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NRC INFORMATION NOTICE 2011-14: COMPONENT COOLING WATER SYSTEM GAS ACCUMULATION AND OTHER PERFORMANCE ISSUES

ADDRESSEES

All holders of an operating license or construction permit for a nuclear power reactor issued under Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, "Domestic Licensing of Production and Utilization Facilities."

All holders of, or applicants for, an early site permit, standard design certification, standard design approval, manufacturing license, or combined license issued under 10 CFR Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants."

PURPOSE

The U.S. Nuclear Regulatory Commission (NRC) is issuing this information notice (IN) to inform addressees of recent operating experience regarding air intrusion into component cooling water (CCW) systems, as well as other CCW system performance issues. It is expected that recipients will review the information for applicability to their facilities and consider actions, as appropriate, to avoid similar problems. However, suggestions contained in this IN are not NRC requirements; therefore, no specific action or written response is required.

DESCRIPTION OF CIRCUMSTANCES

St. Lucie Plant

On October 16, 2008, at St. Lucie Plant Unit 1, air intrusion into the CCW system from a containment instrument air (IA) compressor resulted in an unanalyzed condition. A similar event subsequently occurred in 2009. Had a design-basis accident occurred, the continued air ingress into the CCW system could have led to a loss of safety function.

The CCW system is a safety-related system that provides cooling and seal makeup to the non-safety-related containment IA compressors. Air intrusion into the CCW system began after a routine shift to the other standby containment IA compressor. Air leaked at a slow rate into the CCW system, and took several hours to initiate alarms. Operators initially believed that the CCW surge tank high level alarm / condition resulted from reactor coolant system leaking into the CCW system rather than air intrusion. Subsequent alarms and indications of fluctuating pump motor current and CCW header flow led operators to conclude that an air intrusion was occurring.

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The licensee determined that the air intrusion into the CCW system was caused by leakage through two of the inactive IA compressor discharge check valves combined with the failure of the IA compressor unloading solenoid valve. Additionally, leakage through the IA seal water makeup solenoid valve, which interfaces with the non-essential CCW header, created a pathway for air to enter the CCW system.

The licensee's root cause evaluation determined that these repetitive events resulted from a latent design issue that did not consider the potential for gas intrusion into the CCW system and from the licensee's failure to recognize or understand the potential impact on the CCW and the other safety-related systems that CCW supports during the initial condition report screening process. The original CCW design was vulnerable to gas intrusion that could result in a common mode system failure. Gas intrusion was not typically considered in the CCW system design when the St. Lucie plants were designed as is evident from licensing bases documents. Consequently, St. Lucie operating procedures did not address detection and mitigation of gas intrusion occurrences. The CCW system vulnerability to gas intrusion from the containment IA compressors was not recognized because the leakage path required a failure of the IA compressor unloading valve and air leakage through multiple components (i.e., two check valves and a solenoid valve).

Licensee corrective actions included a design change to isolate the air intrusion path into the CCW system from the containment IA air compressors, procedure revisions to identify and mitigate air intrusion into the CCW system and revisions to licensed operator and non-licensed operator lesson plans and engineering procedures to reflect lessons learned.

For additional information, see St. Lucie Unit 1 Licensee Event Report (LER) 2010-001-00 dated February 4, 2010, in the Agencywide Documents Access and Management System (ADAMS) under Accession No. ML101031100. In that LER, the licensee concluded that it had missed many opportunities to learn from internal and external operating experience to prevent the 2008 CCW air intrusion event.

Additional details appear in "St. Lucie Nuclear Plant—NRC Component Design Bases Inspection—Inspection Report 05000335/2009006 and 05000389/2009006; Preliminary Greater than Green Findings," dated January 19, 2010 (ADAMS Accession No. ML100210081). In addition, the NRC letter, "Final Significance Determination of a Yellow Finding and Notice of Violation (NRC Component Design Bases Inspection Report 05000335/2010007 and 05000389/2010007), St. Lucie Nuclear Plant," dated April 19, 2010 (ADAMS Accession No. ML101090509), documents a violation for the licensee's failure to identify and correct the source of the air in-leakage into the CCW system that occurred in October 2008 and that the corrective actions failed to preclude a similar air intrusion event into the CCW system in 2009. The NRC characterized this violation as "Yellow," meaning a finding of substantial significance with regard to safety.

Wolf Creek Generating Station

On May 24, 2010, at Wolf Creek Generating Station Unit 1, when operators started CCW pump A, the CCW surge tank A level decreased by 68 gallons and CCW system discharge header pressure dropped, causing CCW pump C to automatically start. The following week, the CCW surge tank A level decreased by 65 gallons when CCW pump C was started. Subsequent testing revealed gas pockets in both trains of CCW.

The licensee determined that the CCW system gas voids came from (1) inadequate fill and vent of the CCW system during restoration from the 2009 refueling outage, resulting in air being left in the system, and (2) the use of nitrogen saturated fill water after maintenance conducted on the system during the 2009 refueling outage. Between that outage and the time the gas was vented, the CCW system was in a degraded condition.

Licensee corrective actions included increased monitoring of the CCW system for voids using ultrasonic testing and venting, revising the CCW fill and vent procedures to incorporate dynamic venting and improve the valve operating sequences, and modifying the CCW surge tank connection piping and installing additional high point vents.

Additional details appear in "Wolf Creek Generating Station—NRC Special Inspection Report 05000482/2010008," dated January 7, 2011 (ADAMS Accession No. ML110070347).

San Onofre Nuclear Generating Station

On March 8, 2006, at San Onofre Nuclear Generating Station Unit 2, the licensee observed unexpected fluctuations in the CCW surge tank A level indication, which troubleshooting revealed were being caused by entrained gas. The licensee initiated periodic venting of the CCW system at Unit 2, as well as Unit 3, even though the licensee had not observed similar precursor events there. Nine months later, the licensee vented 120 gallons of entrained gas from the Unit 3 CCW train B return line from the letdown heat exchanger. The licensee determined that Unit 3 CCW train B may have been inoperable for 21 days because of entrained gas.

The licensee determined that the CCW system gas voids were caused by (1) improper filling and venting of the CCW system after being drained during outages, and (2) the throttling effect created by letdown heat exchanger throttle valves. Licensee corrective actions included installing a bypass line around the letdown heat exchanger throttle valves to ensure that the piping remains full of water, revising the CCW system fill-and-vent procedure, and continuing to vent the CCW systems at an appropriate frequency.

Additional details appear in San Onofre Nuclear Generating Station LER 05000362/2006-006-00, dated April 9, 2007 (ADAMS Accession No. ML071070320), and in "San Onofre Nuclear Generating Station—NRC Integrated Inspection Report 05000361/2007003; 05000362/2007003," dated August 9, 2007 (ADAMS Accession No. ML072220153).

Prairie Island Nuclear Generating Plant

On July 29, 2008, the licensee for Prairie Island Nuclear Generating Plant initiated the first of several corrective action program documents describing that the Unit 2 CCW system was inadequately designed to ensure that the system would be protected from licensing basis events (such as high energy line breaks (HELBs), seismic and tornado events) that could occur in the turbine building. These events in the turbine building could cause a loss of CCW inventory from both trains of equipment and a loss of safety function. Licensee corrective actions included modifying the CCW lines vulnerable to HELB and revising procedures to isolate non-safety-related portions of the Unit 1 CCW system during adverse weather that were vulnerable to impacts from tornado-borne missiles.

Additional details appear in "Prairie Island Nuclear Generating Plant, Units 1 and 2–NRC Inspection Report 05000282/2009010; 05000306/2009010 Preliminary White Finding," dated August 5, 2009 (ADAMS Accession No. ML092170122); "Final Significance Determination for a White Finding and Notice of Violation; NRC Inspection Report No. 05000306/2009013; Prairie Island Nuclear Generating Plant, Unit 2," dated September 3, 2009 (ADAMS Accession No. ML092450624); "Prairie Island Nuclear Generating Plant, Unit 2–NRC Supplemental (95001) Inspection Report 05000306/2010009," dated September 22, 2010 (ADAMS Accession No. ML102660207); and "Prairie Island Nuclear Generating Plant, Unit 2–NRC Supplemental (95001) Followup Inspection Report 05000306/2010012," dated November 24, 2010 (ADAMS Accession No. ML103280151).

Other Component Cooling Water or Closed Cooling Water Systems -Related Licensee Event Reports and NRC Inspection Findings

Other LERs and NRC inspection reports have discussed CCW system performance issues. The NRC staff developed a list of CCW-related LERs from 2000 to 2010 and a list of NRC inspection findings from 2004 to 2010 that are available in ADAMS under Accession Nos. ML110400155 and ML110060549, respectively.

The CCW performance issues described in this IN occurred at pressurized-water reactor units. However, the generic implications could also apply to equivalent systems in boiling-water reactor units such as various closed cooling water systems. A listing of LERs and NRC inspection findings involving "closed cooling water" systems is available in ADAMS under Accession Nos. ML111750215 and ML111750219, respectively.

BACKGROUND

Related Generic Communication

NRC Generic Letter 2008-01, "Managing Gas Accumulation in Emergency Core Cooling, Decay Heat Removal, and Containment Spray Systems," dated January 11, 2008, did not specifically cover the CCW system, however, insights provided in the generic letter related to gas accumulation may apply.

DISCUSSION

Licensees are required to maintain the CCW system in an operable condition as specified in the technical specifications. Gas accumulation in nuclear power plant systems can cause water hammer, gas binding of pumps, and inadvertent relief valve actuation that may damage pumps, valves, piping, and supports and may render the CCW system inoperable. The CCW system is a safety-related system that provides cooling to components in other safety-related systems and in non-safety-related systems. This IN describes examples where malfunctions of non-safety-related components could render the safety-related CCW system inoperable. Appendix B to 10 CFR Part 50, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants," Criterion XVI, "Corrective Action," requires licensees to establish measures to assure that conditions adverse to quality be promptly identified and corrected. The events in this IN illustrate the importance of effectively using internal and external operating experience and appropriate corrective action investigations to avoid similar problems. Timely corrective actions are particularly important for issues involving gas accumulation, HELB, and tornado vulnerabilities because they have the potential to render both trains of CCW inoperable and impact nuclear safety.

CONTACT

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

Timothy J. McGinty, Director
Division of Policy and Rulemaking
Office of Nuclear Reactor Regulation

for Laura A. Dudes, Director
Division of Construction Inspection and
Operational Programs
Office of New Reactors

Technical Contact: Mark King, NRR/DIRS
301-415-1150
E-mail: msk1@nrc.gov

Note: NRC generic communications may be found on the NRC public Web site, http://www.nrc.gov, under NRC Library.