

# Comprehensive maintenance keeps electricity flowing

Pacific Gas and Electric Company (PG&E), incorporated in California in 1905, is one of the largest combination natural gas and electric utilities in the United States. Based in San Francisco, the company is a wholly owned subsidiary of PG&E Corp. Supplying energy to the state of California

(the fifth largest economy in the world) is a yeoman's job at best even though PG&E does not quite cover the entire state. Its service area stretches from Eureka in the north to Bakersfield in the south, and from the Pacific Ocean to the Sierra Nevada Mountains.



Pacific Gas & Electric is a major supplier of electrical energy to the state of California.

## Application Note

PG&E's physical plant includes 136,500 circuit miles of electric lines and 45,000 miles of natural gas pipelines. The combined energy sources serve 4.8 million electricity customers and 4 million gas customer accounts. In order to provide both natural gas and electric service to approximately 13 million people throughout its 70,000 square mile service area in northern and central California, PG&E currently employs over 19,000 workers whose primary job is the transmission and delivery of energy to residential, commercial and industrial customers.

### Providing safety while protecting investment

Electrical distribution systems are much more than overhead lines strung on transmission towers and poles. Even though this equipment is probably the most visible to the consumer (and probably the first to be blamed for any power interruption), there exists a wide variety of other equipment that make up an entire distribution system. Electrical substations and their related gear (transformers, breakers, service connections, etc.) are an integral part of the distribution system. In order to provide optimum service while limiting downtime, PG&E maintains a comprehensive preventive and predictive maintenance program.

Les Winebarger, safety director for PG&E, is involved with substation construction, maintenance, and repair for the entire system. This includes 1,200 substations, which drop transmission line voltages to the 70 kV or less

distribution voltage. Generally, substations see a wide variety of operation conditions and environments especially in a state the size of California. Winebarger, whose responsibilities lie between safety education and training, is involved in new substation construction and upgrading. Maintenance is an ongoing concern so each substation must be checked regularly to make sure that all systems remain in optimum condition. For example, the integrity of windings in transformers, breakers, and cabling found in electrical substations must be tested on a regular basis.

Insulation resistance testing has always been an integral part of substation maintenance. By performing a high voltage test between de-energized current carrying conductors and grounding conductors, maintenance technicians can eliminate the possibility of having a life threatening short circuit or short to ground. This test is usually performed after installation of new or refurbished equipment. The process will protect the system against mis-wiring and defective equipment, ensuring installation quality and protection against shock and equipment fire.

Installation resistance testing is also used as a preventive maintenance tool. Over time, electrical systems are exposed to a wide variety of environmental factors (dirt, heat, contamination, vibration, etc.) that cause insulation degradation. Periodic testing of insulation resistance values provides valuable information about the state of insulation deterioration, a condition that can lead to device failures, substation fires, and system downtime. Keeping track of insulation integrity ensures that equipment can be repaired or replaced on a timely basis.

### Technology marches on

In the past, PG&E used a hand-cranked insulation resistance tester to test insulation integrity. The original instrument, well known for motor testing, was analog based and, once the test leads were in place, could impress a voltage across the equipment or wiring to be tested by use of a hand-cranked magneto. Although suitable for most test situations, this device had limitations in both accuracy and functionality. It was a good example of old technology waiting for an upgrade.

Originally the idea for upgrading these pieces of test equipment for his department came out of a discussion between Winebarger and Dan Donoghue, a territory sales manager for Fluke Corp. (Everett WA), who was teaching a safety class at PG&E. As part of a discussion on electrical maintenance safety, Winebarger raised his concerns as to the functionality and inherent safety of the equipment he and his crew were using to perform insulation integrity testing. Knowing that the 1550 MegOhmMeter had just been introduced by Fluke and had started shipping, Donoghue brought it to Winebarger's attention. "I did not have one in my hand at the time but when I brought the spec sheet to PG&E's safety director's attention, he immediately wanted to see a demonstration of this new 5 kV unit," Donoghue said. Upon seeing the performance capability of the 1550B, PG&E purchased three units for the field. More purchases were to follow.

### Operational characteristics abound

Like the original Fluke 1550, the Fluke 1550B is intended for use by plant maintenance and utility technicians, electricians, and engineers who install, repair, or maintain electrical devices and cabling where insulation degradation is problematic. The 1550B offers standard test voltages up to 5000 V dc and measures resistances up to one Tera-Ohm. A warning voltage function alerts users that voltage is present and displays a voltage reading up to 600 V ac or dc. Additionally, the instrument's guard system eliminates the effect of surface leakage current on high resistance measurements. The 1550B measures cable or installation capacitance and leakage current and runs off of high capacity rechargeable batteries.



PG&E technicians used the Fluke 1550 to check for insulation degradation as an integral part of their intensive preventive/predictive maintenance program.

The 1550B features standard test voltages of 250 V dc, 500 V, 1,000 V, 2,500 V, and 5,000 V. New programmable test voltages are now available in 50-volt steps from 250 to 1,000 V and 100-volt steps from 1,000 to 5,000 V. The 1550B automates the calculation of Dielectric Absorption and Polarization Index with no additional setup, which means the user doesn't have to write down and manually calculate insulation resistance values. The 1550B also features an improved ramp function for breakdown testing.

The rugged, reliable instrument is lightweight and portable. It includes the Fluke Quicklink software and an optical interface cable for easier download to any Microsoft Windows®-based PC for data collection and reporting. Measurements can now be stored in up to 99 memory locations with each location assigned with a unique, user-defined alphanumeric label for easy recall. With values stored internally, spot measurements can be compared with previous readings on location, saving time and reducing the dependence on written maintenance records when onsite.

### Going the extra mile

Since utility-based electrical equipment is large, Fluke originally provided 10-ft leads with the original units purchased by PG&E. Once these units made it into the field, Winebarger found that longer leads would be both advantageous and safer to use especially in situations where the equipment to be tested was large or the wiring to be tested was high overhead.

With a man in a boom truck hooking up test leads to very large transformers or elevated wiring, Winebarger felt that it would be safer to have the instrument on the ground where another technician could easily operate it. Having the same man doing both jobs, especially in a situation where balance and stability could be compromised, seemed dangerous to him. Donoghue explained, "In order to allow more stable test setups, Fluke now offers optional 25-ft test leads that give users the option of placing the instrument apart from the equipment or cabling being tested."

According to Winebarger, the Fluke engineering team worked closely with PG&E to provide both longer leads and lead materials that would be safer to work with considering the voltages regularly encountered. To date, the 1550 units have provided PG&E with the functionality and flexibility necessary to keep the electrical system at maximum uptime. When asked how he felt about his experience with the 1550's performance in the field and Fluke's commitment to meet PG&E's safety needs, he summed it up in one word, "impressed."

**Fluke.** *Keeping your world up and running.*

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