NERC
NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION

Lesson Learned

Breaker Failure Due to Trip Coil Polarity

Primary Interest Groups
Generator Owners (GOs)
Transmission Owners (TOs)
Distribution Providers (DPs)

Problem Statement
A temporary phase-phase-ground fault occurred on a 115 kV line. A 115 kV line breaker at one end of the line was slow to operate. Breaker failure protection operated, which caused the remaining two 115 kV breakers of a three-breaker switching station to open. This left the switching station de-energized. The breaker that failed to operate utilized two trip coils. Onsite investigation indicated that both trip coils had been damaged when they were energized to trip the breaker.

Details
The breaker has a common trip coil assembly that had been wired such that the polarity was opposing for each trip coil. When the trip coils were energized simultaneously, cancellation of magnetic flux occurred due to the opposing trip coil polarity, causing the coil armature to remain immobile (See Figures 1a, 1b, 1c). Microprocessor relay data indicated that the trip coils were energized by separate primary and secondary relay trip contacts within a time span of less than 3 ms (Figure 2). Figures 3 and 4 show the trip coil assembly and the trip coils.

Figure 1a-c: Simplified Drawings

Figure 1a: Proper Arrangement

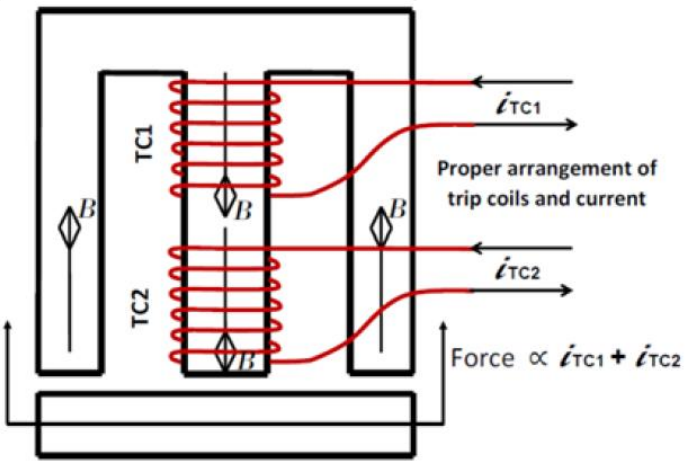

Figure 1b: Coil Orientation Wrong

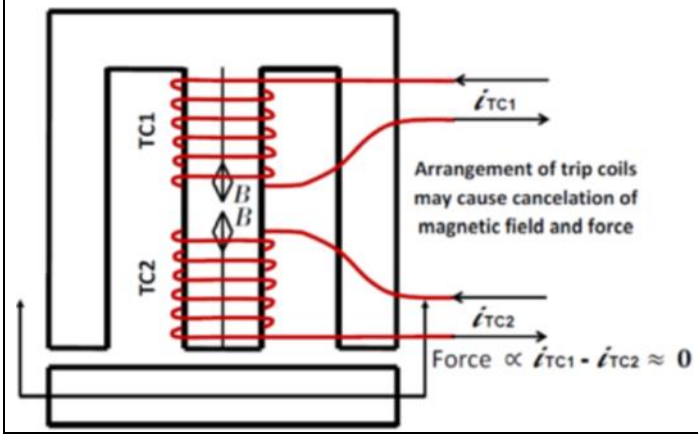

Figure 1c: Wiring / Current Flow Wrong

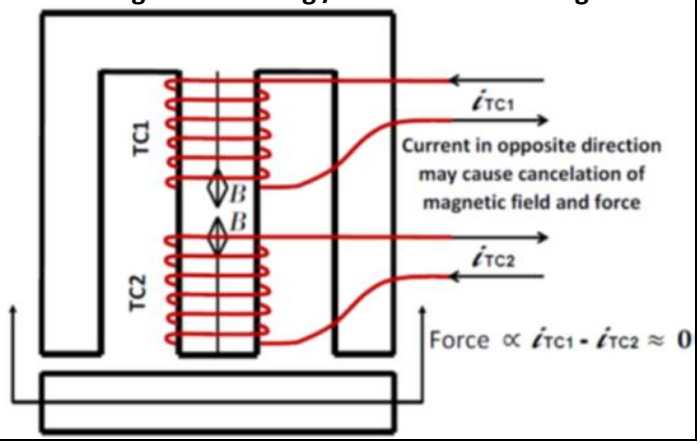

Figure 2: Sequence Snapshot

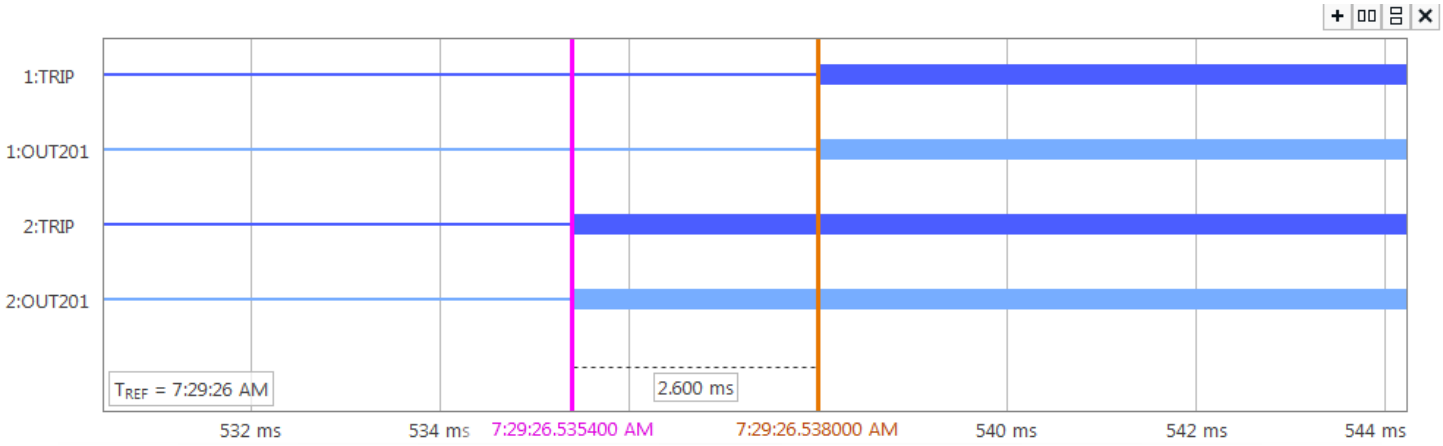

Figure 3: Trip Coil Assembly

Figure 4: Burned Trip Coils

Corrective Actions

The trip coils were replaced and tested to verify proper operation by applying simultaneous trips to the trip coils.

Simultaneous trip coil energization tests should be conducted on all breakers with multiple trip coils that share a common magnetic path. Care should be observed to simultaneously energize the trip coils for a very short time (tripping time of breaker).

One test method option is a test set-up with at least two parallel contacts (from an auxiliary relay or switch) that could be used and configured to energize two trip coils from their separate DC circuits. Engineering should be consulted for test set-up options, and company safety procedures should be followed.

- If the trip coils are installed properly the series 52a contacts should interrupt the trip coil currents.
- If the trip coils are installed improperly (to cancel magnetic flux through the armature), then the test set contacts will be called on to interrupt the trip coil currents.
- Beware of inductive kick-back voltage while interrupting DC current flowing through the trip coils.

Lessons Learned

- Common assembly trip coils installed by a vendor need to be verified.
- Field wiring also needs to be verified as it may defeat properly installed trip coils
- Test breakers with common trip coil assemblies for proper tripping when trip coils are energized simultaneously.

NERC's goal with publishing lessons learned is to provide industry with technical and understandable information that assists them with maintaining the reliability of the bulk power system. NERC requests that you provide input on this lesson learned by taking the short survey provided in the link below.

Click here for: Lesson Learned Comment Form

For more Information please contact:

NERC – Lessons Learned (via email)	MRO – Event Analysis
Source of Lesson Learned:	Midwest Reliability Organization
Lesson Learned #:	20180302
Date Published:	March 6, 2018
Category:	Transmission Facilities