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

May 6, 2004

NRC INFORMATION NOTICE 2004-11: CRACKING IN PRESSURIZER SAFETY AND RELIEF NOZZLES AND IN SURGE LINE NOZZLE

Addressees

All holders of operating licenses or construction permits for nuclear power reactors, except those that have permanently ceased operations and have certified that fuel has been permanently removed from the reactor.

Purpose

The U.S. Nuclear Regulatory Commission (NRC) is issuing this information notice (IN) to alert addressees to cracking and leakage indications found on pressurizer safety and relief nozzles and in a surge line nozzle-to-safe end weld. It is expected that the recipients of this notice 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.

Background

During an annual inspection in September of 2003, cracking and leakage were discovered on pressurizer safety and relief nozzles in Tsuruga Power Plant, Unit 2 (Tsuruga 2), in Japan. Tsuruga 2 is a four-loop pressurized water reactor (PWR) unit (similar to the PWRs in the U.S). Tsuruga 2, which started commercial operation in February 1987, was designed and fabricated by Mitsubishi Heavy Industries. Full power for Tsuruga 2 is 1160 MWe. At 100% power, the average primary coolant temperature is 289 °C (552 °F) in the cold leg and 322 °C (612 °F) in the hot leg.

During a refueling outage in October 2003, an indication was detected in a surge line nozzle-to-safe end dissimilar metal weld at Three Mile Island, Unit 1 (TMI-1). TMI-1 is a Babcock and Wilcox pressurized water reactor which started commercial operation in September 1974.

Description of Circumstances

Tsuruga 2

Tsuruga 2 was in its 13th annual inspection, which started in September of 2003. During a visual inspection of the pressurizer safety and relief nozzles with insulation removed, boric acid deposits were found on the pressurizer relief nozzle. Subsequent ultrasonic testing performed on the pressurizer safety and relief nozzles revealed linear indications in the nozzle-to-safe-end weld metal on the relief nozzle and on safety nozzle A, one of the three safety nozzles (Figure 1).

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Each nozzle consists of a safe end made of Type 316 stainless steel and a nozzle end made of a low-alloy steel, similar to Type 508 ferritic steel typically used in the same nozzles for U. S. plants (Figures 2 and 3). The safety and relief nozzles are the same size, about 190 mm (7.5 inches) outside diameter and about 130 mm (5.1 inches) inside diameter. Weld butter with Alloy 132 (which has properties similar to Alloy 182) was initially applied to each of the nozzles. The component was stress-relieved. Then a safe end was welded to each nozzle with Alloy 132. The weld is approximately 40 mm (1.6 inches) in width.

Plant personnel found that a repair was made to the nozzle-to-safe-end weld on safety nozzle A.

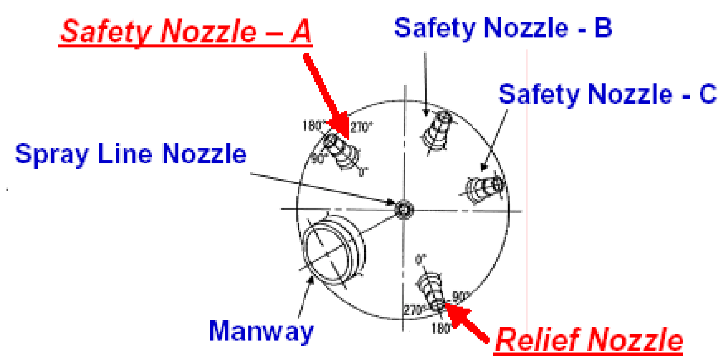

Figure 1. Top View of Reactor Pressurizer (Courtesy of Japan Atomic Power)

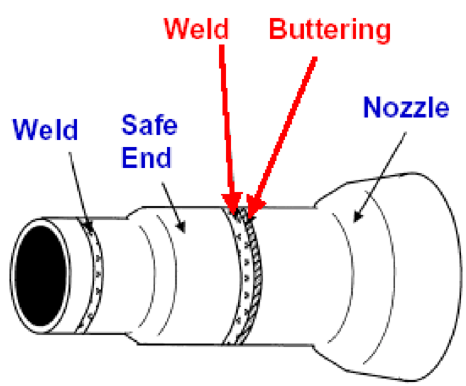

Figure 2. Nozzle Configuration (Courtesy of Japan Atomic Power)

All of the flaws found were axially oriented and located in the welds, that is, the flaws did not extend into the base metal. The 0° location of each nozzle is the point of the nozzle closest to the centerline axis of the pressurizer cylinder, marked by the spray line nozzle in Figure 1. On safety nozzle A, two indications with a maximum length of 24 mm (0.9 inches) were found at the 35° - 45° location. On the relief nozzle, two indications with a maximum length of 35 mm (1.4 inches) were found at the 90° location, and one indication with a maximum length of 34 mm (1.3 inches) was found at the 315° location.

The samples removed for destructive examinations contained the entire weld and a portion of the base metal on each side of the weld.

Radiography was performed on the severed pieces, confirming the linear flaws. Metallurgical failure analysis was performed on these samples. The results showed that the cracks initiated from the inside diameter surface, were axially oriented and were intergranular or interdendritic in nature. A through-wall crack was confirmed at the 90° location in the weld on the relief nozzle. The conclusion of the metallurgical analysis was that the nozzle failures were caused by primary water stress corrosion cracking (PWSCC) in the nozzle weld.

Personnel at the plant stated that visual inspections, with insulation removed, were performed on the pressurizer nozzles during the 1st, 2nd, 9th, and 10th annual inspections. Ultrasonic testing (normal beam method using 0° angle wave, straight beam) and dye penetrant testing were

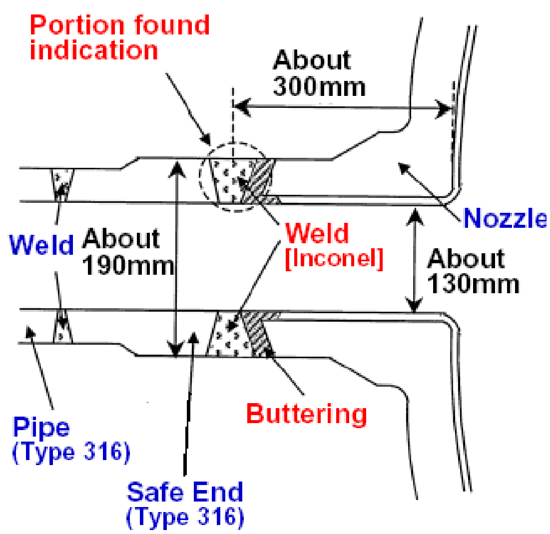

Figure 3. Nozzle Materials (Courtesy of Japan Atomic Power)

performed during the 9th refueling outage in early 1998, and during the 10th refueling outage in late 1999. Plant personnel stated that no indications were detected during the previous inspections.

TMI-1

During refueling outage 15 in October 2003, an indication was detected in a surge line nozzle-to-safe end dissimilar metal weld at TMI-1. The nozzle is a 25.4 cm (10-inch) diameter, schedule 140, American Society for Testing and Materials (ASTM) A-105, Grade 2, carbon steel product with an Alloy 82/182 filler metal butter and welded with Alloy 82/182 filler metal to an ASTM A-336 Class F8M forged stainless steel safe end. The surge line nozzle is connected to the steam generator “A” hot leg of the primary coolant loop and normally is operating at 317 °C (602 °F).

TMI-1 was performing planned manual ultrasonic testing (UT) of the surge line nozzle-to-safe end weld and found an axial indication in the weld material. During subsequent UT examinations, the licensee characterized the indication as spanning the width of the weld on the inside surface and extending 12 mm (0.48 inches) into the weld.

The indication was confined in the Alloy 82/182 weld material and stopped at the base metal interface on either side of the weld. The indication was in a region that was repaired during original fabrication. Based on the location, acoustic response, and operating temperature, TMI-1 concluded that the indication was due to PWSCC.

TMI-1 performed a full structural weld overlay repair to maintain weld integrity. The overlay was installed using an machine tungsten arc welding, temper bead process and Alloy 52 filler material.

Discussion

It is well known that Alloy 600/82/182 materials are susceptible to PWSCC. A pressurizer relief nozzle leak was detected at Palisades in 1993. The leak was attributed to PWSCC in the Alloy 82/182 nozzle weld. PWSCC in nozzles of the same materials in the reactor coolant environment was also reported in recent years. For example, cracking and leakage were discovered in the reactor vessel hot-leg nozzle weld at V. C. Summer during a refueling outage in October 2000. Metallurgical examinations revealed both axial and circumferential cracks in the nozzle weld. The root cause was attributed to PWSCC of the Alloy 82/182 weld. Axial cracks caused by PWSCC were also detected in hot-leg nozzle welds at Ringhals Unit 3 in 1999 and at Ringhals Unit 4 in the fall of 2000 during outage inspections.

Based on currently available information, the NRC believes that the degradation that occurred at Tsuruga 2 and TMI-1 is relevant to PWR facilities. The NRC has issued a number of generic communications and an order over the past 2 years related to PWSCC in the reactor coolant system of PWRs. The NRC staff continues to evaluate the adequacy of inspections to assure that reactor coolant pressure boundary integrity is maintained at each facility.

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.

/RA/
William D. Beckner, Chief
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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.

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Information Notice No.	Subject	Date of Issuance	Issued to
2004-10	Loose Parts in Steam Generators	05/04/2004	All holders of operating licenses for pressurized-water reactors (PWRs), except those who have permanently ceased operations and have certified that fuel has been permanently removed from the reactor.
2004-09	Corrosion of Steel Containment and Containment Liner	04/27/2004	All holders of operating licenses for nuclear power reactors except those who have permanently ceased operation and have certified that fuel has been permanently removed from the reactor vessel.
2004-08	Reactor Coolant Pressure Boundary Leakage Attributable to Propagation of Cracking in Reactor Vessel Nozzle Welds	04/22/2004	All holders of operating licensees for nuclear power boiling-water reactors (BWRs), except those who have permanently ceased operations and have certified that fuel has been permanently removed from the reactor vessel.
2004-07	Plugging of Safety Injection Pump Lubrication Oil Coolers with Lakeweed	04/07/2004	All holders of operating licenses or construction permits for nuclear power reactors, except those who have permanently ceased operations and have certified that fuel has been permanently removed from the reactor vessel.

Note: NRC generic communications may be received in electronic format shortly after they are issued by subscribing to the NRC listserver as follows:

To subscribe send an e-mail to <listproc@nrc.gov >, no subject, and the following command in the message portion:

subscribe gc-nrr firstname lastname

OL = Operating License
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