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

January 30, 1991

NRC INFORMATION NOTICE NO. 91-05: INTERGRANULAR STRESS CORROSION CRACKING IN PRESSURIZED WATER REACTOR SAFETY INJECTION ACCUMULATOR NOZZLES

Addressees:

All holders of operating licenses or construction permits for pressurized water reactors (PWRs).

Purpose:

This information notice is intended to inform licensees of recent problems involving intergranular stress corrosion cracking (IGSCC) of PWR safety injection accumulator nozzles. 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 do not constitute NRC requirements; therefore, no specific action or written response is required.

Description of Circumstances:

In January 1988, personnel at the Prairie Island Nuclear Generating Plant, Unit 2, detected a leak in one of the safety injection accumulators. The leak was determined to be in a two-inch diameter nozzle for the water level sensing instrumentation line. The licensee (Northern States Power Company) determined that the failure mode was IGSCC in a crack that started as a consequence of high stresses caused by the improper fit-up of the pipe to the nozzle in preparation for welding.

In October 1990, personnel detected a leak from safety injection accumulator "C" at the H. B. Robinson Steam Electric Plant, Unit 2, during the 10-year inservice inspection hydrostatic test. This leak was also located in a two-inch diameter nozzle for the water level sensing instrumentation line. In both cases, the accumulators involved are part of the safety injection system and contain borated water maintained at approximately 600 psig by nitrogen cover gas.

Discussion:

At Prairie Island Unit 2, the leak occurred in a nozzle that was submerged in the borated water near the bottom of the tank. Westinghouse Electric Corporation performed a failure analysis at the request of the licensee which revealed

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that the cause of the failure was IGSCC. Westinghouse attributed the stresses that were responsible for initiating the crack to the improper fit-up of the nozzle socket to the pipe in preparation for welding. Specifically, during the fit-up of the nozzle, the small gap which is required to be maintained between the end of the pipe and the bottom of the socket while the welding procedure is performed was not established. The investigation at Prairie Island confirmed that the gap had not been maintained and that the pipe had been seated fully into the nozzle before welding. This situation is believed to have caused the stresses that initiated the crack and promoted IGSCC in the nozzle. The analysis by Westinghouse also clearly indicated that the nozzle material was in a sensitized condition, making it susceptible to IGSCC. The licensee inspected other nozzles at Prairie Island and found no significant indications of cracking. At that time, Westinghouse attributed the failure primarily to the fit-up problem and took no further actions.

Carolina Power and Light Company (CP&L, the licensee) performed a failure analysis on the cracked nozzle from Robinson, Unit 2. The results of the analysis indicated that IGSCC caused the leak. The nozzle appeared to be manufactured from 304 stainless steel based on a chemical analysis of a sample that was removed from the nozzle. The crack had started on the inside diameter (ID) of the coupling and extended axially along the nozzle ID within the tank shell. The portion of the crack that propagated to the outside diameter (OD) of the nozzle was approximately 3/16-inch long and did not extend into the nozzle attachment fillet weld reinforcement. CP&L concluded that the full penetration weld (double-V groove design) connecting the nozzle to the shell produced the residual stresses that initiated the cracking. The axial orientation of the crack appears to provide some justification for this conclusion.

The failed nozzle at Robinson, Unit 2, was manufactured using austenitic stainless steel that became sensitized. CP&L attributed the sensitization of the coupling primarily to the post weld heat treatment (PWHT) of the accumulator performed by the manufacturer (Delta Southern Company, formerly located in Baton Rouge, Louisiana) in combination with the welding of the coupling to the accumulator. Typically, when a manufacturer plans to perform PWHT on a component that contains stainless steel, a low carbon grade of the material, containing a maximum of 0.035 percent carbon (e.g. types 304L or 316L), would be preferred. These low carbon grades of stainless steel are much less susceptible to sensitization and are therefore typically considered to be resistant to IGSCC. During the failure analysis, CP&L determined that the carbon content of the failed nozzle was 0.062 percent. No certified material test reports could be located for the 2-, 1-, and 3/4-inch diameter nozzles on the accumulator. CP&L determined that none of these small nozzles on the three accumulators at Robinson Unit 2 were made using low carbon content stainless steel, but that the 10-inch nozzles on the bottom of the tanks were made using stainless steel with low carbon content. The Westinghouse specification for the nozzles called for 304 stainless steel and did not specify a requirement for low carbon content.

The exact corrosive environment that contributed to the crack's propagation could not be determined. This particular nozzle was in the portion of the accumulator that was filled with gaseous nitrogen, and not under water as was the nozzle at Prairie Island.

Later, the licensee performed liquid penetrant and ultrasonic examinations on all of the nozzles on the three accumulators at Robinson Unit 2 and found that another 2-inch diameter nozzle, in this case on accumulator "A", had a crack with the characteristics of IGSCC. Further excavation of the nozzle from accumulator "A" revealed that the cracking was identical to that found in the nozzle on accumulator "C." In both of these cases, the licensee found no indication of any problem with the fit-up for the nozzle.

CP&L has reported this condition to the NRC under the provisions of 10 CFR Part 21 and has evaluated other tanks and vessels in its plant that were supplied by Delta Southern Company and found no further problems. In order to accurately determine the material used in and the condition of the nozzles on the safety injection accumulators, CP&L had to review their plant-specific drawings and associated records and take filing samples from the nozzles for analysis. Ultrasonic examination of the nozzles in a circumferential direction has proven to be the most effective crack detection method if examinations are required.

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 NRR project manager.

Charles E. Rossi

Charles E. Rossi, Director
Division of Operational Events Assessment
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(404) 331-5584

Robert A. Hermann, NRR
(301) 492-0768

Attachment: List of Recently Issued NRC Information Notices

LIST OF RECENTLY ISSUED
NRC INFORMATION NOTICES

Information Notice No.	Subject	Date of Issuance	Issued to
91-04	Reactor Scram Following Control Rod Withdrawal Associated with Low Power Turbine Testing	01/28/91	All holders of OLs or CPs for nuclear power reactors.
91-03	Management of Wastes Contaminated with Radioactive Materials ("Red Bag" Waste and Ordinary Trash)	01/07/91	All medical licensees.
91-02	Brachytherapy Source Management	01/07/91	All Nuclear Regulatory Commission (NRC) medical licensees authorized to use byproduct material for medical purposes.
91-01	Supplier of Misrepresented Resistors	01/04/91	All holders of OLs or CPs for nuclear power reactors.
90-82	Requirements for Use of Nuclear Regulatory Commission-(NRC-)Approved Transport Packages for Shipment of Type A Quantities of Radioactive Materials.	12/31/90	All registered users of NRC-approved packages.
90-81	Fitness for Duty	12/24/90	All U.S. Nuclear Regulatory Commission (NRC) material and non-power reactor licensees.
90-80	Sand Intrusion Resulting in Two Diesel Generators Becoming Inoperable	12/21/90	All holders of OLs or CPs for nuclear power reactors.
90-79	Failures of Main Steam Isolation Check Valves Resulting in Disc Separation	12/20/90	All holders of OLs or CPs for nuclear power reactors.

OL = Operating License
CP = Construction Permit

Later, the licensee performed liquid penetrant and ultrasonic examinations on all of the nozzles on the three accumulators at Robinson Unit 2 and found that another 2-inch diameter nozzle, in this case on accumulator "A", had a crack with the characteristics of IGSCC. Further excavation of the nozzle from accumulator "A" revealed that the cracking was identical to that found in the nozzle on accumulator "C." In both of these cases, the licensee found no indication of any problem with the fit-up for the nozzle.

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Original Signed by
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Document Name: IGSCC IN

*SEE PREVIOUS CONCURRENCES

		D/DOEA:NRR CERossi 01/24/91	C/OGCB:DOEA:NRR CHBerlinger 01/22/91	*RPB:ADM TechEd 12/17/90
*OGCB:DOEA:NRR AJKugler 12/14/90	EMCB:DET:NRR GGeorgiev 01/16/91	EMCB:DET:NRR BHermann 01/17/91 CYCheng 1/17/91	*RII JLColey 12/19/90	*RII JJBlake 12/20/90

Later, the licensee performed liquid penetrant and ultrasonic examinations on all of the nozzles on the three accumulators at Robinson Unit 2 and found that another 2-inch diameter nozzle, in this case on accumulator "A", had a crack with the characteristics of IGSCC. Further excavation of the nozzle from accumulator "A" revealed that the cracking was identical to that found in the nozzle on accumulator "C." In both of these cases, the licensee found no indication of any problem with the fit-up for the nozzle.

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		D/DOEA:NRR	C/OGCB:DOEA:NRR	*RPB:ADM
		CERossi	CHBerlinger	TechEd
		01/ /91	01/ /91	12/17/90
*OGCB:DOEA:NRR	EMCB:DET:NRR	EMCB:DET:NRR	*RII	*RII
AJKugler	GGeorgiev	BHermann	JLColey	JJBlake
12/14/90	01/16/91	01/ /91	12/19/90	12/20/90

c.f. Cheng OGC
1/15/91

The presence of chlorides and sulfates was confirmed by water leachable analyses of the failed nozzle. However, the exact corrosive environment that contributed to the crack's initiation could not be determined. This particular nozzle was in the portion of the accumulator that was filled with gaseous nitrogen, and not under water as was the nozzle at Prairie Island.

Later, the licensee performed liquid penetrant and ultrasonic examinations on all of the nozzles on the three accumulators at Robinson Unit 2 and found that a 2-inch diameter nozzle on accumulator "A" also had a crack with the characteristics of IGSCC. Further excavation of the nozzle from accumulator "A" revealed that the cracking was identical to that found in the nozzle on accumulator "C." In both of these cases, the licensee found no indication of any problem with the fit-up for the nozzle.

CP&L is evaluating other tanks and vessels in its plant that were supplied by Delta Southern Company to determine whether further examinations are required. In order to accurately determine the material used in and condition the nozzles on the safety injection accumulators, CP&L had to review their plant-specific drawings and associated records and take filing samples from the nozzles for analysis. Ultrasonic examination of the nozzles in a circumferential direction has proven to be the most effective crack detection method if examinations are required.

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*SEE PREVIOUS CONCURRENCES

				D/DOEA:NRR CERossi 12/ /90
OGCB:DOEA:NRR AJKugler AJK 12/14/90	*RII JLColey 12/19/90	*RII JJBlake 12/20/90	*RPB:ADM TechEd JEFF MIMS 12/17/90	C/OGCB:DOEA:NRR CHBerlinger 12/ /90

"A" also had a crack with the characteristics of IGSCC. Further excavation of the nozzle from accumulator "A" revealed that the cracking was identical to that found in the nozzle on accumulator "C." In both of these cases, the licensee found no indication of any problem with the fit-up for the nozzle.

CP&L is evaluating other tanks and vessels in its plant that were supplied by Delta Southern Company to determine whether further examinations are required. The U.S. Nuclear Regulatory Commission recommends that all PWR licensees review their plant-specific drawings to determine whether any tanks or vessels at their facilities contain nozzles with sensitized stainless steel. Ultrasonic examination of the nozzles in a circumferential direction has proven to be the most effective detection method if examinations are required.

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