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

August 17, 1994

NRC INFORMATION NOTICE 94-59: ACCELERATED DEALLOYING OF CAST ALUMINUM-BRONZE VALVES CAUSED BY MICROBIOLOGICALLY INDUCED CORROSION

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 consequences of increased corrosion rates in aluminum-bronze valves in service water systems when microbiologically induced corrosion (MIC) is present. 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 October 12, 1993, operators making their rounds at Surry Power Station Units 1 and 2 noted varying degrees of corrosion on a total of 22 Jamesbury cast aluminum-bronze ball valves in the 1½- and 2-inch nominal diameter service water lines to the charging/safety injection pumps. The corrosion conditions ranged from a slight seepage of water to a buildup of corrosion products on the external valve parts. There are approximately 25 such valves for each unit. The maximum valve leakage noted was a few drops of water through one valve body in a 1-hour period.

Five valves were removed and submitted to the site metallurgical laboratory for evaluation of the failure mechanism. Sectioned valves exhibited dealloying to varying degrees. Dealloying of aluminum-bronze is the selective removal of aluminum from the structure. Cross-sections through the leaking areas examined under the light microscope revealed that the aluminum-rich phases had been leached out, leaving a porous structure through which the weeping occurred. An analysis of the corrosion product on the outside of the valves revealed a large percentage of aluminum, thus confirming the dealloying process. The dealloying was most severe under corrosion nodules. The location of the leak appeared to coincide with a corrosion nodule. Bacterial analysis of the corrosion nodules revealed several bacteria types, e.g.,

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sulfate-reducing and acid-producing. The licensee concluded that once a nodule was formed by the bacteria, an acidic condition was created under the nodule and this resulted in an accelerated rate of corrosion/dealloying of the alloy.

Discussion

The service water valves at Surry Power Station were installed in 1986. They were made of cast aluminum-bronze, alloy C 95400. Chemical analysis of the cast valves showed that they met the chemical composition requirements of American Society for Testing Materials, Specification B 148, "Standard Specification for Aluminum-Bronze Sand Castings," (ASTM B 148). This material contains a nominal 11-percent aluminum. Aluminum-bronzes with aluminum contents above approximately 9 percent require heat treatment for optimum corrosion resistance. ASTM B 148 specifications require no heat treatment. Thus, the as-cast material is not optimally conditioned to resist corrosion. Corrosion of this material often occurs by dealloying.

At Surry Power Station, the affected portion of the service water system provided brackish cooling water to the charging/safety injection pump lubricating oil and seal cooler heater exchangers. The system flow is normally approximately 189 liters [50 gallons] per minute, but varies on a seasonal basis. The flow velocity can be as low as 0.6 to 0.9 meter [2 to 3 feet] per second. Flow below approximately 1.5 meters [5 feet] per second lends to the system the potential for fouling which can promote the formation of microbiologically induced corrosion nodules as found in the subject valves.

Cast aluminum-bronze valves continue to be used successfully in fluids from fresh water to brackish water when fouling is inhibited. However, any valve or component manufactured from C 95400 alloy may experience dealloying under certain corrosive conditions. Visual leakage and corrosion deposits are the first indications of dealloying.

The dealloying of the aluminum-bronze valve body reduces the tensile strength and the toughness of the material and increases the susceptibility to transient and impact loading. A failure of the valve body could reduce the flow of cooling water to the charging/safety injection pump lubricating oil and seal cooler heat exchangers. After analyzing the five removed valves, the licensee for Surry Power Station determined that sufficient safety margin remained to warrant continued operation with the installed valves until the next scheduled refueling outage. At that time, the licensee intends to replace the affected valves with valves more resistant to the conditions in the service water system.

Related Generic Communications

- NRC Information Notice 85-30, "Microbiologically Induced Corrosion of Containment Service Water Systems," dated April 19, 1985.

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: John W. York, RII
(404) 331-5536

Morris W. Branch, RII
(804) 357-2101

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

Attachment:
List of Recently Issued NRC Information Notices

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LIST OF RECENTLY ISSUED NRC INFORMATION NOTICES

Information Notice No.	Subject	Date of Issuance	Issued to
94-58	Reactor Coolant Pump Lube Oil Fire	08/16/94	All holders of OLs or CPs for pressurized water reactors.
94-57	Debris in Containment and the Residual Heat Removal System	08/12/94	All holders of OLs or CPs for nuclear power reactors.
94-56	Inaccuracy of Safety Valve Set Pressure Determinations Using Assist Devices	08/11/94	All holders of OLs or CPs for nuclear power reactors.
94-55	Problems with Copes-Vulcan Pressurizer Power-Operated Relief Valves	08/04/94	All holders of OLs or CPs for nuclear power reactors.
91-79, Supp. 1	Deficiencies Found in Thermo-Lag Fire Barrier Installation	08/04/94	All holders of OLs or CPs for nuclear power reactors.
94-54	Failures of General Electric Magne-Blast Circuit Breakers to Latch Closed	08/01/94	All holders of OLs or CPs for nuclear power reactors.
91-45, Supp. 1	Possible Malfunction of Westinghouse ARD, BFD, and NBFD Relays, and A200 DC and DPC 250 Magnetic Contactors	07/29/94	All holders of OLs or CPs for nuclear power reactors.
94-42, Supp. 1	Cracking in the Lower Region of the Core Shroud in Boiling-Water Reactors	07/19/94	All holders of OLs or CPs for boiling water reactors (BWRs).
94-53	Hydrogen Gas Burn Inside Pressurizer During Welding	07/18/94	All holders of OLs or CPs for nuclear power reactors.

OL = Operating License
CP = Construction Permit

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orig /s/'d by BKGrimes

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OFFICE	DRP/RII	DRP/RII	SC:DRP/RII	OGCB/DORS	TECH ED
NAME	JWYork*	MWBranch*	GABelisle*	PCWen*	RFSanders*
DATE	07/25/94	07/25/94	07/25/94	07/25/94	07/27/94

OFFICE	EMCB/DE	SC:EMCB/DE	C:EMCB/DE	D:DE
NAME	GPHornseth*	RAHermann*	JRStrosnider*	BWSheron*
DATE	07/27/94	07/27/94	07/27/94	07/29/94

OFFICE	OGCB/DORS/NRR	AC:OGCB/DORS	D:DORS
NAME	JBirmingham*	ELDoolittle*	BKGrimes
DATE	08/03/94	07/29/94	08///94

DOCUMENT NAME: 94-59.IN

Notes:
- The PM (B. Buckley) was informed of the development of this IN.
- RII management concurrence was covered by the memo from E. Merschoff to B. Grimes, dated Dec. 21, 1993.

Peter Wen

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