CONSTRUCTION STANDARD SPECIFICATION

SECTION 16272

PADMOUNT TRANSFORMERS

CONSTRUCTION STANDARD SPECIFICATION

SECTION 16272

PADMOUNT TRANSFORMERS

PART 1 - GENERAL

1.01 SUMMARY

A. This specification is written for three-phase, 60 hertz, 65°C temperature rise, liquid filled, self-cooled, pad mounted, live-front, compartmentalized distribution transformers, rated 1,500 kVA and below, radial feed.

B. Pad mounted transformers shall be provided and installed in accordance with the details and ratings on the working drawings and in accordance with this specification.

1.02 REFERENCES

A. Related Drawings: Refer to the following Sandia National Laboratories (SNL) Facilities Standard Drawings:

1. WP3003STD – Transformer Fire Barrier Wall.

B. American National Standards Institute/Institute of Electrical and Electronic Engineer (ANSI/IEEE)

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

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

C. American National Standards Institute (ANSI)

C57.12.22 Pad-Mounted, Compartmental-Type Self-Cooled Three-Phase Distribution Transformers with High-Voltage Bushings, 2500 kVA and Smaller; High Voltage 34,500 Grd Y/19,920 Volts and Below; Low Voltage, 480 Volts and Below-Requirements

C57.12.26 Pad-Mounted Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers for Use with Separable Insulated High-Voltage Connectors, High-Voltage, 34,500 Grd Y/19,920 Volts and Below; 2500 kVA and Smaller

1.03 SUBMITTALS

The following shall be submitted in accordance with Division 1, Section 01330, “Submittal Procedures."

A. Outline drawings including overall height, overall width, overall depth, base dimensions, arrangement of bushings, and other appurtenances, and compartment dimensions.

B. Weights of the tank, oil, and total transformer.

C. Volume of oil, gallons.

D. Test and Performance Data

The manufacturer shall perform the following routine tests as defined in ANSI C57.12.00 (latest edition).

1. Exciting current at 100% and 110% of rated voltage.

2. Average excitation loss in accordance with ANSI C57.12.00-1987 the latest edition), Section 9, paragraph 9.3, and Table 18, line 3.

3. Average total loss in accordance with ANSI C57.12.00-1987 the latest edition), Section 9, paragraph 9.3, and Table 18, line 3.

4. Percent impedance volts, of the low voltage winding with respect to the high voltage winding at rated self-cooled kVA.

5. Steady state transformer top oil temperature rise above ambient, degree Celsius.

6. Transformer oil time constant, time for top oil to obtain 63% of steady state rise above ambient.

7. Certified statement of compliance with short circuit capability requirements of Paragraph 2.06.

8. Certification of tamper resistant design with complete test data.

9. Certified high and low voltage impulse data.

E. Production Test Data

10. The manufacturer shall perform all routine tests as defined in ANSI C57.12.00 (latest edition).

11. The manufacturer shall perform production line high voltage and low voltage impulse tests on each unit as defined in ANSI C57.12.00 (latest edition).

12. The manufacturer shall provide Sandia with the following certified data by transformer serial number for each transformer shipped.

    a. Excitation loss, watts.

    b. Impedance, % Z.

    c. Total loss, watts @ 85º C.

F. Manufacturer shall certify that all transformers supplied under this specification contain less than 1 ppm PCB.

G. All required information and laboratory test performance data per Section 3.1.2 of "EEI Finishing Guidelines for Padmounted Equipment," Draft 6.

H. No individual transformer shall be shipped with losses that exceed quoted losses by more than the tolerances in ANSI C57.12.00 (latest edition), Table 18, line 2, without written approval of Sandia National Laboratories/New Mexico (SNL/NM).

1.04 QUALITY ASSURANCE

A. All characteristics, definitions, terminology, and voltage designations, except as otherwise specified herein, shall be in accordance with applicable provisions of the latest edition of ANSI C57.12.22, or its successors, and applicable ANSI C57 series specifications including C57.12.00 (latest edition).

B. Manufacturer will state the edition and date of ANSI C57.12.22 on submittals.

C. Manufacturer shall provide a warranty on each unit stating that the unit will be free of defects in workmanship and material for a period of twelve (12) months from the date of initial installation or eighteen (18) months from the date of manufacture, whichever shall occur first.

PART 2 - PRODUCTS

2.01 KVA RATINGS

Kilovolt-ampere ratings shall be 75, 150, 300, 500, 750, 1000, or 1500.

2.02 VOLTAGE RATINGS AND TAP RATINGS

Voltage ratings, minimum BIL rating, and tap ratings shall be in accordance with Table 1, below.

TABLE 1

High Voltage Rating (Volts) Delta	BIL Rating (kV)	Low Voltage Rating (Volts) Wye	kVA Rating	High Voltage Taps Required
2,400	45	208Y / 120	75 - 1500	2½% Above & Below
2,400	45	480Y / 277	75 - 1500	2½% Above & Below
4,160	60	208Y / 120	75 - 1500	2½% Above & Below
4,160	60	480Y / 277	75 - 1500	2½% Above & Below
12,470	95	208Y / 120	75 - 1500	2½% Above & Below
12,470	95	480Y / 277	75 - 1500	2½% Above & Below

2.03 CORE DESIGN

Transformers shall be of five-legged core design and connected delta-wye. A fully insulated, neutral bushing will bring the secondary winding neutral to the outside of the tank and a ground pad will be provided on the outside tank wall and will be connected to the neutral bushing with a removable ground strap.

2.04 HIGH VOLTAGE TAPS

High voltage taps shall be provided in accordance with Table 1. Taps shall be suitable for de-energized operation only. The tap changer switch shall be ganged and shall be externally operable. Locate the operating handle either in the high voltage compartment above the primary bushings or in the secondary compartment above the low voltage bushings. Set the tap changer on the 100% tap at the factory and secure to prevent inadvertent change from this position.

2.05 TRANSFORMER IMPEDANCES

Minimum impedances shall be in accordance with Table 2 below:

TABLE 2

Secondary Voltage
*Minimum AC Impedance %

kVA	208Y / 120	480Y / 277
75	2.9	2.6
150	3.0	2.6
300	4.7	2.6
500	4.7	4.3
750	5.75	5.75
1,000	5.75	5.75
1,500	N/A	5.75

*ANSI Standard Tolerance (±7.5 %)

2.06 SHORT-CIRCUIT CAPABILITY

A. Mechanical short-circuit capability shall be demonstrated by design compliance with ANSI C57.12.90 (latest edition).

B. Thermal short-circuit capability shall be demonstrated by design compliance with ANSI C57-12.00 (latest edition).

2.07 OVERCURRENT PROTECTION

A. Overcurrent protection devices shall not be supplied in radial feed transformers.

2.08 CONSTRUCTION

A. Description

13. Transformers shall be designed to protect people against accidental contact of energized parts, discourage unauthorized access to or climbing upon the unit by the public, and protect against weather.

14. The pad mounted transformer shall consist of the transformer tank, high-voltage cable terminating compartment, and the low-voltage cable terminating compartment. The transformer tank and compartment shall be assembled as a rain tight compartment, outdoor, and tamper-resistant integral unit suitable for mounting on a flat surface. The transformer design shall not use gasketing to meet this requirement.

15. There shall be no exposed screws, bolts, or other fastening or hinging devices (other than the pentahead bolt specified in 2.08 D.5) that are externally removable. There shall be no opening through which foreign objects such as sticks or wires might be inserted to contact energized parts. Suitable means for padlocking the compartment door(s) shall be provided. Normal entry shall be possible only with the use of proper access tools.

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

17. Construction of the unit shall be such that it can be lifted, skidded, and slid into place on the mounting pad without disturbing the entrance cables.

18. All external surfaces shall be constructed of steel, 13 USS gauge or thicker.

19. The transformer and compartment hoods shall be crowned to insure water run off or manufactured with a full weather cover.

B. Bottom Protection

20. The transformer tank base shall be raised above the pad to protect the bottom finish during installation and to minimize corrosion due to moisture accumulation. The base shall be cross-braced to permit rolling in two directions.

21. All external surfaces of ferrous material used in the construction of the assembly shall have undercoating over the regular finish, applied to the bottoms of the components and extending up the side to a point one to two inches above the bottom of their bases in a straight edge.

C. Protective Coating

1. All coated surfaces both exterior and interior shall be painted using a system that conforms to the requirements of "EEI Proposed Finishing Guidelines for Padmounted Equipment," Draft 6. The finish coat shall be light gray (ANSI Color No. 70).

D. High- and Low-Voltage Compartments

1. Terminal compartments shall be full height, air-filled compartments with separate hinged doors. The compartments shall be completely isolated from each other by a steel barrier without opening or discontinuity of any kind.

2. The edges of the access doors and hoods shall be formed to provide a close fitting mating surface, with internal insertion-prevention lip that will be shaped to resist entry or prying by screwdrivers, wrecking bars, tire irons, single-socket lug wrenches or other readily accessible tools.

3. Hinges and hinge pins shall be passivated American Iron and Steel Institute Type 304 stainless steel or equivalent corrosion-resistant metal.

4. There shall be a threaded fastening device for the high voltage door, accessible only through the low voltage compartment. Screen door latches with wing nuts and gravity hooks are acceptable. The low-voltage compartment door shall have a minimum of three-point latching and the handle shall have provisions for padlocking.

   The padlocking provision shall be so designed and located as to resist prying or breaking off by screwdrivers, wrecking bars, tire irons, single-socket lug wrenches, or other readily accessible tools and to inhibit removal of the padlock with a bolt cutting device or hacksaw.

5. In addition to the regular locking provision above, the access doors shall be secured by a captive, recessed pentahead bolt as depicted in Figure 11, ANSI C57.12.26-1987 (or the latest edition). Bolts and associated hardware must be rust and corrosion resistant. The design shall minimize the possibility of

misalignment and cross threading. The design must be such that wire entry through the bolthole into the compartment(s) is prohibited when the bolt is removed. The non-rotating cup shall be permanently attached.

a. The captive pentahead bolt shall be coordinated with the latch and padlock to prevent unlatching and insertion of the padlock into the hasp when and until the bolt is completely threaded, respectively.

b. The captive pentahead shall also function as an interlock device to pin the latch closed.

6. Both compartment doors shall be equipped with stops for holding each door in a 90° open position. The stops shall be captive to prevent loss of the device.

7. Doors on the high- and low-voltage compartments shall be of sufficient size to provide adequate working space when open.

8. The bottom edge of the transformer shall provide for flush mounting on a flat rigid surface to prevent wire entry into the high- or low-voltage compartments.

E. Maximum Size

Transformer sizes shall not be larger than the "A" and "B" dimensions on the transformer pad dimensions shown on Sketch "A".

2.09 MANUFACTURER

Padmount transformers manufactured by ABB Company, General Electric, Cooper Industries or Howard Industries..`

2.10 LOW VOLTAGE BUSHINGS AND TERMINALS

A. Electrical characteristics of completely assembled low-voltage terminations shall comply with Table 3 of ANSI C57.12.26-1987 (or the latest edition) unless otherwise stated herein.

B. All low voltage terminals shall be insulated from the tank with 1.2 kV class bushings. Terminals of low-voltage windings shall be arranged to the specific dimensions shown in Figure 2 and 3 (a) ANSI C57.12.22-1989 (or latest edition). In line arrangements are unacceptable.

C. The low-voltage neutral shall be a fully insulated bushing. A ground pad shall be provided. A removable copper ground strap shall be provided and connected between the neutral bushing and ground pad. The ground strap shall be capable of carrying a line to ground fault of the magnitude and duration defined in ANSI C57.12.00 (latest edition).

D. Low-voltage terminals shall be 2-hole spades with NEMA hole spacing to provide the number of holes given in Table 3.

TABLE 3

Secondary Terminals

	Transformer kVA Size						
Secondary Voltage	75	150	300	500	750	1000	1500
208Y / 120	4	6	6	8	8	8	N/A
480Y / 277	4	6	6	6	6	8	8

2.11 HIGH VOLTAGE BUSHINGS AND TERMINALS

A. Bushings arrangement for live front, radial feed transformers shall comply with the latest revision of ANSI C57.12.22.

B. High voltage bushings are to be made of wet-process porcelain and clamped externally to the wall of the transformer. Reusable nitrite rubber gaskets shall seal the bushing to the tank wall in the terminals to the porcelain.

C. Transformer sizes of 75-1500 kVA, shall have 2-hole blade terminals with 9/16-in. (14.30 mm) diameter holes, with NEMA hole spacing.

D. High-voltage cable terminals shall be oriented for vertical take-off of primary cables entering the compartment from below in accordance with Figure 4, ANSI C57.12.22-1989.

E. Transformer design shall allow field replacement of high voltage bushing wells and low voltage bushings by means of common hand tools and oil handling equipment, without totally untanking the transformer.

2.12 ACCESSORIES

A. The following accessories are required on all transformers and located in the low-voltage compartment in such a manner as to not interfere with low-voltage terminals:

1. Pressure relief device.

2. Upper filter valve or plug.

3. One-inch combination drain, lower-filter valve, and sampling device. Combination drain plug and sampling device may be substituted.

B. The following accessories are required on all transformers rated 500 kVA and above located in the low-voltage compartments, above terminals:

1. Liquid level gauge.

2. Top oil thermometer.

2.13 JACKING, ROLLING, LIFTING, AND MOUNTING FACILITIES

A. Suitable jack bosses or equivalent jacking facilities shall be provided on the tank. Vertical clearance for jack shall be 1½ inches (38.1 mm) minimum, 3½ inches (88.9 mm) maximum.

B. Transformer base shall be arranged for rolling in two directions: parallel to and at right angles to the centerline of the high-voltage bushings.

C. Lifting lugs shall be adequately strengthened, sized, and arranged on the tank to provide a suitable lift for the completely assembled unit.

D. 3/4 inch (19.05 mm) minimum and 1½ inch (38.1 mm) maximum integral flange shall be provided at the base of the high-voltage and low-voltage compartments to provide means of anchoring the unit to the pad.

2.14 TERMINAL MARKINGS

External terminals on radial feed transformers shall be marked H1, H2, H3, and X0, X1, X2, and X3 by stenciled white or yellow lettering on the tank.

2.15 INSTRUCTION NAMEPLATE

A. Instruction nameplate shall be located on the inside of the low-voltage compartment door.

B. Instruction nameplate shall contain the information specified in paragraph 5.12 of ANSI C57.12.00-1987 (or latest edition).

C. Nameplate shall indicate that the transformer oil contained less than 1 ppm PCB at time of manufacture.

D. A winding diagram with high- and low-voltage connections shall be shown on the instruction nameplate.

2.16 OIL PRESERVATION

Transformers shall be of sealed tank construction, so designed that the interior is sealed from the atmosphere and the gas plus oil volume remains constant. The transformer shall remain effectively sealed for all temperatures to plus 105°C top oil.

2.17 TANKS

The tank will be of sufficient strength to withstand a pressure of 7 psi (48.26 kPa) gage, without permanent distortion.

A. Welded main cover construction shall be provided. Access to internal connection for test purposes shall be provided by means of a hand hole, accessible only from the padlocked compartments.

B. Tank grounding provision shall consist of:

1. 500 kVA and below - two steel pads, each with a 1/2 inch (12.7 mm) 13 NC tapped hole, 7/16 inch (11.13 mm) deep.

2. Above 500 kVA - two unpainted copper-faced steel or stainless-steel pads, 2 inches x 3½ inches (50.8 mm x 88.9 mm) each with two holes spaced on 1¾ inch (44.45 mm) centers and tapped for 1/2 inch (12.7 mm) - 13 NC thread. The minimum thickness of the copper facing shall be 0.015 inch (.381 mm). Minimum threaded depth of holes shall be 1/2 inch (12.7 mm).

C. These ground pads shall be welded on the transformer base or on the tank wall near the base, one in the high-voltage compartment and one in the low-voltage compartment.

PART 3 - EXECUTION

NOTE: This section is applicable to the construction contractor installing the transformer.

3.01 INSTALLATION

A. Transformer shall be installed on a concrete pad as shown on contract drawings. Handling of the transformer shall be in accordance with manufacturer's instructions. Provide a minimum of 5 feet working clearance in front of doors accessing primary and secondary terminations.

B. Touch up scratched or marred surface to match original finish.

C. Two-hole compression cable connectors shall be used on the primary and secondary cables. They shall be crimped only with the approved manufacturer’s recommended tool.

D. The following electrical tests shall be performed prior to energization by SNL. The SDR shall be notified to coordinate and schedule the electrical testing.

1. Perform insulation-resistance tests, winding-to-winding, and winding-to-ground [(high-low and ground) and (low-high and ground)] utilizing a megohmeter with test voltage output as follows:

Transformer Insulation-Resistance Test Voltages

Transformer Coil Reading	Minimum DC Test Voltage	Recommended Minimum Insulation Resistance in Megohms
0 - 600 volts	1,000 volts	100
600 - 5,000 volts	2,500 volts	1,000
5000 - 15,000 volts	5,000 volts	5,000

2. Perform a turns-ratio test (TTR) between windings at all tap positions.

3. Sample insulating oil and perform a dielectric breakdown voltage test.

E. The following visual and mechanical inspections shall be performed on each transformer prior to energization:

1. Inspect for physical damage, cracked insulators, leaks, tightness of connections, and general mechanical and electrical conditions.

2. Check tightness of accessible bolted electrical connections.

3. Verify proper liquid level in tank.

F. Energization of primary circuits and transformer shall be in accordance with Division 16, Section "Primary System Safety Requirements" and contract drawings.

G. Upon energization of the transformer, the phase rotation shall be verified and secondary voltages measured, line-to-line and line-ground, on all phases.

3.02 IDENTIFICATION TAGS

All transformers shall have 3¼" (82.55 mm) high intensity reflective black on yellow labels, manufactured by "Electromark", Catalog # Intens - 3.0 - KY - X (where X is the letter or digit ordering). The labels shall read "TF-XXXX-Y"; X will indicate building number and Y will indicate its number at the building site. Refer to construction drawings for exact transformer number.

EVALUATION

4.01 LOSS EVALUATION

A. Transformers bid under this specification will be evaluated for no load losses and load losses using the present worth method. Each type of loss is associated with a demand charge and an energy charge. The present value of carrying charges associated with each of the charges are multiplied by the appropriate loss figure supplied by the manufacturer for each unit then added to the each unit bid transformer price to obtain the total evaluated cost (TEC) per unit:

TEC = T$ + PVDC x NLL + PVEC x LL; where:

TEC = Total Evaluated Cost

T$ = Unit bid transformer price, $

PVDC = Present worth value of demand charges per kilowatt of no load losses, $/KW.

PVEC = Present worth value of energy charges per kilowatt of load losses, $/KW.

NLL = Transformer no load losses, KW.

LL = Transformer load losses, KW.

Current Values:

PVDC = $8134.00
PVEC = $3326.00

B. In the event actual losses exceed the losses guaranteed, SNL shall have the right to either reject the equipment or to accept the equipment for a reduced price. The amount due SNL shall be calculated as follows:

Price Reduction = (NLLA - NLLQ) x PVDC +(LLA - LLQ) x PVEC; where:

NLLA = Actual transformer no load losses, KW.

NLLQ = Quoted transformer no load losses, KW.

LLA = Actual transformer load losses, KW.

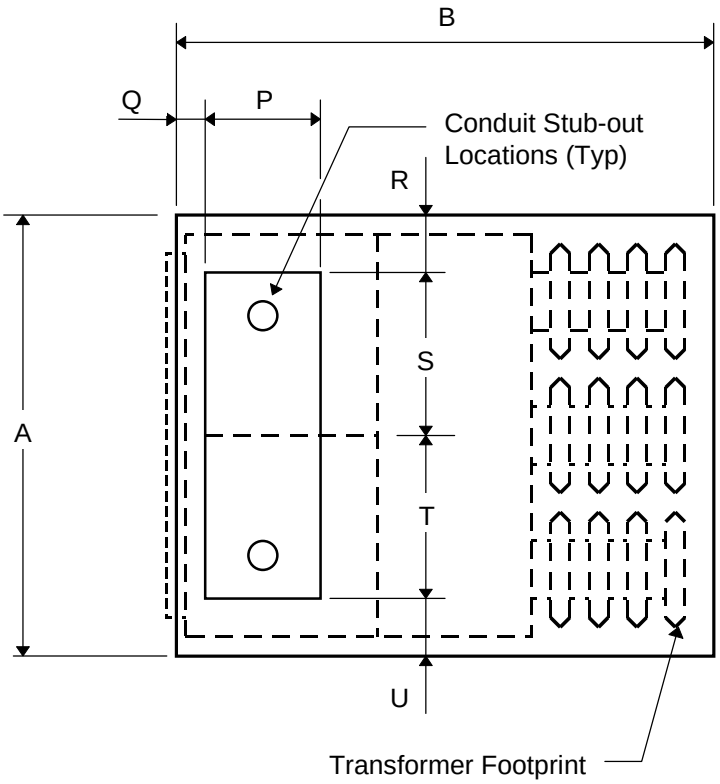
LLQ = Quoted transformer load losses, KW.

END OF SECTION 16272

ATTACHMENT

SKETCH "A"

Transformer Pad Dimensions



ENLARGED PLAN VIEW

TRANSFORMER PAD DIMENSIONS										
XFMR kVA	Gallon Oil	Total Fluid Vol. Ft^3 (V_c)	A	B	P	Q	R	S	T	U
75	130	34.507	6'-11"	5'-8.5"	1'-1.5"	0'-9.5"	1'-8"	2'-2"	1'-5"	1'-8"
150	140	36.319	6'-11"	5'-10"	1'-1.5"	0'-9.5"	1'-8"	2'-2"	1'-5"	1'-8"
300	185	44.139	7'-4"	6'-3.5"	1'-1.5"	0'-9.5"	1'-4.5"	2'-2"	1'-5"	2'-0.5"
500	185	46.111	7'-8"	6'-5.5"	1'-1.5"	0'-9.5"	2'-1/2"	2'-2"	1'-5"	2'-0.5"
750	380	73.993	8'-0"	7'-0.5"	1'-1.5"	0'-9.5"	2'-0"	2'-3"	2'-2"	1'-6.5"
1000	400	78.917	8'-0"	8'-5.5"	1'-1.5"	0'-9.5"	1'-4"	2'-11"	2'-2"	1'-6.5"
1500	490	95.431	8'-6"	8'-8.5"	1'-1.5"	0'-9.5"	1'-8"	3'-0"	2'-3"	1'-7"