

# Dry-Type General Purpose Power Transformers

## Single and Three Phase, 15-150 kVA

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### Instructions for the Safe Handling, Installation, Operation and Maintenance of Ventilated Dry-Type Transformers

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## 1. General Information

General-purpose dry type transformers have a ventilated, encased construction suitable for indoor service only, unless converted for protective outdoor service. All encased models are designed for floor or platform mounting; however, wall mounting bracket kits are available through 75kVA three phase and 50kVA single phase. The core and coil structure is mounted on rubber isolation pads at the base to minimize transmission of vibration.

Rainshield conversion kits are available to convert standard indoor NEMA Type 2 enclosures to NEMA Type 3R enclosures suitable for protected outdoor installation. The transformer nameplate specifies the proper kit to match the indoor enclosure and transformer. Special NEMA Type 3R totally enclosed non-ventilated (TENV) enclosures are also available for indoor or protected outdoor applications through 75kVA three phase. The enclosure has vent guards that deter rodents, birds or debris from entering.

Each transformer is assembled and given complete electrical tests at the factory, after which it is inspected and packed for shipment.

## 2. Temperature Class

Industry standard UL 1561 classifies insulation systems in accordance with the following rating system:

Ambient	+ Winding Rise	+ Hot Spot	= Temp Class
40C	55C	10C	105C
40C	80C	30C	150C
40C	115C	30C	185C
40C	150C	30C	220C

All standard, general-purpose transformers meet applicable IEEE, ANSI, NEMA, CSA and UL standards.

These transformers are designed using a 220C insulation system with a standard 150C temperature rise.

Transformers for applications requiring lower temperature rise, generally 115C and 80C, are readily available.

Transformers with a standard 150C winding temperature rise, operating at full load will have a maximum 50C/122F temperature rise on the surface areas of the enclosure. With a 40C ambient, the measured enclosure surface temperature could be as high as 90C/194F.

## 3. Handling

Provisions for lifting are provided. Because transformers are surprisingly heavy, check the weight shown on the nameplate or the shipping label to assure adequate capacity of lifting equipment. For safety, spreaders should be used with lifting equipment. Lifting holes are provided on the top core clamps, accessible by removing the top cover. The unit may also be lifted by forks or skidded at the base. *To prevent damage to the transformer enclosure base when lifting the transformer by forks, always be sure that all enclosure panels are in place. Always move transformers in an upright position only.* Refer to enclosure assembly picture on last page.

## 4. Receiving

Upon receipt of shipment, examine the package for damage that may have been sustained in transit. If the shipping container must be opened outdoors, take proper precautions to prevent the entrance of moisture. While unpacking, examine the product for broken, bent, or loose parts or other damage. If damage from shipment is evident, file a damage claim with the transportation company and notify the nearest sales office.

## 5. Installation

Dry-type transformers should be located in an area where the transformer can be inspected at any time. It is a requirement of the NEC/CEC that sufficient access and working space be provided and maintained about all electrical equipment to permit maintenance.

### **WARNING**

**TO AVOID ELECTRICAL SHOCK DO NOT REMOVE COVERS WHILE TRANSFORMER IS ENERGIZED.  
TRANSFORMERS OPERATE AT HAZARDOUS VOLTAGES THAT COULD CAUSE SEVERE INJURY OR DEATH!**

### **CAUTION**

ONLY EXPERIENCED AND QUALIFIED PERSONNEL SHOULD PERFORM INSTALLATION AND MAINTENANCE. NO ATTEMPT SHOULD EVER BE MADE TO CHANGE THE TAPS OR MAKE CABLE CONNECTIONS WHILE THE TRANSFORMER IS ENERGIZED.

TRANSFORMERS SHOULD BE INSTALLED IN SECURE, CONTROLLED ACCESS AREAS, NEVER IN AREAS SUBJECT TO DELIBERATE, UNAUTHORIZED ACTS BY MEMBERS OF THE UNSUPERVISED PUBLIC. IF INSTALLED IN SUCH AREAS, TAMPER RESISTANT ENCLOSURE SCREWS SHOULD BE USED.

## **5.1 Preparation**

Remove all shipping braces identified as such. Any accumulation of dirt or dust may be removed by vacuuming, brushing or by blowing dry air on the unit. If moisture is evident by the appearance of rust or mildew, or moisture is visible on the insulation surfaces, the unit should be dried out by placing it in an oven or by blowing heated air over it. In either case the temperature should not exceed 110C/230F. Insulation resistance tests of the type used on liquid filled transformers are of little value on dry-type transformers. The nature of insulation used in dry type transformers is such that megger readings are not reliable and may be misleading. Refer to ANSI/NEMA C57.12.91 paragraph 10.9 for additional information.

## **5.2 Mounting and Placement**

The only foundation necessary is a non-combustible flat surface strong enough to support the weight of the unit. Note that permanent and effective grounding of the metal case in accordance with NEC/CEC is recommended as a safety precaution.

Free circulation of ambient air is essential for the proper operation of all ventilated dry-type transformers. The sides of the transformer with ventilation openings require a minimum distance of six inches to adjacent noncombustible structures or equipment to ensure proper circulation of air. Refer to enclosure assembly picture on the last page.

### **CAUTION**

TRANSFORMERS SHOULD BE INSTALLED AT LEAST TWELVE INCHES FROM COMBUSTIBLE MATERIALS, INCLUDING MOUNTING SURFACE UNLESS SEPARATED BY FIRE RESISTANT HEAT INSULATING BARRIERS. SPECIFIC REQUIREMENTS ARE DESCRIBED IN NEC, SECTION 450-21. CHECK LOCAL CODES.

## **5.3 Ventilation**

Dry-type general-purpose transformers are cooled by free circulation of surrounding air. They depend on air to enter at the bottom, flow upward over the core and coil surfaces and exit through the openings near the top. These transformers will carry full-rated loads continuously when the surrounding air does not exceed 30C/86F average, 40C/104F maximum and adjacent structures permit free movement of cooling air.

The room in which dry-type transformers are located should be sized to permit locating transformers with sufficient spacing between units and sufficient clearances to walls and other obstructions to permit the free circulation of air around each unit and to minimize noise amplification. Sufficient space should also be maintained to permit routine inspection and maintenance.

Adequate ventilation is essential for the proper cooling of transformers. Clean dry air is desirable. Filtered air at or above atmospheric pressure may reduce maintenance if dust or other contaminants present a problem. When transformers are located in rooms or other restricted spaces, sufficient ventilation should be provided to hold the air temperature within established limits (30C/86F average over 24 hours with a 40C/104F maximum) when measured near the transformer inlets.

## **5.4 Audible Sound Sources**

The audible sound produced by transformers is due to the energizing of the core by the alternating voltage applied to the windings. This creates vibrations whose fundamental frequency is twice the frequency of the applied voltage. The audible sound will be present even under no load conditions. The vibrations producing audible sound can occur in the core, coil, mounting, housing, and in the conduit. The transmission of sound from the transformer can be by various media such as air, metal, concrete, wood or any combination. *Amplification of audible sound can occur in a given area due to the presence of reflecting surfaces.*

**CONTROL OF AUDIBLE SOUND SOURCES:** Commercially available vibration isolators can be installed between the transformer and its mounting surface. This will reduce case vibration and compensate for slight unevenness of the mount. They should be sized for the appropriate loading at twice the fundamental frequency. To eliminate possible sound generation, the enclosure panel screws of the transformer housing must be tight and the housing must be securely fastened to the mounting surface. Care must be taken to ensure proper and tight installation of conduit. Flexible conduit is recommended.

**CONTROL OF AUDIBLE SOUND TRANSMISSION:** Acoustical-absorbing material should be mounted on reflecting surfaces to reduce sound reflection and possible amplification. Transformers should be mounted on a firm support having as great a mass as possible. Vibration pads or properly designed isolation mounts under the transformer will reduce transmittal of sound. On general-purpose transformers, neoprene rubber isolation pads isolate the core and coil assembly from the transformer enclosure. The isolation pads are located between the bottom core clamps and the base assembly. The isolation pads are tightened at the factory for shipment and must be loosened to allow the pad to expand prior to the unit being energized. Refer to enclosure assembly picture on last page for details.

KVA (150C RISE)	AVERAGE SOUND LEVEL IN DECIBELS ANSI-C89.2
0-9	40
10-50	45
51-150	50

Dry type general purpose transformers are designed and manufactured to comply with NEMA, CSA and ANSI standards. The decibel values referenced here represent average values obtained in a sound laboratory per industry standard test procedures. Decibel values obtained in field testing are unreliable and can be as much as 10 to 15 dB higher than actual test lab values due to a variety of circumstances beyond the control of the transformer manufacturer. In most cases, transformers returned for noise actually meet the ANSI standard when re-tested in a laboratory.

Some circumstances that can cause high field readings are:

- Higher than rated voltage being applied to transformer windings. Must be measured with a true RMS meter.
- Isolation pad hardware was not adjusted to allow the pads to re-expand and/or shipping braces were not removed.
- Transformer enclosure panels not properly tightened.
- Improper installation of conduit.
- Improper location of transformer. Mount the transformer as far away as possible from corners, walls or ceilings. Installing transformers near hard surfaces such as concrete walls will amplify the sound and may require the use of sound absorbing materials.

**CAUTION**

CARE SHOULD BE USED IN SELECTING SITES FOR TRANSFORMER INSTALLATION. SPECIFIC ATTENTION SHOULD BE GIVEN TO OFFICE, CLASSROOM, MEDICAL AND HOSPITAL FACILITIES. WHEN TRANSFORMERS ARE LOCATED IN ELECTRICAL CLOSETS ADJACENT TO HALLWAYS, SOUND CAN BE GREATLY AMPLIFIED. TRANSFORMERS SPECIFICALLY DESIGNED FOR LOW NOISE ARE AVAILABLE, CONTACT YOUR DISTRIBUTOR.

## 6.0 Connections

### 6.1 Cable Conduit Entrance / Lugs

All cable connections to the transformer should be brought into the enclosure as low as possible to allow for the required cable bending radius. Side entry of cables is recommended as it leaves the ventilation areas unobstructed. When making cable connection or changing taps, always use two wrenches for tightening or loosening bolted connections to prevent distortion or damage. *Note: terminals must be cleaned if it is necessary to change taps. Gently scrape the insulation/coating from the new connection and apply an electrical joint compound.*

All general-purpose transformers are designed for easy accommodation of cables and cable connectors. Lug connector kits are readily available and can be ordered through the sales office, through the distributor, or can be purchased commercially. The assembly of connectors to the line terminals is important. Follow established installation procedures recommended by the connector manufacturer. Do not install washers between the lug and the terminal as this will cause heating and arcing, resulting in failure of the connector. Refer to the NEC/CEC guide for sizing. Follow the torque recommendations of the connector manufacturer or use the adjacent guide.

Bolt Size	Torque (In Lbs.)
1/4"	60
5/16"	120
3/8"	220
1/2"	460

### **WARNING**

**DO NOT REMOVE ENCLOSURE PARTS OR CHANGE CONNECTIONS WHILE THE UNIT IS ENERGIZED.**

### **NOTE**

AFTER INSTALLATION OF CONNECTORS AND CABLING, A MINIMUM OF 1" CLEARANCE MUST BE MAINTAINED FROM ENERGIZED PARTS TO ALL CASE PARTS.

### **CAUTION**

CARE MUST BE TAKEN TO PLACE ALL LEADS FROM THE SAME LOAD THROUGH ONE KNOCKOUT AND THOSE FROM THE SAME SUPPLY SOURCE THROUGH ONE KNOCKOUT SO THAT NO PART OF THE CASE IS BETWEEN SUCH LEADS. IF MULTIPLE KNOCKOUT HOLES ARE REQUIRED, EACH KNOCKOUT HOLE MUST CONTAIN THE SAME NUMBER OF CABELS ROUTED TO EACH PHASE OF THE TRANSFORMER. FAILURE TO DO SO CAN CAUSE EXCESSIVE HEATING OF THE TRANSFORMER ENCLOSURE. TO PREVENT ENCLOSURE DAMAGE, PROVIDE PROPER SUPPORT OF THE TRANSFORMER ENCLOSURE PANELS WHEN PULLING CABLES THROUGH THE PANEL.

## **6.2 Grounding**

Consideration must be given to equipment grounding (case, core, and transformer winding). Grounding methods and practices are well established and are beyond the scope of this installation guide. ANSI/IEEE standard 142 is a recommended publication for this subject and contains an extensive bibliography. The grounding conductor for a transformer should have a current carrying capacity in accordance with the NEC/CEC.

## **6.3 Lighting Tap Applications**

Some transformers with a 240-volt delta connected secondary have a 120-volt single phase lighting tap. The maximum single-phase 120-volt load should not exceed 5% of the three-phase kVA rating. The load should also be balanced at 2.5% maximum between terminals X1 to X4 and 2.5% between terminals X3 to X4.

## **7.0 Before Energizing**

Remove all shipping hardware and store for future use. If it is desired to change location of the transformer at some future date, reinstall all shipping hardware. The bolt and nut connections that extend through the rubber isolation pads and secure the core and core assembly to the frame, should be loosened (with no visible compression of the pads under the bolt head and nut) to minimize the transmission of vibration. Check all other bolted connections for tightness. Securely tighten all screws that hold the panels and covers in place to eliminate possible vibration of these parts.

## **8.0 Operation**

To maintain safe operating conditions do not remove panels of the enclosure while the transformer is energized.

### **CAUTION**

NEVER ATTEMPT TO CHANGE TAPS OR CONNECTIONS UNLESS THE TRANSFORMER IS DE-ENERGIZED AND ALL WINDINGS GROUNDED.

### **NOTE**

**TRANSFORMERS RUN HOT:** AT FULL LOAD, TRANSFORMERS WITH 150C WINDING TEMPERATURE RISE COULD HAVE A MAXIMUM 50C/122F TEMPERATURE RISE ON THE SURFACE AREAS OF THE ENCLOSURE. WITH A 40C AMBIENT, THE MEASURED TEMPERATURE COULD BE AS HIGH AS 90C/194F.

## 8.1 Loading

In general, dry type transformers are designed to operate continuously at their nameplate kVA rating. ANSI C57.96 provides guidance for loading under unusual conditions including: 1. Ambient temperatures higher or lower than the basis for rating; 2. Short term loading in excess of nameplate kVA with normal life expectancy and; 3. Loading that results in reduced life expectancy.

If the transformer is experiencing increased temperatures, the following load characteristics should be considered immediately:

- Rigorous motor starting loads, frequent multiple motor starts, or other impact loading for which a specific transformer for that application is required.
- Over excitation of unit due to excessive supply line voltage.
- Ambient temperatures above standard 40C maximum – 30C average over 24 hours.
- Harmonic distortions of the supply line voltage or currents.
- Loads that are non-linear with harmonic distortion.

Even if evidence of overheating is noticed, external fans (fans blowing on the outside of the enclosure or louvers) must not be directed toward the transformer. This practice can result in mis-directed airflow that can retard or stop normal convection through the transformer coil. As a result the transformer will further overheat creating a risk of fire and failure may result in a short period of time.

## 8.2 Over-excitation

Operation at voltages in excess of rating may cause core saturation, excessive core losses, overheating and abnormally high noise levels. Special care should be taken where higher than rated primary voltage is anticipated. Most general-purpose dry type transformers incorporate primary taps to be able to match the supply voltage. Dry type general-purpose transformers are designed to reach rated temperature rise above ambient air temperature when operated continuously at rated voltage, frequency and load.

### **WARNING**

**SERIOUS OVERHEATING RESULTANTING IN FIRE DAMAGE MAY RESULT IF THE UNIT IS OPERATED FOR SUSTAINED PERIODS ABOVE RATED VOLTAGE OR CURRENT AND/OR AT OTHER THAN RATED FREQUENCY.**

## 9.0 Troubleshooting

### **Problem: Circuit breaker trips on start up**

Possible causes:

- Circuit breaker incorrectly sized for kVA rating of transformer.
- Circuit breaker instantaneous trip (if applicable) set too low.
- Supply voltage too high, over voltage being applied to transformer.
- Supply voltage cables incorrectly connected to transformer secondary.
- Transformer being reverse fed. If the transformer is being reverse fed, i.e. if the supply lines are connected to the transformer secondary terminals, the initial inrush current can be up to 10 times the normal expected inrush.
- Primary ground cable connected to transformer secondary neutral bus.

### **Problem: Wrong secondary voltage or secondary voltage drifts**

Possible causes:

- Improper grounding.
- Incorrect installation, review nameplate connection diagram.
- Primary taps jumpers incorrectly installed.
- Measurements must be taken with a true RMS meter.

### **Problem: Transformer noisy**

Possible causes:

- Transformer not installed per the recommended installation procedures outlined in this publication. Review paragraph 5.4 of this publication.
- Supply voltage to transformer higher than voltage rating of transformer.
- Transformer over loaded.
- Transformer enclosure panel screws not securely tightened.
- Rubber isolation pad hardware not properly loosened.

- Shipping braces not removed.
- Sound reverberating from reflecting surfaces.

### **Problem: Transformer runs hot**

Possible causes:

- Overvoltage being applied to transformer.
- Transformer being loaded at greater than nameplate kVA rating.
- Higher than recommended (30C average / 40C maximum) ambient air.
- Transformer enclosure ventilation openings obstructed or high content of dust and/or lint in transformer air ducts.
- Load contains large amount of harmonics.

#### **NOTE**

GENERAL PURPOSE TRANSFORMERS RUN HOT! UNITS RATED 150C RISE, LOCATED IN 40C AMBIENT, CAN HAVE ENCLOSURE TEMPERATURES CLOSE TO 90C/194F WHEN FULLY LOADED.

## **10. Maintenance**

Under normal environments and operating conditions, dry type transformers are virtually maintenance free. However, they do require occasional internal cleaning, care and inspection. The frequency of inspection will depend on atmospheric and/or environmental conditions at a given transformer installation or location.

#### **CAUTION**

ANY INTERNAL INSPECTION, ADJUSTMENT, CLEANING, OR MAINTENANCE MUST BE DONE WITH THE TRANSFORMER DE-ENERGIZED AND THE WINDINGS GROUNDED.

A continuously energized transformer needs periodic cleaning and maintenance to remove accumulations of dust or dirt from cooling ducts and other surfaces. Large accumulations may reduce cooling efficiency and lead to overheating. Cleaning is recommended at least once a year in relatively clean installations and at more frequent intervals in more heavily contaminated atmospheres.

Transformers that are de-energized for long periods of time generally require more frequent maintenance and cleaning to ensure removal of contamination. Accumulation of dirt on insulating surfaces becomes a hazard when a considerable amount of moisture is absorbed. Vacuuming is the recommended method for cleaning. Special attention should be given to cooling ducts within the winding. Low-pressure dry air can be used if care is taken to avoid driving the contamination into the insulation.

Moisture is detrimental to most insulation systems. It is advisable to dry out any transformer that has been exposed for long periods of time to high humidity. Whenever moisture is visible on insulation surfaces, the unit must be dried before being energized. If moisture is evident, the unit should be dried out by placing it in an oven, by blowing heated air over it, or by placing strip heaters under the coil windings. The temperature of the heated air should not exceed 110C/230F. If strip heaters are used, the elements should not be allowed to come in contact with the transformer. Heat should be applied to both the front and rear of the transformer. Transformers may be subjected to flooding, direct rain or similar applications of water. In such cases, normal drying techniques may not be adequate and the factory should be consulted.

Maintenance would include dust removal and/or drying (if applicable), tap changing, tightening of bolted connections, general servicing and inspection of auxiliary devices. Additional information related to the installation and maintenance of general-purpose transformers can be found in ANSI publication C57.94, "Guide for Installation and Maintenance of Dry Type Transformers".

## **11. Storage**

Condensation and moisture absorption must be prevented during storage. Ventilated dry-type transformers should be stored in a warm dry location having a uniform temperature to prevent condensation. Openings should be covered to keep out dust. If outdoor storage cannot be avoided, the transformer must be protected to prevent the entrance of water, moisture, dust, birds and other foreign material.

## **12. Renewal Parts**

The core-coil assembly precludes replacement parts. In most cases, field repairs are not recommended, are not economical, and can be dangerous. Renewal parts are available for all enclosure parts surrounding the core and coil assembly.

## NOTE

These instructions do not purport to cover all details or variations in equipment or to provide for every possible contingency to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchasers purpose, the matter should be referred to the manufacturer.

### 13. Typical Enclosure Information

**HANDLING** – Units are designed to be lifted and handled by fork truck.

**SHIPPING** - Units are shipped with skids. Skids are to be removed at installation.

**INSTALLATION** – Enclosures are NEMA 2 rated and are intended for indoor use. By adding optional weather shields, the unit can be rated NEMA 3R for outdoor use.

Remove any packing materials and shipping hardware at installation and prior to energizing the unit.

