

1. Scope

This specification covers the requirements for furnishing and delivering single phase, 60-Hz, liquid-immersed, self-cooled, submersible distribution transformer(s) rated 167 kVA or smaller, suitable for use on a 12.47 Grd.Y/7.2kV electrical distribution system.

2. Reference Standards

All characteristics, definitions, terminology, voltage designations and tests, except as otherwise specified herein, shall be in accordance with the following industry standards for distribution, power and regulating transformers. When the following standards are superseded by an approved revision, the revision shall apply.

Industry Standards

ANSI/AIM BC2-1995 Uniform Symbology Specification - Code 39

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

ANSI C57.12.23-2009 IEEE Standard for Submersible, Single-Phase Transformers: 167 kVA and Smaller; High Voltage 25 000 V and Below; Low Voltage 600 V and Below

ANSI C57.12.35-2013 IEEE Standard for Bar Coding for Distribution Transformers

ANSI C57.12.37-2006 IEEE Standard for the Electronic Reporting of Distribution Transformer Test Data

ANSI C57.12.70-2011 IEEE Standard Terminal Markings and Connections for Distribution and Power Transformers

ANSI C57.12.80-2010 IEEE Standard Terminology for Power and Distribution Transformers

ANSI C57.12.90-2010 IEEE Standard Test Code for Liquid-Immersed Distribution, Power, and Regulating Transformers and IEEE Guide for Short Circuit Testing of Distribution and Power Transformers

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

DOE Title 10 Part 431.191 Distribution Transformers — Energy Conservation Standards and Their Effective Dates

NEMA 260-1996 (R2004) Safety Labels for Pad-Mounted Switchgear and Transformers Sited in Public Areas

NEMA TR 1 (R2000) Transformers, Regulators & Reactors

District Standards

Material Standard 387151.1 3-1/2" Labels for Marking District Owned Equipment

Material Standard 890526.1 Padmount Equipment Danger Label

Material Standard 890534.1 Padmount Equipment Warning Label

Material Standard 1000212.1 Non-PCB Label

3. losses, efficiency and impedance

3.1 No-Load Losses

No-load losses (core losses) shall be quoted in watts, referenced at 20°C in accordance with ANSI C57.12.00-2010.

3.2 Load Losses

Load losses (winding losses) shall be quoted in watts, referenced at 85°C in accordance with ANSI C57.12.00-2010.

3.3 Efficiency

Transformers shall meet the efficiency requirements of the U.S. Department of Energy as stated in DOE 10 CFR Part 431, Energy Conservation Program: Energy Conservation Standards for Distribution Transformers; Final Rule, as applicable.

4. Electrical Ratings, Material ID numbers & DOE Minimum efficiencies

kVA Size	High Voltage	Low Voltage	Cat. ID	DOE Min. Efficiency
50	12.47 Grounded. Y /7.2kV	120/240	640509	99.11%
75	12.47 Grounded. Y /7.2kV	120/240	640608	99.19%
100	12.47 Grounded. Y /7.2kV	120/240	640707	99.25%
100	12.47 Grounded. Y /7.2kV	277	1002444	99.25%
167	12.47 Grounded. Y /7.2kV	120/240	640806	99.33%
167	12.47 Grounded. Y /7.2kV	277	1000911	99.33%

5. Construction

5.1 Windings & Core

The transformer core material shall be of low loss material.

Thermal setting adhesive kraft paper shall be used to insulate the coil assembly and a thermal setting adhesive shall be used to bond the primary winding both turn-to-turn and layer-to-layer. In addition, the coil assembly shall be supported with heavy pressure plates.

All aluminum strip windings shall be edge conditioned to remove all edge ridges or protrusions left over from the material's manufacturing process. High-voltage and low-voltage leads shall be insulated between their bushings and the transformer core. Aluminum low-voltage leads shall be attached to low-voltage bushings by means of a hardened aluminum tab or terminal, so as to avoid connection loosening due to cold flow.

5.2 Tank Construction and Finish

Transformer tank and cover shall be constructed of one of the following materials:

- Stabilized ferritic stainless steel, ANSI type 409 or equivalent, with a 3 mil minimum thickness protective topcoat.
- Austenitic stainless steel, ANSI type 304L or equivalent. No topcoat is required.
- Nonmetallic composites. Material and design must be approved by the District.

Transformer cover and all non-moving fittings shall be welded in place.

Two solderless ground connectors which will accommodate AWG copper conductor size No. 8 solid to No. 2 stranded shall be provided and installed on the tank as indicated in ANSI C57.12.23-2009, Figure 1. One ground connector is acceptable on radial feed units.

5.3 Transformer Dimensions

Transformer width, including cooling fins, shall not exceed 33 inches. Transformer height from base to top of cover shall not exceed 48 inches.

6. Components

6.1 High Voltage Terminals

Transformers with 120/240 volt low-voltage ratings shall be designed for loop-feed and equipped with two high-voltage terminals. Transformers with 277 volt low-voltage ratings shall be designed for radial feed and equipped with a single high-voltage terminal. High-voltage terminals shall be furnished with universal loadbreak bushing wells conforming to ANSI/IEEE 386, latest revision, designed to accommodate 8.3/14.4kV 200A loadbreak bushings. Bushing wells shall be mounted as indicated in ANSI C57.12.23-2009, Figure 1. Gasketed bushing wells are not acceptable.

6.2 Low Voltage Terminals

Submersible transformers shall be equipped with copper threaded stud secondary terminals potted in a cast epoxy bushing assembly welded to the tank cover. Gasketed secondary bushings are not acceptable. Low voltage terminals shall be arranged as indicated in ANSI C57.12.23-2009, Figure 1. Each low-voltage terminal shall be supplied with an insulated cable lead permanently attached to a female threaded copper terminal. Number of terminals, terminal thread size, wire size, lead length and terminal thread size shall be as follows:

kVA Size	Low Voltage	No. of Terminals	Thread Size	Cu Wire Size	Min. Length	Mat. ID
50	120/240	4	5/8"-11 UNC 2A	4/0 AWG	16"	640509
75	120/240	4	1"-14 UNC 2S	500 kcmil	18"	640608
100	120/240	4	1"-14 UNC 2S	500 kcmil	18"	640707
100	277	2	1"-14 UNC 2S	500 kcmil	18"	1002444
167	120/240	4	1"-14 UNC 2S	500 kcmil	18"	640806
167	277	2	1"-14 UNC 2S	500 kcmil	18"	1000911

6.3 Taps

Transformer(s) with 120/240 volt low-voltage ratings shall not have taps unless specified on the Special Provision Sheet. Transformer(s) with 277 volt low-voltage ratings shall have two (2) 2.5% taps above and below rated voltage unless otherwise specified on the Special Provision Sheet. Tap changers when furnished shall be externally operable.

6.4 Transformer Oil

The transformer shall be shipped with the proper quantity of mineral insulating oil. Oil shall meet the requirements of ASTM D 3487 for Type II (inhibited) oil. At the time the oil is put into the tank it shall contain less than (1) ppm PCB certifiable by a laboratory test approved by the United States Environmental Protection Agency. The insulating oil, or any of its components, shall not be listed by IARC, NTP, OSHA or ACGIH as carcinogens. The successful bidder shall supply an MSDS sheet for each distinct formulation of insulating oil supplied to the District.

Alternative insulating fluids, including ester-based and silicone-based oils may be supplied with prior District review and approval.

6.5 Relief of Excessive Pressure

Pressure relief devices shall not be installed.

6.6 Fusing

Each transformer shall be provided with a bayonet type fuse assembly with internal isolation link. This fuse assembly shall be mounted on the cover so as to be accessible from above with a hot stick. Each fuse holder shall be equipped with dual sensing fuses, according to the following table:

kVA Size	Fuse Size	Curve No.	Dual Sensing Fuse Element		Isolation Link	
			Cooper Cat. No.	Ermco Cat. No.	Cooper Cat. No.	Ermco Car. No.
50	15A	C8	4000358C08	9F54LFC080	3001861A03	7580ZB0499
75	25A	C10	4000358C10	9F54LFC100	3001861A05	7580ZB0599
100	25A	C10	4000358C10	9F54LFC100	3001861A05	7580ZB0599
167	50A	C12	4000358C12	9F54LFC120	3001861A06	7580ZB0699

The time current curve is R.T.E. TCC 1558B

7. Noise

Transformer sound levels shall not exceed the values listed below when measured in accordance with ANSI C57.12.90-2010:

Equivalent Two-Winding kVA	Average Sound Level Decibels
0-50	48
51-100	51
101-300	55

8. Identification

8.1 Nameplate

A corrosion-resistant nameplate shall be provided which conforms with Section 5.12 of ANSI C57.12.00-2010. Additionally, the nameplate shall show gallons of oil and total transformer weight with oil.

The following statement shall appear on the nameplate: "Contains less than 1 ppm PCB at the time of manufacture".

Nameplates shall be bar coded in accordance with ANSI C57.12.35-2013.

8.2 NON- PCB Decal

A "NON-PCB" decal, if specified in the Special Provisions Sheet, shall meet the following requirements:

- One "NON-PCB" decal shall be attached to each transformer.
- "NON-PCB" decals shall conform to the latest revision of District Material Standard 1000212.1.
- The decals shall be positioned on the transformer cover so as to be clearly visible from above.

9. Test Reports

The bidder shall furnish certified copies of the short-circuit tests they have performed on each transformer design. Short-circuit tests shall be in accordance with ANSI/IEEE C57.12.00-2010 and C57.12.90-2010.

The District may reject any bid, when in its judgment, the bidder has not taken sufficient steps to meet the mechanical short-circuit requirements as detailed in the ANSI/IEEE standards.

10. Packaging

Transformers shall be shipped secured to individual nonreturnable wooden pallets suitable for handling with a forklift.

Transformers shall be shipped in an enclosed van. Transformers shipped on flatbed trucks, even if tarped or otherwise protected shall be refused and returned to vendor.

11. Guarantee

The failure of any transformer due to defective design, material and/or workmanship within twelve months after being energized or eighteen months after delivery, whichever comes first, shall be repaired or replaced without cost to the District. Any defect in design, material and/or construction discovered within this period shall be corrected on all transformers furnished on this order at the manufacturer's expense, either by repair or by replacement.

12. Inspection and Testing

After delivery, all of the delivered lot will be inspected for defects and conformance to this Specification and tested for proper internal connections. The manufacturer (or his representative) will be notified of all defects and mutual arrangements shall be made for correcting the defects at no expense to the District. All subsequent testing required due to the defects will be at the manufacturer's expense.

13. Bidder's Data

For each transformer rating, all bidders shall supply:

- One certified copy of all design tests as called for in ANSI C57.12.00-2010, Table 18.
- Complete data and information as requested on the attached bidders data file.

A description of any proposed changes, additions or exceptions to the Specification shall be submitted along with reasons for the departure.

14. Data to be Furnished by the Successful Bidder

14.1 CAD Drawings

A CAD outline drawing showing the dimensions of each transformer line item with accessories. Acceptable formats include Microstation, AutoCAD or DXF.

14.2 Certified Transformer Test Data

Certified data for each transformer shall be submitted for each transformer at the time of shipment or other mutually agreed upon interval. Test data shall reported in electronic form, supplied as an ASCII file with variable length records, comma delimited. Fields shall be stripped of leading and trailing blanks. The data set shall include the standard and extended data sets per ANSI C57.12.37-2006 modified as given:

Field	Field Name	Data Type	Sample Data	Valid Values
1	User Name	Char(20)	SNOHOMISH COUNTY PUD	SNOHOMISH COUNTY PUD
2	User Purchase Order Number	Char(8)	00026350	PO number including leading zeros.
3	User Stock Number	Char(10)	0000630592	Mat. ID number including leading zeros.
4	Producer Identification	Char(2)	HI	See ANSI C57.12.35-2007.
5	Producer Order Number	Char(14)	4337	
6	Producer Catalog Number	Char(15)	1037-418997-000	
7	Producer Serial Number	Char(13)	1765201303	
8	Product Type	Char(2)	PM	See ANSI C57.12.37-2006, 4.2.8.
9	Number of Phases	Int(1)	1	1,2 or 3
10	kVA Rating	Numeric(7,1)	37.5	Nominal ONAN kVA to 1 decimal point.
11	Primary Voltage	Char(47)	12 470GrdY/7200	See ANSI C57.12.00-2006.
12	Secondary Voltage	Char(28)	240/120	See ANSI C57.12.00-2006.
13	Polarity	Char(1)	S	A (Additive), S (Subtractive), Null (3Ø).
14	Quoted No-Load Loss	Int(5)	45	Quoted no-load losses in watts at nominal kVA, Pri. voltage & 20°C.
15	Quoted Load Loss	Int(6)	201	Quoted load losses in watts at nominal kVA, Pri. voltage & 85°C.
16	Quoted Impedance Voltage (IZ)	Numeric(4,2)	2.57	Quoted IZ in percent at nominal kVA, Pri. voltage & 85°C.
17	Quoted Excited Current (IEX)	Numeric(4,2)	0.27	Quoted IEX in percent at nominal kVA, Pri. voltage & 85°C.
18	Tested No-Load Loss	Int(5)	44	Tested no-load losses in watts at nominal kVA, Pri. voltage & 20°C.
19	Tested Load Loss	Int(6)	189	Tested load losses in watts at nominal kVA, Pri. voltage & 85°C.
20	Tested Impedance Voltage (IZ)	Numeric(4,2)	2.6	Tested IZ in percent at nominal kVA, Pri. voltage & 85°C.
21	Tested Resistance Voltage (IR)	Numeric(4,2)	1.66	Tested IR in percent at nominal kVA, Pri. voltage & 85°C.

Field	Field Name	Data Type	Sample Data	Valid Values
22	Tested Exciting Current (IEX)	Numeric(4,2)	0.30	Tested IEX in percent at nominal kVA, Pri. voltage & 85°C.
23	Total Mass	Int(5)	892	Total mass, including accessories & oil.
24	Mass Unit of Measure	Char(2)	lb	lb (pounds), kg (kilograms).
25	Date of Manufacture	Char(7)	2005/05	Alphanumeric in yyyy/mm format.
26	Test Data Reporting Lot	Char(7)	2005/05	yyyy/mm or yyyy/qx where qx is Q1, Q2, Q3 or Q4.
27	User Release Number	Char(5)	00107	Release number including leading zeros.
28	Producer Plant Location	Char(10)	MSLAUREL	See ANSI C57.12.00-2006, 4.3.2.
29	Quoted Loss Guarantee Type	Char(2)	GA	See ANSI C57.12.00-2006, 4.3.3.
30	No-Load Loss Evaluation Factor	Numeric(5,2)	5.2	00.00 to 99.99
31	Load Loss Evaluation Factor	Numeric(5,2)	1.23	00.00 to 99.99
32	Frequency	Int(2)	60	Nominal operating frequency in hertz, 0 to 99.
33	Cooling Class	Char(9)	ONAN	ONAN, ONAN/ONAF, KNAN/KNAF or LNaN/LNAF.
34	Average Winding Temperature Rise	Char(5)	65	55, 55/65, 65 or other as specified.
35	Type of Insulating Fluid	Char(8)	MIN_OIL	MIN_OIL, FR3, EnviroTemp, R TEMP or as specified.
36	No-Load Loss Reference Temperature	Int(2)	20	0 to 99.
37	Load Loss Reference Temperature	Int(2)	85	0 to 99.
38	Total Volume of Oil	Int(4)	47	0 to 9999.
39	Volume Unit of Measure	Char(2)	GL	GL (gallons) or LT (liters).