# Voltage detection essentials for keeping outside plant technicians safe

*Electricity is present virtually everywhere in the outside plant. There are two key ingredients to keep technicians safe from electrical hazards in the outside plant: training to fully understand the hazards, and awareness to avoid them. We should add a third ingredient because without it, the first two would be mostly useless. That third ingredient would be the right tools to detect and avoid those hazards. This article will give some tips for selecting and using the right tool.*

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Because voltage is such a common yet hazardous phenomenon, many manufacturers have developed hazardous voltage detectors in all sorts of shapes and sizes. Because the most common voltage hobbyists and do-it-yourselfers encounter is 120 to 480Vac, most detectors are designed to work over that range. However, distribution voltages in the outside plant are much higher, behave differently, and require different tools and procedures.

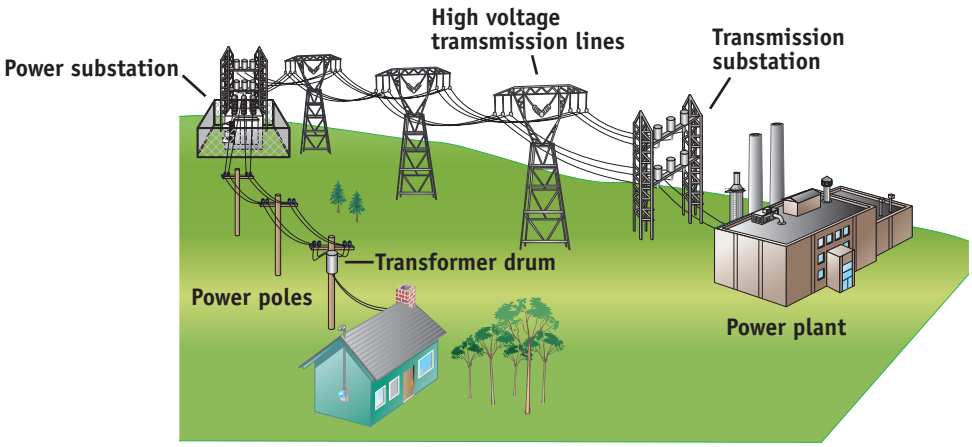


**Figure 1:** Power distribution plant from end to end.

## High Voltage in the Outside Plant

AC Voltage is typically generated at potentials of approximately 30,000 volts. To minimize transmission losses, that voltage is stepped up to anywhere from 138,000 to 768,000 volts. As it nears the point of use, voltage is stepped back down to 12,000 to 14,000V for distribution in the outside plant. This is where it begins to share facilities with the telephone network. Power isn't stepped down to the levels most people are used to seeing – 120-240 Vac – until it reaches the building where it's used.

In addition, high DC voltages (750 to 1500 Vdc) are also present in the outside plant, particularly around electric railways (third-rail and trolley wires) and large electric motors powering elevators or other machinery.

| Voltage levels for various parts of the power distrbution system | |
|---|---|
| Power Grid | Typical |
| Element | Voltages |
| Generation | up to 30 kV |
| Transmission | 115 to 765 kV |
| Primary Distribution | 3.3 to 25 kV |
| Secondary Distribution | 100 to 600V |

Electricity at these higher potentials contains more energy than "household" levels, so technicians working in proximity to it have to take a few extra steps to stay safe. Special precautions and specialized detection equipment are essential.

## Voltage Rating and Adequacy

To meet OSHA and other standards, detection tools must be adequate for the job. With voltages present in excess of 15,000 Vac, a detector should carry a voltage rating of at least that level with some safety margin – say 20,000Vac. Because DC voltage in excess of 1,500V may also be present, the detector should accommodate that as well.

## Spacing and Protection

Related to adequacy is spacing and protection. Because high voltage can jump gaps, a properly designed detector will physically maintain sufficient spacing, sometimes called clearance, between the user and the area being tested, so that energy cannot leap to the user's hand. For 20,000V, a minimum of 16 centimeters provides adequate spacing. For further protection, professional grade voltage detectors also build a flash guard into the handle to prevent burns or other injuries in the event of flashover.

**Key things to look for in a hazardous voltage detector are:**

1. Voltage Rating
2. Clearance/spacing and protection
3. Insulating or dielectric characteristics – material, shape, construction
4. Versatility – the ability to use it in a variety of applications – wet, dry, aerial use.

## Shape, Material and Mechanical Design

Shape, material and mechanical design are also important considerations when evaluating a hazardous voltage detector. Round shapes are safer, because they minimize voltage build up. Also, look for single piece construction. Welding or gluing results in potential inconsistencies in the insulation where high voltage can arc. Detectors used outside need to be constructed of materials that combine high voltage insulation, ruggedness and resistance to moisture. ABS plastic is an ideal material for this application because in addition to being an excellent insulator – protection to over 30,000V – it doesn't absorb moisture, which can compromise insulating properties. Other materials, such as Nylon or Polystyrene, are better suited for indoor use.

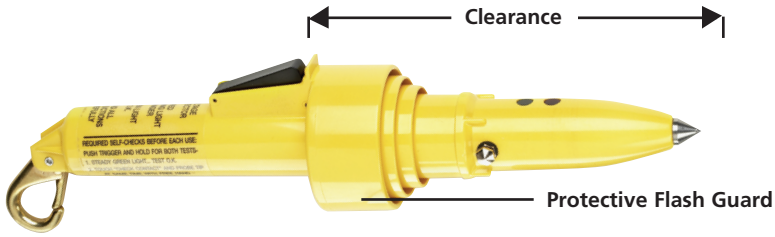


**Figure 2:** The Fluke Networks C9970 is a good example of a voltage detector designed for outside plant voltages. Note its round shape, clearance distance and protective flash guard.

## Ease of Use and Versatility

Versatility and usability are as important as design elements as mechanics or materials used. Technicians work on, above and below ground and face inclement weather, darkness, hot and cold temperatures, to name a few. That dictates additional usability features to make the detector effective.

When it comes to interpreting test results, simple is better. When working around voltage hazards, there usually isn't time to interpret voltage levels. Technicians should be able to assess if hazardous voltage is present instantly, almost without thinking, no matter the environment. There may not be time to interpret a meter reading. When it comes to simple, clear and effective, it's hard to beat simple "good" or "bad" such as, "Red =Danger" and "Green = Safe".

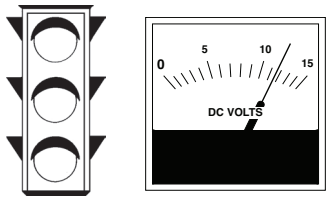


**Figure 3:** The less a technician has to interpret a measurement the better. When it comes to clarity, it's hard to beat a simple pass/fail indicator – green = safe; red = danger. Virtually no interpretation required.

## Contact vs. Non-Contact Detection

How the voltage is detected is also important. Voltage detectors generally fall into two categories: direct contact and inductive. Both have advantages and disadvantages in various applications. Direct contact devices rely on actual contact, while inductive devices detect the magnetic fields induced by voltage. It's important to note that inductive detectors cannot detect dc voltage.

In the outside plant environment, the direct method is usually preferred because it helps the technician to distinguish between objects that are energized from those that aren't. For example, working around storm damage and downed power lines with an inductive detector can be frustrating because everything will appear to be energized.

Both conductive and inductive detectors require a path to earth ground to be effective. Because most OSP technicians work aloft, they are often isolated from earth ground so a hazardous voltage detector must provide a method for reestablishing a ground before testing can begin. For example, the Fluke Networks C9970 features a cap to protect the probe tip when not in use. That cap does double duty. It is made from conductive material, and when attached to the detector's handle, it provides a connection for a cord attached to ground. This capability also allows the technician to deal with magnetic fields that can create false high voltage warnings. These fields can be strong around higher voltage lines and will induce voltage in the technician's body. This ability to externally ground the voltage detector "bleeds" off this voltage, assuring reliable results.

## Summary

To be safe working around hazardous voltage, technicians need training to understand and maintain awareness of the dangers that will confront them. For that to be effective, they also need the right tools to detect hazardous voltage, which behaves differently from household levels with which we are most familiar. Because high voltage behaves differently and presents unique hazards, technician tools must be designed for the job using the right materials and provide protection. Fluke Networks is the manufacturer of the C9970 Voltage Detector. The C9970 was designed by AT&T Bell Labs in the late 1970s for Bell Company field technicians. Also known as the 188A Stoplight, the Fluke Networks Voltage detector is standard issue and widely used throughout the former Bell operating companies, as well as independent telephone companies and CATV companies throughout North America.

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