THE CITY OF FORT COLLINS

Light and Power Department
P.O. Box 580
Fort Collins, CO 80522

SPECIFICATION NO: **368-300**

TITLE: PAD-MOUNTED COMPARTMENTAL-TYPE, THREE-PHASE DISTRIBUTION TRANSFORMERS WITH SEPARABLE INSULATED LOAD BREAK HIGH-VOLTAGE CONNECTORS

APPROVED BY: _____
Tim M. Sagen
Standards Engineering Division Manager

DATE: 8/12/83

REVISED: **9/11/01**

ITEMS COVERED BY THIS SPECIFICATION

DESCRIPTION	STOCK NO.	
	SPECIFICATION NO.	SERIAL
75 KVA, 208Y/120 RADIAL	368-300	-006
75 KVA, 408Y/277 RADIAL	368-300	-007
75 KVA, 208Y/120 LOOP	368-300	-008
75 KVA, 480Y/277 LOOP	368-300	-009
150 KVA, 208Y/120 LOOP	368-300	-015
150 KVA, 480Y/277 LOOP	368-300	-016
300 KVA, 208Y/120 LOOP	368-300	-030
300 KVA, 480Y/277 LOOP	368-300	-031
500 KVA, 208Y/120 LOOP	368-300	-050
500 KVA, 480Y/277 LOOP	368-300	-051
750 KVA, 208Y/120 LOOP	368-300	-075
750 KVA, 480Y/277 LOOP	368-300	-076
1000 KVA, 208Y/120 LOOP	368-300	-100
1000 KVA, 480Y/277 LOOP	368-300	-101
1500 KVA, 480Y/277 LOOP	368-300	-151
2000 KVA, 480Y/277 LOOP	368-300	-201
2500 KVA, 480Y/277 LOOP	368-300	-251

REVISION DESCRIPTIONS

REVISION DESCRIPTION (Previous on file)	APPROVED
REVISION **FF**: • Add Paragraph 5.2.2.9.3: pentahead locking bolts • Paragraph 3.2.2.13.1: add *glossy* requirement.	Tim Sagen Susan Coram 10-18-95
REVISION **GG**: • Title page: Remove revised date • Paragraph 4.4 and Table 2A: Change Temperature Tests and Noise Test from *every* unit to **one** unit of design.	Susan Coram Tim Sagen 9-22-95
REVISION **HH**: • GE removed from Appendix B	Opal Dick Tim Sagen 12-13-96
REVISION **II**: • Add paragraph 3.2.2.10 OVERCURRENT PROTECTION and renumber remaining paragraphs in section 3.2 • Revise Fig. 1 to reflect a "**V**" configuration for the primary bushing arrangement vs. an in-line arrangement. • Revise Fig. 17 to remove requirement for CT mounting studs and increase dimensions A from 5" and 5.5" to **6**" on 225-2500 kVA sizes	Opal Dick Tim Sagen 6/3/99
REVISION JJ • Reformat and converted to MS Word, delete List of Active Pages	Bill Bray Tim Sagen 9 /14 / 2000
REVISION KK • Added drawing 1a to describe cable accessory parking stand detail • Revise to reflect current editions of national standards • Change impedance on 368-300-009 from 1.7% to 1.9%.	Kraig Bader Tim Sagen 9 / 11 / 2001

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SPECIFICATION FOR
PAD-MOUNTED COMPARTMENTAL-TYPE, THREE-PHASE
DISTRIBUTION TRANSFORMERS WITH
SEPARABLE INSULATED LOAD BREAK HIGH-VOLTAGE CONNECTORS

1. SCOPE

This Specification establishes the minimum electrical requirements and mechanical features of three phase, 60 HZ, mineral oil immersed, self-cooled, pad-mounted, compartmental-type distribution transformers rated 2500 kVA and smaller, high voltage 13,200 Grd Y/7620 volts, with separable insulated load break high voltage connectors. These transformers are used for step down purposes from an underground primary cable supply.

This standard generally conforms to ANSI requirements for pad-mounted compartmental-type, self-cooled, three-phase, distribution transformers for use with separable insulated high-voltage connectors, C57.12.26.

2. APPLICABLE DOCUMENTS

The following documents form a part of this Specification to the extent specified herein. The latest issue in effect on the date of invitation for bids shall form a part of this Specification, unless otherwise noted.

- **ANSI C57.12.00** - Distribution, power, and regulating transformers, and shunt reactors, general requirements for
- **ANSI 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, requirements for
- **ANSI C57.12.70** - Terminal markings and connections for distribution and power transformers
- **ANSI C57.12.80** - Terminology for power and distribution transformers
- **ANSI C57.12.90** - Distribution, power, and regulating transformers, and shunt reactors, test code for
- **ANSI/IEEE 386** - Separable insulated connectors for power distribution systems above 600V
- **NEMA STANDARD TR1** - Transformers, regulators and reactors

3. REQUIREMENTS

3.1 GENERAL REQUIREMENTS FOR DESIGN

3.1.1 BASIC DESIGN STANDARDS

Transformers purchased under these Specifications shall be new and, unless otherwise specified, meet the requirements of the applicable ANSI Standards and the modifications and additions given in the subsequent paragraphs. In case of conflict, the requirements of the following documents shall apply in the priority shown:

a) This Specification.
b) ANSI C57.12.26
c) Other applicable ANSI and NEMA Standards.

3.1.2 KILOVOLT-AMPERE TEMPERATURE RATINGS

Kilovolt-ampere ratings are continuous and are based on not exceeding either a 65°C average winding temperature or an 80°C hot spot temperature rise. The temperature rise of the insulating oil shall not exceed 65°C when measured near the top of the tank. The temperature rise is based on an altitude of 3,300 feet.

3.1.3 GENERAL CONSTRUCTION

3.1.3.1 The pad-mounted compartmental-type transformers shall consist of the transformer tank, high-voltage cable terminating compartment, and the low-voltage cable-terminating compartment. All three of these components shall be assembled as an integral unit, tamperproof and weatherproof for mounting on a pad. There shall be no exposed screws, bolts or other fastening devices, which are externally removable, except the main cover bolts may be exposed. Where the main cover bolts are exposed, the

corner bolts shall be welded or otherwise rendered tamperproof. There shall be no opening through which foreign objects such as sticks, rods, or wires might be inserted to contact live parts. Suitable means for padlocking the compartment door(s) shall be provided.

3.1.3.2 The high and low-voltage compartment 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.

3.1.3.3 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.

3.1.3.4 An undercoating over the regular finish or an equivalent treatment shall be applied to all surfaces that are in contact with the pad to minimize corrosion.

3.1.3.5 Minimum dimensions shall be as shown in **Fig. 1** of this Specification. Maximum transformer and minimum pad dimensions are shown in **Fig. 6** of this Specification.

3.1.4 LOSSES

The total losses of a transformer shall be the sum of the excitation losses and the load losses (I^2R losses). Load loss tests shall be performed and reported on all units regardless of whether or not a record of such tests is available on duplicate units. Loss evaluations and loss costs will be based on the values shown in the "Special Conditions and Supplemental Instructions to Bidders." Transformers will be evaluated on excitation losses and I^2R losses at the specified rates. If tested losses exceed quoted losses but are within the tolerances of paragraph 9.3, ANSI C57.12.00-2000, the additional cost incurred from the differential of losses will be calculated using the following equation and the above specified rates and will be deducted from the original Purchase Order or back charged to the manufacturer. In Table 18 and the following equation "Units" shall mean "Transformers of the same size and design on one order."

Excess loss $ = [No. of units] [(No Load Loss Evaluation $) (Avg. No Load Losses – Quoted No Load Losses) + (Load Loss Evaluation $) (Avg. Load Losses – Quoted Load Losses)]. If this equation results in a negative number no credit will be given the Supplier.

If any unit or units exceed the tolerances of paragraph 9.3, ANSI C57.12.00-2000, that unit or units shall not be shipped without express permission from the City. If accepted, the deduction for excess losses will be based on the following equation: Excess loss $ = (No Load Loss Evaluation $) (No Load Losses – Quoted No Load Losses) But Not Less Than Zero + (Load Loss Evaluation $) (Load Losses – Quoted Losses) But Not Less Than Zero.

3.1.5 SERVICE CONDITIONS

Service conditions shall be as defined in paragraph 4.1 of ANSI C57.12.00 except the ambient temperature range shall be 40°C above to 32°C below zero. The transformer shall operate safely with starting temperatures as low as 32°C below zero.

3.2 SPECIFIC REQUIREMENTS FOR DESIGN OF **LOOP -FEED** Units

3.2.1 FUNCTIONAL DESCRIPTION

The transformer shall be a three phase, pad mounted, loop feed-safe break, "deadfront" type for use on a **13.8 kV grounded "Y"** distribution system.

3.2.2 DESIGN AND CONSTRUCTION

3.2.2.1 RATINGS

Table 1 - Loop-Feed Transformer Ratings

Stock No.	kVA	Low Voltage	Impedance	Bushing Type/Config.	
				High Voltage	Low Voltage
368-300- **008**	75	208Y/120	1.9%	①	③④
368-300- **009**	75	480Y/277	1.9%	①	③④
368-300- **015**	150	208Y/120	2.1%	①	③④
368-300- **016**	150	480Y/277	2.1%	①	③④
368-300- **030**	300	208Y/120	2.5%	①	③④
368-300- **031**	300	480Y/277	2.5%	①	③④
368-300- **050**	500	208Y/120	3.04%	①	③⑤
368-300- **051**	500	480Y/277	3.04%	①	③④
368-300- **075**	750	208Y/120	5.75%	①	⑤
368-300- **076**	750	480Y/277	5.75%	①	⑤
368-300- **100**	1000	208Y/120	5.75%	①	⑤
368-300- **101**	1000	480Y/277	5.75%	①	⑤
368-300- **151**	1500	480Y/277	5.75%	①	⑤
368-300- **201**	2000	480Y/277	5.75%	①	⑤
368-300- **251**	2500	480Y/277	5.75%	①	⑤

①Figure 1 (V-config.) of this specification
③ Low-voltage line and neutral terminals shall be stud type bushings in accordance with ANSI C57.12.26-1992, Fig. **9(d)** and shall include a separate spade with NEMA standard drilling
④Figure 9(a) of ANSI C57.12.26 - 1992 (4-hole pad)
⑤Figure 9(b) of ANSI C57.12.26 - 1992 (6-hole pad)

3.2.2.2 INSULATION LEVEL

3.2.2.2.1 The basic impulse level (BIL) of the completely assembled transformer, including high-voltage and low-voltage terminals shall be 95 kV and 30 kV respectively.

3.2.2.2.2 Dielectric test levels shall be in accordance with the distribution levels in Paragraph 5.10 of ANSI C75.12.00-2000

3.2.2.2.3 The unit shall withstand test voltages in accordance with ANSI C57.12.00 and impulse tests in accordance with NEMA Standards for Transformers, Publications No. TR1.

3.2.2.3 TRANSFORMER CORE

A five-legged core-coil assembly or three separate core-coil assemblies shall be employed. The use of three-legged designs is expressly prohibited.

3.2.2.4 HIGH VOLTAGE TAPS

A no-load tap changer with external operating handle shall provide two 2 ½ full capacity taps above and below normal. The operating handle shall be mounted in the primary compartment.

3.2.2.5 BUSHING WELLS AND TERMINALS

3.2.2.5.1 The number, location, and arrangement of bushing wells, terminals and parking stands shall be as shown in **Fig. 1** and **Fig. 5** of this specification. All low-voltage bushings and high-voltage wells shall be externally clamped and shall have leads of sufficient length to allow them to be changed without removing he cover. Welded bushings and wells are expressly prohibited.

3.2.2.5.2 High-voltage bushing wells shall be 200A load-break interface 8.3/14.4 kV bushings in accordance with ANSI/IEEE Std. 386.

3.2.2.5.3 Low voltage bushing arrangement and spacing shall be "staggered", as shown in **Fig. 5** of this Specification.

3.2.2.5.4 The low-voltage neutral shall be a fully insulated bushing. A ground pad shall be provided on the outer surface of the tank and a removable copper ground strap shall be provided and connected between the low-voltage neutral bushing and the ground pad.

3.2.2.5.5 The high-voltage neutral shall be connected to the low-voltage neutral internally with provision for opening this connection for testing.

3.2.2.6 ACCESSORY CABINET

3.2.2.6.1 The accessory cabinet shall consist of a high-voltage and low- voltage compartment generally constructed in accordance with applicable ANSI specifications and dimensioned in accordance with **Fig. 1** of this Specification.

3.2.2.6.2 Cabinet doors shall be hinged, removable, and lockable. Stainless hinge pins shall be provided.

3.2.2.7 ACCESSORY EQUIPMENT

Accessory equipment shall be provided in accordance with Table 1A and the following details:

3.2.2.7.1 Suitable jack bosses or equivalent jacking facilities shall be provided on the tank. Vertical clearance for a jack shall be 1½ inches minimum, 3½ inches maximum.

3.2.2.7.2 The transformer base shall be arranged for rolling in two directions:

Parallel to and at right angles to the centerline of the high-voltage bushings.

3.2.2.7.3 Four lifting lugs shall be provided. These lugs shall be adequate strength and size and arranged on the tank to provide a suitable lift for the completely assembled unit.

3.2.2.7.4 The base of the assembly shall be provided with suitable means for mounting the unit on the pad. An internal flange shall be provided at the base of the accessory compartment to provide means for mounting the unit on the pad. (Fig. 1).

3.2.2.7.5 Terminal designations are shown in Figure 1. The identification of terminal connections shall be shown on the instruction nameplate. Instruction nameplate shall be corrosion resistant, located in the low-voltage compartment, and shall be readable with cables in place. Where the nameplate is mounted on a removable part, the manufacturer's name and transformer serial number shall be permanently affixed to a non-removable part.

Instruction nameplate shall contain the information specified in ANSI C57.12.00-2000, paragraph 5.12. In addition, either on the nameplate or label affixed near it, the manufacturer shall indicate that the dielectric fluid is non-PCB.

3.2.2.7.6 An automatic pressure relief device shall be located within the compartment. This device shall meet the following requirements:

- ¼" NPT or larger male Inlet Port.
- Exposed parts of weather and corrosion resistant materials.
- Non-deteriorating gasket and o-ring material.
- Manual pull ring able to withstand 25 pound force minimum.
- Body able to withstand 100 pound force minimum.
- Bug shield.
- Cracking pressure of 10 ± 2 psig.
- Resealing pressure of 6 psig minimum.
- Zero leak rate from resealing pressure to –8 psig.
- Minimum flow rate of 35 SCFM at 15 psig.

3.2.2.8 OIL PRESERVATION

Transformers shall be of sealed-tank construction. Sealed-tank construction is that which seals the interior of the tank from the atmosphere, and in which the gas plus the oil volume remains constant. The transformer will remain effectively sealed for a top-oil temperature range of –32°C to 105°C.

3.2.2.9 TANKS

The tank shall be domed or sloped to shed water and shall be of sufficient strength to support a minimum of 500 lbs. Construction of the tank shall be in accordance with ANSI C57.12.26-1992, Section 7, except bolted cover is preferred.

3.2.2.9.1 If main cover is welded, adequate handhole(s) shall be provided. Handholes shall be concealed. Bolted-on covers shall be adequately gasketed and tamperproof. Main cover bolts may be exposed; however, where cover bolts are exposed, the corner bolts shall be welded or otherwise rendered tamperproof.

3.2.2.9.2 Tank grounding provision shall be in accordance with paragraph 7.6.4 of ANSI C52.12.26-1992.

3.2.2.9.3 Locking bolts shall be penta head style.

3.2.2.10 OVERCURRENT PROTECTION

Overcurrent protection consisting of a Cooper Power Systems ELSP oil-immersed partial range current limiting fuse in series with a Cooper Power Systems oil-immersed current sensing weak link cartridge shall be provided. Fuses shall be sized to meet the following criteria

- Withstand 25 times transformer rated load current for 0.01 second
- Withstand 12 times transformer rated current for 0.1 second
- Withstand 3 times transformer rated load current for 10 seconds
- Allow not less than 140% nor more than 200% continuous overload
- Clear fault at 3 to 4 times transformer rated current in 300 seconds.

3.2.2.11 COMPONENTS FOR LOOPED PRIMARY

The minimum current-carrying capability of components for the looped primary cable system shall be 200 amperes (continuous) and 10,000 amperes symmetrical (momentary).

3.2.2.12 AUDIBLE SOUND LEVEL

The audible sound level shall be in accordance with NEMA Standard TR1.

3.2.2.13 BASE PLAN

The base plan of a completely assembled unit shall be such that it can be installed on a pad of the dimensions shown in **Fig. 6** of this specification.

3.2.2.14 PAINT

3.2.2.14.1 Surfaces to be painted shall be blast cleaned (commercial blast) to provide a clean dry surface free of dirt, dust, chalk, loose paint, rust, grease and any other contaminants.

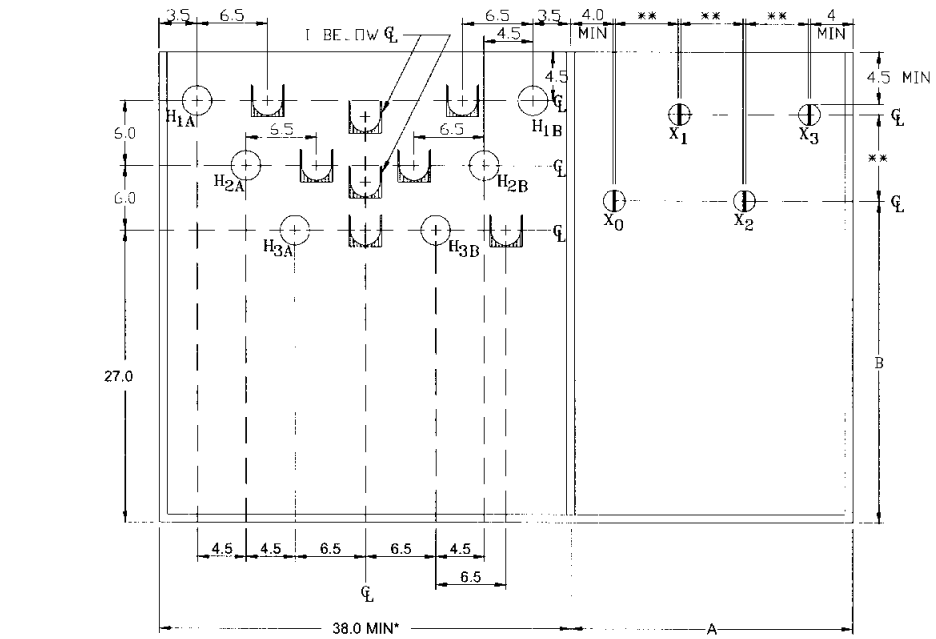
3.2.2.14.2 EEI "Finishing Guidelines" specification shall apply. Finish coat shall be Desert Tan, Munsell #10YR6.0/3.0, glossy.

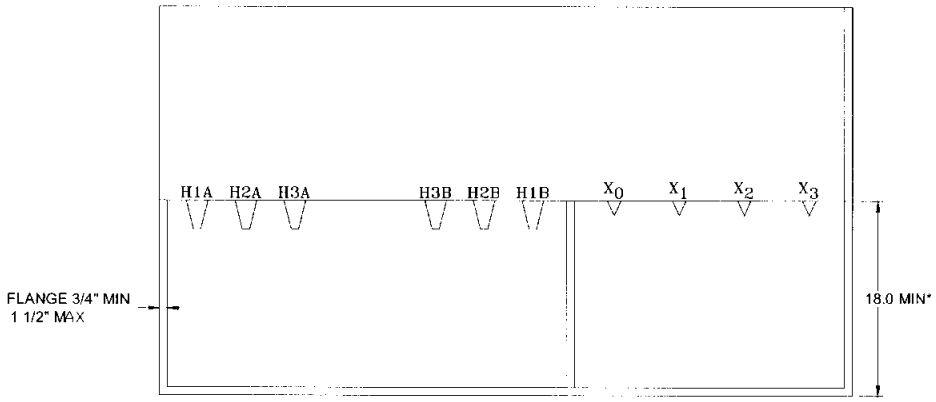
3.2.2.15 SAFETY LABELS

The manufacturer shall not apply NEMA 260 Safety Labels. The Purchaser will apply custom "Mr. Ouch" labels after delivery.

3.2.2.16 ANGULAR DISPLACEMENT:

Per **Fig. 10(b)** of ANSI C57.12.26-1992.





KVA RATINGS	LOW VOLTAGE RATINGS	COMPARTMENT DIMENSIONS (MINIMUM) A*	BUSHING HEIGHT B
75-150	ALL	23.25	27
225-500	ALL	28	31
750-1000	480Y/277,208Y/120	28	46
1500-2500	480Y/227	28	46

NOTE:
* Denotes inside dimensions.
** See Fig.5
All dimensions in (inches).
Maximum dimensions shall allow one inch clearance from edge of pad (Fig. 6).

Figure 1 - Accessory compartment & Bushing Dimensions (Config. 1)

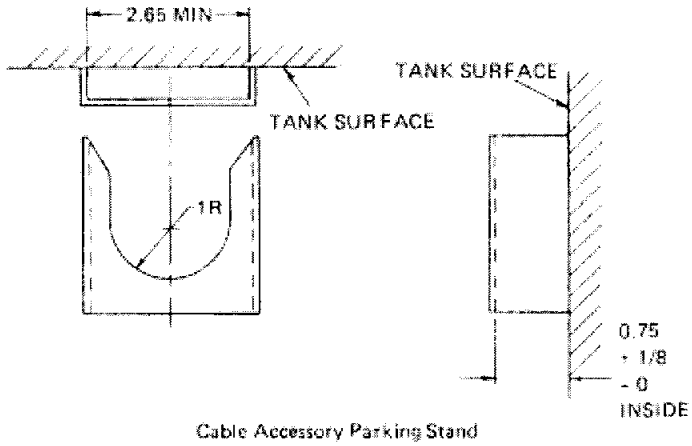
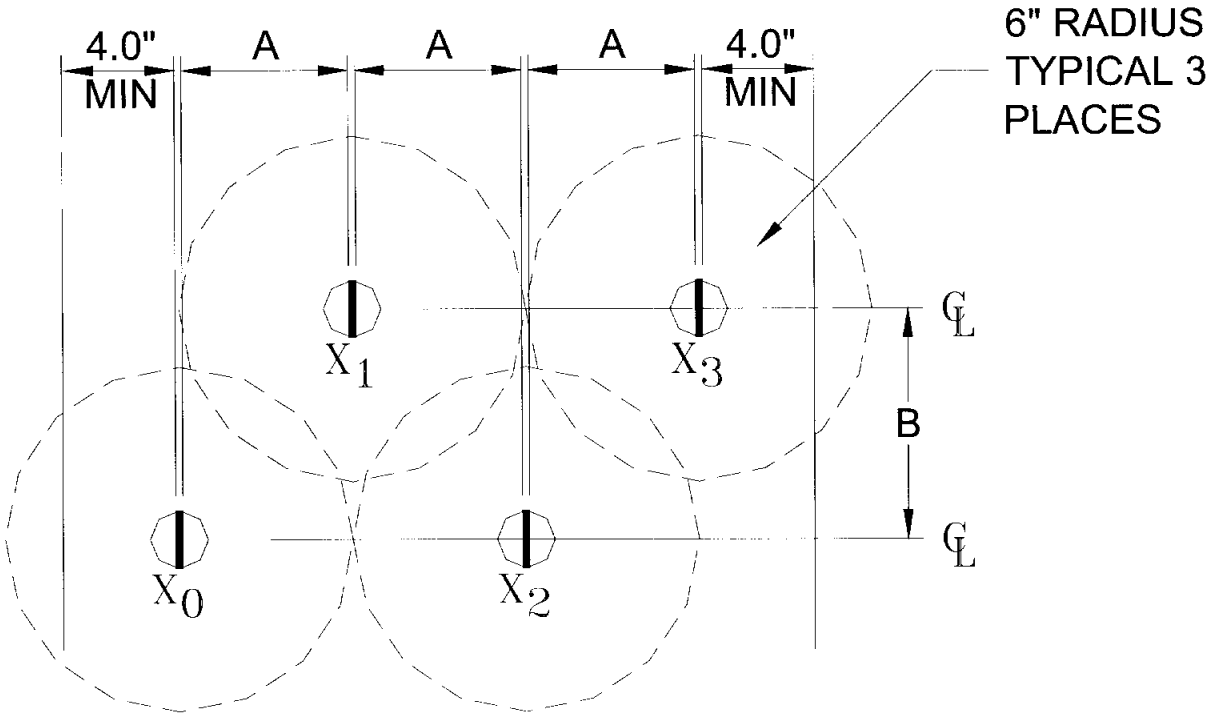


Figure 1A – Cable Accessory Parking Stand Detail

Figure 2 (Config. 2) - **DELETED** 7/92

Figures 3 & 4 - **DELETED** 11/00

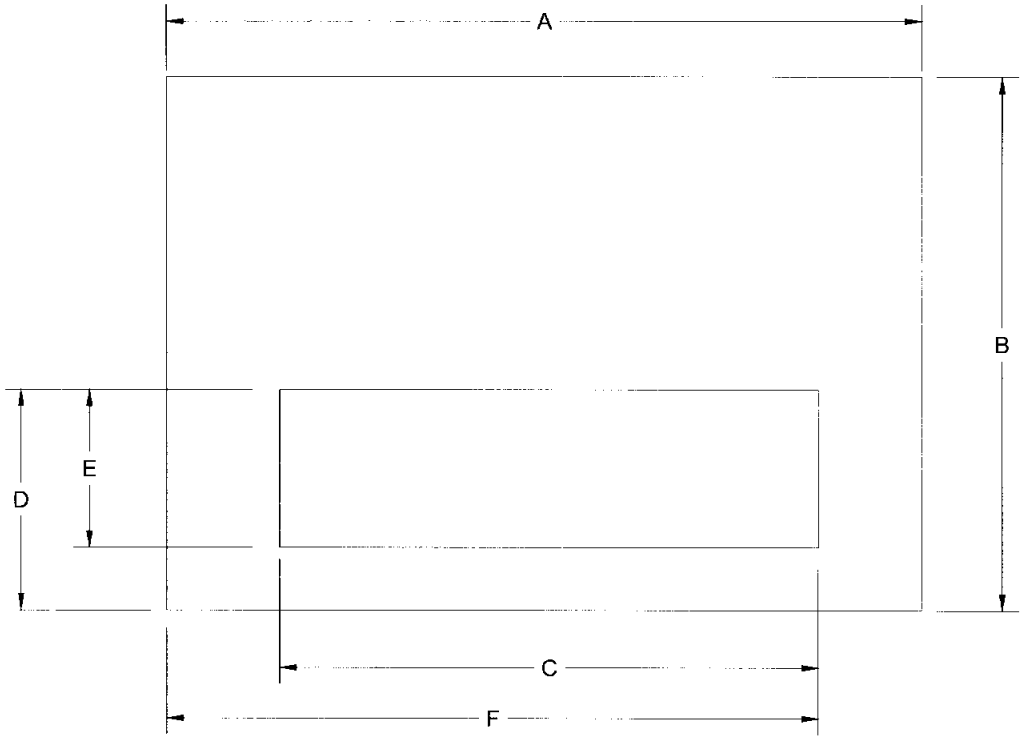
Ref. now to: ANSI C57.12.26 - 1992 figures 9(a) & 9(b)



KVA RATINGS	LOW VOLTAGE RATINGS	A	B
75-150	ALL	4.75	8
225-500	ALL	6	8
750-2500	480/277, 208Y/120	6	10

Figure 5 - Staggered Low - Voltage Bushing Arrangement (all dimensions minimum inches).

NOTE:
An area having a 6 inch radius around each bushing shall remain clear of obstructions such as gauges, etc.



KVA	SERIAL	PAD DIMENSIONS (inches)					
		A	B	C	D	E	F
75	-006 thru –009	75	55	40	21	15	61
150	-015	75	55	40	21	15	61
150	-016	75	55	40	21	15	61
300	-030	75	55	40	21	15	61
300	-031	75	55	40	21	15	61
500	-050	75	55	40	21	15	61
500	-051	75	55	40	21	15	61
750	-076, -075	85	72	49	23	15	67
1000	-101, -100	85	72	49	23	15	67
1500	-151	101	87	51	23	15	76
2000	-201	107	88	51	23	15	79
2500	-251	107	88	51	23	15	79

Fig. 6 – Pad Dimensions

TABLE 1A
ACCESSORY EQUIPMENT

ACCESSORY	KVA		
	75-150	300	500-2500
Tap changer handle in HV compartment	X	X	X
Instruction nameplate in LV compartment	X	X	X
Jacking provisions	X	X	X
Provisions for rolling in two directions	X	X	X
Lifting lugs	X	X	X
Provisions for mounting on pad	X	X	X
Arrester mounting provisions			
Grounding provisions in both compartments	X	X	X
1" oil drain plug	X		
1" oil drain valve with sampling device		X	X
Upper filter press and filling plug (or cap) (1")	X	X	X
Provisions for oil gauge		X	
Provisions for pressure-vacuum gauge		X	X
Oil gauge			X
Thermometer	X	X	X
Secondary CT mounting holes (4 holes on 4 3/8" x 5 5/8" centers)	X	X	X
Manual/automatic pressure relief valve	X	X	X

3.3 SPECIFIC REQUIREMENTS FOR DESIGN OF **RADIAL -FEED** Units

3.3.1 FUNCTIONAL DESCRIPTION

The transformer shall be a three phase, pad mounted, radial feed safe break, "deadfront" type for use on a **13.8 kV grounded "Y"** distribution system.

3.3.2 DESIGN AND CONSTRUCTION

The requirements for radial-feed transformers shall be the same as those of loop-feed with the following **exceptions**:

3.3.2.1 RATINGS

Table 2 - Radial-Feed Transformer Ratings

Stock No.	kVA	Low Voltage	Impedance	Bushing Type/Config.	
				High Voltage	Low Voltage
368-300- **006**	75	208Y/120	1.9%	②	④⑥
368-300- **007**	75	480Y/277	1.9%	②	④⑥

② Per Figures 5A, & 7 of ANSI C57.12.26-1992 (In-Line) **EXCEPTION:** high voltage bushings shall be **32 - 36** inches above the base of the transformer

④ Figures 9(a) & 9(d) of ANSI C57.12.26 - 1992 (stud with 4-hole pad)

⑥ Figure 8(a) of ANSI C57.12.26-1992 (Staggered)

3.3.2.2 ACCESSORY CABINET

The accessory cabinet shall be dimensioned in accordance with **Fig. 7** of ANSI C57.12.26-1992.

4. QUALITY ASSURANCE

4.1 GENERAL

4.1.1 RESPONSIBILITY FOR INSPECTION

Unless otherwise specified, the vendor is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified, the vendor may utilize his own facilities or any commercial laboratory acceptable to the City of Fort Collins. The City reserves the right to perform or witness any of the inspections set forth in this Specification where such inspections are deemed necessary.

4.1.2 TEST REPORT

The manufacturer shall furnish to the purchaser certified copies of the results of all tests prior to payment. Copies shall be sent to the Design Section as well as with the invoice. Unsigned copies are not acceptable even if accompanied by a signed cover letter. The Quality Control Manager shall review and sign each test report.

4.2 TEST CONDITIONS

Unless otherwise specified, testing defined in Section 4.6 shall be conducted under the following conditions:

4.2.1 REFERENCE TEMPERATURE

The reference temperature to which losses, impedance, regulation, and efficiency are corrected shall be 85° C.

4.2.2 TOLERANCE ON IMPEDANCE VOLTAGE

Tolerance shall be as specified in ANSI C57.12.00.

4.2.3 TOLERANCE ON IMPEDAN CE VOLTAGE ON A TAP

The percent departure of tested impedance voltage on any tap from tested impedance voltage at rated voltage shall not be greater than the total tap voltage range expressed as a percentage of the rated voltage.

4.3 FUNCTIONAL TESTS

Functional tests shall consist of those tests and related requirements as cross referenced in Table 2A and shall be performed on each unit, except Temperature and Noise Tests which shall be performed on one unit of each design (KVA) per order.

Table 2A - Functional Tests

TEST	TEST PARAGRAPH	REQUIREMENT OR REFERENCE
Examination Of Product	4.6	3.0, 3.1, 3.2, 3.3 (This specification)
Ratio	4.6	ANSI C57.12.00 Section 8
Polarity And Phase Relation	4.6	ANSI C57.12.00 Section 8
Excitation Loss	4.6	ANSI C57.12.00 Section 8
Excitation Current	4.6	ANSI C57.12.00 Section 8
Impedance & Load Loss	4.6	ANSI C57.12.00 Section 8
Temperature Tests*	4.6	ANSI C57.12.00 Section 8
Dielectric Tests	4.6.1	3.2.2.2 (This specification)
Impulse Tests	4.6.2	3.2.2.2 (This specification)
Leak Testing	4.6.3	3.2.2.8 & 3.2.2.9 (This specification)
Noise Testing*	4.6.4	3.2.2.12 (This specification)

*One unit per design per order.

4.4 TEST METHODS -- FUNCTIONAL TESTS

Each completed unit shall be inspected to determine compliance with respect to dimensions, material, workmanship, construction and marking, and routine tests on all units shall be made as specified in Section 8 of ANSI Standard C57.12.00, and in ANSI Standard C57.12.90. In addition to routine tests, the following test requirements and/or modifications shall apply.

4.4.1 DIELECTRIC TESTS

Induced and applied potential Dielectric Tests shall be performed in accordance with ANSI C57.12.00 and C57.12.90. The low voltage windings shall have a test potential to ground of 10,000 volts for one minute. The test potential between high voltage windings shall be 34,000 volts for one minute.

4.4.2 IMPULSE TESTS

ANSI Standard Impulse Tests shall be performed. Full Wave Impulse Test shall use a 1.5 x 50 microsecond wave.

4.4.3 LEAK TESTING

The transformer tank shall be filled with oil and tested for air and oil leaks under (1) 4 psig vacuum for ½ hour, (2) 7 psig pressure for 24 hours in the sequence indicated. An alternate method of leak testing may be performed by injecting halogen gas under 10 psig and detecting leaks through the use of a halogen detector. (Note, the automatic/manual pressure relief device must be removed for this test).

4.4.4 NOISE TESTING

Noise testing shall be conducted in accordance with applicable NEMA Standards.

5. PREPARATION FOR DELIVERY

Transformers shall be prefilled with the appropriate amount of transformer oil and shall be shipped by open-bed truck. Units shall be packaged in such a way as to provide for ease of handling and to protect units from shipping damage. Units shall be fully palletized in four-way universal pallets with 28" minimum openings to facilitate handling from any side. Pallets shall be independent of the transformer. The Supplier shall give 24-hour notice prior to delivery for any shipments where an individual transformer weighs over 4,000 pounds. In addition to these requirements, the Supplier shall comply with any additional requirements or modifications shown on the purchase order and/or supplemental instructions.

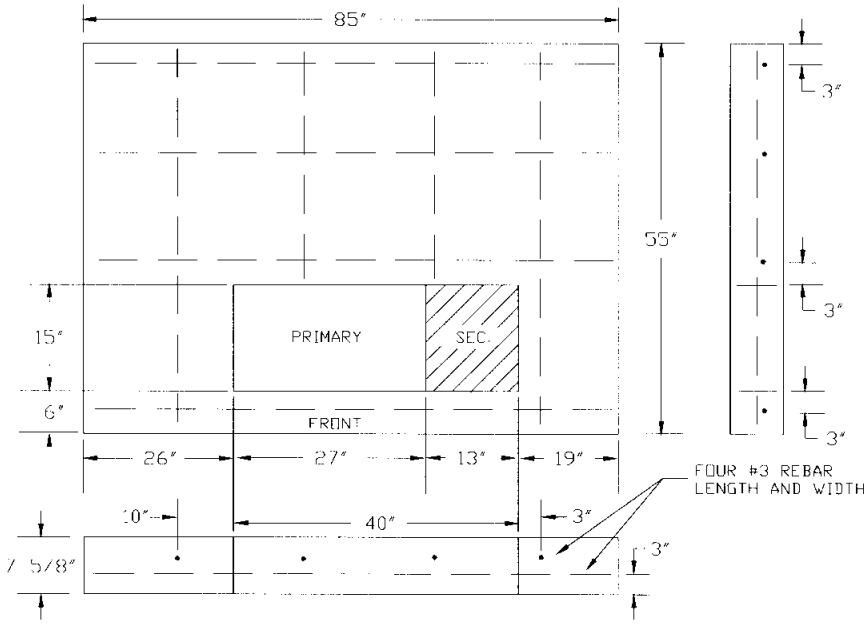
6. DEFINITIONS AND ABBREVIATIONS

- **Vendor or Supplier -** The manufacturer and/or manufacturer's agent supplying or quoting on the specified article.
- **Article, Unit, Assembly -** All refers to the equipment defined by this specification.
- **DC or d.c. -** Direct Current.
- **AC or a.c. -** Alternating Current.
- **°C -** Degree Celsius (Centigrade)
- **°F -** Degree Fahrenheit
- **kV -** 1000 volts.
- **CPS or Hz -** Cycles per second.
- **psig -** Pounds per square inch gauge.
- **V or v -** Volts.
- **kVA -** 1000 Volt-amperes.

APPENDIX A

Typical pad designs are shown in Figures 1A through 3A.

The dimensions in inches of Figures 1A through 3A will fit the minimum compartments on transformers covered by this Specification as well as the maximum transformer envelope.



Notes on Pad Material

1. Concrete must be 3,000 psi minimum.
2. Maximum coarse aggregate size 1 1/2 inches.

Space requirements for pad and primary switching cabinet will generally be 9' X 12'. Factors to be considered in locating the pad include –

1. Accessibility – The transformer pad shall be accessible to line boom trucks equipped for the installation and removal of heavy transformers. Such accessibility shall not require intrusion on adjacent property.

2. Proximity of Buildings, Walls, Barriers, and/or Overhangs – In addition to the clearances required for installation and removal, the minimum clearance in front of the transformer pad shall be eight (8) feet and the minimum clearance from all other sides shall be three (3) feet. If the building has an overhang, clearance to the edge of the transformer pad shall be measures horizontally from the outer edge of the overhang. Transformers through 300 KVA may be installed under the overhang if the vertical clearance between the pad and the overhang is at least 25 feet and the location is accessible to line boom trucks.

3. Codes and Standards – In addition to the above, the installation shall conform to the National Electric Code and federal, state and city codes and standards.

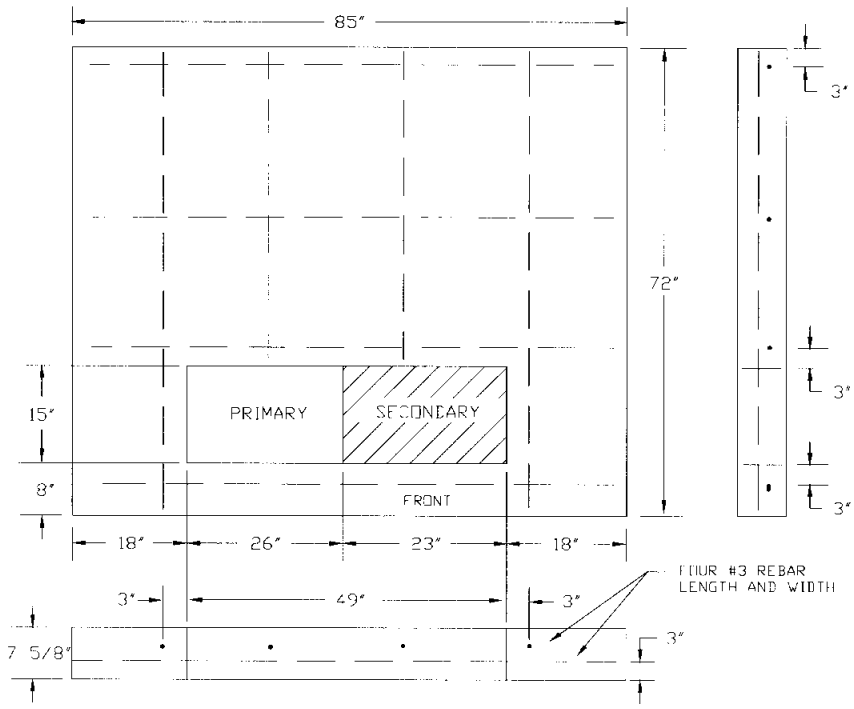
REV NO.	DATE	DWN	D.E. APP	DSNG. ENG APP	DIST. APP
2	8/25/93				

CITY OF FORT COLLINS
LIGHT and POWER

CITY OF FORT COLLINS
LIGHT AND POWER DEPARTMENT
TRANSFORMER PAD DESIGN
75 – 500 KVA
3 PHASE

DWG 3PHASE1

Figure 1A - Pad Design (75 - 500 KVA)



Notes on Pad Material –

1. Concrete must be 3,000 psi minimum.
2. Maximum coarse aggregate size 1 1/2 inches.

Space requirements for pad and primary switching cabinet will generally be 9' X 12'. Factors to be considered in locating the pad include –

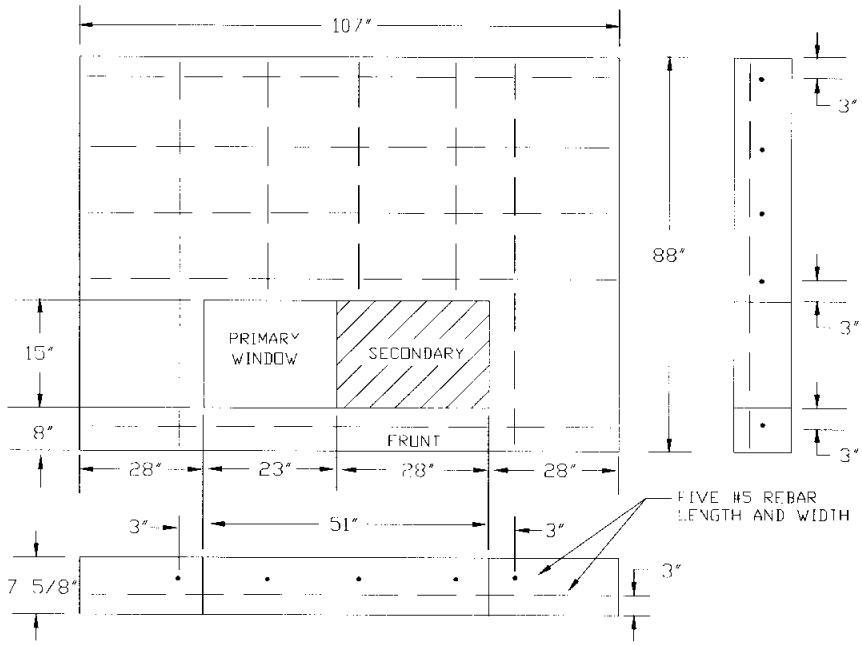
1. Accessibility – The transformer pad shall be accessible to line boom trucks equipped for the installation and removal of heavy transformers. Such accessibility shall not require intrusion on adjacent property.

2. Proximity of Buildings, Walls, Barriers, and/or Overhangs – In addition to the clearances required for installation and removal, the minimum clearance in front of the transformer pad shall be eight (8) feet and the minimum clearance from all other sides shall be four (4) feet. If the building has an overhang, clearance to the edge of the transformer pad shall be measured horizontally from the outer edge of the overhang. Transformers through 300 KVA may be installed under the overhang if the vertical clearance between the pad and the overhang is at least 25 feet and the location is accessible to line boom trucks.

3. Codes and Standards – In addition to the above, the installation shall conform to the National Electric Code and federal, state and city codes and standards.

11/02/90				
REV. NO. DATE	DWN	D.E. APP	DSNG. ENG APP	DIST. APP
CITY OF FORT COLLINS LIGHT and POWER	CITY OF FORT COLLINS LIGHT AND POWER DEPARTMENT TRANSFORMER PAD DESIGN 500 - 1000 KVA 3 PHASE			DWG 3PHASE2

Figure 2A - Pad Design (500 - 1000 KVA)



Notes on Pad Material –

1. Concrete must be 3,000 psi minimum.
2. Maximum coarse aggregate size 1 1/2 inches.

Space requirements for pad and primary switching cabinet will generally be 9' X 12'. Factors to be considered in locating the pad include –

1. Accessibility – The transformer pad shall be accessible to line boom trucks equipped for the installation and removal of heavy transformers. Such accessibility shall not require intrusion on adjacent property.

2. Proximity of Buildings, Walls, Barriers, and/or Overhangs – In addition to the clearances required for installation and removal, the minimum clearance in front of the transformer pad shall be eight (8) feet and the minimum clearance from all other side shall be four (4) feet. If the building has an overhang, clearance to the edge of the transformer pad shall be measured horizontally from the outer edge of the overhang. Transformers through 300 KVA may be installed under the overhang if the vertical clearance between the pad and the overhang is at least 25 feet and the location is accessible to line boom trucks.

3. Codes and Standards – In addition to the above, the installation shall conform to the National Electric Code and federal, state and city codes and standards.

REV NO.	DATE	DWN	D.E. APP	DSNG. ENG APP	DIST. APP
	11/02/90				

CITY OF FORT COLLINS
LIGHT and POWER

CITY OF FORT COLLINS
LIGHT AND POWER DEPARTMENT
TRANSFORMER PAD DESIGN
1000 – 2500 KVA
3 PHASE

DWG 3PHASE3

Figure 3A - Pad Design (1000-2500 KVA)

APPENDIX B

Transformers purchased under this Specification shall be of the make shown below. Manufacturers not listed below may submit written proposals demonstrating compliance with these Specifications for consideration of addition to the accepted manufacturer list prior to the next request for bids. In addition to inclusion on the list below, manufacturer's equipment must also satisfy all requirements of this Specification to be acceptable.

TABLE 3B

MANUFACTURER	SERIAL NO.
Cooper Power Systems	A11
ASEA Brown-Bovari	A11
Howard Industries	A11
Pauwels Transformers	A11

The manufacturers in the following list have been ***conditionally*** approved and may bid as an alternate. The definition and intent of "Conditional Approval" of a manufacturer is to allow the City to gain some experience with the manufacturer's product. Should a conditionally approved manufacturer be the evaluated low bidder, the City reserves the right to award all, part, or none of the order to them, dependant upon the current needs of the City for that item or items.

APPENDIX C

The following forms for Individual and Average Transformer Losses are used by the City of Fort Collins to determine loss penalties.

1) Transformer Loss Evaluation Average Losses Form

2) Individual Transformer Loss Evaluation Form

REV. SYM: KK

TRANSFORMER LOSS EVALUATION - AVERAGE LOSSES

City Order No. _____ S/N _____

Manufacturer _____ Invoice No. _____

KVA/Unit_____

LINE	DESCRIPTION	AMOUNT
(1)	No. of units	_____
(2)	Average core losses	_____
(3)	Quoted core losses	_____
(4)	Excess average core losses: line (2) less line (3)	_____
(5)	Penalty for excess average core losses: line (1) x line (4) x $_____	_____
(6)	Average copper losses	_____
(7)	Quoted copper losses	_____
(8)	Excess average copper losses: line (6) less line (7)	_____
(9)	Penalty for excess average copper losses: line (1) x line (8) x $_____	_____
(10)	Penalty to be assessed manufacturer: line (5) plus line (9) but not less than zero	_____

Date _____ Prepared By: _____
Design Engineering

NOTE: If any unit(s) exceeds the loss tolerances of ANSI C57.12.00, Light & Power will either reject it, include it on these averages, or calculate losses using the Individual Transformer Losses Evaluation Form, whichever is most favorable to Light and Power.

REV. SYM: KK

INDIVIDUAL TRANSFORMER LOSS EVALUATION

City Order No. _____ S/N _____

Manufacturer _____ Invoice No. _____

KVA/Unit_____

LINE	DESCRIPTION	AMOUNT
(1)	Tested core losses	_____
(2)	Quoted core losses	_____
(3)	Excess core losses line (1) less line (2) but not less than zero	_____
(4)	Percent difference Line (3) ÷ line (2) x 100	_____
(5)	Tested total losses	_____
(6)	Quoted total losses	_____
(7)	Excess total losses Line (5) less line (6) but not less than zero.	_____
(8)	Percent difference Line (7) ÷ line (6) x 100	_____
(9)	Tested copper losses	_____
(10)	Quoted copper losses	_____
(11)	Excess copper losses Line (9) less line (10) but not less than zero.	_____
(12)	Penalty for excess core losses Line (3) x $_____	_____
(13)	Penalty for excess copper losses Line (11) x $_____	_____
(14)	Penalty to be assessed manufacturer Line (12) plus line (13)	_____

Date _____ Prepared By: _____
Design Engineering