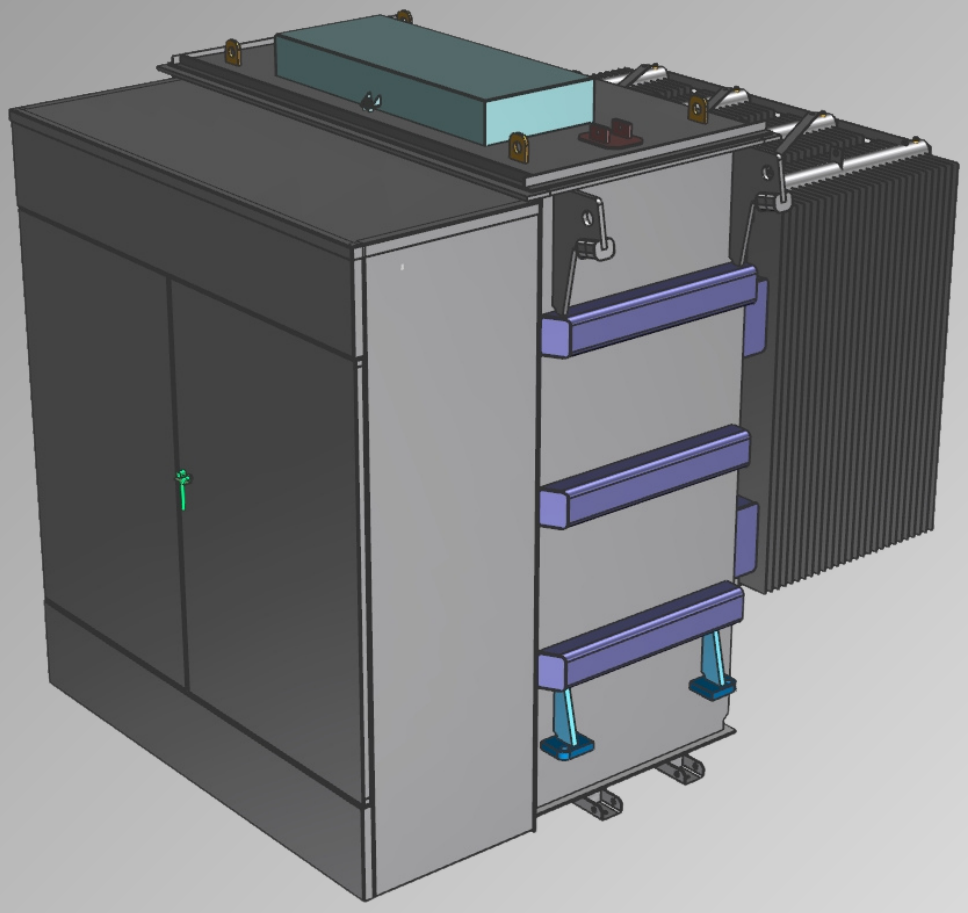
Instruction Manual

Medium Power Padmount Transformer | Utility & Industrial
10 MVA through 20 MVA | 46 kV Max HV



CONTENTS

DISCLAIMER
WARRANTIES AND LIMITATION OF LIABILITY

The information, recommendations, descriptions and safety notations in this document follow WEG Transformers USA (WEG) experience and judgment and may not cover all contingencies.

If further information is required or if in doubt, consult with WEG service office.

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SECTION A
INTRODUCTION

The information contained in this document **("instruction manual")** is subject to change without notice. This instruction manual is not intended as a substitute for proper training or adequate experience concerning the safe operation of the transformer described; hence this is the sole responsibility of the user or purchaser of the transformer.

Only **competent technicians** who are familiar with this transformer should install, operate, and service the transformer.

A **competent technician** must have the following qualifications:

- Thoroughly familiar with the instructions as given in the instruction manual.
- Fully trained in industry-accepted high and low-voltage operating practices and safety procedures.
- Trained and authorized/certified to energize, de-energize, clear, and ground the transformer.
- Well versed in the use and care of personal protective equipment (PPE) such as arc flash clothing, safety glasses, face shield, hard hat, rubber gloves, clamp-stick, hot-stick, etc. as prescribed by OSHA or any other national standards applicable to the transformer.

The information included in this manual is fundamental for a proper understanding of the installation, operation and maintenance for this product.

For the sole purpose of safe installation and operation of the transformer, the operator must read and understand all cautions and warnings labels as included.

DANGER: THIS MEANS AN IMMEDIATE HAZARD WHEN NOT AVOIDED OR NOT COMPLIED WITH WILL CAUSE SEVERE PERSONAL INJURY, DEATH OR PROPERTY DAMAGE.

WARNING: THIS MEANS A HAZARD OR UNSAFE SITUATION WHEN NOT AVOIDED OR COMPLIED WITH CAN CAUSE SEVERE PERSONAL INJURY, DEATH OR PROPERTY DAMAGE.

CAUTION: THIS MEANS A HAZARD OR UNSAFE PRACTICE WHEN NOT AVOIDED OR COMPLIED WITH CAN CAUSE PERSONAL INJURY OR MINOR PROPERTY DAMAGE.

The before mentioned warning labels are fundamental for the safe operation of the transformer. The **certified technician** must be acquainted with the transformer operational guidelines before continuing with the operation activities as intended.

Not understanding well the warning labels may **bring death or individual injury, and harm to the person, transformer, and adjacent property or any other connected electrical equipment such as switchgear or inverters**.

The guidelines contained in this instruction manual are considered to be a general guide for the operator, the activities related, and intended use of the transformer, as well as the upkeep of this equipment, when operated in “Normal Operational Conditions” as prescribed in IEEE Standard C57.12.00.

WEG is not responsible for the upkeep of these standards or its liability to change without notice or its misuse.

Despite the fact that WEG has endeavored to address all major operational aspects of the transformer, the instruction manual does not address each possible application or situation that may be experienced during the installation, operation and maintenance of the transformer.

NOT READING AND COMPLYING WITH ALL SAFETY INFORMATION, INSTRUCTIONS AND WARNINGS LABELS THROUGHOUT THE INSTRUCTION MANUAL BEFORE ATTEMPTING ANY INSTALLATION, OPERATION, OR MAINTENANCE ACTIVITIES MAY LEAD TO DANGEROUS SITUATIONS. IN CASE OF DOUBT CONTACT WEG:

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Nomenclature

Throughout this manual, WEG refers to various components installed on the transformer and its location. These components are generally located per the figure 1(a) and/or figure 1(b) in accordance to IEEE C57.12.00 standards. There may be variations in location due to specific customer requirements.

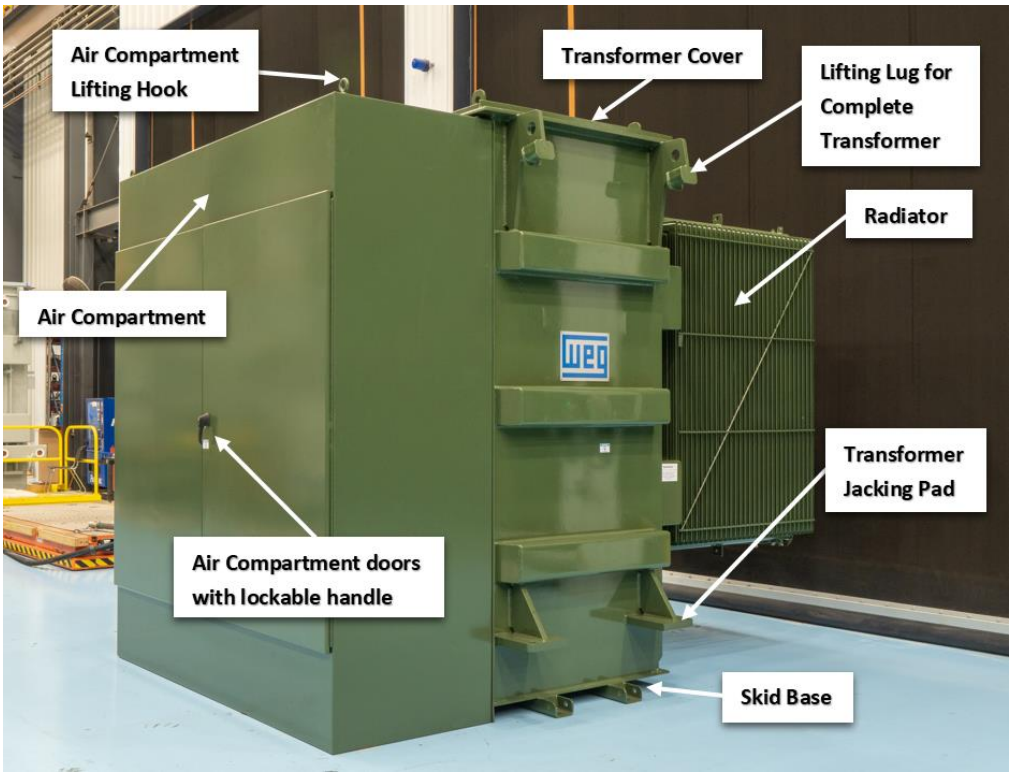

Figure 1a – Nomenclature, Front View

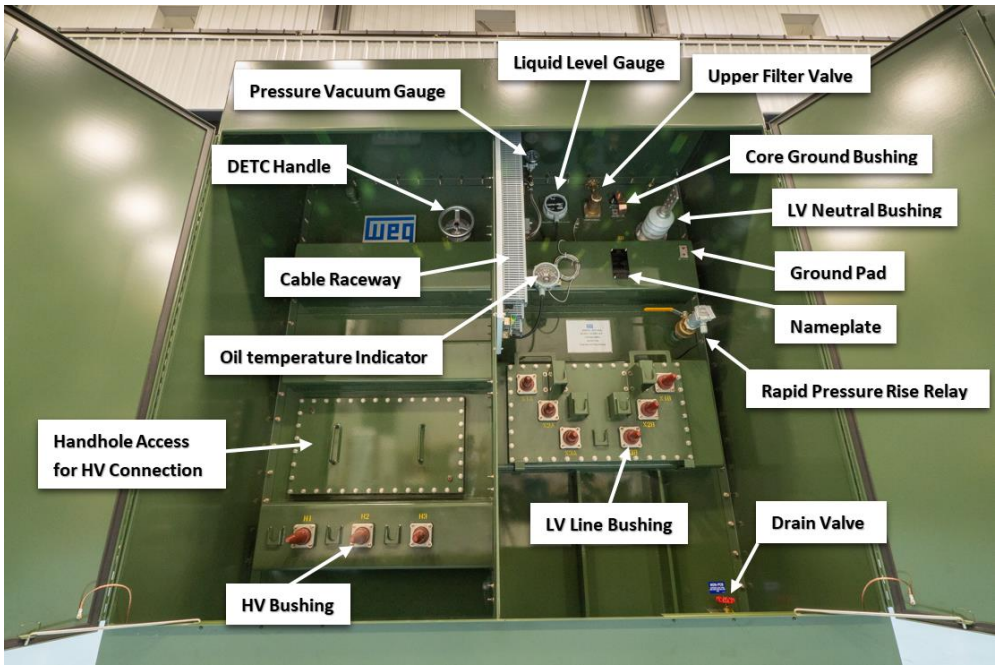

Figure 1b – Nomenclature, Front View with open doors

SECTION B
IMPORTANT SAFETY INFORMATION

In this section, we are advising the purchaser of important cautions and warnings, which must be understood for safe operation of the transformer.

Each of these labels and their application are explained in detail in this instruction manual.

FAILURE TO COMPLY WITH SAFETY WARNINGS OR CAUTION ALERTS MAY RESULT IN SERIOUS PERSONAL INJURY OR EVEN DEATH

No Forklift		When unloading transformers, do not use a forklift. A “NO FORKLIFTS” decal is attached to the transformer.
Grounding		The first electrical connection made must be grounding the transformer. This connection is made from the tank grounding pad to a permanent low impedance ground. The tank ground must be connected to the system ground at all times.
Electrical Loading	 	Make only the connection and operate at voltages indicated on the nameplate. All transformer neutrals should always be connected unless the nameplate indicates otherwise. Ensure all leads NOT used are appropriately grounded. Overloading the transformer **above and beyond** the IEEE C57.12.91 loading standards will result in a loss of life of the transformer.

Crane Lifting & Rigging	 When lifting and rigging the transformer, only use the lifting lugs in combination with a spreader bar to allow vertical lift. **DO NOT** use radiators or any other apparent lifting point such as jacking pads.  Use jacking pads for lifting the transformer only for limited heights of no more than 4 inches. **DO NOT** use radiators or any other apparent jack point.
Venting	 Only when in overpressure, vent the transformer by pulling the ring of the pressure relief valve or un-screw the plug located on the tank front.
Internal Inspection	 Always de-energize and vent the transformer before removing the handhole cover plate located on the tank cover, please ***refer to Section J – Maintenance*** while respecting all required OSHA and National applicable standards.
Switch, Fuses & Arresters	 Always de-energize and vent the transformer before removing the handhole cover plate located on the tank cover for easy access to switches, fuses and under-oil-arresters.  **DO NOT** override any safety interlocks installed.  Closing-in on fault can generate arcing and explosive gases. Read carefully the manufacturer's fusing instructions and vent the transformer before closing the Bay-O-Net fuseholder.  Loadbreak switch will interrupt load current **ONLY.** Consult manufacturer’s instruction before operating. The switch is not suitable for interrupting fault currents. **DO NOT** exceed switch ratings.

Switch, Fuses & Arresters		Prior to operating the Voltage Selector Switch, Delta/Wye Switch or Tap Changer Switch, **ALWAYS** de-energize the transformer.

Liquid Level		Liquid level must be at all times at the proper level. Prior to energization, check liquid level of the transformer. Under **NO** circumstances shall the transformer be energized and operated with a liquid oil level where the needle pointer points outside the 25°C value.
		**DO NOT** energize at minus 15°C liquid level per the nameplate indication as liquid level might expose critical parts of the internal transformer assembly. Consult nameplate and cold start procedures; please ***refer to Table 5 in Section L – Tables and Procedures.***

Installation		Transformer foundation (pad) must be smooth, flat and of the correct size to cover the compartment opening. No gap(s) are allowed between the compartment and the pad. If gap(s) exist, they will compromise the tamper-resistance of the transformer. Always securely mount the transformer on the pad.
		Prior to energization always, remove dirt and any foreign material from all bushings installed as well as critical elements inside any compartment. Consult manufacturer instructions for installing separable-insulated high voltage or low voltage connectors. Do not operate beyond the published ratings.
		Transformer must be level within 4 degrees to prevent internal live part exposure and to ensure proper cooling.

SECTION C
SHIPMENT, HANDLING, RIGGING & STORAGE

Prior to receiving the transformer, the purchaser shall make themselves familiar with the transformer according to the following suggested steps:

Documentation

Gather all documentation related to the transformer such as shipping documents, drawings, and other appropriate data for the off-loading and use of the respective transformer. Make yourself familiar with the characteristics that can be found on the transformer drawings and/or nameplate as well as specific labels or notices given on the transformer itself such as weights and other pertinent characteristics.

Shipment

Every WEG transformer is shipped hermetically sealed from the factory with dielectric fluid. Type II mineral oil is the standard dielectric fluid. If your transformer is filled with FR3™ natural ester dielectric fluid, a specific FR3™ decal is permanently attached to a compartment door.

When the below mentioned label is visible on the air compartment door your transformer is filled with FR3™ dielectric fluid. When re-filling the transformer, fill **ONLY** with FR3™ dielectric fluid to the appropriate level.

Acceptance of the Transformer

Upon receipt and unloading of the transformer from the truck, carefully examine the transformer, parts, and loose parts (spares) delivered (if applicable) for damage. The acceptance assessment should be completed at this time.

Any damages noted prior to unloading as well as bill of lading errors must be noted. Notification shall be given to WEG prior to attempting any form of repair or correction. Issue any claim for missing parts to WEG **within 30 days**. Not doing so may lead to misunderstandings and additional cost for the purchaser.

In case of shipping damage, immediately file a claim with the carrier and contact **WEG Transformers at +1 (636)-239-9300**.

Crane Lifting

Each transformer has four (4) lifting lugs that are the only connection points to be used for lifting the transformer. Lifting the transformer from any other points available on the transformer is unsafe as these are not secure and are not suitable for the purpose of lifting the transformer. Lift the transformer in a vertical position permitting the transformer to tilt no more than 15° from the vertical axis.

When unloading transformer do not use a forklift. A forbidden to forklift sticker is attached to the transformer.

Rigging

When lifting with a crane, use a spreader bar to limit horizontal compression on the lifting lugs. Do not lift the transformer with a forklift as weight stabilization can pose a safety risk.

Take additional precautions when handling the transformer during an ambient temperature that is less than 0°C (32°F).

When lifting the transformer by crane, only use the lifting lugs in combination with a spreader bar to allow vertical lift. **DO NOT** use radiators or any other apparent lifting point such as jacking pads.

Unloading Process

Perform the following critical checks prior to unloading the transformer from the truck:

A. Ensure that the serial number on the transformer nameplate and on the bill of lading match. Likewise, check the nameplate for kVA rating, high-voltage rating, low-voltage rating, and impedance. Ensure that they agree with the order specifications.

B. Check bill of lading and make sure the shipment is complete.

C. If the shipment is not complete, contact WEG immediately. Inability to make a timely claim of incomplete shipment may result in voiding of any future claims.

D. The tank vacuum/pressure must show a positive or negative pressure when the transformer is unloaded contingent upon the relative temperature of the oil and altitude. A rising or falling pressure over time assures the purchaser that the transformer tank is hermetically sealed. If the vacuum/pressure gauge shows a consistent zero pressure reading, then this demonstrates that the tank is not hermetically sealed and that there is a “leak”. In the event that this happens, the tank and its accessories must be checked immediately for oil leaks. Please contact WEG immediately if a leak is found during this examination.

E. Check the transformer for transportation damages. In particular, carefully examine and look for damage to corrugated fin-walls, radiators, tank, compartment, bushings and all other accessories.

F. Check for any damages to paint due to handling. Repair any damaged paint with touch up paint. Make sure not to over-spray labels, nameplate or any specific labels pertaining to the transformer.

G. Do NOT remove any labels on the transformer.

H. Check for missing parts.

I. Store the transformer

Dielectric Fluid Level Check

The transformer is delivered from our manufacturing facility filled with dielectric fluid, either mineral oil or FR3™ fluid, and is filled to the appropriate level.

Prior to energization of the transformer, complete the dielectric fluid level check. The liquid level indicator must be between the **"High"** and **"Low"** marks on the gauge.

For transformers provided with a liquid sight gauge, the liquid level can be observed easily. On the off chance that the transformer does not have a liquid level gauge or sight gauge, check the liquid level by removing the plug at the 25°C level.

DO NOT remove the oil level plug when transformer oil is above 40°C.

CAUTION

When this label is visible on the air compartment door your transformer is filled with FR3™ Fluid. When re-filling the transformer, fill ONLY with FR3™ fluid to the appropriate level.

A transformer found with LOW fluid level (either mineral oil or FR3™ fluid) should be checked for potential leaks and re-filled immediately to the highest possible level with a similar dielectric fluid as defined on the transformer nameplate.

The correct fluid level at approximately 25°C is at the liquid-level plug. Do not operate the unit when the fluid level is below the 25°C mark when the unit temperature is approximately 25°C. When it is necessary to add or refill with fluid, the work must be done in a clean, dry room. When filling do not use a rubber hose. Use an oil resistant hose.

Internal Inspection

When receiving the transformer, an internal inspection is seldom required. It is suggested only when there are clear signs that the transformer was subjected to severe impacts during transportation or when it is important to perform a specific test prescribed per WEG's instructions.

Internal inspection is only authorized in the presence of a WEG technician or their representative or when authorized in writing by WEG.

UNAUTHORIZED OPENING OF THE TRANSFORMER TANK BY THE PURCHASER MAY VOID THE WARRANTY.

When the transformer is opened by a certified technician, specific actions must be taken to avoid weakening of the insulation of the transformer, please ***refer to Section J – Maintenance***. Therefore:

1. Prevent ingress of foreign objects or dirt.
2. Prevent ingress of moisture.

Prior to internal inspection, follow all safety precautions. These include:

1. De-energize the transformer.
2. Make sure the dielectric fluid is at or below 25°C.
3. Vent the transformer.
4. Ground the transformer.
5. Adhere to all applicable OSHA and National Safety standards.

Storage

When storing the transformer, respect the conditions below.

NOT RESPECTING LONG TERM TRANSFORMER STORAGE REQUIREMENTS MAY VOID THE WARRANTY. TRANSFORMER GENERAL CONDITIONS ARE:

1. **CANNOT BE STORED IN A SALTY OR CORROSIVE ENVIRONMENT.**
2. **MUST BE STORED IN A DRY ENVIRONMENT.**
3. **MUST BE STORED HORIZONTALLY, NO MORE THAN 4 DEGREE TILT.**
4. **CONTROL CABINETS, IF ANY, MUST HAVE DESICCANT. CONSULT DESICCANT CALCULATOR ON THE INTERNET OR CONTACT WEG.**

SECTION D
TRANSFORMER INSTALLATION

Prior to installing the transformer on the foundation, the purchaser shall make themselves familiar with the transformer and its basic characteristics.

Crane Lifting

Each transformer has four (4) lifting lugs that are the only connection points to be used for lifting the transformer. Lifting the transformer from any other points available on the transformer is unsafe as these are not secure and are not suitable for the purpose of lifting the transformer. Lift the transformer in a vertical position permitting the transformer to tilt no more than 15° from the vertical axis.

When unloading, do not use a forklift when a “NO FORKLIFTS” decal is attached to the transformer.

Rigging

When lifting with a crane, use a spreader bar to limit horizontal compression on the lifting lugs. Do not lift the transformer with a forklift as weight stabilization can pose a safety risk.

Take additional precautions when handling the transformer during an ambient temperature that is less than 0°C (32°F).

PRIOR TO LIFTING, CHECK THE WEIGHT OF THE TRANSFORMER. THE TRANSFORMER WEIGHT IS INDICATED ON THE NAMEPLATE.

Jack & Skid

The transformer tank base is designed so that it can be jacked and skidded to the installation foundation or can be jacked in place on a skid mounted assembly. Use only the jacking pads provided on the tank.

DO NOT use radiators or any other part of the transformer to jack the transformer in place as this may lead to permanent damage to the transformer and oil leaks.

When skidding the transformer, utilize a sufficient number of rollers to divide the transformers weight equally over the rollers. Rollers size must be able to support the weight of the transformer, as this is key for safe rolling.

Foundation

Prior to installation always, consult with National Codes and IEEE Standard C57.12.00 for installation compliance.

Mount the transformer on a **level** solid horizontal foundation adequate to support the weight of the transformer as indicated on the nameplate. The transformer (**including the air compartment**) must sit flush with the horizontal surface of the pad, such that there are NO openings or gaps between the transformer base and pad.

The transformer must be installed such that it is not tilted **more than 4 degrees**. When tilted more than 4 degrees, it may compromise the life of the transformer. The transformer's internal wiring and components such as fuses, switches, core and coils must be under immersed in dielectric fluid for proper functioning. The tilting could potentially cause dielectric failure or cooling problems leading to overheating and therefore diminish transformer life.

With the transformer installed on its foundation, there must be a minimum clearance of 12 inches beyond the compartment door radius from any obstructions and 2 feet around the transformer.

Installation of the transformer in a salty or corrosive environment should be avoided as this will introduce degradation of the protective paint and ultimately lead to corrosion of mild steel, unless designed for such an environment.

Compartment

Transformer compartment(s) are designed and manufactured per the latest IEEE Standard C57.12.28 or C57.12.29. NEVER modify the tank or compartment as the tamper resistance could be compromised. On the off chance, that in any way, shape or form alterations must be made to the tank or terminal compartment the transformer is not considered anymore by WEG **as tamper resistant compliant** and this may void the warranty and WEG's liability of any kind in general.

Do not alter the transformer tank and compartment such that tamper resistance is compromised. Altering will void the warranty and any WEG liability.

Grounding

Permanently ground the transformer in accordance to local and national standards. Ground the transformer tank using the provided ground pads or any special and adequate connection provided on the transformer tank. Make sure that a proper low-impedance ground connection is established.

The transformer must be grounded properly at all times in accordance with local and national standards. Make sure that a proper low-impedance ground connection is established.

High Voltage and Low Voltage Connections

Prior to making the high voltage and low voltage connections, make sure that all mating connector surfaces are free of burr and debris. All connections must be torqued appropriately to avoid overheating and/or cause failure of the connections leading to failure of the transformer; please ***refer to Section M – Tables and Procedures*.**

All cable connections shall be made in such a way that the high voltage and low voltage bushings and busbar are not undergoing excessive cantilever stress. Excessive cantilever stress can lead to busbar and bushing failure leading to leaking of dielectric fluid followed by failure of the transformer.

Avoid excessive cantilever stress on the high voltage and low voltage bushings and busbars from excessive cable weight.

On a dead-front transformer (high voltage and/or low voltage), make sure all bushings are clean and dry. Apply dielectric grease to dead front high voltage bushings prior to connecting elbow connectors.

High Voltage Connections

The transformer is provided with bushing wells, one-piece (integral) bushings or bushing wells and inserts. One-piece (integral) bushings and bushing inserts are intended to interface with elbow connectors, and can be provided in either load- break or non-load-break design.

Insulated protective caps must be installed on all unused bushings and properly grounded prior to energization.

Low Voltage Connections

Transformers are in most case designed with low-voltage bushings, with or without spade terminals.

Dielectric Fluid

The transformer is thoroughly dried at the factory and shipped filled with insulating fluid (either mineral oil or FR3™ fluid) to the correct level. The dielectric fluid has a minimum dielectric strength of 30 kV at 60 Hz when tested per ASTM D-877.

The inhibited mineral oil is certified and contains less than 1 PPM of PCB's at time of manufacture. FR3™ fluid contains NO PCB's at time of transformer delivery.

When this label is visible on the air compartment door your transformer is filled with FR3™ Fluid. When re-filling the transformer, fill ONLY with FR3™ fluid to the appropriate level.

Transformer Pressure

The transformer is shipped with +3.0 PSIG of pressure from the factory. Due to temperature and altitude changes, the pressure on the transformer may vary substantially upon delivery. The transformer should be vented to the atmosphere before it is placed in service **only when in overpressure**. If equipped with a Schrader valve, the transformer can be pressurized with dry nitrogen up to +1.0 PSIG when the oil temperature is approximately 25°C.

Oil level will drop approximately 1/2 inch for every 10°C drop in temperature. This will often result in slight tank vacuum, and is normal.

DO NOT allow tank to exceed more than 3 PSIG vacuum (-3 PSIG) as tank will deform. Do not allow tank to exceed more than 5 PSIG pressure. Tank will distort over 7 PSIG pressure.

DO NOT add nitrogen to a cold transformer to bring it back up to positive pressure. Doing so, can cause over- pressure and damage to the transformer when the oil temperature rises to normal levels. Pressure at 25°C oil temperature should be between 0.5 to +1.0 PSIG.

When venting the transformer pressure, carefully open the pipe plug or pressure relief valve above the liquid level at approximately 25°C. Screw-in the plug immediately after pressure equalization or let go of the pressure valve such that it will seat again on the seal.

Always verify the dielectric fluid of the transformer by checking the nameplate.

Fill and drain provisions are provided on each transformer.

From time-to-time, it may be necessary to check the oil quality of the transformer. For guidance on taking samples and interpretation of baseline results, please ***refer to Section J – Maintenance***. WEG suggests taking more than one sample to establish a solid baseline for oil quality.

Always vent the transformer prior taking oil samples. **NEVER** take oil samples while the transformer tank pressure is below 0 PSI relative.

SECTION E
PRE-ENERGIZATION

Pre-Energization Inspection and Tests

Inspect the installed transformer on the pad and test prior to energization.

Pre-energization inspections and tests are required as well as standard checks prescribed in the instruction manual. Only certified technicians with the appropriate safety and testing equipment can perform the pre-energization inspections and tests.

DO NOT energize without cleaning the bushings. Always consult the instruction manual for the high voltage connectors.

NEVER operated the transformer beyond the nameplate rating.

DO NOT ENERGIZE without the pre-energization inspection and tests completed**.**

For transformers with a Molded Case Circuit Breaker (MCCB), **DO NOT** energize if the MCCB temperature is less than 0°C (32°F).

DO NOT ENERGIZE without the following pre-energization inspections and tests, please ***refer Section K – Field Acceptance Test Guidelines***:

A. **Ratio test** – using a transformer turns ratio tester (TTR), perform a ratio test to verify the primary to secondary winding ratio.

B. **Insulation resistance test** - perform a 1,000 Volt insulation test (megger test) to measure the resistance of the insulation between windings and from each windings to ground.

C. **Tap Changer Setting** – make sure the tap changer is set to the correct voltage setting and make sure the setscrew is well seated in the bottom of the hole.

D. **Series/Multiple or Delta/Wye Switch Settings** – should the transformer be equipped with delta/wye switch, ensure it is set to the correct position and make sure the setscrew is well seated in the bottom of the hole.

E. **Grounding** - verify the transformer has a solid low impedance grounding.

F. **Bolted Connections** – verify that bolted connections are torqued in accordance to the torque table guide, please ***refer to Section L – Tables and Procedures.***

G. **Dielectric Liquid Level** - verify the transformer is filled correctly by verifying the liquid level gauge or sight gauge, please ***refer to Section C – Shipment, Handling, Rigging and Storage.***

H. **Current Transformers** – should the transformer be equipped with current transformers (CTs), the associated CT leads should be connected to the metering load or relays and with the proper burden. If the CT leads are not connected to a metering load, they **must be shorted together and grounded before transformer energization!**

I. **Control Wiring For Accessories** – verify all control wires, if any, and verify that all are connected and functional. Functionality can be verified by checking continuity of each wire. Ensure that no wire insulation is damaged.

J. **IFD** – if the transformer is equipped with an internal fault detector (IFD), the shipping lock must be removed prior to energization. Turn the shipping lock (red exterior piece) 90 degrees counter clock wise to remove.

K. **Accessories** – verify the functionality of all accessories with or without contacts.

L. **Tank And Compartment Finish** – make sure that all painted surfaces are intact and are not scratched due to installation. If there is damage, use touch-up paint on the damaged surfaces.

M. **External Tank Inspection** – make sure the transformer handhole is closed and a tamper resistant protection cover is installed.

N. **Field Tools** – verify that all tools are removed from the transformer's cabinet/ compartments and are accounted for.

O. **Prior** to connecting the low voltage cables or busbar, make sure the surfaces of all spade terminals and matching connectors or busbars are perfectly clean and smooth.

P. **External Control Cabinet** - if the transformer is equipped with an external control cabinet, make sure all wires are connected and accessories are functional. Make sure cabinet is clean and free of debris. Padlock the cabinet after inspection.

Q. **Padlock** – securely lock all switches, compartments and control cabinet.

R. **Fans** - if your transformer is equipped with fans, make sure they are spinning freely and are operational.

S. **Clearance Inspection** – ensure all line connections maintain clearances per IEEE C57.12.34 2015 table 15, please ***refer to Section L – Tables and Procedures.***

T. **Radiator valves –** should your transformers be supplied with detachable radiators, ensure all radiators valves are **OPEN** at time of pre-energization!

IF performing VLF (Very Low Frequency) Testing, please consult the bushing manufacturer's specification for maximum withstand voltage.

1. In no case shall the voltage exceed 115% of the nominal transformer voltage for a duration of 30 minutes.
2. In no case shall the test be conducted with the transformer switch in the closed position. If the transformer does not have a switch, then the transformer must not be in the circuit when performing this test.
3. Ensure arrestors, if any, are disconnected before starting test.

Pre-energization/verification must be performed on all radiator valves (if any). **Ensure all radiator valves are open (bottom and top)!** Failure to open the valves will damages the transformer by overheating which will **void the WEG warranty**.

SECTION F
POST-ENERGIZATION

Post-Energization inspection and tests

After the transformer pre-energization inspection and tests are successfully completed, the following examination/verification must be performed.

Post-energization/verification must be performed as well as standard checks as described in the instruction manual. Only certified technicians with the appropriate safety and testing equipment are allowed to energize the transformer.

A. **Voltage verification** – prior to loading the transformer, verify that the secondary voltage output is correct. Confirm that the low voltage is correct by utilizing an AC voltmeter. Measure the voltage and verify this agrees with the secondary voltages as indicated on the nameplate.

B. **Leaks** – verify by walking around the tank and compartment and carefully examining that there are no leaks.

C. **Operation** – verify after the transformer is loaded that there are no abnormalities observed such as excess noise, vibration or even heating.
When the transformer is energized, the transformer will make a humming noise. For allowable noise levels, please ***refer to NEMA Standards Publication TR-1***.
If the transformer makes extreme or irregular sounds, this must be investigated, as this may show a potential issue. Always contact WEG in these situations!

D. **Gauges** – verify liquid level gauge and temperature gauge indicate the correct level and temperature.

E. **High Voltage/Low Voltage Compartment,** ensure that all compartments, boxes, and security covers are closed and padlocked.

SECTION G
SWITCHING OPERATION

The directions given in this section are for the switching operation of devices installed on the transformer. This section serves as a general guide only. Please note that these guidelines do not address every conceivable application or circumstance that might be encountered with the product or its installation.

The certified technician should acquaint himself with all warning and instruction labels attached to the installed/optional device and the transformer.

The devices considered in this instruction manual are optional features and may not be included in all WEG transformers.

Tap Changer

The device specifically used to change the general ratio of the transformer. The tap changer setting is controlled through the tap changer rotating knob or handle situated inside the terminal compartment of the transformer. **This switch is for de-energized operation only!**

DO NOT use tap changer to operate at secondary voltage outside nameplate rating.

NEVER operate the tap changer with an energized transformer

Rotary Tap Changer

The rotary tap changer will have a hot stick operable handle, please ***refer to Figure 2.***

Figure 2 – Rotary Tap Changer

Before the handle can be operated, the lock screw must be backed out to clear the index plate.

Next, the handle must be pulled out to clear the index plate and rotate the handle to desired position.

The pointer must drop into the slot of the index plate. If the pad lockable feature is used, tighten lock screw until it bottoms out. Padlocking may then be accomplished through the hole provided.

Linear Tap Changer

If a linear tap changer (TC) is provided, the knob has each position marked precisely, please ***refer to Figures 3 & 4***. A linear type tap changer switch is available with either a knob type-operating handle or a hotstick operable handle.

Figure 3 – Linear TC with Knob Handle

To operate the switch, the notch must first be released by pulling the control knob outwards.

Then turn to the new position as it falls back automatically into its respective notch, please ***refer to Figure 3***.

To prevent unauthorized operation, it is possible to install a padlock between the control knob and the positioning ring.

Figure 4 – Linear TC with Hotstick Handle

The tap changer knob might also be modified to be operated with a hotstick, please ***refer to Figure 4.***

When in place, the padlock prevents pulling the control knob to operate.

The tap changer is set at the factory in the **nominal voltage position, unless otherwise specified by the purchaser**. All tap position indexes are clearly indicated on the nameplate attached to the transformer.

Series Multiple Switch or Delta Wye Switch

If required by the customer for a specific application, the transformer may be equipped with a dual voltage or triple voltage switch provided as indicated on the nameplate of the transformer, please ***refer to Figures 5 & 6***.

For transformers with re-connectable delta/wye windings, a delta/wye switch is provided as indicated on the nameplate of the transformer.

Switch positions are clearly identified on the transformer nameplate and marked by corresponding numbers on the switch mounting plate. The switch is locked in one position by a setscrew that passes through the switch handle and enters a matching hole in the mounting plate.

To operate a rotary type multi-voltage switch (***see Figure 5***):

1. Release the locking bolt and back it out until it clears the position hole.
2. Rotate the switch handle 90-degrees. Line up the locking screw with the desired position hole.
3. Tighten the setscrew until it seats firmly in the position hole.

Figure 5 – Rotary multi-voltage switch

To operate a linear type multi-voltage switch (***see Figure 6***):

1. The locking notch must first be released by pulling the control knob outwards.
2. Then turn the knob to the new position as it falls back automatically into the respective notch.

Multi-Voltage Switches and Delta/Wye switches must only be operated under de- energized conditions. Carefully note the default factory setting of each switch. Dual voltage windings are either connected in series (for the higher voltage) or in parallel (for the lower voltage). Dual voltage and delta-wye switches have two positions. To prevent unauthorized operation, it is possible to install a padlock between the control knob and the positioning ring. When installed, the padlock prevents pulling the control knob to operate the switch.

Figure 6 – Linear multi-voltage switch

NEVER operate the switch with an energized transformer

Load Break Switch

The transformer can be supplied with multiple under-oil load-break switch arrangements, these can be:

A. One two-position (ON-OFF) switch or radial feed switch, which can be used to de- energize the transformer and is designed for load interruption
B. One four or three-position sectionalizing switch for use as a combination of the loop and radial switch functions. Selection of various connection schemes allows a variety of switching possibilities.
C. Two or three two-position switches, which can be used to individually energize each side of the loop, and/or de-energize the transformer

Refer to specific nameplate schematic to verify circuit-switching conditions.

Switch location and positions are clearly indicated on the nameplate of the transformer.

The switches CAN ONLY be operated by attaching a hot-line tool to the external hook eye handle and rotating either to the “ON” or “OFF” position.

Transformers use conventional transformer oil or FR3™ fluid for an insulating liquid. When the insulating liquid temperature is less than -20 °C (-4 °F) for conventional transformer oil or less than -10 °C (14 °F) for FR3™ fluid, the increase in fluid viscosity may reduce make and break capabilities of loadbreak devices. Below these temperatures, under-oil loadbreak accessories should not be used to make or break a load. **Instead, de-energize transformer from a remote upstream source before operating under-oil loadbreak devices.**

SECTION H
PROTECTION

Fuses

The following section includes a variety of possible fuse arrangements that may be selected by a customer and included in a WEG transformer. A blown fuse may be an indication of a faulty transformer. **NEVER** replace the fuse without root cause analysis of what transpired and proper correction of the situation.

> All fuses must be operated within their specific ratings, have equivalent voltage, and time current characteristics per the OEM supplier. If in doubt always, contact WEG.

Please refer to the nameplate attached to the transformer for the specific fusing arrangement included in the transformer. For an example of a fusing arrangement as shown on a transformer nameplate, please ***refer to Diagram 1.***

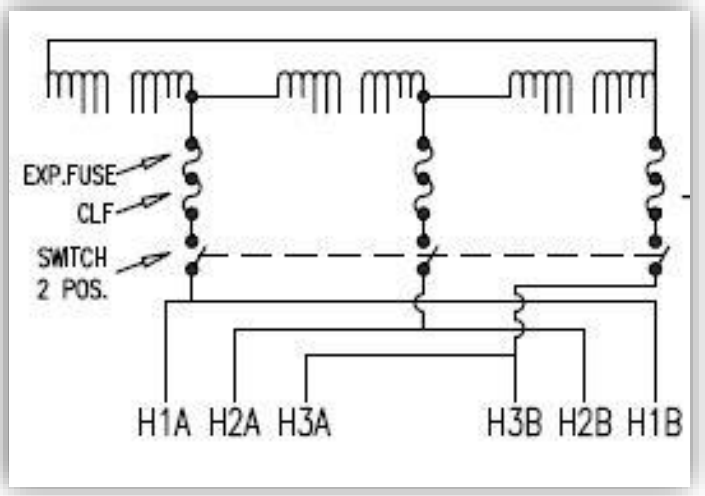

Diagram 1 – Example of Fusing Schematic

A. Expulsion Fuse

Your transformer may be equipped with expulsion type fusing. If equipped with an expulsion type fuse, then it will be one of the two below listed fuse types:

Bayonet Fuse

The Bayonet fuse design is an expulsion type fuse and is tank sidewall mounted. It protects from overload currents, secondary faults and potentially high temperatures depending upon the selected fuse, please ***refer to Figure 7***.

They are designed to allow the cartridge to be easily field replaceable without accessing the main oil compartment. A bayonet type fuse will never exist by itself. It will always be paired either with an isolation link or an under oil current limiting type fuse.

Figure 7 - Bayonet Fuse

RE-FUSING PROCEDURE

For re-fusing procedure follow the below steps:

STEP 1 – Relieve Tank Pressure

If transformer tank has a pressure relief valve, use hotstick and complete the following steps to relieve tank pressure:

- Pull pressure relief valve open, keeping it held open for 30 seconds after pressurized air can no longer be heard evacuating audibly through the valve.
- Close pressure relief valve and wait 30 seconds.
- Pull pressure relief valve open. Keep it open until audible pressure stops and hold it open for an additional 5 seconds. Pulling the valve open again allows any residual pressure to be removed from the tank.

STEP 2 – Unlock Fuse Holder

- Standing to one side of the transformer, attach hotstick to fuse holder eye and twist hotstick to unlock fuse holder.

STEP 3 – Break Seal

- Turn fuse holder 90° in the Bay-O-Net housing to break the seal between the seal gasket and the Bayonet housing.

STEP 4 – Draw Fuse Holder Out

- Draw the fuse holder out rapidly in one motion 6 to 8 inches only after the transformer is de-energized.
- Wait several seconds for fluid to drain.

STEP 5 – Remove Fuse Holder from Bayonet Housing

- Remove fuse holder from Bayonet housing.
- Wipe off fuse cartridge holder and fuse cartridge using a clean cloth.

STEP 6 – Remove Fuse Cartridge

- Use a 3/4 inch wrench to remove fuse cartridge from fuse cartridge holder.
- Carefully inspect the fuse cartridge.

STEP 7 – Remove End Plug and Fuse Link from Fuse Cartridge

- Use 3/4 inch and 1/2 inch wrenches to remove end plug.
- Use screwdriver or other tool to straighten the tulip tip end of fuse link and push fuse link out of fuse cartridge.

STEP 8 – Insert Replacement Fuse Link into the Cartridge

- A slight resistance may occur when inserting fuse link into cartridge.
- If the catalog number of the fuse being replaced is not known or is illegible on the fuse, consult equipment specifications or manufacturer.

STEP 9 – Tighten Cartridge to Fuse Cartridge Holder

- Tighten fuse contact flare end against fuse cartridge holder using 50- 70 in-lbs torque.
- Replace end plug on other end of fuse cartridge and tighten to 50-70 in-lbs torque
- Remove end plug and ensure that leaves of tulip tip have spread uniformly.
- Replace end plug applying 50-70 in-lbs torque to both connections.

STEP 10 – Check Liquid Level

- The fluid level in the transformer should be approximately at the base of the protruding plastic threads of the bayonet housing at 25° C with the transformer on a level surface.

STEP 11 – Install Fuse Holder

- Pull pressure relief valve, keeping it held open until audible pressure evacuation stops and then hold open for another 5 seconds.
- Attach end of fuse holder assembly to hotstick and insert holder assembly firmly into the Bayonet housing.

Ensure that the replacement fuse matches the original fuse that was provided with the transformer. If in doubt contact WEG.

Weak Link Fuse

The weak link fuse is an older technology consisting of a copper or copper alloy fuse element in a tube cartridge, please ***refer to Figure 8***. This type of fuse is designed to protect the circuit from transformer overloads and low current faults.

Figure 8 - Weak Link

In most cases, these fuses are used in series with an under oil current limiting fuse. However, weak link fuses can be used alone. These fuses are also known as zero waiting fuses as they extinguish the arc as the fault current passes through the natural current zero.

This type of fusing is an under oil type expulsion fuse. Therefore, replacement requires access to the main oil compartment through a bolted cover or handhole.

RE-FUSING PROCEDURE

For re-fusing procedure follow the below steps:

STEP 1 – De-Energize the Transformer

STEP 2 – Ensure All Terminals Are Grounded

STEP 3 – Relieve Tank Pressure

If transformer tank has a pressure relief valve, use a hotstick and complete the following steps to relieve tank pressure:

- Pull pressure relief valve open, keeping it held open for 30 seconds after pressurized air can no longer be heard evacuating audibly through the valve.
- Close pressure relief valve and wait 30 seconds.
- Pull pressure relief valve open. Keep it open until audible pressure stops and hold it open for an additional 5 seconds. Pulling the valve open again allows any residual pressure to be removed from the tank.

STEP 4 – Remove Tamper Resistant Cover

- The tamper resistant cover located on the tank cover

STEP 5 – Remove the Handle

- When removing the handhole, please ***refer to Section J – Maintenance.***

When a weak link type fuse has operated, debris has likely been emitted from the fuse during operation. After replacing the fuse, the oil is recommended to be reprocessed/ filtered to ensure removal of small particles.

A. Internal Current Limiting Fuse

The partial range current-limiting fuse is a back-up fuse designed to reduce the energy during high fault situations. This reduction in energy and limiting of total fault current reduces the risk of catastrophic failure or events. The fuse is always used in series with an expulsion fuse to provide full range protection. This fuse is designed to clear high-current faults (up to 50,000 amperes symmetrical) and the expulsion link to clear low current faults. These fuses are located under oil beneath the transformer hand hole. Either internal expulsion fuses or "bayonets" are available as the series expulsion fuse. The bayonet or the internal expulsion fuse is available for replacement. ***Refer to individual sections on these fuses for instructions***. The CL fuse is not available for replacement without removing the main tank hand hole cover.

RE-FUSING PROCEDURE

For re-fusing procedure follow the below steps:

STEP 1 – De-Energize the Transformer

STEP 2 – Ensure All Terminals Are Grounded

STEP 3 – Relieve Tank Pressure

If transformer tank has a pressure relief valve, use hotstick and complete the following steps to relieve tank pressure:

- Pull pressure relief valve open, keeping it held open for 30 seconds after pressurized air can no longer be heard evacuating audibly through the valve.
- Close pressure relief valve and wait 30 seconds.
- Pull pressure relief valve open. Keep it open until audible pressure stops and hold it open for an additional 5 seconds. Pulling the valve open again allows any residual pressure to be removed from the tank.

STEP 4 – Remove Tamper Resistant Cover

- The tamper resistant cover is located on the tank cover

STEP 5 – Remove Handhole

- When removing the handhole, please ***refer to Section J – Maintenance.***

Operation of the internal current limiting fuse, may indicate internal fault conditions. Current limiting fuse can only be replaced after verification of all internal components and assuring these are in good condition

B. Surge Arresters

At the option of the purchaser, the transformer may be equipped with surge arresters to protect the transformer from overvoltage surges. Surge arresters can be mounted in the high-voltage or low-voltage compartment or even internally under oil.
The surge arresters must be sized and installed based upon the design of the electrical distribution system connected to the transformer. The proper selection of the surge arrester ratings will be based upon the electrical systems maximum operating voltage and grounding conditions.

During steady state conditions, line-to-ground voltage is applied continuously across the arrester terminals. If surges occur, the arrester immediately limits the overvoltage to the required protective level by conducting the surge current to ground. Upon passage of the surge, the arrester returns to its initial state and conducts minimal leakage current.

NOTE: Maximum continuous operating voltage to ground (MCOV) of the **system** MUST be less than the MCOV rating of the arrester installed on the transformer.

When the transformer is equipped with surge arresters strictly follow the application and instruction of the OEM supplier for the surge arresters zero voltage.

a) **Under Oil Arresters** – The transformer may be equipped with internal under oil metal-oxide-varistor (MOV) surge arresters. A means of disconnecting and reconnecting an internal under-oil arrester is provided through a switch or switch plunger.

b) **Dead Front Type Arrester** - if the transformer has dead front type bushings (bushings wells with inserts or integral loadbreak or non-loadbreak bushings), the transformer may be equipped with a dead front type arrester. Elbow arresters plug directly onto a high voltage bushing and provide a means of protection. Bushing surge arresters also plug directly onto a high voltage bushing. However, bushing surge arresters also include an integral high voltage connection point in order to not block your current connection point while still providing over-voltage protection. Dead front type arresters are always shipped separately on the pallet and require installation upon arrival to the site. If replacement is required or if a need for arresters arises, then be sure to match the arrester with your bushing interface type.

c) **Live Front Arresters** - If your transformer has porcelain or epoxy bushings with live front spade, eyebolt or stud type terminals, the transformer may be equipped with live front type arresters. These arresters will be installed on the transformer at the factory and will be grounded to the tank with the appropriate wire size. When specifying these arresters, be sure the fault current withstand rating of the arrester matches the fault current expected on the system. Fault ratings increase in order of distribution class normal duty, distribution class heavy duty, intermediate class, and Station class. There are also custom fault ratings you can specify within each class.

If induced-voltage tests, applied voltage tests, low frequency tests, power factor tests and insulation resistance tests are to be performed on a transformer equipped with arresters, then

the arresters must be disconnected during the test and reconnected after the test is completed. Surge arresters should also be disconnected before cables are hi-pot tested. When arresters are mounted internally, a switch for disconnecting them is provided for this purpose.

On a dead-front transformer (high voltage and/or low voltage), make sure all bushings are clean and dry. Apply dielectric grease to dead front high voltage bushings prior to connecting elbow connectors.

Follow the manufacturer's instructions and warnings on the use of these terminations.

DO NOT operate the molded case breaker below the temperature as specified by the OEM supplier for the molded case breaker.

SECTION I
ACCESSORIES

Your transformers may be equipped with the accessories as described in this section; some accessories might be optional and may not be listed in the instruction manual.

Certain optional accessories are provided due to compliance with National Standards as well as to the IEEE Standard C57.12.34.

Figure 9

Liquid Temperature Gauge

Figure 9 is a dial-type bi-metal instrument that measures liquid temperature in degrees and includes a resettable maximum temperature indicator. The temperature gauge is mounted in a dry liquid-tight well for easy replacement.

The red maximum temperature indicator can be reset by turning the magnet at the faceplate center towards the white indicating pointer.

As an optional feature, liquid temperature gauges can be provided with one (1) or more switch contacts to allow for remote indication of abnormal/unacceptable temperature or to control cooling fans installed on the transformer.

Figure 10

Pressure Vacuum Gauge

Figure 10 is a dial-type instrument that measures the pressure in the gas space of the transformer's tank relative to the atmospheric pressure of the environment where the transformer is installed.

As an optional feature, the pressure vacuum gauge can be provided with one (1) or two (2) switch contacts for remote indication of high or low-pressure levels.

Figure 11

Liquid Level Gauge

Figure 11 is a gauge that indicates the dielectric fluid level in the transformer tank and is mounted inside a compartment. If the gauge indicates a "LOW" fluid level, then the transformer must be de-energized and inspected to determine the cause of the low liquid level. A low liquid level can lead to dielectric failure, overheating of the transformer and a reduction in its life expectancy.

As an optional feature, the liquid level gauge can be provided with one (1) or more switch contacts for remote indication of low or high dielectric fluid levels.

Liquid Level Sight Gauge

Figure 12

Transformers may be equipped with a sight glass that gives an approximate indication of the dielectric fluid level at 25°C liquid temperature, please ***refer to Figure 12***.

Unless otherwise specified by the customer, the fluid level will appear at the center of the glass when the transformer fluid is at 25°C.

Pressure Relief Device

Figure 13

Also known as, the (PRD) is intended to relieve extreme levels of tank pressure. The device comprises of a self-resealing, spring-stacked valve. The PRD can also include a re-settable visual indicator to demonstrate that the valve has operated. PRD's are generally mounted on the cover of the transformer tank. Please ***refer to Figure 13***.

As an optional feature, the PRD can be provided with one (1) or two (2) switch contacts for remote indicate of valve actuation.

Winding Temperature Indicator

Figure 14

Approximates the winding temperature with a thermometer installed in a thermal plate, please ***refer to Figure 14***. The thermal plate includes a thermowell heated to the winding hot spot temperature rise above the liquid temperature rise. A heater coil in the thermowell is supplied with a proportional current output from a bushing current transformer connected to the bushing of the winding being measured. For distribution transformers, this is typically the X2 low voltage bushing and winding.

A red maximum temperature indicating pointer and up to 4 user adjustable switches can be provided.

Internal Fault Detector

Figure 15

Also known as the (IFD), is a sensor that detects and indicates internal arcing faults in the transformer, please ***refer to Figure 15*** The sensor releases a highly visible orange signal indicating the transformer has an internal fault.

The IFD also functions as a pressure relieve valve. To manually relieve pressure you only need to pull on the pull ring shown in the photograph.

Drain Valve and Sampling Device

Figure 16

This device is located in a compartment at the base of the tank, please ***refer to Figure 16***. It is used for taking samples of the dielectric fluid for testing, for draining the dielectric fluid should this be required, and for oil processing in the field if required.

When sampling the dielectric fluid, strict sampling procedures must be followed to avoid contaminating the oil and producing false readings.

Small Pressure Relief Valve

Figure 17

The transformer may be equipped with a small mechanical over pressure protection device, please ***refer to Figure 17***. This device provides pressure relief on transformers during over pressure conditions and automatically resealing once pressure has fallen.

This device is also used to manually vent the transformers when required prior to oil filling or opening the tank for inspections.

Current Transformers

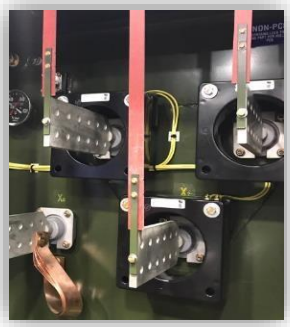

Figure 18

Transformers can be equipped with bushing current transformers (CTs) that are slipped over low-voltage bushings for metering or relaying applications, please ***refer to Figure 18.***

By default, the CT leads are connected to a shorting type terminal block on the compartment barrier or to terminals in the meter panel. If neither of these options are provided, then the CT leads will be shipped with the pins on the CT shorted. The CT leads **must** remain shorted and grounded to keep away from dangerous voltage build up at the CT terminations.

Parking Stands

Figure 19

Parking stands in the high voltage compartment are provided on dead-front transformers to accommodate the portable feed-through insulated bushings when not connected, please ***refer to Figure 19.***

Flip-Top Terminal Compartment Cover

Figure 20

The transformer may be equipped with a flip-top compartment cover that can be raised for easier access to the Bay-O-Net fuse holders or for additional access for cable installation, please ***refer to Figure 20***.

To open the top of the compartment, first open the compartment doors and then withdraw the inside lifting lever from its latching point. Push the top up to the desired position and securely seat the locking lever into the latching point.

Compartment Door Handle, Security Bolt and Padlock

Figure 21

Each transformer has a compartment equipped with a high voltage and low voltage door. The compartment is tamper resistant constructed and designed complying with the IEEE Standards C57.12.28 or C57.12.29, please ***refer to Figure 21.***

The low voltage compartment door interlocks with the high voltage compartment door and is provided with a door security bolt that must first be loosened before being able to open the compartment door. The high voltage compartment door is provided with two (2) additional security bolts that must be loosened before the door can be opened.

The penta-head bolt fits in a standard penta-head socket (wrench) as available in the utility industry.

Other Accessories

Certain transformers might be provided with critical optional devices such as SCADA systems and non-standard busbar systems not mentioned in the instruction manual as these are application specific. If this is the case, contact WEG Transformers USA.

SECTION J
MAINTENANCE

These instructions are a general guide for the maintenance of the transformers as described in this instruction manual. Although special care has been given to accuracy and completeness, these guidelines in the instruction manual do not address every conceivable application or circumstance that might be encountered.

Transformers should be inspected periodically while in service, with the frequency determined by service conditions. Transformers operating in unusual service conditions should be inspected more frequently, please ***refer to IEEE Standard C57.12.00*** for a discussion of usual and unusual service conditions.

Accessories such as a pressure relief device, temperature gauge, liquid level gauge, pressure-vacuum gauge and drain valve typically require no maintenance, except replacement in the event of damage. All gauges should be checked periodically to make sure they are operating properly.

WEG is suggesting visual inspection of each stored transformer. During each inspection, the general condition of all elements and devices of the transformer shall be observed and corrected if required

Internal Inspection

For access, clean thoroughly the tank cover and remove the handhole cover. Place the handhole gasket bolts and washers in storage for re-use. Examine the underside of the cover for signs of moisture. Look inside the transformer for blown fuses, broken leads, or loose parts. If the internal under oil “expulsion type” fuses are blown, they will eject particulates into the oil as a normal part of the arc-break function. In this case, it is recommended to replace the expulsion fuses at an appropriately equipped repair facility where the unit can have the core/coil assembly vacuum cleaned and oil reprocessed.

If any bushings are damaged, repair or replace per the hereafter indicated bushing maintenance procedure. If internal damage is suspected, the following procedure is recommended. Lower the liquid to the top of the core and carefully inspect the interior to see if any damage has occurred. Take an oil sample from the bottom of the tank. If moisture is found inside the tank. **WEG must be contacted to make determination on how to move forward!**

After inspection and repair, refill the unit with dry dielectric fluid to the 25°C level. Fill very slowly under a 3 PSIG vacuum or in a vacuum chamber. Do not use the tank as the vacuum chamber. If the unit cannot be filled under vacuum, fill it through the handhole directing the flow of oil in such a way to prevent aeration of the liquid.

Anytime the dielectric fluid level is lowered below the lead structure in the field and the unit cannot be refilled according to the standard fluid filling procedure, WEG recommends to streamline / hot oil process the unit for 24 hours minimum to eliminate any air bubbles. This process will also help to eliminate any gasses that may have been present if there was a failure or event.

Prior any internal maintenance inspection always follow all safety precautions, these are:

1. De-energize the transformer.
2. Make sure the dielectric fluid is at or below the 25°C level.
3. Vent the transformer.
4. Ground the transformer.
5. Prevent ingress of dirt and or moisture.
6. Adhere to all applicable OSHA and National Safety standards.

Exceeding 3 PSIG vacuum will make the tank collapse!

Bushing Maintenance

If required and warranted, lower the liquid level prior to bushing removal or inspection through the handhole. In all cases, the high-voltage bushings may be changed by removing the external clamp hardware and carefully pulling the bushing out. Access to the internal lead will allow it to be disconnected. Replace the bushing and carefully insert it back in its hole in the tank.

Low-voltage bushings may be replaced externally or through the main tank cover handhole. The bushing may be replaced externally by removing the clamps and pulling the bushing out of its hole. The lead hardware may be removed and the bushing can be changed. Be sure to install the hardware in the original sequence. The gasket must be located so that it will seal properly and not be damaged when repairing the unit.

Detachable Radiators

The transformer uses custom designed radiator assemblies to provide proper cooling for the specific design. Is your transformer shipped with detachable radiators, the following installation procedure must be followed:

Mounting

1. Unpack and check each radiator carefully; remove blind flanges (the inside should be dry, clean and free from foreign objects): clean gasket surfaces.

2. Prior removing the blind flanges make sure the throttle valves are closed (top and bottom valve
3. Clean the gasket surface of each throttle valve.
4. Mount the radiators (one by one) to the tank with the right side up (topside = lifting lug).
5. Always use new gaskets, tighten all throttle valve bolts and retighten after 24 hours. Using a small amount of a correct sealing compound will help to keep the gaskets in place during installation and will limit the risk for leaks.
6. Mount stiffener bars (if any) between the radiators.
7. Install the fans (if any) and connect the power control cables
8. If necessary, touch up the damaged/scratched radiator surfaces

Only left the radiator with the provided lifting lugs; never lift with the spot-welded side rods of the radiators as it may cause a radiator leak.

Filling

Radiator must be filled one by one once the radiator is attached to the tank.

Fill as follows:

1. Open the air-vent screw on the top of the radiator.
2. Partially open the lower throttle valve located on the tank.
3. Wait until oil escapes from the air-vent screw and close the air-vent screw immediately.
4. Completely open the upper and the lower throttle valve.

During this process, the oil level in the transformer tank must be checked regularly; the oil level may never be below the radiator inlet / highest point of the windings to avoid moisture, air, or gas ingress. For this reason, it could be necessary to fill-up oil immediately to safeguard the integrity of the transformer.

Removal

Prior removing the radiator it must be drained by following the below procedure:

1. Close **TOP** and **BOTTOM** throttle valves first prior proceeding with any other described radiator draining procedures.
2. Unscrew the protection cover of the drain plug
3. Make sure that the air vent is fully closed.
4. Unscrew the drain plug entirely and make sure that out coming oil does not drip on the ground.

5. After a while, the oil flow stops due to a vacuum created in the radiator.
6. Connect a flexible hose or another device to the drain plug so that oil spillage is avoided.
7. Remove the protection cover.
8. Open the air vent further by turning the screw in a counterclockwise direction.
9. Incoming air in radiator results in a rapid oil draining via the drain plug.
10. After draining :
    a. Close vent plug
    b. Remount protection cover of vent plug
    c. Close drain plug
    d. Remount protection cover of drain plug

Prior draining the radiator **ALWAYS** close **TOP** and **BOTTOM** throttle valves first prior proceeding with any other described radiator draining procedures as otherwise it main drain the dielectric fluid.

When the radiator need to be detached from the tank, follow the below procedure:

1. Remove the fans and fan supports and disconnect the power control cable if any
2. Verify if radiator is drained and verify bottom and top throttle valve is closed.
3. Unscrew the four (4) nuts on each throttle valves.
4. Remove the radiators by lifting then at the lifting lug provided on each radiator.
5. Place a blank flange on the throttle valves of the transformer when the radiator is removed for longer than 1 hour. If the radiators are to be used again, provide them also with a blank flange

ALWAYS make sure that **TOP** and **BOTTOM** throttle valves are closed as otherwise it main drain the dielectric fluid into the environment.

When mounting or removing the radiator make sure no debris or foreign object is entering in the transformers as it will contaminated live parts resulting in severe personal injury or even death!

Refilling after Repairs

After repairs have been completed, refill the unit under a small vacuum of 3 PSIG with dry dielectric fluid to the 25°C liquid level. When necessary to add or refill the transformer with dielectric fluid, the work must be done in a clean, dry room. When filling do not use a rubber hose, use an oil resistant hose**.**

Always follow the torque guidelines when replacing bushings; please ***refer to Section L*** - ***Tables and Procedures*** for recommended torque values.

Dissolved Gas Analysis (DGA)

IEEE does not have a standard for DGA levels in distribution transformers. However, DGA's can be a very important tool to diagnose the health of a transformer and samples taken over time can certainly show trends of a transformer's health. Interpretation of DGA results is not an exact science, but is subject to variability.

DGA samples can be affected by welding on the tanks or the operation of a load break switch or fuse. In the manufacturing process, units that are welded on after filling with dielectric fluid do see a slight generation of gases due to heating of the fluid inside the tank. It is important to know if units have had any weld repairs or modifications as they can cause DGA increases.

Taking dielectric fluid samples for DGA does reduce the liquid level in a transformer, especially in smaller distribution transformers. Generally speaking, a 2000 kVA transformer can have 4 or 5 samples taken without causing an issue with low dielectric fluid. Caution needs to be used to insure proper fluid levels are maintained when taking many samples from a unit.

Operating a transformer with excessive harmonics or beyond nameplate ratings will cause gas levels to increase.

The following guidelines are used to evaluate a transformer, please ***additionally refer to IEEE C57.104*** for in depth analysis:

Status	H2	CH4	C2H2	C2H4	C2H6	CO	CO2	TDCG
Condition 1	900	250	5	250	100	700	4000	1400
Condition 2	901-2000	251-1200	6-50	251-1500	101-700	701-1000	4001-7000	1401-4600
Condition 3	>2001	>1201	>50	>1500	>700	>1000	>7000	>4601

H2 Hydrogen, CH4 Methane, C2H2 Acetylene, C2H4 Ethylene, C2H6 Ethane, CO Carbon Monoxide,CO2 Carbon Dioxide, TDCG Total Dissolved Combustible Gases

H2 and CH4 will naturally increase over the life of a transformer.
C2H6 will be substantially higher in FR3 filled transformers, but will stabilize over time.

Condition 1: Transformer is operating in a satisfactory manner.
Condition 2: Transformer has greater than normal combustible gas concentrations. Any individual combustible gas exceeding specified levels should be investigated.
Condition 3: Transformer has a high level of decomposition. Any single combustible gas exceeding these levels should be investigated immediately. Immediate action to establish a trend, as faults are probably present. The transformer manufacturer should be contacted.

When drawing samples from the bottom of the transformer, draw sufficient liquid off to ensure that the sample will be from the bottom of the tank, and not the liquid stored in the sampling pipe that can include condensation and sediments.

Always vent the transformer prior to taking samples of dielectric fluid. Never take oil samples while the transformer tank pressure is below 0 PSI relative**.**

Only take dielectric fluid samples when the transformer is warmer than the surrounding air to avoid condensation of moisture inside the tank. ONLY draw samples from the sampling valve located at the bottom of the transformer tank. Always vent the transformer tank by use of the pressure relief valve, located in the compartment, prior to taking a sample of dielectric fluid.

For sampling, a clean dry bottle is required. Rinse the bottle three (3) times with the liquid being sampled. Make sure the liquid being sampled is representative of liquid in the transformer.

Samples of dielectric fluid should ONLY be taken after the liquid has settled for some time, up to several days for a large transformer (2000 kVA and above) that has not been energized. Cold insulating liquid is much slower in settling. If the transformer is or has been operating, dielectric fluid samples can be taken at any time. Liquid samples from the transformer should be taken from the sampling valve at the bottom of the tank.

DO NOT energize the transformer unless it is filled with dielectric fluid. If it should be necessary to add or replace the dielectric fluid in the transformer, only use clean, dry fluid having a minimum dielectric strength of 30 kV and less than 1 ppm PCB's. Make sure before filling that the transformer is sufficiently cooled down to ambient temperature to eliminate the possibility of moisture condensation from the air.

After taking fluid samples, ALWAYS verify dielectric fluid level prior to energization.

External Finish Maintenance

Examine the external condition of the transformer at regular intervals. If it is found that weathering is taking place, then the surface should be cleaned thoroughly and repainted with a high-grade durable paint as recommended by WEG.

Spare Parts

Orders for spare parts may be placed by describing the part and giving the rating and serial number appearing on the nameplate of the transformer.

For quick handling and/or resolution of your needs or non-conformances, always when emailing **WTU-Service DT@weg.net** , provide the following information:

1. Transformer serial number as indicated on the nameplate.
2. Transformer model number as indicated on the nameplate.
3. Figures of the finding(s).
4. Description of the finding(s).

All Inspection check lists, long term and short term storage check lists, as well as non-conformance forms can be downloaded from our web site: www.weg.us

SECTION K
FIELD ACCEPTANCE TEST GUIDELINES

Before listing guidelines for field acceptance tests, it may be helpful to first describe the routine tests provided at the factory. Your new transformer comes from the factory electrically tested per the latest IEEE standards and any special testing specified by the customer.

Routine Tests

The IEEE routine tests for a distribution transformer include the following:

- Transformer turns ratio (TTR) on all tap positions on the HV and LV windings. This test verifies that the coils have the proper number of turns required.
- Winding vector and polarity are tested and checked to verify it matches the nameplate vector diagram. This test verifies that the unit is wired correctly.
- Winding resistance testing of the HV and LV windings on their rated voltage positions. This test verifies that the unit has sufficient electrical connections.
- Lighting impulse testing on the HV windings. This test verifies that the transformer can withstand the prescribed electrical stresses (lead to lead, winding to winding, turn to turn, layer to layer, and phase to ground).
- Applied voltage testing on any floating winding. This test verifies that the transformer can withstand prescribed electrical stresses winding to ground.
- Induced voltage testing at either two times rated voltage or 3.46 times rated voltage plus 1000 volts on the HV if the HV winding is internally grounded. This test verifies that the transformer can withstand the prescribed electrical stresses (lead to lead, winding to winding, turn to turn, and layer to layer).
- Core loss and excitation current testing to verify the unit meets efficiency standards per IEEE, DOE, and customer specific requirements.
- Winding loss and impedance testing to verify that the unit meets the efficiency standards of IEEE, DOE, and customer specific requirements.
- Pressure leak check at 5 PSI for 24 hours to verify the tank is hermetically sealed.
- Function check of installed devices.

Field Acceptance Tests

The most commonly performed field acceptance tests include the following:

If you choose to do any acceptance testing be sure to have personnel that are qualified and trained in high voltage testing practices as hazardous voltages and currents will be present during testing.

Transformer Turns Ratio (TTR)

TTR testing can give an indication of the health of a transformer with the following:

- The ratio of turns from the high voltage winding compared to the low voltage winding.
- Single-phase excitation of the transformer winding to give an indication of a shorted coil. TTR test exciting current should be approximately within 10% between phases.
- Indicates the wiring inside the transformer matches the nameplate wiring diagram and vector.
- Can show an open circuit, or a high resistance connection on one of the three phases or neutral.

When performing this test, please be aware of the following items that can cause invalid test readings:

- Switches not in the proper position: Load break, delta/wye, dual voltage, H0X0. Verify load break switches are closed. Verify Delta / Wye or dual voltage switches are in the proper position. Verify tap changer is in proper position. Verify reading to calculated nameplate ratio. Match data to transformer test report.
- Bay-o-net fuses not installed into the transformer.
- Operated (blown) fuses

Winding Resistance

A winding resistance test will verify that there is a complete circuit between bushings through the transformer windings. When performing the test the values should match the tested winding resistance from the factory.

If the transformer test report is unavailable, a general rule of thumb is that when winding resistance values are compared from one phase of a transformer to another they should be within 5% of each other. Please note that the design of padmount distribution transformers inherently lends itself to have unequal lead lengths due to the required bushing arrangement. These unequal lead lengths can increase variation in winding resistance. It is possible that variations greater than 5% between phases could still match factory test results and be acceptable. Winding resistance values must be corrected to a uniform temperature for accurate comparisons to be made.

The transformer under test must always be demagnetized before putting into service. A magnetized core can cause severe switching currents upon energization due to the core's natural opposition to receive magnetic energy in the magnetized state.

When performing this test, please be aware of the following items that can cause invalid test readings:

- Switches not in the proper position: Load break, delta/wye, dual voltage, H0X0. Verify load break switches are closed. Verify Delta / Wye or dual voltage switches are in the proper position. Verify tap changer is in proper position. Verify reading to calculated nameplate ratio. Match data to transformer test report.
- Bay-o-net fuses not installed into the transformer.
- Operated (blown) fuses.
- Not allowing the test equipment to operate long enough to settle on a stable resistance reading.
- Improper temperature correction factor used or none used at all.

Insulation Resistance (Megger)

Insulation resistance tests (also commonly referred to as “Megger” tests) should be done before putting the transformer into service, and at periodic intervals throughout the transformer’s life cycle. Please note that measured values do not have absolute pass/fail criteria, as tested values for duplicate transformers will vary considerably. Test results for an individual transformer should be trended over time.

Before performing the test, verify bushing insulators are clean and dry as debris and moisture can affect the insulation resistance readings. Testing in humid conditions can also affect the insulation resistance readings.

When performing this test, please be aware of the following items that can cause significant variation in test readings:

- Insulation resistance results need to be done at the same voltage test level for subsequent tests to have comparable results.
- Insulation resistance results need to be temperature corrected to be a comparable result.
- Units filled with FR3 dielectric fluid will naturally have lower insulation resistance values compared to units that are filled with mineral oil.

Insulation Power Factor (Doble, Dissipation Factor, Tan Delta)

Power factor tests should be done before putting the transformer into service, and at periodic intervals throughout the transformer’s life cycle. Measured values do not have absolute pass/fail criteria, as tested values for duplicate transformers will vary considerably. Test results for an individual transformer should be trended over time.

Before performing the test, verify bushing insulators are clean and dry as debris or moisture can affect the insulation power factor readings. Testing in humid conditions or freezing conditions can also significantly affect the insulation power factor readings.

Please keep the shorting wire a minimum of 5 inches away from protrusions on the tank.

When performing this test, please be aware of the following items that can cause significant variation in test readings:

- The capacitance measurement from the insulation power factor test can show shifts in transformer leads if a substantial capacitance change is noticed from subsequent tests.
- Units filled with FR3 dielectric fluid will naturally have lower insulation power factor values compared to units that are filled with mineral oil.
- If the unit is equipped with a core ground bushing, ensure the core ground is connected while performing the test.

Single Phase Excitation

Single-phase excitation is a test to verify the exciting current of each phase of a coil. Test results should be within 10% phase to phase.

Single Phase Excitation results need to be done at the same voltage test level for subsequent tests to have comparable results. Only results in the same tap position are comparable. The transformer core must be demagnetized before doing any single-phase excitation tests.

Single-phase excitation is typically done if there is a suspicion of a transformer fault, but the transformer turns ratio test does not show an issue. This is because single-phase excitation is typically done at a voltage level substantially higher than transformer turns ratio testing.

Oil Quality

Oil quality tests can be done during commissioning testing. If oil samples are taken, they should be done at yearly intervals. Please try to follow the requirements of ASTM Standard D 923, Standard Practices for Sampling Electrical Insulating Liquids. Depending on the size of the transformer, the amount of oil taken from the unit may need to be replaced after an oil sample is taken since taking an oil sample on a small unit can cause an insufficient oil level in the transformer. Oil samples should be taken from the drain valve of the transformer. The transformer should not be under vacuum when attempting to take an oil sample. A minimum of three gallons of oil needs to be drained from the transformer to get a good representative oil sample. It is best to remove the plug at the end of the drain valve and use a reducer plug to connector to the hose used for oil sampling. The oil sampling hose should be made of an oil compatible material such as Tygon® tubing. Do not use a standard rubber hose as the pores of the rubber could introduce moisture into the sample.

If there is a question regarding an oil sample test result, then a second sample should be taken to confirm the result. Oil quality test results should be trended over time.

SECTION L
TABLES AND PROCEDURES

External Electrical Connections

Line connections must be made in a manner not to place undue strain on the bushings. For recommended minimum electrical clearances, please ***refer to Table 1*** below.

Table 1 – Electrical Clearance		
RATED kV **LINE-TO-LINE (MAX)**	**CLEARANCE** **LINE-TO-GRD (INCHES)**	**CLEARANCE** **LINE-TO-LINE (INCHES)**
1.2 2.5 5 8.66 15.5 25 34.5	1.00 2.00 2.50 3.50 5.00 5.75 8.00	1.00 2.00 2.50 4.00 5.50 6.25 9.00

Pressure Variation

Due to temperature variation and altitude variation of the installed transformer the transformer is subject to pressure variation. Specific pressure table calculator can be found at www.weg.us.

Torque Guidelines

Throughout the instruction manual, we refer to torque values. Tables 2 through 4 list recommended torque values for the installation of components commonly found on distribution transformers.

Table 2 - Bushing Installation Torque Guidelines		
Bushing Mounting Hardware	**Nominal Tightening Torque (in-lbs)**	**Torque Tolerance (in-lbs)**
3-Stud External Clamp or 3-Stud Integral Molded Bushing Flange	80	± 10
4-Stud External Clamp or 4-Stud Integral Molded Bushing Flange	144	± 12

Table 3 - Transformer Accessories and Fasteners Torque Guidelines		
Connection Type	**Nominal Tightening Torque (in-lbs)**	**Torque Tolerance (in-lbs)**
Bayonet Fuseholders (ABB)	110	± 10
Bayonet Fuseholders (Cooper / Eaton)	200	± 10
Bayonet Fuse Cartridge to Inner Fuseholder	60	± 10
Bayonet Fuse Cartridge End Plug	60	± 10
Drain Plug	2 - 3 Turns Past Finger Tight with Thread Sealant	
Drain Valve	2 - 3 Turns Past Finger Tight with Thread Sealant	
Fill Plug	2 - 3 Turns Past Finger Tight with Thread Sealant	
Pressure Relief Valve, Small	2 - 3 Turns Past Finger Tight with Thread Sealant	
Pressure Relief Device, Cover-Mounted	300	± 60
Rotary Tap Changer Switch Sealing Nut	100	± 20
Rotary Tap Changer Switch Index Plate Nut	56	-0, + 14
Linear Cable-Operated Tap Changer Switch (ASP or CAPT) Sealing Nut	864	± 60
Dual Voltage Switch	100	± 20
Loadbreak Switch Sealing Nut	1200	-0, + 120
Loadbreak Switch Handle Bolt	30	-0, + 30
4-Position Sectionalizing Switch Sealing Nut	600	± 120
Switch Viewing Window Fasteners	100	± 20
H0X0 Switch	100	± 20
Under-Oil Arrester Disconnect Switch	100	± 20
Stainless Steel Temperature Well	900	± 24
Handhole Cover Plate Fasteners	180	± 24
Bolted Cover Fasteners	180	± 24
Terminal Compartment (Cabinet) Fasteners	288	± 24
Pentahead or Hexhead Door Security Bolt	100	± 20
Ground Connector	144	-0, + 36

Table 4 - External Bushing Connections Torque Guidelines		
Connection Type	**Nominal Tightening Torque (in-lbs)**	**Torque Tolerance (in-lbs)**
5/8" Hex Jam Nut on Low Voltage Bushing	480	-120, + 0
1" Hex Jam Nut on Low Voltage Bushing	480	-120, + 0
High Voltage Bushing Well Insert	Per Manufacturer's Recommendations	
Copper or Aluminum Bus Bar to Bushing Spade Terminal with 1/2"-13 Steel Fasteners	540	± 60

Do not over-tighten any connection. Over-tightening can result in damage to the components and/or to the sealing gaskets resulting in dielectric fluid leakage

Despite the fact that WEG has endeavored to be clear in terms of fulfillment to address torque guidelines, please contact WEG Transformers USA for torque guidelines for any component not listed in these tables.

Cold Start-Up Procedure

The transformer is designed to have all bushings and switches as well as the core/coil assembly sufficiently immersed in dielectric fluid to maintain safe dielectric clearances even under very cold ambient temperatures (up to -50˚C).

Due to the lower liquid level during a cold start (i.e. energizing when ambient temperatures are below -20˚C), it will require some time before the radiators become fully effective at dissipating the heat generated in the coils.

Therefore, WEG does not recommend that the transformer be immediately fully loaded to nameplate rating; hence doing so will result in **loss of life of the transformer**!

To avoid loss of life for a transformer filled with mineral or FR3™ fluid, table 5 defines the cold-start process:

Table 5 – Cold Start Procedure

Elapsed Time	Time Applied	% Load	Instructions
Start-up + 8 hrs	8 hours	0	Energize the transformer, but do not apply any load for at least eight (8) hours
Start-up + 12 hrs	4 hours	25% Max	Gradually increase the applied load to a maximum of 25% of nameplate rating
Start-up + 16 hrs	4 hours	50% Max	Gradually increase the applied load to a maximum of 50% of nameplate rating
Start-up + 20 hrs	4 hours	75% Max	Gradually increase the applied load to a maximum of 75% of nameplate rating
Start-up + 24 hrs	4 hours	100%	Gradually increase the applied load to a maximum of 100% of nameplate rating

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