UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR REACTOR REGULATION
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NRC INFORMATION NOTICE 2005-16: OUTAGE PLANNING AND SCHEDULING - IMPACTS ON RISK

ADDRESSEES

All holders of operating licensees 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 to inform addressees about recent experiences in which outage planning and scheduling and adverse human performance for pressurized water reactors (PWRs) and boiling water reactors (BWRs) have had a significant impact on shutdown risk. 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 information notice are not NRC requirements; therefore, no specific action or written response is required.

BACKGROUND

The NRC has published numerous reports on the generic issue of shutdown risk and specific outage events, including NUREG-1269, “Loss of Residual Heat Removal System, Diablo Canyon Unit 2,” April 10, 1987; NUREG-1410, “Loss of Vital AC Power and the Residual Heat Removal System During Mid-Loop Operations at Vogtle Unit 1", on March 20, 1990; and NUREG-1449, “Shutdown and Low-Power Operation at Commercial Nuclear Power Plants in the United States, Final Report,” dated September 1993. In response to the various studies and events, the NRC has also issued generic communications to highlight the importance of shutdown safety measures to the industry. The generic communications included Bulletin 80-12, “Decay Heat Removal System Operability," Generic Letter (GL) 87-12, "Loss of RHR While the RCS is Partially Filled," and GL 88-17, “Loss of Decay Heat Removal.” This listing of NRC documents regarding the control of shutdown activities and risk is not all inclusive and other relevant studies and generic communications have been issued in this area. For example, NUMARC 91-06, “Guidelines for Industry Actions to Assess Shutdown Management,” dated December 1991, provides guidance to licensees on managing shutdown safety issues.

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DESCRIPTION OF CIRCUMSTANCES

Seabrook, a four loop Westinghouse PWR, has taken the initiative to develop an all-modes probabilistic safety assessment model. Following issues identified during a recent refueling outage, the risk associated with early midloop draindown and shutdown operations over a seven day period was determined to be roughly equivalent to operating at full power for an entire year. The instantaneous risk associated with draining the vessel to mid-loop exceeded 1.0×10^{-3} core damage frequency per year. This high instantaneous risk was discussed in other NRC and industry studies, including the EPRI report, "Low Power and Shutdown Risk Assessment Benchmarking Study," dated December 2002. The Seabrook analysis provides a relatively recent comparison of reactor risk.

During recent refueling outages, several work activities were conducted without appropriate planning, resulting in challenges to operators and to the decay heat removal system. In each case, operators responded appropriately and anomalous plant conditions were returned to normal. However, continued attention is needed for work planning and execution during these high-risk periods.

- At Point Beach Unit 1, the licensee authorized installation of the hot leg nozzle dams prior to establishing an adequate reactor coolant system (RCS) vent path. The plant was in midloop operations and the outage schedule had called for the pressurizer manway to be removed to establish an RCS vent path before installation of the hot leg nozzle dams. Due to unanticipated delays in removing the pressurizer manway, several licensed and experienced personnel (including the shift outage manager, the outage control center operations representative, the work control center supervisor, and the shift manager on shift at the time) decided to begin installing the hot leg nozzle dams before removing the manway. Fortuitously, problems delayed the installation of the hot leg nozzle dams. The nozzle dams were not completely installed before the personnel realized that installation of the hot leg nozzle dams without a RCS vent path would have had a significant adverse impact on safety. Without an adequate vent path, the RCS would become pressurized following a loss of shutdown cooling. If one of the cold leg nozzle dams became dislodged, RCS inventory would quickly be discharged from the vessel and the core could be uncovered within a very short time.

- During a Millstone Unit 2 refueling outage, shutdown cooling was temporarily lost when the shutdown cooling heat exchanger outlet valve inadvertently closed and the heat exchanger bypass valve opened. The valves changed position due to an instrument bus power failure caused by an error in the procedure to synchronize the power supplies to the instrument bus. Shutdown cooling was lost for 13 minutes and the RCS temperature increased by approximately 14 degrees F. An Unusual Event was declared for an uncontrolled heatup of the RCS greater than 10 degrees F. The risk significance of this event was mitigated because operators had not completed preparations to drain the reactor vessel to midloop operations. During previous outages this maintenance activity had been performed with the power to shutdown cooling valves secured, and later in the outage when decay heat was lower.

- Calvert Cliffs Unit 1 had a partial loss of shutdown cooling during midloop operations. Both component cooling water (CCW) heat exchangers were in service at the time of the event. Salt water cooling flow to one CCW heat exchanger was lost when the heat exchanger outlet valve failed closed. The valve closure was caused by the loss of power to the valve controller when a control room maintenance activity inadvertently grounded which resulted in the loss of power to an instrument bus and valve controller. The maintenance activity that resulted in the grounded instrument bus should not have been performed during midloop operations. Decay heat removal from one of the two operating component cooling water heat exchangers, which were cooling two shutdown cooling trains, was lost for 18 minutes resulting in an RCS heatup of 2 degrees F.

- During a Peach Bottom Unit 3 refueling outage, an unexpected decrease in reactor vessel water level of approximately 42 inches (from +200 inches to +158 inches) occurred over 4.5 minutes. Over 27 feet of water still remained above the top of active fuel. This event occurred during a flush activity of the Unit 3 residual heat removal (RHR) crosstie piping. The procedural controls for the flush activity did not contain instructions to isolate the "B" train of RHR during the flush activity. This resulted in an open flow path from the reactor vessel to the suppression pool. Additionally, shift management did not conduct a pre-job brief with all personnel involved in the flush. This event demonstrated the impact of adverse human performance on shutdown risk controls.

DISCUSSION

Planning, scheduling, and execution of work activities during outages can have a significant impact on overall plant risk. Refueling outages have become shorter, causing higher risk evolutions, such as midloop operations at PWRs, to be entered sooner after reactor shutdown. As a result there is reduced inventory in the reactor vessel at a time when the decay heat loads are high and the time to boil and uncover the core is relatively low. During these high risk evolutions, careful attention to work scheduling is necessary to ensure that decay heat removal cooling systems remain functional.

It is also important that work activities be scheduled to minimize distractions to operators and prevent unnecessary challenges to decay heat removal systems. Licensees need to continue to properly implement commitments made to previous generic communications on shutdown operations. Additionally, licensees need to continue to implement the controls specified by NUMARC 91-06 to properly manage shutdown risk.

CONTACTS

This information notice 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 website, http://www.nrc.gov, under Electronic Reading Room/Document Collections.