SAFETY WARNINGS
You will find various types of safety information throughout this manual. The following Safety Statements explain their meaning:

This is the SAFETY ALERT SYMBOL. It is used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.

DANGER DANGER indicates a hazardous situation which, if not avoided, will result in death or serious injury.

WARNING WARNING indicates a hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION CAUTION, used with the safety alert symbol, indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.

CAUTION CAUTION, used without the safety alert symbol, is used to address practices not related to personal injury.

A safety program must be established, verified and followed by all personnel involved with the transformer.

IMPORTANT:
Save this instruction sheet for future use of the product
A safety program must be established, verified and followed by all personnel involved with the transformer.

The information contained in this manual may not cover all variations in equipment or provide for all contingencies which might be met in installation, operation and maintenance. Please contact factory if you have any questions or unique conditions.
WARNING
Failure to follow instructions may result in death or serious injury.

WARNING
Electrical potentials hazardous to human life can exist within this equipment when energized. Disconnect all input power before opening case or touching internal parts. Use proper lock-out/tagout procedures.

The information contained in this manual may not cover all variations in equipment or provide for all contingencies which might be met in installation, operation and maintenance. Please contact factory if you have any questions or unique conditions.

Only qualified personnel should install, inspect, or maintain transformers. Normal operating voltages can be hazardous.

Hazard of electrical shock, explosion or arc flash. Turn off power supplying this equipment before working on it. Discharge all static charges held by coils. Failure to follow these instructions may result in death or serious injury.

Although transformers are static devices, it is necessary to use forethought coupled with care in installation. This will result in satisfactory performance over a long period of time. The minimum requirements for installation and maintenance and limitations of operation have been set forth in this manual. Following these procedures will result in satisfactory performance, whereas disregarding them can void the warranty.

INTRODUCTION
This manual covers 600 V class single-phase and three-phase transformers. Both ventilated (cabinet style) and encapsulated (potted) styles are included.

These instructions set out the limiting factors for satisfactory performance of the transformers. The information contained herein outlines and describes the proper inspection, installation and maintenance of dry type transformers.

INSPECTION ON RECEIVING
- Carefully inspect unit upon receipt to ensure that no damage has occurred during shipment. Any damage should be reported at once and a claim should be placed against the transportation company.
- Check the nameplate on the unit. It should match the job specifications to ensure installation of the correct transformer.

STORAGE
- Store in original packing
- DO NOT-stack units
- Keep in dry location of uniform temperature Recommended temperature is from -40°C (-40°F) to 60°C (140°F)
- Cover ventilating openings to keep out dust
- If exposed to moisture or condensation, dry out before energizing
- If necessary, use a heater to reduce condensation and absorption of moisture

A unit energized with embedded moisture could short and damage the unit, operator or other equipment. Store unit in dry location only.

SITE PREPARATION
- Indoors installation preferred
- Ensure the area is well ventilated and free from explosive or corrosive gas or vapors.
- Do not place or store items on top of unit. A transformer should not be used for storage.
- Consider sound levels when choosing site. See section "Transformer Sound" for more information.
- Install outdoors if fully protected from moisture, foreign materials

Ventilated Enclosure Units
Ventilated style power transformers are 600 Volt Class units with ventilated enclosures for natural draft cooling. They are designed for indoor and, with the appropriate weather shields, outdoor installations.

Do not place combustible materials on or near transformer or mount transformer closer than 6 inches from any adjacent wall.

On smaller kVA sizes a wiring compartment, located below the core and coil, provides cool operation and accessibility of connections. Primary and secondary terminals may share the same terminal board. Larger units are typically top terminated,
front and/or rear, permitting the use of raceway bus or conduit connections. All units are shipped connected for nominal line voltage.

These units can be floor or platform mounted but must always be in a vertical position with the mounting feet down.

The ventilating openings of this transformer must not be blocked or restricted in any way that will reduce the flow of air through the transformer.

Ventilated transformers are designed and manufactured with UL Recognized Class 220°C insulation systems. These systems are rated for operation in an environment with a maximum ambient temperature of 40°C.

Average winding temperature rises are rated at 80°C, 115°C and 150°C above ambient temperature. See transformer nameplate for product specific information.

The insulation rating is guaranteed for altitudes of less than 3300 feet (1005 meters) above sea level unless otherwise noted on unit nameplate.

Encapsulated Enclosure Units

Encapsulated style power transformers are 600 Volt Class units with the transformer sealed with a mix of sand and resin. They are designed for indoor or outdoor installations.

Do not place combustible materials on or near transformer or mount transformer closer than 3 inches from any adjacent wall (other than the wall the unit is mounted on). Units should always be mounted vertically.

The wiring compartment, typically located below the core and coil, provides cool operation and accessibility of connections.

Encapsulated units should be wall mounted with the wiring compartment at the bottom. Some larger units are floor mounted with the wiring compartment on the top.

Encapsulated transformers are designed and manufactured with UL Recognized Class 105°C, 130°C, or 180°C insulation systems. These systems are rated for operation in an environment with a maximum ambient temperature of 25°C or 40°C.

Average winding temperature rises are rated at 70°C, 95°C, 115°C and 135°C above ambient temperature. See transformer nameplate for product specific information.

The insulation rating is guaranteed for altitudes of less than 3300 feet (1005 meters) above sea level unless otherwise noted on unit nameplate.

Transformer Mounting & Spacing

- Typically configured transformers will feel hot to touch. Position units where contact will be infrequent and controlled.

- Transformers must never be mounted next to or above heat generating equipment.

- When installing several transformers, the upper unit should be kept 18–24 inches above the lower unit and still 18–24 inches below the ceiling. The top unit should be specified as a low temperature rise model. Customer is responsible for installing a frame for the top unit. DO NOT STACK UNITS DIRECTLY ON LOWER TRANSFORMER.

Air cooled transformers depend upon the surrounding air for cooling. The free flow of air is important as is the air temperature. A transformer must be mounted so that air can freely circulate all around and through it.

Outdoors Installation Considerations

- Select appropriate location to meet applicable codes, cable installation and mounting hardware.

- Use weather shield on ventilated units. DOE-2106 efficient units have weather shields as a design feature and need no additional accessory.

- Use water tight couplings on all electrical connections

INSTALLATION

**WARNING**

Only qualified personnel should install, inspect, or maintain transformers since the normal operating voltages can be hazardous.

**CAUTION**

Transformers are provided with access covers to facilitate installation and should never be operated without these access covers securely mounted in place.

**CAUTION**

Eliminate any moisture and warm unit up to operating temperature before energizing.

**CAUTION**

A unit operated at temperatures higher than recommended may not perform properly and/or may have a reduced lifespan.

Grounding

**CAUTION**

Grounding must be in accordance with NEC and local electrical codes. The enclosure should in turn be grounded securely and effectively as a safety precaution.

Ventilated core and coil assemblies are solidly grounded to the enclosure. On units equipped with electrostatic shields, the shields are grounded to the core.

Encapsulated units have a ground stud located in the wiring compartment. On units equipped with electrostatic shields, the shield wire is connected to the ground stud.

Wire Selection

Connection cables must be rated for at least 90°C insulation and 75°C ampacity. Connection cables must meet NEC and local electrical codes.

General Installation Instructions

- Inspect the unit for any damage.

- Check the nameplate. It should match the job specifications to ensure installation of the correct transformer.

- Connect the transformer as described on its nameplate.

- Taps should be adjusted, if necessary, to match the available line voltage.
Check all bolted electrical connections, including taps. The fasteners may have loosened during shipment. Tighten if loose.

Ventilated models: loosen core and coil hold down nuts (Figure 1) to reduce possible sound transmission to the case.

CAUTION
The hold-down nuts are designed to be loosened, not removed. Removal will destroy the bolt threads.

Installation Procedures

FOLLOW ALL LOCK-OUT/TAG-OUT PROCEDURES BEFORE INSTALLING UNIT OR PERFORMING ANY SERVICE OR MAINTENANCE.

1. Ensure the area is well ventilated and free from explosive or corrosive gas or vapors.
2. Check the transformer nameplate and verify that it is the correct kVA, frequency, line and load voltage for the application.
3. Place or mount the transformer securely. For seismic rated sites, see special section “Seismic Unit Installation.”
4. Shut off primary voltage using approved procedures.
5. If applicable, remove the cover over the wiring compartment.

NOTE: On ventilated transformers the bottom screws should be loosened and not removed for easier replacement of the cover. See Figure 1.
6. Adjust primary taps if necessary and insulate any unused taps individually. Before changing taps, the protective coating must be removed from the top and bottom of each tap. The tap’s surface must be clean and coated with electrical compound before bolting the wire.
7. Route wires into enclosure using the predefined access holes or by creating holes as needed.

On ventilated units the wires should enter the unit below the terminals and in front of the coil. See Figure 2.

On encapsulated units, the wiring compartment, typically located below the core and coil, provides cool operation and accessibility of connections. These units should be wall mounted with the wiring compartment at the bottom. Some larger units are floor mounted with the wiring compartment on the top.
8. Connect the transformer primary according to the wiring diagram on the nameplate.

See “Cable Termination” section.
9. Ground the enclosure in accordance with NEC and local electrical codes.
10. Energize the unit and check the secondary voltage to ensure it is proper for the load.
11. Shut off the primary voltage using approved lock-out/tag-out procedures.
12. Connect the load to the secondary terminals according to the wiring diagram on the nameplate.

NOTE: After installation of cables and connectors, a minimum of 1” clearance should be maintained between the enclosure and any energized parts.
13. Replace the cover over the wiring compartment.
14. Energize the unit.

Seismic Unit Installation

In order to meet seismic qualifications, rated transformers went through rigorous testing to meet the International Building Code (2015 IBC) and the California Building Code (2016 CBC) requirements. Each test was met in accordance with ICC-ES AC156 seismic qualifications. Units must be installed according to these instructions to be compliant.

Floor Mount Units
For units up to 300 kVA, use Grade 5 bolts, washers and lock washers to attach the unit to the mounting surface. For units over 300 kVA, use Grade 8 bolts, washers and lock washers. Fill all holes provided in the base.

For Wall Mount Units
Install units according to instructions in this manual. Also use the additional holes provided to add additional stability. Use Grade 5 bolts, washers and lock washers to attach the unit to the mounting surface.
**Seismic Unit Installation**

**Typical design for mounting for seismic applications**

**Floor Mount Units**

**NOTE:** If your unit does not have the indicated holes drilled in the mounting plate, it is recommended to drill those holes and install the bolts as described.

**Wall Mount Units**

Extra holes for seismic installation indicated with arrows

**Cable Termination**

To help guard against overheating, the following procedure is recommended when connecting the cables:

- Strip the cable of its insulation to the desired length without ringing or nicking the wire.
- Apply a suitable joint compound (such as a PENETROX A, ALNOX-UG, T&B21059, etc.) to the exposed wire and wire brush through it to remove any oxide film from the other strands.
- Insert the wire into the lug. Make certain all the strands are contained and then tighten the wire retaining screw securely per Table A. This operation should result in compound oozing out from between the individual strands of the wire. If this does not happen, it is an indication that an insufficient quantity of compound was used.
- Wipe the excess compound from the area adjacent to the wire connection. Note: Some compounds contain metallic particles, which could reduce the dielectric strength of the insulating material employed.

**Figure 3 Torque**

- After a few seconds, re-tighten the wire retaining screw per Table A.
- Coat both surfaces with a copper-aluminum joint compound.
- Bend the cable so the hole in the lug aligns with the hole in the terminal and contact surfaces are in good contact alignment.
- Insert the bolt with a flat washer under the head through the holes of the lug and the terminal. Add a flat washer, lock washer and a nut on the opposite side (see Figure 3). Tighten per Table B.
- There must not be any washers between the terminals and the lugs (see Figure 3).
- Align the cables so adequate electrical clearances are maintained per NEC-373-11.
- If electrical clearances are questionable, the exposed electrical connection should be insulated with electrical tape.

**TABLE A**

<table>
<thead>
<tr>
<th>WIRE SIZE</th>
<th>TORQUE IN-LB</th>
</tr>
</thead>
<tbody>
<tr>
<td>14-8</td>
<td>75</td>
</tr>
<tr>
<td>6-4</td>
<td>100</td>
</tr>
<tr>
<td>3-1</td>
<td>125</td>
</tr>
<tr>
<td>1/0-2/0</td>
<td>150</td>
</tr>
<tr>
<td>3/0-200</td>
<td>200</td>
</tr>
<tr>
<td>250-400</td>
<td>250</td>
</tr>
<tr>
<td>500-750</td>
<td>300</td>
</tr>
</tbody>
</table>

**TABLE B**

<table>
<thead>
<tr>
<th>BOLT SIZE (IN)</th>
<th>TORQUE IN-LB</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/4</td>
<td>80</td>
</tr>
<tr>
<td>5/16</td>
<td>180</td>
</tr>
<tr>
<td>3/8</td>
<td>240</td>
</tr>
</tbody>
</table>
**Table C**

<table>
<thead>
<tr>
<th>Screw/bolt Size (SAE Grade 2)</th>
<th>Torque Value (+/- 5 %)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6-32</td>
<td>10 in-lb</td>
</tr>
<tr>
<td>6-40</td>
<td>12 in-lbs</td>
</tr>
<tr>
<td>8-32</td>
<td>19 in-lbs</td>
</tr>
<tr>
<td>8-36</td>
<td>20 in-lbs</td>
</tr>
<tr>
<td>10-24</td>
<td>27 in-lbs</td>
</tr>
<tr>
<td>10-32</td>
<td>31 in-lbs</td>
</tr>
<tr>
<td>1/4-20</td>
<td>66 in-lbs</td>
</tr>
<tr>
<td>1/4-28</td>
<td>76 in-lbs</td>
</tr>
<tr>
<td>5/16-18</td>
<td>11 ft-lbs</td>
</tr>
<tr>
<td>5/16-24</td>
<td>12 ft-lbs</td>
</tr>
<tr>
<td>3/8-16</td>
<td>20 ft-lbs</td>
</tr>
<tr>
<td>3/8-24</td>
<td>23 ft-lbs</td>
</tr>
<tr>
<td>7/16-14</td>
<td>30 ft-lbs</td>
</tr>
<tr>
<td>7/16-20</td>
<td>35 ft-lbs</td>
</tr>
<tr>
<td>1/2-13</td>
<td>50 ft-lbs</td>
</tr>
<tr>
<td>1/2-20</td>
<td>55 ft-lbs</td>
</tr>
<tr>
<td>9/16-12</td>
<td>70 ft-lbs</td>
</tr>
<tr>
<td>9/16-18</td>
<td>80 ft-lbs</td>
</tr>
<tr>
<td>5/8-11</td>
<td>100 ft-lbs</td>
</tr>
<tr>
<td>5/8-18</td>
<td>110 ft-lbs</td>
</tr>
</tbody>
</table>

**Table D**

<table>
<thead>
<tr>
<th>Transformer kVA Rating</th>
<th>NEMA Maximum dB* Ratings</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-9</td>
<td>40</td>
</tr>
<tr>
<td>10-50</td>
<td>45</td>
</tr>
<tr>
<td>51-150</td>
<td>50</td>
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<tr>
<td>151-300</td>
<td>55</td>
</tr>
<tr>
<td>301-500</td>
<td>60</td>
</tr>
<tr>
<td>501-700</td>
<td>62</td>
</tr>
<tr>
<td>701-1000</td>
<td>64</td>
</tr>
</tbody>
</table>

* dB (Decibels): Unit for measuring the loudness of sound.

**Guides for Minimizing Transformer Noise**

Proper installation of the transformer is required since a quiet transformer can develop objectionable sound levels unless certain basic rules are followed.

For a quiet installation:
- Consider the installation and location of the transformer before the building is built. Building modifications to correct sound can be expensive.
- Place sound dampening pads between the transformer and its mounting surface.
- Use flexible conduit coupling between the transformer and the wiring system.
- Install transformer as far away as possible from any area where sound is objectionable.

**CAUTION**

Typically configured transformers will feel hot to touch.

**System Loading**

Overloading, operating in ambient temperatures greater than 40°C and/or elevation greater than 3300 feet will result in reduction of transformer life unless de-rating of the unit is calculated using IEEE Loading Guide in IEEE C57.96.

Fully loaded transformers may appear excessively warm to the touch, particularly on the top cover of the unit. Standards permit the cover temperature to reach 65°C over ambient temperature. This represents normal heating and should not cause concern.

Overloads can be tolerated without exceeding the maximum allowable insulation temperature provided the overload is of short time duration and is preceded and followed by a period of operation at less than rated kVA. The actual conditions and characteristics of the loading cycle must be known in order to calculate the proper kVA rating of the transformer. Refer to Guide for Loading of Dry Type Transformers IEEE C.57.96.

Ambient temperatures above 30°C average with a 40°C maximum require either larger kVA ratings or special low temperature rise transformers.

Altitude correction for application of a standard transformer in altitudes above 3300 feet can be made by reducing the load. Refer to Altitude Correction Factor in IEEE C57.96.
Transformer Life

Transformer life is dependent upon the thermal degradation of the insulation system which in turn is dependent upon the winding temperature and duration of operation at that temperature. This is a high quality product, however, it is possible to misapply or unknowingly abuse a transformer and thus reduce its life.

Factors which affect transformer life are line voltage, load current, load cycle, ambient temperature, and other environmental conditions such as moisture, corrosive atmosphere, vibration, and maintenance. Normal conditions of operation are covered in this standard operating procedure and various Industry Standards.

Circuits, Taps and Connections

Circuits: Three phase transformers may have Delta or Wye inputs with Delta or Wye connected outputs. The most common is Delta input with a Wye output. A Delta input to Delta output is also common. The Delta output may have a center tap for lighting purposes. This center tap is designed for a maximum of 5% of the nameplate kVA.

Single-phase transformers may have up to four input and four output terminals. Four input terminals accommodate a single input voltage when inter-connected. Four output terminals provide a single output voltage or two voltages and a neutral when inter-connected.

Proper connections for transformers are those described on the nameplate of the transformer.

Taps: Transformers are normally supplied with full-capacity primary taps. A typical tap arrangement is two 2.5 percent taps above nominal voltage (FCAN) and two 2.5 percent taps below (FCBN). Transformers are shipped with the taps connected for nominal voltage. A qualified electrician must change the taps if the supply voltage on the job site differs from the nominal voltage rating of the transformer. Jumpers for tap connections are provided with transformers.

Connections: Input and output wires must be connected to their respective terminals with an appropriately sized lug rated for the input or output current. The input and output lugs must be suitable for aluminum or copper transformer terminals. Transformer terminals are typically identified with H’s for high voltage and X’s for low voltage in accordance with NEMA ST-20.

Minimum wire sizes for the source and load side of the transformer must be as specified in the current version of the NEC in table 310-16 in the 75°C column.

Transformer Used in Reverse

All transformers 3 kVA and larger are wound with exact turns ratios according to their voltage rating. This means that they can be used for either step up or step down applications. If a Delta-Wye transformer is wired in reverse (Wye to Delta) application, then its neutral should not be connected. It is not recommended to reverse wire transformers 150kVA and larger as the in-rush may trip normal circuit breakers.

MAINTENANCE

Transformers contain no moving parts and require very little maintenance. Periodic inspection and care are recommended practices especially if the transformer is operating in a harsh environment.

WARNING

Transformer must be de-energized prior to any maintenance. Failure to de-energize before opening the enclosure may result in serious personal injury.

Inspect for loose connections, condition of terminal board, condition of splices, overheating, rust, paint deterioration and general condition of the unit. Corrective measures should be taken if necessary.

Removal of dust, dirt and debris from the external enclosure surfaces is encouraged and may be performed while the transformer is in operation.

If maintenance includes removal of enclosure panels, the transformer must be de-energized. The use of lock-out/tag-out practices is required.

Internal maintenance would include:

- Inspection and tightening of bolted connections.
- Inspection of coil ducts. Removal of dirt can be accomplished using a vacuum cleaner or low-pressure (<20 psi) dry compressed air.

OPTIONAL ACCESSORIES

Weather Shields for Outdoor Applications

The environmental rating of some ventilated transformer enclosure may be elevated from NEMA 1 to NEMA 3R by the addition of weather shields. Weather shields are supplied in kits specific to the enclosure. They must be installed following directions included in the kit. In cases where a weather shield may be installed, the part number of the weather shield kit appears on the transformer nameplate. Verify that the kit number and nameplate number match.

Wall Mounting Brackets

Floor mount transformers (up to about 75 kVA depending on style and weight) may be mounted on a wall using specially designed wall mounting brackets supplied in kits and specific to the enclosure. They must be installed following directions included in the kit.

It is important to check the weight of the unit and confirm that the wall and the fasteners (not supplied with the kit) can support the unit.