Exelon Generation®

Mark Flaherty
Plant Manager

Calvert Cliffs Nuclear Power Plant
1650 Calvert Cliffs Parkway
Lusby, MD 20657

410 495 5205 Office
443-534-5475 Mobile
www.exeloncorp.com
mark.flaherty@exeloncorp.com

10 CFR 50.73

April 14, 2016

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

Calvert Cliffs Nuclear Power Plant, Unit No. 1
Renewed Facility Operating License No. DPR-53
NRC Docket No. 50-317

Subject: Licensee Event Report 2016-002, Revision 00
Pressurizer Safety Relief Nozzle Dissimilar Metal Weld Flaw Exceeded American Society of Mechanical Engineers Code Allowable Limit

The attached report is being sent to you as required by 10 CFR 50.73.

There are no regulatory commitments contained in this correspondence.

Should you have questions regarding this report, please contact Mr. Larry D. Smith at (410) 495-5219.

Respectfully,

FOR M. FLAHERTY AS ACTING PM

Mark D. Flaherty
Plant Manager

MDF/KLG/bjm

Attachment: As stated

cc: NRC Project Manager, Calvert Cliffs
NRC Regional Administrator, Region I
NRC Resident Inspector, Calvert Cliffs
S. Gray, MD-DNR

IE22
NRR

NRC FORM 366 (11-2015) U.S. NUCLEAR REGULATORY COMMISSION

APPROVED BY OMB: NO. 3150-0104 EXPIRES: 10/31/2018

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 and Information Collections Branch (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 Page 2 for required number of digits/characters for each block)

1. FACILITY NAME	2. DOCKET NUMBER	3. PAGE
Calvert Cliffs Nuclear Power Plant, Unit 1	05000317	1 OF 6

4. TITLE

Pressurizer Safety Relief Nozzle Dissimilar Metal Weld Flaw Exceeded American Society of Mechanical Engineers Code Allowable Limit

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	
02	20	2016	2016	- 002	000	04	14	2016	FACILITY NAME	

9. OPERATING MODE	11. THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR§: *(Check all that apply)*			
6	☐ 20.2201(b)	☐ 20.2203(a)(3)(i)	☒ 50.73(a)(2)(ii)(A)	☐ 50.73(a)(2)(viii)(A)
	☐ 20.2201(d)	☐ 20.2203(a)(3)(ii)	☐ 50.73(a)(2)(ii)(B)	☐ 50.73(a)(2)(viii)(B)
	☐ 20.2203(a)(1)	☐ 20.2203(a)(4)	☐ 50.73(a)(2)(iii)	☐ 50.73(a)(2)(ix)(A)
	☐ 20.2203(a)(2)(i)	☐ 50.36(c)(1)(i)(A)	☐ 50.73(a)(2)(iv)(A)	☐ 50.73(a)(2)(x)
10. POWER LEVEL	☐ 20.2203(a)(2)(ii)	☐ 50.36(c)(1)(ii)(A)	☐ 50.73(a)(2)(v)(A)	☐ 73.71(a)(4)
000	☐ 20.2203(a)(2)(iii)	☐ 50.36(c)(2)	☐ 50.73(a)(2)(v)(B)	☐ 73.71(a)(5)
	☐ 20.2203(a)(2)(iv)	☐ 50.46(a)(3)(ii)	☐ 50.73(a)(2)(v)(C)	☐ 73.77(a)(1)
	☐ 20.2203(a)(2)(v)	☐ 50.73(a)(2)(i)(A)	☐ 50.73(a)(2)(v)(D)	☐ 73.77(a)(2)(i)
	☐ 20.2203(a)(2)(vi)	☐ 50.73(a)(2)(i)(B)	☐ 50.73(a)(2)(vii)	☐ 73.77(a)(2)(ii)
		☐ 50.73(a)(2)(i)(C)	☐ Specify in Abstract below or in NRC Form 366A	

12. LICENSEE CONTACT FOR THIS LER

LICENSEE CONTACT	TELEPHONE NUMBER (Include Area Code)
Kenneth Greene, Regulatory Engineer	410-495-4385

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	AB	NZL		Y					

14. SUPPLEMENTAL REPORT EXPECTED	15. EXPECTED SUBMISSION DATE	MONTH	DAY	YEAR
☐ YES *(If yes, complete 15. EXPECTED SUBMISSION DATE)* ☒ NO				

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

On February 20, 2016, during Calvert Cliffs Inservice Inspections of Unit 1 dissimilar metal welds, an evaluation of recorded ultrasonic examination (UT) data identified the presence of one axially oriented flaw in a 4 inch Unit 1 pressurizer [PZR] safety relief nozzle [NZL] to safe end weld. The indicated flaw exhibited characteristics indicative of primary water stress corrosion cracking (PWSCC). The flaw was inner diameter connected and measured 81.6 percent through-wall. This measured axial flaw depth did not meet the American Society of Mechanical Engineers (ASME) Code allowable limit. The UT of this weld done in 2006 and 2010 had determined the axial flaw depth was only approximately 8 percent through-wall. After re-analysis of the prior UT data, the root cause was determined to be limitations in sizing data collection and analysis techniques prior to 2016 that were unable to connect the detected inner diameter indication to the full through-wall extent of ultrasonic signal response of the flaw. The weld was repaired using a full structural weld overlay repair method using PWSCC resistant material deposited around the circumference of the weld area. Two other Unit 1 welds that had previously shown potential PWSCC were examined with the new techniques and showed no change in their indication characteristics and remain within ASME Code allowable limits.

NRC FORM 366A (11-2015) U.S. NUCLEAR REGULATORY COMMISSION	APPROVED BY OMB: NO. 3150-0104 EXPIRES: 10/31/2018
LICENSEE EVENT REPORT (LER) CONTINUATION SHEET	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 and Information Collections Branch (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.

1. FACILITY NAME	2. DOCKET	3. LER NUMBER		
		YEAR	SEQUENTIAL NUMBER	REV NO.
Calvert Cliffs Nuclear Power Plant, Unit 1	05000 317	2016	-- 002 --	00

NARRATIVE

I. DESCRIPTION OF EVENT:

A. INITIAL CONDITIONS:

Unit 1 was shut down in Mode 6 during Calvert Cliffs' Unit 1 refueling outage on February 20, 2016 prior to the event.

B. EVENT:

During Calvert Cliffs Unit 1 2016 refueling outage, nondestructive examination (NDE) technicians conducted Inservice Inspections (ISI) of Unit 1 dissimilar metal (DM) welds per American Society of Mechanical Engineers (ASME) Code Case N-770-1, Inspection Item E, and 10 CFR 50.55a(g)(6)(ii)(F).

On February 20, 2016 at 0330, an evaluation of recorded ultrasonic examination (UT) data identified the presence of one axially oriented flaw in a 4 inch nominal pipe size Unit 1 pressurizer [PZR] safety relief nozzle-[NZL]-to-safe-end weld. The indicated flaw, which was contained within the Alloy 82/182 weld metal, exhibited characteristics indicative of primary water stress corrosion cracking (PWSCC). The flaw was inner diameter (ID) connected and measured 81.6 percent through-wall. This measured axial flaw depth did not meet the ASME Code allowable limit of less than 75 percent through-wall. This condition was reported to Operations and an Emergency Notification System (ENS) report 51747 was made to the Nuclear Regulatory Commission (NRC) in accordance with NUREG-1022, Event Report Guidelines 10 CFR 50.72 and 50.73, for a degraded Reactor Coolant System [AB] due to a weld defect that was not acceptable under ASME Code Section XI.

Calvert Cliffs engaged NDE technical experts from Exelon, the Electric Power Research Institute (EPRI), and other industry NDE experts to analyze the UT data. This group reviewed the 2016 UT data as well as UT data on this weld from previous UT examinations that were performed in 2010 and 2006 pre- and post-stress improvement. In 2006 the manual UT examination performed before the application of stress improvement identified an axial flaw in the same location as identified in 2016. An encoded examination was performed to size the ID connected flaw at that time. The analysis of that data determined the axial flaw to be approximately 8 percent through-wall. After re-analysis by the group of experts, the difference in sizing this flaw between the earlier examinations and the 2016 data is not considered to be due to any substantial growth in the flaw but rather a reflection of improved UT examination techniques used in 2016 that enabled a clearer disposition of the true size of the flaw. As such the root cause was determined to be limitations in sizing data collection and analysis techniques prior to 2016 that were unable to connect the detected inner diameter indication, originally detected in 2006, to the full through-wall ultrasonic signal response from the flaw.

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		YEAR	SEQUENTIAL NUMBER	REV NO.
Calvert Cliffs Nuclear Power Plant, Unit 1	05000 317	2016	-- 002 --	00

NARRATIVE

This pressurizer nozzle-to-safe-end DM weld was repaired using a full structural weld overlay (FSWOL) repair method using PWSCC resistant material deposited around the circumference of the weld area. These repairs were completed on March 7.

C. INOPERABLE STRUCTURES, COMPONENTS, OR SYSTEMS THAT CONTRIBUTED TO THE EVENT:

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

D. DATES AND APPROXIMATE TIMES OF MAJOR OCCURRENCES:

February 20, 2016, 0330 - NDE Technicians identified the presence of one axially oriented flaw in the Unit 1 pressurizer safety relief nozzle-to-safe-end weld. The flaw is ID connected, contained within the weld only, and measured 81.6 percent through-wall.

February 20, 2016, 0912 - ENS report 51747 was made to the NRC for a principal safety barrier being in a degraded condition.

February 26, 2016 - Weld repair team began a FSWOL on pressurizer safety relief nozzle-to-safe-end DM weld

March 7, 2016 - Weld repair team completed FSWOL on pressurizer safety relief nozzle-to-safe-end DM weld

E. FAILURE MODES:

The pressurizer nozzle-to-safe-end weld is a shop fabricated DM weld made during the fabrication of the pressurizer vessel. The nozzle material is a stainless clad carbon steel SA-508, Class 2 forging and the safe end is stainless steel SA-182, F316. The nozzle was buttered and welded to the safe end with Alloy 82/182 weld material in the vessel fabrication facility.

Evaluation of the 2016 recorded UT data identified an axially oriented flaw that exhibited characteristics indicative of PWSCC that was 81.6 percent through-wall and 0.9 inches long. A confirmatory inspection was done by an independent examination vendor that came up with similar conclusions. These determinations were then confirmed by an Exelon NDE Level III certified examiner. A team comprised of Exelon, EPRI, and industry experts was put together to analyze the results from the 2006, 2010, and 2016 examinations of this weld.

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		YEAR	SEQUENTIAL NUMBER	REV NO.
Calvert Cliffs Nuclear Power Plant, Unit 1	05000 317	2016	-- 002 --	00

NARRATIVE

In 2006 a non-encoded conventional UT was performed that identified an axial flaw in the weld/butter region. To size the detected flaw an encoded conventional UT was also performed. From this data the axial flaw was determined to be approximately 8 percent through-wall with a length of 0.6 inches and wholly contained within the weld and butter material. After the planned mechanical stress improvement was completed both UT techniques were again conducted with no changes in flaw through-wall dimensions detected.

In 2010 the UT examination on this weld was done using a non-encoded phase array technique. There was no reported change in flaw dimension from the 2006 examination. The examiner did report the presence of another axial anomaly however, it was not considered to be an extension of the flaw. During the 2010 examination an encoded conventional examination was also performed using the same procedure used in 2006. There was no change from the prior flaw dimension reported using this technique. The 2010 examination also reported several embedded fabrication-related flaws in the area around the PWSCC flaw, but no clear connection to the PWSCC flaw was able to be made.

For the 2016 UT examination an improved scanner was used along with a technique that provided a larger search unit, additional skewed and refracted angles, lower frequency, contoured search units and enhanced focusing. These improved UT techniques enabled examiners to identify the axially flaw as being an inside diameter connected, 81.6 percent through-wall flaw, 0.9 inches long.

The 2016 NDE review team examined the UT results from the 2006 and 2010 examinations to determine whether there was evidence that the axial flaw was incorrectly sized in the 2006 and 2010 examinations. One observation about the earlier recorded examinations was that the data quality was marginal by current standards which made connection of the upper signal response to the ID connected axial indication difficult. Based on their review the team concluded that the axial flaw reported in 2016 is the same flaw as seen in the 2006 and 2010 examinations. Thus the cause for the change in reported flaw depth in 2016 from 2006 and 2010 was not due to flaw growth but rather most likely reflects UT data quality limitations in the earlier examinations. The 2016 review of the earlier examination UT data revealed the presence of ultrasonic signal responses in the region above the reported axial flaw. It is concluded that these UT signal responses were, in hindsight, associated with the ID-connected axial flaw but were mischaracterized due to the absence of high amplitude signal responses between upper and lower flaw components most likely due to the compressive effects of the Mechanical Stress Improvement Process (MSIP®) application. The application of MSIP® in 2006 would have prevented the propagation of a shallow flaw through the compression zone created and may have slowed, through an isolating clamping effect, a deeper flaw's growth. It is also clear that the quality (as compared to today's standards) of the UT data made accurate determination of the axial flaw's true depth size difficult. Thus the root cause is that limitations in UT sizing data collection and analysis techniques in examinations of this weld prior to 2016 were unable to

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		YEAR	SEQUENTIAL NUMBER	REV NO.
Calvert Cliffs Nuclear Power Plant, Unit 1	05000 317	2016	-- 002 --	00

NARRATIVE

connect the detected inner diameter axial indication to the full through-wall signal response of the flaw. Also contributing was that the applied MSIP® compressed the flaw making the flaw at the upper (deeper) limit more difficult to associate with the ID connected flaw. These led to the flaw depth being incorrectly sized in 2006 and 2010.

F. METHOD OF DISCOVERY:

This condition was discovered during the performance of ISI of Unit 1 DM welds as part of the planned ISI examinations. This event is documented in the site's Corrective Action Program under IR 02629063.

II. CAUSE OF EVENT

A. SAFETY CONSEQUENCES:

There were no automatic or manually initiated safety system responses.

The safety consequence of this event was that a flaw size that is 81.6 percent through-wall and 0.9 inches long does not meet ASME Code, Section XI, Appendix C requirements which brings into question the structural integrity of this weld and its ability to perform its safety function to maintain Reactor Coolant System pressure boundary integrity. To make that determination, an outside Engineering firm was contracted to perform an analysis of the structural integrity of the flawed location. The analysis determined that the axial flaw, although it exceeds the ASME Code, Section XI allowable flaw depth, still met the ASME Code, Section XI structural margin, considering a Service Level D structural factor, as required by NRC Inspection Manual Chapter 0326. Thus it was determined that the Reactor Coolant System piping at this location, had maintained the ability to perform its safety function in the past. In addition, a leakage calculation was performed that concluded that in the unlikely event that if the flaw had gone completely through-wall and extended beyond the width of the susceptible Alloy 82/182 weld/weld butter material, it would result in a leak that would have been detected by the plant leakage detection system well before it would reach the 'allowable' axial flaw length limitation.

The subject condition satisfies the criteria in NUREG-1022, Revision 3, for principal safety barriers of the nuclear power plant being seriously degraded. Therefore, this event is reportable pursuant to 10 CFR 50.73(a)(2)(ii)(A). An immediate ENS report (51747) was also made pursuant to 10 CFR 50.72(b)(3)(ii)(A) upon discovery of this degraded condition.

B. CORRECTIVE ACTIONS:

The degraded DM weld condition was repaired by applying a FSWOL meeting ASME Code Case N-740-2 requirements. Use of ASME Code Case N-740-2 was allowed in a relief request

NRC FORM 366A (11-2015) U.S. NUCLEAR REGULATORY COMMISSION	APPROVED BY OMB: NO. 3150-0104 EXPIRES: 10/31/2018
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Calvert Cliffs Nuclear Power Plant, Unit 1	05000 317	2016	-- 002 --	00

NARRATIVE

that was previously approved for Calvert Cliffs on February 24, 2011. Following completion of the FSWOL, it was inspected and found to meet the pre-service requirements of ASME Section XI, 2004 Edition, No Addenda, and Code Case N-740-2.

Following discovery of this degraded condition, the Unit 1 ISI of Unit 1 DM welds was expanded so that all 27 Unit 1 Alloy 82/182 DM welds, 2 inch NPS and greater were inspected during this refueling outage. There are two other Unit 1 DM welds that had detected potential PWSCC flaws in previous examinations. The 2016 UT examinations for these welds indicated that there had been no change to their indication. During the Unit 2 2017 refueling outage, Calvert Cliffs will conduct examinations on 22 Alloy 82/182 DM welds 2 inch nominal pipe size or greater as required by ASME Code Case N-770-1. There are no Unit 2 DM welds with previously identified potential PWSCC flaws.

III. PREVIOUS SIMILAR EVENTS:

A review of site Licensee Event Reports (LERs) reveals there have been several instances of reactor coolant pressure boundary leakage detected that were not related to PWSCC. There were several, including two LERs (LER 317/2008-001 and LER 318/2011-001) in the past ten years that involved PWSCC related issues on pressurizer heater sleeve or their J-grove welds. In the 2008 case, a mechanical nozzle seal assembly was installed until all the heater sleeves were replaced with resistant material in 2012. In the 2011 case, the affected J-groove weld was removed and replaced with corrosion resistant Alloy 52 weld material.

A. COMPONENT INFORMATION:

COMPONENT	IEEE 803 FUNCTION ID	IEEE 805 SYSTEM ID
Pressurizer Nozzle	NZL	AB