

APPLICATION NOTE

Why SF₆ gas detection matters in utilities

Sub-station equipment including circuit breakers and transformers, switch and transform high voltages and currents. The switching of such high voltages poses a risk to safety and production in the form of an arc flash. SF₆ gas is used for insulation purposes in this equipment. Indeed, this greenhouse gas is a more efficient alternative to insulators such as air and oil, due to its ionization properties as a quenching gas. However, as a potent greenhouse gas it is important to ensure that in the event of a gas leak, it is detected and dealt with appropriately.



Figure 1. An inspector uses the Fluke Ti450 SF6 Gas Detector to inspect bolted connections.

Using SF₆ gas requires that utilities have a process in place to track the amount the utility uses and what amount of gas is leaked into the atmosphere. The best choice to address this is to have a reliable infrared camera with SF₆ gas detection for spotting possible leakage during day-to-day maintenance rounds. This is where the rugged Fluke Ti450 SF6 Gas Detector enters the picture, as it's a more affordable infrared camera solution. Using the Fluke Ti450 SF6, utilities professionals can perform thermal inspections to detect leaks of varying significance, reduce downtime, and schedule appropriate repairs to the welds or bolted connections (seals and flanges) of bushings.

The importance of SF₆ gas detection

SF₆ gas is used to insulate outdoor substation equipment with higher than 35,000 volts (with corresponding high current) in utilities such as circuit breakers, transmission line switches and underground distribution switches or devices. If air or moisture sneaks inside the equipment, catastrophic failure like an arc blast can ensue. SF₆ gas helps prevent such calamities but the gas itself

carries some downsides and needs to be contained within the equipment enclosures. Each country will have their own set of regulations. In the United States, the Environmental Protection Agency (EPA) requires utilities to have a process in place to regularly monitor SF₆ gas leakage. Fluke advises that you research and familiarize yourself with your country and local regulations.

The minimum requirements for utilities is to have a process in place to monitor SF₆ gas use and leaks. California is the only state that requires the utility to record SF₆ gas usage and leak rate on an annual basis, achieving transparency through reporting and thorough record-keeping. If the gas leak is more than 1 % of the total gas used across the company, the EPA can fine the company. Utilities can be randomly audited by the EPA during which the government organization checks a facility to determine if a SF₆ monitoring process is both in place and effective enough in accordance with reducing greenhouse gas emissions.

The Fluke Ti450 SF6 reinvents the bar for everyday inspection rounds, combining infrared and gas detection

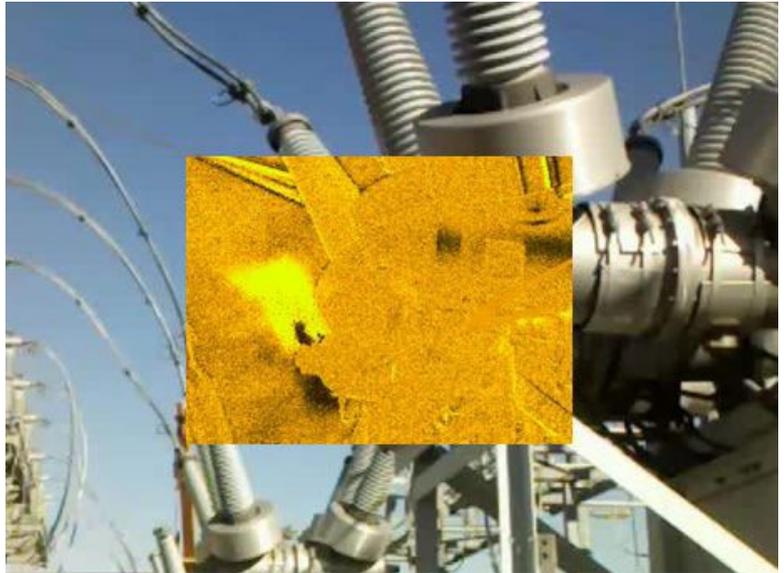


Figure 2: A thermal image with gas detection overlaid on a visible light image of a circuit breaker.

8 tips to capture gas images

- Avoid rainy/windy days—under these conditions gas dissipates too fast unless a massive leak is present
- Gas needs to be a different temperature than your background to see—you need a thermal contrast:
 - Cold sky or heated control box
 - Emissivity is a factor—make sure you plan for it
- Use a tripod to stabilize the camera during inspection
- Place the camera 10–12 feet from the target
- Position your camera lower than the leak and point the camera up – take advantage of the cold sky when you can, as gas leaks out in blurbs, not straight lines
- Be patient—wait for the gas
- Common leak locations are flanges, top and base of bushings, tubes
- When you find the leak, remove the camera from the tripod to get closer or move it to a better angle to get a better image

in one cost-effective tool. This infrared camera combines the Fluke Ti450, a high-performance thermal imager with a dependable pistol grip form factor, and SF₆ gas detection. It empowers inspectors to locate gas leaks without taking equipment offline and monitor equipment from a safe distance. The Ti450 SF6 sports an intuitive interface that seamlessly switches between standard thermal imaging and gas imaging modes.

A utilities inspector lacking a thermal imaging camera with SF₆ detection capability might find it difficult to pinpoint the exact location of the leak. Unfortunately, the all-too-common solution is to shut down the equipment and replace or repair all joints or points where the leak could be occurring just to be safe and in total compliance with government regulations. The Ti450 SF6 helps avoid expensive and potentially unnecessary equipment repairs. The camera offers confident leak detection and can help locate the source of a leak more effectively than other methods.

How utilities locate leaks

The current protocol for detecting a leak is rather cumbersome. A pressure gauge is used to indicate if there is a loss of gas. For a known SF₆ loss, the gas canister used to top up the SF₆ is weighed before and after to determine how much gas has been lost/leaked. Periodic inspections and topping up informs the utility of the rate of the gas leak. Depending on the rate of the gas leak the utility will adopt different strategies to deal with the leak. Before taking any remedial action, the

location of the gas leak needs to be identified. If the amount is very small, utilities teams tend to refill until the next inspection. If a larger amount is leaking, immediate action must be taken. These leaks can be so costly, that extensive and potentially unnecessary repairs may be made. One method to detect gas leaks is by the use of optical gas imaging cameras. These can either be purchased or rented. This can run up cost in a hurry, leading to outright purchasing an optical gas camera for \$85K USD or renting one for \$4,000 USD per week. An alternative is to hire an expensive third-party thermography consultant to perform inspections. The expense and inconvenience of these options usually result in annual or biennial inspections, plus increased spends on maintenance and SF₆ gas refills.

Another technique is to use gas sniffers. Teams often have to shut down the equipment in question, then use a handheld or fixed gas sniffer (combustible gas detector) to confirm the presence of a leak. Reliance on a sniffer alone still doesn't help determine the exact point of leak origin and in some cases workers have to delay testing until a regularly scheduled maintenance time.

All thorough gas inspections take time and are dependent on many environmental factors. Windy conditions can rapidly waft gasses and make it impossible to capture the source of a leak. Astute inspectors will examine any potential welds on the equipment. These can deteriorate over time, rust, or not be properly welded during the installation process. In theory, when this equipment is out in the field it's going to potentially deal with rain and other weather elements dependent on local climate and geography. Rust generally indicates that moisture is getting into the equipment—it is important to inspect any area that displays signs of corrosion. Any area of corrosion is a potential breach and subsequent leak.

Sniffing out SF₆ gas at a utilities facility is like spending a full day fly-fishing in a small stream. Both processes require finesse, technique, and patience. As mentioned earlier the level of gas leak determines the seriousness of action required. Gas leaks interpreted by the inspector to be of more significance will be picked up easily by the Ti450 SF6. It helps inspectors accurately pinpoint issues much earlier, locating the area of risk and leak locations without taking the equipment offline. The tool is affordable enough to own, so you can conduct infrared and gas inspections whenever and wherever you want without having to pay heavy rental charges or hire expensive contractors.

In summary using the Fluke Ti450 SF6 helps with easier early gas detection and fixes which:

- Allow maintenance to be scheduled at a convenient time without any unplanned downtime
- Reduce the potential equipment damage and cost associated with these leaks
- Check for gas leaks from a safe distance while the equipment is running
- Locate leaks in equipment overhead or off the ground
- Help where government reporting regulations are in place to avoid excessive fines

Three achievable goals for utilities maintenance teams are to reduce SF₆ emissions, spending, and dependency on outside contractors. With the Fluke Ti450 SF6 Gas Detector your team will be able to shorten the waiting game during the detection process, and potentially catch more leaks before they cause significant damage.

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