FLUKE®

From 1944 to today:
Restoring the electrical system of the USS *Pampanito*

Application Note

Testing Functions
Case Study

Measuring tools: Fluke digital multimeters (DMMs) and Fluke infrared (IR) cameras

Operators: Rich Pekelney, volunteer restoration technician; Bill Weindorf, electrician with Metropolitan Electric

Tests performed: Isolate circuits, trace circuits, scan panels to find hot spots

It was March 1944. The USS *Pampanito* (SS-383)—a Balao-class submarine—left Pearl Harbor on her first war patrol. Built in the Portsmouth Naval Shipyard in New Hampshire as part of an expanded wartime production effort, the *Pampanito* was one of the most advanced fighting systems of her day.

When the war ended, the *Pampanito* returned to San Francisco, where she sat until 1961, when she was brought back into service as a shore-side Naval Reserve training ship. Nine years later she was again sidelined until the late 1970s, when the Maritime Park Association (MPA) acquired her and turned her into the USS *Pampanito* submarine museum and memorial at Fisherman's Wharf in San Francisco.

The MPA's ultimate goal was to return the USS *Pampanito* to the same condition as after her major overhaul near the end of World War II in 1945. But that would take time, so in the meantime the MPA opened the *Pampanito* as a public museum in 1982 and continued to collect missing equipment and spare parts from all over the country. The submarine was named a National Historic Landmark in 1986.

Bringing equipment back to life

A few years into the restoration, the MPA staff decided to restore some of the sub's equipment to working order. The problem was that during her stint as a training platform a lot of non-historic changes were made to the electrical system. For example, since she was no longer diving and surfacing, the trainers had put ac current on many of the dc circuits to accommodate training simulators.

To get the original equipment operating again, restoration technicians had to first find out how the component was supposed to be powered and then verify that the source of power still existed and was safe. Once they restored the correct ac and dc voltages in the right places, they could start working on the equipment itself.

"To restore a circuit we'd use our Fluke DMMs [digital multimeters] to try to isolate the circuit and make sure it was only attached to the things it was supposed to be attached to," says Rich Pekelney, a volunteer restoration technician.

Tracing those circuits was no easy task. When the *Pampanito* was turned over to MPA it came without as-built drawings. To trace the wires, in many cases technicians had to physically move their hands over the wires and follow them to their source. "Along the way we found all sorts of little crazy cross connections that we removed and then restored the original services," says Pekelney. "Having high-quality test equipment made it much easier to find the problems and fix them."

Submarine turned teacher

Today the *Pampanito's* electrical system has been restored to its original state, nearly all of the missing items have been replaced, and much of the equipment on board has been restored to working condition. With the exception of the new hatch and ladders installed for visitors, the submarine is virtually as she was in 1945.

Each year the *Pampanito* plays host to as many as 110,000 visitors. It also offers educational day and overnight programs to more than 15,000 schoolchildren every year. These programs bring history alive for students and give them the chance to explore the basic scientific principles that make a submarine work.

To provide a safe environment for those visitors, the *Pampanito's* restoration crew has been vigilant about maintaining the electrical system. A buildup of dust or corrosion—resulting from the inevitable presence of moist sea air and salt—can cause resistance and thus heating. So technicians regularly clean and inspect the switchboard and other components to ensure that dust and dirt don't build up and to identify and alleviate any corrosion before it becomes a problem.

Thermal scans expedite electrical inspection

During the *Pampanito's* annual maintenance in fall 2012, MPA added a new dimension to the inspection process, thanks to the generosity of Metropolitan Electric in San Francisco. The firm donated the services of electrician Bill Weindorf, who scanned the *Pampanito's* electrical panels to identify any potential hot spots.

"The kind of Infrared camera technology Fluke offers produces much more sensitive imaging of these switchboards so we can find hot spots much more easily," says Pekelney. This first inspection created a baseline so that subsequent scans can help spot any changes that might indicate a potential problem before it happens.

"Our primary goal with the thermal imager is to look for places where either dirt or loose connections are causing heating that might grow to the point where it becomes a hazard," says Weindorf.

Weindorf scanned two key areas of the electrical system—the lighting distribution panel and the IC switchboard. "The biggest challenge was finding the room to get a good camera angle, because obviously on a submarine you're dealing with very tight quarters," says Weindorf. "Since there was very little load on the electrical panel we didn't see much in the way of heat signatures, but we were able to detect some differences."

"The lighting distribution image showed a tiny bit of temperature rise, which probably shouldn't be there because it's very low current," says Pekelney. "That says to me that there might be some corrosion starting to form in that fuse holder." Following the inspection, Pekelney pulled any of the fuses that showed even a little bit of temperature rise and burnished up the contacts to make sure there was no incipient problem.

The control room is the center of the submarine, both physically and operationally. Bill uses a Fluke Ti125 to look behind the IC switchboard, which has both 120 volt ac and 120 volt dc systems.

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