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C9970

Voltage Detector

Users Guide

PN 1286912

May 2007 Rev. 3 3/10

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C9970 Voltage Detector

Introduction

The C9970 Voltage Detector is a high-voltage probe used for detecting hazardous voltage on conductive objects such as power ground wires, street light fixtures, mobile homes, metal frameworks, metal conduit, pedestals, newly-driven ground rods, homes covered with metallic siding, and electrical machinery.





This manual describes the proper care and use of the C9970 Voltage Detector and its accessories. Read this manual completely before using the Voltage Detector.

Registration

Registering your product with Fluke Networks gives you access to valuable information on product updates, troubleshooting tips, and other support services.

Safety Information

The following IEC symbols are used either on the Voltage Detector or in this manual:

	Warning: Risk of personal injury. See the manual for details. Caution: Risk of damage or destruction to equipment or software. See the manual for details.
	Warning: Risk of electric shock.
	Earth ground
	Do not put products containing circuit boards into the garbage. Dispose of circuits boards in accordance with local regulations.

Warning

To avoid possible electric shock or personal injury, follow these guidelines:

- Only qualified personnel who have been trained and are knowledgeable about the dangers associated with hazardous voltages should use this product.
- Be sure to know and follow your company's procedures for every application. Any conflict between the procedures specified in this manual and those of your company must be resolved before using the Voltage Detector.
- Do not use the Voltage Detector if it is damaged.
- Before you use the Voltage Detector, inspect the case. Look for cracks or missing plastic. Pay particular attention to the insulation surrounding the connectors.
- Do not use if wet.
- Inspect the Voltage Detector for damaged insulation or exposed metal.
- Do not use the Voltage Detector if it operates abnormally. Protection may be impaired. When in doubt, have the Voltage Detector serviced.
- Do not operate the Voltage Detector around explosive gas, vapor, or dust.
- Do not apply more than the rated voltage, as marked on the Voltage Detector, between terminals or between any terminal and earth ground.
- Before use, verify the Voltage Detectors operation by measuring a known voltage.
- When servicing the Voltage Detector, use only specified replacement parts.
- Use caution when working above 30 V ac rms, 42 V peak, or 60 V dc. Such voltages pose a shock hazard.

- Do not use in excess of the voltage specified in this manual.
- When using probes, keep your fingers behind the finger guards on the probes.
- Remove any voltages from the Voltage Detector before accessing the battery.
- Do not operate the Voltage Detector with portions of the case removed or loosened.
- To avoid false indications, which could lead to possible electric shock or personal injury, replace the batteries as recommended. See “Battery Replacement” on page 4 for additional information.
- Use only type 9 V batteries, properly installed in the Voltage Detector case, to power the Voltage Detector.

 **Caution**

To avoid possible damage to the Voltage Detector or to the equipment under test, use the proper terminals and function for your measurements.

Care and Maintenance

Any Voltage Detector with confirmed or suspected damage to the plastic housing (deep scratches, cracks, holes, etc.) or internal circuitry should never be used.

Mechanical Shock

Do not drop the Voltage Detector or subject it to severe mechanical stress which may damage the protective insulation or internal circuitry. The Voltage Detector should be tested and repaired if it appears to be damaged or fails to meet the tests described in “Periodic Performance Tests” on page 8.

Environment

Do not expose the Voltage Detector to extreme temperatures (below -40°C or above $+60^{\circ}\text{C}$) or chemicals that may soften, crack, or otherwise damage the plastic housing.

Water Resistance

Although the Voltage Detector is water resistant, do not expose it to water. If submerged in water, it must be dried completely and checked for proper operation before use. (If a test plug is unavailable, a 110-120 VAC, 60 Hz source may be temporarily substituted with caution.)

If the Voltage Detector appears to have taken on water, open it by unscrewing the handle in a counterclockwise direction and allow it to dry completely before closing. Do not attempt to remove the ground or check contacts or disassemble the front portion of the test set. After closing, test the Voltage Detector with a test plug before returning to use.

Defacing or Altering the Housing

Do not drill, punch, engrave, or otherwise modify the housing of the Voltage Detector. Do not use adhesives, adhesive labels, inks, solvents, or expose to chemicals which may alter the housing. Defacing or altering the Voltage Detector may lower or destroy its sensitivity to hazardous voltages and will void the warranty.

Carrying the Voltage Detector

Keep the conductive cap over the probe end of the Voltage Detector when it is not in use to avoid damage to the tip and possible hazard to the user. The carbide tip is sharp and should be treated accordingly.

Storage

Do not subject the Voltage Detector to possible pressure or damage from other tools or material. Pressure may cause the switch to operate and discharge the battery. Do not store the Voltage Detector near strong magnets.

Battery Replacement

When replacing batteries, work in a dry place. Always replace the battery with a 9 V alkaline battery.

Warning

Some imported 9 V batteries are slightly oversized. If an over-sized battery is installed, the metal shield may be torn from the circuit board. Therefore, if the replacement battery seems tighter than the original, try a different brand of battery.

To replace the battery, do the following:

- 1 Open the Voltage Detector body by unscrewing the handle in a counter-clockwise direction and sliding it back from the front assembly. Do not attempt to loosen the check contact or the ground terminal.
- 2 Gently slide the battery out of the metal shield, attach a new battery, and slide it back into the metal shield. Be careful not to get the battery wires between the metal shield and the side of the battery or to bend or distort the metal shield.
- 3 Slide the handle over the shield and rotate in a clockwise direction until a snug fit is secured. Make sure that the LEDs line up with the trigger, or the probe switch may not operate. A snug fit is required for proper O-ring seal and LED alignment, but it is not necessary to overtighten.

Safety Gloves

The Voltage Detector is designed to protect the user from exposure of up to 20,000 V, 60 Hz, AC. Using gloves reduces the sensitivity of the Voltage Detector and may cause erroneous results (see “Theory of Operation” below). If protective gloves are worn while using the Voltage Detector (or are required by company procedures) and a hazardous voltage is indicated, do not retest without gloves. Move away and refer to your company’s safety procedures. However, if the user is gloved and a safe condition is indicated, perform a second test without gloves and follow the results of this second test.

Theory of Operation

The Voltage Detector uses electronics and high-voltage mechanical design to indicate the presence of dangerously-high AC and DC voltages. To do so, it first determines the voltage difference between the user’s body and the object being tested. Then, it compares that difference to an internal safety reference. If the voltage difference exceeds this reference, the Voltage Detector indicates danger. No interpretation of readings is required.

The capacitance between the handle of the Voltage Detector and the user’s hand is part of the measuring circuit and can affect the sensitivity of the Voltage Detector. Further, voltages induced onto the user’s body can also affect readings. Such voltages can be induced when the user is isolated from ground while working aloft near power transmission lines. These induced voltages can cause the Voltage Detector to indicate danger when none actually exists. These induced voltages are harmless, but must be discharged. The correct procedure is described under “Aerial Testing” on page 14.

Physical Description

The Voltage Detector, shown in Figure 1, is a yellow, plastic, two-piece, unit that weighs approximately one pound.

The front housing includes the carbide probe tip and two LEDs (one green and one red) along with a check contact and a ground terminal. These and the battery are attached to the front housing.

The rear housing, which acts as a handle, includes a set of concentric rings (called the flashguard), the on/off switch (called the trigger), an instruction label, and a belt clip.

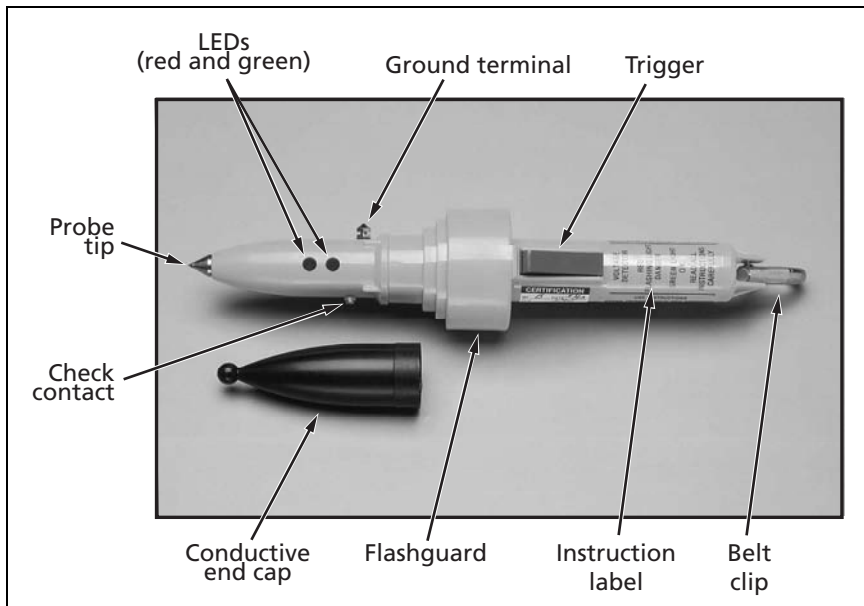


Figure 1. Voltage Detector

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Accessories

The following sections describe the accessories available for the Voltage Detector, which are shown in Figure 2.

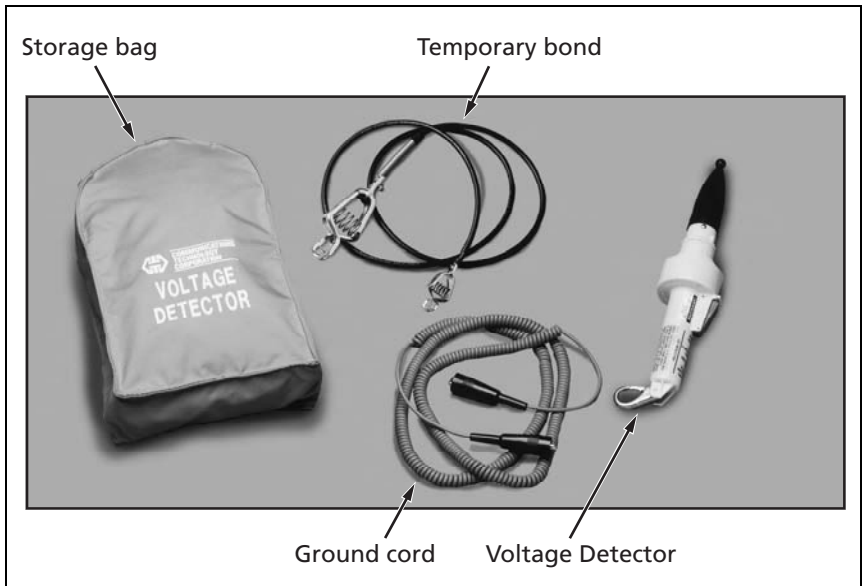


Figure 2. Voltage Detector and Accessories

Temporary Bond

The Voltage Detector temporary bond is used to temporarily ground a light fixture, metallic conduit, power company hardware, power ground wire, or other metallic objects in a work space that could become energized if a fault developed. It is a heavy-duty insulated cord equipped with a large clamp on one end and a smaller clamp on the other end.

Connecting the Temporary Bond

Connect the temporary bond only after the metallic object has first been tested with the Voltage Detector and found to be free of a voltage potential.

To attach the bond, first connect the small clamp to a reliable ground source; then connect the large clamp to the metallic object.

Disconnecting the Temporary Bond

When the work is completed, first disconnect the bond's large clamp from the metallic object; then disconnect the small clamp from the ground source. Should a fault develop while the temporary bond is in place, the insulation may overheat and smoke, at which time you should avoid contact with the bond.

Storage Bag

The Voltage Detector storage bag holds the Voltage Detector and its accessories. The bag's interior is lined with plastic. The bag has a fabric strap with a metal snap hook and a zipper closure.

Ground Cord

The Voltage Detector ground cord is used only in certain aerial applications where the user is isolated from ground and near power transmission lines. The cord is a 25-ft retracting cord with clamps on each end. This cord, along with the conductive plastic end cap, eliminates induced body voltage to prevent false hazard indications.

Test Plug

The Voltage Detector test plug is used to verify the lowest voltage (threshold voltage) at which the Voltage Detector indicates danger. It is an AC-operated plug that provides a suitable, current-limited, reference voltage to verify proper operation of the Voltage Detector. It plugs into a standard, ground-referenced, power outlet. The test plug is current-limited and may be touched without electrical shock, even while energized. The test plug consumes less than 30 milliwatts and may be left in an outlet indefinitely if desired.

Periodic Performance Tests

The Voltage Detector should be checked periodically to ensure that it is working properly and that it retains its protective properties. There are two primary tests that can be used to verify the integrity of the Voltage Detector: a self check and a test plug threshold (sensitivity) test.

Self Check

Perform the self check before each use of the Voltage Detector to verify it is working properly. To perform a self check, do the following:

- 1 Clean and dry the entire housing. Moisture, dirt, and other foreign matter reduces the insulating properties of the plastic surface.
- 2 Examine the housing for cracks.
- 3 Grasp the handle with your bare hand. Press the trigger and observe the green LED. If it does not illuminate or is very dim, check the internal battery and replace if needed. If the green LED still does not illuminate, do not use the Voltage Detector.
- 4 With the trigger pressed, use the free hand to touch both the probe tip and the check contact (shown in Figure 3). The red LED should flash and the green LED should go out. If they do not, the Voltage Detector is malfunctioning.

Note

It may be necessary to wet the fingers that are touching the probe tip and check contact in order to start the red flashing LED. This is acceptable and does not indicate a malfunctioning Voltage Detector.

- 5 Once the red LED starts flashing, remove the free hand while continuing to press the trigger. The red LED should continue to flash as long as the trigger is pressed. If it does not, the Voltage Detector is malfunctioning.

After passing the self check, the Voltage Detector may be used to perform a voltage test. If it fails, contact Fluke Networks as described on page 1.



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Figure 3. Performing a Self Check

Test Plug Threshold Test

While the self check verifies proper operation of most of the circuits, it does not verify proper sensitivity of the Voltage Detector. Therefore, a test plug threshold test should be performed to verify proper sensitivity, check the Voltage Detector's insulation, or after the Voltage Detector has been subjected to severe mechanical stress.

This test should be performed at least weekly.

To perform a test plug threshold test, do the following:

- 1 Plug the test plug into a standard, 3-wire, 110-120 VAC outlet. The test plug provides the proper reference voltage for the threshold test. (The test plug draws little current and may be left in the outlet.)
- 2 Perform a self check (see page 8).
- 3 Touch the Voltage Detector to the screw head test point on the test plug. If the Voltage Detector indicates danger (red flashing LED), it passes the threshold test. If the Voltage Detector does not indicate danger (green LED is on), it is malfunctioning.

Note

The integrity of the test plug can be verified with an ohmmeter. The resistance from the test point to either or both of the two prongs should be $300\text{ K}\Omega, \pm 1\%$. This test should be done each time you perform a Voltage Detector threshold test. A faulty test plug should be discarded immediately.

Warning

Do not use any Voltage Detector that fails either the self check or test plug threshold test. Remove the Voltage Detector from service immediately and contact Fluke Networks as described on page 1.

Service Center Repair and Verification

Repair and verification of your Voltage Detector are available at any Fluke Networks authorized service center. See the contact information on page 1.

Operation

To use the Voltage Detector, do the following:

- 1 Before using the Voltage Detector, always perform a self check (see “Self Check” on page 8).
- 2 Remove the black conductive end cap from the probe tip. Be careful not to unscrew the front and rear housing while removing the cap.
- 3 Hold the Voltage Detector as shown in Figure 4.
- 4 Use your bare hand (except when gloves are required) to grasp the rear housing and your thumb to operate the trigger.



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Figure 4. Holding the Voltage Detector

AC Hazardous Voltage Testing

No grounding is required except when testing aloft near power transmission lines (see "Aerial Testing" on page 14).

The Voltage Detector is designed to detect 60 Hz, AC hazards. At frequencies below 60 Hz, the Voltage Detector requires higher voltages to trigger a hazard indication. At frequencies higher than 60 Hz, the Voltage Detector requires less voltage to trigger.

To test for hazardous AC voltage, do the following:

- 1 Perform a self check (see "Self Check" on page 8).
- 2 Press and hold down the trigger while approaching the object to be tested. The tip must be the closest point to the object under test. If the red LED flashes, immediately move away from the object. A high voltage is present and you should not continue the test.

Caution

When high voltages are present, move away immediately after a hazard indication appears. Otherwise, the Voltage Detector may momentarily arc. Though the user is protected from electrical shock, this may be startling.

- 3 If no hazard indication appears while approaching the object, press the probe tip against the object. It may be necessary to turn the Voltage Detector from side to side to break through paint or other surface finishes or corrosion. Ensure that a reliable contact is made.
- 4 To avoid false indications due to static electrical discharge, release and repress the trigger while still making contact with the object. Ensure that a reliable contact is maintained.
- 5 Still holding the trigger down, remove the Voltage Detector from the object and observe the LEDs:
 - The green LED means a safe condition.
 - The red flashing LED means dangerous voltages are present.

DC Hazardous Voltage Testing

The Voltage Detector indicates the presence of DC voltages between 6 VDC and 2,000 VDC. When testing DC voltages, a connection must be established between the ground terminal of the Voltage Detector and a known earth ground. This connection may be made using a suitable insulated cord equipped with clamps on each end, such as the temporary bond. At no time should the ground terminal on the Voltage Detector be loosened. If there is any doubt as to the continuity of the grounding cord used, test the cord before it is used to test for hazardous voltages.

To test the continuity of a grounding cord, do the following:

- 1 Connect one end of the cord to the probe tip of the Voltage Detector. If you are testing the temporary bond, connect the large clip to the tip.
- 2 Press and hold the Voltage Detector trigger.
- 3 Touch the other end of the cord to the Voltage Detector check contact. The red LED should flash. Do not use the cord for testing if it does not pass this test.

Note

This test verifies whether this ground cord can be used with the Voltage Detector. It does not verify the cord's current-handling ability for use as a bond.

To test for hazardous DC voltage, do the following:

- 1 Perform a self check.
- 2 Perform an AC hazardous voltage test. If the AC hazardous voltage test indicates no hazardous voltage, proceed. Otherwise, halt testing.
- 3 Prepare a temporary ground bond, such as the Voltage Detector temporary bond, and test it as described above.
- 4 Press the probe tip against the object to be tested and press the trigger. It may be necessary to turn the tester from side to side to break through paint or other surface finishes or corrosion. Ensure that a reliable contact is made.
- 5 To avoid false indications due to static electrical discharge, release and repress the switch while still making contact with the object. Ensure that a reliable contact is maintained.
- 6 Still holding the switch down, remove the Voltage Detector from the object and observe the LEDs:
 - The green LED means a safe condition.
 - The red flashing LED indicates hazardous voltages. If a hazardous voltage is present, move away from the object and refer to your company's safety procedures.

Aerial Testing

When working aloft in an insulated bucket or on a ladder where you are well isolated from ground and near power transmission lines, the following procedure is required to prevent false indications due to the voltage induced on you.

- 1 Put on company-required protective equipment, such as a hard hat, eye protection, etc.
- 2 Place the conductive plastic probe end cap on the handle (clip end) of the Voltage Detector. Push on until firmly in place.
- 3 Perform a self check.
- 4 Attach one end of the ground cord to a known earth ground. Attach the other end of the ground cord to the contact knob on the end cap.
- 5 Ascend to a convenient height to make the voltage test. Do not come in contact with the suspected hardware, light fixture, or its wiring.
- 6 Test the suspect object for hazardous voltage as described earlier and observe the LEDs:
 - If after you press the trigger and touch the probe tip to the object, the green LED remains illuminated and the red LED remains off, you may proceed with your work after placing a temporary bond (see "Temporary Bond" on page 7).
 - If the red LED flashes, a hazardous condition exists. Descend immediately and refer to your company's safety procedures.

Applications

Following are additional instructions and safeguards for more specific applications. They expand the previous instructions, but do not replace them.

Ground Level

Mobile homes, trailers, metal sheath buildings, ground rods and electrical machinery all present potential electrical hazards and always require testing. Before starting any work operation, test the skin and frame (or both frames in the case of double wide mobile homes).

In some cases, such as when driving a ground rod, you might wear rubber gloves during the work operation. The final test must be done with the bare hand holding the Voltage Detector.

If a voltage is detected, the property owner should be notified for corrective action according to the user's company procedures. Do not make contact with the potential hazard until all hazardous voltages are removed and the Voltage Detector indicates a safe condition.

Telephone Cable Sheath

When sheath continuity is to be interrupted for the purpose of locating plant, locating faults, or making splices, it is necessary to test the sheath with the Voltage Detector prior to and after opening it.

Damaged Cable Closure

If a telephone, CATV, or power pedestal closure (all closures used in joint-buried plant) has been damaged or disturbed, (for example, knocked over or hit by a car) or a trouble condition involving power is suspected, contact the power company first. Once the power company completes its work, the pedestal should be tested before any bodily contact is made. However, work should not be done on telephone or CATV plant until the power company has completed repairs.

If the Voltage Detector indicates a safe condition, remove the cover of the closure and visually inspect the cable sheath ground. If the cable sheath ground is not intact or is loose, test the cable sheath with the Voltage Detector before performing maintenance work. If for any reason it becomes necessary to open the bonds between telephone facilities and power or across cable sheath openings, a temporary bond strap must be placed before the bond is opened. If the temporary bond cannot be placed due to physical conditions, consult with the power company representative. It may be necessary to de-energize the power briefly for repair operations. When temporary or permanent bonds are placed or removed, insulating gloves and eye protection must be worn.



Electrical continuity of all bonds, including cable shield bonds in closure or at splice locations, must be preserved during the repair process. Until the permanent bond is installed, maintain continuity using a temporary bond strap.

Base of Pole: Telephone Plant Repairs

Examine the pole for potential electrical hazards such as a vertical power ground wire, vertical metallic power conduit, street light fixture, power company primary disconnect hardware, or other foreign metal objects. Also, observe the pole and adjacent spans for such hazards as improper clearance from power conductors or equipment, dangling power wires, inadequate clearance on pole-to-pole guys from power wires or energized attachment, etc. If none of these is present, the pole may be climbed providing no other hazard is evident.

If a vertical power ground wire is present, make a voltage test of the wire before climbing or working on the pole. If a vertical metallic power conduit or other power company hardware extends to the base of the pole, make a voltage test before climbing or working on the pole. If the ground wire is broken, test the portion going up the pole unless the break exists above the telephone space. Do not attempt to test a broken ground wire or fixture in the power company's space (40 inches or more above the highest telephone attachment). Refer to your company's safety procedures.

If the Voltage Detector does not indicate a hazardous voltage, poles carrying vertical power ground wires may be climbed. Care should be taken to avoid simultaneous contact between power ground wires and telephone cable or guys since a small voltage may be present. This is recommended to avoid the possibility of a shock that might cause a fall from the pole.

If an ungrounded street light fixture is less than 40 inches above or below telephone attachments and is on a pole not carrying a telephone cable or a bare vertical power ground wire, wear insulating gloves. Since it is not possible to place a temporary bond to an effective ground, you should avoid contact with the fixture.

Caution

Do not make contact with supply wires going to the fixture.

Loose Plant

In general, you should avoid unsecured objects, dangling wires, etc., which would tend to move if probed. Breaking through corrosion is difficult in such cases and there is a danger that the object might suddenly swing around and hit you.

Temporary Bond

The temporary bond is used to temporarily ground a fixture, conduit, or bare vertical ground wire which has been tested for and found to be free from a voltage potential while working aloft. Should a fault develop, the temporary bond will provide a direct path to ground for the foreign potential. The insulation on the bond may overheat and smoke which should alert you to descend the pole.

Using insulating gloves, attach the bond in the following manner:

- 1 Attach the small clip of the temporary bond to the cable suspension strand in such a manner that it will not be in the way of work operations.
- 2 Attach the large clip of the bond wire to the fixture, conduit, or bare vertical ground wire. Do not bond to a support bracket of multiple line wire or the suspension strand of isolated cable. Never attach to street light wires, terminals that wires are attached to, or a fixture that causes the red LED to flash.

Insulating gloves may be removed only after the temporary bond is in place, and then only if other protection requirements permit. Leave the temporary bond in place until all work operations are complete at this pole for the day. If the bond starts smoking, put on insulating gloves and descend the pole immediately. In that case, avoid contact with the bond, the fixture, or its wiring and refer to your company's safety procedures.

Upon completion of work operations on a pole, remove the temporary bond by doing the following:

- 1 Put on insulating gloves.
- 2 Remove clip from the fixture, metallic conduit, or bare vertical ground wire.
- 3 Remove the other clip, which was attached to the strand. If a spark is detected when removing the bond, descend the pole immediately and refer to your company's safety procedures.

Ungrounded Insulated Conductors

Insulated conductive objects in the presence of live AC current may tend to act as antennae for AC potential. If these test as unsafe, they should be treated as such and avoided.

Traffic Lights

Particular care must be taken when working near traffic light wiring or other wiring which may become energized momentarily. Voltage tests made during one part of a cycle may not be valid during another part.

