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

July 30, 2008

NRC INFORMATION NOTICE 2008-13: MAIN FEEDWATER SYSTEM ISSUES AND RELATED 2007 REACTOR TRIP DATA

ADDRESSEES

All holders of operating licenses for nuclear power reactors, except those who have permanently ceased operations and who 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 a reactor trip event involving a loss of the main feedwater (FW) system that occurred at Perry Nuclear Power Plant, Unit 1. This IN also discusses the NRC review of reactor trip data for 2007, which showed that FW system issues caused an unusually high proportion of reactor trips. 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

Perry Nuclear Power Plant, Unit 1

On November 28, 2007, an unplanned automatic reactor trip occurred at Perry, a boiling-water reactor (BWR), in response to a turbine control valve fast closure signal caused by failure of the digital FW control system (DFWCS). Recovery from the reactor trip was complicated because several means of supplying water to the reactor vessel were lost, including both of the turbine-driven FW pumps, the motor-driven FW pump, and the reactor core isolation cooling (RCIC) pump. Reactor vessel water level was maintained using the high pressure core spray (HPCS) system by cycling the HPCS injection valve. The HPCS system injected water to the reactor vessel nine times over the next 2.5 hours.

Both turbine-driven FW pumps tripped because of DFWCS power supply failures. Operator attempts to recover one of these pumps were unsuccessful. The motor-driven FW pump, which was in standby readiness, did not start because of DFWCS failures. Operators attempted to start the motor-driven FW pump and use it to control reactor vessel water level but the minimum flow valve could not be verified as opened because of the loss of the DFWCS power supplies.

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As the reactor vessel water level decreased, the RCIC pump automatically started but tripped after 13 seconds on low RCIC pump suction pressure. The RCIC system tripped again when an operator manually started the RCIC pump and attempted to supply water to the reactor vessel with the flow controller in automatic. Operators eventually recovered the RCIC system when they started the pump with the flow controller in manual.

The licensee performed a root cause analysis of the reactor trip event. The failure analysis of the DFWCS power supplies found that a transformer on the 24-volt direct current converter board of both the primary and secondary power supplies contained a defect. The investigation identified that on November 28, 2007, the primary power supply was in a degraded condition and the secondary power supply was completely failed. This configuration resulted in erratic performance of the input and output modules.

The licensee took the following corrective actions:

- replaced the DFWCS power supplies with a newer model from the same manufacturer and connected a voltage status alarm to the process alarm for DFWCS (although, the load carrying capacity of the power supplies still cannot be "directly" monitored)
- added an additional power supply, using a different model for diversity and defense-in-depth, to each redundant pair of power supplies in the DFWCS, and to the digital reactor feedpump turbine speed control system
- established preventive maintenance tasks for load testing and line regulation for the DFWCS power supplies.

Before the event, the licensee had two precursor alarms pointing to "possible" problems with the digital power supplies; however, no troubleshooting took place. Industry guidance and operating experience suggest it is important to conduct timely investigation, troubleshooting and analysis of power supply and communications alarms.

The failure of the RCIC system to start and run was the result of improper tuning of the flow controller in January 2006, with the implementation of incorrect RCIC flow controller tuning parameters. This error stemmed from a change in 1987 that removed the controller settings from the configuration control process, since they were considered operational adjustments, without also changing the tuning procedure to specify adjustment limits. Insufficient procedural guidance then resulted in subsequent flow controller adjustments outside of the ranges that would support stable response on a system actuation.

Licensee corrective actions included revising the RCIC flow controller tuning procedure to specify adjustment limits that appropriately consider vendor manual guidance, as well as industry operating experience reports.

The Perry Nuclear Power Plant NRC Special Inspection Report 05000440/2007010, dated January 25, 2008, contains additional information on this event. The inspection report is available on the NRC's public website in the Agencywide Documents Access and Management System (ADAMS) under Accession No. ML080280499. This event is also the subject of Licensee Event Report (LER) 07-004-001, dated February 15, 2008 (ADAMS Accession No. ML080530390).

NRC Review of Reactor Trip Data for 2007

The NRC Operating Experience Branch reviewed the reactor trip data for 2007 and noted that although the total number of reactor trips fleet wide was typical, the proportion of reactor trips caused by the FW system (or the condensate system) in 2007 was 37 percent, which is higher than the typical 10 to 25 percent. The FW system problems often involved (1) insufficient preventive and corrective maintenance, and (2) instrumentation and control malfunctions, particularly associated with the FW regulating valves. The NRC staff has also noted several instances where station knowledge of digital systems was lacking, which resulted in a high reliance on vendors for engineering, equipment recommendations, troubleshooting and maintenance.

Actions that licensees have taken to improve overall FW system performance and reduce operator challenges caused by FW system transients and the related reactor scrams include the following:

- Benchmark similar plants and evaluate actions to address single-point vulnerabilities that have resulted in scrams caused by the FW system
- Develop or improve long-term strategies to anticipate and prevent FW equipment problems caused by aging and obsolescence
- Review and take corrective actions resulting from FW-related operating experience
- Ensure that FW system design improvements and major corrective actions are completed as scheduled to improve overall main FW system reliability
- Ensure that main FW system digital modifications are fully understood and properly implemented, and that operators are trained on the modified system and abnormal operating procedures regarding FW system responses to failures
- Ensure that operators are trained in the monitoring of important parameters such as power supply voltage to provide for early identification and correction of problems.

When the main FW system is lost, licensees rely on other systems to provide feedwater such as the RCIC system at BWRs and the auxiliary feedwater (AFW) system at pressurized-water reactors (PWRs). Since the NRC implemented the revised Reactor Oversight Process in 2000, NRC inspection reports have documented more than 500 findings involving the main FW, AFW, or RCIC systems. More than half of these findings involved maintenance errors and/or corrective action issues. These findings also show that the AFW pumps were the primary contributor in 14 of 17 “greater than green” FW-related inspection findings at PWR plants.

BACKGROUND

NRC IN 2000-01, “Operational Issues Identified in Boiling Water Reactor Trip and Transient” (ADAMS Accession Number ML003682692), discussed an event at Hatch Unit 1 that involved an automatic reactor trip on low reactor water level after one of two main FW lines was isolated when a valve unexpectedly closed in the FW flow path to the reactor.

DISCUSSION

This IN describes FW system performance issues and actions that licensees have taken to improve overall FW system performance and reduce operator challenges caused by FW system transients and the related reactor trips. The reactor trip event at Perry began with the failure of power supplies in the DFWCS, a non-safety related control system. Although there are no specific NRC requirements related to DFWCS, its failure led to a loss of main FW and revealed that the RCIC system was inoperable which necessitated the use of the HPCS system to restore and maintain the reactor vessel level.

The RCIC system at BWRs and the AFW system at PWRs are systems important to safety that are designed to provide feedwater upon a loss of the main FW system. The AFW systems are safety-related and required to be operable as described in technical specifications and are subject to the NRC requirements for "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants," covered in Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, Appendix B, which also includes corrective action requirements. While the main FW system is generally non-safety related, it is scoped under the Maintenance Rule (10 CFR 50.65) and a loss of main FW may be subject to NRC review under the reactive inspection process, event follow-up, or the Reactor Oversight Process performance indicator (PI) for "Scrams" or the PI for "Unplanned Scrams with Complications."

Reducing initiating events caused by the main FW systems and ensuring the availability and operability of the mitigating systems for response to loss of FW events will help enhance overall reactor safety.

CONTACTS

This IN requires no specific action or written response. Please direct any questions about this matter to the technical contacts listed below or the appropriate Office of Nuclear Reactor Regulation (NRR) project manager.

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

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