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

October 5, 1994

NRC INFORMATION NOTICE 94-72: INCREASED CONTROL ROD DROP TIME FROM CRUD BUILDUP

Addressees

All holders of operating licenses or construction permits for pressurized-water reactors.

Purpose

The U.S. Nuclear Regulatory Commission (NRC) is issuing this information notice to alert addressees to potential problems resulting in increase of control rod drop times caused by the buildup of crud in control rod drive mechanisms designed by the Babcock and Wilcox Company (B&W). 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 Units 1 and 2

On April 29, 1993, the licensee for Oconee Nuclear Station Unit 2 conducted control rod drop time tests and found that drop time for control rod Group 3 rod 8 (rod 3-8) exceeded the technical specification limit of 1.66 seconds. This rod had to be dropped several times during startup in the previous refueling outage to achieve the drop time acceptance criteria. Later, the control rod drive mechanism (CRDM) was sent to the B&W facility for disassembly and inspection.

A review of the rod drop data at Oconee Unit 1 revealed a similar problem for rod 1-8 and rod 2-5. On May 4, 1993, based on a licensee request, NRC issued enforcement discretion to allow a drop time of 2 seconds for both rods for one fuel cycle. On August 25, 1993, following a plant trip, rod 2-5 had a drop time of 1.938 seconds, and the time increased to 2.063 seconds when the rod was drop tested on November 3, 1993. The licensee safety evaluation, following B&W inspection, concluded that the degraded drop time was the result of crud deposits that caused sticking of four ball check valves in the thermal barrier region of the CRDM and that the drop time would not exceed 3.0 seconds if all four ball check valves were stuck. Based on this analysis, a technical specification amendment was issued on January 11, 1994, to allow control rod insertion time of 3.0 seconds for rods 2-5 and 1-8 for the remainder of the core operating cycle.

Three Mile Island Nuclear Station Unit 1

On October 14, 1993, the licensee for Three Mile Island Nuclear Station Unit 1 (TMI-1) performed control rod drop time testing. There are seven control rod groups; five groups have 8 rods, one group has 9 rods and one group has 12 rods. One rod in each of the rod groups 1, 3 and 4 initially failed to comply with the technical specification requirement of 1.66 seconds. Drop times varied from 1.72 to 1.83 seconds.

As a followup to the October tests, the licensee conducted rod drop tests on March 17, 1994. Twelve rods failed to meet the technical specification requirements. The actual drop times ranged from 2.06 to 2.88 seconds. With the assistance of B&W, the licensee conducted an extensive study of the probable causes. Repetitive rod drops (ranging from 1 to 47) improved the drop time for all rods to values well below the technical specification requirements. After further evaluation, the licensee and B&W concluded that the excessive drop times had been caused by crud buildup in the thermal barrier region.

After bringing all control rods within the drop time required in the technical specification, plant operation resumed. On March 29, 1994, the NRC issued a confirmatory action letter documenting the following actions: (1) withdrawal of licensee request to raise the technical specification limit, (2) increase of lithium concentration to minimize crud buildup, (3) performance of rod drop time tests within three months of reactor startup, and (4) removal and inspection of a CRDM if the drop time exceeded technical specification limits in those tests.

The rod drop tests conducted in June 1994 after three months of operation showed three rods with drop times ranging from 2.01 seconds to 2.2 seconds. The subsequent CRDM inspection revealed crud buildup in the thermal barrier region and stuck ball check valves.

Discussion

In B&W plants, the operation of at least one of four ball check valves, located at the thermal barrier, is needed to attain rod drop times within technical specification limits. These check valves move up to allow the reactor coolant to quickly flow into the upper CRDM area, replacing the void created by the downward movement of the lead screw. Reactor coolant also rises through the narrow clearance between the control rod and the guide tube. During the surveillance and power control movements of the rod, the check valves are not fully challenged since the coolant flows to the upper structure at a much lower rate and in a much smaller quantity.

The inspections of CRDMs by both licensees identified crud deposits on the thermal barrier ball check valves, and at the clearance between the outer diameter of the lead screw and inside diameter of the thermal barrier bushing. The latter condition could result in significant increase in drop time if the four check valves also are stuck. Both licensees attribute the crud buildup to be the combined result of 24-month fuel cycles, inadequate reactor coolant pH control, and low clearance for the ball check valve movement.

At TMI-1, the drop time degradation began after the plant started operating with 24-month fuel cycles. The 24-month fuel cycles require a higher boron concentration in the coolant for reactivity control during the early part of the cycle. Lithium is used to buffer boric acid and to maintain pH in the allowable range. Compliance with a lithium concentration limit of 2.2 ppm (recommended by the fuel vendor to avoid excessive fuel cladding corrosion rates) resulted in pH values below 6.9 (7.0 is the neutral point between acidity and alkalinity) during the long fuel cycle. This condition may explain increased crud precipitation and deposition. The licensee has since obtained approval from the vendor to operate at higher lithium concentrations (allowing a pH of 6.9 and above).

The corrosion products generally consisted of nickel-substituted spinels of magnetite. The crud solubility depends on pH level and the coolant temperature. A pH of 6.9 or greater should result in relatively less formation of crud.

The TMI-1 licensee also observed that certain rods that were frequently exercised and that were in the central part of the core did not have significant crud buildup. The licensee committed to exercise all rods through 10 percent of their length every 2 weeks in order to cycle the fluid trapped in the upper CRDM area. Such long strokes expose the lead screw area to the reactor vessel environment and increase the coolant exchange with the upper CRDM area.

The B&W thermal barrier design for TMI-1 had narrow tolerances for the ball check valve movement. New thermal barriers with larger tolerances were installed at the four locations where slow rod drop time was observed in the past. The licensee is considering replacement of all thermal barriers and working with the B&W owners group in exploring other options such as chemical cleaning of the thermal barriers.

Primary chemistry control and narrow tolerances at the ball check valve appear to be significant factors in the observed degradation of control rod drop times. Trending of "as found" rod drop times may lead to early detection of potential problems.

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 Project Support
Office of Nuclear Reactor Regulation

Technical contacts: Thomas Koshy, NRR
(301) 504-1176

Howard Richings, NRR
(301) 504-2888

Attachment: List of Recently Issued NRC Information Notices

ATTACHment Filed in JACKET

LIST OF RECENTLY ISSUED NRC INFORMATION NOTICES

Information Notice No.	Subject	Date of Issuance	Issued to
94-71	Degradation of Scram Solenoid Pilot Valve Pressure and Exhaust Diaphragms	10/04/94	All holders of OLs or CPs for boiling water reactors (BWRs).
94-70	Issues Associated with Use of Strontium-89 and Other Beta Emitting Radiopharmaceuticals	09/29/94	All U.S. Nuclear Regulatory Commission Medical Licensees.
94-69	Potential Inadequacies in the Prediction of Torque Requirements for and Torque Output of Motor-Operated Butterfly Valves	09/28/94	All holders of OLs or CPs for nuclear power reactors.
94-68	Safety-Related Equipment Failures Caused by Faulted Indicating Lamps	09/27/94	All holders of OLs or CPs for nuclear power reactors.
94-67	Problem with Henry Pratt Motor-Operated Butterfly Valves	09/26/94	All holders of OLs or CPs for nuclear power reactors.
94-66	Overspeed of Turbine-Driven Pumps Caused by Governor Valve Stem Binding	09/19/94	All holders of OLs or CPs for nuclear power reactors.
94-65	Potential Errors in Manual Brachytherapy Dose Calculations Generated Using a Computerized Treatment Planning System	09/12/94	All U.S. Nuclear Regulatory Commission medical licensees.
94-64	Reactivity Insertion Transient and Accident Limits for High Burnup Fuel	08/31/94	All holders of OLs or CPs for nuclear power reactors and all fuel fabrication licensees.

OL = Operating License
CP = Construction Permit

*See previous concurrence

OEAB:DORS TKoshy / /94	SC/OEAB:DORS EGoodwin* 07/11/94	RPB:ADM RSanders* 06/28/94	C/SRXB:DSSA TCollins* 07/25/94
D/DSSA MVirgilio* 07/29/94	C/EMCB:DE JStrosnider* 08/02/94	D:DE BSheron* 08/08/94	RI JRogge* 08/15/94
RII RCarroll* 08/15/94	PM/PDII-3:ADR2 LWiens* 08/15/94	PM/PDI-4:ADR1 RHernan* 08/15/94	C/OEAB:DORS AChaffee* 09/02/94
AC/OGCB:DORS BDoolittle* 09/08/94	D/DORS BGrimes 9/28 /94		

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DOCUMENT NAME: 94-72.IN
THIS IS A CONCURRENCE PAGE FOR IN 94-72 DTD OCTOBER 5, 1994.

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D/DSSA MVirgilio* 07/29/94	C/EMCB:DE JStrosnider* 08/02/94	D:DE BSheron* 08/08/94	RI JRogge* 08/15/94
RII RCarroll* 08/15/94	PM/PDII-3:ADR2 LWiens* 08/15/94	PM/PDI-4:ADR1 RHernan* 08/15/94	C/OEAB:DORS AChaffee* 09/02/94
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9/9 /94	07/11/94	06/28/94	07/25/94
D/DSSA	C/EMCB:DE	D:DE	RI
MVirgilio*	JStrosnider*	BSheron*	JRogge*
07/29/94	08/02/94	08/08/94	08/15/94
RII	PM/PDII-3:ADR2	PM/PDI-4:ADR1	C/OEAB:DORS
RCarroll*	LWiens*	RHernan*	AChaffee*
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RII RCarroll 08/15/94	PM/PDII-3:ADR2 LWiens 08/15/94	PM/PDI-4:ADR1 RHernan 08/15/94	C/OEAB:DORS AChaffee 9/2/94
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6 /28/94 T Koshy	7/11/94 E Goodwin	6/28/94 R Sanders	/ /94 T Collins

D:DSSA	BC/EMCB:DE:NRR	D:DE	BC/OGCB:DOEA:NRR
7 /29/94 M Virgilio	8/02/94 For J Strosnider	8 /08/94 B Sheron	/ /94

SC:R1	SC:R2	PM:Ogonee	PM:TMI-1	D/DOEA
/ /94 J Rogge	R. Carroll by telecon 8/15/94	8/15/94 L Wiens	8/15/94 R Hernan	/ /94 B Grimes

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T Koshy	E Goodwin	R Sanders	T Collins

D:DSSA	BC/EMCB:DE:NRR	D:DE	BC/OGCB:DOEA:NRR
7/29/94	8/2/94	8/5/94	/ /94
M Virgilio	J Strosnider	B Sheron	
223		#5-8/30 AP	

SC:R1	SC:R2	PM:Oconee	PM:TMI-1	D/DOEA
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J Rogge		L Wiens	R Hernan	B Grimes

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6/28/94	7/11/94	Tech Ed. 6/28/94	/ /94
T Koshy	E Goodwin	R Sanders	T Collins

D:DSSA	BC/EMCB:DE:NRR	D:DE	BC/OGCB:DOEA:NRR
/ /94	/ /94	/ /94	/ /94
M Virgilio	J Strosnider	B Sharon	

SC:R1	SC:R2	PM:Oconee	PM:TMI-1	D/DOEA
/ /94	/ /94	/ /94	/ /94	/ /94
J Rogge		L Wiens	R Hernan	B Grimes

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