

Pad-Mounted Transformers

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Specifications

See Eaton's *Product Specification Guide*, available on CD or on the Web.

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Typical Pad-Mounted Transformer

General Description

Three-Phase Pad-Mounted Transformers



Typical Pad-Mounted Transformer

Introduction

Eaton's three-phase pad-mounted transformer is offered in a variety of designs and configurations. The following pages describe the standard designs and the common options that are available.

Some special designs and options may require additional engineering, factory coordination, unusual application requirements or special manufacturing needs.

Higher impedances limit secondary fault currents such that coordination with secondary low voltage molded-case circuit breakers is usually possible. (Low impedances are also available if required for paralleling, and so on.)

Standard color is pad-mounted green [Munsell® Green (#7GY3.29/1.5)]. ANSI #24, 61 and 70 are available as options.

Application

Liquid-filled, three-phase, commercial pad-mounted distribution transformers are designed for servicing such underground distribution loads as shopping centers, schools, institutions, data centers, and industrial plants. They are also heavily utilized for step-up applications in renewable energy installations. They are available in both deadfront and livefront and construction, for radial or loop-feed applications, with or without taps.

Industry Standards

Pad-mounted transformers meet industry standards: IEEE® C57.12.00, IEEE C57.12.34, IEEE C57.12.28, IEEE C57.12.29, IEEE C57.12.70,

IEEE C57.12.80, IEEE C57.12.90, IEEE C57.91, DOE 10 CFR Part 431 and NEMA®.

Ratings

- 45–10,000 kVA
- High voltages (primary):

4160 Grd. Y/2400	2400Δ
through	through
43,800 GY/25,300	46,000Δ
Grd. Y/19,920	
- HV Taps: 2–2-1/2% above and below normal, or 4–2-1/2% below normal
- Standard BIL levels:

kV Class	BIL (kV)
1.2	30
2.5	45
5.0	60
8.7	75
15.0	95
25.0 Grd. Y Only	125
25.0	150
34.5 Grd. Y Only	150
34.5	150
46	250
- Low voltages (secondary). All voltages through 15 kV class
- UL listing and/or classification available
- Factory Mutual Approval available

Design Impedances

Impedances are supplied to meet IEEE C57.12.34 standards. Customer-specified impedances are available. (Subject to IEEE/ANSI ±7.5% impedance tolerance.)

- Nominal impedance per IEEE C57.12.34:

kVA	%Z
45	2.70–5.75
75	2.7–5.75
112-1/2	3.1–5.75
150	3.1–5.75
225	3.1–5.75
300	3.1–5.75
500	4.35–5.75
750	5.75
1000	5.75
1500	5.75
2000	5.75
2500	5.75
3000	5.75
3750	5.75
5000–10,000	6.0–6.5

Note: Subject to NEMA/IEEE ±7.5% impedance tolerance.

Note: Non-standard design impedance may be obtained by contacting Eaton.

Application Limitations

The transformers described herein are designed for the application conditions normally encountered on electric power distribution systems. As such, they are suitable for use under the “usual service

conditions” described in IEEE Standard C57.12.00 general requirements for liquid-immersed distribution, power and regulating transformers.

Transformers required for step-up applications should be specified as such.

Consult Eaton for unusual service conditions such as:

- Abnormal environmental conditions
- Unusual transient voltages present on the source voltage
- Frequent or planned through-fault duty
- Planned overloading unless in strict accordance with the IEEE loading guide (C57.91)
- Motors whose horsepower rating is greater than half the transformer kVA rating
- Unusual frequency of impact loading may occur when supplying welding apparatus, electric arc furnaces or motors with cyclical loads
- Loads involving abnormal harmonic or DC current that may result where appreciable load currents are controlled by solid-state or similar devices

These lists do not purport to cover all unusual conditions and applicable limitations. Other “unusual service conditions” are described in IEEE Standard C57.12.00.

Table 17.0-1. Temperature Guarantees

Description	Ambient ①	Rise ②③
Standard	30 °C	65 °C
Optional	30 °C	55 °C
Optional	30 °C	75 °C ④

① 30 °C average ambient temperature of cooling air not to exceed 40 °C maximum over any 24-hour period.

② Degree rise is the average winding temperature rise by resistance.

③ A dual temperature rating of 55 °C/65 °C or 65 °C/75 °C adds 12% additional continuous capacity to the base kVA rating of the transformer. 55 °C/75 °C adds 22%.

④ Requires transformer to be filled with Envirotemp™ FR3™ fluid.

Note: Altitudes not to exceed 3300 ft (1006 m). Unit deration or special designs are required above 3300 ft (1006 m).

Fluids—Liquid Dielectric

The choice of fluid, mineral oil or less flammable natural ester fluid (Envirotemp FR3) is made based upon site conditions and proximity to facility walls, windows and flammable structures, environmentally sensitive areas, and when considering extended transformer insulation life.

Note: For additional information about transformer applications and types of insulating fluids, see Tab 14.

General Description

Standard Features

- ① Four lifting hooks
- ② Bolted-on terminal compartment with removable front sill
- ③ Hinged, lift-off cabinet doors
- ④ Interlocked penta-head bolt padlock handle operates a cam assembly that is part of the three-point door latching mechanism
Penta-head bolts must be removed from the flange formed on the steel high/low barrier before the HV door can be opened—not shown
- ⑤ Tank ground pads (1 in HV, 1 in LV) (not shown)
- ⑥ Steel high/low voltage compartment barrier
- ⑦ Nameplate
- ⑧ Fill plug and self-actuating pressure relief device
- ⑨ Externally operated no load tap changer
- ⑩ Drain valve and sampling device (not shown)

Options

Primary Termination

- ⑪ Removable neutral ground strap
- ⑫ For deadfront construction, externally clamped high voltage epoxy bushing wells for 200 A load-break, or 600 A non-load-break inserts
- ⑬ For livefront construction, externally clamped high voltage porcelain bushings double eye-bolt or spade for cable (75–225 kVA) or a single eyebolt or spade for cable (300–1500 kVA). Spade bushings are also offered

⑭ Parking stands

Secondary Termination

- ⑮ NEMA spade terminals with supports

Optional Accessories

- ⑯ Load-break switch
- ⑰ Expulsion fuses, Bay-O-Net mounted with drip shield
- ⑱ Liquid level gauge
- ⑲ Dual primary voltage switch ① (not shown)

① Higher voltage may not exceed lower voltage by more than 3.3:1 ratio. No taps on lower voltage.

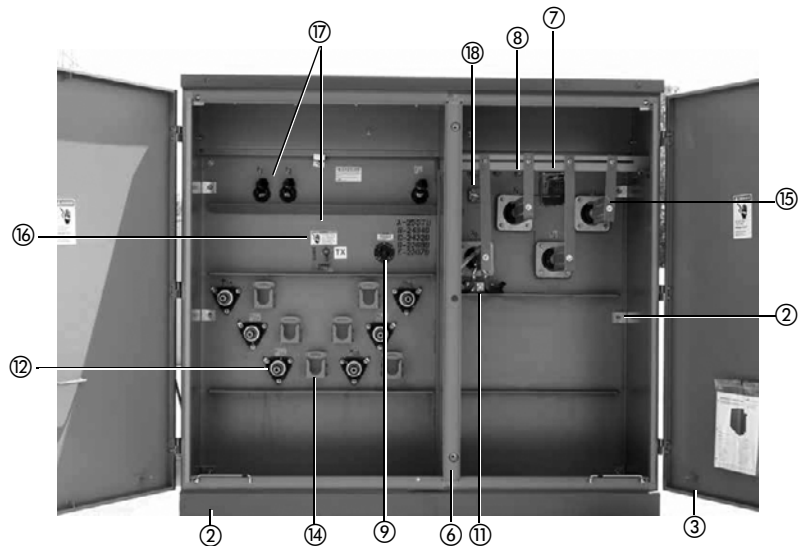
Deadfront construction dimensions are covered in IEEE C57.12.34. There are two configurations: minimum dimensions and specific dimensions.

Minimum Dimensions

- Minimum bushing spacing between bushings
- Minimum bushing heights
- Termination compartment depth

Specific Dimensions

- Specific for interchangeability between manufacturers
- Larger dimensions than the minimum dimensions
- Consideration should be given when specifying specific dimensions to make installations and maintenance easier, and to ensure adequate room for all connections to be made



Primary and Secondary Compartment Features

General Description

Transformer Cooling Classes

Table 17.0-2. Fluids Advantages and Disadvantages

Advantages	Disadvantages
Mineral Oil	
<ul style="list-style-type: none"> ■ Low transformer cost ■ Good dielectric performance ■ Low maintenance cost ■ Good heat dissipation ■ Good cold climate performance ■ Preventative maintenance—DGA historical data available 	<ul style="list-style-type: none"> ■ Potential higher installation cost ■ Vaults required for indoor installations per NEC[®] due to low fire point—160 °C ■ <30% biodegradability
Silicone Fluid	
<ul style="list-style-type: none"> ■ Low heat release ■ Reduced smoke ■ Low flame ■ Self extinguishing ■ Good dielectric performance ■ Low toxicity ■ Moderate viscosity ■ High stability 	<ul style="list-style-type: none"> ■ Non-biodegradable ■ Not suitable for use with internal Bay-O-Net fuses ■ Transformer cost ■ Disposal cost ■ Viton gaskets required ■ Retrofill applications ■ High transformer cost ■ High moisture absorption
Envirotemp FR3	
<ul style="list-style-type: none"> ■ High fire point—360 °C ■ High flash point—330 °C ■ Compatible with mineral oil ■ Excellent retrofill fluid (compatible with oil up to a 7% mixture to maintain minimum 300 °C fire point) ■ Excellent dielectric performance ■ Greater than 99% biodegradable ■ Greater tolerance to moisture, dramatically extending insulation life and therefore, transformer life 	<ul style="list-style-type: none"> ■ Transformer cost (lower than silicone fluid) ■ Pour point (–15 °C to –25 °C) transformer energized with full load with top oil temperature at –50 °C with no problems—no crystals formed at –68 °C ■ Allows transformers to be designed to operate at 10 °C higher average winding rise (75 °C) without reducing normal transformer insulation life ■ Excellent switching medium ■ Excellent cold weather performance

Table 17.0-3. Fluid Properties Comparison

Property	Mineral Oil	Silicone Fluid	Envirotemp FR3
Specific gravity	0.91	0.96	0.91
Flash point °C	145	300	343
Fire point °C	160	330	360
Viscosity (cSt.) 100 °C	3	16	<15
40 °C	12	38	<50
0 °C	76	90	300
Pour point °C	–40	–55	<10
Dielectric strength, kV	30	43	49
Dissipation factor (%) 25 °C	0.05	0.01	<0.20
Permittivity	2.2	2.7	3.1
Resistivity	10 ¹³	10 ¹⁴	10 ¹³
Oxidation inhibitor	Optional	No	Required >99%
Biodegradability	<30%	0%	>99%

General Description

NEC Requirement Guidelines for the Installation of Listed Less-Flammable Liquid-Filled Transformers

NEC (NFPA) Recognition

These guidelines focus on the requirements of Article 450.23 of the National Electrical Code® (NEC®) for the installation of less-flammable liquid-insulated transformers. Less-flammable liquids are used in transformers where an extra margin of fire safety is important. Typical applications include installations indoors, on rooftops, near buildings, in brush and forest fire prone areas and in pedestrian traffic areas.

Less-flammable liquids, also known as high fire point liquids, are transformer dielectric coolants that have a minimum fire point of 300 °C. Commonly used less-flammable fluids include dimethylsiloxane and ester-based fluids. Two Nationally Recognized Testing Laboratories (NRTL); Underwriters Laboratories (UL) and FM Global (FM) currently list less-flammable liquids. They also list less-flammable liquid-filled transformers.

Less-flammable liquid-filled transformers were formally recognized by the NEC for indoor installation in 1978. In 1990, the NEC integrated specific less-flammable transformer requirements for outdoor installations in Article 450.23, recognizing less-flammable transformers as inherently safer than conventional oil-filled transformers. Less-flammable transformers, long recognized as an additional safeguard for indoor installations, are becoming increasingly recognized for outdoor applications as well.

General NEC Requirements

The requirements and options for outdoor installations of less-flammable liquid-insulated transformers per NEC 450.23 are outlined in **Table 17.0-4**.

Requirements for mineral oil insulated transformers installed outdoors are stated in NEC 450.27. In cases where the transformer installation presents a fire hazard, one or more of the following safeguards will be applied according to the degree of hazard involved:

1. Space requirements.
2. Fire-resistant barriers.
3. Automatic fire suppression systems.
4. Enclosures that confine the oil of a ruptured transformer tank.

NEC Article 450.28, Modification of Transformers, requires that when modifications are made to transformers in existing installations that change the

transformer type, the transformers must be marked to show the type of insulating liquid installed and the installations must comply with current requirements of the NEC. Examples of changes include replacing a complete transformer (retrofitting) or replacement of the liquid only (retrofilling). Askarel (PCB) and conventional mineral oil-filled transformers are frequently retrofitted or retrofilled using less-flammable liquids. NEC 110.34 sets minimum clear work space dimensions around transformers.

Seismic Qualification



Refer to **Tab 1** for information on seismic qualification for this and other Eaton products.

Table 17.0-4. NEC Article 450.23 Less-Flammable Liquid Insulated Transformer Requirements

Installation Type	NEC Requirements
Outdoor Installations	
Non-combustible building ^① and no combustible materials stored in area.	If complies with either of the following listing requirements, may be installed adjacent to the building. ^② ■ Underwriters Laboratories ■ FM approvals
Combustible building ^① or combustible materials stored in area.	In accordance with NEC Article 450.27, oil-insulated transformers installed outdoors, i.e., space separation, fire barriers or water spray systems.

^① Refer to NFPA 220-1999 for definition of non-combustible Type I and II building construction.
^② Fine Print Note, Article 450.23, (B) (1) states: "Installations adjacent to combustible material, fire escapes, or door and window openings may require additional safeguards such as those listed in Article 450.27"

General Description

UL Classification Marking for Envirotemp FR3 Fluid

Envirotemp FR3. Classed 4 to 5 less hazardous than paraffin oil in respect to fire hazard. Fire point 358 °C (676 °F). Ignition temperature 428 °C (802 °F).

Also classified as a “less-flammable liquid” as specified in the National Electrical Code when used in three-phase transformers, 45 through 10,000 kVA with the following “use restrictions”:

1. For use only in three-phase transformers having tanks capable of withstanding an internal pressure of 12 psig without rupture.
2. Required use of pressure relief devices on transformer tank in accordance with the following tabulation to limit internal pressure buildup and prevent tank rupture due to gas generation under low current arcing faults

3. Required use of current limiting fusing in the transformer primary having I²t characteristics not exceeding the values in the following tabulation. Under-fluid expulsion fuses may be used in series with the current-limiting fuses, in accordance with the manufacturer’s protection scheme
4. Required use of overcurrent protection in the transformer primary having I²t characteristics not exceeding the values in the following tabulation. If the fuse is designed to vent during operation (such as an expulsion fuse), it shall be located external to the transformer tank.

Primary Overcurrent Protection Options

Primary protective devices are applied to distribution transformers in order to:

1. Prevent injury to personnel.
2. Prevent or minimize damage to equipment.
3. Improve the continuity of service by selectively controlling outages.

Factors that affect the protection scheme are:

1. Industry standard.
2. Customer’s specification.
3. Customer’s system configuration (available fault current, system voltage, system connection, and so on.)
4. Availability of equipment.

The first consideration in determining the ampere rating of a fuse is to verify that the fuse in question is capable of withstanding typical inrush currents without element damage. When a transformer is energized, it is exposed to very large currents for very short periods of time. These currents are known as magnetizing inrush (or fuse withstand) and cold load pickup, and are a result of the transformer’s magnetic circuit, the electrical system configuration and the connected load.

The second consideration for selecting the fuse ampere rating is the maximum load current the fuse is expected to carry without damage. Transformer fusing tables available from the manufacturer normally list the range of overload provided. If the longtime minimum melt current for a particular fuse size is known, it can be compared to the transformer rated current to determine the exact amount of overload permitted. An ambient of 25 °C–40 °C is generally assumed for application tables. Care should be taken when fuses are applied in higher ambient conditions, which may reduce the amount of overload permitted. To accommodate the overload and derating factors referred to, the following ratios are used on general-purpose CL fuses.

Table 17.0-5. UL Classification Marking for Envirotemp FR3 Fluid

Transformer Three-Phase Transformer Rating kVA	Required Protection			Required PRC Minimum Required Pressure Relief Capacity, ② SCFRM at 15 psi
	Required Current Limiting Fusing ① Maximum I ² t (A ² s)	OR	Required Overcurrent Protection ① Maximum I ² t (A ² s)	
45	500,000		700,000	35
75	500,000		800,000	35
112.5	550,000		900,000	35
150	600,000		1,000,000	50
225	650,000		1,200,000	100
300	750,000		1,400,000	100
500	900,000		1,900,000	350
750	1,100,000		2,200,000	350
1,000	1,250,000		3,400,000	350
1,500	1,500,000		4,500,000	700
2,000	1,750,000		6,000,000	700
2,500	2,000,000		7,500,000	5,000
3,000	2,250,000	9,000,000	5,000	
3,750	2,500,000	11,000,000	5,000	
5,000	3,000,000	14,000,000	5,000	
7,500	3,000,000	14,000,000	5,000	
10,000	3,000,000	14,000,000	5,000	

① This is an additional requirement to the overcurrent protection required in accordance with Section 450.3 of the current National Electrical Code.

② Opening pressure, 10 psig maximum.

Contact Eaton for FM approval guidelines.

General Description

Nameplate current rating of fuse/
nameplate current rating of transformer
= 1.25 for enclosures surrounded by
air (EFD, clip mount, arc-strangler).

Derating factors are not applied to
expulsion or backup CL fuses because
high temperature has minimal effect
on their operation.

Finally, it is necessary to verify
that the fuse current rating under
consideration will, in fact, operate
prior to the transformer sustaining
any permanent thermal damage
(conductor or insulation burning or
melting). This is done by comparing
the total clearing characteristics of
the fuse in question with the IEEE (I²t)
damage line.

It is important that the total clearing
characteristics of the device under
consideration lie to the left of the
damage line for all expected values
of fault current. Note that most fuse
characteristics will cross the damage
line at some point. It is important to
make this occur at the lowest possible
value of the current.

The interrupting rating of a device is a
measure of the maximum symmetrical
fault current at which the device can
successfully clear a fault condition
without excessive damage to itself,
the equipment it is protecting or
the surrounding environment.

It is extremely critical that the
interrupting rating of a device be
greater than the maximum available
symmetrical fault current. For devices
applied to the transformer primary,
the maximum fault current must be
supplied by the utility because this
value is dependent on the electrical
system configuration.

Bay-O-Net-Type Expulsion Fuse

- Oil immersed
- Drawout for fuse replacement
- Hookstick operable, load-break design
- Available with load-sensing dual element or fault sensing

Bay-O-Net fuse assemblies are used to
protect transformers and distribution
systems. They are designed for use
in pad-mounted or sub-surface fluid
filled distribution transformers.
The assemblies combine the ease
of hotstick operation with the safety
of deadfront construction. See
Figures 17.0-9 through **17.0-11**.

Removal of the fuse holder from the
assembly indicates that the apparatus
is electrically disconnected. It also
allows convenient fuse element
inspection and replacement.

The Flapper™ Bay-O-Net Assembly
(available as sidewall-mounted only)
includes a flapper valve inside the
housing, which closes when the fuse
holder is removed, thus minimizing
oil spillage.

Table 17.0-6. Bay-O-Net Fuse Electrical Ratings

kV Rating	Specification
-----------	---------------

Electrical Ratings

23	150 kV BIL and full wave crest 50 kV 60 Hz, AC, 1-minute withstand
38	200 kV BIL and full wave crest 70 kV 60 Hz, AC, 1-minute withstand

Maximum Single-Phase Interrupting Ratings ①

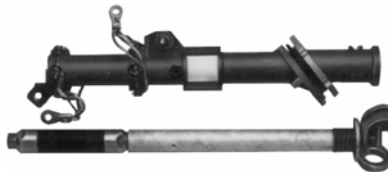
8.3	2500 A rms symmetrical
15.5	1500 A rms symmetrical ②
23	1000 A rms asymmetrical— cover mount
38	900–1000 A rms symmetrical

Load Break Ratings (Phase-to-Phase at 80% PF)

10.0	160 A
15.5	150 A
26.7	80 A
34.5	50 A
38	50 A

① With Cooper Power series Bay-O-Net fuse links only.

② Except high ampere overload links, which are rated at 2000 A rms symmetrical.



Bay-O-Net-Type Fuse Assembly

Partial Range Current Limiting Fuses

- Oil immersed, internally block mounted
- Applied in series with an expulsion type fuse (Bay-O-Net type—see above)
- Protection against tank rupture

The current-limiting backup fuse
is used in series with low-current
primary protection devices such as
an expulsion Bay-O-Net fuse.

The fuse's highly efficient current-
limiting section minimizes the effects
of high fault current stresses on
equipment and the distribution
system. Its minimum interrupting
rating is coordinated with that of a low
current interrupter to avoid undesirable
low current operation; yet its maximum
interrupting rating will clear the highest
fault currents likely to occur. Higher
continuous current ratings can be
achieved by connecting two fuses
in parallel.

The current-limiting fuse is used in
transformers to protect and isolate
faulted equipment. When connected
in series with a low current primary
protection device, the fuse becomes
an element of a two-part protection
system that gives a full range of
fault protection. This is not only an
economical solution, but is safer than
many alternatives as well.

Table 17.0-7. Current-Limiting Backup Fuse Electrical Ratings and Characteristics

Fuse Type	Maximum Interrupting Current
Backup (partial range) "C" rated	50,000 A rms symmetrical ③

③ See **Table 17.0-8** for fuses with ratings other than 50,000 amperes rms symmetrical.

This two-part system provides low
current protection with the replaceable
expulsion fuse and it adds the energy-
limiting protection of a current-limiting
fuse. Together, they coordinate easily
with upstream and downstream devices.

General Description

Table 17.0-8. Current-Limiting Backup Fuse Interrupting Ratings

Continuous Current Rating (A)	8.3 kV			9.9 kV			15.5 kV		
	Minimum Interrupting Capacity (A)	Minimum Melt I ² t (A2*s)	Maximum Clear I ² t (A2*s)	Minimum Interrupting Capacity (A)	Minimum Melt I ² t (A2*s)	Maximum Clear I ² t (A2*s)	Minimum Interrupting Capacity (A)	Minimum Melt I ² t (A2*s)	Maximum Clear I ² t (A2*s)
30	200	1,800	9,400	200	1,800	9,500	200	1,800	10,000
40	250	2,900	14,000	250	2,900	14,000	250	2,900	19,000
50	330	6,300	30,000	330	6,300	30,000	330	6,300	33,000
65	400	9,300	33,000	400	9,300	34,000	400	9,300	40,000
80	300	11,600	56,000	300	11,600	56,000	350	11,600	62,000
100	450	20,600	76,000	450	20,600	76,000	450	20,600	116,000
125	470	32,100	120,000	—	—	—	500	32,100	150,000
150	700	58,500	290,000	—	—	—	700	58,500	260,000
165	800	82,200	395,000	—	—	—	800	82,200	365,000
180	900	103,100	485,000	—	—	—	900	103,100	445,000
250	1,000	148,500	690,000	—	—	—	—	—	—
250 ①	—	—	—	—	—	—	1100	128,500	500,000
300 ①	1,300	234,200	1,280,000	—	—	—	1230	234,200	1,300,000
330 ①	1,500	328,900	1,700,000	—	—	—	—	—	—
360 ①	1,800	412,500	2,100,000	—	—	—	—	—	—
500 ①	2,000	594,000	2,500,000	—	—	—	—	—	—

Continuous Current Rating (A)	17.2 kV			23 kV			38 kV		
	Minimum Interrupting Capacity (A)	Minimum Melt I ² t (A2*s)	Maximum Clear I ² t (A2*s)	Minimum Interrupting Capacity (A)	Minimum Melt I ² t (A2*s)	Maximum Clear I ² t (A2*s)	Minimum Interrupting Capacity (A)	Minimum Melt I ² t (A2*s)	Maximum Clear I ² t (A2*s)
30	200	1,800	10,000	200	1,800	12,000	—	—	—
40	250	2,900	19,500	250	2,900	20,000	—	—	—
50	330	6,300	34,000	330	6,300	39,000	450	3,870	30,600
65	400	9,300	42,000	400	9,300	44,000	490	7,160	39,300
80	350	11,600	62,000	300	11,600	70,000	625	11,450	60,700
100	450	20,600	116,000	450	20,600	120,000	635	16,100	80,500
120	—	—	—	—	—	—	700	21,200	118,000
125	500	32,100	150,000	465	32,100	180,000	—	—	—
140	—	—	—	—	—	—	800	36,240	163,000
150	—	—	—	700	58,500	320,000	—	—	—
165	—	—	—	900	82,200	430,000	—	—	—
250 ①	—	—	—	900	128,500	650,000	—	—	—
300 ①	—	—	—	1200	234,200	1,300,000	—	—	—
330 ①	—	—	—	1500	328,900	1,700,000	—	—	—

① Parallel fuses.

Notes: The 8.3 kV, 80 A and 100 A ratings have been tested and approved for application at 9.9 kV. The 15.5 kV, 80 A through 125 A ratings have been tested and approved for application at 17.2 kV. The maximum interrupting rating for the 15.5 kV fuse, 80 A through 125 A at 17.2 kV is 43 kA. For the 23 kV, 250 A fuse (parallel 125 A) the maximum interrupting rating is 12 kA.

General Description

Pad-Mounted VFI Transformer

Eaton's Cooper Power series VFI transformer combines a conventional distribution transformer with the proven Vacuum Fault Interrupter (VFI). This combination provides both voltage transformation and transformer over-current protection in one space-saving and money-saving package. The pad-mounted VFI transformer protects the transformer and provides proper coordination with upstream protective devices. When a transformer fault or overload condition occurs, the VFI breaker trips and isolates the transformer. The three-phase VFI breaker has independent single-phase initiation, but is three-phase mechanically gang-tripped. A trip signal on any phase will open all three phases. This feature eliminates single-phasing of three-phase loads. It also enables the VFI breaker to be used as a three-phase load break switch.

Due to the resettable characteristics of the VFI breaker via the tri-phase control, restoring three-phase service is faster and easier. The tri-phase control offers over 100 minimum trip settings and an assortment of time-current curves. With standard instantaneous trip, optional ground trip and minimum response characteristics, the tri-phase control will satisfy system protection and coordination needs. A wide selection of TCCs and minimum trip settings make it easily adaptable to distribution systems. The optional SCADA accessory can provide minimum trip multiplier, inrush restraint, ground trip block during inrush restraint, and local phase and ground trip targets and remote trip capabilities.

An optional relay may be installed in lieu of the tri-phase control, offering more flexibility and features to control the primary overcurrent protection by the VFI. In addition to primary protection, secondary CTs may be installed and wired back to the VFI to trip on a secondary overcurrent and to provide additional protection against arc flash downstream when properly set up.

A sealed visible break window and switch is an option that can be installed to provide visible break. This feature allows an operator to see if the load-break switch contacts are in an open or closed position before performing maintenance.



Three-Phase Pad Mounted VFI Transformer with Operating Handle and Control on Door Interior



Three-Phase Pad Mounted VFI Transformer Transparent View

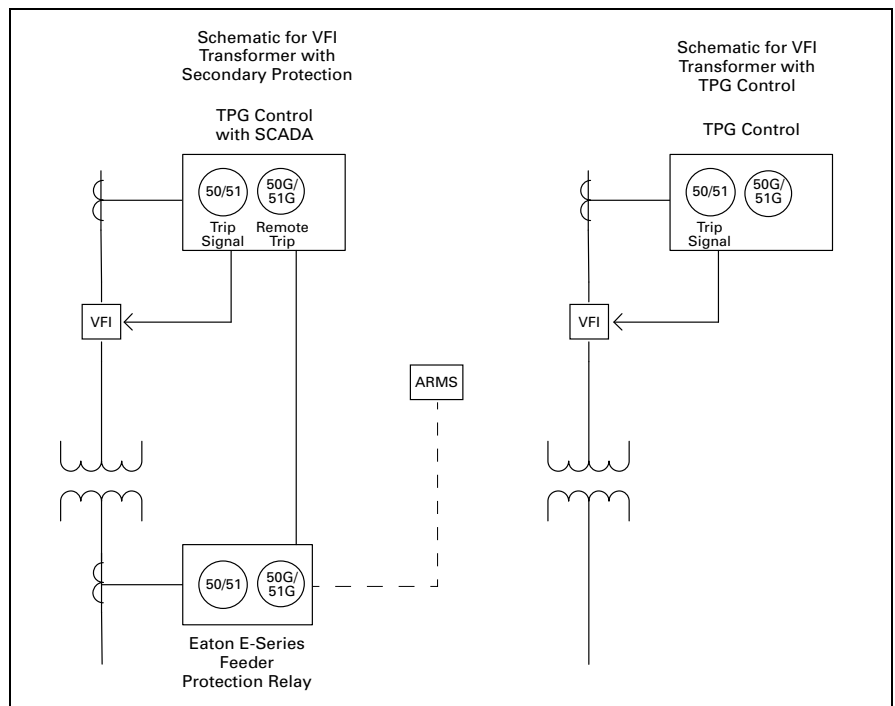


Figure 17.0-1. VFI Schematics with Arcflash Reduction Maintenance System™

Table 17.0-9. Ratings for VFI Switchgear and Load-Break Switch

Nominal Voltage		15 kV	15 kV	25 kV	35 kV
Maximum design voltage, kV		15.5	15.5	27.0	38.0
BIL, kV		95	95	125	150
1-minute withstand voltage (60 Hz), kV		35	35	60	70
Momentary current, 10 cycles (sym.), kA		12.5	16.0	12.5	12.5
Vacuum fault interrupter	Continuous current, (max.), A	600	600	600	600
	Interrupting current (sym./asym.), kA	12.5/20.0	16/25.8	12.5/20.0	12.5/20.0
	Making current (sym.), kA	12.5	16.0	12.5	12.5
	Cable charging interrupting current, A	10.0	10.0	25.0	40.0
Load-break switch	Continuous current, (max.), A	600	600	600	600
	Load switching, A	600	600	600	600
	Fault making (sym./asym.), kA	12.5/20.0	16/25.8	12.5/20.0	12.5/20.0

General Description

Primary Switching Options

There are three types of load-break switches: two-, three-, and four-position. The switch mechanism uses a manually charged over-toggle stored spring assembly, which is independent of operator speed. The spring-loaded activating mechanism ensures quick load-break or load-make operation in less than one cycle. The two-position switch is hotstick operable and requires minimal input torque to operate. The switch is mounted near the core and coil assembly for low cable capacitance. With simultaneous three-phase switching, the possibility of ferroresonance is reduced.

The two-position on-off switch may be used on radial or loop-feed systems. They may be installed as a single switch, two switches for selection between two sources or limited sectionalizing capability or three switches for more comprehensive sectionalizing.

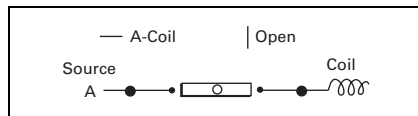


Figure 17.0-2. Two-Position Switch

The three-position switch is for selecting between two sources feeding the transformer and requires no interlocking to keep the two sources from being simultaneously connected.

The four-position sectionalizing switch allows sectionalizing with a single switch instead of three on-off switches. There are two types, a T-blade configuration and a V-blade configuration. Note their optional positions in **Figures 17.0-3 and 17.0-4.**

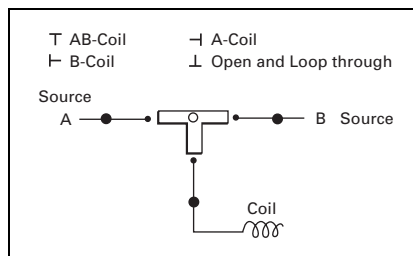


Figure 17.0-3. Four-Position Switch (Loop Feed) "T Blade"

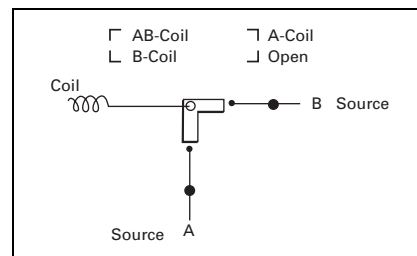


Figure 17.0-4. Four-Position Switch (Loop-Feed) "V Blade"

Table 17.0-10. Two-Position Load-Break Switches

Description	Units	Ratings				
Rated voltage	Phase to phase	kV	15.5	27.6	8	46
	Phase to ground	kV	8.9	15.6	21.9	26.5
Impulse withstand voltage (1.2/50 μs)	kV	200	200	200	200	
Power frequency withstand (1 minute)	kV	70	70	70	70	
Continuous current	A	550	400	300	65	
Switching current	A	550	400	300	65	
Fault withstand current (momentary)— 10 cycle sym.	kA	12	12	12	12	
1 second sym. rms	kA	8	8	8	8	
Fault close and latch— 10 cycle sym.	kA	—	12	12	12	
Fault close and latch— 15 cycle sym.	kA	12	—	—	—	

Table 17.0-11. Three- and Four-Position Load-Break Switches

Description	Units	Ratings			
Rated voltage	Phase to phase	kV	15.5	27.8	38
	Phase to ground	kV	9	17.2	21.9
Impulse withstand voltage (1.2/50 μs)	kV	95	125	150	
Power frequency withstand (1 minute)	kV	35	60	70	
Continuous current	A	630	300	200	
Switching current	A	630	300	200	
Fault withstand current (momentary)— 10 cycle sym.	kA	12.5	12.5	12.5	
1 second sym. rms	kA	12.5	12.5	12.5	
Fault close and latch— 10 cycle sym.	kA	12.5	12.5	12.5	

General Description

Externally Operable Visible Break Load-Break Switch and Gauges

Every day, operators are exposed to the risk of dangerous arc flash when breaking load inside the transformer termination compartment. In addition, maintenance on traditional three-phase pad-mounted transformers can be time consuming and costly. With the external visible load-break option from Eaton, operators can more easily and safely verify an electrical disconnection through an external viewing window. The external visible load-break switch box mounts on the side of the transformer, away from exposure to live circuits. The viewing window allows for a clear view of the disconnected load-break switch without having to access the termination compartment. Avoiding entering the transformer termination compartment reduces the level for wearing additional protective equipment. A qualified individual can simply open the externally operable load-break switch to easily verify, through the external viewing window, that the low voltage bushings have been de-energized. The optional on/off/ground feature also allows the end user to internally ground the transformer windings to the tank, using the load-break switch. ①

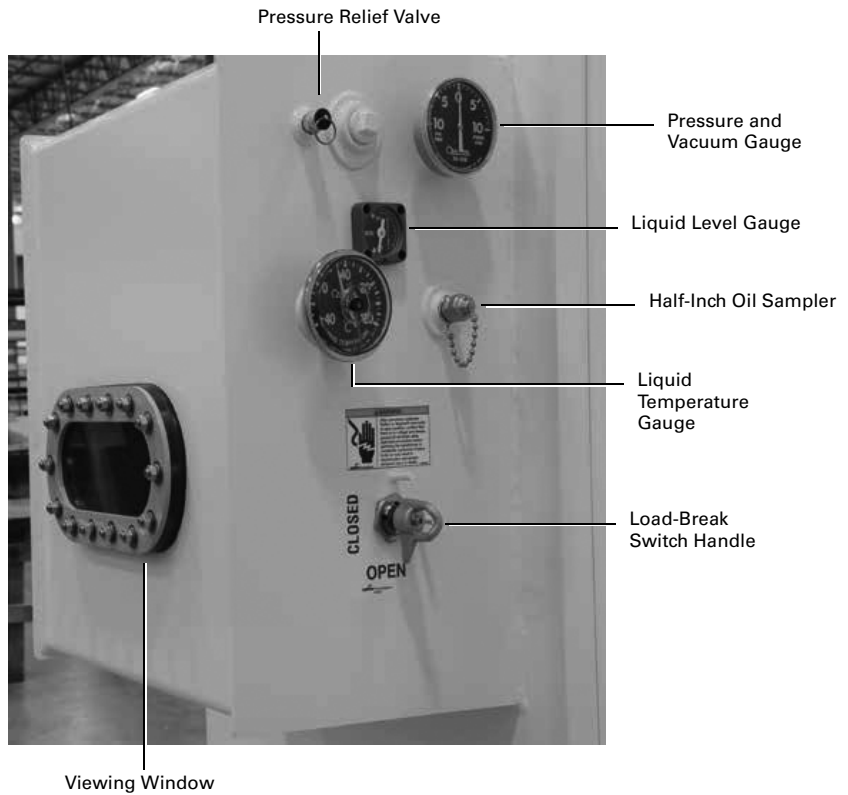
The visible load-break assembly includes:

- Large viewing window for quick verification of circuit isolation
- Rotary handle for operating the isolating contacts
- Gauges mounted on box, shielded with padlockable cover, for easy access

Eaton also offers options for simply locating gauges, pressure relief device and drain valve and sampler external to the low voltage termination compartment less the load-break switch.

Note: The transformer tank must be externally grounded.

① Covers for switch, viewing window, and gauges not shown.



Three-Phase Pad Mounted Transformer with Externally Operable Visible Break Load-Break Switch with Gauges

General Description

PEAK Transformers**Product Description**

Eaton's Cooper Power series PEAK™ transformers are uniquely designed to provide additional capability for managing increased loads and temporary overloads without accelerating loss of insulation system life when compared to mineral oil-filled transformer alternatives. Two options are currently available for PEAK transformers, both utilizing an advanced high-temperature insulation system comprised of thermally upgraded kraft paper, biodegradable Envirotemp™ FR3™ dielectric fluid, and an optimized core and coil design.

Application Description

- For applications where additional overload capacity is most important—to manage increased loads or peak demand—a 65/75 °C (Average Winding Rise) AWR or 55/75 °C AWR PEAK transformer is recommended
- For applications where a smaller footprint and a lighter transformer—capable of the same ratings as a physically larger 65 °C AWR rated unit—are desired, a 75 °C AWR PEAK transformer is recommended

Features, Benefits and Functions**Increased Overload Capacity**

- Customers are now able to operate PEAK three-phase transformers 12% beyond full rated base load with a 65/75 °C AWR slash-rating. Customers are able to operate PEAK three-phase transformers 22% beyond full-rated base load with a 55/75 °C AWR slash rating. These options allow customers to more precisely size transformers based on periods of peak demand—without accelerated reduction of insulation life
- PEAK transformers can perform at higher kVA ratings than traditional mineral oil-filled units
- Aging equipment can be more easily replaced to add increased reliability to an existing system for long-term distribution planning

Increased Load Capacity

PEAK 65/75 °C AWR transformers are designed to accommodate heavier base loading for extended periods of time without accelerating loss of insulation system life. You can load PEAK three-phase transformers 12% beyond full rated base load while maintaining IEEE Std C57.91™ - 2011 standard per unit life requirement. PEAK three-phase transformers can operate at 22% beyond full-rated base load with a 55/75 °C AWR slash rating.

Increased Reliability

Moisture and thermal stress are the enemy of transformer insulation system life. PEAK transformer's superior moisture and thermal stress managing capabilities allow for extended insulation system life, which contributes to better overall system reliability by reducing the frequency of outages due to transformer failures.

- 75 °C AWR designs offer transformer insulation system life extension of up to 4 times that of the IEEE-20.55 year life requirement
- 65/75 °C AWR designs offer transformer insulation system life extension of up to 8 times that of the IEEE-20.55 year life requirement, when operated at the base kVA rating
- Soybean oil-based fluid creates barrier against water at the surface of the insulation, helping to protect the kraft paper in the windings from thermal degradation, resulting in insulation extended life
- Filled with a soybean oil-based dielectric fluid—recognized by UL and FM Global as a less flammable fluid—providing significantly enhanced fire safety
- More than 15 years of field experience with no reported fires in Envirotemp FR3 fluid-filled transformers

Smaller, Lighter Transformers

When compared to traditional 65 °C AWR transformers of the same kVA rating, 75 °C AWR PEAK transformers have the ability to be smaller and lighter. These units will typically use less material and fewer gallons of dielectric fluid resulting in better value, as well as lower handling and operating costs.

- Easier to handle and install
- Lower crane/hoisting costs
- Simplifies retrofitting efforts
- Eliminates need to upgrade utility poles
- Accommodates doorway and elevator constraints
- Eliminates need for larger concrete pad

Product Scope

- 75 °C AWR (Average Winding Rise)
- 65/75 °C AWR
- 55/75 °C AWR, available three-phase only
- 5–167 kVA single-phase pole-mount transformers
- 5–167 kVA single-phase pad-mount transformers
- 45–12,000 kVA three-phase pad-mount transformers
- 500–6667 kVA single-phase substation transformers
- 300–12,000 kVA three-phase substation transformers

Transformer Standard

The IEEE Std C57.154-2012 standard, covering the design, testing, and applications of transformers operating at elevated temperatures, such as the PEAK transformer, was published October 30, 2012.

General Description

PEAK Transformers (Continued)

The example below illustrates the potential footprint change in three-phase pad-mounted transformers.

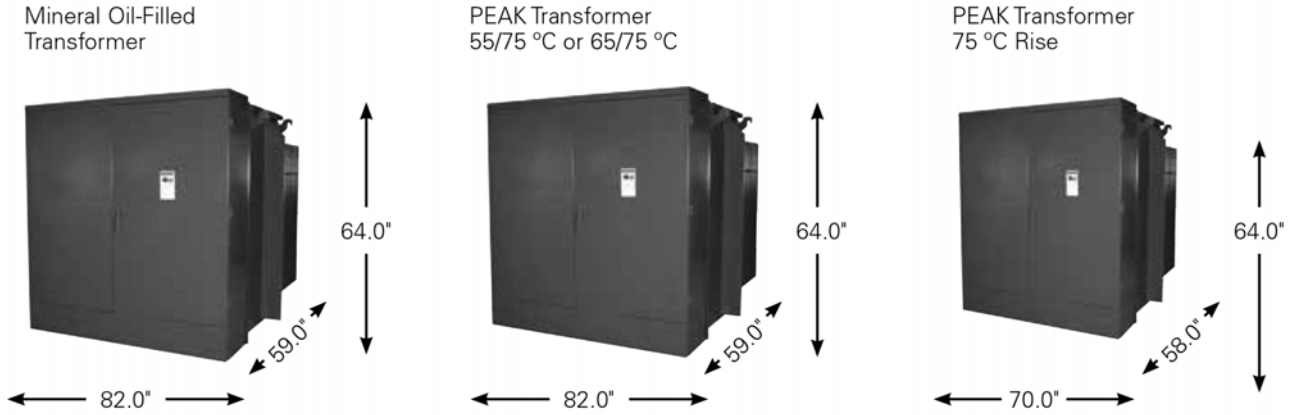
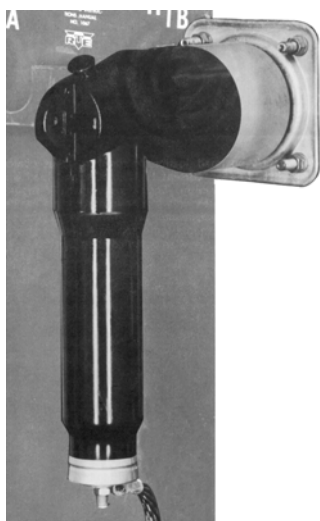


Table 17.0-12. PEAK Transformer Comparison

Description	Mineral Oil	PEAK 75 °C	PEAK 65/75 °C	PEAK 55/75 °C
Three-phase load capacity	IEEE Std C57.91-2011 standard	IEEE Std C57.91-2011 standard	+12% continuous (above base kVA rating)	+22% continuous (above base kVA rating)
Life extension	1x	3-4x	8x (when operating at base kVA rating)	8x (when operating at base kVA rating)
Enhanced fire safety	—	■	■	■
Environmentally preferred	—	■	■	■
First price	Lowest	Lower	Low	Low
Lifetime cost of ownership	Low	Lower	Lowest	Lower
Bioremediation cost	High	Moderate	Moderate	Moderate

Note: All values are design dependent.

General Description

*Deadfront Elbow Arrester***Surge Arresters**

Eaton distribution class surge arresters are supplied on transformers when specified. Transformers with livefront configuration have mounting nuts welded on the tank wall for arrester mounting.

Metal Oxide Varistor Elbow M.O.V.E. Deadfront Arrester

Surge protection is available without losing deadfront construction in the cabinet. The Eaton type M.O.V.E. arrester is completely deadfront. It is compact, and is usable wherever a load-break elbow can be used.

The highly nonlinear characteristics of the varistor elements provide more precise and predictable operating characteristics.

Because it is fully shielded and deadfront, it is mountable at any angle and is submersible rated. Its durable rubber construction means there are no fragile porcelain skirts to chip or crack. The M.O.V.E. arrester is available in ratings from 3 kV to 36 kV.

M.O.V.E. surge arresters are available with 200 A interfaces for installing on 200 A load-break inserts that are installed in 200 A bushing wells, as well as on 200 A feed-through inserts 3–21 kV. 18–36 kV M.O.V.E. surge arresters may be installed on 35 kV 200 A integral load-break bushings.

M.O.V.E. surge arresters are available with a 600 A interface for installing on 600 A or 900 A dead-break bushings. 27–36 kV ratings are available ratings.

Eaton's Cooper Power™ series load-break elbow connector is a fully shielded and insulated plug-in termination for connecting underground cable to transformers, switching cabinets and junctions equipped with load-break bushings. The elbow connector and bushing insert comprise the essential components of all load-break connections. The load-break elbow connector is a fully rated 200 A switching device, designed in accordance to IEEE Std 386™ standard. Connectors are available in 15/25/35 kV ratings and is now available through 200 kV BIL.

Eaton's load-break elbows are molded using high-quality peroxide-cured insulating and semiconducting EPDM rubber. Standard features include a coppertop connector, tin-plated copper load-break probe with an ablative arc-follower tip and stainless steel reinforced pulling-eye. An optional capacitive test point, made of corrosion-resistant plastic, is available for use with fault indicators.

The optional integral jacket seal provides a quick and easy means to sealing the cable jacket to prevent moisture ingress.

Cable ranges are designed to accept a wide range of cable conductor and insulation sizes up to a 4/0 conductor size

Cooper Power series 600/900 A, 15/25/35 kV Class BOL-T™ dead-break connector is fully shielded, submersible and meets the requirements of IEEE Std 386 "Separable Insulated Connector Systems" Ratings now available up through 200 kV BIL. It accepts cable sizes through 1250 kcmil.

Cooper Power series 600/900 A 15/25/35 kV Class BT-TAP™ dead-break connector is designed for use to retrofit existing 600 A BOLT installations or in new installations where a 200 A interface is required and where the system will not need to have the connectors frequently removed and reinstalled. If the system will have connectors frequently removed and reinstalled to sectionalize or to achieve a visible break or ground, Eaton recommends its Cooper Power series T-OP™ II Connector System for easier removal and reinstallation. Ratings now available up through 200 kV BIL.

*600/900 A BOL-T Dead-Break Connector**600/900 A BT-TAP Dead-Break Connector*

General Description

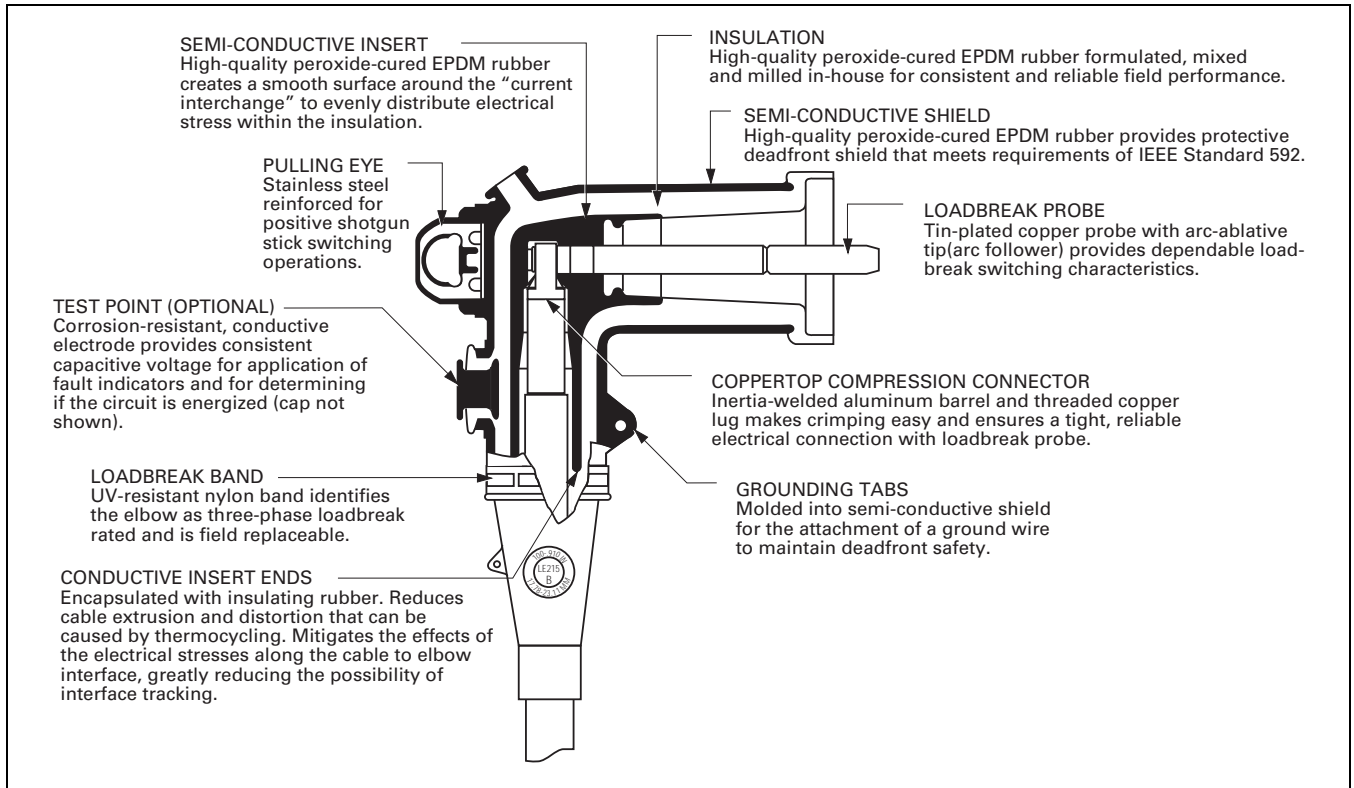


Figure 17.0-5. 200 A, 15 kV Class Load-Break Elbow Connector

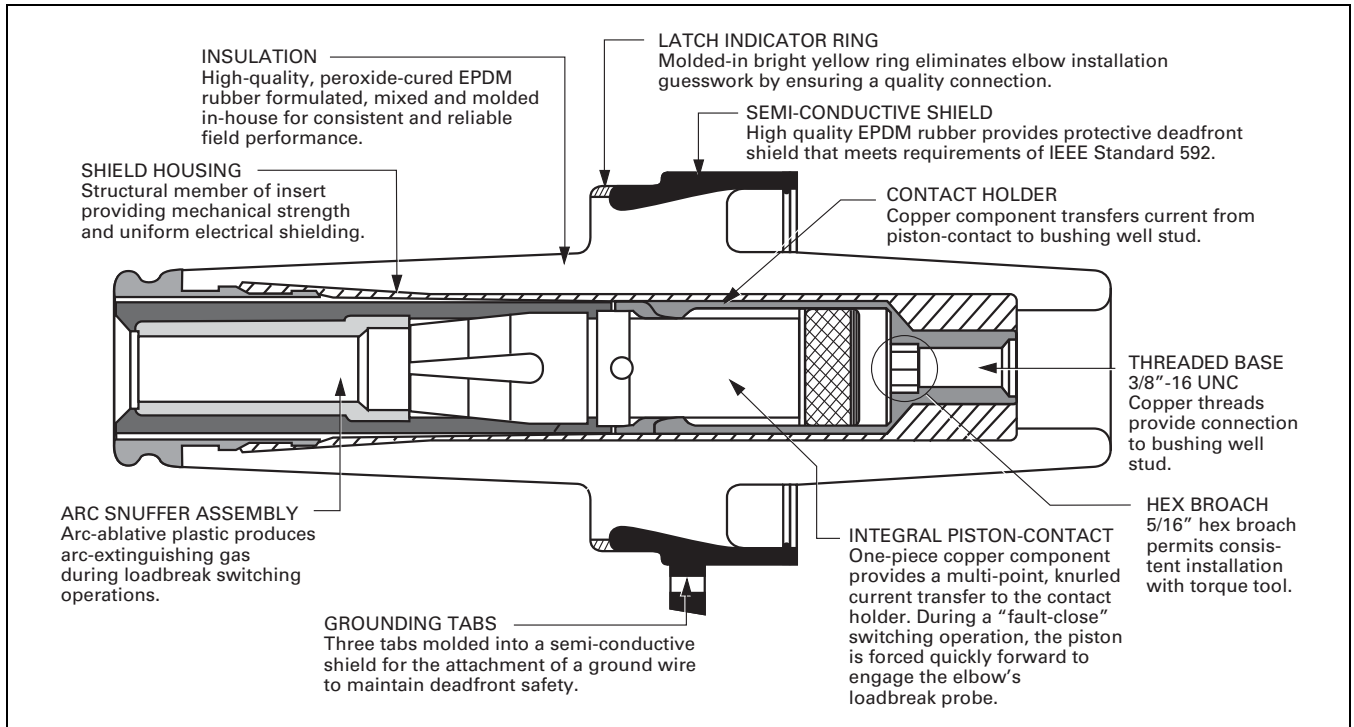


Figure 17.0-6. Bushing Well Insert Cutaway Illustrates Uncomplicated Nature of Current Path

General Description

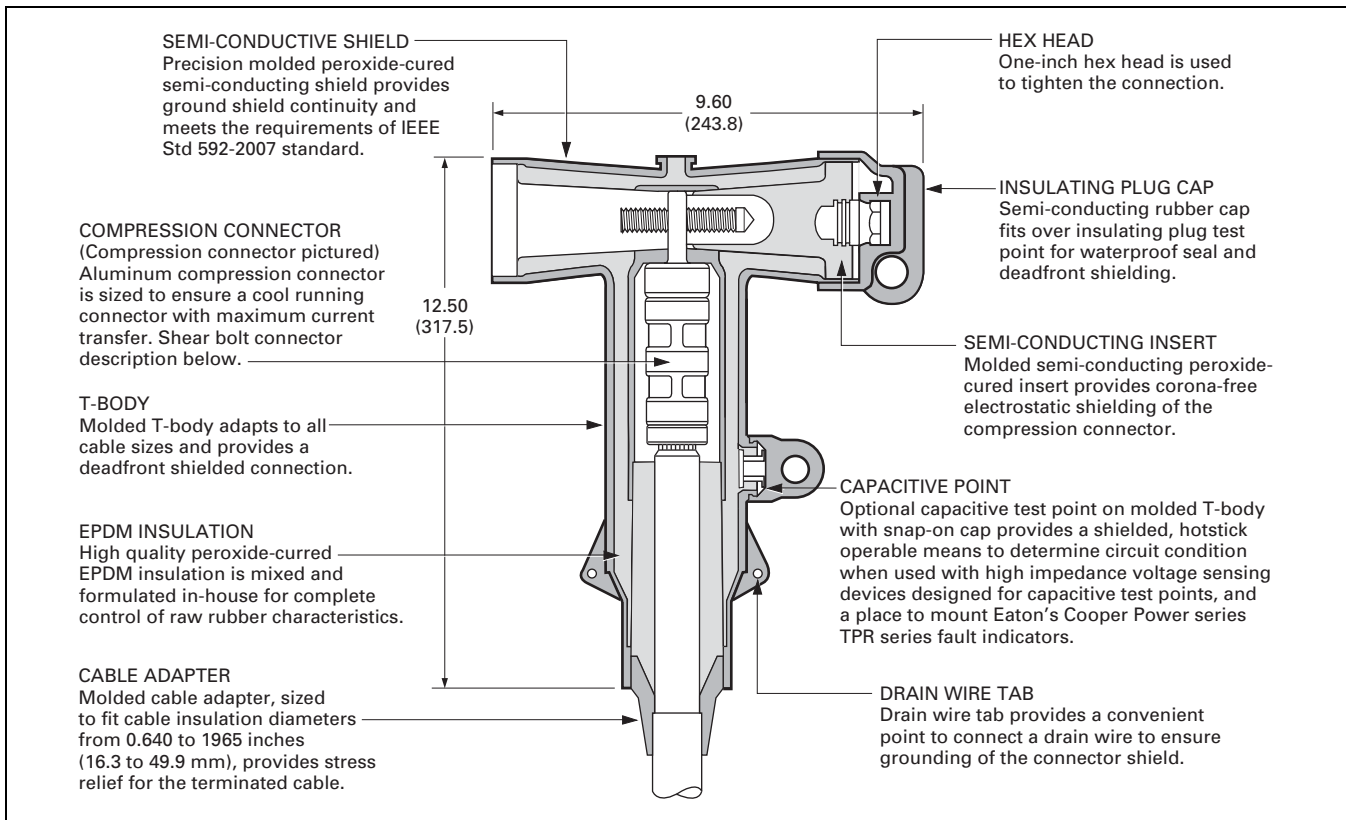


Figure 17.0-7. 600 A, 15/25 kV Class BOL-T Dead-Break Connector

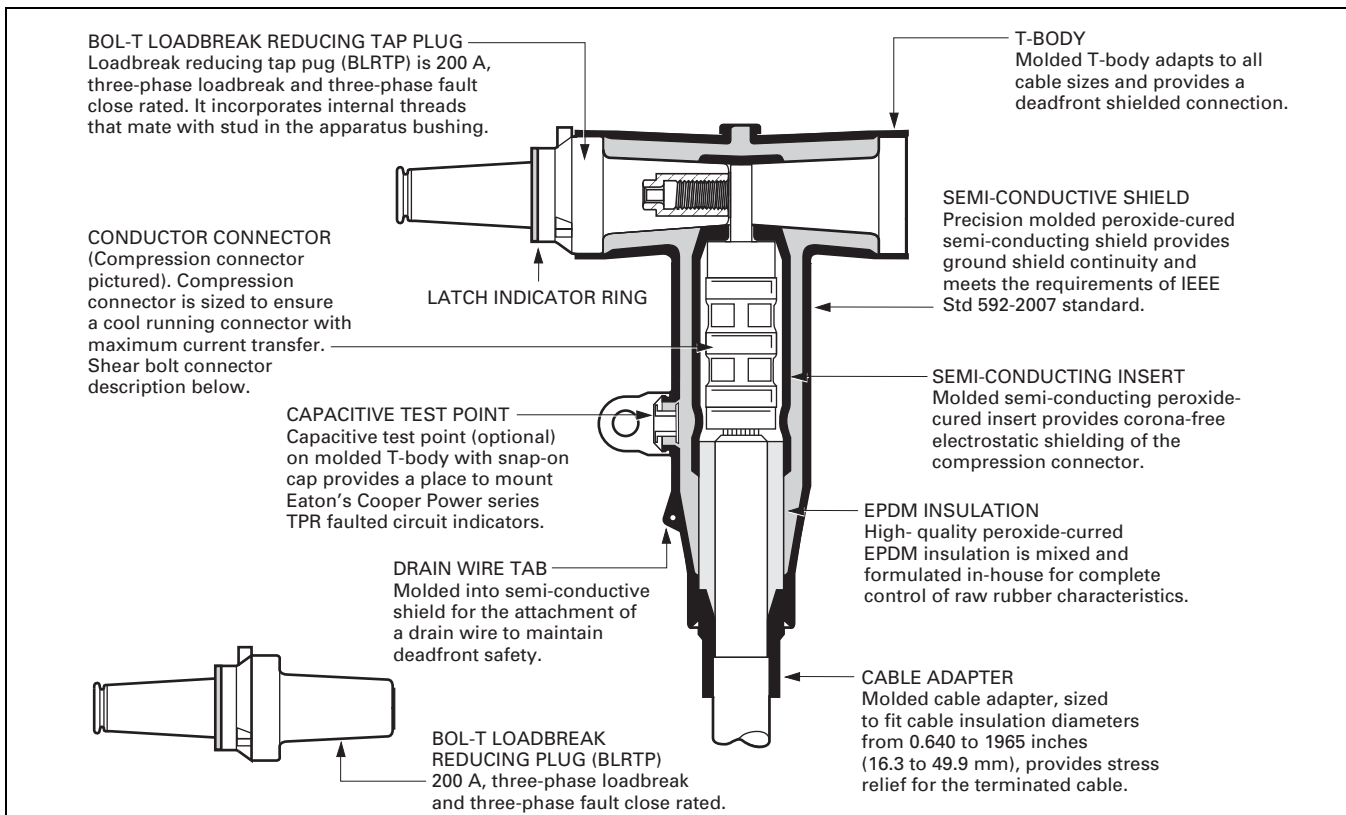


Figure 17.0-8. 600 A, 15 kV Class BT-TAP Dead-Break Connector

General Description

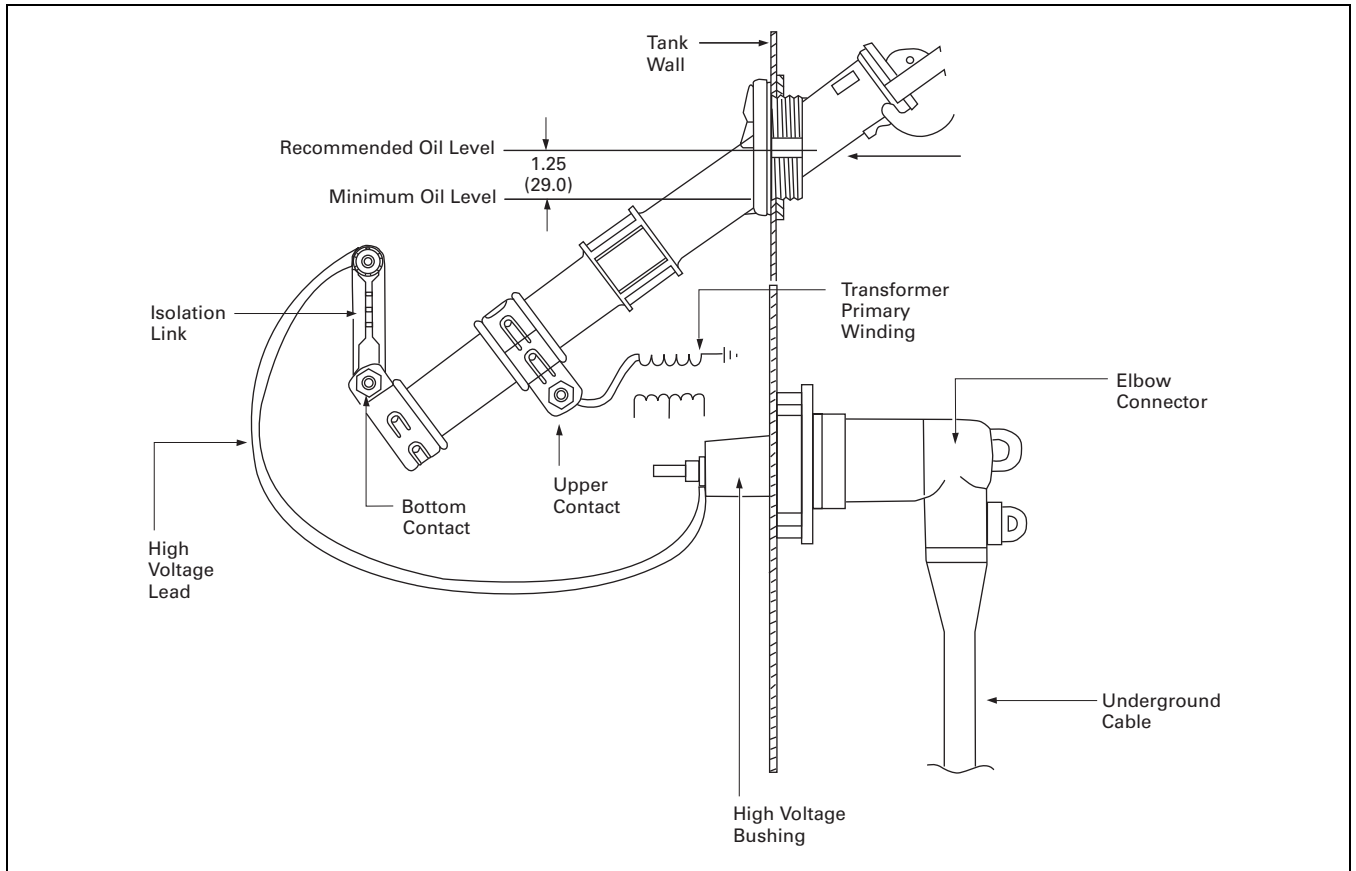


Figure 17.0-9. Bay-O-Net Assembly with Isolation Link

Note: Isolation link is not required if the Bay-O-Net fuse is used in series with a backup energy limiting fuse.

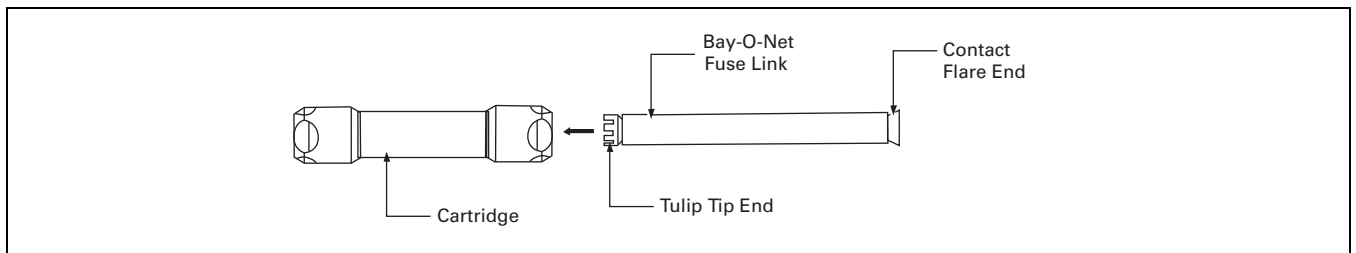


Figure 17.0-10. Insertion of Bay-O-Net Into Cartridge

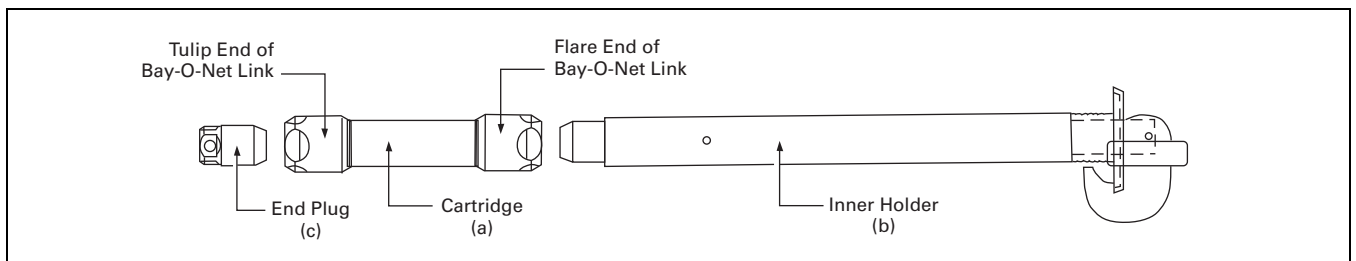


Figure 17.0-11. Assembly of Cartridge with Fuse Onto Inner Holder

Layout Dimensions

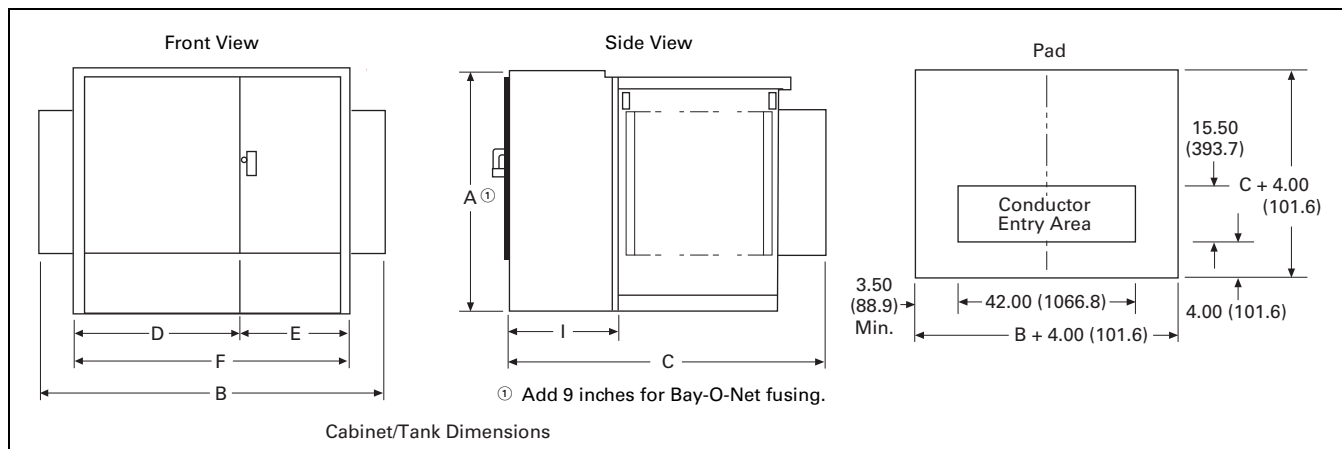


Figure 17.0-12. Pad-Mounted Transformer—Dimensions in Inches (mm)

Table 17.0-13. Dimensions with DOE Efficiency at 65 Degree AWR

kVA	A	B	C	D	E	F	I	Gallons	Approximate Weight	DOE 2016 Efficiency
45	50	68	39	42	26	68	20	115	2150	98.92%
75	50	68	39	42	26	68	20	125	2350	99.03%
112.5	50	68	39	42	26	68	20	135	2600	99.11%
150	50	68	49	42	26	68	20	150	2900	99.16%
225	50	72	53	42	30	72	20	170	3400	99.23%
300	50	72	55	42	30	72	20	190	3950	99.27%
500	50	72	61	42	30	72	20	240	5300	99.35%
750	64	72	63	42	30	72	20	300	7150	99.40%
1000	64	72	64	42	30	72	20	350	8950	99.43%
1500	73	89	71	42	30	72	24	400	11,450	99.48%
2000	73	101	75	42	30	72	24	525	13,800	99.51%
2500	73	101	99	42	30	72	24	600	16,750	99.53%

Note: The reference dimensions in this table cover the following: livefront and deadfront configurations, loop feed and radial feed, mineral oil and FR3 filled units.

Dimensional Variations

Height Variations

1. Add 9.00 inches (228.6 mm) to the height when using bayonet fusing on all kVA ratings.
2. Less flammable natural ester fluid requires deeper tanks on some transformer ratings.
 - a. Add 2.00 inches (50.8 mm) to the depth of kVA ratings 75–1500. Add 8.00 inches (203.2 mm) to the depth of kVA ratings 2000 and 2500.

Layout Dimensions/Technical Data

Technical Data

Table 17.0-14. Liquid Filled <34.5 kV Primary 55 °C Temp. Rise

kVA	No Load at 75 °C Ref. Temp. (Watts)	Load Loss at 100% Load and 75 °C Ref. Temp. (Watts)	Total Losses at 100% Load and 85 °C (Watts)	60–150 kV HV BIL Total Losses at 50% Load and 55 °C LL Ref. Temp. and 20 °C NL Ref. Temp. per DOE (Watts)
75	175	960	1135	413
112.5	250	1250	1500	562
150	300	1630	1930	696
225	330	2500	2830	942
300	520	2600	3120	1164
500	730	4900	5630	1889
750	1100	6200	7300	2567
1000	1500	6700	8200	3221
1500	1900	10,000	11,900	4375
2000	2600	12,000	14,600	5429
2500	2800	15,000	17,800	6408
3000	3800	16,000	19,800	—

Note: Losses offered are typical only, not guaranteed.

Table 17.0-15. Liquid Filled <34.5 kV Primary 65 °C Temp. Rise

kVA	No Load at 85 °C Ref. Temp. (Watts)	Load Loss at 100% Load and 85 °C Ref. Temp. (Watts)	Total Losses at 100% Load and 85 °C (Watts)	60–150 kV HV BIL Total Losses at 50% Load and 55 °C LL Ref. Temp. and 20 °C NL Ref. Temp. per DOE (Watts)
75	190	950	1140	413
112.5	260	1300	1560	562
150	320	1600	1920	696
225	400	2300	2700	942
300	500	3000	3500	1164
500	700	5000	5700	1889
750	1000	6500	7500	2567
1000	1300	8500	9800	3221
1500	1900	10,500	12,400	4375
2000	2100	14,500	16,600	5429
2500	2700	15,500	18,200	6408
3000	4000	18,000	22,000	—

Note: Losses offered are typical only, not guaranteed.

Table 17.0-16. Envirotemp FR3 <34.5 kV Primary 55 °C Temp. Rise

kVA	No Load at 75 °C Ref. Temp. (Watts)	Load Loss at 100% Load and 75 °C Ref. Temp. (Watts)	Total Losses at 100% Load and 85 °C (Watts)	60–150 kV HV BIL Total Losses at 50% Load and 55 °C LL Ref. Temp. and 20 °C NL Ref. Temp. per DOE (Watts)
75	175	960	1135	413
112.5	250	1250	1500	562
150	300	1630	1930	696
225	330	2500	2830	942
300	520	2600	3120	1164
500	730	4900	5630	1889
750	1100	6200	7300	2567
1000	1500	6700	8200	3221
1500	1900	10,000	11,900	4375
2000	2600	12,000	14,600	5429
2500	2800	15,000	17,800	6408
3000	3800	16,000	19,800	—

Note: Losses offered are typical only, not guaranteed.

Table 17.0-17. Envirotemp FR3 <34.5 kV Primary 65 °C Temp. Rise

kVA	No Load at 85 °C Ref. Temp. (Watts)	Load Loss at 100% Load and 85 °C Ref. Temp. (Watts)	Total Losses at 100% Load and 85 °C (Watts)	60–150 kV HV BIL Total Losses at 50% Load and 55 °C LL Ref. Temp. and 20 °C NL Ref. Temp. per DOE (Watts)
75	190	950	1140	413
112.5	260	1300	1560	562
150	320	1600	1920	696
225	400	2300	2700	942
300	500	3000	3500	1164
500	700	5000	5700	1889
750	1000	6500	7500	2567
1000	1300	8500	9800	3221
1500	1900	10,500	12,400	4375
2000	2100	14,500	16,600	5429
2500	2700	15,500	18,200	6408
3000	4000	18,000	22,000	—

Note: Losses offered are typical only, not guaranteed.

Table 17.0-18. DOE 2016 Transformer Efficiencies Three-Phase Liquid Filled Transformers

Three-Phase kVA	% Efficiency ^①
15	98.65
30	98.83
45	98.92
75	99.03
112.5	99.11
150	99.16
225	99.23
300	99.27
500	99.35
750	99.40
1000	99.43
1500	99.48
2000	99.51
2500	99.53

^① Based on transformer operating at 50% of nameplate base kVA.

Layout Dimensions

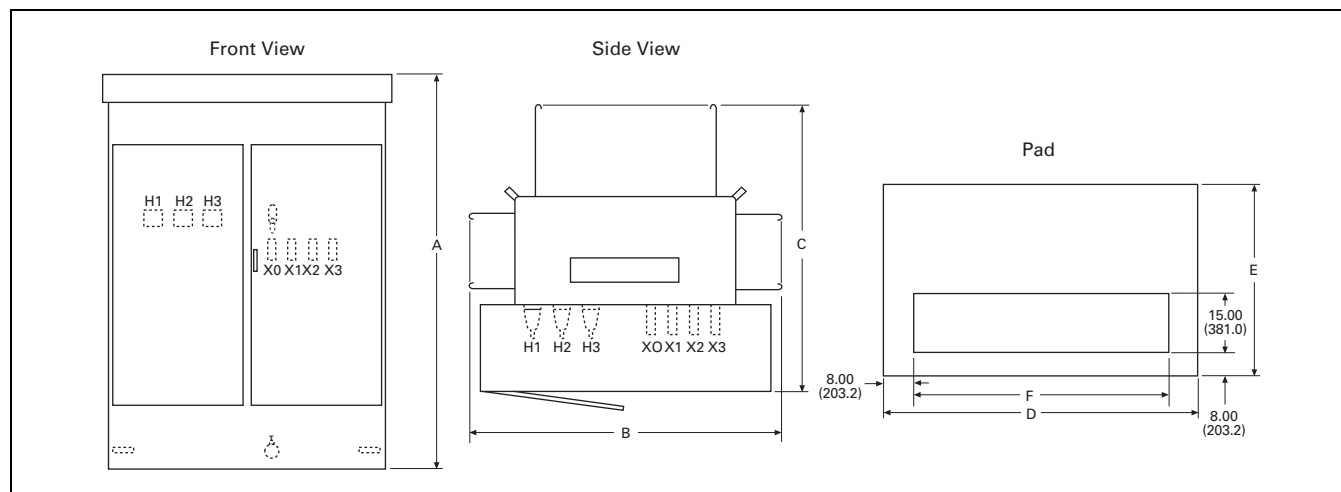


Figure 17.0-13. Pad-Mounted Transformer (3000–5000 kVA)—Dimensions in Inches (mm)

Table 17.0-19. Standard Unit, Oil-Immersed Rated 65 °C Rise, 3000–5000 kVA—Dimensions in Inches (mm)

kVA	Transformer			Pad			Approximate Weight Lb (kg)	Gallons (Liters) of Oil
	A	B	C ①	D	E ②	F		
15 kV Class, Delta Connected HV-HV 95 kV BIL, LV 30 kV BIL ③								
3000	76.00 (1930.4)	119.00 (3022.6)	100.00 (2540.0)	74.00 (1879.6)	72.00 (1828.8)	58.00 (1473.2)	12,900 (5851)	385 (1457)
3750	80.00 (2032.0)	82.00 (2082.8)	111.00 (2819.4)	79.00 (2006.6)	83.00 (2108.2)	63.00 (1600.2)	20,000 (9072)	540 (2044)
5000	78.00 (1981.2)	137.00 (3479.8)	108.00 (2743.2)	76.00 (1930.4)	80.00 (2032.0)	60.00 (1524.0)	21,500 (9752)	565 (2139)
15 kV Class, Wye Connected HV-HV 95 kV BIL, LV 30 kV BIL ③								
3000	74.00 (1879.6)	117.00 (2971.8)	102.00 (2590.8)	78.00 (1981.2)	74.00 (1879.6)	62.00 (1574.8)	15,000 (6804)	390 (1476)
3750	97.00 (2463.8)	81.00 (2057.4)	101.00 (2565.4)	81.00 (2057.4)	77.00 (1955.8)	65.00 (1651.0)	21,800 (9888)	550 (2082)
5000	91.00 (2311.4)	119.00 (3022.6)	108.00 (2743.2)	84.00 (2133.6)	80.00 (2032.0)	68.00 (1727.2)	22,000 (9979)	585 (2214)
25 kV Class, Delta Connected HV-HV 150 kV BIL, LV 30 kV BIL ③								
3000	83.00 (2108.2)	84.00 (2133.6)	101.00 (2565.4)	86.00 (2184.4)	74.00 (1879.6)	70.00 (1778.0)	15,400 (6985)	515 (1949)
3750	96.00 (2438.4)	84.00 (2133.6)	98.00 (2489.2)	86.00 (2184.4)	78.00 (1981.2)	70.00 (1778.0)	20,100 (9117)	650 (2461)
5000	101.00 (2565.4)	101.00 (2565.4)	107.00 (2717.8)	84.00 (2133.6)	79.00 (2006.6)	68.00 (1727.2)	22,900 (10,387)	670 (2536)
25 kV Class, Wye Connected HV-HV 125 kV BIL, LV 30 kV BIL ③								
3000	84.00 (2133.6)	80.00 (2032.0)	102.00 (2590.8)	80.00 (2032.0)	74.00 (1879.6)	64.00 (1625.6)	16,300 (7394)	450 (1703)
3750	93.00 (2362.2)	85.00 (2159.0)	99.00 (2514.6)	84.00 (2133.6)	78.00 (1981.2)	68.00 (1727.2)	21,200 (9616)	575 (2177)
5000	90.00 (2286.0)	110.00 (2794.0)	108.00 (2743.2)	84.00 (2133.6)	80.00 (2032.0)	68.00 (1727.2)	23,100 (10,478)	605 (2290)
35 kV Class, Delta Connected HV-HV 200 kV BIL, LV 30 kV BIL								
3000	86.00 (2184.4)	86.00 (2184.4)	101.00 (2565.4)	78.00 (1981.2)	73.00 (1854.2)	62.00 (1574.8)	15,700 (7121)	420 (1590)
3750	86.00 (2184.4)	82.00 (2082.8)	102.00 (2590.8)	82.00 (2082.8)	76.00 (1930.4)	66.00 (1676.4)	19,800 (8981)	525 (1987)
5000	102.00 (2590.8)	122.00 (3098.8)	106.00 (2692.4)	83.00 (2108.2)	78.00 (1981.2)	67.00 (1701.8)	22,600 (10,251)	580 (2196)
35 kV Class, Wye Connected HV-HV 125 kV BIL, LV 30 kV BIL								
3000	82.00 (2082.8)	86.00 (2184.4)	101.00 (2565.4)	78.00 (1981.2)	73.00 (1854.2)	62.00 (1574.8)	15,700 (7121)	420 (1590)
3750	91.00 (2311.4)	82.00 (2082.8)	102.00 (2590.8)	82.00 (2082.8)	76.00 (1930.4)	66.00 (1676.4)	19,800 (8981)	525 (1987)
5000	92.00 (2336.8)	122.00 (3098.8)	106.00 (2692.4)	83.00 (2108.2)	78.00 (1981.2)	67.00 (1701.8)	22,600 (10,251)	580 (2196)
35 kV Class, Delta Connected HV-HV 150 kV BIL, LV 30 kV BIL								
3000	84.00 (2133.6)	84.00 (2133.6)	100.00 (2540.0)	86.00 (2184.4)	74.00 (1879.6)	70.00 (1778.0)	15,400 (6985)	530 (2006)
3750	84.00 (2133.6)	84.00 (2133.6)	101.00 (2565.4)	86.00 (2184.4)	77.00 (1955.8)	70.00 (1778.0)	19,300 (8754)	630 (2385)
5000	92.00 (2336.8)	122.00 (3098.8)	106.00 (2692.4)	81.00 (2057.4)	78.00 (1981.2)	65.00 (1651.0)	20,500 (9299)	600 (2271)
35 kV Class, Wye Connected HV-HV 150 kV BIL, LV 30 kV BIL								
3000	80.00 (2032.0)	84.00 (2133.6)	104.00 (2641.6)	86.00 (2184.4)	76.00 (1930.4)	70.00 (1778.0)	17,100 (7756)	500 (1893)
3750	86.00 (2184.4)	87.00 (2209.8)	107.00 (2717.8)	86.00 (2184.4)	79.00 (2006.6)	70.00 (1778.0)	20,600 (9344)	560 (2120)
5000	95.00 (2413.0)	105.00 (2667.0)	107.00 (2717.8)	85.00 (2159.0)	79.00 (2006.6)	69.00 (1752.6)	23,800 (10,795)	625 (2366)
35 kV Class, Wye Connected HV-HV 200 kV BIL, LV 30 kV BIL								
3000	88.00 (2235.2)	104.00 (2641.6)	99.00 (2514.6)	107.00 (2717.8)	83.00 (2108.2)	91.00 (2311.4)	19,800 (8981)	720 (2725)
3750	90.00 (2286.0)	104.00 (2641.6)	104.00 (2641.6)	107.00 (2717.8)	90.00 (2286.0)	91.00 (2311.4)	24,400 (11,068)	840 (3180)
5000	101.00 (2565.4)	102.00 (2590.8)	106.00 (2692.4)	107.00 (2717.8)	90.00 (2286.0)	89.00 (2260.6)	28,600 (12,973)	920 (3483)

① Standard compartment depth is 22.00 inches (558.8 mm) except 200 kV BIL has a depth of 30.00 inches (762.0 mm).

Depth may be altered by the addition of switching and fusing.

② Extends under base of transformer only. Does not include rear coolers.

③ Standard low voltages are 480Y and 480 delta (through 3750 kVA only).

Low voltage above 3750 kVA must be 2400 V or above.

Dimensions are approximate—not for construction.

Technical Data

Liquid Filled Technical Data

Table 17.0-20. Liquid Filled 15 kV Primary 55 °C Temp. Rise

kVA	No Load at 75 °C Ref. Temp. (Watts)	Load Loss at 100% Load and 75 °C Ref. Temp. (Watts)	Total Losses at 100% Load and 85 °C (Watts)	95 kV HV BIL Total Losses at 50% Load and 55 °C LL Ref. Temp. and 20 °C NL Ref. Temp. per DOE (Watts)
3000	5517	22,491	28,008	11,140
3750	6521	26,340	32,861	13,110
5000	8193	32,255	40,448	16,260

Table 17.0-21. Liquid Filled 5 kV Primary 55 °C Temp. Rise

kVA	No Load at 75 °C Ref. Temp. (Watts)	Load Loss at 100% Load and 75 °C Ref. Temp. (Watts)	Total Losses at 100% Load and 85 °C (Watts)	60 kV HV BIL Total Losses at 50% load and 55 °C LL Ref. Temp. and 20 °C NL Ref. Temp. per DOE (Watts)
3000	5461	22,269	27,730	11,030
3750	6455	26,076	32,531	12,230
5000	8111	31,932	40,043	16,090

Table 17.0-22. Liquid Filled 25 kV Primary 55 °C Temp. Rise

kVA	No Load at 75 °C Ref. Temp. (Watts)	Load Loss at 100% Load and 75 °C Ref. Temp. (Watts)	Total Losses at 100% Load and 85 °C (Watts)	150 kV HV BIL Total Losses at 50% Load and 55 °C LL Ref. Temp. and 20 °C NL Ref. Temp. per DOE (Watts)
3000	5570	22,046	27,616	11,080
3750	6584	25,815	32,399	13,040
5000	8273	31,612	39,885	16,180

Table 17.0-23. Liquid Filled 35 kV Primary 55 °C Temp. Rise

kVA	No Load at 75 °C Ref. Temp. (Watts)	Load Loss at 100% Load and 75 °C Ref. Temp. (Watts)	Total Losses at 100% LOAD and 85 °C (Watts)	200 kV HV BIL Total Losses at 50% Load and 55 °C LL Ref. Temp. and 20 °C NL Ref. Temp. per DOE (Watts)
3000	5848	21,825	27,673	11,300
3750	6913	25,556	32,469	13,300
5000	8686	31,295	39,981	16,510

Table 17.0-24. Liquid Filled 15 kV Primary 65 °C Temp. Rise

kVA	No Load at 85 °C Ref. Temp. (Watts)	Load Loss at 100% Load and 85 °C Ref. Temp. (Watts)	Total Losses at 100% Load and 85 °C (Watts)	95 kV HV BIL Total Losses at 50% Load and 55 °C LL Ref. Temp. and 20 °C NL Ref. Temp. per DOE (Watts)
3000	5985	24,402	30,387	12,090
3750	7075	28,578	35,653	14,220
5000	8889	34,996	43,885	17,640

Table 17.0-25. Liquid Filled 5 kV Primary 65 °C Temp. Rise

kVA	No Load at 85 °C Ref. Temp. (Watts)	Load Loss at 100% Load and 85 °C Ref. Temp. (Watts)	Total Losses at 100% Load and 85 °C (Watts)	95 kV HV BIL Total Losses at 50% Load and 55 °C LL Ref. Temp. and 20 °C NL Ref. Temp. per DOE (Watts)
3000	5925	24,161	30,086	11,970
3750	7003	28,292	35,295	14,080
5000	8800	34,646	43,446	17,460

Table 17.0-26. Liquid Filled 25 kV Primary 65 °C Temp. Rise

kVA	No Load at 85 °C Ref. Temp. (Watts)	Load Loss at 100% Load and 85 °C Ref. Temp. (Watts)	Total Losses at 100% Load and 85 °C (Watts)	150 kV HV BIL Total Losses at 50% Load and 55 °C LL Ref. Temp. and 20 °C NL Ref. Temp. per DOE (Watts)
3000	6043	23,919	29,962	12,020
3750	7143	28,009	35,152	14,150
5000	8976	34,299	43,275	17,550

Table 17.0-27. Liquid Filled 35 kV Primary 65 °C Temp. Rise

kVA	No Load at 85 °C Ref. Temp. (Watts)	Load Loss at 100% Load and 85 °C Ref. Temp. (Watts)	Total Losses at 100% Load and 85 °C (Watts)	200 kV HV BIL Total Losses at 50% Load and 55 °C LL Ref. Temp. and 20 °C NL Ref. Temp. per DOE (Watts)
3000	6345	23,680	30,025	12,270
3750	7500	27,728	35,228	14,430
5000	9424	33,955	43,379	17,910

Note: Losses offered are typical only, not guaranteed. Losses based on aluminum windings. Losses based on LV rating 0.48 kV.

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