

Pad Mounted, Three-Phase, Natural Ester Fluid Distribution Transformers



1. Scope

This standard details the manufacturer requirements for three-phase, pad mounted transformers from 150 kVA to 2500 kVA as listed in Table 1.

Table 1. Three-Phase, Pad Mounted (PM) Transformers by Stock Number

kVA	High Voltage	Low Voltage		Fuses	Taps
		208Y/120	480Y/277		
150	25 564GrdY/14 760	374840	374440	3	-
225	"	374846	374446	3	-
300	"	374850	374450	3	-
500	"	374860	374460	3	-
750	26 400GrdY/15 242	374866	374466	-	5
1000	"	374872	374472	-	5
1500	"	-	374476	-	5
2000	"	-	374478	-	5
2500	"	-	374480	-	5

2. Application

This class of transformers is installed on concrete pads and is used to serve large businesses when either overhead or submersible transformers are impractical or the customer requires more than 500 kVA of capacity. As of this publication, these units make up less than ten percent of the transformers installed annually in the Seattle City Light (SCL) distribution system. Nominal values for transformer weight and volume are in Appendix A.

3. Industry Standards

Transformers shall meet the applicable requirements of the following industry standards:

IEEE C57.12.34-2009; "IEEE Standard for Requirements for Pad-Mounted, Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers, 5MVA and Smaller; High Voltage 34.5 kV Nominal System Voltage and Below; Low Voltage, 15 kV Nominal System Voltage and Below"

DOE 10 CFR Part 431; "Energy Efficiency Program for Certain Commercial and Industrial Equipment"; Department of Energy

IEEE 386-2006; "IEEE Standard for Separable Insulated Connector Systems for Power Distribution Systems Above 600 V"

IEEE C57.12.00-2010; "Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers"

IEEE C57.12.28-2005; "IEEE Standard for Pad-Mounted Equipment – Enclosure Integrity"

IEEE C57.12.70-2000; "IEEE Standard Terminal Markings and Connections for Distribution and Power Transformers"

IEEE C57.12.90-2010; "Standard Test Code for Liquid-Immersed Distribution, Power, and Regulating Transformers"

IEEE C57.147-2008; "Guide for Acceptance and Maintenance of Natural Ester Fluids in Transformers"

NEMA TR 1-1993 (R2000); "Transformers, Regulators, and Reactors"

RCW 19.29.010, Rule 5-2011; *Revised Code of Washington*, Rules for Test Tag

4. Conflict

Where conflict exists, the following order of precedence shall apply:

1. Seattle City Light Purchase Order (PO)
2. City of Seattle General Terms and Conditions
3. This material standard
4. Other industry standards

5. Ratings

5.1 Kilovolt-Ampere Ratings

Kilovolt-ampere ratings shall comply with the requirements of IEEE C57.12.34, Section 4.1 and be 150, 225, 300, 500, 750, 1000, 1500, 2000, 2500 kVA, or as specified on the purchase order.

Kilovolt-ampere ratings shall be continuous and based on not exceeding a 55 °C average winding temperature rise.

The transformers shall have a temperature rise insulation system of 65 °C.

5.2 Voltage Ratings

Voltage ratings shall be as follows, or as specified on the purchase order:

- 25 564 GrdY/14 760 – 208Y/120 Volts or
- 25 564 GrdY/14 760 – 480Y/277 Volts or
- 26 400 GrdY/15 242 – 208Y/120 Volts or
- 26 400 GrdY/15 242 – 480Y/277 Volts

6. Construction

6.1 General

Transformers shall be according to the requirements of Figure 6.3 and Table 6.3 of this document.

Transformers shall comply with IEEE C57.12.34 Figure 8 (a), Figure 12, and Figure 13A for radial-feed transformers with high-voltage connectors, to include the following clarifications:

BIL shall be 125 kV.

Polarity shall be subtractive.

Transformers shall be constructed with either a 5-legged core or a triplex core to mitigate ferroresonant tank heating.

6.2 High-Voltage Bushing Wells

Three 200 amp high-voltage bushing wells shall be supplied and constructed per IEEE 386, Figure 13 and IEEE C57.12.34 Section 8.7.2.3, Figure 13A with bails. Wells shall include a parking stand and be one of the models listed below:

- Central Moloney 70191855
- Cooper Power WELL 2638372CO2R and CLAMP 2606823A04

City Light connects these transformers to 200 amp deadbreak elbows via bushing well inserts.

Each bushing well will be supplied with bail tabs that are compatible with Cooper and Elastimold deadbreak hold down bail assemblies. A tight-fitting cap shall be fixed in place with wire run between the bail tabs.

6.3 Low-Voltage Terminals

Terminals shall be constructed per IEEE C57.12.34, Section 8.7.3 with the following clarifications:

- Transformers shall be supplied with four low-voltage spades constructed per IEEE C57.12.34 Figure 8(a) and Figure 15A. Neutral terminal shall be labeled HoXo.
- Transformers shall be supplied with an additional ground pad near the low-voltage neutral terminal to match the ground pads required in Section 6.13.3 of this document. HoXo terminal shall be connected to this ground pad via a removable strap per IEEE C57.12.34 Section 8.7.4.1.
- Transformers shall be provided with an HoXo switch to disconnect the primary neutral from the secondary neutral to allow for testing. HoXo switch shall be hand operable without tools and accessible only from within the handhole. HoXo switch can be submerged no more than 6 inches below the insulating fluid.

**Figure 6.3 Transformer showing the location of terminals and accessories, based on IEEE C57.12.34
 Figure 12, Figure 8, and Figure 13A**

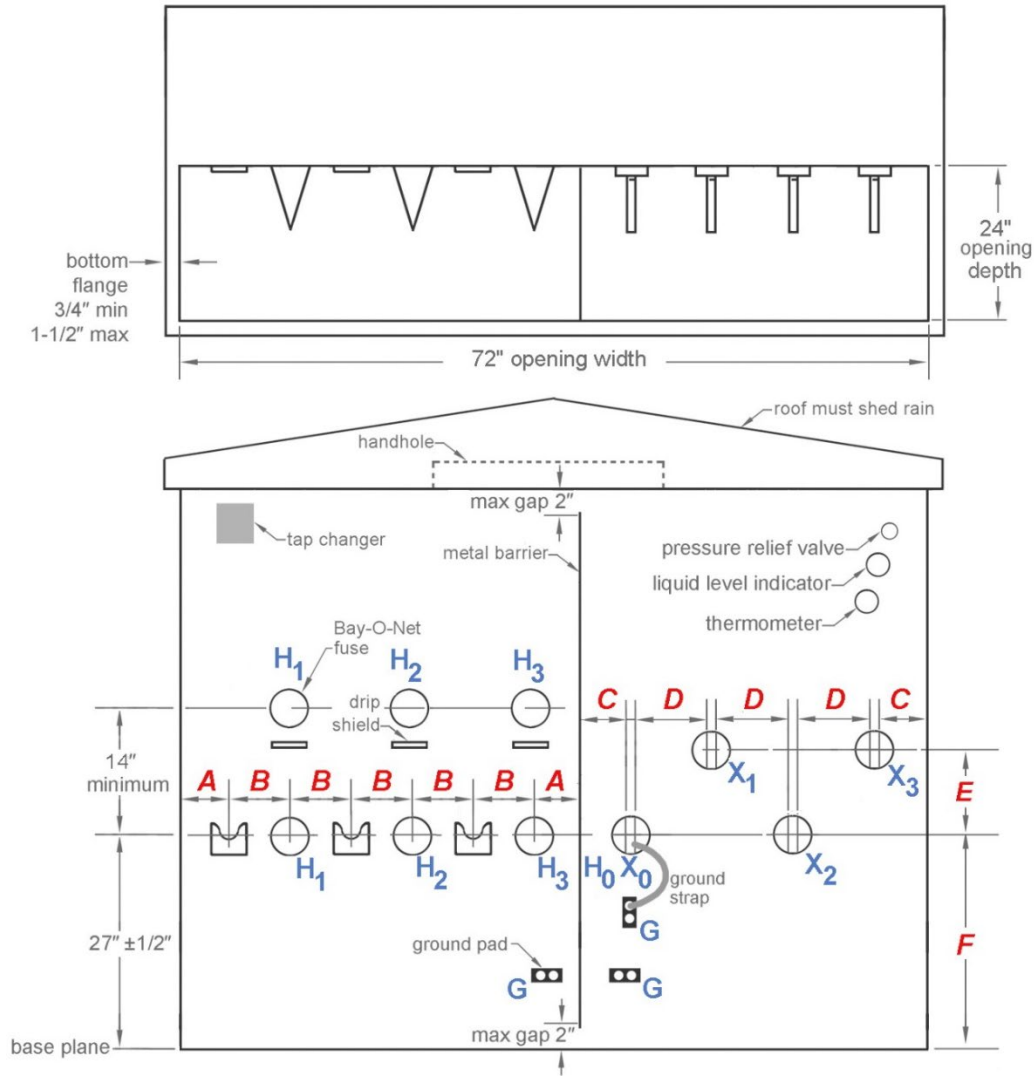


Table 6.3 Transformer Requirements

kVA	150	225	300	500	750	1000	1500	2000	2500
A , in, min	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
B , in, min, ± 1/4 in	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5
C , in, min	4	4	4	4	4	4	4	4	4
D , in, ± 1/4 in	5	6	6	6	6	6	6	6	6
E , in, ± 1/4 in	6	8	8	8	8	8	8	8	8
F , in, ± 1/4 in	27	31	31	31	46	46	46	46	46
208Y/120 terminal holes	4	4	4	6	10	10	-	-	-
480Y/277 terminal holes	4	4	4	4	6	6	6	10	10
W x D, ft, max	6.5 x 7	6.5 x 7	6.5 x 7	6.5 x 7	7 x 9	7 x 9	7 x 9	7 x 9	7 x 9

6.4 Taps

For transformers rated 750 kVA or more, a full-capacity de-energized tap changer shall be supplied and located per Figure 6.3 of this document. Taps shall comply with C57.12.34 Section 4.3 except the nominal voltage shall be 26400 volts and there will be one tap above and three below. Tap voltages shall be 27060, 26400, 25740, 25080, and 24420. Units shall be shipped on the 25740-volt tap.

6.5 Overcurrent Protection

For transformers rated 500 kVA or less overcurrent protection shall be a Bay-O-Net fuse assembly installed and furnished with a dual sensing fuse as listed below. Isolation links shall not be installed because each transformer is protected upstream by a backup current limiting fuse. A drip shield shall be provided on each unit.

Bay-O-Net Fuse Assembly

Cooper Power Systems 4000361C99MC

Dual-Sensing Bay-O-Net Fuse

Transformer, kVA	Cooper Power Systems Catalog No	amps
150	4000358C08	15
225	4000358C08	15
300	4000358C08	15
500	4000358C10	25

6.6 Liquid Level Marking

Liquid level indication shall be provided for every unit. See IEEE C57.12.34, Section 8.10.2.

For transformers rated 750 kVA or more, provide a liquid level gauge and temperature gauge in the low-voltage compartment. Liquid level gauge shall include an indication of the correct liquid level at 25 °C. Temperature gauge shall be a resettable dial-type thermometer with needles indicating the current top of oil temperature and the highest temperature recorded since last reset.

6.7 Lifting Provisions

Lifting provisions shall be provided per IEEE C57.12.34, Section 8.6.

6.8 Pressure Relief Valve

A pressure relief valve shall be provided per SCL 4480.10 and IEEE C57.12.34, Section 8.9.2 with the following clarifications:

6.8.1 Indicator

The pressure relief valve shall include an orange or red indicator that becomes visible only after the valve has vented.

Figure 6.8.1 Pressure Relief Valve



6.8.2 Cap and Pull Ring

The valve shall be covered by a cap with a pull ring. The cap will separate from the assembly during venting, revealing the orange or red indicator and will hang down from the valve via a chain or strap.

6.8.3 Sealant

Valve threads shall be sealed with a liquid pipe thread compound such as Rectorseal, liquid Teflon, or similar, not Teflon tape.

6.8.4 Approved Models

The pressure relief valve shall be listed for use with the included transformer fluid and be one of the models listed in SCL 4480.10.

6.8.5 Location

The valve shall be installed in the low-voltage portion of the terminating compartment as shown in Figure 6.3.

6.9 Enclosure Integrity

The completely assembled transformer enclosure shall comply with IEEE C57.12.28.

Terminal compartment shall be constructed per IEEE C57.12.34 Sections 8.1, 8.2, 8.3, 8.4, and 8.5.

Enclosure roof shall shed rain and prevent collection of water.

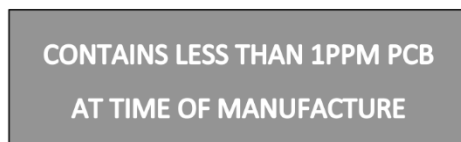
6.10 Polarity, Terminal Markings, and Angular Displacement

Polarity, terminal markings, and angular displacement shall be according to the requirements of IEEE C57.12.34, Section 8.7.

Primary terminals, secondary terminals, and ground lugs shall be marked with minimum 1-inch tall letters.

6.11 Nameplate

Figure 6.11 Nameplate, PCB Statement



Nameplate shall be according to the requirements of IEEE C57.12.34, Section 8.8 and IEEE C57.12.00, Section 5.12 (Nameplate C for all kVA ratings) with the following clarifications:

- Class shall be KNAN.
- BIL shall be 125 kV.
- Tested impedance shall be listed.
- Tested X/R ratio shall be listed.
- Total weight in pounds shall be indicated for each individual transformer.
- Volume in gallons of insulating fluid shall be indicated.
- Manufacturer name and part number of the Bay-o-Net fuse assembly shall be indicated.
- Manufacturer name and part number of the dual sensing fuse shall be indicated.
- Tank design pressures shall be listed to comply with Section 6.13.4 of this document.
- HoXo switch shall be shown in the phasor diagram.
- The statement "CONTAINS LESS THAN 1PPM PCB AT TIME OF MANUFACTURE." shall appear on the nameplate.

6.12 Fluid

Natural ester insulating fluid complying with IEEE C57.147 shall be provided in the transformer up to the liquid level marking.

Fluid shall be Cooper Envirottemp FR3. Each transformer shall have a minimum 5-inch diameter label indicating fluid brand.

6.13 Tank

Tank shall meet all the integrity requirements of IEEE C57.12.34, Section 8.10.

6.13.1 Cover

Cover shall comply with IEEE C57.12.28.

Cover shall be welded to the tank.

6.13.2 Tank Finish

Tank finish shall comply with IEEE C57.12.28, Section 5. The tank finish color shall be Semi Gloss Dark Green Munsell Notation 7GY 3.29/1.5.

6.13.3 Tank Grounding

Tank grounding provision shall comply with IEEE C57.12.34, Section 8.11 and will accommodate #8 solid through #2 stranded copper wire.

Figure 6.13.3 Ground Pad



6.13.4 Strength

Tank will be designed to withstand negative and positive 7 psig per IEEE C57.12.34 Section 8.10.1.

6.13.5 Handhole

Tank shall include a handhole to access internal components for testing. The handhole shall have a cover that can be unbolted from within the terminal compartments to prevent unauthorized access. The handhole shall have a minimum opening of 121 square inches and will provide access to the HoXo switch. The gasket shall be one-piece material.

6.13.6 Drain Valve

A one-inch globe-type drain valve shall be installed, including a 3/8-inch sampling device and a plug. The valve shall be installed on a pipe nipple welded to the tank in the primary section of the terminal compartment.

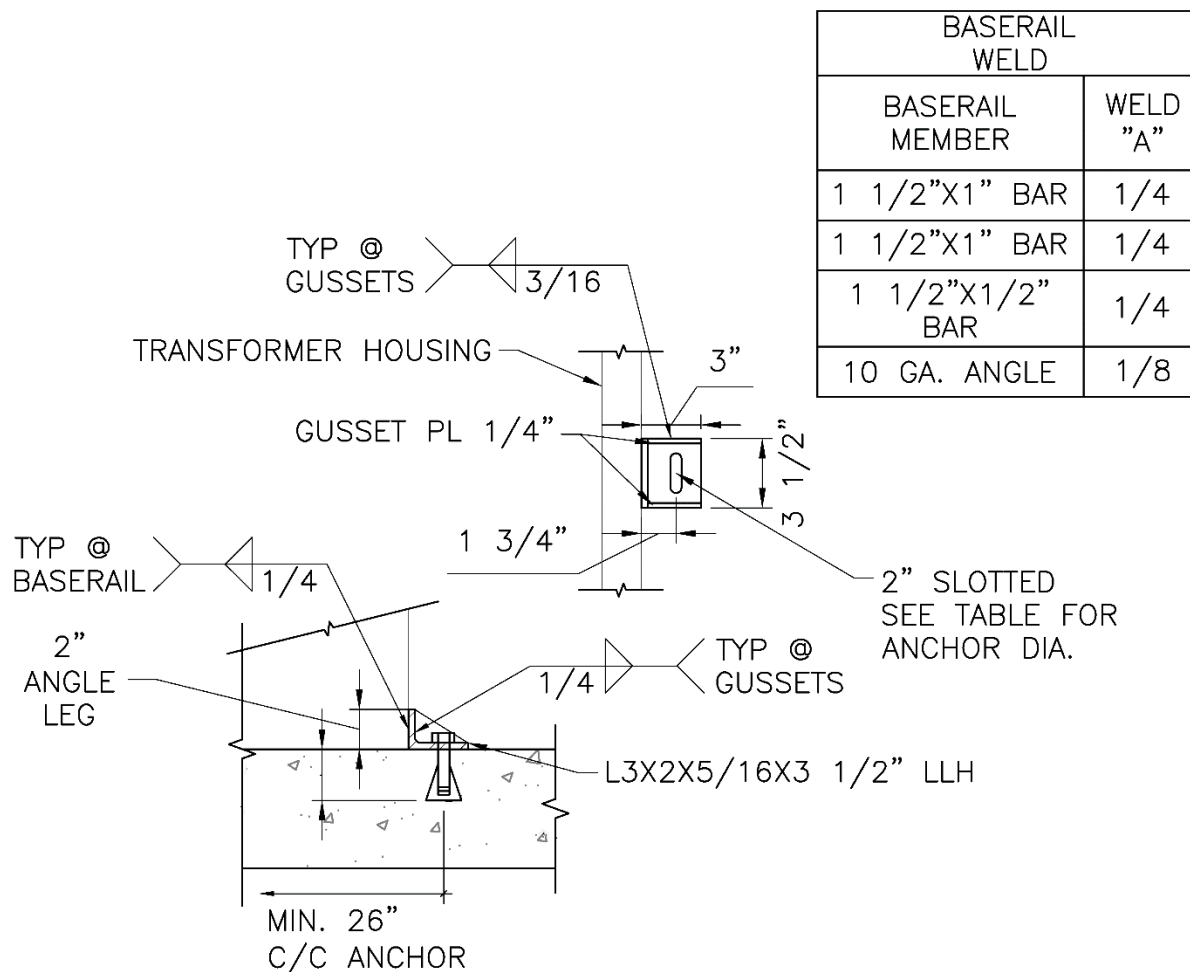
Figure 6.13.6 Drain Valve



6.14 Transformer Anchor Tabs

Provide four tabs on the tank for mounting the transformer to the pad. See Figure 6.14.

Figure 6.14 Transformer Anchor Tabs



7. Tests

7.1 General

All applicable tests shall be performed as specified in IEEE C57.12.00 and in IEEE C57.12.90.

7.2 Dielectric Tests

Dielectric tests shall be performed as specified in IEEE C57.12.34, Section 7.2 and IEEE C57.12.90, Section 10. Dielectric test levels shall be in accordance with the levels specified in IEEE C57.12.00, Section 5.10.

7.3 Tank and Enclosure Tests

Tests shall be performed as specified in IEEE C57.12.34, Section 8.10.1 and IEEE C57.12.28.

7.4 Short Circuit Tests

Short circuit tests shall be performed as specified in IEEE C57.12.90, Section 12.

7.5 Audible Sound Levels

Audible sound levels for each unit shall be according to the requirements of NEMA TR-1, Section 0.05. Tests shall be performed per IEEE C57.12.90, Section 13.

7.6 Radio Influence Voltage Test

Radio influence voltage shall be according to the requirements of NEMA TR-1, Section 0.03.

7.7 Load and No-Load Tests

Load and no-load loss measurements shall be performed at 85 degrees C and 20 degrees C, respectively, according to the requirements of IEEE C57.12.00, Section 5.9 and shall comply with IEEE C57.12.90.

7.8 Documentation

Tests reports demonstrating conformance to all tests completed shall be submitted in a single electronic document. All documentation shall be in English and use customary inch-pound units.

7.9 Test Tag

A weatherproof test tag conforming to the requirements of the Revised Code of Washington RCW 19.29.010, Rule 5 shall be firmly attached to each unit.

Tag shall read "THIS TRANSFORMER HAS BEEN SUBJECTED TO AN INSULATION TEST IN ACCORDANCE WITH THE STANDARDIZED RULES OF IEEE/ANSI. THIS TRANSFORMER HAS BEEN TESTED AT RATED LINE VOLTAGE."

Tag shall indicate:

- Transformer serial number
- Date on which the test was performed
- Name of the person who performed the test

Figure 7.9. Test Tag, Example



8. Design Changes

Manufacturer shall inform Seattle City Light in writing of all design changes that could affect the transformer's understood or published capabilities.

9. Shipping and Handling

Each transformer shall be supplied on its own pallet.

9.1 Pallet Material

Pallet and all pallet accessories shall be constructed of unpainted wood and suitable for yard storage through all weather conditions.

9.2 Support

Pallet shall be 4 inches high to accommodate lifting by both forklifts and pallet jacks.

The most central pallet stringer shall be centered and a maximum of 7 inches wide to insure picking by pallet jacks.

9.3 Orientation

Transformer shall be centered on pallet and secured via its pad attachments.

Transformer shall be oriented on the pallet to prevent transformer enclosure from coming into contact with pallet moving equipment or otherwise shall be enclosed by protective devices to prevent damage.

9.4 Arrival Condition

Transformers shall be delivered on covered or enclosed trucks.

Transformers shall be received by Seattle City Light in clean condition.

10. Seattle City Light Processes

10.1 Bid Process

Bid process details are available at www.seattle.gov.

Bid documentation shall be submitted with details demonstrating conformance to this standard. Submittal details shall be listed to correspond with this standard's section formatting.

Any exceptions taken to the standard shall be summarized in an attached letter, complete with section numbering relating to this standard. Requests for approved equal components must be submitted with first bid documents; all subsequent requests will be rejected.

10.2 Loss Factors

Load and no-load loss measurements shall be performed at 85°C and 20°C, respectively according to the requirements of IEEE C57.12.00, Section 5.9 and shall comply with IEEE C57.12.90.

10.2.1 Load Loss

Load losses shall be assessed at \$2.60 per watt.

10.2.2 No-Load Loss

No-load "core" losses shall be assessed at \$5.90 per watt.

10.2.3 Loss Assessment

Total Price (\$) = Bid Price + Loss Total

Loss Total = Load Loss + No-load Loss

Load Loss = Losses (Watts) x \$2.60

No-load Loss = Losses (Watts) x \$5.90

The manufacturer will be assessed a penalty for transformers delivered that exceed the total loss value stated and calculated on the bid proposal. The penalty shall be the difference between the total loss values delivered less the total loss value in the bid proposal.

Tolerances will be allowed in accordance with IEEE C57.12.90, Section 9.3, except, tolerances shall apply to transformers of a given size and voltage; i.e., one line item. Individual transformers that exceed these tolerances may be rejected and returned to the manufacturer.

10.3 Bid Completion

Upon completion of the bidding process, the successful bidder shall submit in a single electronic file the following:

- Transformer dimensions and spare parts list
- Nameplate
- Loss data
- Instructional materials demonstrating the proper installation, operation, and maintenance of the equipment.
- Certified test data for each transformer type bid and for every category listed in IEEE C57.12.00, Section 8.6. Format test data using numbering system shown in IEEE C57.12.00, Section 8.6.

10.4 Inspection and Electrical Testing

Upon delivery, the transformers will be inspected for physical defects and conformance to this standard.

The transformers will be tested electrically for Radio Influence Voltage (per NEMA TR-1, Section 7 at 1MHz and 17.4kV, RIV not to exceed 100 microVolts), losses and a small battery of other tests.

If any transformer fails, the manufacturer will be contacted and given the option to take back the lot or take back the lot except the units that passed during initial testing.

10.5 Guarantee

Any transformer failing due to defective design, material, and/or workmanship within 12 months after being energized or 18 months after delivery, shall be repaired or replaced without cost to the City of Seattle. Any defect discovered within this period shall be corrected on all transformers furnished on the order at the manufacturer's expense, either by repair or replacement.

11. Issuance

Stock Unit: EA

12. Approved Manufacturers and Factories

ABB	Jefferson City Missouri
Carte International	Winnipeg, Manitoba, Canada
Cooper Power	Waukesha, Wisconsin
Howard	Laurel, Mississippi

13. Accessories

Stock No.	Description	Carte Part No.
014931	Neutral ground strap, 0.0315" x 1.50" x 16" long	2440159A89



References

SCL Material Standard 4480.10; "Valve, Transformer Pressure Relief"

14. Sources

Hanson, Brett; SCL Standards Engineer and subject matter expert for 4240.00

SCL Material Standard 0028.3; "Distribution Transformer, Three-Phase, Padmount Type 75 through 500 kVA, No Taps, Natural Ester Fluid" (canceled)

SCL Material Standard 0028.5; "Distribution Transformer, Three-Phase, Padmount Type 750 through 2500 kVA, With Taps, Natural Ester Fluid" (canceled)

Appendix A. Transformer Weight and Volume Examples, Nominal Values

kVA	Secondary Voltage	Stock No.	Weight (lb)	Insulating Fluid Volume (gal)
150	208Y/120	374840	5200	255
	480Y/277	374440	5200	255
225	208Y/120	374846	5850	280
	480Y/277	374446	5450	235
300	208Y/120	374850	6450	275
	480Y/277	374450	5650	235
500	208Y/120	374860	6067	245
	480Y/277	374460	7100	305
750	208Y/120	374866	8953	428
	480Y/277	374466	9200	485
1000	208Y/120	374872	12312	583
	480Y/277	374472	10800	490
1500	480Y/277	374476	13300	575
2000	480Y/277	374478	15100	620
2500	480Y/277	374480	17800	730

Note:

The values in this table are only estimates, not requirements. Transformer weight and volume are expected to increase. Use engineering judgement before applying these values to any project.