North American Transmission FORUM

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NATF Redacted Operating Experience Report

Stored Energy Hazard in Bushing Capacitors

About NATF Redacted Operating Experience (OE) Reports

North American Transmission Forum (NATF) operating experience reports highlight positive or negative transmission (reliability or resiliency) experiences worth sharing for learning opportunities or potential trending. The overall goal is to help each other learn without experiencing the same issues first-hand. This sharing originates confidentially within the NATF membership.

Redacted operating experience reports are posted on the NATF public website to allow the NATF and its members to more broadly share information, especially safety-related alerts and learnings, with contractors and other utilities to benefit the industry at large.

The NATF member company that submitted the initial restricted distribution OE report for this topic/event has approved the NATF to issue this redacted OE report.

Open Distribution

Disclaimer

Topic

Stored Energy Hazard in Bushing Capacitors

Description

An electrical worker received a shock from the bushing shunt capacitors on a new 138 kV breaker. The steps leading up to the incident were as follows:

1. The leads were removed between the circuit breaker and the reactors prior to energization in order to test the breaker. The capacitor bank and reactors were intentionally disconnected so the breaker could be independently energized.
2. The breaker was closed and energized for 10 minutes to prove proper dielectric operation. See attached "Breaker Energization" figure.
3. The breaker and disconnect switches were opened and grounds were installed so the leads could be re-attached. With the breaker open, the bushing shunt capacitors remained charged. See attached "Post-Energization – Capacitor Charged" figure.
4. As the electrical worker went to reattach the lead on bushing number one, he touched the bushing top while holding the lead in his right hand. This created an electrical path to ground, causing the capacitor to discharge and shock the electrical worker.

Lessons Learned

1. If a point for grounding cannot be established, stop work and consult with the manufacturer on proper grounding methodology. (For this situation, there was not an adequate or obvious point on which to install typical c-clamp grounds.)
2. The manufacturer's documentation lacked any information on the bushing capacitors.
3. Initial energization procedure did not acknowledge the existence of the charged bushing capacitors. The procedure included installing breaker leads after the capacitors were charged. The procedure walked the electrical worker into the trap.
4. Many coworkers mistook the bushing capacitors to be lightning arrestors. Conduct training on how to identify bushing capacitors. In addition, install warning labels on the equipment with bushing capacitors to raise awareness.
5. Electrical worker had grounds on both sides of work area, but the breaker was open. He failed to recognize that the capacitor was not grounded. Never ground through a breaker. Always test for dead. Always ground conductors.

Actions Taken

1. Informed electrical workers of the hazard and performed a safety stand-down.

Reference: NATF-OER-476

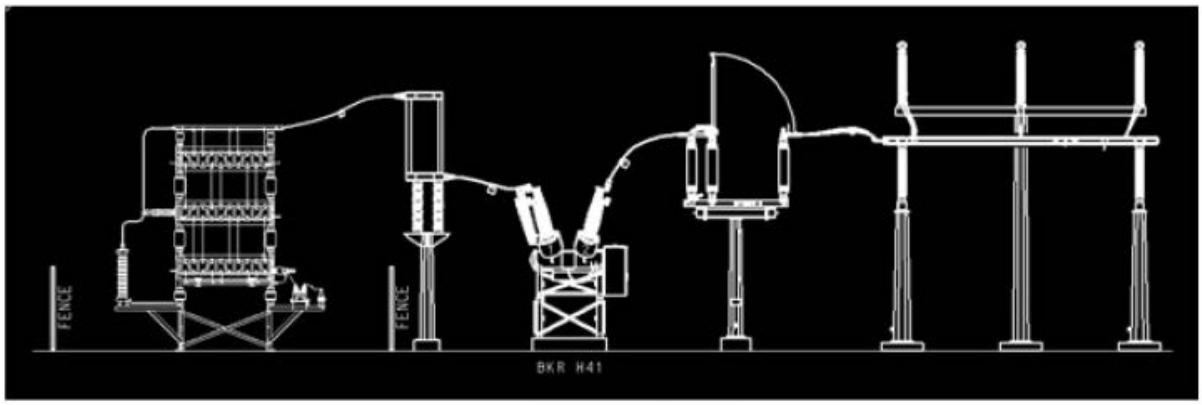
2. Requested that the breaker manufacturer provide warning signs and a grounding point for the capacitor. Signs have been placed on existing in-service breakers. The manufacturer will make available a retrofit kit for our in-service breakers. Our company revised breaker specifications to require signs and ground points. The manufacturer will revise its documentation to illustrate the hazard and provide guidance on how to safely discharge and ground the equipment.
3. Existing breakers with bushing capacitors were identified and flagged.
4. Design group revised work procedures to afford additional oversight and review time for initial energization procedures.

Extent of Condition

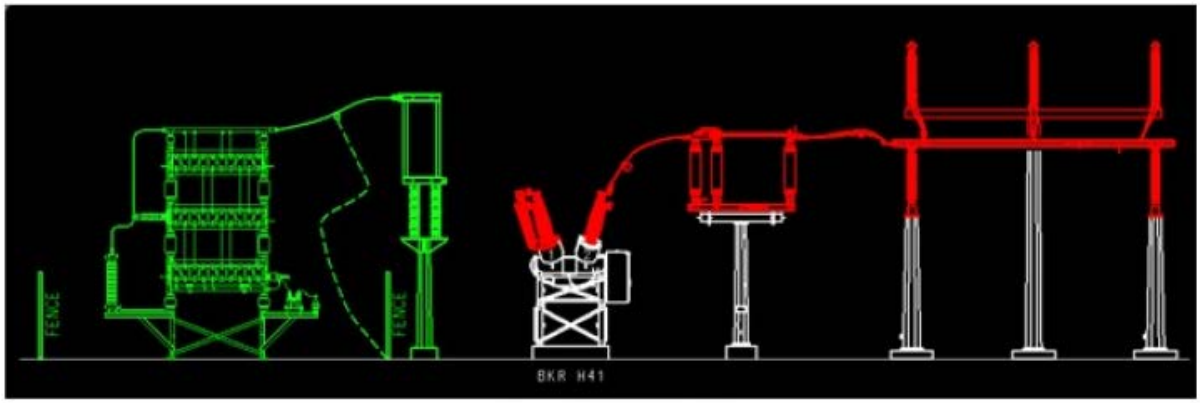
All breakers with bushing capacitors have the potential to create this scenario.

Reference Pictures

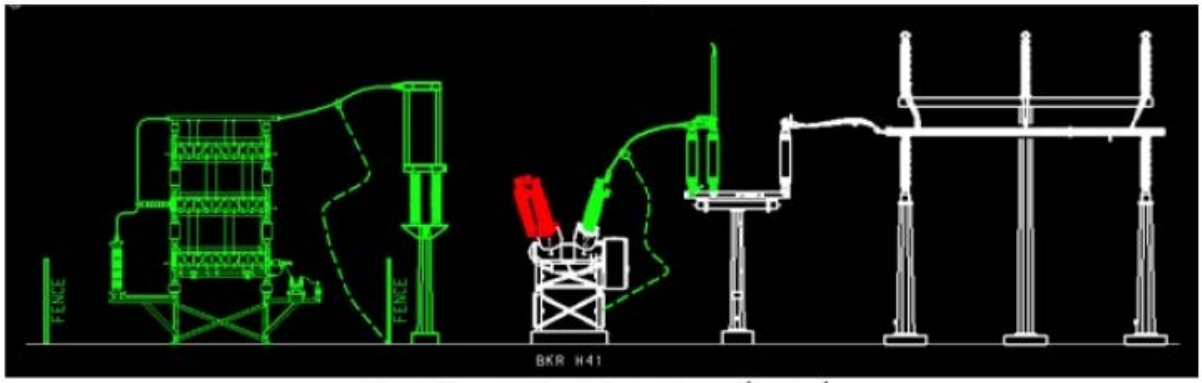
See reference pictures on next page.



Initial Condition



Breaker Energization



Post-Energization - Capacitors Charged