NERC
NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION

Lesson Learned

Lockout Relay Component Failure Causes Misoperation and Reportable Event

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

Problem Statement
Unnecessary trips for nonfault conditions are problematic for any protective relay and can be particularly problematic for lockout relays. Lockout relays are typically used to isolate and hold BES electrical equipment out of service for extended periods of time to allow for visual inspection and typically result in the operation of multiple interrupting devices. Many lockout relay types require manual reset, meaning that field personnel must travel to the relay location, inspect, and perform switching to restore systems to service. The resulting extended abnormal operating condition of the system may put the reliability of the BES at risk.

Figure 1 illustrates a recent example of a lockout relay misoperation. The lockout relay associated with 345 kV BKR A1 at Substation A misoperated during a nonfault condition, resulting in the trip of the circuit breakers circled in the figure. 345 kV BKR B1 at Substation B was out of service as part of a planned outage prior to the event.

The breaker operations removed the following BES equipment from service as a result of the misoperation of this lockout relay:

- 345 kV transmission line for Substation A–Substation B–Substation C
- 345 kV transmission line for Substation A–Substation D
- 345/161 kV transformer A-T1 at Substation A

Field personnel were dispatched to Substation A to investigate in response to this event. Their subsequent investigation determined that the lockout relay had failed due to a faulty lighted nameplate control circuit board. The investigation and repairs took approximately eight hours and the system was returned to the pre-event condition later the same day.

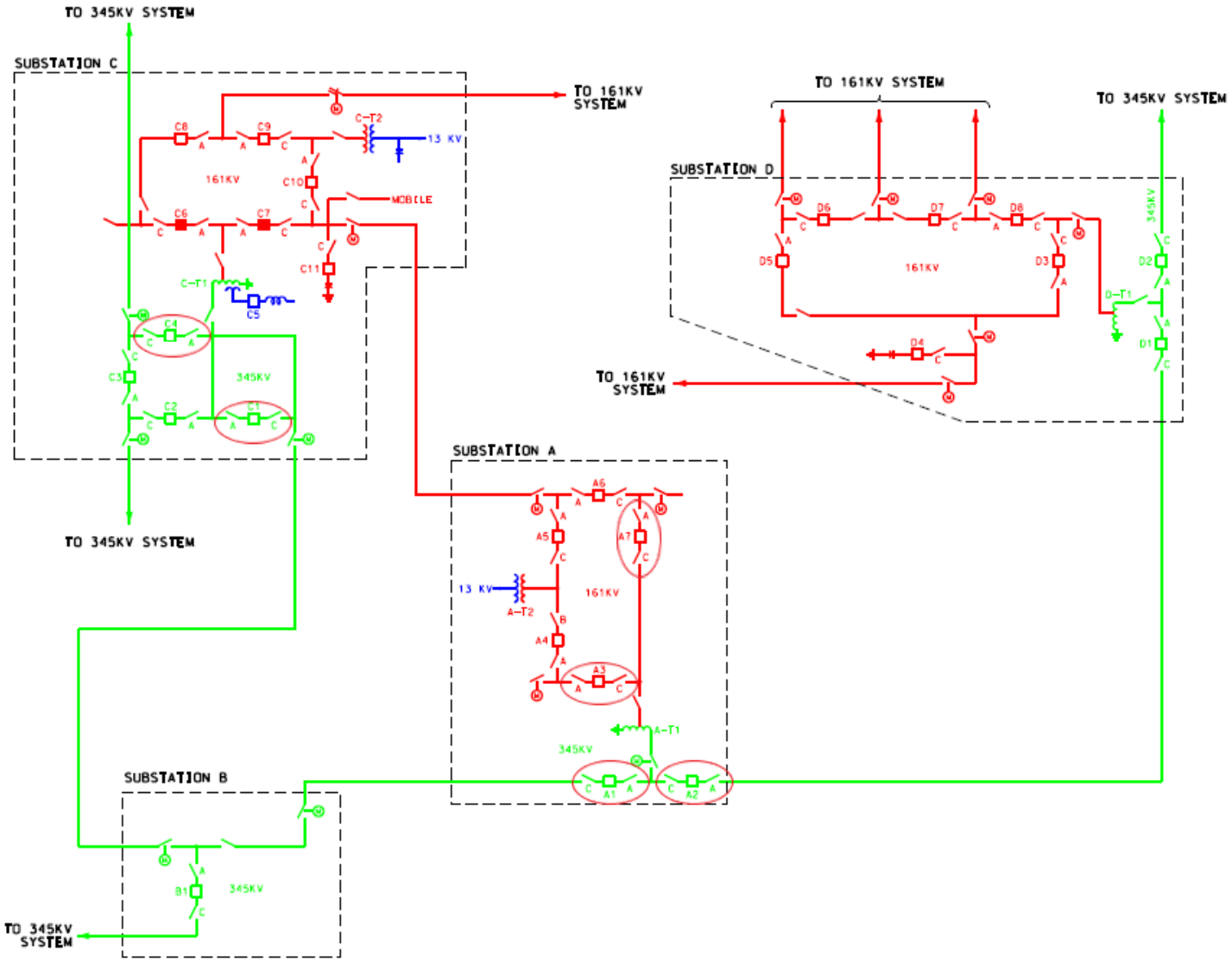

Figure 1: Breaker Operations Resulting from Lockout Relay Misoperation

Details

It was determined the misoperation was due to a faulty lighted nameplate control circuit board within the lockout relay. A detailed investigation uncovered a 2014 product advisory note from the lockout relay manufacturer. The note documented a potential problem with the lighted nameplate circuit board on their lockout relays manufactured between 2000 and 2008. The note stated "…symptoms have included the nameplate LEDs not lit or flashing, the SCADA contact alarm on or intermittent and in a very few reported instances, failures resulting in an unintended breaker "trip/open" operation." **Figure 2** below contains photos of the failed circuit board that illustrate the circuit discoloration mentioned in the product advisory note.

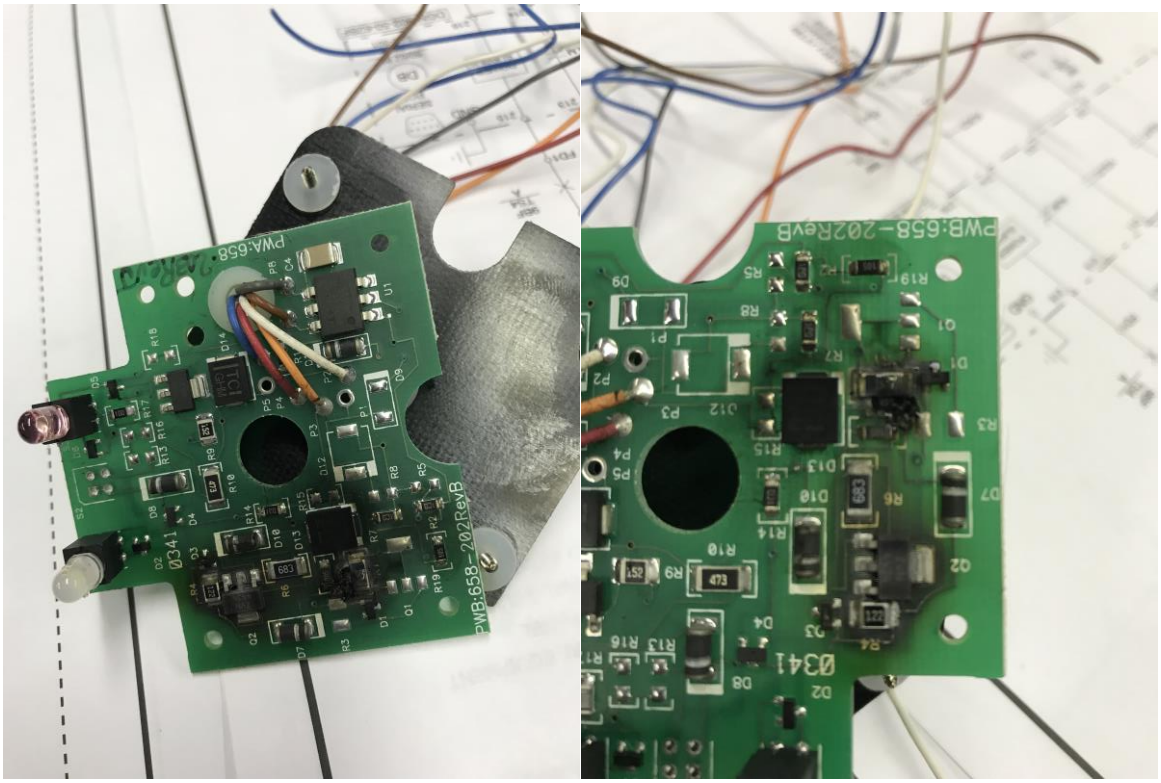

Figure 2: Failed Lighted Nameplate Circuit Board from Lockout Relay

There was no record of receiving the manufacturer's product advisory note in 2014 or thereafter prior to the event. If the note had been received, the wording was vague enough as to the risk of failure that it would not have caused excessive concern. The product advisory note concluded by suggesting customers consider replacement where the nameplates may have been subjected to elevated voltages or were exhibiting the symptoms described in the advisory note. Symptoms included the nameplate LEDs not lit or flashing, the SCADA contact alarm on or on intermittently in addition to discoloration of the board itself. The discoloration symptom of the lighted nameplate circuit board can only be observed by removal of the nameplate cover, which is not a standard practice during maintenance and is considered risky without taking an outage on the affected equipment.

This event seems to indicate that the insulating material and electrical clearances used within the lighted nameplate controls may be less than adequate, resulting in dielectric breakdown and undesired breaker trip and lockout operations. The entity believed that this lockout relay had been operated within normal device specifications (i.e. control voltage and temperature). Lighted nameplate circuit boards have been replaced on a few other lockout relays that exhibited symptoms discovered after the event. Further research has revealed more entities have experienced similar lighted nameplate circuit board failures that had also caused unintended operations.

Corrective Actions

Conduct a system-wide survey to determine locations of lockout relays affected by the product advisory note. Work with the manufacturer to determine a corrective action that best fits constraints of the user.

The following actions have been implemented by different entities:

- Replacement of the lighted nameplate circuit board with manufacturer recommended model on individual lockout relays.
- Replacement of individual lockout relays with lighted nameplate circuit boards affected by the product advisory note with lockout relays of a different model.

Lesson Learned

Improve the response to product advisories for existing or planned equipment:

- When information is insufficient to determine the system risk or required corrective action associated with a product advisory, request additional details from the manufacturer, including in-service failures, and develop a corrective action plan that is suitable to individual requirements.
- Processes and procedures are needed to ensure all future advisory notes are received from manufacturers of relay equipment employed and logged appropriately. Included in those needs to be a methodology to review each advisory, determine what actions are needed, and track the actions to completion.
- Review previously received advisories to determine the need to apply the above process.
- Survey manufacturers of equipment determined critical to BES reliability to assure all advisories have been received, logged, reviewed and assessed to the extent practical.

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