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Fluke instruments add reliability to oceanographic research

Application Note

Testing Functions
Case Study

Tools: Fluke 434 Power Quality Analyzer, Fluke Ti30 Thermal Imager

Operator: Mike Gagne, Marine Electronics Manager, Woods Hole Oceanographic Institution

Measurements: Power quality logging, harmonics, transients, electrical thermal scans, predictive maintenance

Woods Hole Oceanographic Institution (WHOI), headquartered in Woods Hole, Massachusetts, is the largest non-profit oceanographic institution in the world. As such, it operates four primary research vessels ranging from the 279-foot Knorr, a ship set up to stay at sea for as long as eight weeks, to the 60-foot Tioga, a vessel with a range of 350 miles used for day trips to coastal waters.

Each of WHOI's research vessels has onboard sophisticated communications and navigational equipment, and the smooth functioning and upkeep of that equipment falls to Mike Gagne, the institute's marine electronics manager. Gagne's job includes coordinating all aspects of keeping the vessels' marine electronics shipshape, as well as electrical troubleshooting both on the vessels and at WHOI's on-shore facilities. It was in his capacity as an electrical troubleshooter and an electronics expert that Gagne, almost two years ago, first began to use a Fluke 434 Power Quality Analyzer and a Ti30 Thermal Imager.

The Fluke 434 Power Quality Analyzer measures and stores power quality factors for troubleshooting or for trending over time.

The Fluke Ti30 Thermal Imager records the surface temperatures of objects and displays them as thermal images that reveal abnormal hotspots. Since electrical problems often cause an increase in temperature. If one component appears hotter than others, there could be a problem.

Both instruments prove useful

Gagne has used the 434 and the thermal imager as a "tag team." For example, one of the institute's buildings had a power problem.

WHOI electrical personnel set up the Fluke 434 with current clamps and a voltage probe across the three-phase panel and left it monitoring the peaks and dips for almost two weeks. Analysis of the collected data revealed a bad connection somewhere in the panel, and the Ti30 was then brought in to locate it.

A scan of the panel with the infrared camera revealed an overheating bolt lug on a connection to the compressor in the building's central air conditioning and air quality systems. "We pulled the bolt off and found that for some reason there were threads missing on the inside portion of the bolt," Gagne recalls "The nut felt tight, but the lug was a little loose. It had arc welded itself to the bus bar. Carbon in between was causing significant resistance. With the tag team of the 434 and the Ti30, we were able to solve the problem."

Onboard solutions

Gagne's Fluke instruments are also used onboard the vessels. "We've always had some harmonics problems on our vessels. On the Knorr, for example, distortions took away from the amount of power on the grid and were causing problems with the onboard generators. We used the Fluke 434 to isolate distortion producing loads and then installed filters to remove them. On one vessel, we simply moved the filter closer to the source, and that solved the problem. Initially, the filter had been installed in the wrong place."

Besides isolating and correcting power quality issues such as harmonic distortion, the instruments are also used to troubleshoot the ships' onboard 480-volt electrical systems and their diesel/electrics propulsion systems. But one of the most interesting and revealing onboard problems was one that was detected but not corrected.

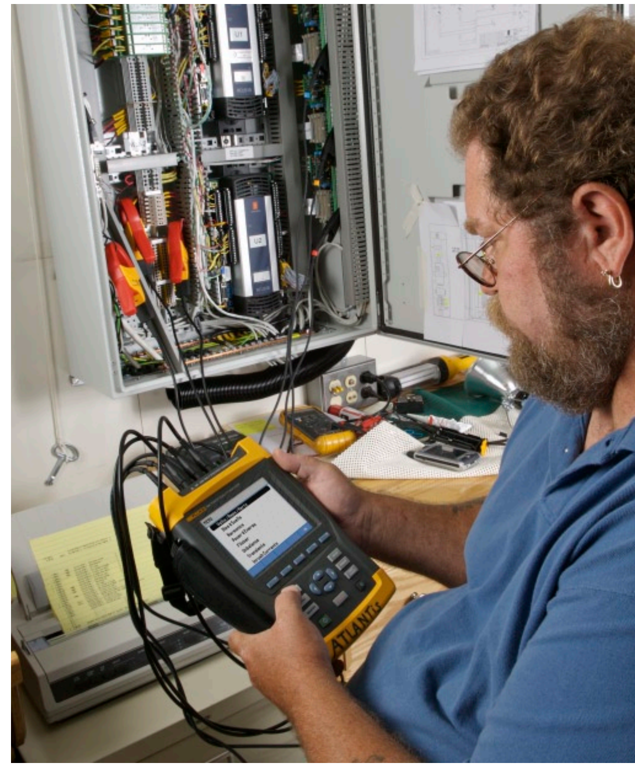
The problem was a large fan that normally circulates air in the engine room for the generator intake. Readings using the Fluke 434 Power Quality Analyzer indicated some anomalies in the power to the fan. The electricians discounted the readings, but they shouldn't have.

In retrospect, here's what happened: At one point, the fan was pulled to the stack for circulation because maintenance was occurring in the stack. The armored, low-voltage cable to the fan, which penetrated through the deck via a watertight arrangement called a kick tube, was laid to its side, and it cracked, a condition covered over by many coats of paint. The analyzer detected the elevated phase current but nothing was done about it until, in Gagne's words, "Moisture and other contaminants got in there and (ultimately) it just blew. It blew, blew!"

The electronics manager laments that had WHOI personnel believed what the instrument was telling them they might have averted the failure. "One of the things we're going to have to do," he says, "is learn to trust what the instruments tell us. The tool was doing its job quite well. It recorded a small arcing condition, but we ignored it because the instrument was new to us. The oversight was hard to swallow at the time."

An additional onshore solution

One other issue Gagne addressed with the Fluke instruments concerned two shore-to-ship power cables that feed 400-amp, 480-volt, three-phase power to docked vessels from onshore generators. Voltage sags onboard a ship at the dock were apparent when power was being supplied over one of these six-inch diameter umbilicals. In response, Gagne set up the Fluke 434 on the transformer pedestal and monitored voltage and current for a whole weekend. At the same time, onboard voltmeters monitored what was happening on the ship.



Gagne reports, "The voltage stayed the same on the shore side but the current dipped. The voltmeters on the ship were indicating the same thing. There was some sort of a voltage drop in between. Next, I took the Ti30 and just started walking along the cable, and at one point, it started showing some different colors. At the same time I could see that there were some scrapes on the cable."

The electronic manager reasoned that at some time in the past, the cable got pinched between the vessel and the dock, possibly damaging the dielectric (insulation) inside. A physical examination revealed that Gagne's opinion was correct. A crew made a temporary repair using a special waterproof splice. Once the cable was fixed, everything functioned well, and an order was placed for a new cable.

As the foregoing examples indicate, data logging capabilities add significantly to the power of the Fluke 434. Gagne notes that without data logging, a tech might not find a problem, even if he or she systematically took readings on a circuit at regular intervals. "No matter what you do, you just can't be there all the time," he says, "and maybe a transient is so quick you cannot see it (on an instrument) with the human eye. In such cases, the 434 can detect and record it (the transient). So, we park the 434 with current clamps and a voltage probe and let it record. Later, using the data, we are able to make rational repair decisions rather than using a hit-or-miss method."

Developing a comprehensive program

Gagne says that the most important aspect of acquiring the new instruments for the institute's research vessels is to institute a proactive, not reactive, maintenance program. He says, "We don't want to say to parts suppliers, 'We had a bad panel that just burned up, and you have to hurry to send these parts because we've got downtime.' No, we want to find degrading components long before they ever start creating problems. If we don't see it in an infrared image, we want to see it in the data in the spreadsheets."

The plan is for engineers and electricians assigned to research vessels to do walk-throughs every two or three months. They will open panels, record a thermal image and perhaps collect data with the power quality analyzer and put the panel back together. Then, using the software that accompanies these instruments, WHOI personnel will be able to do trend-line analysis, document the values present during normal operations and pinpoint anomalies as they occur. The plan is to establish baselines against which to compare subsequent readings.

Following the establishing of baselines, the next step is to monitor equipment regularly. Gagne explains: "At some point you end up saying, 'I don't like the way this is looking. The voltage or current has changed a little bit from the baseline.' Ninety-nine percent of the time it will be a bad connection somewhere. We all know that. It's just a matter of helping the electricians and the engineers narrow it down and eliminate the guesswork. They end up using their time more productively, and we save money by not using up spares unnecessarily with a hit-or-miss approach."

Fluke digital multimeter monitors research submarine's battery array

Alvin is a U.S. Navy-owned, WHOI-operated, human-occupied deep submergence research vehicle capable of taking two research scientists and a pilot to ocean depths of 4,500 meters (about three miles). While diving and surfacing is accomplished by gravity and buoyancy using water ballast and expendable steel weights, the submersible relies on six battery-powered, reversible thrusters to hover and maneuver.

Safety and operational considerations make it essential to monitor the Alvin's battery array, and WHOI has selected a Fluke digital multimeter to do the job. The meter serves as a permanently mounted voltmeter that constantly monitors the state of the batteries in the submersible's battery compartment.

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