UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR REACTOR REGULATION
WASHINGTON, D.C. 20555

August 9, 1993

NRC INFORMATION NOTICE 93-61: EXCESSIVE REACTOR COOLANT LEAKAGE FOLLOWING A SEAL FAILURE IN A REACTOR COOLANT PUMP OR REACTOR RECIRCULATION PUMP

Addressees

All holders of operating licenses or construction permits for nuclear power reactors.

Purpose

The U.S. Nuclear Regulatory Commission (NRC) is issuing this information notice to alert addressees to the potential for excessive reactor coolant leakage following a seal failure in a reactor coolant pump or reactor recirculation pump. 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.

Description of Circumstances

Oconee Nuclear Station, Unit 1

On May 24, 1992, the licensee commenced a reactor shutdown from 100 percent power because of excessive leakage from the 1A2 Reactor Coolant Pump seal. The maximum leakage was approximately 23 liters per minute [6 gpm]. The seal failed because of the premature degradation of obsolete seal parts that had mistakenly been installed.

Westinghouse supplied the Unit 1 reactor coolant pumps, incorporating a three-stage seal series arrangement to limit coolant flow up the pump shaft. Although Westinghouse had provided the necessary information on the design change of the seal, the information was not properly communicated to plant personnel. As a result, the obsolete seal parts were not removed from the station stock and appropriate maintenance procedures were not revised to reflect the change. These deficiencies contributed to the fact that maintenance personnel inadvertently installed the obsolete seal parts.

Further details can be found in Licensee Event Report (LER) 50-269/92-09 and NRC Inspection Report No. 50-269/92-13.

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Millstone Unit 1

On May 25, 1989, the licensee started up Unit 1 for Cycle 13 operation. During plant heatup on May 27, 1989, operators noted indications of intermittent seal failure for the "A" Reactor Recirculation Pump inner seal. The licensee continued power escalation and cycle startup testing while making plans to replace the seal. On May 29, 1989, while at full-power operation, the drywell leakage exceeded the Technical Specifications limit and the licensee commenced plant shutdown. The leakage was approximately 34 liters per minute [9 gpm] at the start of the event and increased to about 174 liters per minute [46 gpm] during the shutdown process. After reviewing the failed seal and consulting with the pump manufacturer, Byron Jackson, the licensee still did not identify the exact cause of the seal failure. However, the licensee did determine that the pump seal had probably failed as a result of one or more of the following causes: (1) improper seal handling prior to installation, (2) introduction of debris and corrosion products into the seal cavity, and (3) improper depressurization following hydrostatic testing of the seal assembly.

Further details can be found in LER 50-245/89-14, Revision 1, and in NRC Inspection Report No. 50-245/89-12.

Clinton Unit 1

On May 21, 1989, the licensee took the reactor to critical for Cycle 2 operation. On May 25, 1989, the pressure in the seal outer cavity decreased to approximately 414 kPa gauge [60 psig], indicating failure of the upper seal stage. Approximately 10 hours later, the seal appeared to reseal and operated properly. On June 1, 1989, with the reactor at about 42-percent power during power ascension, upon shifting the "B" Reactor Recirculation Pump speed from low to high, the operators immediately noted indications that both the upper and lower seals in the pump had failed. The seal failures resulted in increased flow from the drywell floor drain sump inlet; the leakage reached a maximum of 242 liters per minute [64 gpm]. The licensee then initiated plant shutdown. Although the exact cause of the seal failure was not determined, the licensee indicated that the probable cause was improper assembly or improper installation.

Further details can be found in the licensee special report submitted to NRC on June 30, 1989, and in NRC Inspection Report No. 50-461/89-21.

Discussion

Both reactor coolant pumps and reactor recirculation pumps use a series of primary and secondary seals to limit the reactor coolant leakage to containment. A loss-of-coolant accident (LOCA) can occur if leakage through the seals of reactor coolant pump or reactor recirculation pump exceeds the capacity of the normal makeup systems. Thus, the failure of these seals can represent a significant degradation of the reactor coolant pressure boundary.

The NRC has, over a period of years, evaluated the issue of reactor coolant pump and reactor recirculation pump seal-related problems (Generic Issue 23) and the need for additional licensing requirements to reduce the potential core-melt risk resulting from the failure of these pump seals. An evaluation program was initiated to resolve the generic issue and address several reactor coolant pump seal leaks that occurred in the late 1970s and the early 1980s. Analysis performed in conjunction with the evaluation indicated that the overall probability of core-melt due to small-break LOCAs could be dominated by reactor coolant pump seal failures. The two conditions under which seals have failed or could fail, normal operating conditions and off-normal operating conditions, are addressed below:

Seal performance under normal operating conditions

Based on the review of LERs and feedback from industry, some licensees appear to have recently made major improvements in reactor coolant pump and reactor recirculation pump seal performance. This improvement is attributed to a combination of factors, including the following: enhanced seal quality assurance programs, modified seal design, improved maintenance procedures and training, closer attention to detail, improved seal operating procedures, more knowledgeable personnel involved in seal maintenance, reduction in frequency of transients that stress the seals, and seal handling and installation equipment designed with the appropriate precision. However, not all plants have implemented such measures, and some seal failures have caused substantial reactor coolant leakage (as described above).

Development and implementation of appropriate procedures and training can help assure correct operator action for operational conditions related to seal degradation and can assist to identify seal degradation in a timely manner. This can thereby prevent or mitigate cascade failure of multistage seal assemblies.

Section III of the ASME Boiler and Pressure Vessel Code has included specific exclusions for seal components under NB-3411.2 and NB-2121(b) relative to design requirements. However, code exclusions by themselves do not relieve licensees from other pertinent regulatory requirements such as Appendix B to 10 CFR Part 50, as applicable. For those items covered by Appendix B, as reflected in plant-specific licensing bases, a quality assurance program is required. The staff is considering additional generic action to address whether all licensees should treat certain seal components as safety-related.

Seal performance under off-normal operating conditions

With respect to off-normal operating conditions, particularly loss of all seal cooling water which can be caused by station blackout, loss of component cooling water or loss of service water, the major concerns involve seal failures due to adverse temperature effects on elastomer seal materials and performance instabilities at the primary seal face related to coolant flashing and two-phase flow. The staff is proceeding with rulemaking to address issues of ensuring reactor coolant pump seal function or compensating for seal failure during loss of seal cooling events, including station blackout.

This information notice requires no specific action or written response. If you have any questions about the information in this notice, please contact one of the technical contacts listed below or the appropriate Office of Nuclear Reactor Regulation (NRR) project manager.

Brian K. Grimes, Director
Division of Operating Reactor Support
Office of Nuclear Reactor Regulation

Technical contacts: Jai Raj N. Rajan, NRR
(301) 504-2788

Peter C. Wen, NRR
(301) 504-2832

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List of Recently Issued NRC Information Notices

LIST OF RECENTLY ISSUED
NRC INFORMATION NOTICES

Information Notice No.	Subject	Date of Issuance	Issued to
93-60	Reporting Fuel Cycle and Materials Events to the NRC Operations Center	08/04/93	All fuel cycle and materials licensees.
93-59	Unexpected Opening of Both Doors in An Airlock	07/26/93	All holders of OLs or CPs for nuclear power reactors.
93-58	Nonconservatism in Low-Temperature Overpressure Protection for Pressurized-Water Reactors	07/26/93	All holders of OLs or CPs for pressurized-water reactors.
93-57	Software Problems Involving Digital Control Console Systems at Non-Power Reactors	07/23/93	All holders of OLs or CPs for test and research reactors and nuclear power reactors.
93-56	Weakness in Emergency Operating Procedures Found as Result of Steam Generator Tube Rupture	07/22/93	All holders of OLs or CPs for pressurized water reactors.
93-55	Potential Problem with Main Steamline Break Analysis for Main Steam Vaults/Tunnels	07/21/93	All holders of OLs or CPs for pressurized water reactors.
93-54	Motor-Operated Valve Actuator Thrust Variations Measured with A Torque Thrust Cell and A Strain Gage	07/20/93	All holders of OLs or CPs for nuclear power reactors.
93-53	Effect of Hurricane Andrew on Turkey Point Nuclear Generating Station and Lessons Learned	07/20/93	All holders of OLs or CPs for nuclear power reactors.

OL = Operating License
CP = Construction Permit

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Original signed by
Brian K. Grimes

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*D:DE	*D:DSSA	*TECH ED	*C:OGCB:DORS	D:DORS
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THE PMs (L. WIENS, J. ANDERSEN, AND D. PICKETT) HAVE BEEN INFORMED OF THIS DRAFT INFO. NOTICE. THEY HAVE NO COMMENTS.

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