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Exelon Nuclear

10 CFR 50.73

April 26, 2011
BW110041

U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555-0001

Braidwood Station, Unit 1
Facility Operating License No. NPF-72
NRC Docket No. STN 50-456

Subject: Licensee Event Report 2011-001-00 – Through Wall Crack on 1A Safety Injection Pump Discharge Line Due to Outside Diameter (Transgranular) Stress Corrosion Cracking Initiated at External Diameter of Pipe

The enclosed Licensee Event Report (LER) is being submitted in accordance with 10 CFR 50.73, "Licensee event report system," paragraph (a)(2)(i)(B), any operation or condition which is prohibited by the plant's Technical Specifications. On February 25, 2011, a through wall crack on the 1A safety injection pump discharge line was identified, and may have existed for a period longer than allowed by the Technical Specifications. 10 CFR 50.73(a) requires an LER to be submitted within 60 days following discovery of the event. Therefore, this report is being submitted by April 26, 2011.

There are no regulatory commitments contained in this letter. Should you have any questions concerning this submittal, please contact Mr. Chris VanDenburgh, Regulatory Assurance Manager, at (815) 417-2800.

Respectfully,

Daniel J. Enright
Site Vice President
Braidwood Station

Enclosure: LER 2011-001-00

cc: NRR Project Manager – Braidwood Station
Illinois Emergency Management Agency – Division of Nuclear Safety
US NRC Regional Administrator, Region III
US NRC Senior Resident Inspector (Braidwood Station)
Illinois Emergency Management Agency - Braidwood Rep

NRC FORM 366 (10-2010) U.S. NUCLEAR REGULATORY COMMISSION

APPROVED BY OMB: NO. 3150-0104 EXPIRES: 10/31/2013

Estimated burden per response to comply with this mandatory collection request: 80 hours. Reported lessons learned are incorporated into the licensing process and fed back to industry. Send comments regarding burden estimate to the FOIA/Privacy Section (T-5 F53), U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001, or by internet e-mail to infocollects.resource@nrc.gov, and to the Desk Officer, Office of Information and Regulatory Affairs, NEOB-10202, (3150-0104), Office of Management and Budget, Washington, DC 20503. If a means used to impose an information collection does not display a currently valid OMB control number, the NRC may not conduct or sponsor, and a person is not required to respond to, the information collection.

LICENSEE EVENT REPORT (LER)

(See reverse for required number of digits/characters for each block)

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4. TITLE

Through Wall Crack on 1A Safety Injection Pump Discharge Line Due to Outside Diameter (Transgranular) Stress Corrosion Cracking Initiated at External Diameter of Pipe

5. EVENT DATE			6. LER NUMBER			7. REPORT DATE			8. OTHER FACILITIES INVOLVED	
MONTH	DAY	YEAR	YEAR	SEQUENTIAL NUMBER	REV NO.	MONTH	DAY	YEAR	FACILITY NAME	DOCKET NUMBER
									N/A	N/A
02	25	2011	2011	- 001 -	00	04	26	2011	FACILITY NAME: N/A	DOCKET NUMBER: N/A

9. OPERATING MODE

1

10. POWER LEVEL

100

11. THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: *(Check all that apply)*

- ☐ 20.2201(b)
- ☐ 20.2201(d)
- ☐ 20.2203(a)(1)
- ☐ 20.2203(a)(2)(i)
- ☐ 20.2203(a)(2)(ii)
- ☐ 20.2203(a)(2)(iii)
- ☐ 20.2203(a)(2)(iv)
- ☐ 20.2203(a)(2)(v)
- ☐ 20.2203(a)(2)(vi)
- ☐ 20.2203(a)(3)(i)
- ☐ 20.2203(a)(3)(ii)
- ☐ 20.2203(a)(4)
- ☐ 50.36(c)(1)(i)(A)
- ☐ 50.36(c)(1)(ii)(A)
- ☐ 50.36(c)(2)
- ☐ 50.46(a)(3)(ii)
- ☐ 50.73(a)(2)(i)(A)
- ☒ 50.73(a)(2)(i)(B)
- ☐ 50.73(a)(2)(i)(C)
- ☐ 50.73(a)(2)(ii)(A)
- ☐ 50.73(a)(2)(ii)(B)
- ☐ 50.73(a)(2)(iii)
- ☐ 50.73(a)(2)(iv)(A)
- ☐ 50.73(a)(2)(v)(A)
- ☐ 50.73(a)(2)(v)(B)
- ☐ 50.73(a)(2)(v)(C)
- ☐ 50.73(a)(2)(v)(D)
- ☐ 50.73(a)(2)(vii)
- ☐ 50.73(a)(2)(viii)(A)
- ☐ 50.73(a)(2)(viii)(B)
- ☐ 50.73(a)(2)(ix)(A)
- ☐ 50.73(a)(2)(x)
- ☐ 73.71(a)(4)
- ☐ 73.71(a)(5)
- ☐ OTHER

Specify in Abstract below or in NRC Form 366A

12. LICENSEE CONTACT FOR THIS LER

FACILITY NAME	TELEPHONE NUMBER *(Include Area Code)*
Chris VanDenburgh, Regulatory Assurance Manager	(815) 417-2800

13. COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT

CAUSE	SYSTEM	COMPONENT	MANU-FACTURER	REPORTABLE TO EPIX	CAUSE	SYSTEM	COMPONENT	MANU-FACTURER	REPORTABLE TO EPIX
B	BQ	PSP	N/A	Y	N/A	N/A	N/A	N/A	N/A

14. SUPPLEMENTAL REPORT EXPECTED

☐ YES *(If yes, complete 15. EXPECTED SUBMISSION DATE)* ☒ NO

15. EXPECTED SUBMISSION DATE

MONTH	DAY	YEAR
N/A	N/A	N/A

ABSTRACT *(Limit to 1400 spaces, i.e., approximately 15 single-spaced typewritten lines)*

On February 25, 2011, dried boric acid was identified on a 1A safety injection (SI) pump discharge line. At 1830 hours, upon receipt of the non-destructive examination results indicating a potential pressure boundary leak, the 1A SI train was declared inoperable, and Technical Specification Limiting Condition for Operation (LCO) 3.5.2, "Emergency Core Cooling Systems – Operating," Condition A was entered for one train inoperable. Following pipe replacement, on March 3, 2011, at 2028 hours, the system was returned to service and LCO 3.5.2 Condition A was exited.

The apparent cause of the through wall crack is outside diameter (transgranular) stress corrosion cracking that initiated from the external surface of the pipe caused by chloride exposure.

Corrective actions included replacing the portion of the SI line containing the flaw with new stainless steel pipe, and performing extent of condition walkdowns of portions of the SI discharge piping.

There were no actual safety consequences impacting plant or public safety as a result of the event.

This event is reportable under 10 CFR 50.73(a)(2)(i)(B), any operation or condition which is prohibited by the plant's Technical Specifications.

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NARRATIVE

A. Plant Operating Conditions Before the Event:

Event Date: February 25, 2011 Event Time: 1830 CDT

Unit: 1 MODE: 1 Reactor Power: 100 percent

Unit 1 Reactor Coolant System [AB]: Normal operating temperature and pressure

B. Description of Event:

No structures, systems or components were inoperable at the start of this event that contributed to the event.

On February 25, 2011, dried boric acid was identified on a 1A safety injection (SI) [BQ] pump discharge line.

A dye penetrant test was performed on the area where the dried residue was identified. The dye penetrant test revealed numerous pits and curvilinear indications in the area that contained the dried boric acid. Chemical analysis performed on the dried residue retrieved from the surface of the pipe was consistent with boric acid concentrations in the refueling water storage tank (RWST). The RWST is the water source for the SI system.

At 1830 hours, upon receipt of the non-destructive examination results indicating a potential pressure boundary leak, the 1A SI train was declared inoperable, and Technical Specification (TS) Limiting Condition for Operation (LCO) 3.5.2, "Emergency Core Cooling Systems – Operating," Condition A was entered for one train inoperable. Condition A has a required action of restoring the train to OPERABLE status within seven days.

The section of the 1A SI pump discharge line containing the flaw was cut out of the system and replaced with a new like for like pipe. Following pipe replacement and radiography of new welds, an ASME Section XI Inspection (VT-2) was performed with the system pressurized to nominal operating pressure as part of the post maintenance test. No leakage was observed from the new pipe and new pipe welds.

On March 3, 2011, at 2028 hours, the system was returned to service and LCO 3.5.2 Condition A was exited.

The boric acid leakage on the SI line may have existed for a longer period of time than is allowed by LCO 3.5.2 Condition A. Therefore, this condition is reportable under 10 CFR 50.73(a)(2)(i)(B), any operation or condition prohibited by the plant's Technical Specifications.

C. Cause of Event

The apparent cause of the through wall crack is outside diameter (transgranular) stress corrosion cracking (ODSCC) that initiated from the external surface of the pipe caused by chloride exposure.

Following identification of the dried boric acid, a sample was retrieved for chemical analysis and the pipe surface cleaned for non-destructive examination. A dye penetrant test was performed on the area where the dried boric acid was identified. The dye penetrant test revealed numerous pits and curvilinear indications in the area that contained the dried boric acid. The location of the indications was on the pipe itself away from welds. These indications were found to be consistent with ODSCC. Chemical analysis performed on the dried boric acid retrieved from the surface of the pipe was consistent with boric acid concentrations in the RWST. The RWST is the water source for the SI system. The age of the dried residue deposit could not be determined since the RWST does not have isotopic contents comparable to that of the reactor coolant system, which would provide reliable age determination.

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In addition to the dried boric acid identified, evidence of a previous installed pipe clamp was noticed in the area where the dried boric acid was identified and it was later confirmed that a snubber had previously existed at this location. The snubber and pipe clamp were removed as part of the snubber reduction program in the early 1990s.

A failure analysis was performed on the section of pipe that was cut out of the system. An internal dye penetrant examination was performed and only one 0.010 inch long indication was detected on the pipe internal diameter. Further testing confirmed the suspected through wall crack. Based on the conclusions provided under the test report, the through wall crack was caused by ODSCC that initiated from the external surface of the pipe caused by chloride exposure. Qualitative analysis of the exposed crack surface indicated the cracking was caused by an aqueous chloride exposure. Additional qualitative analysis was performed on the tape residue removed from the flawed pipe revealing a high chloride peak, which confirmed the probable source of chloride. The tape residue was located in the area where the pipe clamp was installed. Additionally, the test report indicated that industry literature reports show pipe clamps as preferential locations for externally initiated stress corrosion cracking. As a result, the previously removed snubber clamp contributed to the leak for the following reasons: 1) The clamp generated crevice conditions that could locally retain moisture for long periods of time, and 2) The clamp to pipe crevice would concentrate detrimental chlorides by a crevice corrosion mechanism. The inadequate removal of tape residue occurred during initial plant construction.

D. Safety Consequences:

There were no actual safety consequences impacting plant or public safety as a result of this event. Following identification of the dried boric acid, the 1A SI train was declared inoperable and the appropriate TS required actions were taken.

In a design basis accident, there is reasonable assurance the SI system would have performed its design function, based on:

- The size of the defect, 0.010 inches, is very small as indicated in the PowerLabs failure analysis report (report number BRW-36383). The report also stated the piping wall thickness ranged from 0.325" to 0.343" near the leak area, which was within the 12.5% tolerance for 4" NPS, Schedule 80S piping that was fabricated to ASTM/ASME A312-Type 304. Based on the relatively small indication size and the 45 degree angled orientation for the cracking, there was little concern for a catastrophic pipe failure.
- Austenitic stainless steel piping is not prone to brittle fracture due to the inherent ductility at all relevant temperatures of the material. The annealed austenitic stainless steel used for piping applications has a high resistance to brittle fracture and this resistance does not diminish over time, because the material is not expected to be embrittled as a result of neutron radiation nor are the wrought forms of austenitic stainless steels susceptible to thermal embrittlement since they have low (<1 percent) delta ferrite. For these reasons, catastrophic failure of austenitic stainless steel pipe due to SCC is rare.
- The failure mechanism involved with this failure, ODSCC, is a slow progressing mechanism. Braidwood's probabilistic risk assessment (PRA) model credits the SI pump operation for a 24 hour mission time. Therefore, there would be a very limited time frame for flaw growth in an accident scenario.
- No failure of the discharge piping occurred during the most recent SI pump runs, with flow in recirculation;
  - Prior to the discovery of the through wall crack on February 25, 2011, on December 3, 2010 an ASME Section XI Inspection (VT-2) was completed on this pipe. The system was pressurized to approximately 1575 psig for approximately two hours. No indication of leakage was identified.
  - Additionally, between this time period (December 3, 2010 and February 25, 2011), the 1A and 1B SI pumps were operated in support of testing on February 1, 2011 and February 23, 2011, respectively. During pump operation, the discharge piping of both trains of SI was pressurized to approximately 1565 psig and 1500 psig, respectively. The system was pressurized for approximately one half hour in both instances. No adverse effect on the discharge piping was evident.

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- The discharge pressure of the SI pumps operating with flow in recirculation to the RWST would bound the pressure expected in an accident condition.

Based on the information provided above, this event did not result in a safety system functional failure.

E. Corrective Actions:

Completed corrective actions include:

- Replaced the portion of the SI line containing the flaw with new stainless steel pipe.
- Performed extent of condition walkdowns of portions of the SI discharge piping. No other anomalies were identified.

Additional corrective actions include:

- Perform a flaw evaluation to determine the allowable flaw size to demonstrate that the structural integrity of the SI discharge line was maintained.
- Review the sticker labels used by site or by suppliers for chloride content for conformance to concentrations listed in the Chemical Control Program procedure.
- Review tape adhesive currently available at the station for chloride content for conformance to concentrations listed in the Chemical Control Program procedure.

F. Previous Occurrences:

There has been one previous, similar Licensee Event Report identified at the Braidwood Station in the past three years:

- Licensee Event Report 2010-003-00 – Unit 1 Through-weld Leak of the Line from the 1B Seal Injection Filter to the Vent Valve

G. Component Failure Data:

This event has been reported to EPIX as Failure Report No. 1013.