RIC 2008

Summary of Recent Circuit Breaker Issues

George A. Wilson
NRR/ADES/DE/EEEB
March 12, 2008

1

Issue Description

- Based on recent operating experience, performance problems with circuit breakers continue to occur and the trend appears to be increasing.

2

Operating Experience Trends

- 10 reported events in last 10 years (LERs)
- 14 inspection findings in last 6 years
- 7 INPO reports
- 12 Part 21 reports since 1996
- 6 International Operating Experience Reports

3

Significance of Issue

- Can cause or contribute to significant plant events or appreciably degrade the performance of mitigating systems
  - Circuit breaker malfunctions are significant contributors to pump unavailability and reliability (increasing conditional core damage probability)
- Potential common-cause failure that could impact multiple trains, diverse systems or components

4

Root Cause Categories

- Design Flaws
- Configuration Control
- Maintenance Practices

5

Root Causes

- Manufacturer Design Flaw
  - Actuating rods for circuit breaker auxiliary switch inadequately designed for cyclic mechanical load

6

Root Causes

- Configuration Control
  - DC power control switches/relay knife switches not correctly positioned, preventing proper operation of the breaker

7

Root Causes

- Maintenance
  - Gaps/clearances out of specification preventing proper racking & operation of breaker
  - Hardened greases, causing the circuit breaker mechanism and auxiliary switch not operating as designed
  - Main stabs with excessive wear lead to misalignment while racking breaker into bus and resulted in the failure of the high resistance stab connection causing a fault

8

Root Causes

- Maintenance
  - Circuit breaker to cubicle misalignment such that control power contacts did not connect
  - Crimping of control power lead lugs, causing loss of control power
  - Inadvertent actuation of relaying mounted on circuit breaker cubicle doors during circuit breaker maintenance

9

International Operating Experience

- Nuclear Energy Agency International Common Cause Data Exchange: Common Cause Failures of Switching Devices and Circuit Breakers
  - Dominant root causes
    - Design, manufacture or construction inadequacy (37% of events analyzed)
    - Malfunctioning of parts internal to component (32% of events analyzed)

10

NRC Actions: Most Recent INs

- 16 INs since 1990
  - IN 2007-34: Operating Experience Regarding Electrical Circuit Breakers
  - IN 2006-31: Inadequate Fault Interrupting Rating of Breakers
  - IN 1999-13: Insights from NRC Inspections of Low and Medium Voltage Circuit Breaker Maintenance Programs

11

NRC Actions

- 1 Generic Safety Issue Report (NUREG 0933, Issue 55)
- Follow-up inspections at plants with significant events

12