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Utility's instrument lab foreman develops

MET/CAL® procedures for calibrating secondary reference watt hour standards

Application Note

Testing Functions

Case Study

Tools: 6100A Electrical Power Standard, MET/CAL®

Operator: Mark Kraus, Instrument Lab Foreman for Portland General Electric Company (PGE)

Measurements: Calibrating secondary reference watt hour standards

Because electric companies buy energy from and sell energy to one another, they have to know with certainty how much power comes into and goes out of their substations. Of course, watt-hour meters record that data, and success in the electricity business depends upon those meters accurately measuring the power received or sent during transactions. As elsewhere, this is true for Portland General Electric Company (PGE), an investor-owned utility that serves 808,000 customers in 52 different cities in the Portland, Oregon metropolitan area and the northern Willamette Valley.

Mark E. Kraus is the working foreman in PGE's instrument lab, the facility responsible for ensuring the accuracy of the so-called *secondary reference meters*, often called *secondary standards*. These watt-hour standards are the instruments the company's meter and relay technicians take to substations and use to determine the accuracy of the meters there.

By mandate of the Oregon Public Utility Commission, these secondary standards must be calibrated every six months. "So, we send a notice out to each technician every six months," Kraus reveals, "saying 'it's time to get your standard recalibrated.' Then, they bring it in to us. We recalibrate it to ensure it meets specification and send it back out."

The Fluke 6100A

Playing an instrumental role in the recalibration of PGE's secondary watt-hour references is the Fluke 6100A Electrical Power Standard. The 6100A is in essence a very accurate *arbitrary waveform generator*. It can deliver both voltage amplitude and current amplitude very precisely. Also, the phase angle one-year accuracy between the voltage and the current output is better than 3 millidegrees.

The 6100A comes as a single phase unit, but users can add phases to make it a system that will generate (simulate) as many as four phases, in which the voltages and currents can be precisely synchronized between each of the multiple phases. The unit offers very accurate control of the phase angle between volts, volts and current, and current among any of the phases.

In addition to these fundamental outputs, the 6100A is an instrument capable of replicating "real world" phenomena, allowing it to calibrate complex power-quality and power monitoring instruments. It can output flicker, harmonic distortion, inter-harmonics, fluctuating harmonics, dips and swells, all to user-defined parameters. These capabilities allow users to calibrate in conformance with virtually any standard in any part of the world.

As far as PGE standards compliance, Kraus says, "We do what our public utility commission mandates, and they say we have to follow the guidelines in ANSI C.12.1." The lab foreman goes on to explain that ANSI C12.1 deals with utility metering, including specific guidelines for the calibration laboratories that support metering activities. ANSI C.12.1 clearly specifies that portable secondary standards will be tested at a minimum of six-month intervals with primary standards (described below) tested annually.

Note: While Portland General Electric conforms to the ANSI standards outlined here, ANSI represents the US on the IEC technical committee, so PGE is indirectly related to IEC. Other labs and utilities around the world must adhere to other written standards, and the Fluke 6100A is designed to meet those varying needs.

The 6100A at PGE

With power accuracy of 200 parts per million (ppm), one might think that Kraus would use the 6100A as a primary reference in the calibration of the company's secondary watt-hour standards. That is not the case. For that task, PGE's lab uses an RD-22 Dytronic Primary Reference Standard from Radian Research Inc. This instrument is more accurate than the Fluke 6100A by a factor of two (50 ppm compared to 200 ppm), with a worst case accuracy of ± 0.01 % and repeatability in the range of 0.00001 %.

Most of the secondary portable watt-hour standards under test at PGE are also from Radian Research. In these tests, the 6100A serves as a source of simulated waveforms and phase angles as well as a pulse comparator. The 6100 counts the pulses from the device under test (DUT) as well as the RD22 and displays the error or registration.

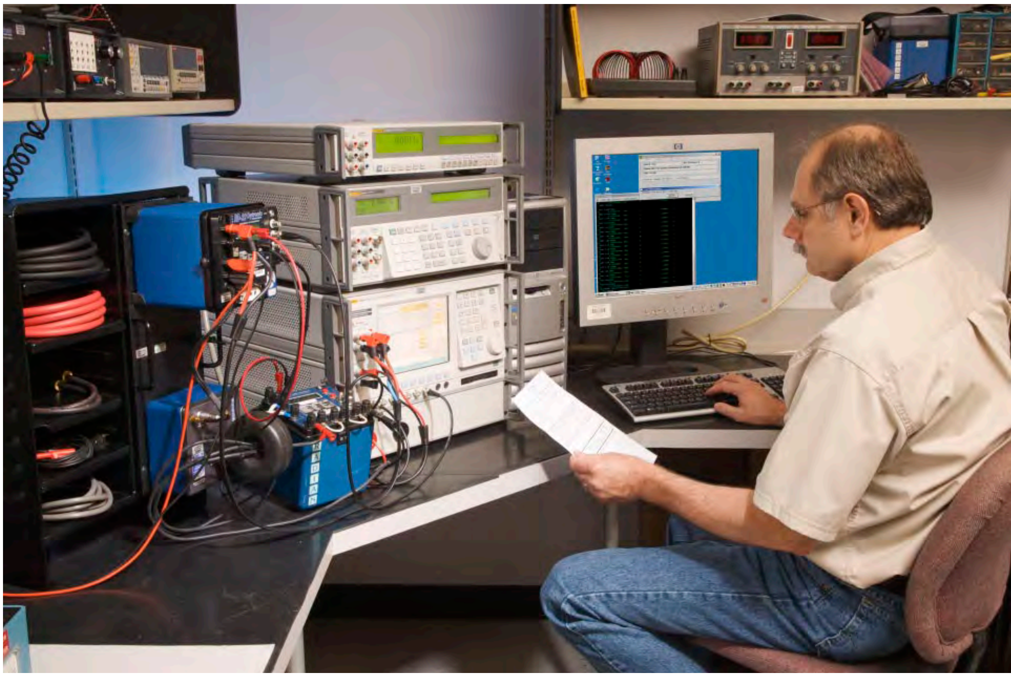
Kraus explains that what a watt-hour standard (and also a DUT for that matter) does is put out a train of pulses that are proportional to the input energy. The input energy is generally a combination of voltage and current and a phase angle between the voltage and current. "And so, what we do," Kraus says, "is simultaneously input a series of identical watt-hour levels into the standard and the DUT. The voltages are parallel for the standard and the DUT, and the currents are in series. So, both the standard and the DUT see the same voltage and the same current and the same phase angle at the same time."

MET/CAL® automated software at PGE

The knowledgeable reader will realize that the Radian RD-22 has a built-in comparator. So, why is PGE's lab using the Fluke standard as its source and its comparator? The answer lies in the fact that Fluke-written MET/CAL® Calibration Management Software is at the heart of the calibration system devised by Kraus for use in calibrating the company's secondary watt-hour standards.

MET/CAL is an automated calibration environment for PCs running the Microsoft® Windows® operating system. It generates and writes test results to a SQL database. The system enables a user to create and edit calibration procedures using a wide range of standards. In fact, PGE already used the software for other tasks, and wrote a MET/CAL calibration program to control the output of the Fluke 6100A at different energy levels. "Since our Radian RD-22 standard is auto-ranging," Kraus says, "other than changing current carrying leads from the 6100A 20 amp output to the 6100A high current module output, our calibration procedures are nearly fully automated."

Using the software, PGE's lab can select and run the calibration procedures and collect the calibration data. The software supports generating calibration reports and certificates and makes data available to other software applications such as Microsoft Word and Excel. MET/CAL software automation is reportedly four to eight times faster than manual calibration, and Kraus' experience, described below, bears that out.



Mark Kraus at his test bench, using MET/CAL.

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A big payback: the details

Kraus explains that during the typical calibration of a secondary watt-hour standard the lab supplies the primary standard and the DUT typically with 132 discrete energy levels or points. "What we do," he explains, "is start out at a quarter amp and 120 volts. We do that at zero degrees phase, and then we check it at a phase angle of -60 degrees. Then we continue taking points all the way up to 50 amps. And we do this at voltage levels of 120, 240 and 480 volts at both unity and -60 degree phase angles. So, the discrete levels are a quarter amp, one-half amp, one, one-and-a-half, two-and-a-half, three, five 10, 15, 30 and 50 amps."

The lab foreman notes that in the past a technician had to set up every point, one at a time and generate each energy level using a phase-relational voltage/current calibrator, sometimes in combination with a voltage transformer, and then record the results. "In some instances," Kraus says, "it would take more than a day to calibrate one DUT. A technician had to sit and wait while a point ran and then manually make the setup for the next test point. It was just extremely time consuming!"

Kraus explains that the manual procedure was not something a technician could walk away from. Now, however, the setup involves simply connecting the voltage output of the 6100A to the standard (RD-22) and to the DUT in parallel and then connecting the current output of the 6100A in series to the same two units. A third connection is from the pulse output of both the primary standard and the DUT to the 6100A. The 6100A then compares the two pulse streams. It counts the pulses, and the computer running the MET/CAL software and controlling the test sequence stores the test results for analysis.

"Briefly stated, the system tells us what the difference between the DUT and the primary standard is, if any," Kraus says. "With the 6100A and the automation it provides, we can start a test and then move on to do other things while the test is running. We periodically check the test in progress, and make lead changes as necessary. The procedure we've established frees us up to perform other tasks in our lab while the test continues."

Kraus describes the payback in terms of the time saved. He estimates that the lab has cut the time it takes to calibrate a secondary watt-hour reference (standard) by two-thirds to three-quarters – from, say, eight hours to two or three hours. "It's been very, very effective in freeing up lab personnel to do other things," he says.

What if a secondary standard is out of calibration? On older models, Kraus reveals, the lab can adjust them in house. "For the newer digital ones," he says, "we have to return them to their manufacturer to have them adjusted."

Using the Fluke 6100A for other calibrations

Among the instruments used by Portland General Electric (PGE) is a Model 931A Power System Analyzer from Arbiter Systems®, Inc. The unit is designed especially to measure levels of current (40 mA to 20 A) and voltages to 750 V, values typically encountered in relaying, instrumentation, and metering circuits. Like any piece of test instrumentation, the unit requires periodic calibration. To perform that task, Mark Kraus, PGE's calibration lab's working foreman uses the same Fluke 6100A Electrical Power Standard that he uses as a generator and comparator in calibrating the company's secondary watt-hour standards.

Kraus describes the 931A as "a voltage and current meter with firmware built in to allow it to measure many other electrical parameters," and describes its calibration using the 6100A as "just something else we have developed a procedure for." He says that the 6100A has helped his lab better calibrate devices like the 931A. "We had to use a number of other discrete pieces of calibration equipment that required numerous lead changes to calibrate them before, and now we can for the most part automate that entire calibration process. It's simplified it to a great degree," Kraus reveals.

Noting that the Arbiter 931A can measure voltage up to 750 volts as well as current, Kraus says, "We use the 6100A as a voltage source for a calibrated input into the ac voltage-measuring portion of the Arbiter, and we use it as a current source for a calibrated current input, too. And while the Arbiter 931A does not measure typical power quality parameters like sags, spikes and flicker, one capability we do use that's critical is the phase angle relationship between voltage and current, because the Arbiter does measure phase angles with a specified accuracy of 0.05 degrees. The 6100A's published phase specification at 60 Hz and a one year calibration interval is better by more than ten times the 0.05 degree specification of the Arbiter 931A, so it is an excellent choice for the calibration of the Arbiter's phase angle readings."

Calibrating the primary standard

The annual calibration of the RD-22 Dytronic Primary Reference Standard that Portland General Electric (PGE) uses as its primary watt-hour standard involves several instruments. Together, they meet the manufacturer's protocol for re-calibration of the RD-22.

The foreman of PGE's calibration lab, Mark Kraus, says that there are three things required to calibrate the primary standard:

1. A very steady calibrated 10-volt reference standard
2. An accurate DC milliamp current
3. A very stable one-cycle-per-second square wave in order to verify the RD-22's time-measuring

The 10-volt reference standard is achieved with a Fluke 732B Voltage Reference, a direct voltage standard with 10 V and 1.018 V outputs. Kraus recalls that a Radian Research representative recommended this instrument.

The accurate DC milliamp current, which must be within the 2.0 to 2.3 milliamp range, can be generated using a Fluke 5720A Multifunction Calibrator. "If I standardize the current from the Fluke 5720A, I can do it with that," he says. "And as far as the time signal goes, I use a Stanford Research Systems Model FS700, 10 MHz LORAN-C frequency standard."

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