NERC
NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION

Lesson Learned

Transmission Relaying – Backup Ground Protection

Primary Interest Group
Transmission Owners (TO)

Problem Statement
During the switching to re-energize an autotransformer, a relay that was monitoring the tertiary winding current operated on a time overcurrent element and tripped the transformer. The relay had unexpectedly operated on a long-duration, unbalanced magnetizing current.

Details
The protection system for the autotransformer had recently been modernized with digital relays that provided better analysis capability than was previously available. The function of the tertiary winding relay was long-delay ground backup relaying for the surrounding system. The transformer was being returned to service from an outage caused by the failure of a sudden pressure relay seal-in board.

The sequence of events follows:

1. The transformer was isolated (i.e., both low-side breakers and high-side breakers were open, the primary Motor Operated Disconnect (MOD) switch was open, and tertiary station service breaker was open).
2. The low-side breakers were closed into the low side of the transformer, which energized all windings of the transformer up to the primary MOD switch and station service disconnects.
3. The high-side primary MOD switch was closed into the dead high-side bus. The tertiary winding overcurrent relay operated and tripped the transformer to lock out.

Closing the MOD energized the dead high-side bus and appeared to increase the unbalanced current, which was already elevated from a sustained magnetizing in-rush condition initiated by closing the low-side breakers (i.e., step 2). This raised the circulating tertiary current above the relay pickup. After reviewing digital relay records (see traces in Figure 1) during routine switching of the autotransformer, it was determined that sustained tertiary current flows close to relay pickup were commonly experienced.

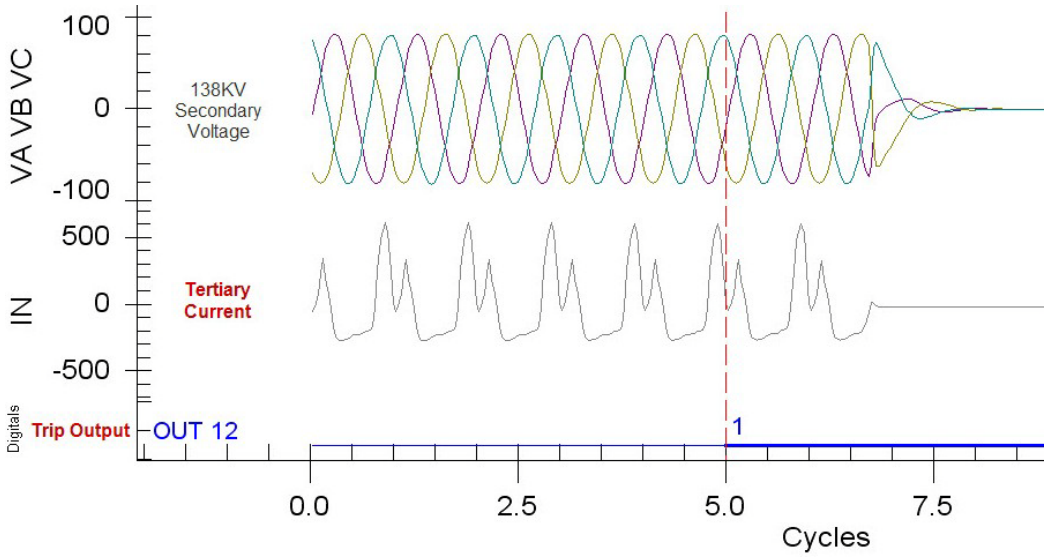

Figure 1: Secondary Phase Voltages and Tertiary Current After Energization and at Trip Point

Corrective Actions

The tertiary winding relay pickup was set differently than previous electromechanical relays to improve coordination for through faults. The pickup was set extremely close to the minimum pickup of the overcurrent element that allowed the use of a long-delay, inverse-time overcurrent operating curve. After the misoperation, the pickup setting was raised slightly, but not enough to adversely reduce sensitivity or speed of operation for the facility during fault conditions. The protective relay with the revised settings was tested and operated correctly during magnetizing inrush conditions.

Lesson Learned

It is difficult to model the zero sequence current in the tertiary winding of an autotransformer caused by magnetization and switching. However, this naturally occurring current must be accounted for in some relaying (such as long-delay, ground-system backup relaying). Modern microprocessor protection devices may be more sensitive to transformer energization currents.

Entities should review tertiary overcurrent relay settings to ensure undesired operation does not occur during energization of the transformer. If disturbance monitoring or digital relay records are available, a review of records generated by switching events may be used as an aid in determining a secure minimum pickup level for this type of relay application.

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For more Information please contact:

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