NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION

Lesson Learned

Current Transformer Ground Relay

Primary Interest Groups

Transmission Operators (TOP) Transmission Owners (TO)

Problem Statement

A relay misoperation at a BES substation was determined to have been caused by the configuration of the Current Transformer (CT) used to measure ground currents. (See Diagrams 1 and 2.)

Details

New live tank breakers and CTs, that the entity received were supplied without a column CT that would encircle the entire CT column. In an attempt to provide the CT column ground protection, a window CT was mounted on the corner of the structure, and a ground cable was connected from the base of the column through the CT to the substation ground mat. There was another ground cable at the opposite corner of the structure that was attached to the steel structure and connected to the ground mat. (See Diagram 1.) Both grounds should have been run through the CT as shown in the original design. The entity though that in the event of a second column ground fault there would still be enough fault current going through the CT. However, the two grounds created a parallel path (across the ground mat) for ground fault current to the ground mat. (See Diagram 2.) The entity did not anticipate that there would be enough current looping through the two grounds from the ground grid for faults outside of the Column Ground zone. A fault caused a large enough current in the ground mat that current was allowed to flow through both these grounds. With only one ground connection being monitored for current, the CT column ground relay could not distinguish parallel current (flowing up one ground conductor and down the other) from actual column CT fault current. Thus, the CT column ground relay initiated an incorrect breaker operation for a faulted phase B arrestor on a shunt reactor in the station.

The attached diagrams show the initial configuration of the window CT monitoring just one ground of the column CT as well as the associated problem with parallel ground current.

Corrective Actions

The initial short-term corrective action was an increase to the over-current pickup setting of the CT column ground relay to a value above the current experienced during this event.

The entity's relay protection group analyzed the design used for the CT column ground protection and proposed the following possible solutions:

- 1. Investigate the feasibility of acquiring a large CT from the manufacturer to put around the CT column just like the design of existing live tank breaker and CT column grounds currently in service.
- 2. Measure the ground current from both ground conductors through the window CT.
- 3. Measure the ground current from each ground conductor through a separate CT.





The entity decided to use the second solution.

Lessons Learned

When modifying the design of a live tank breaker and CT column, care must be taken to ensure the current passing through the CT will be adequate to operate for a CT column ground fault and ensure that the scheme is secure enough not to operate for a fault external to the intended zone of protection.

In this case, the addition of a second ground conductor created a parallel path for ground grid fault current for an external fault to pass through the CT, which resulted in a relay misoperation. (See Diagrams 1 and 2.)

It is important for substation engineers and protection and control engineers to be involved (and coordinate closely) in implementation or modification of equipment with grounding current transformers.

Diagram 1







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