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Instruction Manual

Ventilated Dry-Type Transformers

Unit Substation Type and Other Transformers Above 600 Volts

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

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IMPORTANT: The information contained herein is general in nature and is not intended for specific application purposes nor is it intended as a training manual for unqualified personnel. It does not relieve the user of responsibility to use sound practices in application, installation, operation and maintenance of the equipment purchased or in personnel safety precautions. Should a conflict arise between the general information contained in this publication and the contents of drawings or supplementary material or both, the latter shall take precedence.

SAFETY INFORMATION

Understanding Safety-Alert Messages

There are several types of safety-alert messages which may appear throughout this instruction bulletin. Familiarize yourself with these types of messages and the importance of the various signal words as explained below.

⚠ 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 serous injury.

⚠ CAUTION

CAUTION indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.

NOTICE

NOTICE is used to address practices not related to physical injury.

SAFETY INSTRUCTIONS

Safety Instructions (or equivalent) signs indicate specific safety-related instructions or procedures.

1. General

The successful and safe operation of dry-type transformers is dependent upon proper handling, installation, and maintenance. Neglecting certain fundamental installation and maintenance requirements may lead to personal injury and the failure and loss of the transformer as well as damage to other property.

⚠ DANGER

There is a hazard of electric shock or burn whenever working in or around electrical equipment. Power must be off before working inside a transformer.

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

2. Inspection Upon Receipt

Immediately upon receipt of the shipment, identify all units and check them against the shipping list. Make a visual examination to detect any damage which may have been incurred during transit.

If any damage is discovered, file a claim immediately with the carrier and send notice of the extent of damage to the local sales office, giving complete identification, carrier's name and railroad car number if the shipment was made by rail.

The information will enable the company to supply necessary data in support of claim.

3. Handling

Unit substation transformers and high voltage general purpose (HVGP) transformers with enclosure "Style B" (see Figure 1) with bases using welded structural steel may be dragged or skidded into position. The base is suitable for rolling in all directions. The base angles on the front and rear of encased transformers are suitable for jacking. HVGP transformers with "Style A" enclosure may only be positioned with forklifts and/or rolling. It is recommended that the skid be left underneath encased transformers unless it is to be moved by rolling. No provisions are made for jacking on core and coils. Core and coil units with no enclosure should be left on the skid for handling because the mounting structure is not designed for skidding or rolling.

Style A *Style B*

***Figure 1**- High Voltage General Purpose Transformer Enclosure Styles. Style A – formed steel feet on base, Style B – welded structural steel base.*

Lifting and towing eyes are located on the base structure of unit substations and HVGP "Style B" encased transformers. The eyes are designed to allow overhead lifts with a crane and spreader bar. Provisions for lifting are also located at the top ends of core and coil assemblies. Care should be taken when lifting to prevent cables or slings from damaging enclosures or other parts of the transformer. **Four-point lifting** with a **spreader bar** should always be used as shown in Figure 4 on page 11.

⚠ CAUTION

Never attempt to lift a transformer from points other than the lifting eyes provided. (See Figure 4)

No transformer should be laid on its side or end for any reason. The windings, structure and vibration isolators are designed to handle the normal weight and stresses of shipment and usage. These parts are not designed to accept stresses from tipping or similar actions. Damage beyond repair can occur if the transformer is turned on its side or end.

If it is necessary to handle ventilated dry-type transformers outdoors during inclement weather, they should be thoroughly protected against the entrance of moisture

⚠ WARNING

Never stand or walk on the top of the transformer, as the roof is not designed to support the weight of a person.

4. Storage

Any transformer, which is not installed and energized immediately, should be stored in a clean dry space having a uniform temperature to prevent condensation. Preferably, it should be stored in a heated building having adequate air circulation and protected from powdered cement, plaster, paint, dirt and water. In locations where moisture and condensation can exist, it is recommended that heat lamps or heaters be installed. Areas, which can flood or retain water, should be avoided.

The protective plastic wrapping should be left in place during storage indoors. This provides protection from moisture and falling dirt. All coverings and shipping braces must be removed before the transformer is energized.

NOTE: The tag stating "Do Not Store Outside" is a precaution to prevent storage of the ventilated transformers outside with the shipping wrap still in place. With this wrap installed, the air is restricted from flowing through the transformer and this seal enhances condensation.

Outdoor 103R transformers must be stored in a manner that allows some air flow through the unit to reduce risk of condensation. If Outdoor 103R transformers are stored outside or in an indoor area whose ambient air is not continuously controlled for proper humidity and temperature, heaters with controls are recommended to prevent condensation. Factory installed heaters are wired to a well-identified power terminal block. Heaters may be thermostatically or humidistatically controlled for optimum performance.

⚠ DANGER

The heaters always are energized from an "external" source and never from the CPT within the transformer.

5. Installation

Dry-type transformers are for indoor use unless the enclosure is specifically designed for outdoor service. They are cooled by means of free circulation of air, the maximum ambient temperature of which should not exceed 40°C (104°F) unless otherwise stated on the nameplate. Damage may result if the air flow is restricted, or the transformer is loaded beyond its rated capacity. Installations should be made in an area reasonably free from dust, moisture, chemical and corrosive vapors or fumes. Transformers must be installed in an upright position. Factors which should be kept in mind when locating dry-type transformer are: personnel safety, accessibility, ventilation, locations affecting sound level, and environmental conditions.

⚠ DANGER

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. To maintain safe operating conditions, do not remove the panels or cover while the transformer is in operation.

5.1 Working Space Requirements

Dry-Type Transformers should be located in an area where the transformer can be inspected at any time. The wiring compartment should be easily accessible at all times. It is a requirement of the National Electrical Code that sufficient access and working space shall be provided and maintained about all electrical equipment to permit the ready and safe operation and maintenance of such equipment. Refer to the requirements of the NEC paragraph 110.34 and applicable local or state codes for the particular installation involved.

The working space required by this standard should not be used as a passageway or for storage. Normally enclosed live parts which have become exposed during inspection or servicing should be guarded from possible contact in working spaces adjacent to a passageway or general open space where other work is being performed.

5.2 Ventilation

Adequate ventilation is essential for the proper cooling of dry-type transformers and clean air is desirable. If factory provided filters are used, they must be kept clean to permit proper air flow. Filters should not be added to a transformer without consulting factory as air circulation effectiveness for cooling is reduced. The ventilating screens and openings in the transformers are designed to provide adequate ventilation for the transformer and should not be restricted in any way.

The transformer nameplate will indicate minimum air clearances from walls and obstructions at ventilation openings. This space is a minimum for cooling and additional space should be provided whenever possible to allow both air circulation and access for maintenance. Air flow is best maintained when inlet air vent openings in the room are near the floor and outlet air vent openings are located on the OPPOSITE upper end of the room.

5.3 Sound

Sound waves may be amplified by reflected or radiated waves resonating through ceilings, walls, floors and mechanical vibrations from conduits, vent or air ducts and base mountings. Larger transformers should be installed near a main building support to insure a minimum of vibration transmission through the structure. Reinforced sections of the building may be required for heavier transformers. Loosen shipping bolts between transformer mounting feet and enclosure base to relieve pressure on vibration isolation pads. The vibration isolation pads must be loosened to work properly. CAUTION - DO NOT LOOSEN vibration isolation pads on seismic braced units.

Consideration should be given to the specific location and method of installation of the transformer keeping in mind the following suggestions:

- Mount the transformer away from corners of walls or ceilings.
- Provide a solid foundation for mounting and then use vibration dampening mounts if not already provided in the transformer.
- Provide flexible bus and conduit to make the connection to the transformer.
- Use sound absorbing material on the walls and ceilings.
- Locate the transformer as far as practical from areas where high sound levels are undesirable.

5.4 Environmental Conditions

Ventilated dry-type transformers are normally designed for installation indoors in dry locations. They may be installed outdoors if they are of outdoor construction (outdoor construction is indicated on the nameplate as Type "103R" or "Outdoor").

They will operate successfully where the humidity is high, providing precautions are taken to keep them dry if they are shut down for appreciable periods.

Locations where there is dripping water should be avoided or suitable protection should be provided to prevent water from entering the enclosure. Precautions should be taken to guard against the accidental entrance of water from an open window, skylight or other opening, a break in a water or steam line, flooding, or from the use of water near the transformer.

Transformers should be installed in locations where the ambient atmosphere is free from unusual chemical fumes, dust or combustible gases and vapors.

5.5 Outdoor Installation

As with indoor transformers, the same care must be taken when selecting a location for outdoor dry-type transformers.

Walls may be built around the transformer if proper care is taken to allow sufficient air flow. It is recommended that a suitable concrete pad with adequate drainage be used for the outdoor location. Pad should be approximately 4" above grade level.

Strip or space heaters to heat the coils and control moisture are located just beneath the coils on each side of the core assembly when specified. Terminal blocks are provided for the connection of independent external power leads. The current and voltage rating are clearly indicated at the terminal block. They are conveniently located for ease of access in the low voltage compartment when supplied.

The strip or space heaters are to be used during times of prolonged shut down where external temperature changes could cause moisture to condense on the coils. It is recommended that these heaters be connected to an external power source during extended shutdown periods. Extended periods should be considered to be greater than 12 hours.

⚠ DANGER

Standard outdoor transformers rated as 103R are not tamper proof. The location of the transformer must be away from children and all unauthorized personnel. Failure to do so may result in serious injury or death. Only transformers with "Category A" construction (such as padmount construction) are allowed in areas with unsupervised public access.

6. Connections

Unit substation transformers are designed for cable or bus connections to the primary and secondary terminals. Air filled terminal compartments may be provided for customer's primary or secondary terminations. Cable connections should be terminated only at identified connection points to prevent exposure to higher ambient conditions within the enclosure and away from live internal parts.

6.1 Bolted Joints

All joints suitable for field connection of cable or bus in secondary unit substations have tin or silver-plated contact surfaces. The lug or bus used for connection should be tin or silver-plated. No additional surface preparation is required when joining clean plated parts. Non-plated terminals in general purpose units used for cable connections are cleaned and greased at the factory. Table 1 gives clearances for unshielded cable connections.

Surfaces of tap connections and other internal electrical connections made of aluminum are cleaned to remove oxides and covered with a protective film of high temperature grease. If it is necessary to change taps or re-assemble a joint of bare aluminum, lightly brush the contact surfaces taking care to contain any particles that may be dislodged. Do not remove the grease. Once the contact areas have been abraded, assemble the parts and tighten securely. **Always use two wrenches when breaking or making joints to prevent damage to parts.**

Table 1

Clearances for Unshielded Cable Connections	
If cable connections are used, the minimum clearances listed below should be maintained at the terminals or other live parts.	
Transformer kV BIL Rating	**Minimum Clearance (Inches)**
10	1.0
20	1.250
30	1.875
45	3.50
60	5.0
75	5.5
95	6.00
110	7.50
125	8.75
150	11.25

⚠ CAUTION

Make only those connections shown on the nameplate or connection diagram. Before energizing, check all tap jumpers for proper locations and all bolted connections for tightness.

All cable connections should be a snug and tight connection with the lock washer flattened out. The connection should not be tightened to the point of causing damage. The torque values shown in Table 2 must be adhered to in accordance with the grade of hardware to ensure good electrical connections:

Table 2 - Recommended Torque Values

NOTE: Not all units of measure shown in foot-lbs

Nominal Thread Size	No Grade To Grade 2 U.O.S.		Stainless Steel		Grade 5		Grade 8	
Course Thread	Torque	Clamp Load Lbs	Torque	Clamp Load Lbs	Torque	Clamp Load Lbs	Torque	Clamp Load Lbs
1/4 20	49 IN LBS		75 IN LBS		75 IN LBS		107 IN LBS	
5/16 -18	49 IN LBS		132 IN LBS		157 IN LBS		220 IN LBS	
3/8 - 16	15 FT LBS		20 FT LBS		25 FT LBS		E5 FT LBS	
7/16 - 14	25		30		40		55	
1/2 - 13	35		(50)		60		80	
9/16 - 12	55		60		80		115	
5/8 - 11	75		90		115		160	
3/4 - 10	130		125		200		280	
Fine Thread								
1/4 - 28	55 IN LBS		94 IN LBS		85 IN LBS		120 IN LBS	
5/16 - 24	112 IN LBS		142 IN LBS		173 IN LBS		245 IN LBS	
3/8 - 24	15 FT LBS		20 FT LBS		25 FT LBS		40 FT LBS	
7/16 - 20	30		30		40 FT LBS		60	
1/2 - 20	40		50		65		90	
9/16 - 18	60		60		90		130	
5/8 - 18	80		100		130		180	
3/4 - 16	140		125		25		315	

6.2 Tap Connections

⚠ DANGER

Transformer taps are used to adjust for power source voltages above or below preferred operating levels. For example, if incoming power is 5% high on average, the plus 5% tap can be used to bring the output voltage down 5%. Tap connections may only be changed after the transformer is de-energized.

Standard dry-type transformers have taps located on the face of each high voltage coil. Tap arrangements are shown on the nameplate provided typically mounted on the outside of the enclosure. High voltage taps are supplied to maintain rated output voltage when actual input voltage differs from the nominal rated voltage.

Tap Changing Procedure:

1. First de-energize the transformer.
2. Short-circuit both the high voltage and low voltage terminals and ground both sides.
3. Remove enclosure panels to access the coil taps.
4. Carefully unbolt the tap jumper links and re-position them to the desired tap location on each high voltage coil. Use two wrenches (one on top and one on bottom) to prevent twisting and damaging the tap.
5. Verify the correct tap location by examining the diagram on the core clamp and/or the diagrammatic nameplate mounted on the enclosure.
6. Ensure all tap links are connected to identically labeled taps on each coil.
7. Remove the devices used to provide short circuit safety and the ground connections on both high and low voltage sides.
8. Examine the transformer to ensure all tools and extraneous hardware are removed.
9. Last, replace the enclosure panels and re-energize the transformer.

Transformers are typically supplied from the factory with taps positioned for rated voltage. Use the torque values listed in Table 2, Section 6.1 for tap connections.

6.3 Grounding

All core and coil structures have a flexible ground connection to the enclosure, which ensures that all dead metal parts have the same potential. The transformer enclosure should be solidly grounded so that no danger will exist for operating or maintenance personnel. A transformer ground block, ground bus or other acceptable grounding provision is provided for the customer's ground connections.

The grounding conductor for a transformer should have a current-carrying capacity in accordance with the National Electrical Code (Section 250) and all applicable local and state codes.

7. Before Energizing

Perform the following before energizing transformer.

1. Loosen or remove all shipping hardware and store for future use.

NOTICE

Failure to remove shipping hardware could cause increased transformer vibration thus causing increased sound levels. (NOTE - Shipping hardware will need to be reinstalled if transformer is moved in the future.

2. Transformers are provided with vibration isolators between the core and coil assembly and base. Actual location will vary somewhat depending on the design. These isolators are made ineffective during shipment by shipping bars and/or bolt-down hardware. Bars and hardware painted red should be removed. This will allow the core and coils to be mechanically isolated by the vibration isolators thus minimizing sound levels. Failure to relieve pressure on the vibration isolators may result in undesirable high sound levels.

NOTICE

The only time the shipping hardware holding vibration isolators in place should not be removed is if the unit is braced for seismic forces.

It is suggested the bolt-down hardware be placed in a small, non-metallic container or bag and stored at the bottom of the enclosure for future use in the event the transformer ever needs to be removed from its installation. The unit should not be moved unless the shipping hardware is in place.

3. Check all tap jumpers for proper locations and that they are secure and tight with locks washers completely flat.
4. Check all bolted connections for tightness, using two wrenches as described in Section 6.1. Lock washers should be completely flat when properly tightened. Internal buss connections with misaligned torque marks indicate loosening has occurred and should be re-tightened per specified torque values.
5. Remove any debris from the bottom of the wiring compartment after installation is completed. Securely tighten all screws, which hold the panels and covers in place to eliminate possible vibration of these parts.
6. Inspect transformer for tools, materials or supplies of any kind which may have accidentally been left anywhere on or in the transformer.

7.1 Testing

⚠ WARNING

Only qualified personnel should perform field tests. Improper testing by unqualified persons could result in serious injury or death.

Tests may be performed on transformers prior to energizing them to determine that they are in satisfactory condition after shipment from the factory. Tables 3 and 4 give suggested and optional pre-service transformer tests. The following IEEE standards should be consulted before performing field tests of any kind so they are performed safely, correctly and without harming the transformer.

- IEEE C57.94 - "Recommended Practice for Installation, Application, Operation, and Maintenance of Dry-Type Distribution and Power Transformers"
- IEEE C57.12.91 - "Standard Test Code for Dry-Type Distribution and Power Transformers"

Table 3 - Suggested Pre-Service Tests

	Test	Notes
1	Insulation Resistance Test	Test values in megaohms are highly subject to interpretation and are greatly affected by moisture and humidity. These measurements can be recorded periodically and monitored for substantial changes which could indicate a problem. All measurements should be made using the same voltage for comparison purposes. See Table 5 below for acceptable insulation resistance values.
2	Ratio, Polarity and Phase Relation Test	Verifies polarity of single-phase units and angular displacement of three-phase units. It may also indicate an internal winding failure, incorrect tap connections or other wiring problems.

Table 4 - Optional Pre-Service Tests

	Test	Notes
1	Winding Resistance Test	This test can be used to identify open circuits or poor internal connections. Special instrumentation specifically designed for transformer resistance measuring is generally necessary for this test.
2	Applied Voltage Test (also known as Hi-Pot)	This test is not generally recommended since it is a destructive test. If this test is deemed necessary, test voltage should not exceed 75% of factory values (65% on a periodic basis) and should only be performed when transformer is completely dry. Note - do not perform this test without first testing insulation resistance.

Table 5 - Acceptable Insulation Resistance Values

Winding kV Class	Insulation Resistance in MΩ
1.2	600
2.5	1000
5	1500
8.7	2000
15	3000

Consult IEEE C57.94 for other optional periodic tests that can be used for preventive maintenance beyond the scope of this instruction manual. Consult factory regarding questions about field testing.

8. Operation

To maintain safe operating conditions do not remove panels or covers over openings in the enclosure while the transformer is energized.

⚠ DANGER

Never attempt to change taps or connections unless the transformer is de-energized and all windings grounded.

For all relatively clean and dry indoor installations, the transformer will operate satisfactorily under normal conditions of energization and load. There is no concern over the transformer's ability to retain its electrical strength during reasonable periods of shut down. Under severe conditions and extended shutdown periods condensation may form and ultimately be absorbed into the insulation. If such a situation occurs, the transformer should be inspected for visible signs of moisture before re-energizing. The transformer should be dried as specified in Section 10 "Drying" if moisture is visible.

8.1 Forced Air Operation (Optional)

The "FA" rating (fan cooled) is intended to supply additional capacity for emergency and peak loading rather than capacity for a normal operating condition. Fan cooling packages can be installed most of the time on a transformer that was not originally fitted with a fan cooling system. Consult factory to inquire about adding fan cooling.

Refer to the provided instruction manual for operating instructions of the electronic transformer monitor used for fan control. This device monitors hottest phase temperature and individual coil temperatures. Fan activation and control contacts are custom programmable as a function of temperature. The fan and trip settings shown in Table 6 are preset at the factory in accordance with temperature rise rating of the transformer.

Table 6 -
Factory Pre-Set Transformer Monitor Fan and Relay Settings

Contacts	150°C Rise	115°C Rise	80°C Rise
Fan Activation	190°C	155°C	120°C
Alarm	200°C	165°C	130°C
Trip	210°C	175°C	140°C

Note - There is normally no need to adjust the relay settings. Consult factory if adjustments are deemed necessary.

⚠ DANGER

NOTE: When a control power transformer (CPT) is used to power the fans and fan controller, NEVER energize these devices from an external source without first DISCONNECTING and ISOLATING the CPT from the control circuit to avoid a dangerous voltage back-feed to the high voltage terminals of the transformer. If the electrician wants to check the fans or controller using an external voltage source, the CPT MUST BE DISCONNECTED AND ISOLATED prior to energizing this part of the control circuit.

Transformer Monitor / Fan Controller Features

- Digital Temperature Display
- Manual Fan Control
- Thermocouple Failure Alarm (Will not cause trip)
- Individual and Hottest Winding Temperature Monitoring (Three Thermocouple Inputs)
- Programmable Periodic Fan Exerciser (frequency and duration programmable)
- Programmable Relays for Fan, Alarm, Trip and (2) Auxiliary Relays
- Hottest Phase Indication
- Fan, Alarm and Trip Indicator LED Lights
- See Manual for Communication Connectivity (SCADA systems and MODBUS)
- Dual Fused Fan Relay Circuits
- Audible Alarm with Silencer Button

⚠ CAUTION

The use of external fans blowing on the outside of the enclosure across or into ventilation opening to cool a transformer can result in miss-directed air flow which can reduce or stop normal convection through cooling ducts. As a result, the transformer will further overheat and failure may result in a short period of time

8.2 Fast Transient Considerations

Medium voltage transformers may be vulnerable to high frequency transients when fast-acting switching technology like vacuum or SF6 breakers are used in the electrical system. The high-frequency nature of these transients can produce harmful localized voltage stresses within the transformer windings leading to premature insulation breakdown. These transients are caused by the combined effect of transient recovery voltages, breaker re-ignitions (re-strikes or pre-strikes) and current chopping. Voltage stresses are escalated further when resonance conditions exist between the cable capacitances, transformer inductance and load impedance. Transformers directly cable connected to fast-acting switches are more vulnerable to these transients under certain system conditions which include (1) switching at no-load or under light loads, (2) switching inductive or non-linear loads like UPS systems, variable speed motor controllers or rectifier loads and (3) frequent switching (daily or weekly). The use of traditional metal oxide varistors (MOV) lightning arresters connected line-to-ground alone will not provide adequate protection. RC-snubbers have been shown to provide reliable protection against switching transients. Refer to IEEE C57.142, “Guide to Describe the Occurrence and Mitigation of Switching Transients Induced by Transformers, Switching Device and System Interaction” for aid in assessing risk due to switching transients and recommended mitigation techniques. Performing a thorough system study is the best way to determine whether or not a particular transformer installation requires additional switching transient mitigation devices like snubbers.

9. Maintenance

Dry-type transformers are virtually maintenance free under normal environmental and operating conditions. However, they do require occasional external cleaning, repainting, internal cleaning, and periodic care and inspection. It should be recognized that the life of the transformer may be adversely affected where periodic inspection of any kind cannot be made.

The frequency of inspection will depend on the atmospheric and/or environmental conditions at a given transformer installation or location. A transformer may operate satisfactorily for many years without attention but maintenance may be required in a matter of months under unusual service conditions.

A continuously energized transformer needs periodic maintenance only to remove accumulations of dust and dirt from cooling ducts and other surfaces. Large accumulations may reduce cooling efficiency and lead to overheating. The frequency of cleaning will depend on the environment in which the transformer is located. 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 periods of time generally require more frequent maintenance to insure removal of contamination. Accumulation of dirt on insulating surfaces becomes a hazard when a considerable amount of moisture is absorbed. It is always advisable to clean any transformer suspected of having been contaminated with dirt and moisture.

Vacuuming with a HEPA filter is the recommended method for cleaning. Special attention should be given to cooling ducts within the windings.

When it is known that a transformer has been exposed to severe conditions of moisture, it should be cleaned and dried before energization.

⚠ DANGER

Maintenance must be done with the transformer in a de-energized condition.

This would include such things as tap changing, internal inspection and cleaning, tightening bolted connections, lubricating fan motors, etc. Corrective maintenance should be performed by a person who is familiar with the construction and operation of the apparatus and the hazards involved. In conducting corrective maintenance, such a person should:

- Be sure that the transformer is disconnected from all electric power sources before servicing.
- After power has been disconnected from the transformer, attach ground leads or their equivalent to the input and output terminations of the transformer. Such grounding may be unnecessary in the case of transformers that can be visibly isolated from energized conductors by other disconnecting means.
- Inspect terminals for alignment, tightness, pressure, burns, or corrosion. Consult factory to replace pitted or badly burned lugs.
- Inspect for moisture conditions which may cause corrosion, voltage tracking or harmful lowering of insulation levels.
- Inspect air ducts for the accumulation of dust and foreign substances; vacuum any accumulation.
- See that bolts, nuts, washers, pins, terminal connectors, including ground connection, are tight, in place and in good condition. All lock washers should be completely flat.
- Coils are supported with fiberglass blocks and secured in place with jack bolts installed between the clamp and block. Check the coil jacking bolts and tighten if necessary. There are no specific torque values for coil jacking bolts. Use two wrenches to avoid damaging block. Coil jacking bolts should be tightened to be snug plus a quarter turn. Lock washers should be flat where used.

10. Drying

Moisture is detrimental to most insulation systems. It is advisable to dry out any transformer which has been exposed for long periods of high humidity. Whenever moisture is visible on insulation surfaces, the unit must be dried before being energized.

Drying may be accomplished by application of hot air, radiant heat or internal heat. Heated air should rise through the windings. Heaters should be located beneath the windings and elements should not be allowed to come in contact with the transformers. Heat should be applied on both front and rear of the transformer. The capacity of heaters required can generally be taken to be one-half watt for each pound of transformer nameplate weight. The application of heat should be maintained for a minimum of twenty-four hours after moisture is no longer visible. IEEE C57.94 gives instructions for an effective process whereby insulation resistances values taken from winding to ground are plotted over time and compared to initial insulation resistance readings. The process continues until readings remain relatively constant for 3 to 4 hours. See IEEE C57.94 for detailed instructions on this drying technique.

When transformers are subjected to flooding, direct rain or similar applications of water, normal drying techniques may not be adequate and the factory should be consulted.

11. Fan Equipment Maintenance (Optional)

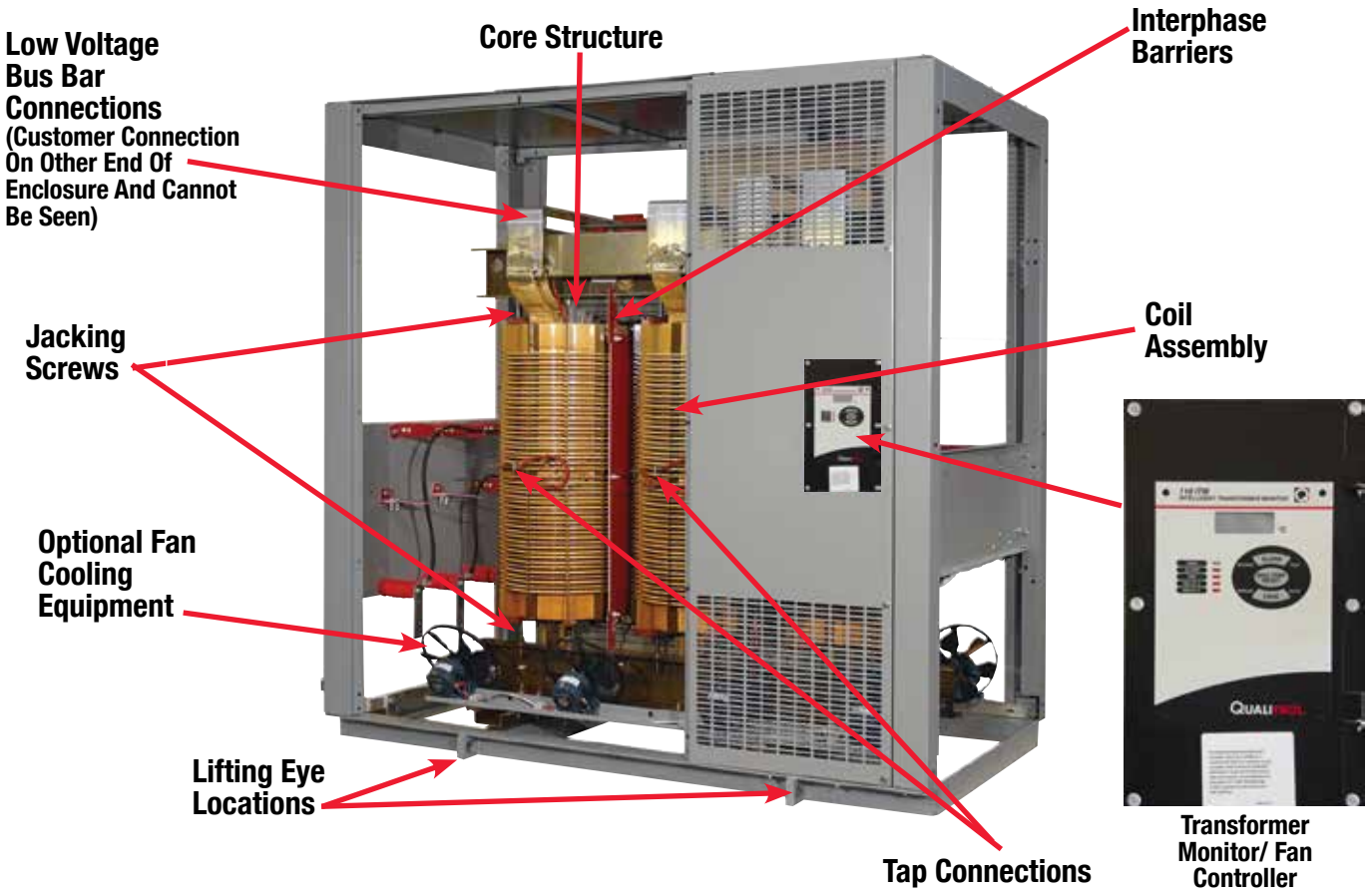
Self-cooled transformers (Class AA) 500KVA and above, if specified, are suitable for the application of supplemental fan cooling to give a self-cooled/forced air cooled (Class AA/FA) rating. Fan motors supplied are totally enclosed, non-ventilated type and are designed to be maintenance free. However, it is recommended to exercise the fans on a periodic basis. The transformer monitor / fan controller is conveniently preset from the factory to automatically exercise the fans for three minutes every seven days to help keep the fans in good working order. This can be modified by the user if desired. The fans can also be manually operated if desired. Defective motors should be replaced immediately

The transformer monitor / fan controller used for monitoring winding temperatures and controlling fan, alarm and trip relays requires no specific maintenance. However, proper functionality can easily be checked on a periodic basis if desired during routine scheduled maintenance. Consult instruction manual of transformer monitor / fan controller for detailed operating instructions.

FIGURE 2

Typical NEMA 1 Indoor Dry-Type Substation Unit

(Covers Removed for Illustration Purposes)



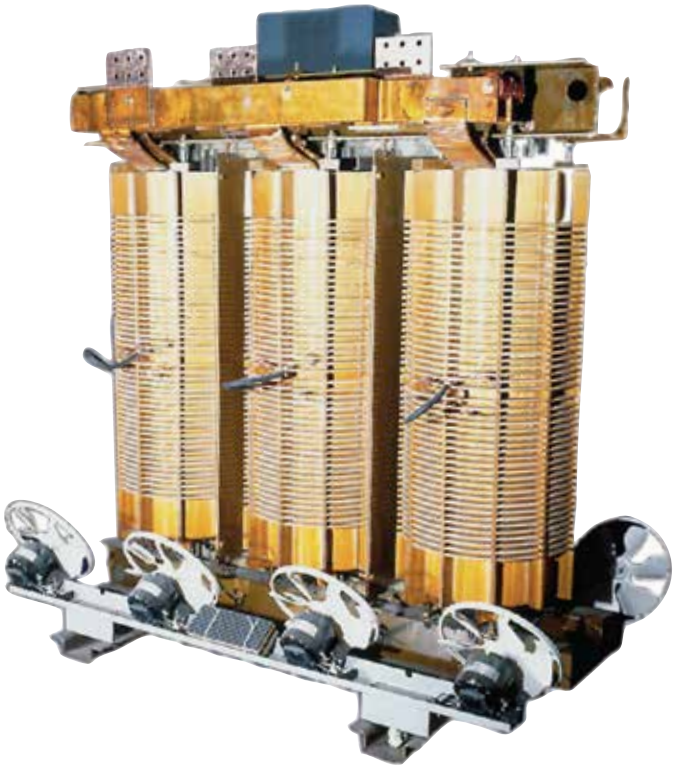
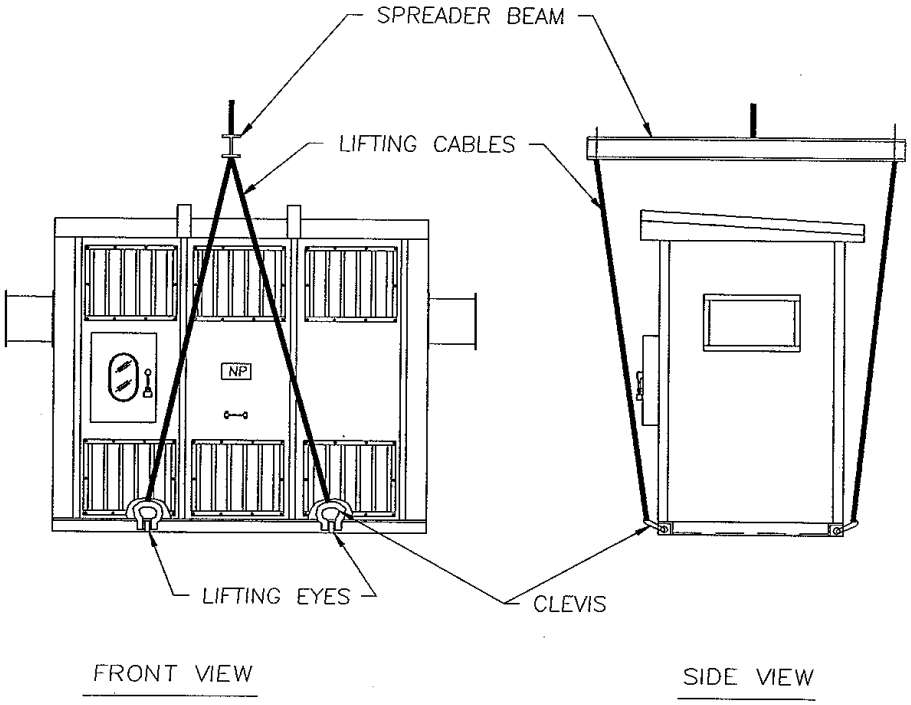


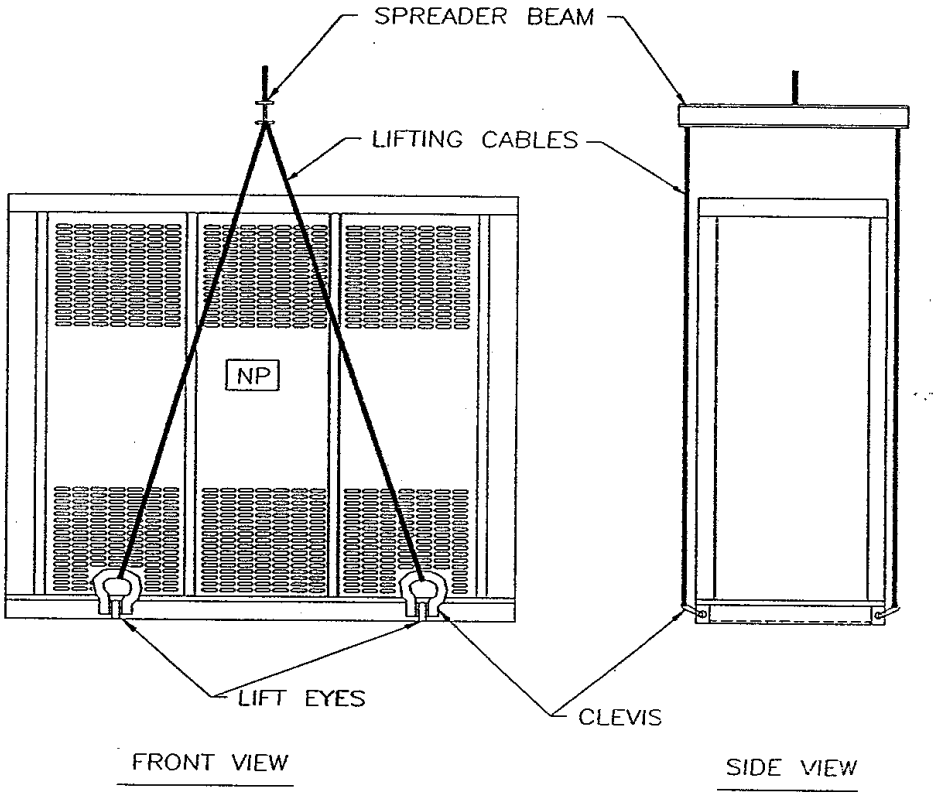
FIGURE 3

Typical Substation Unit

FIGURE 4

Lifting Instructions





Every effort is made to ensure that customers receive an up-to-date instruction manual on the use of our products; however, from time to time, modifications to our products may without notice make the information contained herein subject to alteration.