

Three Phase Pad Mount Liquid Filled Transformer Operation and Installation Manual



kVA: Up to 5000 kVA
Primary Voltage: Up to 34.5 kV
BIL: Up to 200 kV

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1. Safety Information:

The instructions in this manual are not intended as a substitute for proper training or adequate experience in the safe operation of the equipment described. Only competent technicians who are familiar with this equipment should install, operate, and service it. These instructions cannot cover all details or variations in the equipment, procedures, or process described, nor to provide directions for meeting every possible contingency during installation, operation, or maintenance.

The following conventions are used to indicate and classify precautions and on product safety labeling. Failure to observe precautions could result in injury to people or damage to property.

HAZARD Statement definition:



This symbol/pictorial is used to identify an ELECTRICAL SHOCK or ELECTROCUTION hazard, all installation, maintenance, or repair should be performed by trained, experienced, and qualified personnel only.



This is the safety alert symbol. It is used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.

Safety Instructions



WARNING: A potential risk exists if operating instructions are not followed which could result in severe personal injury or death, and equipment damage.



WARNING: The contents of this manual should be carefully read and understood before attempting any test, repair, installation, removal, or operation of this equipment. Severe personal injury and equipment damage can occur from the result of improper handling, maintenance, or operation of this equipment.



WARNING: Transformers should never be opened, serviced, or otherwise tampered with while they are energized, ungrounded or connected to the system. Removing or tampering with any covers, doors, bushings, or seals of an energized transformer may result in death, severe personal injury and equipment damage.



WARNING: This equipment is not intended to protect human life. Follow all locally approved procedures and safety practices when installing or operating this equipment. Failure to comply with these warnings may result in death, severe personal injury and equipment damage.



WARNING: This equipment requires routine inspection and maintenance. Failure to properly inspect and maintain this equipment could result in unsafe conditions in and around this unit, which could lead to death, severe personal injury and equipment damage.

2. General Information:

2.1 Acceptance and Inspection upon Receipt:

All Larson Electronics' transformers are thoroughly tested and rigorously inspected before shipment from the factory to ensure the highest quality.

Upon receipt:

1. Thoroughly check all materials against the bill of lading.
2. Locate accessory parts that may have been shipped separately.
3. Carefully check the unit and associated components for any signs of damage caused during shipment. A damaged crate or pallet can be an indication of rough handling; if this condition is found, make a close inspection of the base and radiators (if equipped) and verify no damage has occurred.
4. In the event that significant damage to the unit or any associated equipment is noticed, rejection of the shipment should be made before it is unloaded. In the event of minor damages (nicks, scratches, etc.), carefully inspect the unit and note all damage on the carrier's copy of the freight receipt.

Larson Electronics' ships most units FOB Point of Manufacture, and it is the customer's responsibility to file a claim against the carrier.

Note: If acceptance of the transformer is made and damage to the unit is noticed at a later time, it is extremely difficult to file a claim against the carrier.

2.2 Proper Handling and Unloading



WARNING: Heavy Equipment. Improper handling can cause severe injury, death, or damage to transformer. Before moving the transformer, read the handling instructions provided in this manual.



CAUTION: The transformer weight is shown on the transformer nameplate. Most of the weight is in the tank that holds the core and coil assembly and the insulating liquid. Do not use hoists, cranes, jacks or forklifts with load capacity less than the transformer weight.



WARNING: Transformer accessories such as bushings, leads, arrestors, etc... Should never be used as a handle to move the transformer.

2.1.1 Moving transformers shipped on pallets

Transformers shipped on pallets may be lifted or moved by forklift trucks of proper capacity. When using a forklift, lift with the transformer tank closest to the mast of the forklift since most of the transformer weight is in the tank. Pallet mounted equipment may also be moved by crane or hoist.

2.1.2 Lifting transformers by crane or hoist

Lifting lugs, welded to all transformer tanks, are designed and provided for lifting the complete unit as shipped. Larson Electronics recommends lifting by these lugs as the primary means of movement. Care should be taken to ensure straps, chains, and cables used to lift the units are inspected prior to use.

All straps, chains, cables, and lifting devices should be in good working order with sufficient capacity to perform the job intended. Straps, chains, and cables should **NEVER** be looped from one lug to another to form a continuous loop around the unit or even on one side of the unit. Each chain, strap, or cable should be run only to one lifting lug at a time to prevent loss of control of the unit in the event of a failure with one of the lifting devices.

Cable pull angles should **NEVER** exceed 30° from vertical or damage to the lifting lugs may occur. Spreader beams/bars should be used to hold the cables apart and as close to vertical as possible to minimize the forces on the lifting lugs and lifting devices.

2.1.3 Skidding/Rolling Transformers

Larson Electronic transformers are designed to be rolled or skidded into place where accessibility to a crane or other overhead lifting device is limited or not available.

If the unit must be rolled, insure that the area is level, free from obstructions and debris, and is of sufficient strength and thickness to support the load. When rollers are used, use as many as necessary to distribute the weight uniformly.

2.1.4 Using Jacks to move transformers

Place jacks under the tank base on the open ends of the transformer tank. **DONOT** place jacks under radiators, valves, cabinets or sheet metal components. **ALWAYS** use at least two jacks per side and raise evenly to prevent warping of the base.

3. Storage

3.1 Storage for 90 days or less

All units have been thoroughly dried at the factory and shipped with oil at the correct level. Transformers should always be stored with oil in place to prevent possible contamination and absorption of moisture. Transformers should be stored in a dry location with no rapid or radical temperature changes. If possible, the transformer should be stored in its permanent location on the foundation which has been prepared for it. If the permanent foundation is not available, it should be stored in its correct upright position on a level foundation capable of withstanding the weight of the unit without deformation.

CAUTION:



- Never store a transformer solely under the jacking steps, on jacks, or on temporary blocking.
- Never store the transformer on rollers.
- Never store the unit in or near standing water or in areas with high moisture, salt levels, or corrosive gases in the air.

3.2 Storage for more than 90 days

All transformers are shipped with a 2 psi dry nitrogen blanket. During long term storage, it is recommended that this nitrogen blanket be maintained by the addition of a bottle of dry nitrogen, through a regulator, to the transformer tank. If the unit is equipped with anti-condensation heaters in the control cabinets, they should be energized and checked for proper operation. Units with any enclosed air filled spaces, such as control cabinets and Air Terminal Chambers, should be supplied with an appropriate amount of moisture absorbing desiccant packets. Desiccant should be monitored and replaced in regular maintenance intervals as moisture levels in the storage area dictates.

3.3 Removable Radiators

Larson Electronics ships all transformers, when possible, completely assembled and ready for use. In the event that removable radiators are shipped separately to accommodate shipping or space requirements, radiator openings are shipped with temporary protective caps. Ensure these protective caps are tightly sealed before storage.



CAUTION: Radiator assemblies should never be stored directly on the ground or in areas in which water could collect near sealed openings.

4. Installation

4.1 Pre-service inspection



ELECTRICAL SHOCK: Never attempt to change connections on an energized transformer. All installation, maintenance, or repair should be performed by trained, experienced, and qualified personnel only.

New transformers, or transformers which are being activated after a period of storage, should be thoroughly inspected before being connected to the power distribution system to identify damage which may have occurred during storage.

1. The transformer exterior should be inspected for nicks, dents, and scratches. Repair damage to weather-resistant finishes promptly.
2. The tank cover and manhole/hand hole cover seals and all gaskets or seals at bushings, gauges, fuses, operating devices, etc., should be inspected for evidence of insulating liquid seepage. Repair leaking or improperly tightened gaskets and seals before the transformer is placed in service.
3. The liquid level inside the tank must be checked (read directly from gauge on transformers equipped with liquid level gauge).
4. Basic electrical tests should be conducted before energizing a transformer which was stored for a period of 90 days or more. Tests include DC insulation Test and Transformer Turns Ratio (TTR). The results of these tests should be verified with the original factory test results to assure they are still within acceptable limits.

4.2 Location Consideration

The unit should not be placed within 36 inches of any obstructions and ample room should be provided for the removal of cabinets, covers, and inspection hatches. Ample room should be available to perform periodic maintenance inspections and perform repairs as needed. Proper ventilation should be considered to prevent overheating of the unit. For outdoor installations, proper placement of the unit should be away from walls, fences, vegetation, or any other structures that would restrict air movement around the unit.

Special precautions should be taken for units installed indoors. Care should be taken to insure adequate ventilation is provided. Auto-closing vents should be permanently fixed in the open position to prevent unintended closure and accidental overheating of the unit. Fans, blowers or other means of positive air movement in the space is strongly encouraged to prevent overheating.

Indoor Units Recommendation:

1. The size of vents in an enclosed space should be at least 20 ft² of inlet and 20 ft² of outlet area per 1000 kVA of unit capacity.
2. High Fire Point Insulating Liquid.
3. Cover Mounted Pressure relief device (PRD) also referred to as Explosion Relief device.



CAUTION: Check with local authorities in the intended installation area to verify compliance of any and all applicable laws.

4.3 Mounting the Transformer

The transformer must be placed on a concrete pad or steel deck of sufficient strength to support the full weight of the unit. The location must be flat and level and prepared to prevent the transformer from tilting beyond two degrees from horizontal.



WARNING: Fire Hazard. Non-level installation of transformer can result in fire and cause severe personal injury or death. Prepare transformer installation site such that transformer does not tilt more than two (2.0) degrees from horizontal while the transformer is in service at the site.

To maintain full cabinet security, the transformer tank and cabinet base have provisions for installing cleats to secure transformer to pad. If gaps still exist between the cabinet and pad after cleating the cabinet, the installation will not provide the security needed to prevent tampering by the public. Add a permanent mortar seal to fill the gaps.

4.4 External Connection



ELECTRICAL SHOCK: Hazardous voltage can cause severe injury, death, or damage to equipment. Ground transformer following industry-accepted safe grounding practices before making other electrical connections. De-energize power distribution wires that will be connected to transformer. Verify that wires are de-energized at the transformer before connecting to transformer.



ELECTRICAL SHOCK: Live front parts such as cables, bushings and other components must be thoroughly tightened and periodically checked to prevent arcing and overheating.

Clean bushings and terminals before making Connections. Remove dirt, grease or foreign material. Contamination can cause failure of the bushings. Cables connected to the transformer terminals are to have sufficient flex to allow normal pad movement due to ground freeze/thaw and settling. Insufficient cable flex may cause premature failure of the bushings

4.4.1 Ground Connection

The transformer tank must be connected to a permanent, low-resistance ground. If the tank is not solidly grounded and the transformer is connected to the power distribution system, then the tank should be regarded as energized. An energized tank is extremely dangerous. Contact with an energized tank can shock, burn, or cause death.

Larson Electronics transformers are equipped with at least two ground pads (Fig. 1) or two ground bosses (Fig. 2) depending on transformers size. One in the primary side and the other in the secondary side.

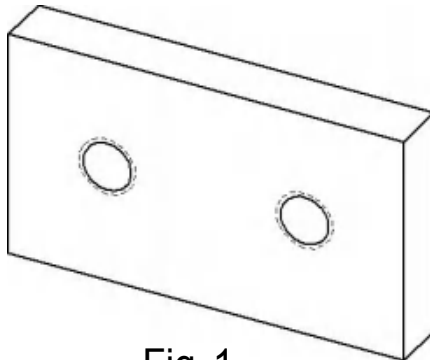


Fig. 1



Fig. 2

4.4.2 High Voltage Connection

Diagrams and information supplied on the nameplate must be followed for making connection. There are two types of typical high voltage connections:

a. Live front transformer connections

Externally/internally clamped porcelain bushings are normally provided for high voltage connection to padmount transformers, supplied with eyebolt or Spade terminals that are suitable for copper and aluminum conductors.

b. Dead front transformer connections

Bushing wells or one piece bushings are normally provided for high voltage connection to padmount transformers, suitable for elbow connections.

4.4.3 Low Voltage Connection

Spade Terminals ranging from two holes to twenty holes are normally provided for low voltage connection to padmount transformers.

5. Accessories

5.1 Pressure Relief Valve

Automatic Pressure relief valve (Fig. 3) is standard on all transformers and is intended to slowly release pressure to prevent rupture of the transformer tank. These valves are factory adjusted to vent at 5 ± 2 PSI. Normal operation and atmospheric temperature fluctuations cause the oil and components in the tank to naturally expand and contract causing the gas filled head space inside the tank to fluctuate in pressure.

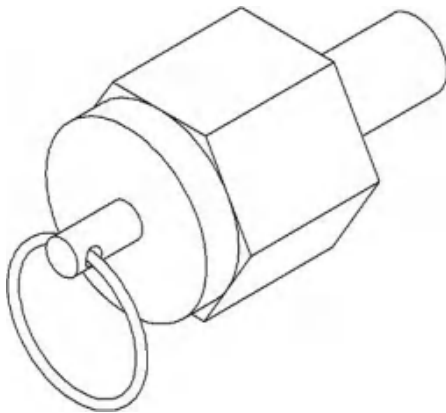


Fig. 3



CAUTION: Before performing any kind of service, which may include but is not limited to: opening the tank or inspection cover, removal of fuses, removal of bushings, opening drain or fill valves, or any other similar operation, the pressure inside the tank must be safely vented manually.



CAUTION: Do not open the transformer in the presence of rain, fog, snow, or if there is condensation on the exterior components of the unit or when the outside air temperature is higher than the temperature of the unit. Even small amounts of moisture that are allowed to enter the transformer tank can decrease the dielectric strength of the insulating fluid and compromise the integrity of the unit.

To manually vent the tank, pull the ring supplied on the valve (as shown in the Fig. 3) until all pressure or vacuum is relieved.

5.2 Fill Plug/Filler Valve with Schrader Valve

Fill Plug with Schrader Valve (Fig. 4 A) or Filler Valve with Schrader Valve (Fig. 4 B) is provided to facilitate addition of dielectric fluid and Nitrogen to the tank.

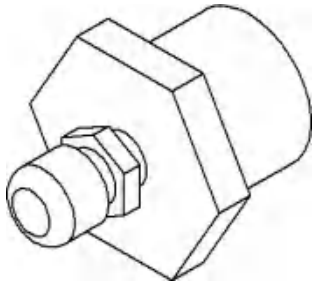


Fig. 4 A

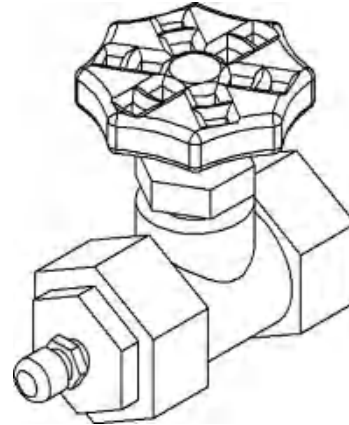


Fig. 4 B

5.3 Drain Valve and Fluid Sampler

The Drain Valve and Fluid Sampler (Fig. 5) is provided to facilitate sampling of the dielectric fluid for testing and other purposes. The valve is also equipped with a plug ranging from $\frac{1}{2}$ " to 2" to provide means of draining the dielectric fluid.

Sampling is usually performed on the side of the valve without the need to remove the end plug.

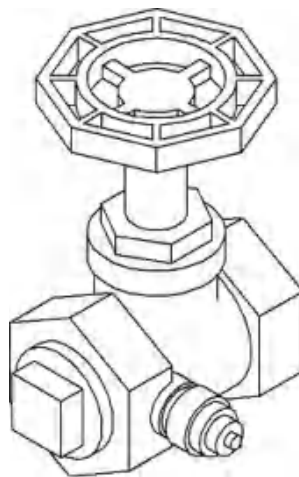


Fig. 5

5.4 Liquid level gauge

A liquid level gauge (Fig. 6) is supplied to indicate the amount of dielectric fluid in the transformer tank. The gauge consists of a float arm inside the tank magnetically coupled to the indicator needle inside the gauge. The magnetic coupling maintains a liquid tight separation between the interior oil and the outside to minimize potential leaks.



Fig. 6

Larson Electronics utilizes several different brands and models of liquid level gauges depending on the application. Transformers can be supplied with a standard gauge or more sophisticated models with either one or two SPDT (Single Pole Double Throw) alarm contacts to facilitate external monitoring.

Liquid Levels may vary under normal operation according to temperature and pressure. The 25° C mark is only a reference fluid level at 25° C

For wiring and other information, please refer to the schematics included in the submittal drawings.

5.5 Temperature gauge

The temperature gauge (Fig. 7) is supplied to indicate the dielectric fluid temperature in degrees centigrade at the top of the oil column. The gauge consists of two needles (one white and one red). The white needle is the current oil temperature of the unit.

The red needle is a resettable maximum indicator. As the temperature of the oil rises, the white needle pushes the red needle higher with it. If the temperature of the oil declines the white needle follows and goes down with temperature, the red needle however remains at the highest temperature reached and acts as a recorder to indicate the highest temperature achieved by the unit. The red needle (maximum indicator) can be reset by turning the knob on the front of the gauge face.

The temperature gauge consists of a long thermocouple that extends into the tank inside a protective thermocouple well. The isolation between the thermocouple and the dielectric fluid facilitates the removal and replacement of the gauge without draining down the dielectric fluid.

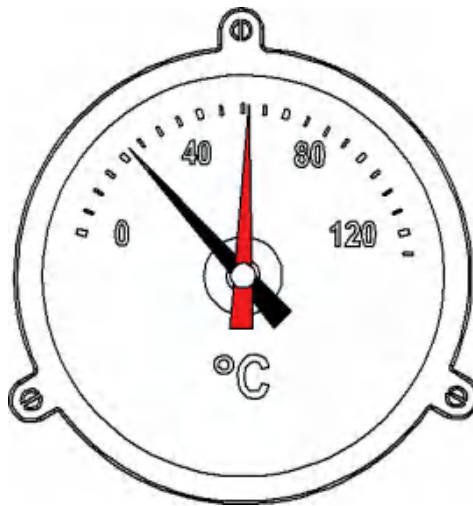


Fig. 7

The temperature gauge can be equipped with either one or two SPDT alarm contacts for remote monitoring or fan control. These alarm contacts are factory set but can be adjusted if desired.

To adjust the contacts, remove the face of the gauge. Look toward the center of the gauge for a small Allen head set screw. Loosen this set screw and manually move the contacts (red indicators toward the outer edge of the dial) to the desired temperature settings. Gently retighten the set screw and replace gauge face. For wiring and other information, please refer to the schematics included in the submittal drawings.

5.6 Pressure Vacuum Gauge

The pressure vacuum gauge (Fig. 8) indicates whether the head space pressure inside the tank is positive, negative or neutral. The pressure inside the tank will vary depending on the load of the unit, temperature of the oil and ambient temperature outside. As the oil temperature rises, the pressure inside the tank also rises. As the temperature falls, the pressure falls. It is common for a transformer to have either a positive pressure or a negative pressure.

Do not be alarmed by a consistent negative pressure (for example, if it's winter time In Wisconsin, it will probably be negative for the duration of the season). However, if the gauge consistently reads zero and does not appear to be changing with environmental or load conditions, this may be an indication of a leak and may need attention. Visually inspect the unit for any signs of a leak or damaged seal.

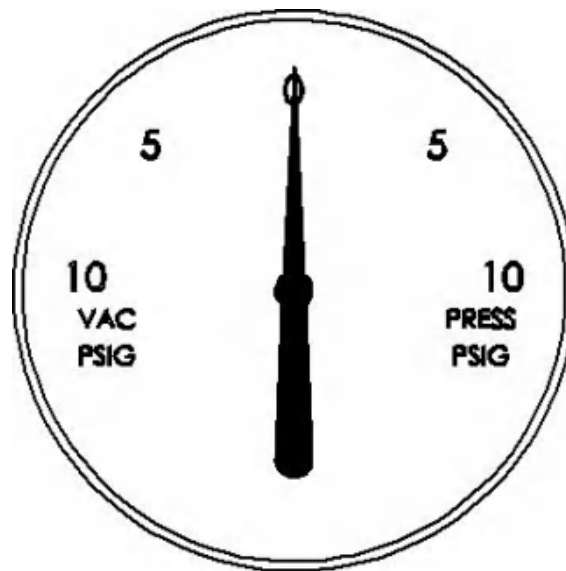


Fig. 8

The pressure/vacuum gauge can also be equipped with SPDT alarm contacts (by adding a separate pressure alarm switch) for remote monitoring of positive and negative pressures. When requested, the pressure/vacuum gauge can also be equipped with a bleeder or regulator; when used in conjunction with an external nitrogen supply, positive pressure can be maintained inside the tank (2.5 to 3.0 PSI). The regulator is also equipped with a fitting and valve to take gas samples.

5.7 Fault Pressure Relief Device (FPRD)

Also commonly referred to as an Explosion Relief Device (Fig.9), this device facilitates the rapid release of gas pressure in the event of an internal fault. This device should not be confused with a standard Automatic Pressure Relief Valve as shown in (Fig. 3), which only releases pressure slowly to account for thermal expansion and contraction. A PRD is cover mounted and equipped with a spring loaded diaphragm that is factory set to open at a predetermined pressure level (Typically 10 psi). After the tank pressure returns to normal the Diaphragm will close and reseal the unit. The FPRD is equipped with an indicator (yellow button on top) that will protrude vertically after an event until it is reset.

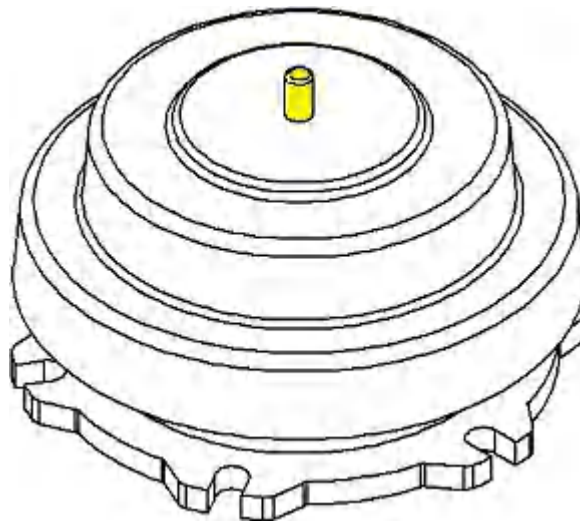


Fig. 9

The FPRD can also be supplied with SPDT alarm contacts for remote monitoring.

For wiring and other information, please refer to the schematics included in the submittal drawings.

5.8 Rapid Pressure Rise Relay (RPRR) with Seal-in relay

This RPRR (Fig. 10) is a device for detection of sudden pressure events based on the rate of pressure rise in the transformer. When a dangerous pressure rise has been detected, the rapid pressure rise relay (RPRR) will change state. This can be used as an alarm or trip signal to minimize the potential of transformer tank damage.

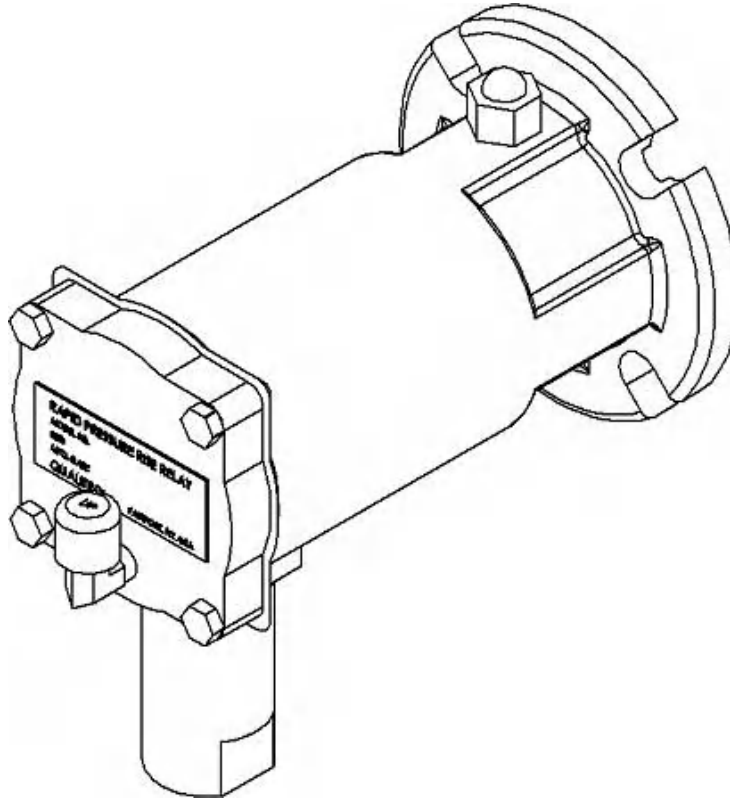


Fig. 10

For wiring and other information, please refer to the schematics included in the submittal drawings.

5.9 Winding Temperature Indicator

Larson Electronics utilizes a digital winding temperature monitor (Fig. 11), this system consists of thermocouples wound into each coil of the transformer in strategic locations to accurately monitor the temperature inside the coil itself. The thermocouple leads are brought out of the tank through a sealed bulkhead type fitting within a protective enclosure. The digital readout and controls are housed in a separate NEMA 4 enclosure typically mounted on side of the tank.

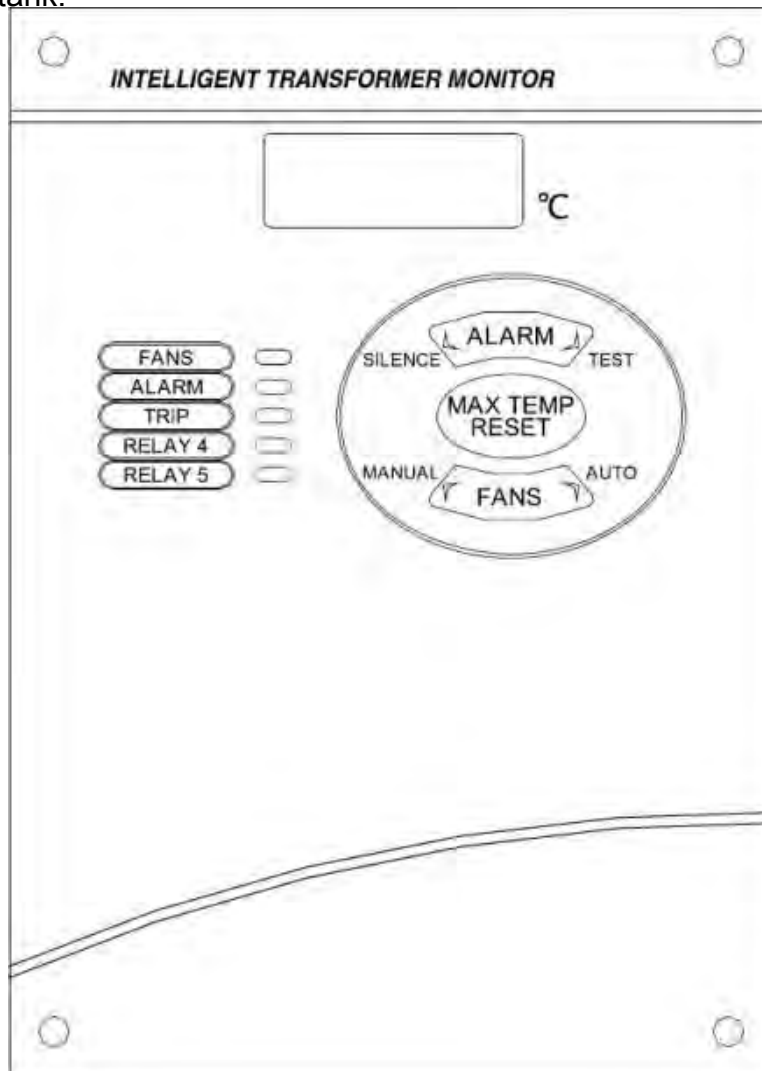


Fig. 11

For wiring and other settings information, please refer to the schematics included in the submittal drawings.

5.10 Forced Air Cooling Fans

Forced Air Cooling Fans (Fig. 12) are provided optionally for units supplied with radiators to increase the KVA capacity of the transformer by up to 25% without overheating or experiencing detrimental effects. The size and number of fans can vary depending on the application. Fans can either be controlled by a top oil temperature gauge with contacts or by a winding temperature indicator.

For wiring and other refer to the schematics submittal drawings.

information, please included in the

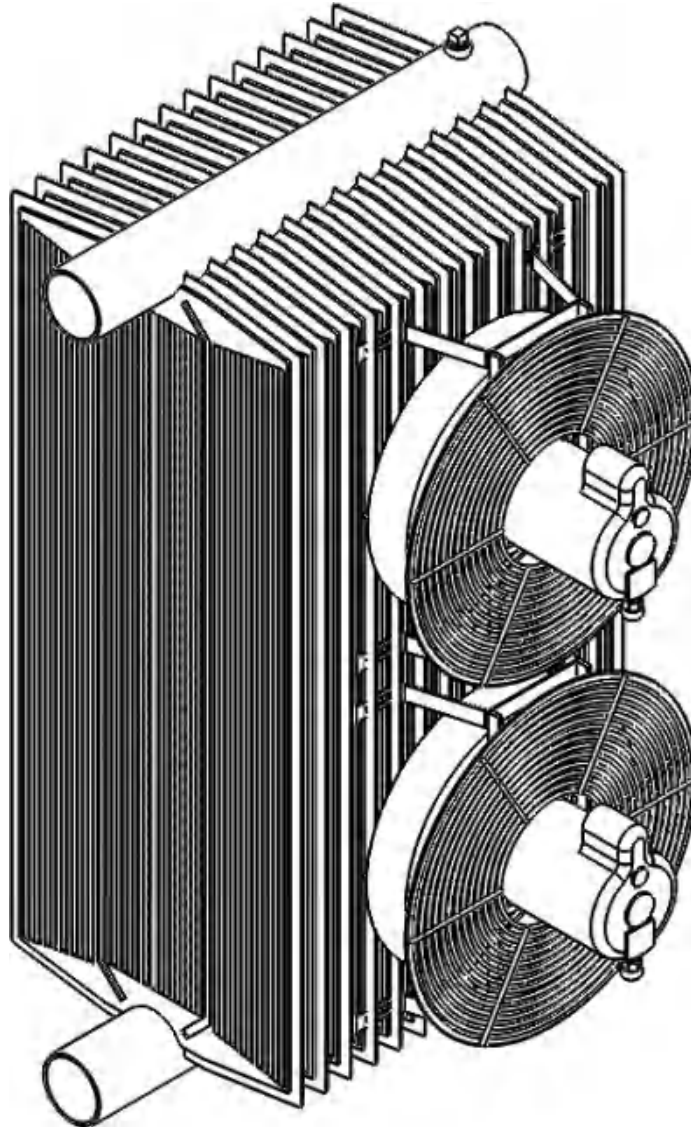


Fig. 12

5.11 Current Transformers & Meter Sockets and Watt-Hour Meters.

Padmount transformers may be equipped with CT's for various reasons such as metering or relaying, they also may be equipped with meters mounted on the transformer.

Different types and classes of CT's are used according to the application and the customer needs. (Fig. 13 A) is a bushing mounted CT, (Fig. 13 B) is an internally mounted CT, and (Fig. 13 C) is a meter socket with Watt-Hour meter that is used in some of the transformers.

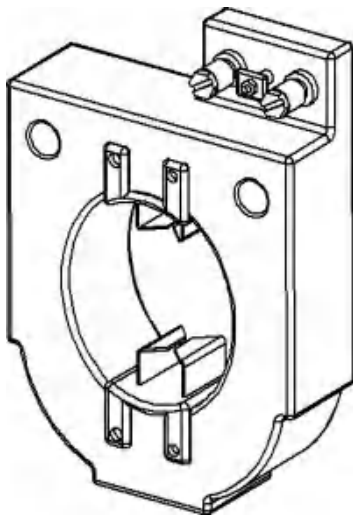


Fig. 13A

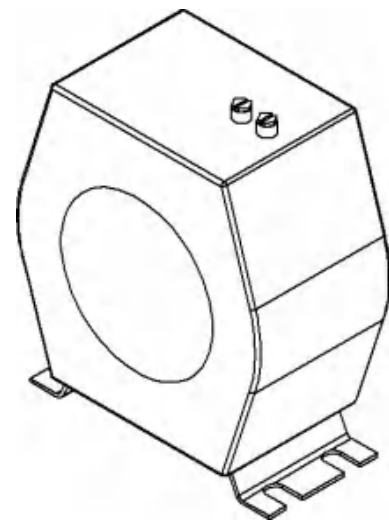


Fig. 13B

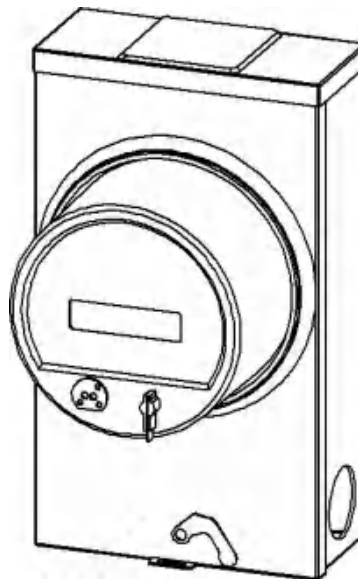


Fig. 9C

6. Switching and Protection Devices



ELECTRICAL SHOCK: Can cause severe injury, death, or damage to equipment. De-energize transformer from a remote upstream source before operating no-load tap-changers, dual-voltage switches, or Delta-wye switches.

6.1 Tap Changers

Externally operated No-Load Tap changer (NLTC) (Fig. 14 A & B) is provided for all transformers, unless otherwise specified, to change from one operating voltage to another. Typical taps are configured at $\pm 2 \times 2.5\%$ of rated voltage; this means that the output voltage of the transformer can be adjusted in 2.5% increments

Tap-changers will have a hot stick operable handle. There are two styles of tap-changer with this type of handle, each requiring a slightly different method for changing tap settings.

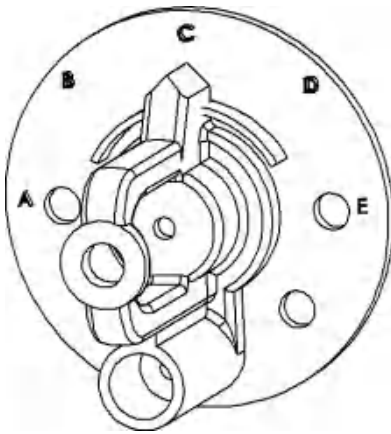


Fig. 14A

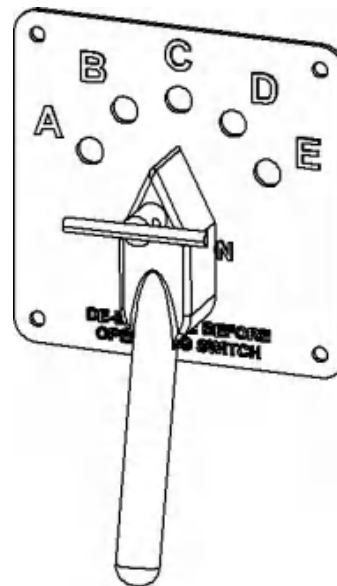


Fig. 14B

Please refer to Name Plate and other supplied information for more details.

6.2 Load Break Oil-Immersed Rotary Switches (LBOR)

-  **WARNING:** Do not operate load break equipment if a fault condition is suspected. Doing so can cause an explosion or fire.
-  **WARNING:** Use a hotstick to operate transformer load break equipment.
-  **WARNING:** After operating transformer load break equipment, check that voltages at transformer terminals are the expected values. Checking voltages verifies that load break equipment operated properly and that electrical circuit conditions are as expected.
-  **WARNING:** Before servicing transformer secondary connected equipment, verify that all transformer secondary terminals have zero voltage and ground the transformer secondary terminals following industry accepted safe grounding practices. Grounding secondary terminals protects against situations such as a standby generator energizing transformer from the secondary circuit.

6.2.1 Two-Position LBOR Switch

The Two-Position LBOR Switches (Fig. 15) are provided optionally in padmount transformers to achieve load breaking or making and loop feed switching. LBOR's will have a hotstick operable handle



Fig. 15

Multiple 2-Position LBOR Switches may be utilized to achieve loop-Feed switching (Fig. 15A)

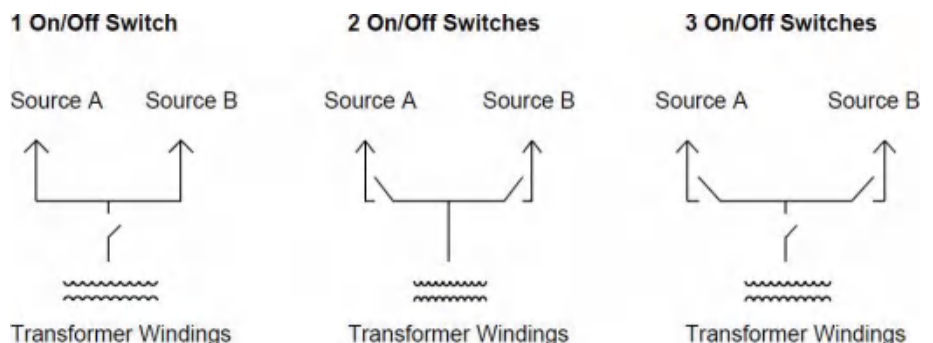


Fig. 15A

The spring-loaded activating mechanism of the switch ensures quick load break or load make operations in less than one cycle, and should be performed with a hotstick

Please refer to Name Plate and other supplied information for more details.

6.2.2 Four-Position LBOR Switch “Sectionalizing Switch”

The Four-Position LBOR Sectionalizing Switch (Fig. 16 A & B) is provided optionally in loop-feed padmount transformers to select the feed source, open or close the feed-thru loop and open or close the transformer.

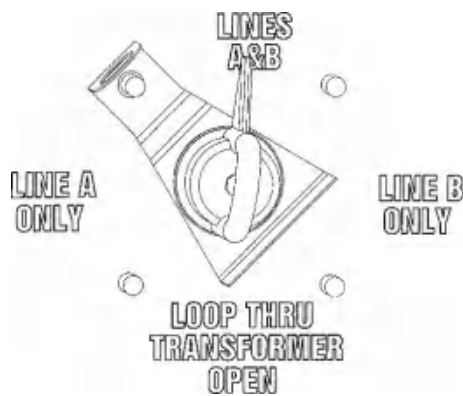


Fig. 16 A – T-Blade 4-Position LBOR Switch

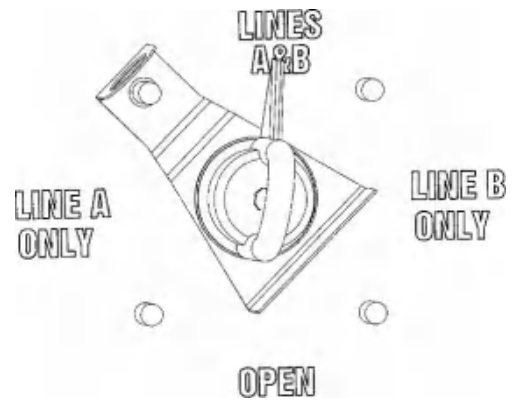


Fig. 16 B – V-Blade 4-Position LBOR Switch

The spring-loaded activating mechanism ensures quick load break action and positive contact engagement through all positions. Switching can be accomplished in less than one cycle, and should be performed with a hotstick.

For switch ratings and additional switch configurations refer to submittal drawings provided with the transformer.

6.3 Dual Voltage Switch



WARNING: Excessive current can cause damage to transformer winding. Tap-changers and other switches must be in the position shown on the transformer nameplate.



WARNING: The transformer must be de-energized and grounded before dual voltage switch is operated. Attempting to change dual-voltage switch on an energized transformer may result in damage to the equipment and severe personal injury.

The Dual Voltage Switch (Fig. 17) is typically provided in dual primary padmount transformers to facilitate selecting one primary voltage from another.

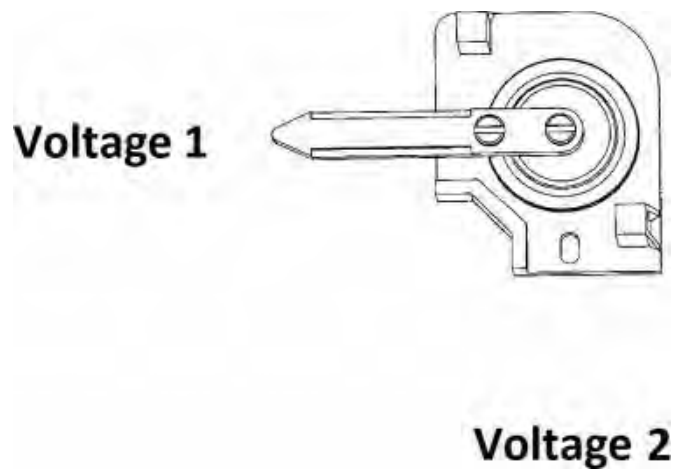


Fig. 17

For switch ratings and additional switch configurations refer to submittal drawings provided with the transformer.

6.4 Delta-Wye Switch



WARNING: Excessive current can cause damage to transformer winding. Tap-changers and other switches must be in the position shown on the transformer nameplate.



WARNING: The transformer must be de-energized and grounded before dual voltage switch is operated. Attempting to change dual-voltage switch on an energized transformer may result in damage to the equipment and severe personal injury.

The Delta-Wye switch (Fig. 18) is provided with special padmount transformers that are built and configured to support switching between Delta and Wye voltages.

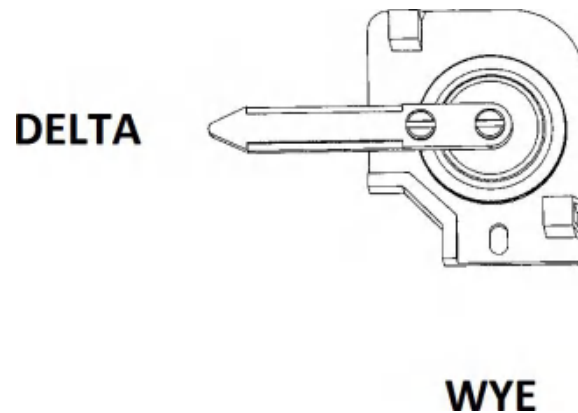


Fig. 18

For switch ratings and additional switch configurations refer to submittal drawings provided with the transformer

6.5 Surge Arresters



ELECTRIC SHOCK: Can cause severe injury, death, or damage to equipment. De-energize transformer from a remote upstream source before servicing or operating surge arresters or disconnect switches. Check that all transformer terminals and bushings have zero voltage. Ground transformer following industry accepted safe grounding practices.



CAUTION: Excessive test voltage can damage surge arresters. Disconnect surge arresters before running impulse or applied potential tests on the transformer.

Surge Arresters (Fig. 16) are provided optionally in padmount transformers to protect equipment and cables from overvoltage surges.

During steady state conditions, line-to-ground voltage is applied continuously across the arrester terminals. When 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, conducting minimal leakage current.

6.5.1 Dead front Surge Arresters

Dead front Surge Arrester (Fig. 19 A) also called elbow arrestor is a pre-molded rubber elbow that houses zinc oxide Varistor technology to provide overvoltage system protection to dead front padmount transformers.

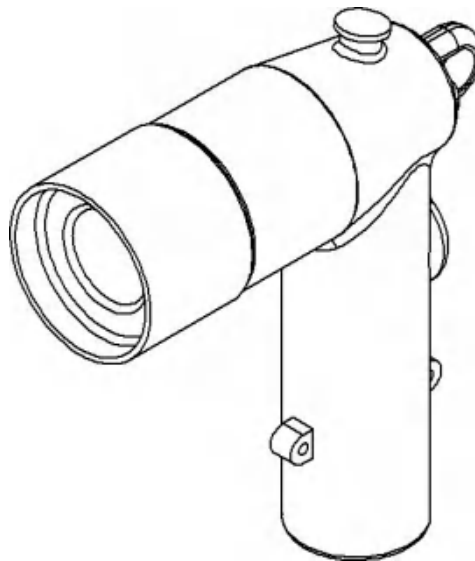


Fig. 19A

6.5.2 Live front Surge Arresters

Live front Surge Arrester (Fig. 19 B) is a polymer that houses a metal oxide Varistor to provide overvoltage system protection to Live front padmount transformers.

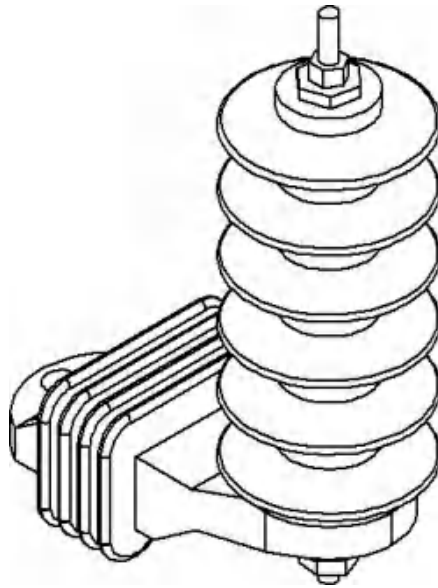


Fig. 19B

6.6 Fusing



ELECTRIC SHOCK: Can cause severe injury, death, or damage to equipment. Use a hotstick to service a Bay-O-Net fuse. Do not install a fuse to complete an electrical circuit if a fault condition is suspected. Do not re-energize suspected failed equipment. After installing fuses, energize transformer from a remote upstream source.



WARNING: Never attempt to remove fuses with pressure on the tank. Severe burns and personal injury may result from hot dielectric fluid.

6.6.1 Bay-O-Net Fuses

The Bay-O-Net fuse (Fig. 20 A) is used in series with an isolation link or current-limiting fuse “ELSP Back-up Fuse” to achieve over current protection and high current interrupting current rating. The bay-o-net fuses are field replaceable without needing to open the transformer tank.

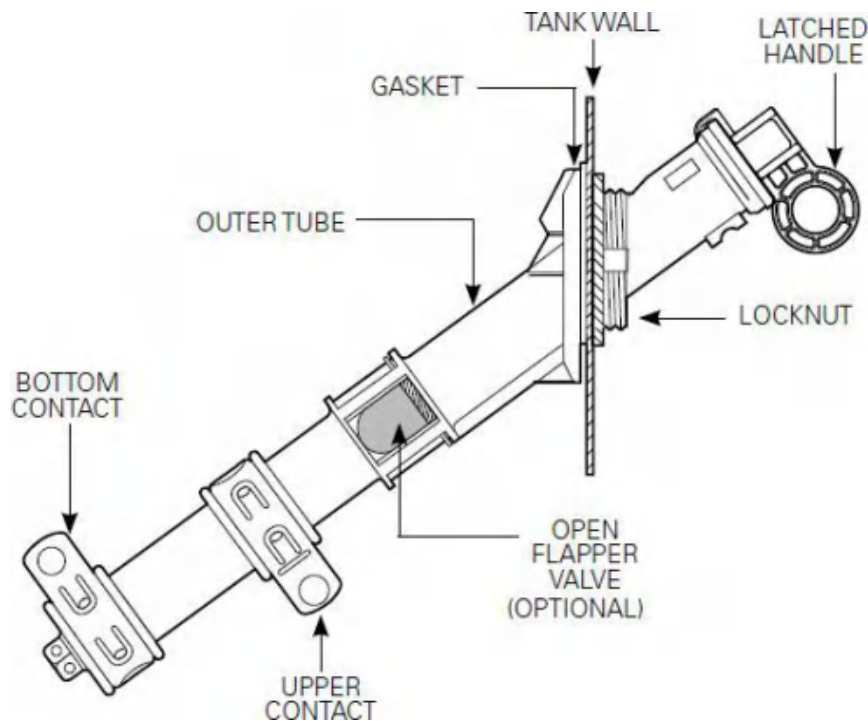


Fig. 20 A

Bay-O-Net fuse replacement instruction (Fig. 20 B):

1. Relieve pressure in the transformer tank by pulling out the pressure relief valve for 30 seconds or until the hissing sound of the valve stops.
2. Repeat step 1 to insure any residual pressure is released.
3. Attach a hot stick to the fuse holder eye and twist to unlock
4. Turn fuse holder 90° to break seal gasket and Bay-O-Net housing.
5. Draw fuse holder out quickly 8-10 inches to interrupt load
6. Wait several seconds for fluid to drain from the fuse holder and remove from housing
7. Remove fuse cartridge from fuse cartridge holder using a $\frac{3}{4}$ " wrench.
8. Remove end plug using a $\frac{3}{4}$ " and a $\frac{1}{2}$ " wrench
9. Replace the fuse

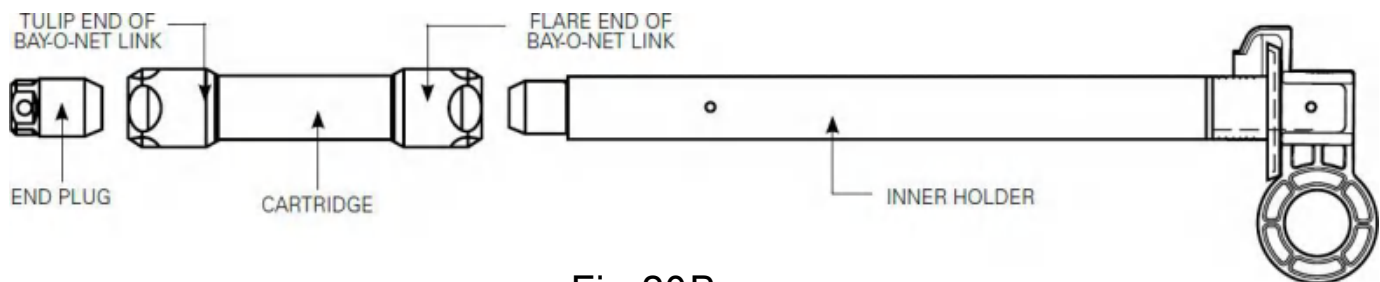


Fig.20B

6.6.2 Dry-Well Canister Fuses

The dry-well housing (Fig. 21 A & B) consists of filament-wound glass tubing with a resin-rich outer surface, this outer surface serves as the barrier against oil permeation through the tubing wall.

The current limiting fuse that these fuse-holders are designed to accept will not function properly if exposed to transformer oil; the interior of the fuse holder must remain oil tight.

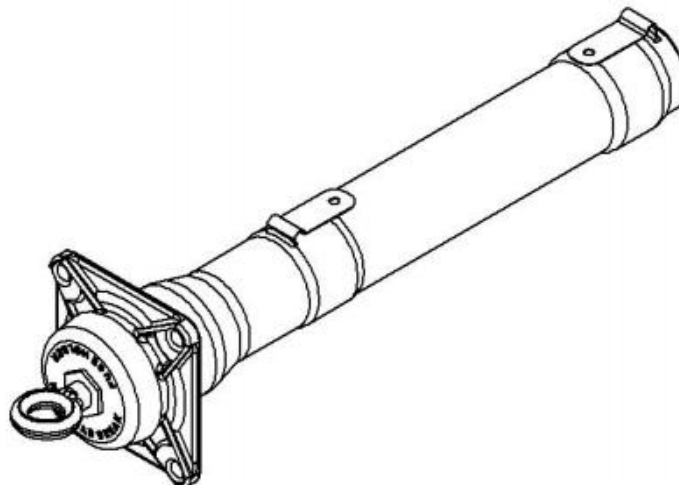
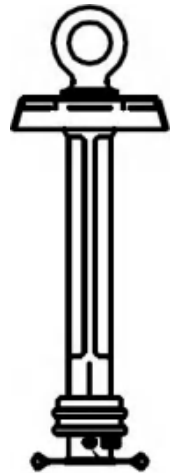


Fig.21A

Non-Loadbreak Dry-Well Canister Fuse replacement instruction (Fig. 21 B):

1. De-energize transformer from a remote upstream source
2. Disassemble by loosening 4 set screws
3. Attach a hot stick to the fuse holder eye and pull out
4. Draw fuse holder out
5. Replace the fuse and reinsert the fuse with the fuse holder
6. Assemble by tightening 4 set screws

**Loadbreak Dry-Well Canister Fuse replacement instruction (Fig. 2**

1. Disassemble by loosening 4 set screws
2. Attach a hot stick to the fuse holder eye
3. Draw fuse holder out rapidly to interrupt load "Load Break"
4. Replace the fuse and insert it rapidly "Load Make"
5. Assemble by tightening 4 set screws.

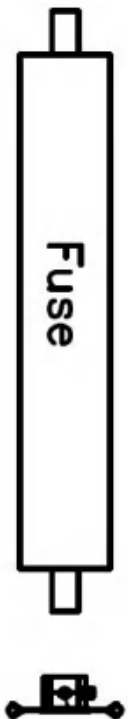


Fig. 21 B

7. Dielectric Fluid

7.1 Type II Mineral Oil

Padmount transformers filled with mineral oil that complies with ASTM D-3487, TYPE II.

TYPICAL PHYSICAL AND CHEMICAL PROPERTIES

pH: N/A	PCB: No	closed cup flash point: >145°C
Auto ignition temperature: > 315°C		Boiling point: >238°C
Relative density (H ₂ O = 1): 0.89		Vapor pressure (mm Hg): <0.01 @ 20°C
Pour point: -54°C		Vapor density (air = 1): N/A
Evaporation rate (butyl acetate = 1): N/A		Solubility in water: negligible; < 0.1%
Volatile organic compounds: < 0.001 g/L		Viscosity: 9.3 TO 9.5 CsT at 40°C
Miscibility: mixes with other dielectric fluids except silicone		
Appearance and odor: Clear bright liquid with Mineral odor		

7.2 High Fire Point Dielectric fluid

Padmount transformers filled with High Fire Point Dielectric fluid typically use Envirotemp FR3 fluid which complies with ASTMD-6871

FR-3 is a natural ester derived from renewable vegetable oils – providing improved fire safety and environmental benefits that are superior to mineral oil.

TYPICAL PHYSICAL AND CHEMICAL PROPERTIES

pH: neutral	PCB: No	Closed cup flash point: 320 – 330°C
Auto ignition temperature: 401 – 404°C		Boiling point: >360°C
Relative density (H ₂ O = 1): 0.92		Vapor pressure (mm Hg): <0.01 @ 20°C
Pour point: -18 to -24°C		Vapor density (air = 1): N/A
Evaporation rate (butyl acetate = 1): nil		Solubility in water: negligible; < 0.1%
Volatile organic compounds: < 0.001 g/L		Viscosity: 32 – 34 CsT at 40°C
Miscibility: mixes with other dielectric fluids except silicone		
Appearance and odor: clear light-green liquid with slight vegetable oil odor		

8. Factory Testing

 **CAUTION:** The information below is not intended to be as a guideline for testing transformers, please refer to IEE/ANSI C57.12.90-2006 and ANSI/NETA ATS-2009 for more details.

8.1 Routine Tests

8.1.1 Ratio

The turn ratio of a transformer is the ratio of the number of turns in the high-voltage winding to that in the Low voltage winding. When the transformer has taps, the turn ratio shall be determined for all taps and for the full winding.

Note: The ratio test can also be used to test **polarity, phase relation, and phase sequence.**

8.1.2 Winding Resistance

Resistance measurements are of fundamental importance for the calculation of the I^2R component of conductor losses and calculation of winding temperatures at the end of a temperature rise test.

8.1.3 No Load and Excitation Current

No-load (excitation) losses are losses that are incident to the excitation of the transformer. No-load losses include core loss, dielectric loss, conductor loss in the winding due to excitation current, and conductor loss due to circulating current in parallel windings. These losses change with the excitation voltage.

Excitation current (no-load current) is the current that flows in any winding used to excite the transformer when all other windings are open-circuited. It is generally expressed in percent of the rated current of the winding in which it is measured. The no-load losses consist primarily of the core loss in the transformer core, which is a function of the magnitude, frequency, and waveform of the impressed voltage. No-load losses also vary with temperature and are particularly sensitive to differences in waveform; therefore, no-load loss measurements will vary markedly with the waveform of the test voltage.

8.1.4 Load Losses and Impedance Voltage

The load losses of a transformer are losses incident to a specified load carried by the transformer. Load losses include I^2R loss in the windings due to load current and stray losses due to eddy currents induced by leakage flux in the windings, core clamps, magnetic shields, tank walls, and other conducting parts

The impedance voltage of a transformer is the voltage required to circulate rated current through one of two specified windings when the other winding is short-circuited, with the windings connected as for rated voltage

operation. Impedance voltage is usually expressed in per unit or in percent of the rated voltage of the winding across which the voltage is applied and measured

8.1.5 Dielectric Strength

The dielectric test of the transformer is intended to check the ability of main insulation to earth, inter turn and line end insulation to earth. It is generally performed in two different steps, likewise, Separate applied voltage withstand test (Hi-Pot) and induced voltage withstand test

8.2 Special/Design Tests

8.2.1 Insulation Power Factor (Tan δ)

The insulation power factor is the ratio of the power dissipated in the insulation in watts to the product of The effective voltage and current in volt-amperes when tested under a sinusoidal voltage and prescribed Conditions.

8.2.2 Insulation Resistance

Insulation resistance tests are made to determine the insulation resistance from individual windings to ground or between individual windings. Insulation resistance tests are commonly measured in mega ohms or may be calculated from measurements of applied voltage and leakage current.

8.2.3 Temperature Rise

A temperature-rise test is defined as a test to determine the temperature rise above ambient of one or more of the transformer's windings, as measured at the terminals. The result for a given terminal pair or winding is the average value of the temperature of the entire circuit; it is not the temperature at any given point in a specific winding. The term average temperature rise refers to the value determined by measurements on a given terminal pair of the winding. It does not refer to the arithmetic average of results determined from different terminal pairs of the transformer

8.2.4 Lightning Impulse

Lightning impulse tests shall consist of and be applied in the following order: one reduced full wave, two chopped waves, and one full wave. The time interval between applications of the last chopped wave and the final full wave should be minimized without intentional delays, to avoid recovery of dielectric strength if a failure were to occur prior to the final full wave. Impulse tests shall be made without excitation.

Please refer to IEEE Standard C57.98-2011.

8.2.5 Audible Sound Level

Audible sound from transformers originates principally in the transformer core and transmits through the dielectric fluid and/or structural supports, to the outer shell and/or other solid surface, where it radiates as airborne sound. In some situations, the windings may be a noise source under rated load conditions, but this noise is not included in this standard. The frequency spectra of the audible sound consists primarily of the even harmonics of the power frequency; thus, for a 60 Hz power system, the audible sound spectra consists of tones at 120 Hz, 240 Hz, 360 Hz, 480 Hz, and so on. The audible sound also contains the noise emitted by any dielectric fluid mechanical cooling system. Mechanical cooler sound consists of broadband fan noise, plus discrete tones at the fan blade passage frequency and its harmonics.

9. Maintenance

9.1 Spare Parts

Larson Electronics specializes in manufacturing custom transformers and makes only limited quantities of any one design. Replacement parts are best handled on a case-by-case basis. Should additional or replacement parts be necessary for any Larson Electronics unit, please contact the factory and provide all available nameplate data.

9.2 Routine Inspection

Routine inspection of the exterior of the unit should be performed periodically. The inspection interval should take the environmental conditions of the site into consideration. Salty, damp or otherwise corrosive environments will require shorter inspection intervals than dry and mild conditions.

Periodically check between the radiators (if equipped) for debris and obstructions. Ensure that the unit is getting adequate airflow and that brush, overgrowth or surrounding equipment is not impeding proper airflow. If the unit is equipped with forced air cooling, manually cycle the fans using the switch in the control panel to ensure proper operation. Clean any dirt or buildup away from the base and cabinet areas to prevent premature rust and deterioration.

During an external inspection, check the paint for signs of deterioration, including cracked or chipping paint and rust spots. If paint damage or deterioration has occurred, touch-up or repaint the exterior of the unit as soon as possible to prevent further degradation. Larson Electronics uses several different painting processes depending on the application. An inquiry to the factory, with the serial number of the unit, will determine the type and compatibility of the touch-up paint required.

Gauges should be checked regularly for proper operation. The temperature gauge should fluctuate with load conditions and ambient temperature but should never read over the design value on the nameplate plus the average daily ambient temperature (for example, if it is a 25°C day and it has a 65°C rating on the nameplate it should not read over 90°C on the gauge). The liquid level gauge will also fluctuate slightly with temperature and loading but a steady drop may indicate a leak and should be addressed. The pressure/vacuum gauge will vary with temperature as well, but should never register zero for prolonged periods of time (another indication of a leak).

9.3 Dielectric Fluid Sampling

Dielectric fluid samples should be taken at least on an annual basis and analyzed by DGA (Dissolved Gas Analysis). Routine DGA testing is one of the best methods of determining the “Health” of a transformer. Although the ultimate failure of a transformer may be impossible to predict, routine oil testing can often indicate a detrimental internal condition before it destroys the unit.

THESE INSTRUCTIONS MAY NOT COVER ALL DETAILS OR VARIATIONS OF THIS PRODUCT FOR YOUR EQUIPMENT OR INSTALLATION REQUIREMENTS. SHOULD FURTHER INFORMATION NOT COVERED BY THESE INSTRUCTIONS BE REQUIRED, PLEASE CONTACT LARSON ELECTRONICS BY EMAIL AT SALES@LARSONELECTRONICS.COM OR BY PHONE AT 1-877-348-9680 FOR FURTHER ASSISTANCE.

PLEASE VISIT LARSONELECTRONICS.COM FOR **WARRANTY** AND **RETURN** INFORMATION.

LOADBREAK ELBOW SAFETY INFORMATION AND INSTRUCTION MANUAL

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200 A 15 and 25 kV class elbow with optional integral jacket seal



Safety



Larson Electronics meets or exceeds all applicable industry standards relating to product safety in its MT-PML series products. We actively promote safe practices in the use and maintenance of our products through our service literature, instructional training programs, and the continuous efforts of all Larson employees involved in product design, manufacture, marketing, and service.

We strongly urge that you always follow all locally-approved safety procedures and safety instructions when working around high-voltage lines and equipment.

Safety information

The instructions in this manual are not intended as a substitute for proper training or adequate experience in the safe operation of the equipment described. Only competent technicians who are familiar with this equipment should install, operate, and service it.

A competent technician has these qualifications:

- Is thoroughly familiar with these instructions.
- Is trained in industry-accepted high- and low-voltage safe operating practices and procedures.
- Is trained and authorized to energize, de-energize, clear, and ground power distribution equipment.
- Is trained in the care and use of protective equipment such as arc flash clothing, safety glasses, face shield, hard hat, rubber gloves, clampstick, hotstick, etc.

Following is important safety information. For safe installation and operation of this equipment, be sure to read and understand all cautions and warnings.

Hazard Statement Definitions

This manual may contain four types of hazard statements:

 DANGER

Indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.

 WARNING

Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

 CAUTION

Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury.

NOTICE

Indicates a potentially hazardous situation which, if not avoided, may result in equipment damage only.

Safety instructions

Following are general caution and warning statements that apply to this equipment. Additional statements, related to specific tasks and procedures, are located throughout the manual.

 DANGER

Hazardous voltage. Contact with hazardous voltage will cause death or severe personal injury. Follow all locally-approved safety procedures when working around high and low-voltage lines and equipment.

 WARNING

Before installing, operating, maintaining, or testing this equipment, carefully read and understand the contents of this manual. Improper operation, handling, or maintenance can result in death, severe personal injury, and equipment damage.

 WARNING

This equipment is not intended to protect human life. Follow all locally-approved procedures and safety practices when installing or operating this equipment. Failure to comply can result in death, severe personal injury, and equipment damage.

 WARNING

Power distribution and transmission equipment must be properly selected for the intended application. It must be installed and serviced by competent personnel who have been trained and understand proper safety procedures. These instructions are written for such personnel and are not a substitute for adequate training and experience in safety procedures. Failure to properly select, install, or maintain power distribution and transmission equipment can result in death, severe personal injury, and equipment damage.

200 A 15 and 25 kV class elbow with optional integral jacket seal

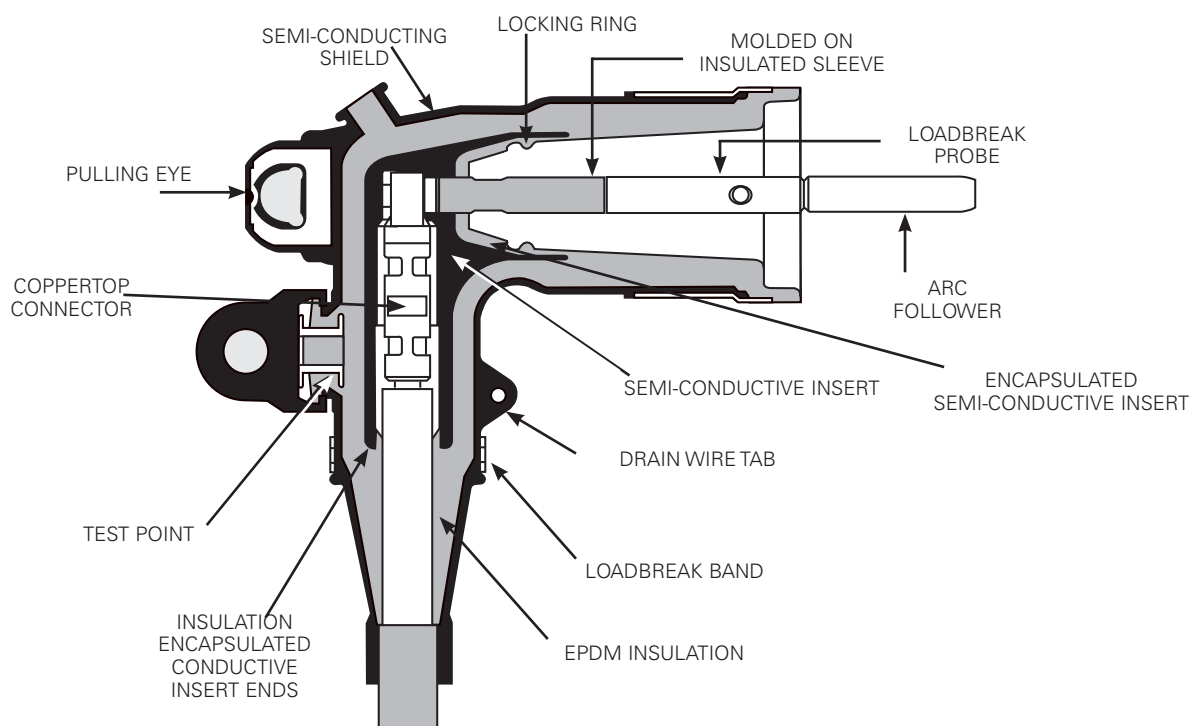


Figure 1. Line illustration of 200 A 25 kV expanded range POSI-BREAK™ elbow.

⚠ WARNING

All associated apparatus must be de-energized during any hands-on installation or maintenance. Failure to comply could result in death, severe personal injury and equipment damage.

Product information

Introduction

Larson Electronics MT-PML series loadbreak elbow connector is a fully-shielded and insulated plug-in termination for connecting underground cable to transformers, switching cabinets and junctions equipped with loadbreak bushings. The elbow connector and bushing insert comprise the essential components of all loadbreak connections.

Read this manual first

Read and understand the contents of this manual and follow all locally approved procedures and safety practices before installing or operating this equipment

Additional information

These instructions cannot cover all details or variations in the equipment, procedures, or process described nor provide directions for meeting every possible contingency during installation, operation, or maintenance. When

additional information is desired to satisfy a problem not covered sufficiently for the user's purpose, please contact Larson Electronics.

⚠ WARNING

Optional Capacitive Test Point Operating Instructions: Use only voltage indicating instruments specifically designed for test points. Use of conventional voltage sensing devices may provide false "No Voltage" indications.

The test point must be dry and free of contaminants when checking for voltage. After indication is taken: clean, dry, and lubricate the test point cap with silicone grease and assemble to the test point.

Always consider the termination to be energized until the test point "No Voltage" indication is confirmed by other means. Failure to comply could result in death or severe personal injury.

Acceptance and initial inspection

Each loadbreak elbow connector is completely inspected and tested at the factory. It is in good condition when accepted by the carrier for shipment. Upon receipt of a loadbreak elbow connector kit, inspect the connector thoroughly for damage and loss of parts incurred during shipment. If damage or loss is discovered, file a claim with the carrier immediately.

200 A 15 and 25 kV class elbow with optional integral jacket seal

Handling and storage

If the loadbreak elbow connector is to be stored for an appreciable time before installation, provide a clean, dry storage area. Locate the connector so as to minimize the possibility of physical damage.

Quality standards

ISO 9001 Certified Quality Management System

Installation procedures

Cable stripping and scoring tools, available from various tool manufacturers, are recommended for use when installing loadbreak elbows. After preparing the cable, the elbow housing is pushed onto the cable. The load-break probe is threaded into the coppertop connector using the supplied installation tool or an approved equivalent. Use a clampstick to perform loadmake and loadbreak operations. (See **"Operating procedures" on page 7.**)

Complete elbow kit includes:

- Standard Elbow Body or Elbow Body with Jacket Seal
- Coppertop Compression Connector
- Loadbreak Probe
- Probe Installation Tool
- Silicone Lubricant
- Mastix Strips (**Jacket Seal Elbow Only**)
- Installation Instruction Sheet

Tools/Accessories needed:

- Tape Measure
- Wire Brush
- Knife
- Cable Stripping Tool
- Crimping Tool
- Cable Cleaner
- Cable Cutters
- Clampstick
- Personal Protection Equipment

Preparation of concentric neutral cable

Note: Stripbacks shown in these instructions for concentric neutral cable are the same for tape shielded and drain wire cables. Refer to shield adapter kit being used for metallic shield stripbacks.

Cable Training

Position cable vertically so that it is centered between apparatus bushing and parking pocket, parallel to the apparatus frontplate. Provide adequate slack in the cable to permit unrestricted movement of the elbow connector from the apparatus bushing to a standoff bushing or portable feedthru.

Once installed, the cable should enter the elbow connector in a straight line. Avoid a tight bend radius at the cable entrance of the elbow that causes the elbow to bend. (See **Figure 2.**)

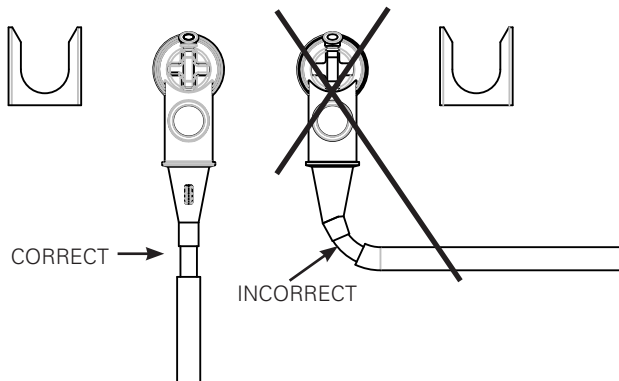
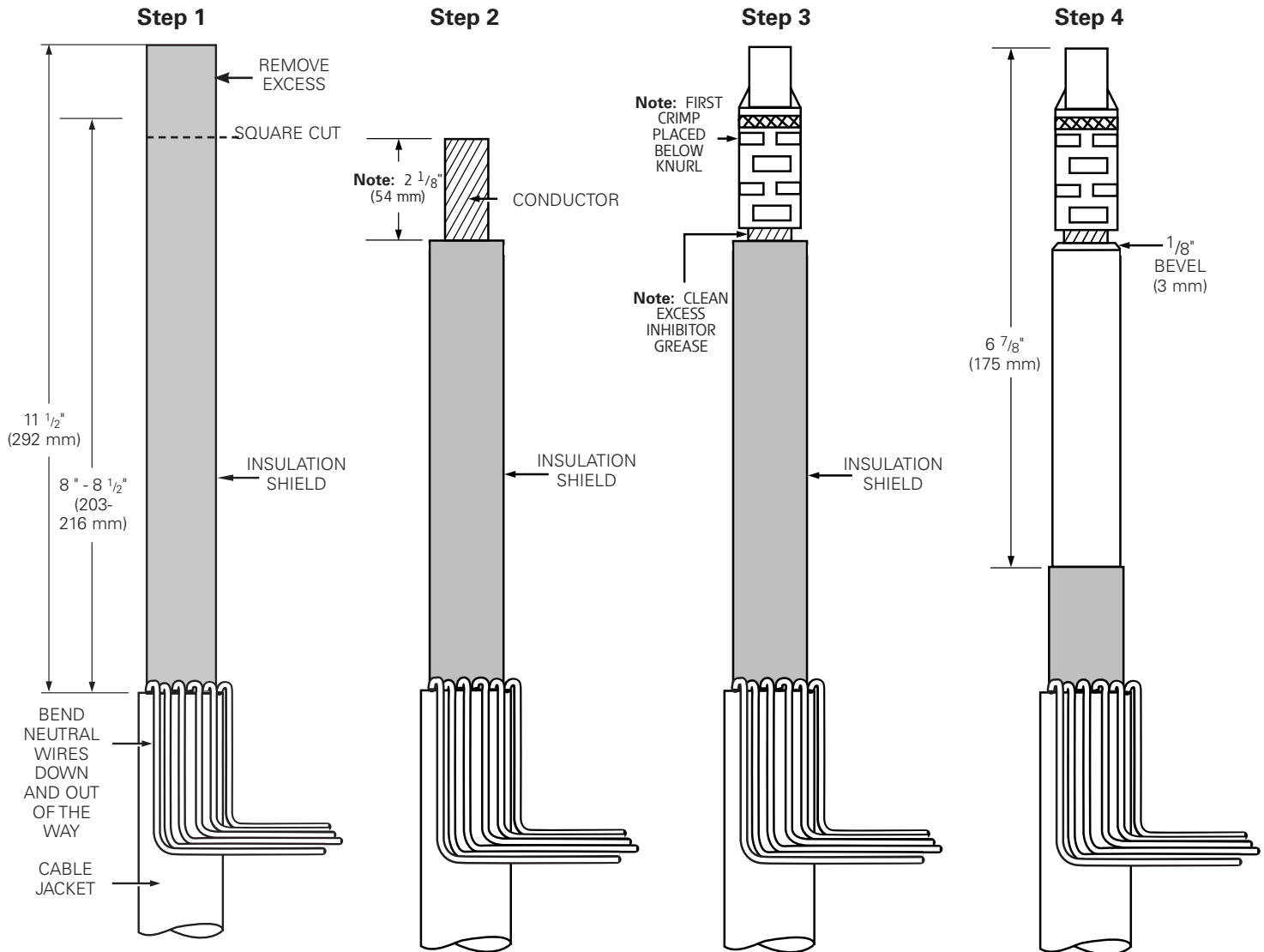


Figure 2. Proper cable training.



Step 1.

- Measure down from top of the cable a minimum of 11 1/2" (292 mm).
- Remove cable jacket (if jacketed cable is used) to expose neutral wires.
- Unwind neutral wires.
- Measure up 8" to 8 1/2" (203 to 216 mm) and make a square cut to remove excess cable.

Step 2.

- Measure down from the top of the cable 2 1/8" (54 mm).
- Remove the insulation and conductor shield to expose the bare conductor. Take care not to nick the conductor.

Step 3.

- Clean the exposed conductor using a wire brush.

Note: The probe (male contact) should be preassembled into the threads of the compression connector prior to crimping to ensure proper thread engagement.

- Place the coppertop (bimetal) connector on the conductor. Make sure the threaded hole in connector faces the apparatus bushing.

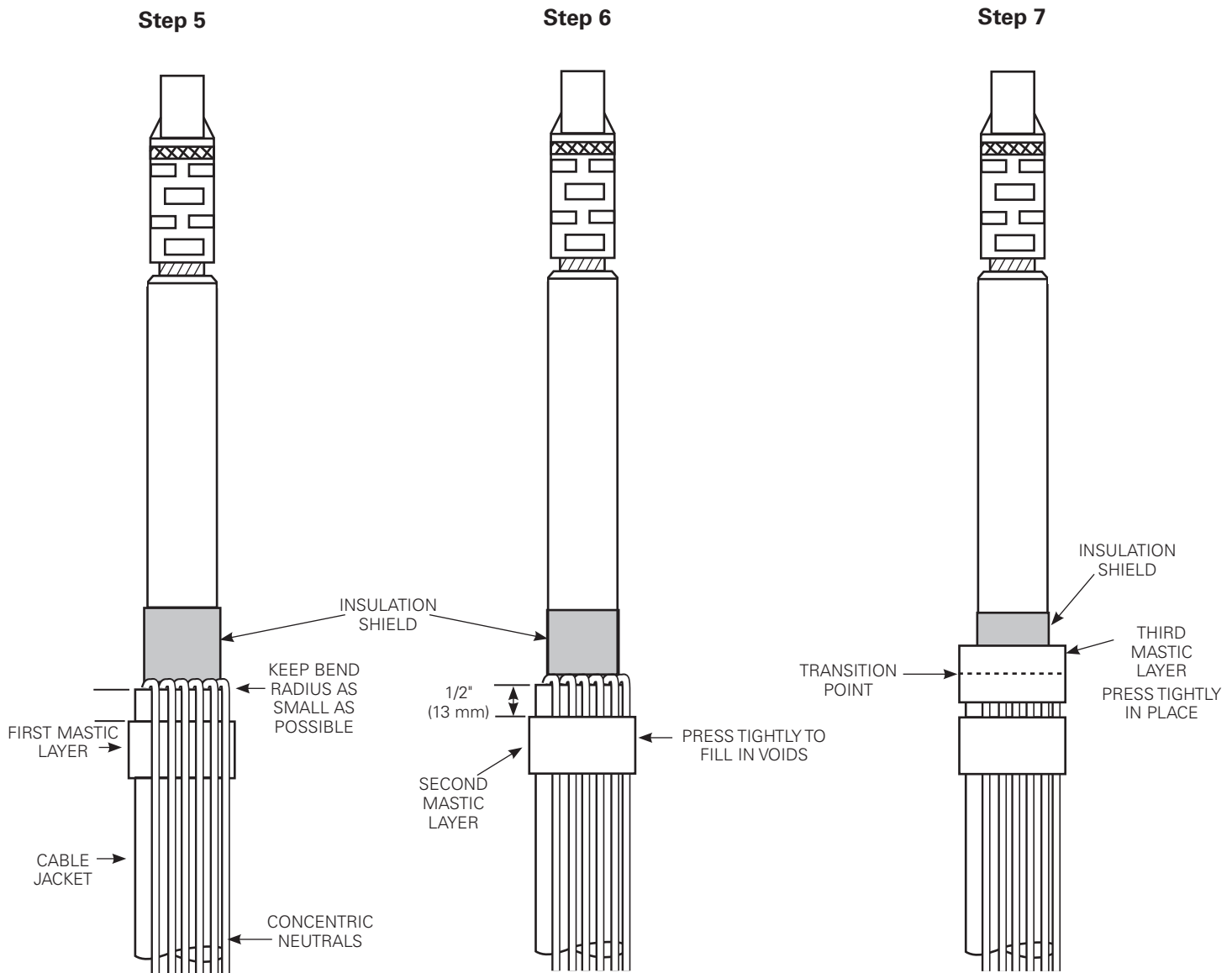
- Crimp the connector in place using an appropriate tool and die combination. Start crimping just below the knurled line and rotate each successive crimp to prevent bowing. Do not overlap crimps.
- Clean excess inhibitor grease from coppertop connector by wiping toward threaded eye.
- Smooth any sharp edges on the crimp connector surface.

Step 4.

- Measure down from the top of the connector 6 7/8" (175 mm).
- Remove the insulation shield. Take care not to nick or gouge the insulation.
- Place a 1/8" (3 mm) bevel on the insulation to ease elbow installation.

Note: If a standard elbow is used, proceed to Step 9. If integral jacket seal elbow is used, proceed to Step 5.

200 A 15 and 25 kV class elbow with optional integral jacket seal



Step 5.

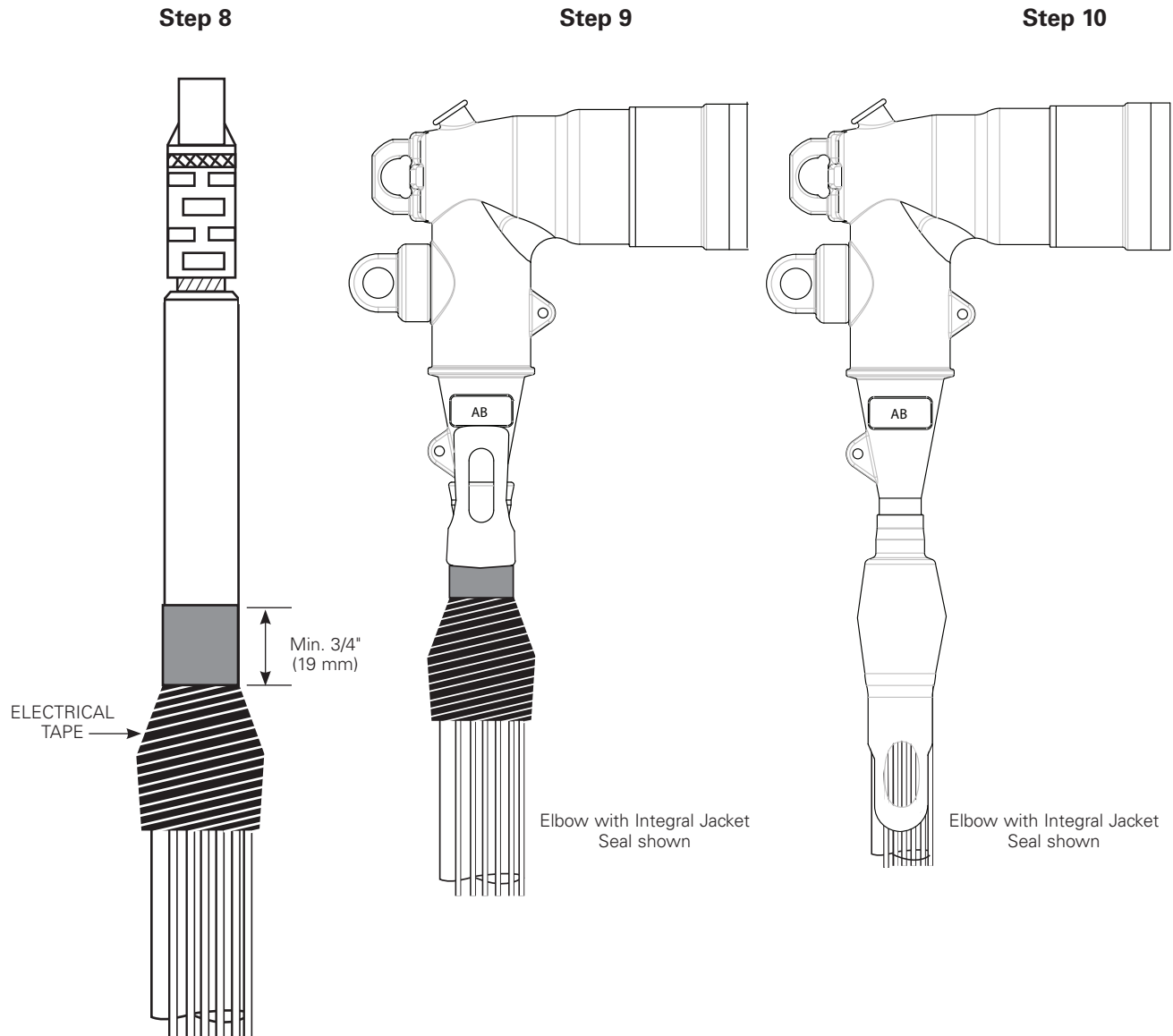
- Apply first supplied mastic strip around the cable jacket approximately 1/2" (13 mm) below the point where the jacket is removed.
- Do not stretch mastic when installing.
- Bend the concentric neutral strands back as tightly as possible against the cable, forming as small a radius as possible. Press the neutral wires into the mastic strip.

Step 6.

- Apply second layer of mastic over the neutrals directly on top of the first layer. Press tightly to fill in any voids. Do not stretch mastic when installing.

Step 7.

- Apply the third layer of mastic centering it on the transition point of the stripped back jacket and insulation shield. Press tightly in place. Do not stretch mastic when installing.



Step 8.

- Wrap the cable and mastic with one half layer of vinyl electrical tape (User Supplied). The tape should extend from just above the third mastic applied at the transition point, to just below the first and second mastic onto a portion of the jacket still in place.

Note: A minimum of 3/4" (19 mm) of the semi-con insulation shield should remain uncovered.

Elbow and loadbreak probe installation

Step 9.

- Clean insulation with a lint free cloth saturated with a cleaning solution. Wipe insulation toward insulation shield.
- Apply a thin coating of supplied lubricant to the insulation.

- Clean and lubricate the cable entrance of the elbow.
- Place elbow on cable. With a twisting motion, push elbow onto cable until threaded eye of coppertop connector is aligned with the elbow.

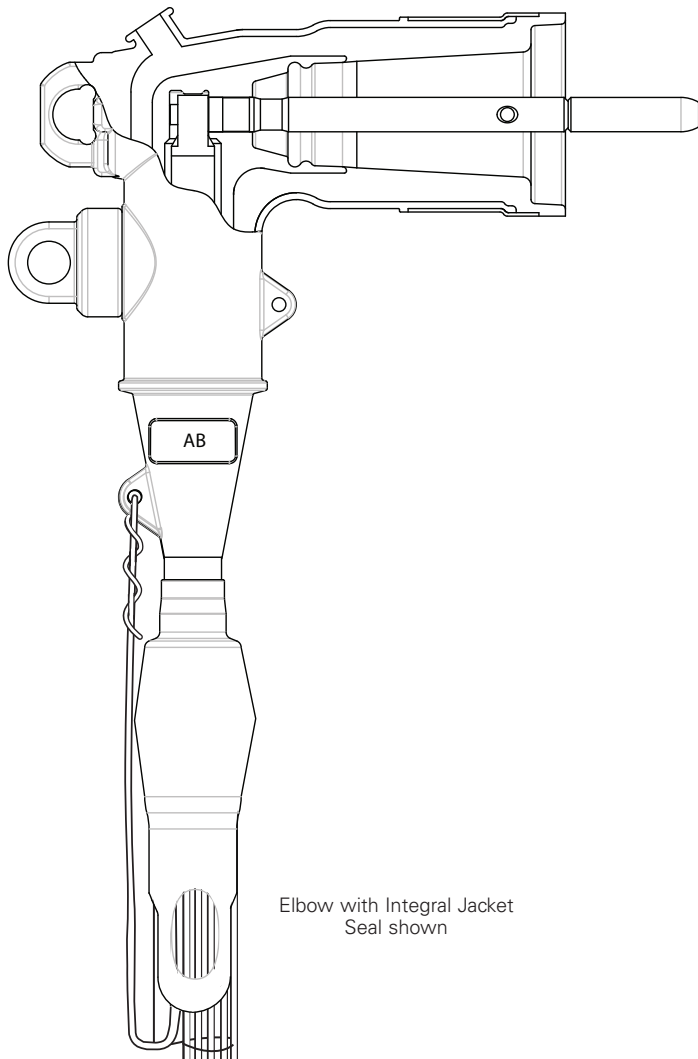
Note: If a standard elbow is used, proceed to Step 11. If an integral jacket seal elbow is used, proceed to Step 10.

Step 10.

- Apply a thin layer of supplied silicone grease over the cable and vinyl tape. Grasping the thumbholes of the jacket seal, pull down firmly over the cable until all of the vinyl tape is covered.

200 A 15 and 25 kV class elbow with optional integral jacket seal

Step 11



Step 11.

- Push down and twist the elbow to align the coppertop compression connector, the threaded hole in the connector should be centered with respect to the hole in the elbow and perpendicular to the probe axis. By hand, insert the probe into the elbow along the center axis of the interface and thread the loadbreak probe into the coppertop connector. A thin layer of silicone lubricant applied to the last 1/4" (6 mm) of the probe body (not on the threads) can aid in installation, especially when installing a POSI-BREAK™ elbow probe.

Note: If installing a POSI-BREAK elbow, be sure to use a POSI-BREAK probe with black insulating sleeve.

- After at least three full turns or when the probe is seated (5 1/2 turns) onto the connector, use the provided installation tool to properly torque the loadbreak probe. Proper torque is applied when the tool twists at least 180° (1/2 turn).

Note: If a different installation tool is used it must apply a torque of 100 to 120 lb-in (11.0 - 13.5 Nm).

- Clean and lubricate bushing and elbow interface areas with a thin even coating of the silicone lubricant provided.
- Attach a drain wire lead to the drain wire eye of the elbow.

Operating procedures



WARNING

The operator should always use personal protective equipment (insulated gloves, clampstick and eye protection) whenever operating the elbow. The operator should always be in the best possible operating position, providing firm footing and enabling a secure grasp of the clampstick, while maintaining positive control of the elbow before, during and immediately after operation. If there is any question regarding the operator's operating position, de-energize the elbow before operation. The operator should not be looking directly at the connector during the moment of circuit interruption or connection. Failure to comply could result in death or serious injury.

Do not connect two different phases of a multiple-phase system. Before closing a single-phase loop, make certain both ends of the loop are the same phase.

Loadmake operation

- Area must be clear of obstructions or contaminations that would interfere with the operation of the loadbreak elbow.
- Securely fasten a clampstick to the pulling eye of the elbow.
- Place the loadbreak elbow over the bushing, inserting the white arc follower of the probe into the bushing approximately 2-1/2" (64 mm) until a slight resistance is felt. This will align and stabilize the elbow.
- Turn your back to the bushing and grasp the clampstick securely and obtain good footing. Slam the elbow onto the bushing with one quick and continuous motion.
- Turn around and apply a force to the clampstick to push the elbow onto the bushing. A popping or snapping sound is often heard when this operation is performed.
- To check that the elbow is properly latched apply a gentle pull force to the clampstick. When latched properly the elbow will not slide back off of the bushing.
- As a last operation, push on the clampstick to seat the elbow all the way onto the bushing again. This insures that the elbow is latched and was not dislodged during the latching check in previous step above.

Fault close

1. It is not recommended that operations be made on known faults.
2. If a fault is experienced, the elbow connector, probe, and the bushing must be replaced.

Loadbreak operation

- Area must be clear of obstructions or contaminants that would interfere with this operation.
- Use clampstick to secure standoff insulator or portable feedthru in bracket. Ground devices to system ground per appropriate Installation Instructions. All associated apparatus must also be grounded.
- Secure elbow eye firmly onto clampstick and lock.
- Twist clampstick clockwise until the elbow rotates slightly on bushing — about 1/4" (6 mm). This action will break any surface friction between outer surface of bushing and inner surface of elbow.
- Withdraw elbow from bushing with a fast, firm, straight motion. Minimum amount of travel of elbow to break load is 9" (229 mm).
- Use clampstick to place elbow on lubricated standoff insulator or portable feedthru. (Follow loadmake instructions.)
- Place an insulated protective cap with ground wire attached to system ground on any exposed energized bushing using clampstick. Follow the same operating procedures as for the elbow as outlined above under Loadmake Operation.

DEADBREAK ELBOW FOR TRANSFORMER



Safety information

The instructions in this manual are not intended as a substitute for proper training or adequate experience in the safe operation of the equipment described. Only competent technicians who are familiar with this equipment should install, operate, and service it.

A competent technician has these qualifications:

- Is thoroughly familiar with these instructions.
- Is trained in industry-accepted high and low-voltage safe operating practices and procedures.
- Is trained and authorized to energize, de-energize, clear, and ground power distribution equipment.
- Is trained in the care and use of protective equipment such as arc flash clothing, safety glasses, face shield, hard hat, rubber gloves, clampstick, hotstick, etc.

Following is important safety information. For safe installation and operation of this equipment, be sure to read and understand all cautions and warnings.

Hazard Statement Definitions

This manual may contain four types of hazard statements:

DANGER

Indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.

WARNING

Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION

Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury.

CAUTION: Indicates a potentially hazardous situation which, if not avoided, may result in equipment damage only.

Safety instructions

Following are general caution and warning statements that apply to this equipment. Additional statements, related to specific tasks and procedures, are located throughout the manual.

DANGER

Hazardous voltage. Contact with hazardous voltage will cause death or severe personal injury. Follow all locally approved safety procedures when working around high- and low-voltage lines and equipment.

G103.3

WARNING

Before installing, operating, maintaining, or testing this equipment, carefully read and understand the contents of this manual. Improper operation, handling or maintenance can result in death, severe personal injury, and equipment damage.

G101.0

WARNING

This equipment is not intended to protect human life. Follow all locally approved procedures and safety practices when installing or operating this equipment. Failure to comply can result in death, severe personal injury and equipment damage.

G102.1

WARNING

Power distribution and transmission equipment must be properly selected for the intended application. It must be installed and serviced by competent personnel who have been trained and understand proper safety procedures. These instructions are written for such personnel and are not a substitute for adequate training and experience in safety procedures. Failure to properly select, install or maintain power distribution and transmission equipment can result in death, severe personal injury, and equipment damage.

G122.3

**DANGER**

All associated apparatus must be de-energized during any hands-on installation or maintenance.

**WARNING**

The 600 A Deadbreak Connector System is designed to be operated in accordance with normal safe operating procedures. These instructions are not intended to supersede or replace existing safety and operating procedures. The elbow connector should be installed and serviced only by personnel familiar with good safety practices and the handling of high-voltage electrical equipment.

**WARNING**

Optional Capacitive Test Point Operating Instructions: Use only voltage indicating instruments specifically designed for test points. Use of conventional voltage sensing devices may provide false "No Voltage" indications.

The test point must be dry and free of contaminant's when checking for voltage. After indication is taken: clean, dry, and lubricate the test point cap with silicone grease and assemble to the test point.

The capacitive test point is not sufficiently accurate, nor is it intended for, actual voltage measurements or phasing operations.

A reading of no voltage from the test point should not be the only indication of a de-energized circuit obtained before touching the connector. Other procedures can include direct conductor voltage testing or grounding using a live-line tool.

Product information

Read this manual first

Read and understand the contents of this manual and follow all locally approved procedures and safety practices before installing or operating this equipment.

Additional information

These instructions cannot cover all details or variations in the equipment, procedures, or process described nor provide directions for meeting every possible contingency during installation, operation, or maintenance. For additional information, contact your representative.

Acceptance and initial inspection

Each deadbreak connector is in good condition when accepted by the carrier for shipment. Upon receipt, inspect the shipping container for signs of damage. Unpack the deadbreak connector and inspect it thoroughly for damage incurred during shipment. If damage is discovered, file a claim with the carrier immediately.

Handling and storage

Be careful during handling and storage of the deadbreak connector to minimize the possibility of damage. If the deadbreak connector is to be stored for any length of time prior to installation, provide a clean, dry storage area.

Standards

ISO 9001 Certified Quality Management System

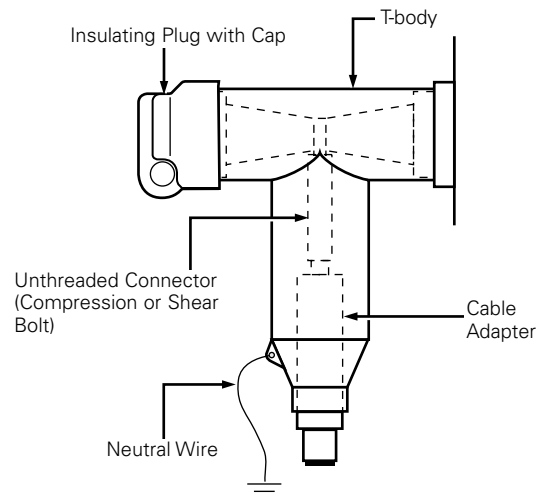


Figure 1. Line illustration of 35 kV 600 A Deadbreak connector.

Compression connector procedures

Equipment provided

- Deadbreak Connector Assembly Kit includes:
 - T-body
 - Cable adapter
 - Insulating plug with cap
 - Compression connector
 - Silicone lubricant
 - Threaded stud
 - Instruction sheet

Tools required

- Torque wrench
- 5/16" Hex wrench for splice application
- Cable stripping tools

Table 3. Conductor size and type

Compression connector

Concentric or Compressed		Compact or Solid		Compression conductor code
AWG or kcmil	mm ²	AWG or kcmil	mm ²	
No Connector				00
#2	35	1	-	11
#1	-	1/0	50	12
1/0	50	2/0	70	13
2/0	70	3/0	-	14
3/0	-	4/0	95	15
4/0	95	250	120	16
250	120	300	-	17
300	-	350	-	18
350	-	400	185	19
400	185	450	-	20
450	-	500	240	21
500	240	600	300	22
600	300	700	-	23
650	-	750	-	24
750	-	900	-	25
900	-	1000	500	26
1000	500	-	-	27
1250	630	-	-	28

Prepare the cable

Step 1.

Train cable

- Position cable vertically so that it is centered between apparatus bushing and parking pocket, parallel to, and 7" (178 mm) from apparatus frontplate.
- Provide adequate cable slack for cable movement between standoff bushing and apparatus bushing.
- Support cable as needed to maintain position.
- Cut cable 1 3/4" (44 mm) from centerline of bushing. Refer to Figure 14.

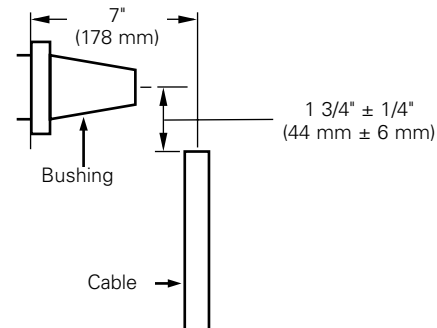


Figure 14. Line illustration for cable training.

Step 2.

Remove concentric neutral wires or jacket

Note: Care should be taken to not cut or score the neutral conductors when cutting the cable jacket.

- Measure 13" (330 mm) from end of cable. Refer to Figure 15.
- For jacketed neutral cable, remove jacket to 13" dimension.
 - For unjacketed neutral cable, bind neutral wires using three (3) wraps of tape at 13" dimension.
- Pull back concentric neutral wires. Allow enough extra concentric neutral wires to connect to ground after installation and allow movement to insulated standoff bushing.

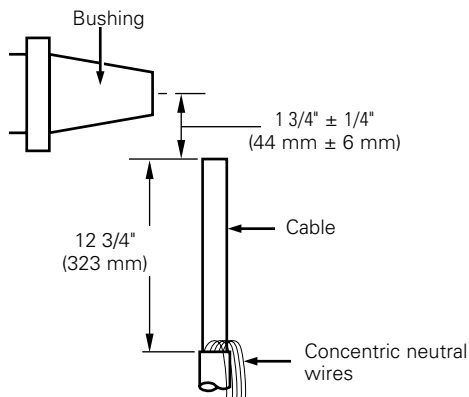


Figure 15. Line illustration of removing concentric neutral wires.

Step 3.

Remove insulation shield

- Remove insulation shield 10 1/2" (267 mm) from end of cable. Refer to Figure 16.
- Do not cut or nick insulation.

Step 4.

Put tape marker in place

- Measure 1" (25 mm) from end of insulation shield. (Refer to Figure 16.)
- Wrap two turns of tape to serve as marker for cable adapter location.

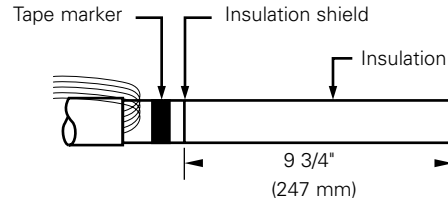


Figure 16. Line illustration of cable stripback.

Step 5.

Remove conductor insulation

Note: Do not pencil cable.

- Remove insulation exposing bare conductor to length of 4 1/2" (114 mm). Refer to Figure 17.

Note: Do not unwind conductor strands.

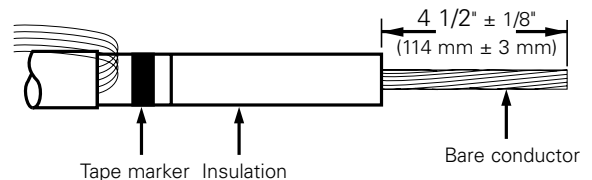


Figure 17. Line illustration of bare conductor length.

Step 6.

Bevel insulation

- Remove sharp edge of insulation by beveling at a 45° angle for approximately 1/4" (6 mm). (Refer to Figure 18.)

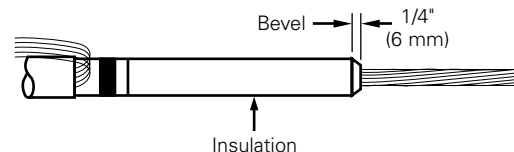


Figure 18. Line illustration of insulation bevel.

Step 7.

Clean insulation

Note: Do not apply solvent directly to cable.

- Clean insulation thoroughly with solvent dampened rag, wiping from conductor end toward insulation shield. (Refer to Figure 19.)
- Ensure that all traces of conductive residue are removed.

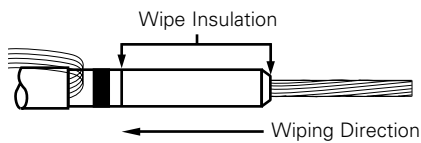


Figure 19. Line illustration of insulation cleaning.

Step 8.

Lubricate and install cable adapter

- Lubricate exposed cable insulation.
- Lubricate inside of cable adapter.
- Slide small end of cable adapter over cable using twisting motion until small end is flush with tape marker. (Refer to Figure 20.)
- After sliding the cable adapter into position make sure that no bulge is present (see Figure 21).

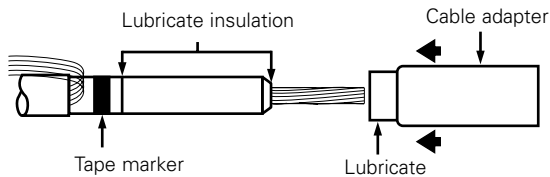


Figure 20. Line illustration of insulation cable adapter.

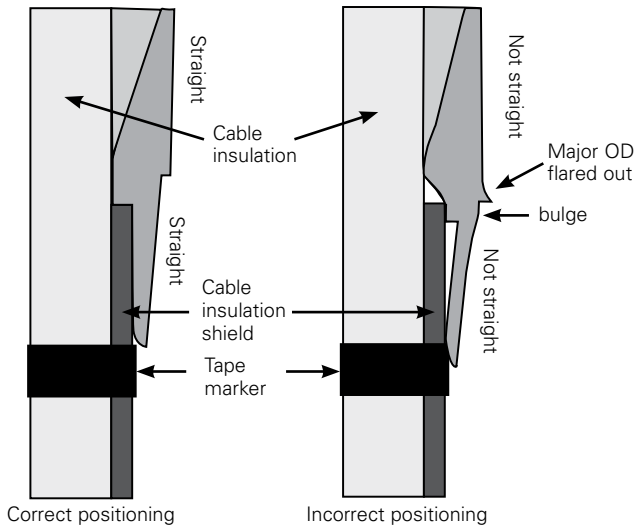


Figure 21. Cross sectional view of cable adapter positioning.



WARNING

Equipment Damage/Personal Injury. Improperly positioned cable adapter may result in equipment damage or personal injury.

Step 9.**Install compression connector**

Note: Refer to the chart supplied with the crimp connector for tool and die to be used.

- Wire brush conductor (aluminum only).
- Remove protective cap from compression connector.
- Insert conductor completely into compression connector and rotate connector to distribute inhibitor.

Note: Connector must be fully seated on cable conductor.

- Align flats of connector and apparatus bushing for minimum conductor strain.
- Make first crimp 1/2" (13 mm) below shoulder of compression connector. (Refer to Figure 22).
- Rotate each successive crimp 90° on compression connector and allow 1/8" (3 mm) between crimps.
- Wipe excess inhibitor from connector and adapter surfaces.

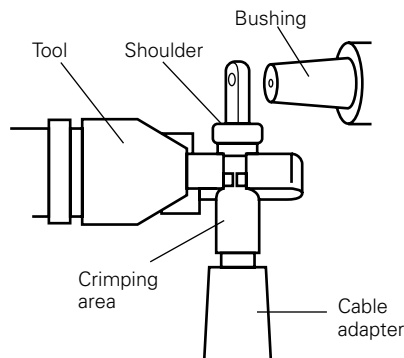


Figure 22. Line illustration of crimping area.

Step 10.

Check lug

- Check that the lug is facing the correct direction.

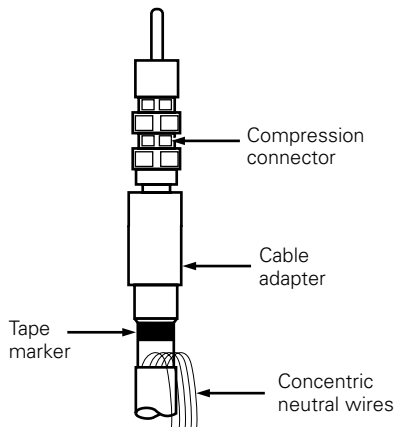


Figure 23. Line illustration for dimensional check.

Install Deadbreak T-body with mating parts
Step 11.

Install T-body

- Clean and lubricate outside of cable adapter with lubricant supplied.
- Clean and lubricate inside of T-body with lubricant supplied.

Note: If test point T-body is used, insure test point is opposite front plate side of T-body.

- Without moving the cable adapter, slide T-body onto cable adapter until compression connector eye is centered in 600 A interfaces. (Refer to Figure 24.)

Note: The end of the cable adapter must line up with the top edge of the tape marker after T-body assembly. Refer to Figure 21.

- Remove tape marker from cable.

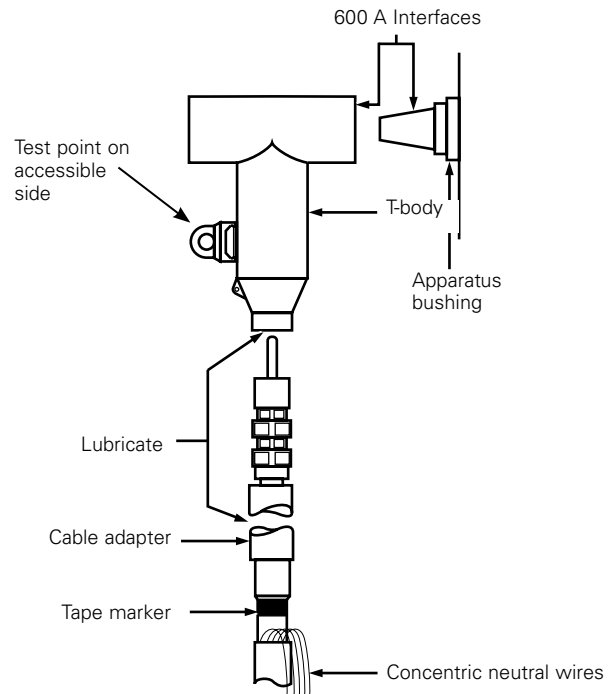


Figure 24. Line illustration of Deadbreak T-body installation.

- Go to Step 12, page 13 to complete T-body termination.

Completing T-body termination

Step 12.

Install STUD into apparatus bushing

Note: Use only the symmetrical aluminum or copper stud in separable splice and Deadbreak applications. **Do not use the non-symmetrical extended length STUD-T.**

- Ensure unit is de-energized.
- Thread the stud into the apparatus bushing unit hand tight. Refer to Figure 25.

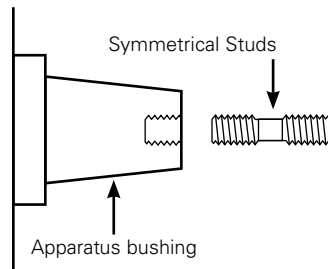


Figure 25. Line illustration of bushing stud installation.

- Engage the flats on the stud with a 1/2" wrench and thread the stud into the bushing an additional 1/4 revolution past hand tight.
- Remove any shavings that may have been raised during the threading procedure.

Install Deadbreak connector onto apparatus bushing Step 13.

Install T-body onto apparatus bushing

- Clean and lubricate mating interfaces of apparatus bushing and T-body with lubricant supplied.
- Push T-body onto apparatus bushing ensuring that the stud on the bushing passes through the hole of the compression connector. See Figure 26.

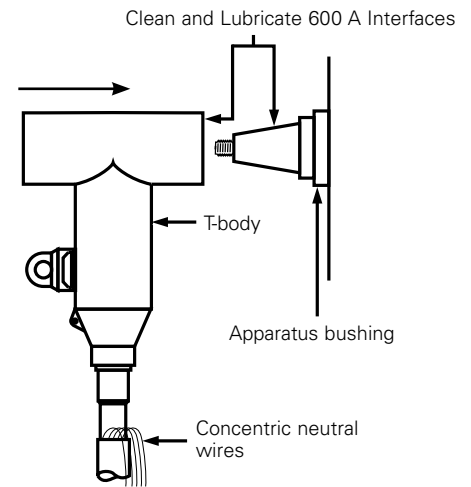


Figure 26. Line illustration of Deadbreak connector installation onto apparatus bushing.

Step 14.

Install insulating plug

- Clean and lubricate the mating interfaces of T-body and insulating plug.
- Insert insulating plug into back of T-body engaging the threads of the stud. See Figure 27.

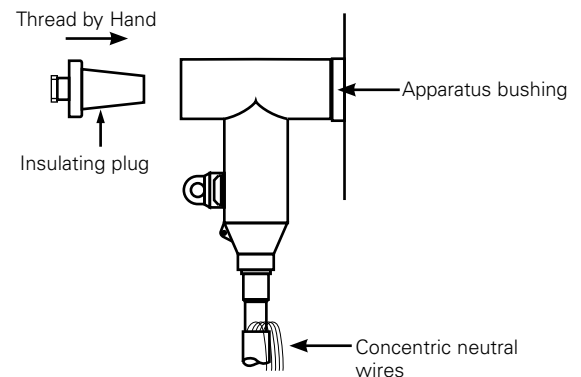


Figure 27. Line illustration of insulating plug installation.

- By hand, turning clockwise, thread insulating plug in as far as possible.
- Using a torque wrench and 1" socket complete threading clockwise until tight. Torque to 55 ft-lbs. See Figure 28.

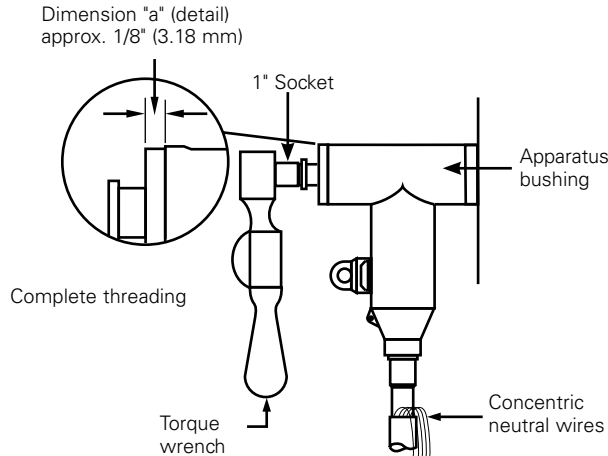


Figure 28. Line illustration of tightening termination.

Step 15.

Check tightness of termination

- Check tightness by hand by moving T-body forward and back (perpendicular to the apparatus frontplate). Do not move side to side as this may loosen the connection.
- If tight:
 - Re-torque to 55 ft-lbs.
- If loose:
 - Remove insulating plug and T-body from apparatus bushing.
 - Inspect threads of the stud and insulating plug for damage.
 - If damaged, replace damaged component and re-install per previous installation instructions.
 - If no damage is found, re-install per previous installation instructions.

Step 16.

Cap the insulating plug

- Clean and lubricate inner surface of insulating plug cap with lubricant supplied.
- Attach hotstick onto cap ring.
- Push cap onto insulating plug until it snaps into place. Refer to Figure 29.

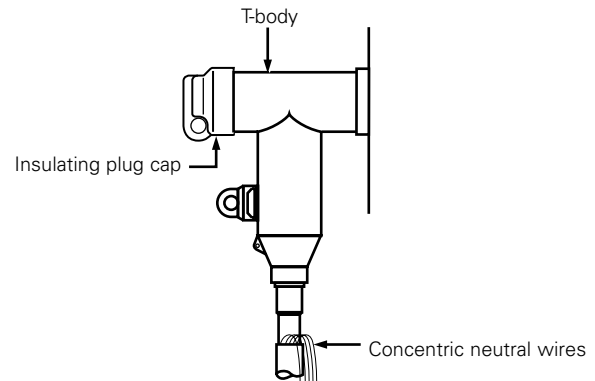


Figure 29. Line illustration of installing the insulating plug cap.

Step 17.

Ground system

- Connect one concentric neutral wire to drain wire tab of the T-body or use a separate uninsulated copper wire (#14 AWG/1.6 mm). Refer to Figure 30.
- Twist to bundle all concentric neutral wires and connect to common ground point. Provide sufficient slack to allow T-body movement to standoff bushing.

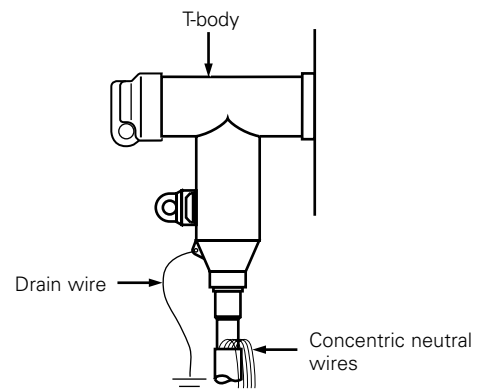


Figure 30. Illustration of the drainwire.

Multi-tap separable splice assembly instructions

Note: Use only the symmetrical aluminum or copper stud in separable splice applications. Do not use the non-symmetrical T-OP™ II stud.

- To assemble a separable splice prepare all cable following Steps #2 through #11.

Note: Before any component is installed, clean and lubricate, using the grease provided or an approved alternate, all mating interfaces (i.e. T-bodies, insulating plugs, connector plugs, and cable adapters).

- Obtain first insulating plug, if a stud is not factory installed, hand thread a .625" stud into the insulating plug and torque to 55 ft-lbs using a crows foot type wrench (1/2" open end) and torque wrench. Insert the insulating plug into the first T-body, lining up the hole in the compression connector with the .625" stud.
- Insert the connecting plug into the open interface of the first T-body and hand tighten to the .625" stud of the insulating plug.
- Secure the connecting plug by inserting a 5/16" hex style wrench (HD625, T-wrench, or customer supplied alternate), into the hex hole at the base of the connector plug threads. Use a torque wrench to tighten the insulating plug to 55 ft-lbs. Refer to Figure 17.
- Insert the interface of the connecting plug into the interface on the second T-body.
- To assemble additional splice taps, obtain a second connecting plug, if stud is not factory installed, hand thread a .625" stud into one end and torque in to 55 ft-lbs.
- Install the stud end of the connector plug into the open interface of the second Tbody. Hand thread the connector plug to the previously installed connector plug. Secure the first insulating plug with a 1" wrench. Insert a 5/16" hex shaft with socket drive tool (HD625, or customer supplied alternate), into the 5/16" hex hole at the base of the connector plug threads. Connect a torque wrench to hex shaft tool, while keeping first insulating plug secure, torque the second connector plug to 55 ft-lbs. Refer to Figure 18.

- Repeat the assembly procedure used to install the second connector plug and T-body for each additional splice tap.
- After all connecting plugs are installed, obtain the second insulating plug, if stud has not been factory installed, hand thread a .625" stud into the insulating plug and torque to 55 ft-lbs.
- Install the second insulating plug, with stud, into the open interface of the last T-body. Hand thread the insulating plug into the connector plug.
- Secure the first insulating plug using a 1" wrench. Using a 1" socket on a torque wrench tighten the second insulating plug to 55 ft-lbs. Refer to Figure 31.

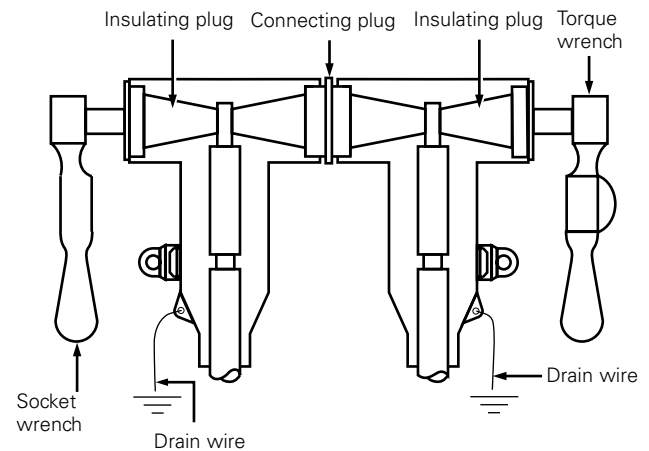


Figure 31. Line illustration of second insulating plug installation.

- Clean and lubricate the inner surface of two insulating plug caps with the lubricant supplied.
- Push the caps onto the insulating plugs until they snap into place.
- Connect one strand of the cable concentric neutral wire to the tie-off tab of each T-body.

Note: If splice is disassembled, all connector plugs and insulating plugs should be removed completely, cleaned, regreased, and reassembled following the above procedure to ensure connection points are properly torqued.