UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR REACTOR REGULATION
WASHINGTON, D.C. 20555-0001

June 3, 1997

NRC INFORMATION NOTICE 97-31: FAILURES OF REACTOR COOLANT PUMP THERMAL BARRIERS AND CHECK VALVES IN FOREIGN PLANTS

Addressees

All holders of operating licenses or construction permits for pressurized-water reactor (PWR) plants.

Purpose

The U.S. Nuclear Regulatory Commission (NRC) is issuing this information notice to alert addressees to reported problems discovered at foreign pressurized-water reactor (PWR) plants. Degraded conditions of the reactor cooling pump (RCP) thermal barriers were found after 10 years of service in the French 900-MWe PWR plants. 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

The degraded conditions were described in a paper presented during the July 1996 NRC/American Society of Mechanical Engineers (ASME) Symposium on Pump and Valve Testing (NUREG/CP-0152, July 1996) and subsequently discussed with the French authorities. After 10 years of service a sample inspection was conducted to determine the condition of a 900-MWe French PWR RCP. The inspection was carried out on RCP No. 2 at the Fessenheim Unit 2 Power Station. The RCP had completed 95,000 hours of operation.

During the visual examination, a crack was detected on the outside surface of the thermal barrier housing. Further detailed examinations revealed other cracks inside the housing and on the underside of the thermal barrier flange. Additionally, the thermal barrier cooling coil isolation check valves were found to be jammed open.

Subsequently, other inspections revealed that cracks existed in almost all of the 900-MWe plant RCP thermal barrier housings. Examinations performed on a 1300-MWe power station did not reveal the cracking phenomenon. About two-thirds of the check valves in the 9O0-MWe and 1300-MWe plants were found jammed open.

Discussion

The RCP thermal barrier, located directly above the pump impeller, prevents the hot reactor primary coolant (RPC) from reaching the RCP shaft seals. Exposure of the shaft seals directly to hot versus cooled RPC would degrade the seals. The thermal barrier is cooled by a cooling coil, which circulates water supplied from the component cooling water (CCW) system. The thermal barrier housing shields the cooling coil from the direct thermal effects of the hot primary coolant. Check valves are located in the supply lines to the thermal barrier cooling coil for the purpose of isolating the CCW system from the reactor coolant system in the event of a cooling coil rupture.

The safety concerns were identified and evaluated with regard to the potential consequences of (1) the formation of loose parts, generated by the thermal barrier housing, which could damage the pump seals, (2) the jamming of the pump impeller, (3) the rupture of the cooling coil without the check valve isolation of the CCW system, and (4) the disintegration of the thermal barrier flange.

On the basis of metallographic examinations, it was concluded that intergranular brittle rupture of niobium carbides occurred at the grain boundaries in some housings as a result of the very low ferrite content of the material (UNS S34700 SS). Further, it was concluded that the circumferential cracking located on the inside cylindrical surface at the interface with the base of the thermal barrier housing resulted from a fatigue phenomenon. The thermal barrier flange required further evaluation and testing to understand the root cause of the cracking of the surface.

The cause of the jammed-open check valves was attributed to a layer of metallic oxide deposits generated in the CCW system carbon steel piping. The valves were a lift-type check valve. Lift-type check valve internals, particularly in the smaller valves, typically have small clearances and passages for coolant flow and are highly susceptible to corrosion products buildup.

The corrective actions taken for these plants included (1) the installation of alert alarms and monitoring programs to detect high temperatures in the CCW system coolant at the thermal barrier outlet, (2) the replacement of the thermal barrier housings with a configuration-modified unit and a material change, (3) a check on the condition of thermal barrier flanges in 3 years, (4) the inservice testing of the lift-type check valves during refueling outages, and (5) the systematic replacement of the lift check valves with swing check valves during refueling outages.

In some recent events, similar failures at domestic plants have been reported with regard to RCP thermal barrier check valves. PWR components in safety-related code class systems such as the RCP check valves located in CCW system flowpaths are subject to the ASME/OM Code inservice testing requirements.

On November 16, 1993, with Sequoyah Nuclear Plant Unit 1 in cold shutdown and Unit 2 at 100-percent power, the Tennessee Valley Authority reported that both units were outside their design basis as a result of eight inoperable check valves in the Unit 1 component

cooling system piping, located upstream of the RCP thermal barrier heat exchangers. The Unit 1 condition was discovered by radiographic inspections of the check valves. The inspections indicated that seven of the eight check valves were stuck in the open position. The eighth valve was found to be improperly assembled. Subsequent inspections of corresponding valves in Unit 2 indicated that seven valves were stuck in the open position. The cause of the condition was iron oxide corrosion product buildup wedging between the valve piston and the bonnet. The Unit 2 valves were cleaned, reassembled, and returned to service. The carbon steel bonnets on the Unit 1 valves were replaced with stainless steel bonnets.

On October 29, 1991, the Comanche Peak Unit 1 stop check valves (SCVs) in the CCW lines to the RCP thermal barriers were being tested to satisfy inservice testing requirements. During the test, five of the eight SCVs failed to close. The valves were subsequently manually exercised, after which they operated as designed. On November 6, 1991, two of the failed valves were inspected. A small accumulation of corrosion products between the plug and the stem of the valves, and a slight scaling along the bore, were found. Larger accumulations of corrosion products that may have been present were flushed out when the valves were manually exercised. The root cause of the event was attributed to the accumulation of corrosion products and less than adequate preventive maintenance. Corrective action included the development of a preventative maintenance procedure to manually exercise these valves.

Similar valve fouling conditions were indicated during inservice testing at several other plants over the past 5 years.

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Seymour H. Weiss for
Marylee M. Slosson, Acting Director
Division of Reactor Program Management
Office of Nuclear Reactor Regulation

Technical contacts: Francis Grubelich, NRR
301-415-2784
E-mail: fxg@nrc.gov

Eric J. Benner, NRR
301-415-1171
E-mail: ejg1@nrc.gov

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LIST OF RECENTLY ISSUED NRC INFORMATION NOTICES

Information Notice No.	Subject	Date of Issuance	Issued to
97-30	Control of Licensed Material During Reorganizations, Employee-Management Disagreements, and Financial Crises	06/03/97	All material and fuel cycle licensees
97-29	Containment Inspection Rule	05/30/97	All holders of OLs or CPs for nuclear power reactors
97-28	Elimination of Instrument Response Time Testing Under the Requirements of 10 CFR 50.59	05/30/97	All holders of OLs or CPs
97-27	Effect of Incorrect Strainer Pressure Drop on Available Net Positive Suction Head	05/16/97	All holders of OLs or CPs for light-water power reactors, except those licensees who have permanently ceased operations and have certified that fuel has been permanently removed from the reactor vessel
97-26	Degradation in Small-Radius U-Bend Regions of Steam Generator Tubes	05/19/97	All holders of OLs or CPs for pressurized-water reactors
87-10, Sup. 1	Potential for Water Hammer During Restart of Residual Heat Removal Pumps	05/15/97	All holders of OLs or CPs for boiling-water reactors
97-25	Dynamic Range Uncertainties in the Reactor Vessel Level Instrumentation	05/09/97	All holders of OLs or CPs for Westinghouse pressurized-water reactors

OL = Operating License
CP = Construction Permit

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original signed by S. H. Weiss for

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E-mail: fxg@nrc.gov

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DATE	04/30/97	05/05/97	05/15/97	05/28/97 for

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