



**Southwest Electric Company**

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**INSTRUCTION MANUAL  
FOR  
INSTALLATION, OPERATION AND MAINTENANCE  
OF  
SPECIALTY TRANSFORMERS**

6501 Southeast 74<sup>th</sup> Street  
Oklahoma City, Oklahoma 73135, U.S.A.



**Southwest Electric Company**

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## DOCUMENT INDEX



## **DOCUMENT INDEX**

- 1. Installation & Operating Instructions**
  - A. Nameplate**
  - B. Tank Grounding**
  - C. Transformer Oil**
  - D. Opening Transformer**
  - E. Operating Limits**
  - F. Safety Precautions**
  - G. Maintenance**
  - H. Repairs or Service**
  
- 2. Shipping and Storage Instructions**
  - A. Shipping Damage**
  - B. Storing**
  - C. Lifting**
  - D. Tank Finish**
  
- 3. Material Safety Data Sheets**
  
- 4. Ratio and Polarity**
  
- 5. Megger Testing**
  
- 6. Oil Sampling**
  
- 7. Safety**
  
- 8. Warranty**
  
- 9. Disclaimer of Warranties and Limitations of Liability**



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## **INSTALLATION & OPERATING INSTRUCTIONS**



## **Installation & Operating Instructions**

### **A. Nameplate**

Refer to the transformer nameplate for the transformer ratings and for proper connections of the transformer to the system. No internal connections should be made inside the transformers.

**WARNING: THE TRANSFORMER MUST BE DE-ENERGIZED WHEN OPERATING THE TAP CHANGER. FAILURE TO DO SO COULD RESULT IN SERIOUS PERSONAL INJURY, DEATH OR PROPERTY DAMAGE.**

### **B. Tank Grounding**

The transformers are provided with a tank-grounding pad. When installing a transformer, the safest procedure is to make the ground connection first, the connection to the low voltage lines next and finally the high voltage connections, including those to protective devices, should be opened before removing the ground connections.

### **C. Transformer Oil**

These transformers are thoroughly dried at the factory by baking and then filled with dry, de-gassed, mineral oil, silicone oil, or R-temp. The oil is put into the tank after the transformer has been assembled and while the tank is under vacuum.

### **D. Opening Transformer**

Prior to placing in service, it should not be necessary to open up the transformer and inspect its interior. It has been carefully sealed and leak tested at the factory. It therefore should not be opened except for repairing damage.

**CAUTION: WHEN A TRANSFORMER IS OPENED USE CARE TO PREVENT ENTRANCE OF MOISTURE OR FOREIGN OBJECTS. WHEN THE TRANSFORMER IS CLOSED, IT MUST BE CAREFULLY SEALED TO PREVENT EITHER LEAKING OR BREATHING MOISTURE, DIRT OR FOREIGN OBJECTS IN A TRANSFORMER CAN WEAKEN THE INSULATION AND GREATLY SHORTEN ITS LIFE.**

## **E. Operating Limits**

The transformers described herein are designed for the applications and conditions normally encountered on electric utility power distribution systems. As such they are suitable for use under the "usual service conditions" described in ANSI C57.12.00 (General Requirements for Liquid-Immersed Distribution, Power and Regulating Transformers). All other conditions are considered unusual service and should be avoided unless specific factory approval is obtained. Specific considerations include:

1. Frequency should not be appreciably lower than rating, unless the transformer was design for such usage.
2. Voltage applied to the transformer should not exceed its rating by more than 5% while under full kVA rating or by more than 10% at no load.
3. Elevation at installation should not exceed 3300 ft. (1000 meters) above sea level unless the transformer was designed for higher elevations.
4. Continuous kVA load should not exceed rating. However, short time overloads do little damage to the transformer when the loadings recommended in ANSI Standards C57.91 are not exceeded.

## **F. Safety Precautions**

**WARNING: THE FOLLOWING PRECAUTIONS SHOULD BE FOLLOWED. FAILURE TO DO SO COULD RESULT IN SERIOUS PERSONAL INJURY, DEATH OR PROPERTY DAMAGE.**

1. When a transformer is to be worked on while installed on a platform, the primary fuse cutout should be open. Then the HV and LV bushing terminals should be grounded before the leads are disconnected from the high voltage bushings.
2. If a transformer is opened for any reason, care should be taken to prevent loose articles from falling into it. It must be kept free of moisture and re-sealed carefully to prevent breathing. The life of any transformer depends on the absence of moisture in the insulation.
3. Never operate tap changer when transformers are energized.
4. Carefully check the transformer nameplate for its rating and the connections that can be made to it.

5. Never lift or move the transformer except at the lifting ears.
6. Except where prohibited by codes or laws, transformer tanks should be grounded before the transformer is energized.
7. Measure the secondary voltage of transformers to be sure the output voltage is correct before connecting a load to the transformer.
8. Do not lay a transformer on its side. To do so can possibly cause air to be trapped under the bottom of the coils when the transformer is again put in the upright position. This air can get trapped in between the layer insulation and could cause a coil failure.

#### **G. Maintenance**

**WARNING: IMPROPER OR INADEQUATE MAINTENANCE COULD RESULT IN REDUCED TRANSFORMER LIFE, CAUSE SEVERE PERSONAL INJURY, AND DEATH OR PROPERTY DAMAGE.**

Distribution transformers can be stored outdoors for two years or less when not in service. However, for longer storage period it is recommended that procedures of ANSI C57.93 be followed.

If a transformer has been removed from service, it is recommended the following inspections be made and repairs made where necessary:

1. Inspect bushings for cracks and leaks.
2. Remove all rust from the tank and cover, prime the bare spots and then repaint them.
3. Inspect all gasket seals for possible leaks.
4. Check oil level. It should be within ½ inch below fill plug.
5. Check for signs of moisture entering the tank at any of the gasket joints.
6. If electrical tests are made, the values given in ANSI Standard C57.12.00 should not be exceeded.

#### **H. Repairs or Service**

If any information on how to repair or recondition these transformers is needed, please contact Southwest Electric Company.



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## **SHIPPING & STORAGE INSTRUCTIONS**





## **Shipping and Storage Instructions**

### **A. Shipping Damage**

All Distribution transformers should be inspected immediately upon receipt for any external damage. If there is any damage, the transportation company should be notified in writing on the waybill at the time the waybill is signed. This inspection should be for damage to bushings, oil leaks at any place on the transformer, damage to the tank, its cover, cabinet, other accessories or parts. It is recommended that units being unloaded via forklift utilize 4x4s as opposed to pallets; pallets can be provided for an additional charge if needed

### **B. Storing**

No unusual precautions for storing are needed because distribution transformers are built for outdoor service. It is recommended that the transformers be stored and transported, within a facility or storage yard, on pallets to minimize damage to radiators, cabinets, etc. resulting from bumping and scraping another transformer during handling. This also minimizes damages to transformer finish and causes of oil leaks. Pallets should be adequately sized and constructed based on the dimensions and weight of the transformer.

### **C. Lifting**

The transformers should be lifted by means of a sling with a spreader bar approximately as wide as the transformer. The sling should be put onto the lifting lugs on the transformer tank and not any other part of the transformer. The spreader bar is needed to prevent the sling from scraping the coating off the edge of the cover, the cover gasket seal.

### **D. Tank Finish**

The transformer is supplied with a high quality finish to withstand long outdoor exposure service. However, in transformer shipping and handling the finish may be scratched or abraded. The scratches and abrasions should be touched up with approved outdoor materials recommended by Southwest Electric Company.



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**MATERIAL SAFETY DATA SHEETS**



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## **RATIO AND POLARITY**



## Ratio and Polarity

Ratio and polarity tests are carried out on every transformer to ensure that the turns ratio of the windings is correct and also that the tapping on any of the windings have been made at the correct position. The standard tolerance for such ratios is plus or minus .5% of the calculated voltage ratio or to the nearest turn. To calculate the turns ratio you must first determine the connections of each winding (delta or wye). Once you have determined the connections you can use the following table to calculate the ratio.

**HIGH VOLTAGE DELTA - LOW VOLTAGE DELTA**

HIGH VOLTS DIVIDED BY LOW VOLTS

example: 13800-480

$$13800 \div 480 = 28.75$$

**HIGH VOLTAGE WYE - LOW VOLTAGE DELTA**

HIGH VOLTS DIVIDED BY 1.732 DIVIDED BY LOW VOLTS

example: 12470Y/7200-480

$$12470 \div 1.732 \div 480 = 15.00$$

**HIGH VOLTAGE WYE - LOW VOLTAGE WYE**

HIGH VOLTS DIVIDED BY LOW VOLTS

example: 12470Y/7200-480Y/277

$$12470 \div 480 = 25.98 \text{ or } 7200 \div 277 = 25.99$$

**HIGH VOLTAGE DELTA - LOW VOLTAGE WYE**

HIGH VOLTS MULTIPLIED BY 1.732 DIVIDED BY LOW VOLTS

example: 2200-480Y/277

$$2200 \times 1.732 \div 480 = 7.94$$

When ratioing with a TTR you also need to ratio by the phase relations or vectors. Note in Figure 1A that the phase relationship of H1 to H3 corresponds to the phase relationship of X1 to X0, the phase relationship of H2 to H1 corresponds to X2 to X0, and H3 to H2 corresponds to X3 to X0 in a Delta - Wye transformer.

In Figure 1B the phase relationship of H1 to H3 corresponds to X1 to X3, the phase relationship of H2 to H1 corresponds to X2 to X1 and H3 to H2 corresponds to X3 to X2 in a Delta - Delta transformer. Figure 1C also shows some of the other phase relationships of other transformers.

**CAUTION: Be certain the transformer to be tested is completely de-energized and all incoming and outgoing leads are removed and safely terminated.**

To begin Ratio-ing, connect the exciting leads BR (Big Red) and BB (Big Black) leads to the lower-voltage winding of the two windings to be compared. Connect the LR (Little Red) secondary lead to the higher-voltage terminal which corresponds to the BR connection as indicated in Figure 2 connect the LB (Little Black) lead to the other high-voltage terminal.



FIGURE 1A

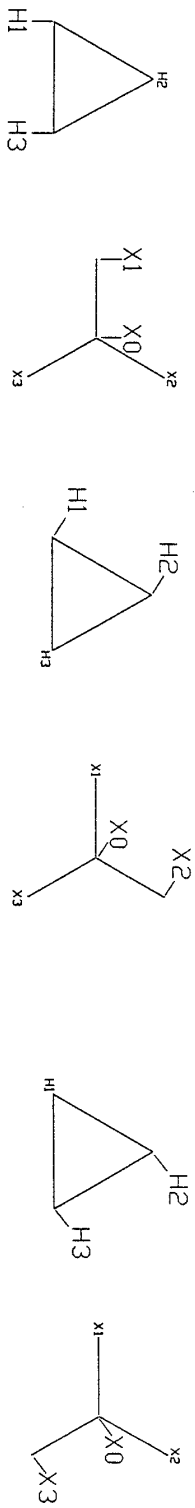


FIGURE 1B

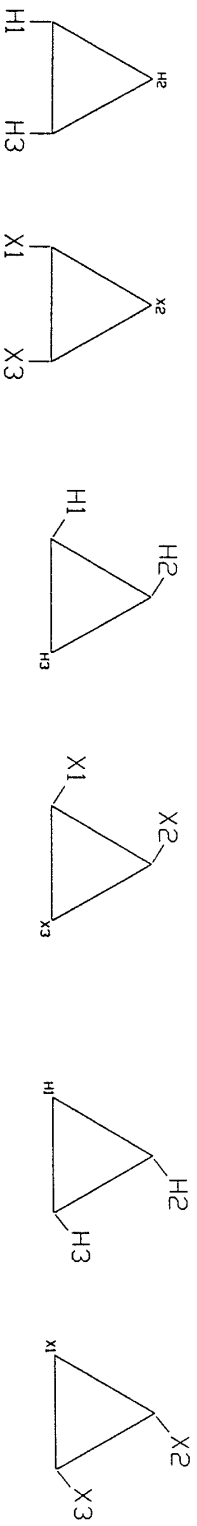


FIGURE 1C

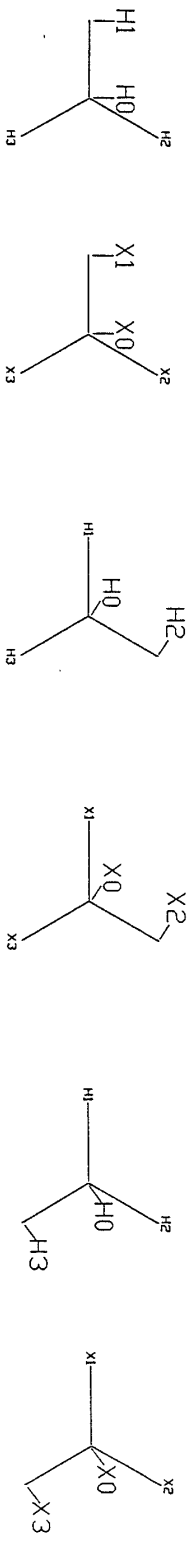
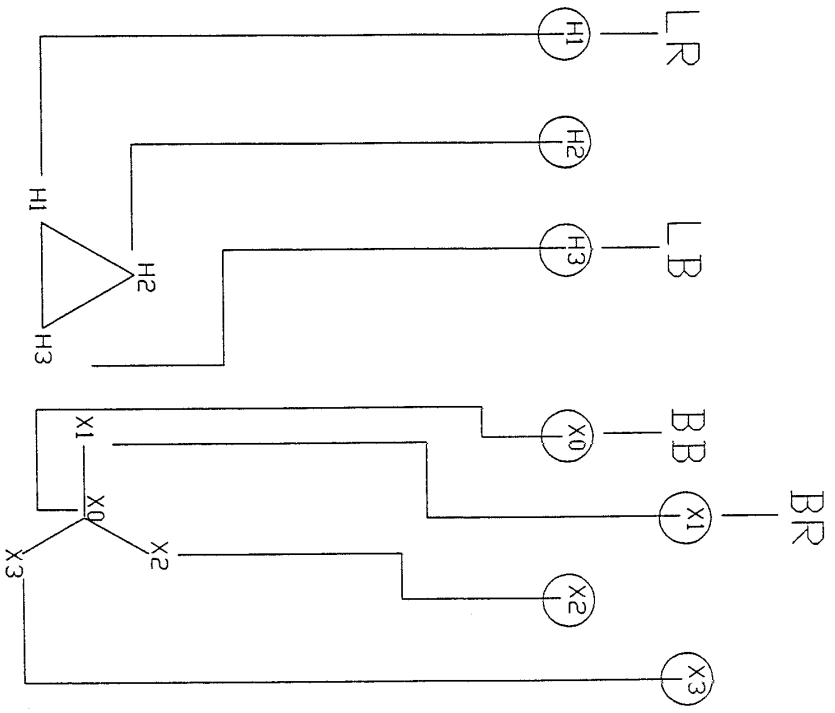


FIGURE 2





## **Balancing**

Set the TTR dials to zero and give the TTR crank a quarter turn. Note with an electric TTR slowly raise the voltage.

If the null meter deflects to the left, the transformer is subtractive. The LR and BR leads are then connected to terminals of the same polarity as are the LB and BB leads; proceed with the ratio.

If the null meter deflects to the right, then the transformer connected is additive. It will be necessary to interchange the secondary leads LR and BR to properly connect the TTR set to an additive transformer. When this is done, leads of the same color connect to terminals of the same polarity as in above.

If when the transformer is connected properly and deflection is to the left, balancing may be accomplished with the null meter. CAUTION: Do not crank the TTR or raise the voltage while anyone is touching the secondary connectors. At high ratios high voltage can be developed across the secondary with only 8 volts on the primary.

Turn the first dial one step clockwise. Crank the TTR crank a quarter turn or slightly raise the voltage. Observe the null meter. If it deflects to the left, turn the dial further clockwise until finally one of the steps causes the null meter to deflect to the right, upon cranking the TTR or raising the voltage. Back up one step (counter clockwise). The meter will then deflect to the left upon cranking or raising the voltage.

Follow the same procedure with the second and third dials in turn. Then proceed to the fourth dial, turning it slowly clockwise until the meter deflection becomes small while cranking slowly and continuously or raising the voltage. Now increase the cranking speed or raise the voltage until the voltmeter reads 8 volts and at the same time adjust the fourth dial so that the null meter shows no deflection from the center mark on the null meter. The ratio can now be read from the TTR.

NOTE: Not all turns ratios will correspond with voltage ratios.





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This test is to confirm the ratio of a transformer, using a low voltage power source and a voltmeter.

To calculate the voltage ratio of the transformer:

Divide the secondary (high) voltage that corresponds to the tap position of the tap changer by the primary (low) voltage of the nameplate. (Note! This will be a single phase test so use the secondary voltage found in the delta column of the nameplate.)

Secondary tap voltage (Delta)

Nameplate primary voltage

Example for a 200 kVA:

Switch #1, Position #1

Switch #2, Position #1

Voltage = 2200

$$\frac{\text{Secondary tap voltage (Delta)}}{\text{Nameplate primary voltage}} = \frac{2200}{480} = 4.583$$

The calculated voltage ratio is 4.583

To compare the calculated voltage ratio to the actual voltage ratio, apply 480 volts to the secondary winding and measure the primary winding. Note: 480 volts is used in this example for the voltage applied. To determine the output voltage, divide the applied voltage by the calculated ratio.

$$\frac{480}{4.583} = 104.7 \text{ volts}$$

The phase relationship of the 200 kVA is as follows:

Secondary		Primary
H1—H4	relates to	X1—X3
H2—H5	relates to	X2—X1
H3—H6	relates to	X3—X2

When set on the 2200 volt secondary tap and 480 volts is applied to:

H1 & H4 the voltage across X1 & X3 will be 104.7

H2 & H5 the voltage across X2 & X1 will be 104.7

H3 & H6 the voltage across X3 & X2 will be 104.7

If the output voltage differs, then verify the applied voltage with a voltmeter.

### **CAUTION**

**THE VOLTAGE MUST BE PROPERLY APPLIED TO THE TRANSFORMER. FAILURE TO DO SO COULD RESULT IN SERIOUS PERSONAL INJURY, DEATH OR PROPERTY DAMAGE. ALL TESTS SHOULD BE PERFORMED BY QUALIFIED PERSONAL.**



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## **MEGGER TESTING**



## **RECOMMENDED FIELD TESTING, MEGGER TEST**

**CAUTION: !!HIGH VOLTAGE!!**

**ALL TESTS TO BE PERFORMED BY QUALIFIED PERSONNEL, ALL POWER TURNED OFF AND LOCKED OUT, AND BOTH PRIMARY AND SECONDARY BUSHINGS DISCONNECTED.**

### **MEGGER TEST**

#### **A. Equipment required.**

1. A 500-Volt or 1000-Volt Megohmmeter.

#### **B. Procedure.**

1. Short all Primary bushings (H1, H2, H3) together and all Secondary bushings (X1, X2, X3, X4, X5, X6, X7, and X8) together.
2. Primary to ground. Connect the positive lead to any Primary bushing (H) and the negative lead to ground (tank).
3. Secondary to ground. Connect the positive lead to any Secondary bushing (X) and the negative lead to ground (tank).
4. Secondary to Primary. Connect the positive lead to any Primary bushing (H) and the negative lead to any Secondary bushing (X).
5. All megohm readings should be in excess of 500 megohms.



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## **OIL SAMPLING**



## **Oil Sampling**

### **FLUID SAMPLE FOR UNITS WITH DRAIN VALVES AND SAMPLER**

- A. Equipment required.
  - 1. One clean dry, one pint or quart can with lid.
- B. Wipe any contaminants from the sample valve on the side of the main drain valve and drain a small amount of fluid into a separate container to flush the valve.
- C. Drain approximately a cup to a pint of fluid into the prepared sample can.
- D. Visually inspect the fluid for carbon or cloudiness (an indication of moisture). The natural color of the mineral oil, silicone or R-temp should be clear.
- E. Send the sample to a laboratory for dielectric test and moisture content test.

### **FLUID SAMPLE FOR UNITS WITHOUT DRAIN VALVES AND SAMPLER**

- A. Equipment required.
  - 1. One clean dry, one pint or quart can with lid.
  - 2. One siphon hose and pump.
- B. Wipe any contaminants from around the fill plug.
- C. Siphon approximately a cup to a pint of fluid into the prepared sample can.
- D. Visually inspect the fluid for carbon or cloudiness (an indication of moisture). The natural color of the mineral oil, silicone or R-temp should be clear.
- E. Send the sample to a laboratory for dielectric test and moisture content test.



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**SAFETY**



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## **SAFETY PRECAUTION**

**WARNING: THE FOLLOWING PRECAUTIONS MUST BE FOLLOWED. FAILURE TO DO SO COULD RESULT IN DEATH, SERIOUS INJURY, OR PROPERTY DAMAGE!**

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### ***IMPORTANT! IMPORTANT! HAZARD!***

**NOTE: ONLY QUALIFIED PERSONNEL SHOULD PERFORM SERVICE ON ELECTRICAL TRANSFORMERS. DANGEROUS VOLTAGES, PRESSURES, AND OTHER HAZARDS ARE PRESENT WHICH CAN RESULT IN SERIOUS INJURY OR DEATH! ADDITIONALLY, IMPROPERLY PERFORMED WORK CAN RESULT IN CATASTROPHIC FAILURE OR EXPLOSION OF THE TRANSFORMER!**

**ALL SOURCES OF POWER TO THE TRANSFORMER MUST BE TURNED OFF! ALL SOURCES OF POWER MUST BE LOCKED OUT AND DISCONNECTED! FAILURE TO DO SO CAN RESULT IN SERIOUS INJURY OR DEATH!**

- 1. PRIOR TO INSTALLING A TRANSFORMER ENSURE THAT THE TRANSFORMER'S KVA, VOLTAGE, WINDING CONFIGURATION, AND OTHER CHARACTERISTICS ARE SUITABLE FOR THE APPLICATION. THIS INFORMATION IS DETAILED ON THE NAMEPLATE OF THE TRANSFORMER.**
- 2. THE TRANSFORMER SHOULD ALWAYS BE LIFTED BY ALL FOUR TANK LIFTING LUGS. ENSURE THAT THE WEIGHT OF THE TRANSFORMER DOES NOT EXCEED THE CAPACITY OF THE EQUIPMENT TO BE USED TO LIFT IT.**

3. DO NOT LAY A TRANSFORMER ON ITS SIDE. TO DO SO CAN CAUSE AIR TO BE TRAPPED IN THE WINDINGS. THIS CAN RESULT IN THE FAILURE OF THE TRANSFORMER.
4. THE TRANSFORMER TANK MUST BE SOLIDLY GROUNDED BEFORE IT IS ENERGIZED.
5. NEVER OPERATE A TAP SWITCH, VOLTAGE CHANGE SWITCH, OR A DELTA-WYE SWITCH WHILE THE TRANSFORMER IS ENERGIZED. THE TRANSFORMER CAN FAIL VIOLENTLY IF YOU DO SO.
6. PRIOR TO CONNECTING ANY EQUIPMENT TO THE SECONDARY OF THE TRANSFORMER, THE SECONDARY VOLTAGE SHOULD BE MEASURED TO ENSURE THAT IT IS SUITABLE FOR THE EQUIPMENT THAT IS TO BE CONNECTED. SINCE DEADLY VOLTAGES WILL BE PRESENT, USE SUITABLE MEASURING EQUIPMENT, AND OBSERVE ALL SAFETY PRACTICES.
7. WHEN A TRANSFORMER IS TO BE WORKED ON, ALL SOURCES OF POWER MUST BE TURNED OFF! THE SOURCES MUST BE LOCKED OUT SO THAT THEY CANNOT BE TURNED ON ACCIDENTLY. THE HV AND LV TERMINALS SHOULD BE GROUNDED WHEN YOU ARE POSITIVE THERE IS NO VOLTAGE PRESENT AT THESE TERMINALS. THE HV AND LV LEADS SHOULD THEN BE DISCONNECTED FROM THE TRANSFORMER BUSHINGS. REMOVE THE GROUNDS PLACED ON THE TERMINALS PRIOR TO REAPPLYING POWER.
8. THE TRANSFORMER TANK COVER OR INSPECTION ACCESS COVER MUST NOT BE REMOVED UNDER CONDITIONS WHICH MAY ALLOW MOISTURE, DIRT OR OTHER CONTAMINATION, OR FOREIGN OBJECTS TO ENTER THE TRANSFORMER TANK. YOU SHOULD REMOVE LOOSE ITEMS FROM YOUR POCKETS PRIOR TO OPENING THE COVER. THE ENTRY OF THESE MATERIALS INTO THE TRANSFORMER TANK MAY RESULT IN THE PREMATURE FAILURE OF THE TRANSFORMER.

**CAUTION - ALL PRESSURE MUST BE RELIEVED FROM THE TRANSFORMER TANK PRIOR TO REMOVING THE COVER. THIS MAY BE ACCOMPLISHED BY PULLING THE RING ON THE PRESSURE RELIEF VALVE UNTIL ALL PRESSURE IS EXPELLED. THE TRANSFORMER MUST BE RESEALED SO THAT IT IS PRESSURE TIGHT. IT IS RECOMMENDED THAT ONCE A TRANSFORMER IS RESEALED, THAT IT BE PRESSURE TESTED WITH DRY NITROGEN. IT SHOULD BE PRESSURIZED AT 7 PSIG. IT SHOULD THEN BE THOROUGHLY CHECKED FOR ANY LEAKS.**



9. IF THE LEVEL OF THE INSULATING LIQUID MUST BE LOWERED TO PERFORM SERVICE, UNDER NO CIRCUMSTANCES SHOULD THE LEVEL OF THE OIL DROP LOWER THAN APPROXIMATELY THREE (3) INCHES ABOVE THE TOP OF THE TRANSFORMER COILS. THIS HELPS PREVENT THE COILS FROM BEING EXPOSED TO AIR OR MOISTURE.

THE LIQUID REMOVED FROM THE TRANSFORMER MUST BE STORED IN ABSOLUTELY CLEAN, TIGHTLY SEALED BARRELS. THE HOSES AND PUMP THAT ARE USED MUST ALSO BE ABSOLUTELY CLEAN. IF THERE IS A DOUBT, OBTAIN ENOUGH EXTRA INSULATING FLUID OF THE SAME TYPE AS IS IN THE TRANSFORMER TO THOROUGHLY FLUSH THE HOSES AND PUMP. DO NOT REUSE THIS FLUID.

WHEN THE TRANSFORMER IS REFILLED, CARE MUST BE TAKEN TO ENSURE THAT AIR IS NOT FORCED INTO THE WINDINGS OF THE TRANSFORMER. AIR THAT ENTERS THE COILS WILL RESULT IN THE FAILURE OF THE TRANSFORMER.

AFTER THE TRANSFORMER IS REFILLED, A MINIMUM OF THREE HOURS SHOULD ELAPSE PRIOR TO ENERGIZING THE TRANSFORMER. THIS ALLOWS TIME FOR AIR IN THE INSULATING FLUID TO DISSIPATE. PRIOR TO ENERGIZING THE TRANSFORMER, ALL SWITCHES SHOULD BE OPERATED TO DISLodge ANY TRAPPED AIR.

TRANSFORMERS WITH A WINDING VOLTAGE THAT EXCEEDS 5,000 VOLTS SHOULD BE VACUUM FILLED. CONTACT THE FACTORY FOR SPECIFIC INSTRUCTIONS.



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## **WARRANTY**



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## **Three Phase Transformer Warranty**

**Southwest Electric Company warrants transformers to be free of defects in material and workmanship for a period of twelve (12) months after date of shipment under normal use and when used in the manner intended, providing:**

- 1) The insulating paper has not been thermally degraded prior to the occurrence of failure.**
- 2) A fuse of rating normally accepted by the utility industry is in service in the primary circuit of the transformer at the time of failure.**

**If the purchaser notifies Southwest Electric Company of any failure to conform to warranty and delivers the failed transformer to the original shipping point freight prepaid, Southwest Electric Company will repair or replace, at our option, the failed transformer.**

**This is the sole warranty of Southwest Electric Company pertaining to transformers and no other warranty is applicable either expressed or implied, in fact or by law.**

**The customer's only remedy in regard to any failed transformer shall be the repair or replacement of the transformer.**

**Southwest Electric Company shall not be liable for any consequential, special, incidental or punitive damage resulting from or caused by any transformer.**



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**DISCLAIMER  
OF  
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### **Disclaimer of Warranties and Limitation of Liability**

The information, recommendations, descriptions and safety notations in this document are based on Southwest Electric Company's experience and judgement with respect to transformers. **THIS INFORMATION SHOULD NOT BE CONSIDERED TO BE ALL-INCLUSIVE OR COVERING ALL CONTINGENCIES.** If further information is required, Southwest Electric Company should be consulted.

**NO WARRANTIES, EXPRESSED OR IMPLIED, ARE MADE REGARDING THE INFORMATION, RECOMMENDATIONS, DESCRIPTIONS AND SAFETY NOTATIONS CONTAINED HEREIN.** Under no circumstances shall Southwest Electric Company be liable for the loss of profits, actual losses, loss of power or production or any other special, indirect or consequential damages or loss whatsoever including but not limited to damage to, or loss of equipment, plant or power system, cost of capital, loss of profits or revenues, cost of replacement power, additional expenses in the use of existing power facilities, or claims against the user by its customers resulting from the use of the information, recommendations, descriptions and safety notations contained herein.