Medium-voltage power distribution and control systems > Integrated power systems >

Primary unit substations — 1000 V and above

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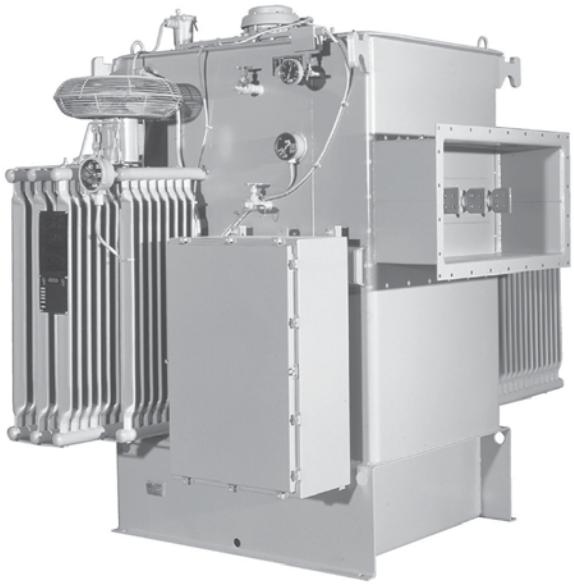

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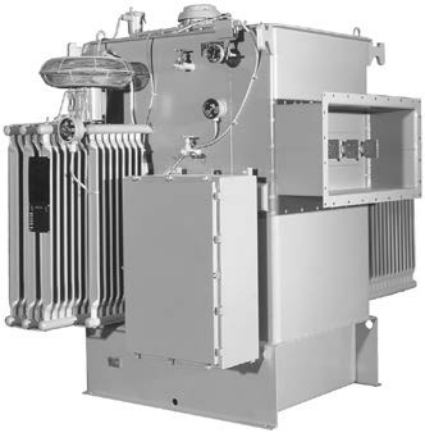
Primary Liquid-Type Substations



Primary Unit Substation Transformer —Liquid-Filled

Definition

A primary unit substation is a close-coupled assembly consisting of enclosed primary high-voltage equipment, three-phase power transformer and enclosed secondary medium-voltage equipment. The following electrical ratings are typical:

- Primary voltage: 6.9–69 kV
- Transformer kVA: 500–20,000 kVA
- Secondary voltage: 2.4 kV–34.5 kV

A primary unit substation is defined in the following standard:

- IEEE® Standard No. 100-2000

Primary unit substations are used to step down utility distribution voltages to in-plant distribution voltages.

Primary unit substation transformers are designed, manufactured and tested in accordance with applicable IEEE standards.

Advantages

As a result of locating power transformers and their close-coupled equipment as close as possible to the areas of load concentration, the secondary distribution cables or busways are kept to minimum lengths. This concept has obvious advantages such as:

- Reduced power losses
- Improved voltage regulation
- Improved service continuity
- Reduced exposure to faults
- Increased flexibility
- Minimum installation cost
- Efficient space utilization

Additional advantages of Eaton's unit substations in this unified approach are:

- Single-source responsibility
- Complete electrical and mechanical control over coordination of the three close-coupled sections
- Availability of all switchgear types as secondaries gives broad application flexibility
- Modern design
- Composite assembly retains proven safety and integrity of each of its three major parts

Easier to Specify

Standardization through IEEE standards results in proven designs with complete accessory equipment and features.

Highest Short-Circuit Strength

Highly researched and thoroughly tested designs provide the short-circuit strength necessary to withstand the repeated large short-circuit currents that are available in modern systems.

Easier Handling and Reduced Maintenance

Compact designs reduce the cost of rigging and hauling and require smaller installation space. Straight-forward design and simplified accessories reduce maintenance costs.

Ratings Available

kVA—Three-Phase:

- 6.9–69 kV (350 kV BIL and below)
- 500–20,000 kVA

Frequency

- 60 Hz or 50 Hz

Transformer Fluids

- Mineral oil
- Silicone fluid
- Envirotemp™ FR3™

Primary and Secondary Equipment

- Air terminal chamber (ATC)
- Load interrupter switchgear, Type MVS
- Metal-enclosed circuit breaker switchgear, Types MEB, MEF and MSB
- Metal-clad circuit breaker switchgear, Type VacClad-W
- Vacuum fault interrupter (VFI)—liquid-filled transformer only
- MV motor control assemblies, Type AMPGARD
- Cover-mounted bushings (liquid transformer only)
- Medium-voltage busway

Standard Features—Liquid-Filled Transformer

① Cover—welded to tank

② Cooling tubes (radiators)

Note: Radiator position and number of radiators will vary based upon design.

③ Bolted handhole on cover

④ Automatic resealing mechanical pressure relief device

⑤ HV bushing, three total, located in ANSI Segment 2

⑥ LV bushing, four total (wye connected), located in ANSI Segment 4

Note: HV and LV bushings may be cover mounted or left/right orientation may be reversed.

⑦ Z-bar flange

⑧ Lifting loops—two for lifting cover only

⑨ Lifting hooks—four for lifting complete unit

⑩ Jacking provisions on tank or base

⑪ Ground pad—two total

⑫ Drain valve—for combination lower filter press connection and complete drain with sampler

⑬ Base (may be flat or formed)

⑭ Control cabinet for alarm lead termination

⑮ Diagram instruction nameplate with warning nameplate

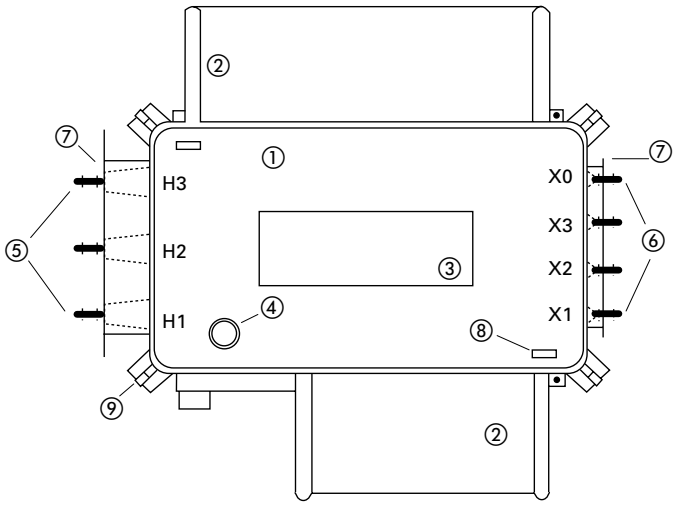
⑯ De-energized tap changer with padlock provisions

⑰ Liquid temperature indicator with maximum indicating hand

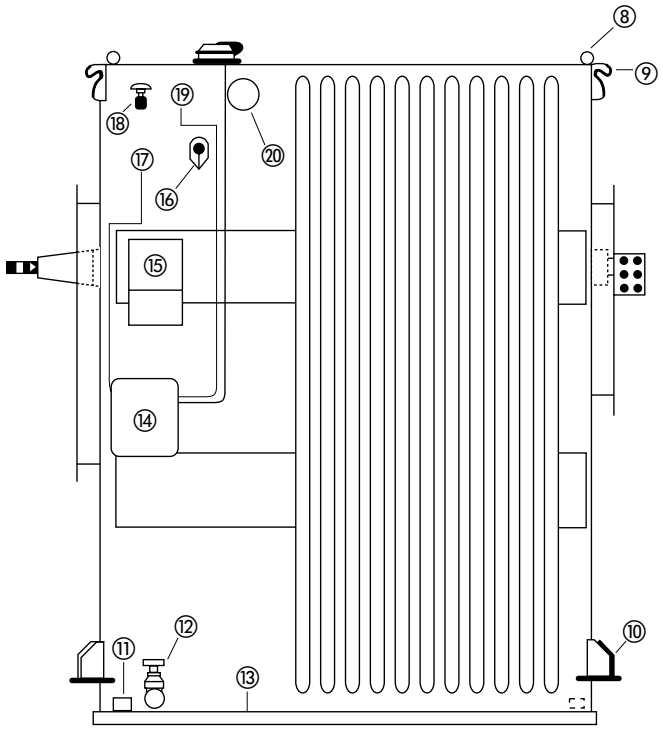
⑱ Upper valve for upper filter press connection

⑲ Magnetic liquid level gauge

⑳ Vacuum pressure gauge with air test and Sealedaire® valve



Top View



Front View

Figure 13.1-1. Liquid-Filled Primary Unit Substation Transformer with Wall-Mounted HV and LV Bushings

Primary Dry-Type Transformers

- Indoor/outdoor applications
- No fire risk
- No need for containment or fire suppression
- Low maintenance
- Easy transit/installation
- Close-coupled with switchgear/ switchboard
- Primary voltage: 6.9–69 kV
- Transformer kVA: 500–20,000 kVA
- Secondary voltage: 2.4–34.5 kV

VPI

- Aluminum windings—copper optional
- Step-lap mitered core
- 220 °C insulation system—150 °C average temperature rise
- Vacuum pressure impregnated in polyester resin
- Four full-capacity taps on HV winding rated 2-1/2% 2-FCAN—2-FCBN on units with voltage above 601 V
- NEMA® 1 heavy-gauge ventilated enclosure with removable panels front and rear
- ANSI 61 gray paint electrostatically applied using dry powder
- Vibration isolation pads between core and coil and enclosure
- Base equipped with jacking pads and designed for rolling or skidding enclosure in any direction
- Provisions for lifting core and coil assembly
- Diagrammatic aluminum nameplate
- 100% QC impulse test
- Short-circuit design verification

Dry-Type Unit Substation Transformer

Cast Coil

- Windings cast in a mold. HV coils vacuum cast in epoxy in a metal mold. LV coils encapsulated/pressure-injected in epoxy for 600 V and below
- Aluminum windings—copper optional
- Step-lap mitered core
- 180 °C insulation system—115 °C average temperature rise
- Four full-capacity taps on HV winding rated 2-1/2% 2-FCAN—2-FCBN on units with voltage above 601 V
- NEMA 1 heavy-gauge ventilated enclosure with removable panels front and rear
- ANSI 61 gray paint electrostatically applied using dry powder
- Vibration isolation pads between core and coil and enclosure
- Base equipped with jacking pads and designed for rolling or skidding enclosure in any direction
- Provisions for lifting core and coil assembly
- Diagrammatic aluminum nameplate
- 100% QC impulse test
- Partial discharge-free (less than 10 pc at 150% rated voltage)

RESIBLOC

- High-voltage windings cast in epoxy reinforced by fiberglass rovings
- Copper high voltage, aluminum low-voltage windings
- Step-lap mitered core
- 155 °C insulation system—80 °C average temperature rise
- Four full-capacity taps on HV winding rated 2-1/2% 2-FCAN—2-FCBN on units with voltage above 601 V
- NEMA 1 heavy-gauge ventilated enclosure with removable panels front and rear
- ANSI 61 gray paint electrostatically applied using dry powder
- Vibration isolation pads between core and coil and enclosure
- Base equipped with jacking pads and designed for rolling or skidding enclosure in any direction
- Provisions for lifting core and coil assembly
- Diagrammatic aluminum nameplate
- 100% QC impulse test
- Partial discharge-free (less than 10 pc at 150% rated voltage)

Outdoor Liquid-Filled Primary Unit Substations

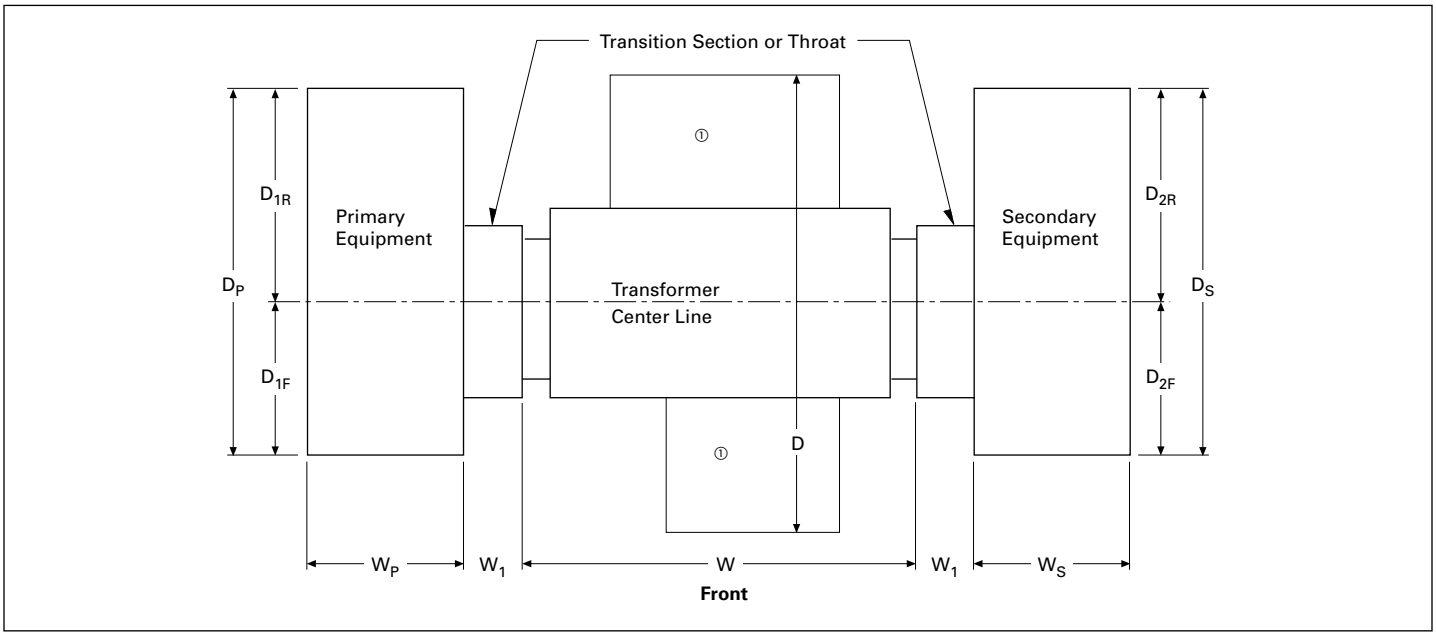


Figure 13.1-2. Outdoor Liquid-Filled Primary Unit Substations—Plan View

① Radiator position and number of radiators will vary based on design.

Table 13.1-1. Outdoor Dimension References

Equipment	Dimensions	Reference
Transformer	W, D	**Page 13.1-7** through **Page 13.1-9**
MVC	W_S, D_S	②
MVS	W_P, D_P, W_S, D_S	②
ME	W_P, D_P, W_S, D_S	②
MC	W_P, D_P, W_S, D_S	②

Transition Section or Throat and other Reference Dimensions

Primary or Secondary Equipment		Three-Phase, Three-Wire or Four-Wire ③				
		D1F	D1R	W1	D2F	D2R
5 kV	MVC ③	—	—	12	—	21
5 kV	MVS	25.25 ④	—	20	25.25 ④	—
or	ME	25.25 ④	—	20	25.25 ④	—
15 kV	MC	—	16.5 ⑤	16	—	16.5 ⑤
27 kV	MVS	⑥	—	35	⑥	—
	ME	⑥	—	35	⑥	—
	MC ⑦	—	—	—	—	—
38 kV	MVS	⑥	—	35	⑥	—
	ME ⑦	—	—	—	—	—
	MC ⑥	—	—	—	—	—

② See Eaton.com/designguides.
③ Four-wire connections are not available with MVC equipment.
④ For three-phase, four-wire, D1F and D2F are 30.25.
⑤ For three-phase, four-wire, D1R and D2R are 14.5.
⑥ Contact Eaton.
⑦ This product is not available for this voltage and configuration.

Legend:

MVC = Medium-Voltage Motor Control, Type AMPGARD
MVS = Medium-Voltage Metal-Enclosed Switches, Type MVS
ME = Medium-Voltage Metal-Enclosed Breakers, Type MEB, MEF, MSB
MC = Medium-Voltage Metal-Clad Breaker Assemblies, Type VacClad-W

Substation with Air Terminal Chamber (ATC) Utilization—Liquid-Filled Transformer

A substation using one or two Air Terminal Chambers (ATCs) is different from a substation using close-coupling on both the primary and secondary sides. An ATC uses a cable connection on either the primary side, secondary side or both, and is placed between the transformer and the remotely mounted primary or secondary equipment.

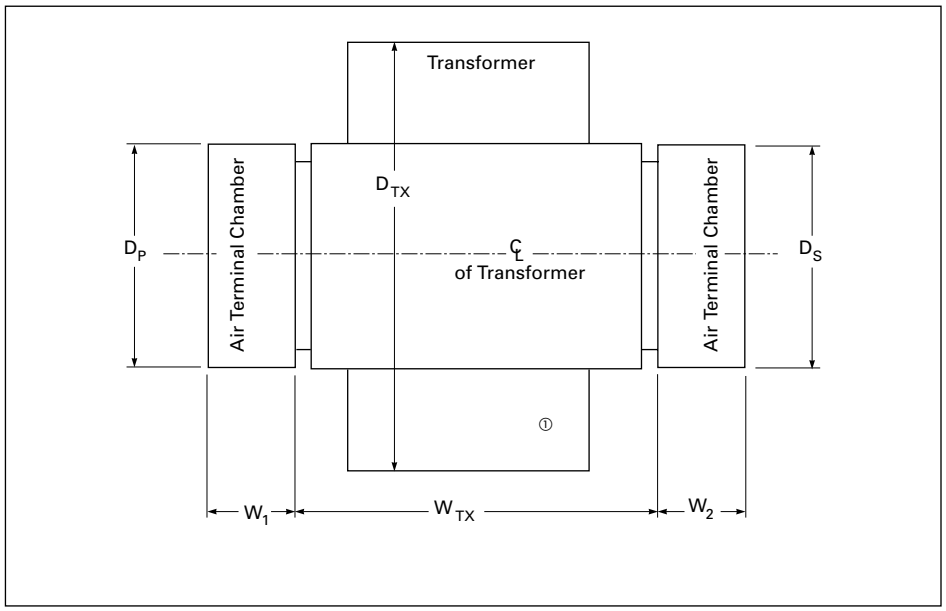


Figure 13.1-3. Liquid-Filled Indoor/Outdoor Using Air Terminal Chambers—Top View

① Radiator position and number of radiators will vary based on design.

Table 13.1-2. Primary or Secondary ATC or Transition Section—Dimensions in Inches (mm)

Voltage	Three-Phase, Three-Wire or Three-Phase, Four-Wire			
kV	W_1	D_P	W_2	D_S
5 or 15	22.00 (558.8)	48.00 (1219.2)	22.00 (558.8)	48.00 (1219.2)
27	25.00 (635.0)	54.00 (1371.6)	25.00 (635.0)	54.00 (1371.6)
38	35.00 (889.0)	60.00 (1524.0)	35.00 (889.0)	60.00 (1524.0)

Note: Minimum ATC widths by kVA are listed in the table above. The width of any ATC can be expanded to allow for the installation of additional conduits. When calculating the area of the conduit opening, allow for a 2.00-inch (50.8 mm) lip around the entire perimeter of the ATC.

For special 55 °C rise units, bus duct throats and air terminal chambers, see **Notes 2 through 6** at bottom of page for dimensions that should be added to the table dimensions.

Table 13.1-3. 65 °C Rise, Oil-Filled
HV 6900D, 75 BIL
LV 2400Y, 45 BIL

kVA Rating	Weight Lb (kg)	Gallons (Liters) Liquid	Dimensions in Inches (mm)		
			Height	Width	Depth
500	4520 (2050)	120 (454)	92 (2336.8)	56 (1422.4)	56 (1442.4)
750	4750 (2155)	150 (568)	92 (2336.8)	56 (1422.4)	56 (1442.4)
1000	5590 (2536)	170 (644)	92 (2336.8)	59 (1498.6)	59 (1498.6)
1500	7380 (3348)	210 (795)	92 (2336.8)	67 (1701.8)	67 (1701.8)
2000	8890 (4032)	240 (908)	92 (2336.8)	70 (1778.0)	70 (1778.0)
2500	10,060 (4563)	260 (984)	92 (2336.8)	70 (1778.0)	70 (1778.0)
3000	11,110 (5039)	290 (1098)	95 (2413.0)	70 (1778.0)	70 (1778.0)
3750	13,200 (5987)	340 (1287)	95 (2413.0)	73 (1854.2)	73 (1854.2)
5000	18,020 (8174)	620 (2347)	113 (2870.2)	74 (1879.6)	74 (1879.6)

Table 13.1-4. 65 °C Rise, Oil-Filled
HV 13800D, 95 BIL
LV 2400Y, 45 BIL

kVA Rating	Weight Lb (kg)	Gallons (Liters) Liquid	Dimensions in Inches (mm)		
			Height	Width	Depth
750	4840 (2195)	160 (606)	92 (2336.8)	56 (1422.4)	79 (2006.6)
1000	5720 (2595)	180 (681)	92 (2336.8)	59 (1498.6)	78 (1981.2)
1500	7370 (3343)	210 (795)	92 (2336.8)	65 (1651.0)	92 (2336.8)
2000	8760 (3973)	230 (871)	92 (2336.8)	68 (1727.2)	114 (2895.6)
2500	9940 (4509)	260 (984)	92 (2336.8)	68 (1727.2)	125 (3175.0)
3000	11,650 (5284)	350 (1325)	95 (2413.0)	70 (1778.0)	127 (3225.8)
3750	13,330 (6046)	390 (1476)	95 (2413.0)	72 (1828.8)	127 (3225.8)
5000	16,640 (7548)	480 (1817)	95 (2413.0)	75 (1905.0)	131 (3327.4)
7500	30,300 (13,744)	1220 (4618)	114 (2895.6)	113 (2870.2)	138 (3505.2)
10,000	34,830 (15,799)	1230 (4656)	114 (2895.6)	118 (2997.2)	139 (3530.6)

Table 13.1-5. 65 °C Rise, Oil-Filled
HV 13800D, 95 BIL
LV 4160Y, 60 BIL

kVA Rating	Weight Lb (kg)	Gallons (Liters) Liquid	Dimensions in Inches (mm)		
			Height	Width	Depth
750	5120 (2322)	170 (644)	92 (2336.8)	57 (1447.8)	79 (2006.6)
1000	5980 (2712)	180 (681)	92 (2336.8)	62 (1574.8)	81 (2057.4)
1500	7280 (3302)	210 (795)	92 (2336.8)	63 (1600.2)	100 (2540.0)
2000	8700 (3946)	230 (871)	92 (2336.8)	65 (1651.0)	108 (2743.2)
2500	10,290 (4667)	270 (1022)	92 (2336.8)	70 (1778.0)	114 (2895.6)
3000	11,860 (5380)	320 (1211)	95 (2413.0)	73 (1854.2)	127 (3225.8)
3750	13,410 (6083)	360 (1363)	95 (2413.0)	73 (1854.2)	129 (3276.6)
5000	17,030 (7725)	520 (1968)	99 (2514.6)	75 (1905.0)	131 (3327.4)
7500	29,720 (13,481)	1140 (4315)	109 (2768.6)	113 (2870.2)	140 (3556.0)
10,000	35,790 (16,234)	1310 (4959)	116 (2946.4)	117 (2971.8)	143 (3632.2)

Note:
1. Dimensions are APPROXIMATE. NOT FOR CONSTRUCTION.
2. For 55 °C units, add 5.00 inches (127.0 mm) to width dimension and 10 in (254.0 mm) to depth dimension.
3. Add 9.00 inches (228.6 mm) to width dimension for each bus duct throat.
4. Add 22.00 inches (558.8 mm) to width dimension for each 15 kV air terminal chamber.
5. Add 25.00 inches (635.0 mm) to width dimension for each 27 kV air terminal chamber.
6. Add 35.00 inches (889.0 mm) to width dimension for each 34.5 kV air terminal chamber.

Table 13.1-6. 65 °C Rise, Oil-Filled
HV 22900D, 150 BIL
LV 2400Y, 45 BIL

kVA Rating	Weight Lb (kg)	Gallons (Liters) Liquid	Dimensions in Inches (mm)		
			Height	Width	Depth
750	5650 (2563)	220 (833)	92 (2336.8)	59 (1498.6)	81 (2057.4)
1000	6400 (2903)	220 (833)	92 (2336.8)	61 (1549.4)	87 (2209.8)
1500	8020 (3638)	250 (946)	92 (2336.8)	64 (1625.6)	101 (2565.4)
2000	9500 (4309)	280 (1060)	92 (2336.8)	68 (1727.2)	101 (2565.4)
2500	10,550 (4785)	300 (1136)	92 (2336.8)	70 (1778.0)	107 (2717.8)
3000	12,000 (5443)	330 (1249)	95 (2413.0)	73 (1854.2)	127 (3225.8)
3750	14,350 (6509)	450 (1703)	95 (2413.0)	73 (1854.2)	128 (3251.2)
5000	19,110 (8668)	700 (2650)	117 (2971.8)	74 (1879.6)	129 (3276.6)
7500	30,880 (14,007)	1210 (4580)	117 (2971.8)	102 (2590.8)	140 (3556.0)
10,000	39,080 (17,726)	1600 (6057)	124 (3149.6)	106 (2692.4)	145 (3683.0)

Table 13.1-7. 65 °C Rise, Oil-Filled
HV 22900D, 150 BIL
LV 4160Y, 60 BIL

kVA Rating	Weight Lb (kg)	Gallons (Liters) Liquid	Dimensions in Inches (mm)		
			Height	Width	Depth
750	5660 (2567)	210 (795)	92 (2336.8)	58 (1473.2)	83 (2108.2)
1000	6640 (3012)	230 (871)	92 (2336.8)	62 (1574.8)	87 (2209.8)
1500	8000 (3629)	250 (946)	92 (2336.8)	64 (1625.6)	107 (2717.8)
2000	9350 (4241)	290 (1098)	92 (2336.8)	66 (1676.4)	107 (2717.8)
2500	10,860 (4926)	310 (1173)	92 (2336.8)	71 (1803.4)	107 (2717.8)
3000	12,400 (5625)	340 (1287)	95 (2413.0)	73 (1854.2)	130 (3302.0)
3750	14,500 (6577)	430 (1628)	95 (2413.0)	74 (1879.6)	130 (3302.0)
5000	19,510 (8850)	720 (2725)	118 (2997.2)	74 (1879.6)	132 (3352.8)
7500	30,270 (13,730)	1120 (4240)	118 (2997.2)	101 (2565.4)	143 (3632.2)
10,000	38,140 (17,300)	1500 (5678)	124 (3149.6)	105 (2667.0)	146 (3708.4)

Table 13.1-8. 65 °C Rise, Oil-Filled
HV 22900D, 150 BIL
LV 12470Y, 95 BIL

kVA Rating	Weight Lb (kg)	Gallons (Liters) Liquid	Dimensions in Inches (mm)		
			Height	Width	Depth
750	6630 (3007)	250 (946)	92 (2336.8)	65 (1657.0)	64 (1625.6)
1000	7510 (3406)	280 (1060)	92 (2336.8)	66 (1676.4)	78 (1981.2)
1500	9040 (4100)	290 (1098)	92 (2336.8)	69 (1752.6)	88 (2235.2)
2000	10,110 (4586)	290 (1098)	92 (2336.8)	70 (1778.0)	96 (2438.4)
2500	11,670 (5788)	330 (1249)	92 (2336.8)	73 (1854.2)	106 (2692.4)
3000	12,760 (5793)	350 (1325)	95 (2413.0)	74 (1879.6)	130 (3302.0)
3750	15,280 (6931)	440 (1666)	95 (2413.0)	75 (1905.0)	133 (3378.2)
5000	19,370 (8786)	650 (2461)	107 (2717.8)	76 (1930.4)	136 (3454.4)
7500	30,850 (13,993)	1180 (4467)	114 (2895.6)	100 (2540.0)	139 (3530.6)
10,000	38,320 (17,382)	1450 (5489)	122 (3098.8)	104 (2641.6)	143 (3632.2)

For special 55 °C rise units, bus duct throats and air terminal chambers, see **Notes 2 through 6** at bottom of page for dimensions that should be added to the table dimensions.

Table 13.1-9. 65 °C Rise, Oil-Filled
HV 34400D, 200 BIL
LV 2400Y, 45 BIL

kVA Rating	Weight Lb (kg)	Gallons (Liters) Liquid	Dimensions in Inches (mm)		
			Height	Width	Depth
750	7000 (3175)	330 (1249)	115 (2921.0)	67 (1701.8)	66 (1676.4)
1000	7720 (3502)	350 (1325)	115 (2921.0)	67 (1701.8)	79 (2006.6)
1500	9880 (4481)	380 (1438)	115 (2921.0)	69 (1752.6)	98 (2489.2)
2000	11,300 (5126)	410 (1552)	115 (2921.0)	71 (1803.4)	112 (2844.8)
2500	12,880 (5842)	450 (1703)	115 (2921.0)	71 (1803.4)	122 (3098.8)
3000	13,760 (6241)	460 (1741)	115 (2921.0)	72 (1828.8)	130 (3302.0)
3750	16,030 (7271)	520 (1968)	115 (2921.0)	85 (2159.0)	136 (3454.4)
5000	19,780 (8972)	660 (2498)	117 (2971.8)	100 (2540.0)	138 (3505.2)
7500	30,270 (13,730)	1070 (4050)	129 (3276.6)	124 (3149.6)	138 (3505.2)
10,000	39,290 (17,822)	1480 (5602)	136 (3454.4)	127 (3225.8)	140 (3556.0)

Table 13.1-10. 65 °C Rise, Oil-Filled
HV 34400D, 200 BIL
LV 4160Y, 60 BIL

kVA Rating	Weight Lb (kg)	Gallons (Liters) Liquid	Dimensions in Inches (mm)		
			Height	Width	Depth
750	7230 (3279)	340 (1287)	115 (2921.0)	68 (1727.2)	67 (1701.8)
1000	8040 (3647)	360 (1363)	115 (2921.0)	68 (1727.2)	80 (2032.0)
1500	9920 (4500)	390 (1476)	115 (2921.0)	69 (1752.6)	94 (2387.6)
2000	11,700 (5307)	430 (1628)	115 (2921.0)	71 (1803.4)	116 (2946.4)
2500	13,120 (5351)	460 (1741)	115 (2921.0)	73 (1854.2)	124 (3149.6)
3000	14,400 (6532)	500 (1893)	115 (2921.0)	76 (1930.4)	128 (3251.2)
3750	16,210 (7353)	540 (2044)	115 (2921.0)	77 (1955.8)	136 (3454.4)
5000	20,490 (9294)	740 (2801)	124 (3149.6)	95 (2413.0)	139 (3530.6)
7500	31,470 (14,275)	1190 (4505)	133 (3378.2)	122 (3098.8)	140 (3556.0)
10,000	36,390 (16,506)	1190 (4505)	132 (3352.8)	125 (3175.0)	145 (3683.0)

Table 13.1-11. 65 °C Rise, Oil-Filled
HV 34400D, 200 BIL
LV 13800Y, 95 BIL

kVA Rating	Weight Lb (kg)	Gallons (Liters) Liquid	Dimensions in Inches (mm)		
			Height	Width	Depth
750	9110 (4132)	410 (1552)	115 (2921.0)	72 (1828.8)	63 (1600.2)
1000	9370 (4250)	390 (1476)	115 (2921.0)	72 (1828.8)	70 (1778.0)
1500	10,760 (4881)	410 (1552)	115 (2921.0)	72 (1828.8)	93 (2362.2)
2000	12,210 (5538)	450 (1703)	115 (2921.0)	72 (1828.8)	108 (2743.2)
2500	13,600 (6169)	470 (1779)	115 (2921.0)	74 (1879.6)	109 (2768.6)
3000	14,990 (6799)	510 (1931)	115 (2921.0)	77 (1955.8)	125 (3175.0)
3750	16,590 (7585)	540 (2044)	115 (2921.0)	77 (1955.8)	137 (3479.8)
5000	20,480 (9290)	710 (2688)	122 (3098.8)	94 (2387.6)	138 (3505.2)
7500	32,220 (14,615)	1050 (3975)	125 (3175.0)	123 (3124.2)	139 (3530.6)
10,000	38,460 (17,445)	1350 (5110)	135 (3429.0)	124 (3149.6)	148 (3759.2)

Notes: 1. Dimensions are APPROXIMATE. NOT FOR CONSTRUCTION.
2. For 55 °C units, add 5.00 inches (127.0 mm) to width dimension and 10 inches (254.0 mm) to depth dimension.
3. Add 9.00 inches (228.6 mm) to width dimension for each bus duct throat.
4. Add 22.00 inches (558.8 mm) to width dimension for each 15 kV air terminal chamber.
5. Add 25.00 inches (635.0 mm) to width dimension for each 27 kV air terminal chamber.
6. Add 35.00 inches (889.0 mm) to width dimension for each 34.5 kV air terminal chamber.

Table 13.1-12. 65 °C Rise, Silicone/Environmentally Friendly Fluid
HV 6900D, 75 BIL
LV 2400Y, 45 BIL

kVA Rating	Weight Lb (kg)	Gallons (Liters) Liquid	Dimensions in Inches (mm)		
			Height	Width	Depth
750	4930 (2236)	160 (606)	87 (2209.8)	48 (1219.2)	76 (1930.4)
1000	5940 (2694)	180 (681)	87 (2209.8)	52 (1320.8)	92 (2336.8)
1500	7690 (3488)	220 (833)	87 (2209.8)	59 (1498.6)	95 (2413.0)
2000	9270 (4205)	250 (946)	87 (2209.8)	62 (1574.8)	107 (2717.8)
2500	10,630 (4822)	280 (1060)	87 (2209.8)	62 (1574.8)	112 (2844.8)
3000	12,280 (5570)	340 (1287)	87 (2209.8)	63 (1600.2)	121 (3073.4)
3750	14,540 (8446)	380 (1438)	87 (2209.8)	67 (1701.8)	122 (3098.8)
5000	18,620 (8453)	580 (2196)	98 (2489.2)	68 (1727.2)	123 (3124.2)

Table 13.1-13. 65 °C Rise, Silicone/Environmentally Friendly Fluid
HV 13800D, 95 BIL
LV 2400Y, 45 BIL

kVA Rating	Weight Lb (kg)	Gallons (Liters) Liquid	Dimensions in Inches (mm)		
			Height	Width	Depth
750	5010 (2272)	160 (606)	87 (2209.8)	48 (1219.2)	79 (2006.6)
1000	6090 (2762)	180 (681)	87 (2209.8)	53 (1346.2)	82 (2082.8)
1500	7730 (3506)	220 (833)	87 (2209.8)	55 (1397.0)	116 (2946.4)
2000	9270 (4205)	250 (946)	87 (2209.8)	59 (1498.6)	118 (2997.2)
2500	10,510 (4767)	270 (1022)	87 (2209.8)	61 (1549.4)	119 (3022.6)
3000	12,100 (5488)	310 (1173)	87 (2209.8)	65 (1651.0)	119 (3022.6)
3750	14,380 (6523)	390 (1476)	87 (2209.8)	65 (1651.0)	121 (3073.4)
5000	18,490 (8387)	560 (2120)	97 (2463.8)	68 (1727.2)	122 (3098.8)
7500	32,180 (14,597)	1020 (3861)	98 (2489.2)	112 (2844.8)	131 (3327.4)
10,000	46,580 (21,128)	1760 (6662)	119 (3022.6)	120 (3048.0)	131 (3327.4)

Table 13.1-14. 65 °C Rise, Silicone/Environmentally Friendly Fluid
HV 13800D, 95 BIL
LV 4160Y, 60 BIL

kVA Rating	Weight Lb (kg)	Gallons (Liters) Liquid	Dimensions in Inches (mm)		
			Height	Width	Depth
750	5340 (2422)	180 (681)	87 (2209.8)	49 (1244.6)	79 (2006.6)
1000	6120 (2776)	190 (719)	87 (2209.8)	51 (1295.4)	82 (2082.8)
1500	7660 (3475)	220 (833)	87 (2209.8)	56 (1422.4)	116 (2946.4)
2000	9080 (4119)	250 (946)	87 (2209.8)	59 (1498.6)	118 (2997.2)
2500	11,180 (5071)	290 (1098)	87 (2209.8)	64 (1625.6)	119 (3022.6)
3000	12,470 (5656)	310 (1173)	87 (2209.8)	66 (1676.4)	115 (2921.0)
3750	14,590 (6618)	360 (1363)	87 (2209.8)	68 (1727.2)	121 (3073.4)
5000	18,330 (8314)	540 (2044)	93 (2362.2)	68 (1727.2)	122 (3098.8)
7500	31,330 (14,211)	970 (3672)	98 (2489.2)	111 (2819.4)	131 (3327.4)
10,000	39,050 (17,713)	1230 (4656)	101 (2565.4)	114 (2895.6)	131 (3327.4)

For special 55 °C rise units, bus duct throats and air terminal chambers, see **Notes 2 through 6** at bottom of page for dimensions that should be added to the table dimensions.

Table 13.1-15. 65 °C Rise, Silicone/Environmentally Friendly Fluid HV 22900D, 150 BIL LV 2400Y, 45 BIL

kVA Rating	Weight Lb (kg)	Gallons (Liters) Liquid	Dimensions in Inches (mm)		
			Height	Width	Depth
750	5970 (2708)	230 (871)	87 (2209.8)	52 (1320.8)	73 (1854.2)
1000	6820 (3093)	240 (908)	87 (2209.8)	54 (1371.6)	91 (2311.4)
1500	8710 (3951)	280 (1060)	87 (2209.8)	57 (1447.8)	95 (2413.0)
2000	10,140 (4599)	310 (1173)	87 (2209.8)	58 (1473.2)	110 (2794.0)
2500	11,890 (5393)	338 (1279)	87 (2209.8)	62 (1574.8)	121 (3073.4)
3000	13,480 (6114)	380 (1438)	87 (2209.8)	66 (1676.4)	124 (3149.6)
3750	15,820 (7176)	440 (1666)	87 (2209.8)	68 (1727.2)	125 (3175.0)
5000	19,250 (8732)	540 (2044)	87 (2209.8)	70 (1778.0)	129 (3276.6)
7500	32,700 (14,832)	1090 (4126)	100 (2540.0)	99 (2514.6)	133 (3378.2)
10,000	50,160 (22,752)	2200 (8328)	120 (3048.0)	118 (2997.2)	133 (3378.2)

Table 13.1-16. 65 °C Rise, Silicone/Environmentally Friendly Fluid HV 22900D, 150 BIL LV 4160Y, 60 BIL

kVA Rating	Weight Lb (kg)	Gallons (Liters) Liquid	Dimensions in Inches (mm)		
			Height	Width	Depth
750	6090 (2762)	230 (871)	87 (2209.8)	52 (1320.8)	75 (1905.0)
1000	7110 (3225)	250 (946)	87 (2209.8)	55 (1397.0)	91 (2311.4)
1500	8630 (3918)	280 (1060)	87 (2209.8)	56 (1422.4)	102 (2590.8)
2000	10,050 (4559)	310 (1173)	87 (2209.8)	58 (1473.2)	107 (2717.8)
2500	12,170 (5520)	350 (1325)	87 (2209.8)	63 (1600.2)	114 (2895.6)
3000	13,600 (6169)	380 (1438)	87 (2209.8)	66 (1676.4)	116 (2946.4)
3750	15,300 (6940)	420 (1590)	87 (2209.8)	68 (1727.2)	126 (3200.4)
5000	19,350 (8777)	580 (2196)	89 (2260.6)	70 (1778.0)	129 (3276.6)
7500	32,590 (14,783)	1040 (3937)	94 (2387.6)	98 (2489.2)	134 (3403.6)
10,000	40,250 (18,257)	1370 (5186)	109 (2768.6)	102 (2590.8)	137 (3479.8)

Table 13.1-17. 65 °C Rise, Silicone/Environmentally Friendly Fluid HV 22900D, 150 BIL LV 12470Y, 95 BIL

kVA Rating	Weight Lbs (kg)	Gallons (Liters) Liquid	Dimensions in Inches (mm)		
			Height	Width	Depth
750	6930 (3143)	360 (1363)	87 (2209.8)	56 (1422.4)	66 (1676.4)
1000	7920 (3592)	300 (1136)	87 (2209.8)	58 (1473.2)	72 (1828.8)
1500	9370 (4250)	310 (1173)	87 (2209.8)	59 (1498.6)	90 (2286.0)
2000	11,240 (5098)	330 (1249)	87 (2209.8)	62 (1574.8)	104 (2641.6)
2500	12,760 (5788)	370 (1401)	87 (2209.8)	66 (1676.4)	110 (2794.0)
3000	14,260 (6468)	390 (1476)	87 (2209.8)	69 (1752.6)	111 (2819.4)
3750	15,910 (7217)	420 (1590)	87 (2209.8)	69 (1752.6)	122 (3098.8)
5000	19,830 (8995)	530 (2006)	89 (2209.8)	71 (1803.4)	130 (3302.0)
7500	33,990 (15,418)	1100 (4164)	94 (2387.6)	97 (2463.8)	139 (3530.6)
10,000	39,610 (17,967)	1280 (4845)	109 (2768.6)	99 (2514.6)	139 (3530.6)

Notes:
1. Dimensions are APPROXIMATE. NOT FOR CONSTRUCTION.
2. For 55 °C units, add 5.00 inches (127.0 mm) to width dimension and 10 in (254.0 mm) to depth dimension.
3. Add 9.00 inches (228.6 mm) to width dimension for each bus duct throat.
4. Add 22.00 inches (558.8 mm) to width dimension for each 15 kV air terminal chamber.
5. Add 25.00 inches (635.0 mm) to width dimension for each 27 kV air terminal chamber.
6. Add 35.00 inches (889.0 mm) to width dimension for each 34.5 kV air terminal chamber.

Table 13.1-18. 65 °C Rise, Silicone/Environmentally Friendly Fluid HV 34400D, 200 BIL LV 2400Y, 45 BIL

kVA Rating	Weight Lbs (kg)	Gallons (Liters) Liquid	Dimensions in Inches (mm)		
			Height	Width	Depth
750	7600 (3447)	370 (1401)	107 (2717.8)	60 (1524.0)	68 (1727.2)
1000	8460 (3837)	390 (1476)	107 (2717.8)	60 (1524.0)	84 (2133.6)
1500	10,740 (4872)	420 (1590)	107 (2717.8)	62 (1574.8)	107 (2717.8)
2000	12,260 (5561)	460 (1741)	107 (2717.8)	64 (1625.6)	115 (2921.0)
2500	13,760 (6241)	490 (1855)	107 (2717.8)	64 (1625.6)	121 (3073.4)
3000	15,020 (6813)	520 (1968)	107 (2717.8)	66 (1676.4)	121 (3073.4)
3750	16,950 (7688)	570 (2158)	107 (2717.8)	78 (1981.2)	129 (3276.6)
5000	20,270 (9194)	650 (2461)	109 (2768.6)	92 (2336.8)	132 (3352.8)
7500	33,980 (15,413)	1200 (4542)	120 (3048.0)	117 (2971.8)	136 (3454.4)
10,000	42,340 (19,205)	1440 (5451)	129 (3276.6)	150 (3810.0)	136 (3454.4)

Table 13.1-19. 65 °C Rise, Silicone/Environmentally Friendly Fluid HV 34400D, 200 BIL LV 4160Y, 60 BIL

kVA Rating	Weight Lb (kg)	Gallons (Liters) Liquid	Dimensions in Inches (mm)		
			Height	Width	Depth
750	7930 (3597)	380 (1438)	107 (2717.8)	61 (1549.4)	68 (1727.2)
1000	8840 (4010)	400 (1514)	107 (2717.8)	61 (1549.4)	81 (2057.4)
1500	10,710 (4858)	440 (1666)	107 (2717.8)	62 (1574.8)	95 (2413.0)
2000	12,530 (5684)	470 (1779)	107 (2717.8)	64 (1625.6)	117 (2971.8)
2500	13,920 (6314)	500 (1893)	107 (2717.8)	66 (1676.4)	117 (2971.8)
3000	15,620 (7085)	560 (2120)	107 (2717.8)	69 (1752.6)	127 (3225.8)
3750	17,580 (7974)	610 (2309)	107 (2717.8)	71 (1803.4)	127 (3225.8)
5000	20,980 (9516)	680 (2574)	108 (2743.2)	84 (2133.6)	132 (3352.8)
7500	32,460 (14,724)	1080 (4088)	119 (3022.6)	116 (2946.4)	135 (3429.0)
10,000	40,320 (18,289)	1360 (5148)	129 (3276.6)	119 (3022.6)	135 (3429.0)

Table 13.1-20. 65 °C Rise, Silicone/Environmentally Friendly Fluid HV 34400D, 200 BIL LV 13800Y, 95 BIL

kVA Rating	Weight Lb (kg)	Gallons (Liters) Liquid	Dimensions in Inches (mm)		
			Height	Width	Depth
750	9270 (4205)	400 (1514)	107 (2717.8)	65 (1651.0)	55 (1397.0)
1000	9900 (4491)	420 (1590)	107 (2717.8)	65 (1651.0)	67 (1701.8)
1500	11,620 (5271)	460 (1741)	107 (2717.8)	65 (1651.0)	96 (2438.4)
2000	13,160 (5969)	500 (1893)	107 (2717.8)	65 (1651.0)	117 (2971.8)
2500	14,580 (6613)	530 (2006)	107 (2717.8)	67 (1701.8)	117 (2971.8)
3000	16,090 (7298)	560 (2120)	107 (2717.8)	69 (1752.6)	123 (3124.2)
3750	17,930 (9711)	600 (2271)	108 (2743.2)	77 (1955.8)	130 (3302.0)
5000	21,410 (9720)	680 (2574)	110 (2794.0)	77 (1955.8)	131 (3327.4)
7500	32,060 (14,542)	1010 (3823)	114 (2895.6)	116 (2946.4)	132 (3352.8)
10,000	41,850 (18,983)	1330 (5035)	122 (3098.8)	148 (3759.2)	116 (2946.4)

Indoor VPI/VPE/Cast/RESIBLOC Primary Unit Substations

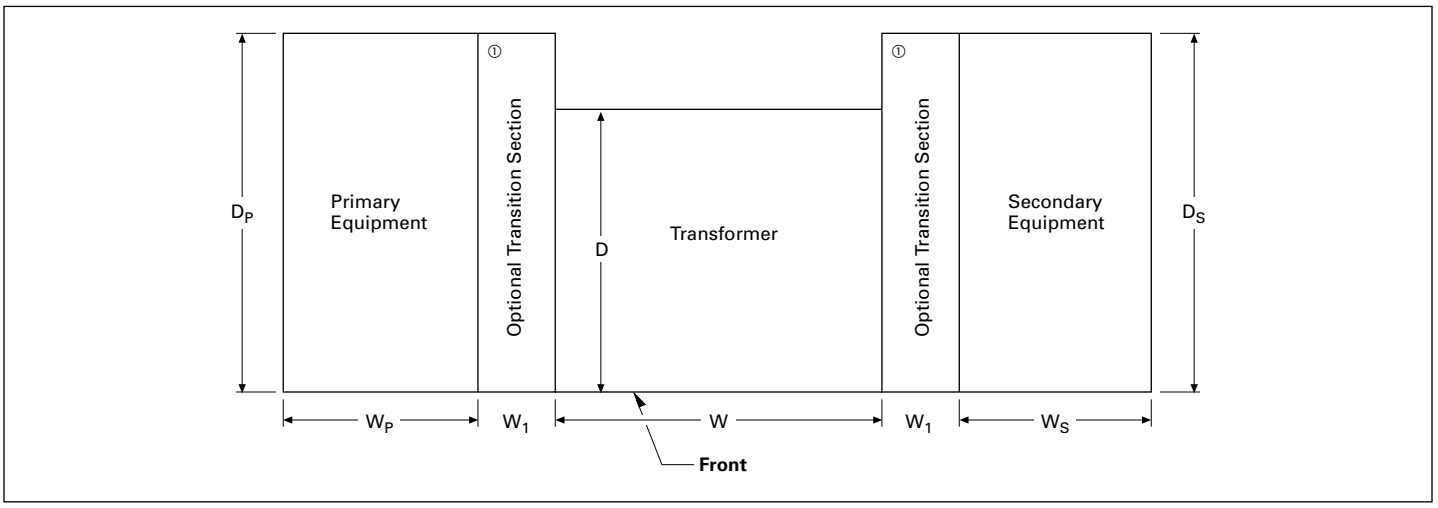


Figure 13.1-4. Indoor VPI/VPE/Cast/RESIBLOC Primary Unit Substations—Plan View

① Optional transition section is not required for most dry-type transformers. They may only be required for connection to existing transformers or for rear alignment. Contact Eaton for additional details.

Table 13.1-21. Indoor Dimension References

Equipment	Dimensions	Reference
Transformer	W, D	**Page 13.1-12**
MVC	W_S, D_S	②
MVS	W_P, D_P, W_S, D_S	②
ME	W_P, D_P, W_S, D_S	②
MC	W_P, D_P, W_S, D_S	②

Transition Section Dimensions in Inches (mm)

Primary or Secondary Equipment	W1			
	5 kV	15 kV	27 kV	38 kV
MVC ③④	7.5	—	—	—
MVS	0	0	30	30
ME	20	20	30	30
MC	18	18	36	42

② See Eaton.com/designguides.
③ Front to rear centerline aligns with centerline of the transformer.
④ Four-wire connections are not available with MVC equipment.

Note: Dimensions are APPROXIMATE.

Legend:

MVC = Medium-Voltage Motor Control, Type AMPGARD
MVS = Medium-Voltage Metal-Enclosed Switches, Type MVS
ME = Medium-Voltage Metal-Enclosed Breakers, Type MEB, MEF, MSB
MC = Medium-Voltage Metal-Clad Breaker Assemblies, Type VacClad-W

Substation with Air Terminal Chamber (ATC) Utilization Dry-Type Transformer

A substation using one or two air terminal chambers (ATCs) is different from a substation using close-coupling on both the primary and secondary sides. An ATC uses a cable connection on either the primary side, secondary side or both, and is placed between the transformer and the remotely mounted primary or secondary equipment.

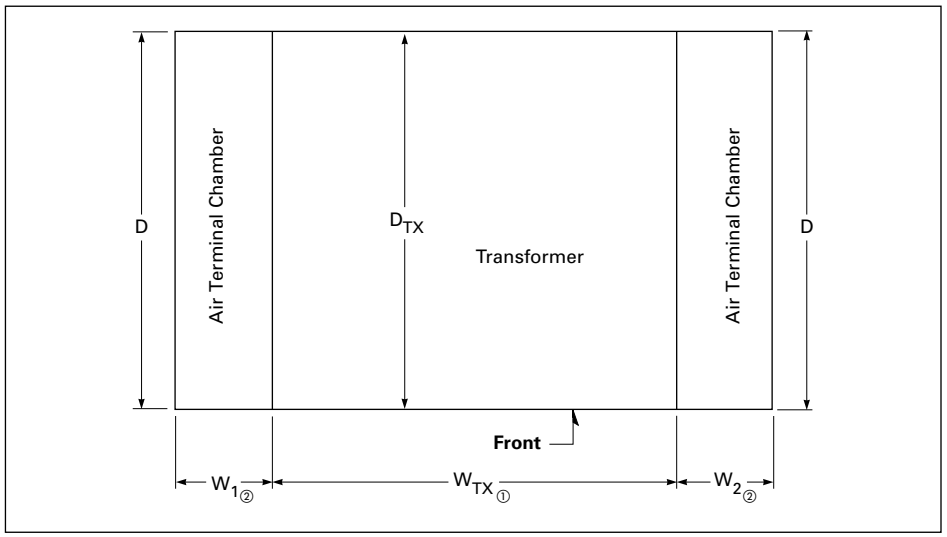


Figure 13.1-5. Dry-Type Indoor Using Air Terminal Chambers—Top View

① Transformer dimensions are shown on the following page in **Table 13.1-23**.
② ATC depths shall match transformer depth, for any kVA of interest. See **Table 13.1-23**.

Table 13.1-22. Primary or Secondary ATC or Transition Section—Dimensions in Inches (mm)

Voltage	Three-Phase, Three-Wire or Three-Phase, Four-Wire		
	ATC Widths		ATC Depths
kV	W_1	W_2	D
5 or 15	18.00 (457.2)	18.00 (457.2)	D_{TX}
27	30.00 (762.0)	30.00 (762.0)	D_{TX}
38	36.00 (914.4)	36.00 (914.4)	D_{TX}

Note: Typical ATC widths by kV are listed in the table above. The width of any ATC can be expanded to allow for the installation of additional conduits. When calculating the area of the conduit opening, allow for a 3.00-inch (76.2 mm) lip around the entire perimeter of the ATC.

Table 13.1-23. VPI/VPE/Cast/RESIBLOC Ventilated Dry-Type—Dimensions in Inches (mm)
Aluminum Windings, Standard Design and Losses, Delta-Wye
VPI/VPE = 150 °C Rise, Cast/RESIBLOC = 80 °C Rise

kVA	HV (kV)	HV BIL	Height	Width	Depth	Weight in Lb (kg)	
						VPI/VPE	Cast/ResibloC
5 kV Secondary							
2000	15 27 38	95 125 150	102 (2590.8) 112 (2844.8) 130 (3302.0)	120 (3048.0) 130 (3302.0) 148 (3759.2)	68 (1727.2) 72 (1828.8) 78 (1981.2)	11,000 (4994) 13,000 (5902) 13,500 (6129)	14,000 (6356) 16,000 (7264) 18,000 (8172)
2500	15 27 38	95 125 150	112 (2844.8) 130 (3302.0) 138 (3505.2)	124 (3149.6) 140 (3556.0) 150 (3810.0)	68 (1727.2) 78 (1981.2) 78 (1981.2)	13,500 (6129) 15,000 (6810) 15,500 (7037)	17,000 (7718) 19,000 (8626) 21,000 (9534)
3000	15 27 38	95 125 150	120 (3048.0) 130 (3302.0) 138 (3505.2)	130 (3302.0) 140 (3556.0) 150 (3810.0)	72 (1828.8) 78 (1981.2) 78 (1981.2)	16,500 (7491) 18,500 (8399) 19,500 (8853)	22,000 (9988) 24,000 (10,896) 26,000 (11,804)
5000	15 27 38	95 125 150	130 (3302.0) 138 (3505.2) 140 (3556.0)	140 (3556.0) 148 (3759.2) 150 (3810.0)	78 (1981.2) 78 (1981.2) 82 (2082.8)	22,000 (9988) 23,000 (10,442) 24,000 (10,896)	31,000 (14,074) 33,000 (14,982) 35,000 (15,890)
7500	15 27 38	95 125 150	140 (3556.0) 140 (3556.0) 140 (3556.0)	150 (3810.0) 150 (3810.0) 154 (3911.6)	78 (1981.2) 84 (2133.6) 88 (2235.2)	24,500 (11,123) 26,000 (11,804) 27,000 (12,258)	48,000 (21,792) 50,000 (22,700) 52,000 (23,608)
10000	15 27 38	95 125 150	140 (3556.0) 140 (3556.0) 148 (3759.2)	160 (4064.0) 160 (4064.0) 160 (4064.0)	78 (1981.2) 84 (2133.6) 90 (2286.0)	29,000 (13,166) 30,000 (13,620) 31,000 (14,074)	62,000 (28,148) 64,000 (29,056) 66,000 (29,964)
15 kV Secondary							
2000	27 38	125 150	102 (2590.8) 112 (2844.8)	120 (3048.0) 130 (3302.0)	72 (1828.8) 72 (1828.8)	12,000 (5448) 13,500 (6129)	18,000 (8172) 20,000 (9080)
2500	27 38	125 150	112 (2844.8) 120 (3048.0)	140 (3556.0) 140 (3556.0)	78 (1981.2) 78 (1981.2)	14,000 (6356) 14,500 (6583)	21,000 (9534) 23,000 (10,442)
3000	27 38	125 150	120 (3048.0) 124 (3149.6)	148 (3759.2) 150 (3810.0)	78 (1981.2) 82 (2082.8)	15,500 (7037) 16,000 (7264)	26,000 (11,804) 28,000 (12,712)
5000	27 38	125 150	124 (3149.6) 130 (3302.0)	150 (3810.0) 154 (3911.6)	88 (2235.2) 88 (2235.2)	17,500 (7945) 19,000 (8626)	35,000 (15,890) 37,000 (16,798)
7500	27 38	125 150	140 (3556.0) 140 (3556.0)	154 (3911.6) 160 (4064.0)	88 (2235.2) 90 (2286.0)	20,500 (9307) 22,500 (10,215)	52,000 (23,608) 54,000 (24,516)
10000	27 38	125 150	148 (3759.2) 148 (3759.2)	160 (4064.0) 160 (4064.0)	90 (2286.0) 90 (2286.0)	23,500 (10,669) 25,000 (11,350)	66,000 (29,964) 68,000 (30,872)

Notes: 1. Add 18.00 inches (457.2 mm) to width dimension for each 15 kV air terminal chamber.
2. Add 30.00 inches (762.0 mm) to width dimension for each 25 kV air terminal chamber.
3. Add 36.00 inches (914.4 mm) to width dimension for each 38 kV air terminal chamber.
4. Add 6.00 inches (152.4 mm) to depth dimension for seismic rating <1.25 SDS.
5. Add 12.00 inches (304.8 mm) to depth dimension for seismic rating ≥1.25 SDS.
6. Dimensions are APPROXIMATE. NOT FOR CONSTRUCTION.

ANSI Segment Identification for HV and LV Bushings/ Terminations on Dry and Liquid Transformers

The plan view below shows the ANSI segments used to identify the location of both the HV and LV bushings.

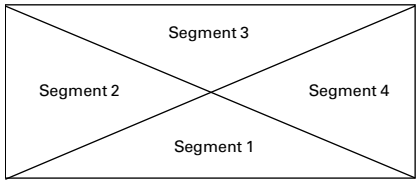


Figure 13.1-6. Front (Nameplate, Gauges, etc.)

HV: Segment 2 is standard for wall-mounted bushings (optional Segment 4) Segment 3 is standard for cover-mounted bushings

LV: Segment 4 wall-mounted is standard (optional Segment 2)

Table 13.1-24. Dry-Type Transformer Ratings—112 to 10,000 kVA

Primary/Secondary	
BIL kV ①	**Maximum Voltage (kV)**
20/30/45	2.5
30/45/60/75/95	5.0
45/60/75/95	8.7
60/75/95/110/125	15.0
110/125	25.0
125	27.0
150	34.5

① First BIL rating given below is standard. Others shown are optional.

Table 13.1-25. Liquid Transformer Ratings—500 to 10,000 kVA

Primary		Secondary	
BIL kV ②	**Voltage Range**	**BIL kV**	**Voltage Range**
95/110	12000D, 12470D, 13200D, 13800D	45	2400Y, 2400D, 2520D
95/110	12000D, 12470D, 13200D, 13800D	60	4160Y, 4160D, 4360Y, 4800D, 5040D
125/150	22900D	45	2400Y, 2400D, 2520D
125/150	22900D	60	4160Y, 4160D, 4360Y, 4800D
125/150	22900D	75	6900D, 7200D, 7560D, 8320D, 8720D
125/150	22900D	95	12000D, 12470Y, 12600D, 13090Y, 13200Y, 13200D, 13800Y, 14400D
150/200	34400D, 34500D	45	2400Y, 2400D, 2520D
150/200	34400D, 34500D	60	4160Y, 4160D, 4360Y, 4800D, 5040D
150/200	34400D, 34500D		
150/200	34400D, 34500D	75	6900D, 7200D, 7560D 8320Y, 8720D
250	46000	95	12000D, 12470Y, 12600D, 13090Y,
350	69000		13200Y, 13200D, 13800Y, 14400D

② First BIL rating given below is standard. Others shown are optional.

Note: Transformers will have a minimum 98% efficiency for all ratings (maximum 2% losses).

Table 13.1-26. Standard Sound Levels—Decibels (per ANSI TR-1)

kVA	Liquid-Filled Transformers		Vent Dry-Type and Cast Coil Transformers	
	OA	FA	AA	FA
500	56	67	60	67
750	58	67	64	67
1000	58	67	64	67
1500	60	67	65	68
2000	61	67	66	69
2500	62	67	68	71
3000	63	67	68	71
3750	64	67	70	73
5000	65	67	71	73
6000	66	68	72	74
7500	67	69	73	75
10000	68	70	—	76

Table 13-27. Standard Impedances (Percent)

HV kV BIL Class	Low Voltage Below 2400 V	Low Voltage 2400 V and Above
45–150	5.75 ③	6.50 ④
200	7.25	7.00
250	7.75	7.50
350	—	8.00

③ 6.75% is also available as an option.
④ 5.50% is also available as an option.

Table 13.1-28. 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)
750	1795	10,085	11,880	4320
1000	2277	12,741	15,018	5460
1500	3193	17,352	20,545	7530
2000	4045	21,031	25,076	9300
2500	4833	23,776	28,609	10,780
3000	5364	23,823	29,187	11,320
3750	6424	28,273	34,697	13,490
5000	8152	35,345	43,497	16,990
7500	11,458	48,205	59,663	23,510
10,000	14,565	59,352	73,917	29,400

Table 13.1-29. Liquid Filled 5 kV Primary 55 °C Temp. Rise

kVA	No Load at 75 °C Ref. Temp. (Watts)	Load Loss at100% 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)
750	1777	9984	11,761	4270
1000	2254	12,613	14,867	5410
1500	3161	17,178	20,339	7460
2000	4004	20,820	24,824	9210
2500	4784	23,538	28,322	10,670
3000	4310	23,584	27,894	10,210
3750	6359	27,990	34,349	13,360
5000	8070	34,991	43,061	16,820
7500	11,343	47,722	59,065	23,270
10,000	14,419	58,758	73,177	29,110

Table 13.1-30. Liquid Filled 25 kV Primary 55 °C Temp. Rise

kVA	No Load at 75 °C Ref. Temp. (Watts)	Load Loss at100% 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)
750	1812	10,183	11,995	4360
1000	2299	12,865	15,164	5520
1500	3224	17,521	20,745	7600
2000	4084	21,236	25,320	9390
2500	4879	24,008	28,887	10,880
3000	4396	24,055	28,451	10,410
3750	6486	28,549	35,035	13,620
5000	8231	35,690	43,921	17,150
7500	11,569	48,676	60,245	23,740
10,000	14,707	59,933	74,640	29,690

Table 13.1-31. 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)
750	1902	10,692	12,594	4580
1000	2413	13,508	15,921	5790
1500	3385	18,397	21,782	7980
2000	4288	22,298	26,586	9860
2500	5122	25,208	30,330	11,420
3000	4615	25,257	29,872	10,930
3750	6810	29,976	36,786	14,300
5000	8642	37,474	46,116	18,010
7500	12,147	51,109	63,256	24,920
10,000	15,442	62,929	78,371	31,170

Table 13.1-32. 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 °CNL Ref. Temp. per DOE (Watts)
750	1947	10,942	12,889	4680
1000	2470	13,823	16,293	5930
1500	3464	18,826	22,290	8170
2000	4388	22,818	27,206	10,090
2500	5243	25,796	31,039	11,690
3000	5819	25,847	31,666	12,280
3750	6970	30,676	37,646	14,640
5000	8844	38,349	47,193	18,430
7500	12,431	52,302	64,733	25,510
10,000	15,803	64,396	80,199	31,900

Table 13.1-33. 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)	60 kV HV BIL Total Losses at 50% Load and 55 °C LL Ref. Temp. and 20 °C NL Ref. Temp. per DOE (Watts)
750	1928	10,832	12,760	4640
1000	2445	13,685	16,130	5870
1500	3429	18,638	22,067	8090
2000	4344	22,589	26,933	9990
2500	5190	25,538	30,728	11,570
3000	4676	25,584	30,260	11,070
3750	6899	30,369	37,268	14,490
5000	8755	37,965	46,720	18,250
7500	12,307	51,778	64,085	25,250
10,000	15,644	63,752	79,396	31,580

Table 13.1-34. 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)
750	1966	11,048	13,014	4730
1000	2494	13,958	16,452	5980
1500	3498	19,010	22,508	8250
2000	4431	23,041	27,472	10,190
2500	5293	26,048	31,341	11,810
3000	4769	26,099	30,868	11,290
3750	7037	30,875	37,912	14,760
5000	8930	38,735	47,665	18,610
7500	12,552	52,813	65,365	25,760
10,000	15,957	65,027	80,984	32,210

Table 13.2-35. Liquid Filled 35 kV Primary 65 °C Temp. Rise

kVA	No Load at 85 °C Ref. Temp. (Watts)	Load Loss at1 00% 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)
750	2063	11,600	13,663	4960
1000	2618	14,656	17,274	6280
1500	3672	19,960	23,632	8660
2000	4652	24,193	28,845	10,700
2500	5557	27,350	32,907	12,390
3000	5007	27,403	32,410	11,860
3750	7388	32,523	39,911	15,520
5000	9376	40,659	50,035	19,540
7500	13,179	55,453	68,632	27,040
10,000	16,754	68,277	85,031	33,820

Note: Losses offered are typical only, not guaranteed. Losses based on aluminum windings. Losses based on LV rating 2–5 kV.

Table 13.1-36. Biotemp 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)
750	1774	9587	11,361	4170
1000	2258	11,942	14,200	5240
1500	3188	15,734	18,922	7120
2000	4069	18,298	22,367	8640
2500	4900	19,638	24,538	9810
3000	5299	21,758	27,057	10,740
3750	6350	24,962	31,312	12,590
5000	8085	30,018	38,103	15,590
7500	11,495	39,066	50,561	21,260
10,000	14,824	46,694	61,518	26,500

Table 13.1-37. Biotemp 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)
750	1756	9491	11,247	4130
1000	2235	11,822	14,057	5190
1500	3156	15,576	18,732	7050
2000	4028	18,115	22,143	8560
2500	4851	19,441	24,292	9710
3000	5246	21,540	26,786	10,630
3750	6286	24,712	30,998	12,460
5000	8004	29,717	37,721	15,430
7500	11,380	38,675	50,055	21,050
10,000	14,675	46,227	60,902	26,230

Table 13-38. Biotemp 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)
750	1791	9680	11,471	4210
1000	2279	12,058	14,337	5290
1500	3219	15,887	19,106	7190
2000	4108	18,477	22,585	8730
2500	4948	19,829	24,777	9910
3000	5350	21,970	27,320	10,840
3750	6411	25,206	31,617	12,710
5000	8164	30,311	38,475	15,740
7500	11,607	39,448	51,055	21,470
10,000	14,968	47,150	62,118	26,760

Table 13.1-39. Biotemp 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)
750	1880	10,164	12,044	4420
1000	2392	12,660	15,052	5560
1500	3379	16,681	20,060	7550
2000	4313	19,400	23,713	9160
2500	5195	20,820	26,015	10,400
3000	5617	23,068	28,685	11,380
3750	6731	26,466	33,197	13,350
5000	8572	31,826	40,398	16,530
7500	12,187	41,420	53,607	22,450
10,000	15,716	49,507	65,223	28,090

Table 13.1-40. Biotemp 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)
750	1924	10,401	12,325	4520
1000	2449	12,957	15,406	5690
1500	3458	17,071	20,529	7730
2000	4414	19,853	24,267	9380
2500	5316	21,307	26,623	10,970
3000	5749	23,607	29,356	11,650
3750	6889	27,083	33,972	13,660
5000	8772	32,569	41,341	16,910
7500	12,472	42,386	54,858	23,070
10,000	16,084	50,662	66,746	28,750

Table 13.1-41. Biotemp 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)	60 kV HV BIL Total Losses at 50% Load and 55 °C LL Ref. Temp. and 20 °C NL Ref. Temp. per DOE (Watts)
750	1905	10,297	12,202	4480
1000	2424	12,826	15,250	5630
1500	3424	16,899	20,323	7650
2000	4370	19,654	24,024	9280
2500	5263	21,093	26,356	10,540
3000	5691	23,370	29,061	11,530
3750	6820	26,812	33,632	13,520
5000	8684	32,242	40,926	16,740
7500	12,347	41,962	54,309	22,840
10,000	15,922	50,156	66,078	28,460

Table 13.1-42. Biotemp Filled 25 kV Primary °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)
750	1943	10,502	12,445	4570
1000	2472	13,082	15,554	5740
1500	3492	17,237	20,729	7800
2000	4457	20,047	24,504	9470
2500	5368	21,514	26,882	10,750
3000	5804	23,837	29,641	11,760
3750	6955	27,348	34,303	13,790
5000	8857	32,887	41,744	17,080
7500	12,593	42,801	55,394	23,290
10,000	16,240	51,157	67,397	29,030

Table 13.1-43. Biotemp 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)
750	2039	11,027	13,066	4800
1000	2595	13,736	16,331	6030
1500	3666	18,098	21,764	8190
2000	4679	21,049	25,728	9940
2500	5636	22,589	28,225	11,280
3000	6094	25,028	31,122	12,350
3750	7303	28,715	36,018	14,480
5000	9300	34,531	43,831	17,930
7500	13,222	44,940	58,162	24,460
10,000	17,051	53,715	70,766	30,480

Note: Losses offered are typical only, not guaranteed. Losses based on aluminum windings. Losses based on LV rating 2–5 kV.

Table 13.1-44. Typical Losses for Dry-Type Transformers (Watts)

kVA Rating	VPI/VPE			Cast Coil/RESIBLOC		
	No Load Loss	Load Loss	Total Loss	No Load Loss	Load Loss	Total Loss
2000	5000	15,500	20,500	5400	12,000	17,400
2500	6300	22,500	28,800	6900	14,200	21,100
3000	7900	24,000	31,900	8000	16,300	24,300
5000	10,500	26,500	37,000	12,400	18,000	30,400
7500	13,200	38,000	51,200	19,200	20,000	39,200
10,000	15,200	47,200	62,400	21,000	28,800	49,800

Note: Losses offered are typical only, not guaranteed. Loss estimates based on aluminum windings for VPI and copper windings for Cast/RESIBLOC. Losses based on LV rating 2–5 kV.

Eaton
1000 Eaton Boulevard
Cleveland, OH 44122
United States
Eaton.com

Printed in USA
Publication No. DG022016EN / Z23483
February 2020

Powering Business Worldwide