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

March 16, 2006

NRC INFORMATION NOTICE 2006-08: SECONDARY PIPING RUPTURE AT THE MIHAMA POWER STATION IN JAPAN

ADDRESSEES

All holders of operating licenses, 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) involving foreign operating experience to alert addressees of the root causes and lessons learned from a secondary piping rupture at the Mihama Power Station, Unit 3 (Mihama 3) in Japan. 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 Mihama 3, is an 826 Megawatts electric, 3-loop Westinghouse type pressurized-water reactor (PWR) owned by Kansai Electric Power Company, Inc., and licensed by the Japanese government. This unit has been in service since 1976.

On August 9, 2004, a fire alarm annunciated in the central control room at Mihama 3. Upon investigation, operators discovered the area covered by the alarm was filled with steam. Suspecting that steam or high temperature water was leaking from the secondary piping, the operators began an emergency load reduction. While they were doing this, the reactor tripped automatically based on the steam flow from the 3A steam generator exceeding the feedwater flow to that steam generator.

The rupture occurred in a 55.9 centimeter (cm) (22 inch) outside diameter pipe in the ‘A’ loop condensate system between the fourth feedwater heater and the deaerator, downstream of an orifice for measuring single-phase water flow. At the time of the secondary piping rupture, 105 workers were preparing for the periodic inspections to commence. The accident resulted in five deaths and six injuries.

A review of plant parameters did not uncover any precursor indicators before the accident nor were there any special operations that could have caused the pipe rupture. An investigation concluded that water quality had been maintained since the commissioning of the plant.

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The rupture opening measured 51.5 cm (20.3 inches) in the axial direction and 93.0 cm (36.6 inches) in the circumferential direction of the carbon steel pipe. The nominal wall thickness of the pipe at the time of initial plant service was 10 millimeters (mm) (0.39 inches). The thinnest section of the pipe wall was 0.4 mm (0.02 inches). The same section of piping in the 'B' loop was 1.8 mm (0.07 inches) at its thinnest place. The pipe was designed for a maximum service temperature of 195 ECentigrade (EC) (383 EFahrenheit (EF)) and a maximum service pressure of 1.27 megapascal (MPa) (184 pounds per square inch (psi)). At the time of the pipe rupture, the flow rate through the pipe was 1700 cubic meters per hour (7485 gallons per minute) with a temperature of 140 EC (284 EF) and a pressure 0.93 MPa (135 psi).

A microscopic inspection of the inside surface of the ruptured pipe revealed a fish scale-like pattern over almost the entire inner surface of the pipe downstream of the orifice, except at the bottom of the pipe. The thickness along the bottom of the pipe was found to be the nominal wall thickness. The inside surface of the bottom of the pipe was covered with a thick surface film. These conditions are characteristic of flow-accelerated corrosion (FAC).

BACKGROUND

The condensate system and main feedwater system, as well as other power conversion systems, are important to safe plant operation. Failures in these systems may challenge plant safety systems required for safe shutdown and accident mitigation. All U.S. licensees have committed to adhere to criteria, codes and standards for high-energy piping systems described in licensing documents. Part of this commitment is keeping pipes within the allowable thickness values. The NRC has issued numerous generic communications, including IN 2001-09, "Main Feedwater System Degradation in Safety-Related [American Society of Mechanical Engineers] ASME Code Class 2 Piping Inside the Containment of a Pressurized-Water Reactor," on various pipe wall thinning issues and events.

DISCUSSION

In May 1990, the operators of PWRs in Japan established "Guidelines for Secondary Piping Wall Thickness Control at Nuclear Facilities (PWR)," (abbreviated PWR Management Guidelines, hereafter) which were implemented at Mihama 3. These guidelines are based on the known wall thinning rate of secondary system piping at various plants and describe the methods for managing pipe wall thinning. The guidelines cover carbon steel piping in the secondary system, where flow makes the walls susceptible to wall thinning. Approximately 25 percent of the piping within the scope of the guide is inspected within a 10-year period. The frequency of inspection is determined by the calculated residual life before the minimum pipe wall thickness is reached. Repeated inspections ensure that either the calculated residual life is greater than 2 years or that the pipe is replaced with a pipe made of corrosion-resistant material.

An investigation of the accident by the Nuclear and Industrial Safety Agency (NISA) found no reviews of the PWR Management Guidelines after 1990 to reflect new data. In addition, NISA concluded that the direct cause of the pipe failure was wall thinning but that the omission of this pipe from the initial inspection plan, ineffective management, ineffective quality management systems, and insufficient penetration of safety culture were contributing factors. As a result, the plant owner and the owner's contractors developed preventive measures to address quality assurance and maintenance management, inspection plans, and assessment of management programs. After reviewing the owner's preventive measures, NISA concluded that the actions described were appropriate.

The Japanese regulatory authority has asked the Japanese Society of Mechanical Engineers to develop new guidelines to replace the existing industrial guidelines on FAC. In its investigation report, NISA noted the importance of periodically examining program management and reviewing industry operating experience. NISA also emphasized that the success of these programs depends on owner corporate commitment to foster a strong safety culture.

FAC is managed differently in Japan than in the U.S. Most U.S. licensees manage FAC by implementing the Electric Power Research Institute (EPRI) guidelines described in NSAC-202L, "Recommendations for an Effective Flow Accelerated Corrosion Program." Nevertheless, successful implementation of the EPRI guidelines relies on several of the factors addressed by the NISA investigation report. For example, a successful FAC program depends upon periodic review and re-evaluation of the program in the light of new information and operating experience, application of sound engineering judgement, evaluation of the effect of design changes with respect to FAC, a strong safety culture, and management support. This and previous INs point to the continuing need for attention to the potential effects of FAC on piping system integrity and to the elements of an effective degradation management program.

REFERENCES

"Interim Summary on Secondary Piping Rupture Accident at Mihama Power Station, Unit 3 of the Kansai Electric Power Co., Inc.", (translated by Japan Nuclear Energy Safety Organization (JNES)), September 27, 2004, The Nuclear and Industrial Safety Agency.

"Secondary Piping Rupture Accident at Mihama Power Station, Unit 3 of the Kansai Electric Power Co., Inc. (Final Report)", Revision 1 (translated by Japan Nuclear Energy Safety Organization (JNES)), May 14, 2005, The Nuclear and Industrial Safety Agency.

CONTACT

This information notice does not require any specific action or written response. Please direct any questions about this matter to the technical contact listed below.

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

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ADAMS ACCESSION NUMBER: ML052910008 (TAC #MC8529)

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