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

October 2, 2009

NRC INFORMATION NOTICE 2009-22: RECENT HUMAN PERFORMANCE ISSUES AT NUCLEAR POWER PLANTS

ADDRESSEES

All holders of operating licenses or construction permits for nuclear power reactors under the provisions of Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, "Domestic Licensing of Production and Utilization Facilities," except those who have permanently ceased operations and have certified that fuel has been permanently removed from the reactor.

PURPOSE

The U.S. Nuclear Regulatory Commission (NRC) is issuing this information notice (IN) to inform addressees of recent plant events that were attributed at least in part to human performance issues. The NRC expects recipients to review the information for applicability to their facilities and to 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.

BACKGROUND

The NRC is issuing this IN to communicate the circumstances, details, and consequences of several recent events in the cross-cutting area of Human Performance. Previously issued INs related to similar plant events include the following:

- IN 2005-16, "Outage Planning and Scheduling – Impacts on Risk," dated June 20, 2005
- IN 2007-11, "Recent Operator Performance Issues at Nuclear Power Plants," dated March 6, 2007

In addition, NUREG-1449, "Shutdown and Low Power Operation at Commercial Nuclear Power Plants in the United States," dated September 1993 highlights several of the same event types discussed in this IN. These include loss of reactor coolant inventory, pressurized-water reactor venting, and inadvertent reactivity addition.

DESCRIPTION OF CIRCUMSTANCES

Oconee Nuclear Station, Unit 1

On April 12, 2008, while performing plant cooldown and depressurization activities for a refueling outage at Oconee Nuclear Station, Unit 1, operations personnel identified abnormally

high vibrations on all three operating reactor coolant pumps (RCPs); the fourth RCP had been secured before the plant was shut down. During the event, the licensee operated RCP 1A2 outside of its normal vibration tolerances to facilitate the cooldown and depressurization of the reactor coolant system (RCS). The original purpose of operating the RCP at vibration levels in excess of normal tolerances was to allow the initiation of low-pressure injection decay heat removal. Licensee management approved this action after consulting with the pump vendor. However, the pump remained in operation for an additional 2.5 hours after initiation of decay heat removal, which eventually led to multiple seal failures on RCP 1A2 and an 8-gallon-per-minute RCS leak past the pump seals.

As a result of the RCP 1A2 seal failures and the subsequent RCS leak, the reactor building iodine detector began to alarm. However, the operating crew did not recognize the condition, the alarm response procedure was not entered until 9 hours later, and outage work, including the removal of the reactor building equipment hatch, was allowed to continue. After securing RCP 1A2, licensee management met and determined that RCP 1B2 should be restarted with increased vibration tolerances to assist with RCS degasification and crud burst mitigation. Within 1 hour of starting RCP 1B2, two of its three seals failed, and the pump was secured. In its response to the failed seals on RCP 1B2, the operating crew did not properly monitor plant parameters as required by procedure. Adherence to the procedure would have alerted the crew to the alarming reactor building iodine detector and to the severity of the ongoing RCS leak caused by the RCP 1A2 seal failure. Additional details of this event can be found in NRC Special Inspection Report 05000269/2008008, Agencywide Documents and Access Management System (ADAMS) Accession No. ML082140807.

Oconee Nuclear Station took the following corrective actions related to this event:

- identified vulnerabilities and improvements needed in RCP motor and seal design, monitoring, maintenance practices, spare parts, procedures, knowledge and expertise
- presented an RCP case study to industry leadership academies
- conducted training for plant management on the importance of maintaining independence and focusing on equipment qualification, validation and verification when performing its operational decisionmaking role
- reviewed applicable abnormal operating procedures for entry conditions and appropriateness for shutdown events
- ensured clear criteria were established for containment closure and replacement of the equipment hatch
- changed plant procedures to emphasize the primary supervisory and oversight function of the control room supervisor and to remove administrative burden

Three Mile Island Nuclear Generating Station, Unit 1

During the Three Mile Island Unit Nuclear Generating Station refueling outage that began October 22, 2007, there were several human performance-related issues that resulted in NRC inspection findings which are summarized below, and in NRC Integrated Inspection Report 05000289/2007005, ADAMS Accession No. ML080430321.

- TMI's procedure for authorizing workers to exceed work hour limits of 72 hours/week was determined to be deficient in that it did not provide reasonable assurance that station management would properly control overtime for plant staff performing safety-related functions.

- Due to a lack of coordination of maintenance and operational activities, installation of a once-through-steam-generator (OTSG) primary lower manway cover during mid-loop operation resulted in an unexpected drop in reactor vessel level indication. The change in level indication prompted operators to declare an Unusual Event for the plant. Reactor vessel level indication dropped because the OTSG lower manway cover was installed while temporary ventilation fans were exhausting air from the OTSG handhole RCS vent. This event resulted in an inspection finding with a cross-cutting aspect in Human Performance Work Control because activities were not properly coordinated while the plant was in an elevated shutdown risk condition.

- Fuel handling operators failed to properly implement procedures while moving a control rod assembly (CRA) in the spent fuel pool. After the grappling tool indicated that it had failed to engage a CRA, operators moved the refueling bridge to the next fuel assembly without first visually checking to ensure the CRA was not grappled. Oncoming fuel handling operators visually checked the mast and noticed that the CRA was grappled. Further investigation revealed that the CRA fingers were still inserted in the previous fuel assembly and that the subsequent movement of the refueling bridge severely bent them.

Vogtle Electric Generating Plant, Unit 1

On August 19, 2008, the licensee was conducting a flush of the boron thermal regeneration system (BTRS) chilled water piping. The procedure for this evolution requires that components be manipulated both locally and in the control room. A system operator was directing the flush from outside the control room, where most of the procedure steps for the flush take place. The system operator read a procedure step to the Operator at the Controls (OATC) that required the OATC to place a control room handswitch in the "Closed" position. Despite a requirement to do so, the OATC did not have the procedure in hand when performing this evolution. Due to misinterpretation of the procedure step, the OATC verified that the valve was closed but did not place the handswitch in the "Closed" position.

When operators performed subsequent steps in the procedure, the valve automatically opened, and approximately 500 gallons of un-borated water were flushed from the BTRS to the volume control tank. The resulting positive reactivity transient caused control rods to automatically insert in order to compensate. Control room operators also responded to the transient by continuing to insert control rods, borating, and reducing main generator load; but not before the 1-minute average reactor power level increased to 100.73 percent. Additional details are

available in NRC Integrated Inspection Report 05000424/2008004, ADAMS Accession No. ML083040204.

Salem Nuclear Power Plant, Unit 1

On October 15, 2008, one day after shutting down for a refueling outage, control room operators at Salem Nuclear Power Plant, Unit 1, began draining the pressurizer from a water-solid condition to a target level of 10 to 15 percent. A higher-than-normal dissolved gas concentration in the RCS, combined with a rapid decrease in RCS pressure, caused the reference leg for the pressurizer cold-calibrated level instrument to partially void, resulting in an erroneously high pressurizer level reading. Control room operators were not aware that the reference leg was voiding and began the pressurizer drain down evolution using the cold-calibrated level instrument as their primary level indication.

Nearly 2 hours into the evolution, operators noted that the pressurizer level unexpectedly stabilized at 80 percent. The control room supervisor directed the reactor operator to raise the charging flow and increase RCS inventory. After troubleshooting the level instrument, technicians backfilled the reference leg of the pressurizer level cold-calibrated instrument, and stabilized the level at 14 percent several hours after increasing the charging flow. The licensee determined that the pressurizer had completely drained during this event allowing nitrogen from an ongoing pressurizer relief tank purge to migrate into the top of the reactor vessel and into some of the steam generator u-tubes. Additional details of this event can be found in NRC Special Inspection Report 05000272/2008009, ADAMS Accession No. ML090200076.

The licensee's investigation revealed several missed opportunities for mitigating this event, including the following:

- The procedure for draining the pressurizer did not require operators to use diverse and redundant indications for controlling RCS inventory.

- When the "Pressurizer Heater Off Level Low" annunciator alarmed, operators did not properly implement the response procedure, which could have alerted them to the erroneous level indication sooner.

- The licensee did not properly implement corrective actions for a similar industry event that occurred in 1997 at the Sequoyah Nuclear Plant.

The licensee developed several corrective actions following this event, including procedure updates to include diverse and redundant indications for RCS inventory monitoring, and simulator training prior to outages that refreshes operator knowledge on upcoming evolutions.

DISCUSSION

The events related to human performance discussed above occurred, for the most part, during refueling outages. They often involved either the failure of licensees to provide adequate procedures or the failure of operators to properly follow those procedures. In several instances, it appeared that shutdown risk was either under-estimated or not considered. Overall, the events involved behaviors that are often associated with an operator's loss of safety focus, such

as taking actions when the consequences of those actions are uncertain, or taking actions outside the scope of the relevant procedure(s). Monitoring and controlling reactivity and RCS inventory in accordance with plant procedures are two of the most important responsibilities of an on-duty licensed reactor operator. Operating experience shows that errors often occur before, during, and immediately after refueling outages, when evolutions are less familiar to the operators because they are infrequently performed. From a risk perspective, refueling outages can constitute as much as one-third of a plant's overall core damage frequency even though the average plant is only in refueling outages about 5 percent of the time.

CONTACT

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

/RA/

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ADAMS Accession No.: ML091940257 TAC ME1026

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