

External Arrester

External surge arresters ordered with the transformer must be installed and connected in the field before the transformer is put into service.

Arrester and tank ground connections must be completed before the transformer is connected to the high voltage or low voltage lines. Proper connection places the arrester in a direct shunt relationship to the transformer insulation.

MAINTENANCE

Exterior Maintenance

On an annual or more frequent interval, inspect all exposed surfaces for evidence of tampering, battered metal, gouges, etc. Dents or deformities should be repaired at once. Scratched or weathered paint or protective coatings should be touched up promptly.

Keep the area around the transformer clean. Do not store tools, materials or equipment on or against the transformer.

Cabinet Interior Maintenance



WARNING: Hazardous voltage. Can cause severe injury, death, or damage to equipment. De-energize transformer from a remote upstream source before opening cabinet and doing cabinet interior inspection or maintenance. Check that all transformer terminals and bushings have zero voltage. Ground transformer following industry accepted safe grounding practices.

Periodically inspect the terminal compartment interior and all operating equipment. Check all gauges and controls for proper operation. Repair or replace damaged or defective equipment.

Inspect drain cocks, plugs, fuse mountings, and switches. Look for evidence of insulating liquid seepage around tank-wall gaskets, seals, etc. Repair as required.

Replacement of gaskets or seals in the tank wall may require that the tank be opened and the insulating liquid lowered to the appropriate level. For instruction on opening the tank and for draining and replacing the insulating liquid, refer to the Insulating Liquid Maintenance section in this manual.

Tank Internal Maintenance

(For Envirotran™ Transformers see the Envirotran Transformers section of this manual before continuing)



CAUTION: Elevated Pressure. Can cause personal injury or damage to transformer. Release internal pressure with pressure relief device before removing tank cover, manhole cover or handhole cover.



WARNING: Hazardous voltage. Can cause severe injury, death, or damage to equipment. De-energize transformer from a remote upstream source before opening cabinet and doing internal tank inspection or maintenance. Check that all transformer terminals and bushings have zero voltage. Ground transformer following industry accepted safe grounding practices.


Service to bushings or equipment inside the transformer tank will require that the tank be opened and the insulating liquid lowered to the appropriate level. Before opening the transformer tank, read the Insulating Liquid Maintenance section in this manual. The Liquid Maintenance section explains safety precautions that should be taken and gives instructions on how to prevent insulating liquid contamination. Precautions must be taken to prevent dirt or moisture from entering the opened transformer tank. Contamination of the insulating liquid will prevent the transformer from operating properly and may cause serious damage to the transformer.


Three-phase padmounted transformers may have either bolt-on or weld-on main tank covers. Bolt-on covers can

be removed to access the tank interior. Access to the interior of a transformer with a weld-on tank cover is typically through a manhole/handhole. To gain additional internal access to tanks with weld-on tank covers, the tank cover must be cut open.

Tank Cover Removal and Installation

(For Envirotran Transformers see the Envirotran Transformers section of this manual before continuing)

 **CAUTION:** Elevated Pressure. Can cause personal injury or damage to transformer. Release internal pressure with pressure relief device before removing tank cover, manhole cover or handhole cover.

 **WARNING:** Hazardous voltage. Can cause severe injury, death, or damage to equipment. De-energize transformer from a remote upstream source before opening cabinet and doing internal tank inspection or maintenance. Check that all transformer terminals and bushings have zero voltage. Ground transformer following industry accepted safe grounding practices.

Transformers that have been system-connected should be de-energized, grounded, and disconnected before being opened for inspection.

If the tank seal is broken, it is recommended that a leak test be performed to verify that the tank is properly sealed. To leak test, remove the pressure relief device and pressurize the headspace. The test pressure should not exceed 7 psig. The established pressure should be maintained for at least four hours to insure that all the seals are proper.

Bolt-On Tank Cover Removal

Transformer tanks are factory-sealed to prevent ingress of ambient air and moisture. Do not open under any precipitation conditions.

1. Verify that tank is grounded. De-energize transformer from a remote upstream source. Ground all bushings and terminals before removing cover.
2. Thoroughly clean tank cover to help prevent contamination of insulating liquid when removing the cover. Remove all dirt, grease, and moisture.
3. From within the cabinet, remove the hardware (3/8" nuts using a 9/16" socket) which attaches the cover nutguard to the faceplate.

4. Relieve internal tank pressure by operating the pressure relief valve. Remove the hardware (3/8" nuts using a 9/16" socket) which attaches the cover to the tank.
5. Gently pry the cover upward. Do not allow the cover gasket to come in contact with the transformer insulating liquid. Allowing the gasket to contact the liquid will make it slippery and difficult to hold in position during cover installation. Lift cover straight up to prevent damage to cover, bolts, and tank gasket.
6. Note the location and orientation (up/down) of each gasket section as they are removed from the tank flange so that they can be reinstalled properly.

Bolt-On Tank Cover Installation

1. Return the gasket sections to their original positions and orientation.
2. Re-install the cover, using 25 ft-lbs. torque to tighten the cover hardware. After installing all the nuts, re-torque each nut to ensure proper torque is achieved.
3. Remove the pressure relief valve and pressurize the headspace through the pressure relief valve coupling to ensure that there are no leaks. Test pressure should not exceed 7 psig. Established pressure should be maintained for at least four hours to insure that all seals are proper.
4. Re-install the nutguard using 25 ft-lbs. torque to tighten nutguard access hardware.
5. Re-install pressure relief valve.

Bolt-On Manhole/Handhole Cover Removal

Transformer tanks are factory-sealed to prevent ingress of ambient air and moisture. Do not open under any precipitation conditions.

1. Verify that tank is grounded. De-energize transformer from a remote upstream source. Ground all bushings and terminals before removing cover.
2. From within cabinet, remove hardware (3/8" nuts using a 9/16" socket) attaching manhole/handhole access cover to cabinet.
3. Remove manhole/handhole access cover.
4. Thoroughly clean tank and manhole/handhole cover to help prevent contamination of insulating liquid when removing manhole/handhole cover. Remove all dirt, grease, and moisture.

5. Relieve internal tank pressure by operating pressure relief valve.
6. Remove hardware (3/8" nuts using a 9/16" socket) attaching manhole/handhole cover to tank.
7. Gently pry cover upward. Do not allow cover gasket to come in contact with transformer insulating liquid. Allowing the gasket to contact the liquid will make it slippery and difficult to hold in position during cover installation. Lift cover straight up to prevent damage to cover, bolts, and tank gasket.
8. Note location and orientation (up/down) of each gasket section as they are removed from tank flange so they can be re-installed properly.

Bolt-On Manhole/Handhole Cover Installation

1. Return gasket sections to their original positions and orientation.
2. Re-install manhole/handhole, using 25 ft-lbs. torque to tighten hardware. After installing all nuts, re-torque each nut to ensure proper torque is achieved.
3. Remove pressure relief valve and pressurize headspace through pressure relief valve coupling to ensure that there are no leaks. Test pressure should not exceed 7 psig. Established pressure should be maintained for at least four hours to ensure that all seals are proper.
4. Re-install access cover using 25 ft-lbs. torque to tighten access cover hardware.
5. Re-install pressure relief valve.

Weld-On Tank Cover Removal



WARNING: Explosive gas. Can cause severe injury, death, or damage to equipment. Before cutting open a weld-on tank cover, fill tank headspace with nitrogen gas. Keep nitrogen gas flowing while cutting. Keep tank headspace filled with nitrogen until cutting is finished.

Transformer tanks are factory-sealed to prevent ingress of ambient air and moisture. Do not open under any precipitation conditions.

Explosive gases can develop inside a transformer tank headspace during the life of the transformer. It is strongly recommended that weld-on cover removal be done only in a controlled repair facility by experienced maintenance personnel. To prevent explosions, the following procedures must be followed during weld-on cover removal:

1. Verify that tank is grounded. De-energize transformer from a remote upstream source. Ground all bushings and terminals before removing cover.
2. Relieve internal tank pressure by operating pressure relief valve.
3. Remove manhole/handhole cover as outlined in the Tank Cover Removal and Installation section of this manual.
4. Drain insulating liquid to the top of core clamp as outlined in the Insulating Liquid Maintenance section of this manual.
5. Allow transformer to sit with manhole/handhole removed for a minimum of 24 hours to allow explosive gases to escape.
6. Place a rubberized blanket on top of core clamp and completely cover core/coil assembly to protect core/coil assembly from weld spatter contamination during cover cutting.
7. Remove pressure relief valve and attach a nitrogen source in its place.
8. Fill headspace with nitrogen with manhole/handhole cover still removed. Nitrogen gas will help prevent a volatile gas explosion while tank cover is being cut off.
9. While continuing to keep nitrogen flowing into the headspace, use carbon arc machinery or a hard-wheel grinder to cut cover weld.
10. Thoroughly clean tank cover to help prevent contamination of insulating liquid when removing cover. Remove all dirt, grease, and moisture.
11. Remove tank cover from tank.

Weld-On Tank Cover Installation

1. Grind smooth and then clean cover, removing all weld spatter accumulated during cover removal.
2. It is recommended that the tank weld rope gasket be replaced around the tank lip prior to re-installing cover. The tank weld rope gasket helps prevent weld spatter from entering the tank during cover weld. The rubberized blanket installed during cover removal should still be covering the core/coil assembly.
3. Re-position cover on tank.
4. Fill headspace with nitrogen through pressure relief valve coupling, with manhole/handhole still removed.
5. Continue to keep nitrogen source flowing into headspace, and weld cover fully around the tank lip.

6. Remove rubberized blanket that was installed during cover removal.
7. Refill insulating liquid as outlined in Insulating Liquid Maintenance section of this manual.
8. Re-install manhole/handhole cover as outlined in Tank Cover Removal and Installation section of this manual.
9. Pressurize headspace through pressure relief valve coupling to insure that there are no leaks. The test pressure should not exceed 7 psig. The established pressure should be maintained for at least four hours to ensure that all seals are proper.
10. Re-install pressure relief valve.

Bushing Removal and Replacement

1. Verify that tank is grounded. De-energize transformer from a remote upstream source. Ground all bushings and terminals before performing maintenance on bushings.
2. Open tank by removing tank cover or manhole/handhole cover as outlined in Tank Cover Removal and Installation section of this manual.
3. Lower insulating liquid level as outlined in Insulating Liquid Maintenance section of this manual. Lower liquid level to completely expose the bushing.
4. Disconnect all internal and external cable and leads. Note position of all nuts, flat washers, spring washers, etc., so they can be re-installed in same locations.
5. Remove all bushing clamp hardware, noting position of all nuts, flat washers, spring washers, etc., so they can be re-installed in same locations.
6. Remove external bushing clamp, bushing, and gasket.
7. Install a new bushing and gasket. Center bushing and gasket to obtain an effective seal. Install exterior bushing clamp and clamp hardware. Tighten clamp nuts per torque specified in Table 1.
8. Re-connect all external and internal cables and leads. Replace all nuts, flat washers, spring washers, etc., in their original position. Tighten all connections per torque specified in Table 1.
9. Restore insulating liquid to appropriate level as outlined in Insulating Liquid Maintenance section of this manual. Close, reseal, and leak test tank as outlined in the Tank Cover Removal and Installation section of this manual. Inspect bushing-to-tank seal for leaks or seepage.

Bushing Clamps	
Clamp Type	Hardware Tightening Torque
Cast Aluminum Clamp	70-80 in-lbs.
Molded Polymer Tri-Clamp	40-60 in-lbs.
All other 3 & 4 hole Clamps	40-60 in-lbs.

Bushings With Internal Spade Connections	
Bushing Hardware	Hardware Tightening Torque
1/2" Steel (Grade 8)	50 ft-lbs.
3/8" Steel (Grade 8)	50 ft-lbs.

Bushings With Internal Stud Connections	
Bushing Hardware	Hardware Tightening Torque
3/8"-16 Brass Nuts	16 ft-lbs.
5/8"-11 Aluminum Nuts	60 ft-lbs.
5/8"-11 Brass Nuts	75 ft-lbs.
1"-14 Brass Nuts	121 ft-lbs.
Bushing Lead Block, 1/2" Steel Hardware	110 ft-lbs.

Table 1.
Bushing Hardware Tightening Torque

Cabinet Removal and Installation

Cabinet Removal



CAUTION: Potential Falling Object. Can cause personal injury or damage to transformer. Do not open cabinet doors when cabinet is removed from transformer tank. Opening cabinet doors will cause cabinet to fall forward.



WARNING: Hazardous voltage. Can cause severe injury, death, or damage to equipment. De-energize transformer from a remote upstream source before opening cabinet and doing cabinet interior inspection or maintenance. Check that all transformer terminals and bushings have zero voltage. Ground transformer following industry accepted safe grounding practices.

1. Verify that tank is grounded. De-energize transformer from a remote upstream source. Ground all bushings and terminals before performing maintenance on cabinet.

2. Place one 1/4 to 3/8 inch shim directly below faceplate on both sides of tank at points A and A' (see Figure 30).
3. Place one 1 1/2 inch wedge under each side of cabinet at points B and B' to relieve strain on the cabinet.
4. Note position and orientation of gasket that is between top of cabinet and tank so it can be re-installed in same fashion.
5. Disconnect HV-LV barrier from vertical bracket of faceplate.
6. Remove hardware attaching cabinet to faceplate on left and right sides of faceplate. Note position of all nuts, flat washers, spring washers, etc., so they can be re-installed in same locations.
7. Fully close HV and LV doors.
8. Slide cabinet assembly away from tank.

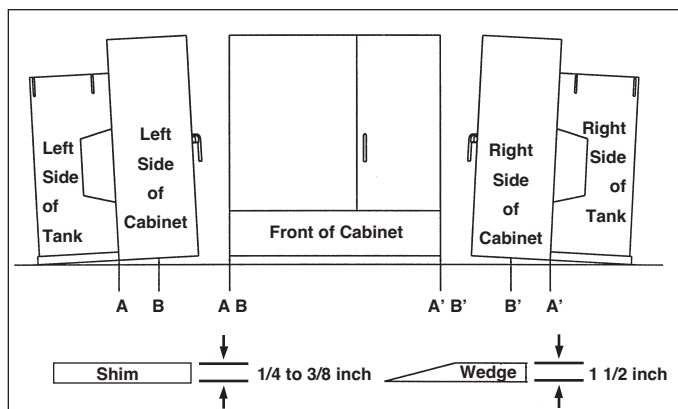


Figure 30.
Cabinet Removal Diagram

Cabinet Installation

Reverse removal procedure to re-install cabinet. Re-attach cabinet using shims under front of tank and wedges under sides of cabinet, making sure cabinet gasket is inserted into cabinet back channel prior to attaching cabinet. Tighten cabinet hardware to 20 ft-lbs. torque.

Insulating Liquid Maintenance

Transformer tanks are factory-sealed to prevent ingress of ambient air and moisture. Do not open under any precipitation conditions.

If it is necessary to drain and refill the transformer, special care should be taken to avoid the entrapment of gas bubbles in the system. Gas bubbles have lower dielectric integrity than the insulating liquid and will

degrade the performance characteristics of the insulating system.

Conventional Oil-Filled Transformers

Refer to ANSI C57.106, "Guide For Acceptance and Maintenance of Insulating Oil in Equipment", for additional guidelines when testing and handling conventional transformer oil. Periodic maintenance tests should be performed.

R-Tran® Transformers

R-Tran transformers are filled with R-Temp fluid. R-Temp fluid is a non-toxic, readily biodegradable, less-flammable (high fire point), high molecular weight hydrocarbon dielectric fluid.

Refer to IEEE C57.121, "Guide for Acceptance and Maintenance of Less Flammable Hydrocarbon Fluids in Transformers." Periodic maintenance tests should be performed on the same schedule as would be used for transformers of similar application filled with conventional transformer oil.

Request Cooper Power Systems Bulletin 97038 or contact your factory representative for additional handling guidelines for R-Temp fluid.

Mixtures of R-Temp Fluid and Conventional Transformer Oil

R-Temp fluid is fully miscible with conventional transformer oil. There is no known detrimental performance impact when R-Temp fluid is mixed with conventional transformer oil. Conversely, except for some reduction in flash and fire points, the same is true for conventional transformer oil mixed with R-Temp fluid. Conventional transformer oil content of >3% in R-Temp fluid lowers the fire point below 300°C. Measure the ASTM flash and fire points if the presence of conventional transformer oil is suspected. If flash or fire points fall below the minimum values required, refilling may be required.

Envirotran Transformers

Envirotran transformers are filled with Envirotemp FR3 fluid. Envirotemp FR3 fluid is a less-flammable (high fire point) dielectric fluid based on edible seed oils.

Periodic maintenance should be performed on the same schedule as would be used for transformers of similar application filled with conventional transformer oil. Basic recommended tests for Envirotemp FR3 fluid are dielectric strength, moisture content, and flash and fire points.

Envirotran transformer tanks are shipped from the factory with a dry nitrogen-filled headspace. Internal pressure should not be equalized with atmosphere by

manually opening the pressure relief valve device unless access to Bay-o-Net fuses or other internal tank components is required.

If Internal Service is Required

If the tank cover or manhole/handhole must be removed for internal service, exposure time to ambient air should be minimized. Avoid exposure times greater than 24 hours. Immediately after service is completed, replace the cover or manhole/handhole. The tank headspace must then be purged and recharged with dry nitrogen. Envirotran transformers are equipped with two 1/4" fill valves on the upper left and upper right corners of the face plate and are intended for the recharging process. The following steps should be followed when purging and recharging Envirotran transformers:

1. Verify that tank is grounded. De-energize transformer from a remote upstream source. Ground all bushings and terminals.
2. Release internal pressure by operating pressure relief device.
3. Fill headspace with dry nitrogen through one of the 1/4" fill valves to a pressure of 2-3 psig.
4. Release internal pressure by operating pressure relief device.
5. Refill headspace with dry nitrogen through one of the 1/4" fill valves to a pressure of 2-3 psig. Internal pressure must be maintained for at least four hours prior to transformer energization to verify seal integrity.

Bay-O-Net Fuse Replacement

When replacing fuses in Flapper™ style Bay-O-Net fuse assemblies, refer to Bay-O-Net Fuse Re-Fusing Instructions in this manual. Follow the same procedure as with conventional oil-filled transformers.

Mixtures of Envirotemp FR3 Fluid and Conventional Transformer Oil

Envirotemp FR3 fluid is fully miscible with conventional transformer oil. There is no known detrimental performance impact when Envirotemp FR3 fluid is mixed with conventional transformer oil. Conversely, except for some reduction in flash and fire points, the same is true for conventional transformer oil mixed with Envirotemp FR3 fluid. Conventional transformer oil content of >7% in Envirotemp FR3 fluid lowers the fire point below 300°C. Measure the ASTM flash and fire points if the presence of conventional transformer oil is suspected. If flash or fire points fall below the minimum values required, refilling may be required. To maintain its exceptional environmental classification, mixing of Envirotemp FR3 dielectric coolant with any other fluids should be avoided.

Request Cooper Power Systems Bulletin 99048 or contact your factory representative for additional handling guidelines for Envirotemp FR3 fluid.

Sampling Insulating Liquid

Before sampling the insulating liquid, verify that tank is grounded. De-energize the transformer from a remote upstream source. Ground all bushings and terminals.

Refer to ASTM D923 "Standard Practices for Sampling Electrical Insulating Liquids" for sampling techniques.

A sample of the liquid should be taken when the liquid temperature is equal to or greater than the surrounding air to avoid condensation of moisture on the liquid.

Containers used for sampling liquid should be clean and dry large mouth glass bottles. Make sure that the liquid being sampled is representative of the liquid in the unit. Sufficient liquid must first be drawn off to ensure that the sample will be from the bottom of the tank, and not the liquid stored in the sampling pipe

Testing Insulating Liquid

For the dielectric strength of the insulating liquids, follow the technique as specified by ASTM D877, "Standard Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using Disk Electrodes".

If the dielectric strength of the liquid drops below 26kV, it should be filtered until it tests at 26kV or better.

Filtering Insulating Liquid

Conventional transformer oil, R-Temp, or Envirotemp FR3 fluids can be filtered by means of a filter press. The filter press is effective for removing all types of foreign matter, including finely divided carbon and small amounts of moisture. The purifier equipment consists of a specifically proportioned filter press, a positive volume gear pump, driving motor, combined drip pan and mixing tank, necessary piping, valves, strainer, gauges and drying oven. Follow manufacturer's instructions for purifier equipment operation.

Filtration should be continued until the dielectric test of the insulating liquid is 26kV or better.

When filtering R-Temp or Envirotemp FR3 fluid, the filtering equipment must be free of contaminants and other liquids. The presence of other liquids may alter the physical and electrical characteristics of R-Temp or Envirotemp FR3 fluid. This could result in a reduction of fire point.

Lowering Insulating Liquid Level

1. Verify that tank is grounded. De-energize transformer from a remote upstream source. Ground all bushings and terminals.

2. If cover removal is required, remove cover as outlined in Tank Cover Removal and Installation section of this manual.
3. Prepare a clean, dry storage container to receive liquid.
4. Use pumps and hoses that have not been contaminated by contact with dissimilar liquids. Use a metal or non-rubber hose. Oil dissolves the sulfur found in rubber and will prove harmful to conductor material.
5. Attach pump intake line to drain valve on transformer tank.
6. Place output line nozzle on bottom of storage container. Do not permit liquid to splash into receiving container. Splashing will introduce air and moisture into liquid.
7. Do not lower liquid below top of core clamp unless absolutely necessary. Exposing coils may allow moisture to contaminate coil insulation.

Restoring Insulating Liquid Level

If it is necessary to drain and refill the transformer, special care should be taken to avoid the entrapment of gas bubbles in the system. Sufficient time should be allowed between refilling and energization of the transformer to be sure that any gas bubbles created during the process have been dissipated.

1. Pump from bottom of temporary storage tank. Do not permit intake line to draw in air, since air bubbles will lower dielectric integrity of insulating system.

CAUTION: It may be necessary to add extra liquid to the storage container from a reserve supply to replace the small quantity lost in the pump and lines and to prevent aeration of replacement liquid.

2. To prevent aeration at hose output, locate hose output below liquid surface
3. Pump slowly. If tank cover is not attached to tank, fill transformer to fill line marked on inside of transformer faceplate. If the tank cover is attached to tank, liquid level gauge may be read directly. On transformers that are not gauge-equipped, liquid level should be filled to bottom edge of liquid level plug hole (see Figure 3).

Applicable Standards

1. ASTM D92, "Standard Test Method for Flash and Fire Points by Cleveland Open Cup."
2. ASTM D877, "Standard Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using Disk Electrodes."
3. ASTM D923, "Standard Practices for Sampling Electrical Insulating Liquids."
4. ANSI C57.106, "Guide For Acceptance and Maintenance of Insulating Oil in Equipment."
5. IEEE C57.121, "Guide for Acceptance and Maintenance of Less Flammable Hydrocarbon Fluids in Transformers."

Spare Parts and Service

We suggest that one spare set of gaskets for manhole/handhole and any gasket-type bushings be kept on hand. Other renewal parts may be ordered through your local factory representative. When ordering parts, describe to your factory representative the maintenance being performed or the problem experienced. Also, tell the factory representative the complete transformer catalog number and serial number listed on the transformer nameplate.