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

June 16, 2010

NRC INFORMATION NOTICE 2010-11: POTENTIAL FOR STEAM VOIDING CAUSING RESIDUAL HEAT REMOVAL SYSTEM INOPERABILITY

ADDRESSEES

All holders of or applicants for 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," except those that have permanently ceased operations and have certified that fuel has been permanently removed from the reactor vessel.

All holders of or applicants for a 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 an issue at three pressurized-water reactor (PWR) plants where on multiple occasions, their residual heat removal (RHR) systems were inoperable because of the potential for steam voids at the RHR pump suction piping. Recipients should review the information for applicability to their facilities and consider actions to avoid similar occurrences. The suggestions contained in this IN are not NRC requirements, and no specific action or written response is required.

DESCRIPTION OF CIRCUMSTANCES

In 2008 and 2009, the licensees at the Shearon Harris Nuclear Power Plant, Prairie Island Nuclear Generating Plants, and Wolf Creek Generating Station discovered that their RHR systems were potentially inoperable during shutdown periods because of elevated system temperatures at the RHR pump suctions. The elevated system temperatures resulted from the licensees' lack of adequate procedures to ensure RHR system operability during all modes of operation. At each of these plants, the fluid in the piping between the reactor coolant system (RCS) hot leg to RHR system connection and the RHR minimum-flow line return connection remained stagnant and at elevated temperatures following forced cooling as a result of unrecognized system flow characteristics; namely, forced flow did not occur in that section of pipe. Consequently, each licensee concluded incorrectly that the RHR system was properly cooled, prior to shifting the RHR system to Emergency Core Cooling System (ECCS) injection mode, when the system temperature was actually such that the affected RHR systems could have incurred steam voiding if they had been used for emergency core cooling purposes.

ML100640465

Additional information is available on the Wolf Creek Generating Station in the NRC Focused Baseline Inspection Report 05000482/2009006, dated August 12, 2009; the Wolf Creek Licensee Event Report (LER) 50-482/2008-008-02, dated August 25, 2009; the Shearon Harris LER 50-400/2009-002, dated December 15, 2009; and the Prairie Island LER 50-282/2009-004, dated June 5, 2009. These documents can be found on the NRC's public Web site under Agencywide Documents Access and Management System (ADAMS) Accession Nos. ML092240087, ML092450426, ML093580024, and ML091560611, respectively.

BACKGROUND

Gas accumulation in ECCS is an enduring issue associated with commercial nuclear power plant operations. To address this problem the NRC issued Generic Letter 2008-01, "Managing Gas Accumulation in Emergency Core Cooling, Decay Heat Removal, and Containment Spray Systems" (ADAMS Accession No. ML072910759). During system reviews in response to the generic letter, several PWR licensees discovered the potential for their RHR systems to become inoperable during certain shutdown cooling evolutions.

When an RHR train is used for cooling the reactor coolant system, the temperature of the water in that RHR train can reach 350 degrees Fahrenheit (F) (Mode 4 upper temperature limit). With the temperature of the water in the RHR train as high as 350 degrees F, if its suction source is switched from the RCS hot leg to the refueling water storage tank (e.g., during ECCS operation in response to a loss-of-coolant accident) or to the containment sump (e.g., during extended response to a loss-of-coolant accident), conditions at the suction of the RHR pump would result in steam voiding since the temperature at the RHR pump suction would exceed the saturation temperature. Steam voiding can result in binding of an RHR pump and the refueling water storage tank discharge check valve, system flow interruptions, and water hammer; potentially inhibiting the capability of the RHR system to fulfill its ECCS function. Some PWR plants occasionally use multiple RHR trains to perform plant cooldowns. In such cases, multiple RHR trains can become simultaneously inoperable for emergency core cooling.

The pressure and temperature at the suction of the RHR pump depends on the RHR system lineup and the as-built system configuration. For example, when the RHR system is aligned for shutdown cooling, the RHR pump suction pressure is the same as RCS pressure; during safety injection and containment sump recirculation operations, the pressure at the suction of an RHR pump is equal to the static head pressure created by the refueling water storage tank and the containment sump, respectively. In all system lineups, the as-built configuration also determines the head loss associated with different system configurations. The range of possible pump suction pressures makes the RHR system susceptible to steam voiding and water hammer during system lineup changes with suction temperatures above certain values. Since the pressure and corresponding saturation temperature at the suction of an RHR pump depends on RHR system design and as-built configuration, it is important that each licensee ensure that its particular RHR operating procedures are tailored to their specific systems and include parameters validated as plant-specific to ensure RHR systems required by Technical Specifications remain operable.

DISCUSSION

Industry operating experience and guidance has shown that effective methods of maintaining RHR system temperature within appropriate limits exist. For example, licensees can isolate the RHR system, or a single train of the RHR system, from the RCS at a low enough temperature so that the fluid at the RHR pump suction remains below the saturation temperature corresponding to the pressure at the suction of a running RHR pump.

Another method of maintaining RHR system temperature is forced cooling through the minimum-flow line. The main function of the RHR minimum-flow line is to allow RHR pump operation during a safety injection signal when RCS pressure is still above the pump's shutoff head. A typical minimum-flow line flow path takes suction from the discharge of the RHR pump, after flow has passed through the RHR heat exchanger, and returns flow to the suction of the RHR pump. Neglecting minor conduction heat transfer, the amount of RHR piping that can be cooled through the minimum-flow recirculation method is dependent on the location of the minimum-flow return connection. Specifically, the RHR pipe upstream of this connection would not be cooled due to there being little to no flow through this section of pipe.

Some licensees incorrectly assumed that using the minimum-flow recirculation method of cooling their RHR system was sufficient when, in fact, the as-built configuration of the plant did not allow for complete RHR system cooldown using this method. For example, approximately 140 feet of Wolf Creek's RHR system piping is not subject to minimum-flow recirculation because it is located upstream of the minimum-flow return connection. The stagnant water inside this 140 foot section of RHR pipe can only cool through ambient losses; therefore, it remains at elevated temperatures for extended periods of time, possibly exceeding 24 hours. Nevertheless, station procedures allowed the RHR system to be realigned to the ECCS injection mode of operation under these conditions and resulted in both trains of the RHR system being inoperable during periods of operation in Modes 3 and 4. Sharon Harris and Prairie Island plants discovered a similar condition occurred in their plants with the length of affected pipe being the primary variable.

Other licensees may be susceptible to a similar issue in that their plants may contain piping runs that are not able to be effectively cooled using the forced cooling method; yet their station procedures may allow them to shift the RHR system to ECCS injection mode during elevated system temperatures.

Licensees should consider this operating experience to ensure that their RHR system procedures address their plant specific configurations and that they provide adequate methods for satisfying the plant's RHR system operability requirements as stated in the plant's Technical Specifications.

CONTACT

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.

/RA/

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

/RA by MShuaibi for/

Glenn Tracy, Director
Division of Construction Inspection and Operational Programs
Office of New Reactors

Technical Contacts: David Garmon, NRR
301-415-3512
E-mail: david.garmon-candelaria@nrc.gov

Warren Lyon, NRR
301-415-2897
E-mail: warren.lyon@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.

CONTACT

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.

/RA/

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

/RA by MShuaibi for/

Glenn Tracy, Director
Division of Construction Inspection and Operational Programs
Office of New Reactors

Technical Contacts: David Garmon, NRR
301-415-3512
E-mail: David.Garmon-Candelaria@nrc.gov

Warren Lyon, NRR
301-415-2897
E-mail: Warren.Lyon@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.

ADAMS Accession Number: ML100640465 TAC ME3411

OFFICE	DIRS/IOEB	Tech Editor	BC/DIRS/IOEB	DSS/SRXB	BC/DSS/SRXB
NAME	DGarmon	KAzariah-Kribbs	JThorp	WLyon	AUlses
DATE	5/13/10	04/05/10 e-mail	05/14/10 e-mail	05/13/10	5/14/10 e-mail
OFFICE	D/DSS	BC/NRO/SRSB	DPR/PGCB	DPR/PGCB	BC/DPR/PGCB
NAME	WRuland	JDonoghue	CHawes	DBeaulieu	SStuchell (Acting)
DATE	05/26/10	05/18/10 e-mail	6/10/10	05/27/10	6/11/2010
OFFICE	D/NRO/DCIP	D/DPR/PGCB			
NAME	GTracy (MShuaibi for)	TMcGinty			
OFFICE	6/15/2010	6/16/2010			

OFFICIAL RECORD COPY