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

February 9, 2007

NRC INFORMATION NOTICE 2007-06: POTENTIAL COMMON CAUSE VULNERABILITIES IN ESSENTIAL SERVICE WATER SYSTEMS

ADDRESSEES

All holders of operating licensees for nuclear power reactors, except those who have permanently ceased operations and have certified that fuel has been permanently removed from the reactor vessel.

PURPOSE

The U.S. Nuclear Regulatory Commission (NRC) is issuing this information notice (IN) to alert addressees of the importance of maintaining essential service water (ESW) systems in a manner that precludes the development of potential common cause failure vulnerabilities due to piping or heat exchanger degradation. 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 IN are not NRC requirements; therefore, no specific action or written response is required.

DESCRIPTION OF CIRCUMSTANCES

There have been two events at foreign operating reactors in which external corrosion of piping located in vaults has caused a catastrophic loss of one train of the ESW system. These two events also had common cause failure aspects that were identified as part of the extent-of-condition reviews. The first foreign event occurred at a pressurized-water reactor (PWR) designed by Westinghouse, that began commercial operation in 1988. On August 25, 2004, while operating at 100 percent power, an ESW system manhole pipe broke circumferentially prompting a plant shutdown from the total loss of the B train of the ESW system. The event was of great concern for plant safety because it could have led to a common cause failure in a system that is the ultimate heat sink for most safety loads. The ESW pipes are buried and use manholes at certain intervals to allow for inspection and maintenance. The ESW piping is a BONNA design that uses a steel pipe lined with cement on both sides to prevent corrosion. The manhole filled with surface water and corroded the exposed carbon steel manhole piping neck. The break resulted from external corrosion due to improper installation of external cement pipe coating. The licensee extent-of-condition review found corrosion at two other ESW manhole necks that also required significant repair.

The second foreign event occurred at a PWR, designed by Framatome, that began commercial operation in 1988. On December 11, 1998, while operating at 75 percent power, an ESW pipe ruptured and flooded the piping gallery with sea water. Since the B train of the ESW system was lost, the operators shutdown the plant. The pipe is composed of prestressed, inner and

ML062840608

outer concrete pipes with embedded strings and steel pipe. A visual inspection of the failed pipe revealed a 3.3 foot long by 2.8 inches wide through-wall rupture. The prestressed wire and steel cylinder were found to be severely corroded. The pipe is located in an underground gallery that has very humid conditions. The licensee determined that condensation got inside a small crack on the surface of the pipe causing corrosion of the steel wire. The licensee extent-of-condition review identified 16 other pipe spools that were also replaced.

There also have been two events at domestic operating reactor plants that experienced significant internal degradation of critical ESW components that had the potential for common cause failures. On June 27, 2005, at the South Texas Project, Unit 2, a three gallons/hour through-wall leak was identified in Train 2A, essential cooling water (ECW) system piping flange. The pipe is 30 inches in diameter, composed of an aluminum-bronze, and is located immediately downstream of an ECW return throttle (butterfly) valve. Subsequent licensee investigation found cavitation pitting, circumferential pipe cracking, and pipe-to-end flange weld separation in the pipe. On August 15, 2005, as part of their extent-of-condition review, the licensee inspected Train 2B of the ECW system and determined that a similar downstream flange had an approximately 30 inches-long by three inches-wide segment of the aluminum-bronze pipe that broke free. Train 2B of the ECW system was declared inoperable for the same reasons as ECW Train 2A and was reported to the NRC as a common-cause inoperability of independent trains (Licensee Event Report No. 499/2005004, Agencywide Documents Access and Management System (ADAMS) Accession No. ML052630031). The licensee determined the cause of the damage was cavitation impingement from the heavily throttled butterfly valve. The root cause was the failure to incorporate requisite inspection activities for ECW piping into station programs.

On March 20, 2005, at Point Beach Nuclear Plant, Unit 1, the G-01 emergency diesel generator (EDG) became inoperable due to a through-wall leak in the endbell of the EDG cooling system heat exchanger (Inspection Report 50-266/2005-010, ADAMS Accession No. ML053000237). Licensee inspections identified significant damage to the endbell due to microbiologically induced corrosion (MIC). The licensee maintenance rule evaluation determined that the poor condition of the endbells from pitting caused by MIC was known for nearly ten years, but timely and effective corrective actions were not taken. Also, on April 22, 2005, a through-wall service water (SW) leak occurred on the G-02 EDG heat exchanger alternate SW supply line due to MIC.

BACKGROUND

The ESW system (or its equivalent) for U. S. commercial reactor plants is the assured, safety-related means of transferring sensible and decay heat from the reactor coolant system to the ultimate heat sink. The ESW system is also relied upon for other critical safety functions, such as providing cooling water for most of the essential, safety-related equipment used for mitigating plant accident and transient conditions, reactor coolant pump seal cooling, spent fuel pool cooling, and for dissipating sensible and reactor decay heat during shutdown conditions.

Also, on PWRs, the safety related auxiliary feedwater systems typically rely on the ESW system as an emergency makeup water source for feeding the steam generators. Plant-specific probabilistic risk assessments (PRAs) have shown that the loss of the ESW system may be a significant contributor to the potential for a core damage accident.

DISCUSSION

The first foreign event involved the failure to properly protect the exterior piping surfaces in the vicinity of weld neck flanges that had been installed to allow personnel access for inspecting the inside ESW system piping surfaces. The unprotected weld neck joints were subject to corrosion. All of these areas were also subject to routine wetting of the unprotected exterior surface of weld neck areas. In addition, NRC staff concluded that a fundamental shortcoming associated with the first foreign event was the utility's failure to adequately trend and take appropriate corrective action for a known degraded condition. Domestic operating reactor plants are subject to Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, Appendix B, Criterion XVI, "Corrective Action," which requires that prompt and effective corrective actions be taken to address significant conditions adverse to quality.

The second foreign event also involved the failure to protect the exterior piping surface of the ESW system. One of the lessons learned was to implement an inspection program that inspects for both internal and external corrosion. The licensee also painted the outside of the ESW pipes to minimize the potential for corrosion.

Domestically, a potentially similar problem was noted during an NRC inspection at the Point Beach facility. Like the first foreign event, the licensee for Point Beach did not take appropriate corrective action to resolve a known degraded condition until MIC resulted in an actual failure. Also, like the first foreign event, MIC attack of the EDG endbells represented a common cause failure mechanism that could render all of the EDGs inoperable if not properly monitored and resolved.

ESW systems for U. S. nuclear power plants are generally unique from one plant to another. However, domestic ESW systems typically include piping sections that are buried and not readily accessible for inspection. Buried sections of piping can be subject to periodic wetting from storms or local flooding conditions. Exterior protective coatings may also not be fully intact due to improper installation, age degradation, or maintenance practices. It is also possible for some ESW piping sections to be located in vaults or pipe chases that are subject to periodic flooding and/or high humidity that can closely mimic the foreign events.

Also, at South Texas Project Unit 2, ESW system degradation led to a through-wall leak that ultimately became an actual common cause failure vulnerability. Similar cavitation damage was found in two trains of the ESW system at Unit 2. Proper application of the recommendations of NRC Generic Letter (GL) 89-13, “Service Water System Problems Affecting Safety-Related Equipment,” and 10 CFR Part 50, Appendix B, Criterion XVI, “Corrective Action,” likely would have prevented this event.

RELEVANT GENERIC COMMUNICATIONS

NRC GL 89-13, “Service Water System Problems Affecting Safety-Related Equipment,” dated July 18, 1989, requested specific licensee actions to resolve SW system problems. In particular, this GL recommended that licensees ensure by a routine inspection and maintenance program for open-cycle SW system piping and components that corrosion, erosion protective coating failure, silting, and biofouling cannot degrade the performance of safety related systems supplied by service water.

NRC GL 90-05, “Guidance for Performing Temporary Non-Code Repair of ASME Code Class 1, 2, and 3 Piping,” dated June 15, 1990, provides guidance for Code Class 3 piping. Two specific flaw evaluation approaches, as discussed in Enclosure 1 to the GL, should be considered, namely, the "through-wall flaw" and the "wall thinning" approaches.

NRC IN 92-49, “Recent Loss Or Severe Degradation Of Service Water Systems,” dated July 2, 1992, alerted licensees to several service water related events, including one event that resulted in the loss of the ultimate heat sink for a short period of time.

NRC IN 94-79, “Microbiologically Influenced Corrosion Of Emergency Diesel Generator Service Water Piping,” dated November 23, 1994, alerted licensees that stagnant or intermittent-flow conditions, as in the case of emergency diesel service water supply headers, are conducive to the growth of microorganisms that can accelerate corrosion rates.

NUREG-1275, Volume 3, "Operating Experience Feedback Report - Service Water System Failures and Degradations in Light Water Reactors," (November 1988) summarizes and discusses SW system events from 1980 to early 1987.

NUREG-1461, "Regulatory Analysis for the Resolution of Generic Issue 153: Loss of Essential Service Water in LWRs,” (August 1993) provides a review of industry experience and plant-specific PRAs and insights related to ESW system vulnerabilities.

CONTACT

This information notice requires no specific action or written response. Please direct any questions about this matter to the technical contacts listed below.

/TQuay for MCase/

Michael J. Case, Director
Division of Policy and Rulemaking
Office of Nuclear Reactor Regulation

Technical Contacts: Richard A. Laura, NRR/DIRS
301-415-1837
E-mail: ral1@nrc.gov

James E. Tatum, NRR/DSS
301-415-2805
E-mail: jet1@nrc.gov

Note: NRC generic communications may be found on the NRC public web site, http://www.nrc.gov under Electronic Reading Room/Document Collections.

CONTACT

This information notice requires no specific action or written response. Please direct any questions about this matter to the technical contacts listed below.

/TQuay for MCase/

Michael J. Case, Director
Division of Policy and Rulemaking
Office of Nuclear Reactor Regulation

Technical Contacts: Richard A. Laura, NRR/DIRS
301-415-1837
E-mail: ral1@nrc.gov

James E. Tatum, NRR/DSS
301-415-2805
E-mail: jet1@nrc.gov

Note: NRC generic communications may be found on the NRC public web site, http://www.nrc.gov under Electronic Reading Room/Document Collections.

ADAMS Accession Number: ML062840608

OFFICE	DIRS:IOEB	Tech.Editor	BC:DSS:SBPB	TL:DIRS:IOEB	PGCB:DPR
NAME	RLaura	CBladey	JSegala	MKing	CHawes CMH
DATE	10/18/2006	10/18/2006	10/23/2006	02/01/2007	10/27/2006
OFFICE	PGCB:DPR	IP	BC:ADRA:DPR	D:DPR	
NAME	QNguyen	JDunnLee	CJackson	MJCase	
DATE	02/02/2007	01/22/2007	02/082007	02/09/2007	

OFFICIAL RECORD COPY