

## Lesson Learned Breaker Failure Logic

### Primary Interest Groups

Generator Operators  
Generator Owners  
Transmission Operators  
Transmission Owners

### Problem Statement

During a fault, a properly-initiated breaker failure scheme failed to operate for a closed pole condition on a circuit breaker. This resulted in the operation of back-up relaying on several lines to clear the fault.

### Details

Prior to the fault, an operating rod became disconnected from the gearing mechanism on the B-phase of a circuit breaker. Upon detecting the fault, the protection system relaying operated properly and initiated both a circuit breaker trip and the circuit breaker failure scheme. The circuit breaker A- and C-phase main contacts opened as expected when the circuit breaker was tripped, however B-phase main contacts failed to open as a result of the disconnected operating rod. The circuit breaker auxiliary contacts (52a) were unaffected by the disconnected operating rod and opened as a result of the trip. This resulted in an incorrect circuit breaker status being provided to the breaker failure control logic.

Based on the breaker failure logic design, two conditions were required in order for the breaker failure scheme to operate: 1) the fault detector (50BF) must be picked up, indicating the presence of fault current; and 2) the circuit breaker auxiliary contacts (52a) must be in the closed position, indicating the circuit breaker had not opened. This type of breaker failure logic is often referred to as “And” logic.

Although the B-phase element of 50BF was picked up due to the fault current, the 52a contacts incorrectly indicated an open circuit breaker. Since only one of the two required conditions was true, the breaker failure scheme did not operate. The result was the operation of back-up relaying on multiple lines to clear the fault.

### **Corrective Actions**

Because failure of the circuit breaker linkage mechanism was determined to be the root cause, the disconnected linkage mechanism was repaired. The Transmission Owner will review its breaker failure relay practices to determine if additional improvements should be made.

### **Lesson Learned**

In this event, the breaker failure logic utilized “And” logic which requires that both indications of a breaker failure condition (50BF and 52a) must be asserted at the end of the timing interval before the scheme will output a trip.

An alternative is to utilize “Or” logic which requires that either the 50BF or 52a contacts be asserted for the breaker failure scheme to output a trip. If either the 50BF or 52a contacts are asserted at the end of the timing interval, the scheme will output a breaker failure trip. This scheme would have produced a breaker failure trip for this event.

“And” breaker failure logic is considered to be more secure, although less dependable, while “Or” logic is considered to be more dependable, although less secure. This event has demonstrated that adequate dependability was not provided by “And” logic for the situation when the states of a circuit breaker main contacts and its 52a contacts were not in agreement. In this case, the circuit breaker had actually failed. However, the incorrect opening of the 52a contact caused the breaker failure scheme to not operate by design.

Industry must carefully weigh the advantages and disadvantages of using either scheme and assess whether dependability or security of the breaker failure protection will contribute more to overall system reliability. This assessment should consider both the probability of a Misoperation with either scheme as well as the potential consequence of a Misoperation. Depending on the power system topology surrounding a circuit breaker, the consequence of non-operation of a breaker failure scheme for a failed circuit breaker may result in a much larger outage. In such cases, a more dependable breaker failure scheme may be necessary to maintain system reliability.

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