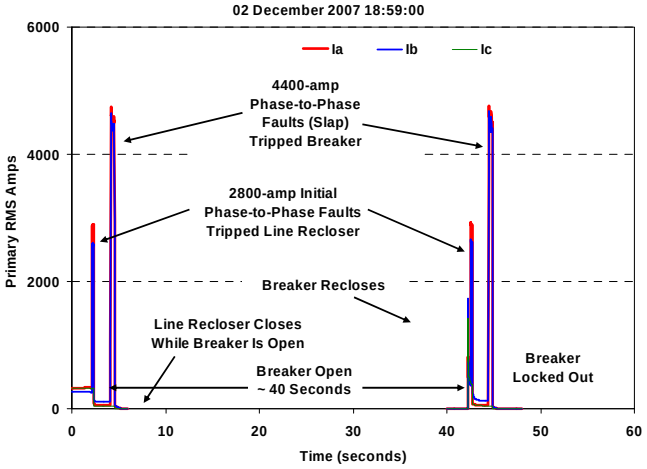
BC Hydro Uses DFA Technology to Prevent Conductor-Slap and Outages

BC Hydro and other utilities have used DFA technology detect and locate conductor-slap events on overhead lines, enabling proactive repairs, to prevent future outages and stresses to the system. A conductor-slap event occurs when an initial fault induces magnetic forces that cause a second fault, closer to the substation, often leading to breakers tripping entire feeders.

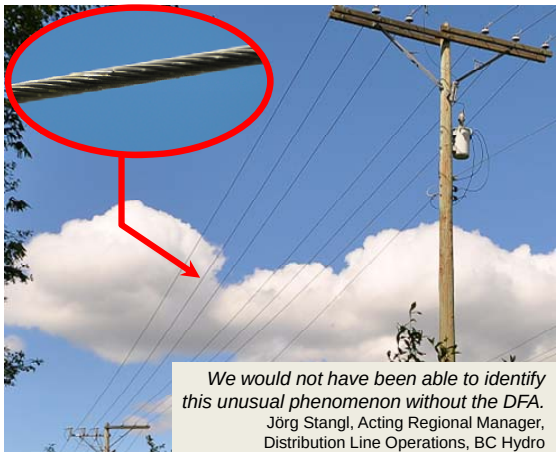


The figure at right illustrates RMS current during a ten-cycle, 2,800-amp, phase-to-phase fault that tripped a pole-mount line recloser. This operation should have isolated the fault and left the rest of the feeder in service. Instead, the substation breaker tripped and locked out the entire feeder. BC Hydro noted the failure of protection to coordinate properly, but the detailed investigation that followed indicated proper coordination settings, leaving them with no explanation for the feeder lockout.

Prior to tripping the line recloser, the initial, 2,800-amp fault current had induced magnetic forces in the overhead conductors between the substation and the fault point, pushing the conductors away from each other. Interrupting the fault removed the magnetic forces abruptly, allowing the conductors to swing back toward their normal resting points. Momentum caused them to over-swing, contact one another, and create a second fault. In such scenarios, the second fault often occurs relatively close to the substation, producing high fault current and tripping the substation breaker. That is what occurred here. To make matters worse, when the feeder breaker reclosed forty seconds later, the initial fault resumed, causing the whole sequence to repeat, culminating in the entire feeder locking out.

Multiple utilities have used DFA to identify and locate conductor-slap events. Left uncorrected, conductor-slap may recur and continue to cause unnecessary breaker or recloser operations, degradation of system components, and outages. Following the lockout described above, for example, BC Hydro was unable to undertake corrective action, because engineers performing the investigation did not have access to DFA information and conventional tools at their disposal were inadequate for reaching the correct diagnosis. Two years later, conductor-slap recurred at the same location, again locking out the feeder. When investigating the second feeder lockout, engineers used DFA information that indicated conductor-slap as the likely cause. They then used DFA information to locate the offending span, where they found visible arc damage on the conductors.

The electrical sequence of events during conductor-slap events is predictable, typically consisting of a phase-to-phase fault, followed by a higher-current fault on the same phases within a second or so. Once this sequence is identified, the DFA system provides a fault-current estimate that the utility can compare to fault-study maps. This typically puts a line crew within a few spans of the slap point. Experience has shown that conductor-slap usually occurs in spans of unusual construction, such as slack spans, transition spans, and extra-long spans. Therefore, once DFA fault-current estimates and fault-study maps lead a crew to the right vicinity, the contact point typically is easy to find by looking for signs of arcing on conductors in a nearby span of unusual construction.



We would not have been able to identify this unusual phenomenon without the DFA.
Jörg Stangl, Acting Regional Manager, Distribution Line Operations, BC Hydro

About DFA Technology

Distribution Fault Anticipation (DFA) technology was developed at Texas A&M University as the result of analysis and characterization of thousands of high-fidelity electrical current and voltage waveforms. Researchers created this database of waveforms with extensive support by EPRI and more than a dozen utilities, which installed high-fidelity, high-capacity data-recording devices in their substations and connected CTs and PTs as inputs. Sensitively triggered waveforms were recorded over multiple years, to produce a database that documents the electrical waveform signatures of numerous failure modes and incipient-failure modes of line apparatus, enabling researchers to develop sophisticated, on-line algorithms to alert utilities about failures, sometimes even before they result in outages. The DFA system performs autonomously, to deliver actionable information without requiring human experts to analyze and interpret raw data.

For More Information

For more information about DFA technology, please contact Dr. B. Don Russell, Regents Professor (bdrussell@tamu.edu, 979-845-7912), or Mr. Carl Benner, Senior Research Engineer (carl.benner@tamu.edu, 979-845-6224) at Texas A&M.