UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR REACTOR REGULATION
WASHINGTON, DC 20555-0001

July 7, 2008

NRC INFORMATION NOTICE 2008-12: BRAIDWOOD UNIT 1 REACTOR TRIP DUE TO OFF-SITE POWER FLUCTUATION

ADDRESSEES

All holders of operating licenses for nuclear power reactors, except those who have permanently ceased operations and have certified that fuel has been permanently removed from the reactor vessel.

PURPOSE

The U.S. Nuclear Regulatory Commission (NRC) is issuing this information notice (IN) to inform addressees of the results of a staff evaluation of a recent automatic trip of the Braidwood Unit 1 Nuclear Power Plant due to an offsite power voltage fluctuation coupled with a failed protective relaying circuit. The NRC expects that recipients will review the information for applicability to their facilities and consider actions, as appropriate, to avoid similar problems. Suggestions contained in this IN are not NRC requirements; therefore, no specific action or written response is required.

DESCRIPTION OF CIRCUMSTANCES

Braidwood Unit 1 experienced an automatic reactor trip from full power on June 27, 2007. The reactor trip was triggered by low flow in the 1D Reactor Coolant Loop after the 1D Reactor Coolant Pump (RCP) tripped (appropriate reactor protection system actuation given loss of flow due to the RCP trip). The event was initiated by a lighting strike 4.3 miles from the plant that created a single-phase-to-ground fault on transmission line number 2001, which is a 345kV transmission line. The ground fault suppressed the B-phase voltage to 48 percent of nominal until 345kV protective breakers at Braidwood and the East Frankfort Transmission Substation isolated the line about 3 cycles after fault initiation. The suppressed B-phase voltage created a momentary phase imbalance on the Braidwood RCPs resulting in elevated current on the unaffected A- and C-phases. The C-phase current on the 1D RCP exceeded the trip set point of an instantaneous overcurrent protective relay. Normally (by design), the RCP trip on momentary overcurrent would have been blocked by an in-series impedance relay; however, at the time of the event, the impedance relay was in a tripped state due to a failed Bussman type KTN-R fuse in an impedance monitoring circuit.

The licensee has been working on a generic reliability issue with Bussman KTN and KTN-R style fuses over the last two years (based on Title 10, Part 21, “Reporting of Defects and Noncompliance,” of the *Code of Federal Regulations* reporting for these fuses). There have been several intermittent or complete fuse failures caused by fuse element cracking characterized as fatigue failure. After a fuse failure on 6.9kV Bus 157 in January 2007, the licensee made the decision to replace all Bussman fuses installed on the 6.9kV bus protective relay circuits. However, due to the risk of tripping an RCP during fuse replacement, these fuses were to be replaced during outages. The fuse that failed in the 1D RCP protective relay circuit was scheduled for replacement in the next refueling outage. The licensee considered this a small risk, since fuse failures had been self-revealing and promptly replaced to restore the designed relay scheme. However, the only fuse in the RCP protective relaying circuit without a loss-of-bus-voltage indication or alarm (not self-revealing), failed in this event. Only the disturbance in the transmission system and the resulting Unit 1 trip indicated the vulnerability within the RCP protective relaying circuitry.

The corrective action planned by the licensee was to either implement a design change to eliminate the identified vulnerability from the RCP protective relaying system, or, if design changes were not appropriate, to develop alternate actions to address the vulnerability.

Additional information is available in Braidwood Station, Unit 1, Licensee Event Report 2007-001-00, dated August 27, 2007 (ADAMS Accession No. ML072400074).

DISCUSSION

The event was initiated by a lightning strike to a 345kV transmission line which caused a line-to-ground fault. The fault caused the voltage on B-phase to drop to 48 percent of the nominal voltage until the transmission line breakers opened, appropriately isolating the fault. The duration of the event from fault initiation until the breakers opened was about 0.051 seconds (about 3 cycles). With the B-phase voltage low, the plant’s RCPs responded by drawing more current on A- and C-phases to maintain RCP power output. The 1D RCP’s supply breaker tripped on overcurrent in the C-phase. The instantaneous over-current relay set point was exceeded and it actuated appropriately. Based on the circuit’s design, a series impedance relay should normally block the momentary overcurrent condition; however, at the time of this event, the impedance relay was in a tripped state due to a failed fuse in the impedance relay’s voltage sensing circuit.

The root cause of this event was a design flaw which allowed the RCP protective relay circuit to be in a degraded state without proper indication to the operators. This degraded relay circuit state placed the plant in a condition less tolerant to grid voltage excursions without the requisite knowledge of the operators. A contributing factor was the failure of the fuse used in the relay voltage sensing circuit. Consequently, as a result of the design flaw coupled with the grid voltage excursion, a reactor trip occurred from full power. Unplanned reactor trips are identified in the NRC’s Reactor Oversight Process as a performance indicator associated with the “Initiating Events” cornerstone.

Licensees rely on plant controls, indications, and alarms to inform operators of plant, system, and sub-system conditions such that proper operation of the plant can be conducted during normal, abnormal, and emergency conditions. More specifically, these controls, indications, and alarms allow the operation of the plant while avoiding unnecessary transients and automatic trips. Relaying circuits should provide indication to the operators upon failure or partial failure of such circuits. In particular, circuits should indicate protective relay actuation within relaying circuits (such as the fuse opening and the impedance relay operation, in this case).

CONTACT

This IN requires no specific action or written response. Please direct any questions about this matter to the technical contact listed below.

/RA by TQuay for/

Michael J. Case, Director
Division of Policy and Rulemaking
Office of Nuclear Reactor Regulation

Technical Contact: Kenneth A Miller, NRR
(301) 415-3152
e-mail: Kenneth.miller2@nrc.gov

Note: NRC generic communications may be found on the NRC public Web site, http://www.nrc.gov. Select Electronic Reading Room and then Document Collections.

CONTACT

This IN requires no specific action or written response. Please direct any questions about this matter to the technical contact listed below.

/RA by TQuay for/

Michael J. Case, Director
Division of Policy and Rulemaking
Office of Nuclear Reactor Regulation

Technical Contact: Kenneth A Miller, NRR
301-415-3152
e-mail: Kenneth.miller2@nrc.gov

Note: NRC generic communications may be found on the NRC public Web site, http://www.nrc.gov, under Electronic Reading Room/Document Collections.

Distribution: IN Reading File

ADAMS Accession Number: **ML081830163**

OFFICE	TECH EDITOR	EEEB:DE	BC:EEEB:DE	D:EEEB
NAME	KAzariah-Kribbs	KMIller	GWilson	PHiland
DATE	06/26/2008	7/2/08	7/2/08	7/3/08

OFFICE	LA:PGCB:DPR	PGCB:DPR	BC:PGCB:DPR	D:DPR
NAME	CHawes	DBeaulieu	MMurphy	TQuay for MCase
DATE	7/3/08	7/03/08	7/07/08	7/07/08

OFFICIAL RECORD COPY