

Low-voltage Ratings			Number of Holes	Dimensions			
208Y/120	240	**480Y/277, 480**		**A**	**B**	**C**	**D**
75 – 300	75 – 500	75 – 500	4	105 (4.125)	89 (3.5)	16 (0.625)	22 (0.875)
500	750	750 – 1500	6	137 (5.375)	102 (4.0)	22 (0.875)	29 (1.125)
750 – 1000	1000	2000 – 2500	10	225 (8.875)	102 (4.0)	22 (0.875)	29 (1.125)

NOTES
1—All dimensions are in millimeters (inches) and are minimums.
2—Kilovolt-ampere ratings separated by a dash indicate that all ratings covered in this range as shown in 4.1 of this standard are included.

Figure 13(a)—Low-voltage terminals



kVA Ratings	Low-voltage Ratings (Volts)	Thread size [a]	L [a] Minimum
75 – 150	240, 208Y / 120	5/8 – 11 UNC-2A	32 (1.250)
75 – 300	480, 480Y / 277	5/8 – 11 UNC-2A	32 (1.250)
225 – 300	240, 208Y / 120	1 – 14 UNS-2A	44 (1.750)
500	480, 480Y / 277	1 – 14 UNS-2A	44 (1.750)
500	240, 208Y / 120	1 1/4 – 12 UNF – 2A	67 (2.625)

NOTES
1—All dimensions are in millimeters (inches) and are minimums.
2—Kilovolt-ampere ratings separated by a dash indicate that all ratings covered in this range as shown in 4.1 of this standard are included.

[a] If materials other than copper are used, larger thread size or length, or both, may be required.

Figure 13(b)—Low-voltage terminals

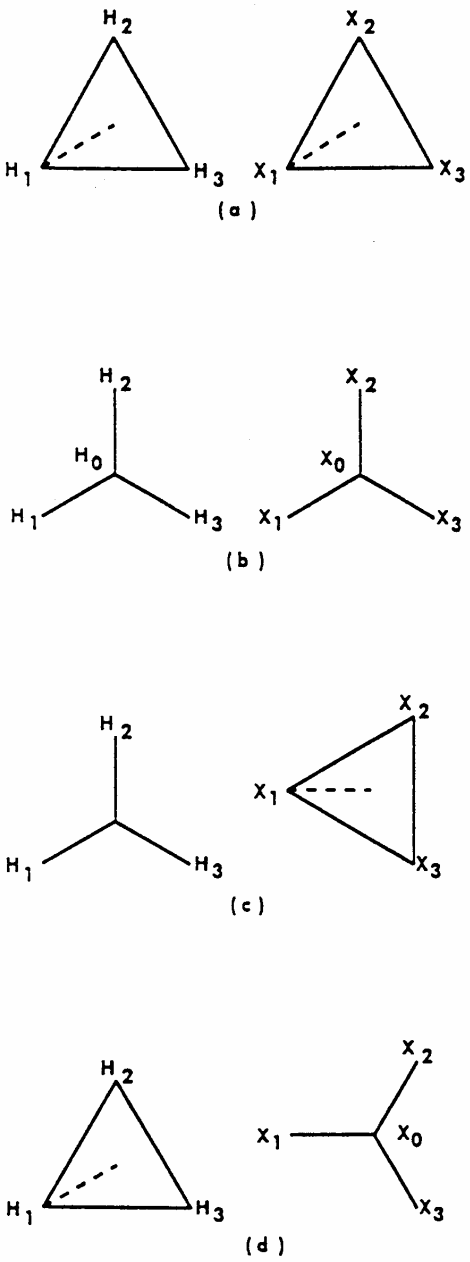


Figure 14—Angular displacement