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

December 1, 1993

NRC INFORMATION NOTICE 93-90: UNISOLATABLE REACTOR COOLANT SYSTEM LEAK FOLLOWING REPEATED APPLICATIONS OF LEAK SEALANT

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 an application of an on-line leak sealing process which substantially degraded the integrity of the reactor coolant pressure boundary. 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

On May 24, 1993, at the Millstone Nuclear Power Station, Unit 2, Northeast Utilities (the licensee) identified a leak in a body-to-bonnet gasket on valve 2-CH-442. This valve is a Velan 2-inch gate valve which is used to manually isolate the letdown portion of the chemical and volume control system from the reactor coolant system for maintenance and local leak rate testing of containment isolation valves. The valve is upstream of the automatic letdown isolation valves, and itself cannot be isolated from the reactor coolant system. Between June 4, and August 5, 1993, leak sealant was injected approximately 30 times in an attempt to stop the leakage from the body-to-bonnet joint. Five sealant injections were performed by Leak Repairs, Inc., and the remainder were performed by Furmanite, Inc.; these activities were performed under the direction of the licensee. The injections had marginal results; after sealing, the valve would remain leak free for various periods ranging up to 18 days in length and would then start to leak again.

On June 12, 1993, following the 7th leak-seal injection, technicians attempted to install a body-to-bonnet peripheral clamp to provide a boundary for the leak-sealant compound. The clamp could not be installed because of fit-up problems with the irregularly shaped valve bonnet. The bonnet had been installed 90 degrees away from its normal orientation, further complicating the attempted clamp installation. Subsequent on-line attempts to seal the leak included mechanical peening to prevent injection material from extruding out of the gasket area. This peening closed the body-to-bonnet joint.

On August 5, 1993, leak sealant was injected to obtain the dry valve surfaces required for welding a second (hybrid) clamp across the body-to-bonnet joint. During the injection, technicians observed that the leakage increased dramatically, from slight seepage to a 3.1-meter [10-foot] steam jet. The technicians also reported that the valve bonnet appeared to lift and that one body-to-bonnet stud moved. In response to the increased leakage, the Director of Millstone, Unit 2, ordered a controlled normal shutdown. During the shutdown, the maximum reactor coolant system leakage was 16.3 liters [4.3 gallons] per minute.

Discussion

When valve 2-CH-442 was disassembled, it was discovered that one stud was broken. Because the body of valve 2-CH-442 is an unisolatable reactor coolant system pressure boundary, the broken stud changed the character of the incident from a routine gasket-related failure to a significant structural failure. An ABB-CE metallurgical study indicates that the stud broke in response to loads applied as part of the on-line leak sealing process. The most likely potential sources of loads were evaluated. These likely load sources are: (1) drilling, tapping, and injection port installation, (2) peening, and (3) injecting. Subsequent testing performed for the licensee at the ABB-CE facility indicated that stud loads produced by drilling, tapping, and injection port installation were moderate. However, when body-to-bonnet joints are peened to the point that the edges contact, the adjacent bolt can be loaded to failure due to the wedging action of the deformed metal.

Inspection revealed that two of the four studs had drill holes in them from the injection port and clamp installation drilling processes. The broken stud and one other stud each had 0.49 centimeter [0.19 inch] diameter holes that penetrated 0.25 centimeter [0.10 inch] and 0.28 centimeter [0.11 inch] deep, respectively. The holes did not appear to contribute to the stud failure. The licensee had intended to limit the injection port locations to low stress zones. However, the injection ports had actually been drilled in restricted high-stress zones located near the studs. Later analysis determined that the drilling caused very little stress on the studs.

The leak-sealant injection procedure at Millstone permitted some peening between the body and bonnet to prevent sealant extrusion (it did not allow peening along the entire perimeter of the valve). Inspection of valve 2-CH-442 revealed a significant amount of metal moved by the peening process. Peening essentially obscured the body-to-bonnet interface, leaving a groove-like indentation along the split line, and metal was peened so that it was in contact with all four bonnet studs. In addition, chisel-like marks were evident around the leak-sealant injection ports where hand peening was performed. The licensee determined that the extensive peening was responsible for the stud failure.

The licensee had made no provision to limit the amount of leak sealant injected into the valve. As a result, a total of approximately 2.16 liters [0.57 gallon] of leak sealant was injected into the body-to-bonnet joint.

The repeated attempts to seal the valve at Millstone Unit 2 indicated that an adequate engineering evaluation was not performed. The licensee evaluation did not adequately consider the effects of the sealing process and the borated water on the fasteners. Also, the evaluation did not adequately consider the amount or effect of sealant entering the system after repeated injections. Further, the evaluation did not adequately consider the operational and safety consequences of structural failure of the component or the fasteners during and after the leak-seal attempts. In addition, management and quality assurance oversight did not identify the failures to follow procedures, the failures to adhere to engineering documents and the lack of weight given to personnel safety considerations.

Events such as the one discussed above have the potential to cause a loss-of-coolant accident and to result in personnel injury or death. This event illustrates the importance of properly performed engineering and safety evaluations and the importance of considering occupational safety hazards in support of on-line leak sealant use. When ASME Code Class 1 pressure boundary components are involved, these considerations are especially important to public safety.

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 Grimes

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

Technical contacts: Eric J. Benner, NRR
(301) 504-1171

Geoffrey P. Hornseth, NRR
(301) 504-2756

Charles G. Hammer, NRR
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Attachment:
List of Recently Issued NRC Information Notices

LIST OF RECENTLY ISSUED NRC INFORMATION NOTICES

Information Notice No.	Subject	Date of Issuance	Issued to
93-89	Potential Problems with BWR Level Instrumentation Backfill Modifications	11/26/93	All holders of OLs or CPs for boiling water reactors.
93-88	Status of Motor-Operated Valve Performance Prediction Program by the Electric Power Research Institute	11/30/93	All holders of OLs or CPs for nuclear power reactors.
93-87	Fuse Problems with Westinghouse 7300 Printed Circuit Cards	11/04/93	All holders of OLs or CPs for nuclear power reactors.
93-86	Identification of Isotopes in the Production and Shipment of Byproduct Material at Non-power Reactors	10/29/93	All holders of OLs or CPs for test and research reactors.
93-85	Problems with X-Relays in DB- and DHB-Type Circuit Breakers Manufactured by Westinghouse	10/20/93	All holders of OLs or CPs for nuclear power reactors.
93-84	Determination of Westinghouse Reactor Coolant Pump Seal Failure	10/20/93	All holders of OLs or CPs for pressurized water reactors (PWRs).
93-83	Potential Loss of Spent Fuel Pool Cooling Following A Loss of Coolant Accident (LOCA)	10/07/93	All holders of OLs or CPs for boiling water reactors (BWRs).
93-82	Recent Fuel and Core Performance Problems in Operating Reactors	10/12/93	All holders of OLs or CPs for nuclear power reactors and all NRC-approved fuel suppliers.

OL = Operating License
CP = Construction Permit

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* See attached page for previous concurrences

Concurrence page for IN 93-90

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OFC	OEAB:DORS	SC/OEAB:DORS	EMCB:DE	C/EMCB:DE
NAME	EBenner*	EGoodwin*	GHornseth*	JStrosnider*
DATE	11/2/93	10/19/93	11/2/93	11/4/93
OFC	EMEB:DE	C/EMEB:DE	D/DE	PUB:ADM
NAME	GHammer*	JNorberg*	JWiggins*	Tech Ed*
DATE	11/2/93	11/4/93	11/4/93	11/05/93
OFC	C/OEAB:DORS*	OGCB:DORS	C/OGCB:DORS*	D/DORS
NAME	AChaffee	PWen*	GMarcus	BGrimes
DATE	11/17/93	11/19/93	11/23/93	11/29/93

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At this time, the licensee is developing significant new information about the effects of excessive peening. Ongoing laboratory experiments are showing that when body-to-bonnet joints are peened to the point that the edges contact, the adjacent bolt can be loaded to failure. This is apparently due to the wedging action of the deformed metal.

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