



# S&C Testing Lab Helps Certify a Fault Indicator for a Customer's Field Application

**S&C Featured Solution:** Laboratory Services—Hybrid Short-Circuit Testing

**Location:** NJC High-Power Laboratory in Chicago

## Customer Challenge

A global safety consulting and certification company was conducting an ongoing field evaluation of a test-point type faulted-circuit indicator used in a wind farm. As a part of this complex plan, the company had to perform a specific test to demonstrate the indicator's immunity to faults on adjacent conductors positioned extremely close to unfaulted circuits having the same indicators.

The challenge the testing introduced was in replicating the indicator mounting and the voltage and current requirements for the indicators before introducing the fault in the adjacent circuit. IEEE Standard 495 requires the tested three-phase set of indicators to be "reset" for a few minutes on energized conductors at close to the nominal voltage of a typical distribution system.

Reasonable load current also had to be flowing in all three phases before and during the occurrence of a nearby fault. Providing such current is usually impossible to achieve in short-circuit test laboratories, where generators are used to apply only a short-duration fault current during a test shot. The labs do so because they are not typically designed to carry sustained pre-fault load currents.

## S&C Solution

The manufacturer of the faulted-circuit indicator had previous experience testing other products in S&C's Nicholas J. Conrad High-Power Laboratory, so it recommended S&C to the certification company to do the indicator testing. To satisfy the requirements of IEEE Standard 495, S&C engineers developed a hybrid test circuit in one of the lab's test cells.

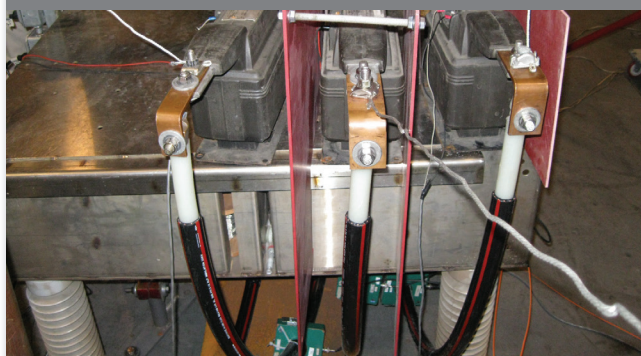
The synthetic test circuit S&C developed produced the required phase currents and voltages for the unfaulted

phase elbows equipped with the indicators. A short-circuit generator circuit also produced the short-circuit current through an adjacent faulted phase cable and elbow. The synthetic test circuit used distribution and current transformers that were both back-fed from two three-phase sources to supply the required phase voltages and currents in the unfaulted phases. See Figures 1 and 2.

*Figure 1. Circuit setup showing use of distribution transformers to energize unfaulted phases having faulted-circuit indicators.*



*Figure 2. Current transformers used for load-current injection in unfaulted phases having faulted-circuit indicators.*



*S&C's expertise in replicating actual field conditions allowed testing of a faulted circuit indicator's immunity to a fault in an adjacent conductor.*



S&C's experience as a manufacturer of products for distribution systems was helpful in designing a test fixture that properly replicated the phase-to-phase center-center distance of the actual field conditions. For the testing, the mounted elbow bushings were all equipped with faulted-circuit indicators connected to the voltage test tap points of the elbow bushings. An adjacent elbow was mounted next to the three elbows and served as the faulted conductor for these tests. The position of the adjacent elbow was adjustable to provide for testing at specified distances from the unfaulted phase elbows. See Figure 3.

A series of 16 tests was performed to demonstrate the indicator's compliance with the IEEE standard. Each test for the symmetrical and asymmetrical faults was conducted with no load on the faulted conductor and with load current and normal phase-to-ground voltage on the unfaulted conductors. The cable and elbow representing the adjacent faulted circuit were subjected to a 10-kA symmetrical fault as well as fully asymmetrical fault currents lasting approximately 10 cycles. As expected, indicators on the unfaulted phases did not show a faulted status during any of these tests.

An additional test was performed by moving an indicator from the unfaulted phase to the elbow of the fault-circuit path to demonstrate that the indicator would properly show a fault when subjected to fault-current levels above its trigger level and would then reset after being exposed to normal voltage for a period of time. This was demonstrated by subjecting the faulted phase to a fault current and monitoring for a few minutes until the indicator status changed from faulted to unfaulted because normal voltage

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*“The expertise of S&C's test engineers and our laboratory support team made it possible to meet the customer's expectations and produce very successful test results.”*

*– Ernst Camm, Sr. Manager, Consulting and Analytical Services, S&C Electric Company*

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**Figure 3. Test stand with one faulted phase elbow and three unfaulted phase elbows with faulted-circuit indicators mounted.**



was continuously present on the circuit connected to the indicator. In other words, the test simulated the fault being cleared by a downstream device, thereby leaving the circuit energized after the indicator saw a downstream fault.

## Results

The customer's program manager enjoyed his lab experience with the S&C team and was very pleased with the support the team provided. He also was appreciative that S&C was able to design a test circuit that completely replicated actual field conditions.

S&C supported the testing by using its internal resources, namely S&C's Vista® Underground Distribution Switchgear, to build the test fixture. In doing so, the customer was appreciative because this helped minimize its need to provide any additional hardware and equipment.

S&C helped the customer achieve its goal to successfully test the faulted-circuit indicator in compliance with IEEE 495 standard to demonstrate the device's immunity to magnetic fields caused by a fault on an adjacent cable circuit. This result allowed the customer to certify the manufacturer's product for the application. As an additional benefit, the wind farm owner could use the certified faulted-circuit indicator on its collector system, allowing the electrical inspector to approve the wind farm development.