

Research Update

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Bottom Line

An external magnetic flux generated by fault current flowing adjacent to a current transformer caused localized saturation and an unnecessarily differential trip. This research project recreated this misoperation and identified potential solutions. The issues identified with this research have Reclamation and industry-wide implications, as this neutral current transformer configuration is very common.

Better, Faster, Cheaper

Increase the reliability of a power system by reducing the number of forced outages experienced by electric power generation equipment.

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Localized Saturation on Generator Neutral Current Transformers

Recreating a misoperation of a generator relay that was caused by localized current transformer saturation and identifying potential solutions

Problem

A hydrogenerator at a Reclamation powerplant facility tripped offline due to a differential relay element operation. Concurrent to this event, an external phase-A line-to-ground fault occurred on the nearby 230-kilovolt transmission system. Post analysis of the event indicated that the fault did not originate within the generator differential zone of protection. The generator step-up transformer is 230/13.8 kilovolts with a wye-delta winding connection. For an external phase-A line-to-ground fault, generator fault current flows on phase-A and phase-C, but should not cause differential relay element operation.

Analysis of the generator differential relay data showed that currents from the phase-B current transformers did not sum to zero. The waveform traces suggested an issue with the phase-B's neutral current transformer. Based on the physical orientation of the neutral bus connections, it was determined that the external magnetic flux generated by the fault current on the phase-A bus, the neutral shorting bar, and phase-C bus caused local saturation of the phase-B current transformer. The local saturation of the phase-B current transformer caused the current through the secondary leads to misrepresent the actual current flowing through the primary side. This misrepresentation, when summed with the phase-B generator terminal current transformer secondary current, created an operate current above the differential relay element operate point. This error unnecessarily tripped the generator offline.



Generator neutral current transformer leads.

Solution

In this Reclamation Science and Technology Program research project, the Hydropower Diagnostics and SCADA Group in Reclamation's Technical Service Center recreated a misoperation of a generator relay that was caused by localized current transformer saturation, and identified potential solutions.

The two identified potential solutions can be pursued in an effort to mitigate such erroneous trip situations. The first potential solution is to implement new high-security relay settings, which were recently developed for the microprocessor relay installed at the Schweitzer Engineering Laboratories. The second is to use current transformers that are designed to reject external flux for use on the generator's neutral bus.

Application and Results

The issues identified with this research have Reclamation and industry-wide implications, as this neutral current transformer configuration is very common.

Future Plans

The Hydropower Diagnostics and SCADA Group proposed to thoroughly test both potential solutions next fiscal year using new research funding and publish the results in a subsequent report. One or both solutions will be implemented at Reclamation facilities where similar neutral current transformer configurations exist, to prevent future misoperations.

“Localized saturation of current transformers may be responsible for many of the unexplained differential relay misoperations that have occurred at Reclamation’s powerplants.”

James DeHaan
Electrical Engineer
Reclamation’s Technical
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Collaborators

Reclamation field personnel at impacted powerplant facility.

More Information

www.usbr.gov/research/projects/detail.cfm?id=2446

www.usbr.gov/research/projects/researcher.cfm?id=13