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May 19, 2016 10 CFR 50.73

SVP-16-036

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

Quad Cities Nuclear Power Station, Unit 2
Renewed Facility Operating License No. DPR-30
NRC Docket No. 50-265

Subject: Licensee Event Report 265/2016-001-00, "Main Steam Isolation Valve Local Leak Rate Tests Exceed Technical Specification Limits"

Enclosed is Licensee Event Report (LER) 265/2016-001-00, "Main Steam Isolation Valve Local Leak Rate Tests Exceed Technical Specification Limits," for Quad Cities Nuclear Power Station, Unit 2.

This report is submitted in accordance with the requirements of the Code of Federal Regulations, Title 10, Part 50.73(a)(2)(i)(B), which requires the reporting of any operation or condition which was prohibited by the plant's Technical Specifications.

There are no regulatory commitments contained in this letter.

Should you have any questions concerning this report, please contact Mr. W. J. Beck at (309) 227-2800.

Respectfully,

Scott Darin
Site Vice President
Quad Cities Nuclear Power Station

cc: Regional Administrator – NRC Region III
NRC Senior Resident Inspector – Quad Cities Nuclear Power Station

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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
Quad Cities Nuclear Power Station Unit 2	05000265	1 OF 6

4. TITLE

Main Steam Isolation Valve Local Leak Rate Tests Exceed Technical Specification Limits

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
03	21	2016	2016	- 001	- 00	05	19	2016	FACILITY NAME N/A	DOCKET NUMBER N/A

9. OPERATING MODE	11. THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: *(Check all that apply)*			
4	☐ 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)
	☐ 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)
000	☐ 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)	☐ OTHER Specify in Abstract below or in NRC Form 366A	

12. LICENSEE CONTACT FOR THIS LER

LICENSEE CONTACT	TELEPHONE NUMBER *(Include Area Code)*
Mark Humphrey – Regulatory Assurance	(309) 227-2810

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	SB	ISV	C684	Y					

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

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

On March 21, 2016, at 2200 hours, with Unit 2 shutdown for refuel outage Q2R23, the as-found local leak rate tests (LLRT) for the four (4) main steam lines (MSL) were performed following closure of the main steam isolation valves (MSIV). The initial as-found LLRT on the "A" and "C" MSL MSIVs exceeded the minimum pathway criteria (lesser leakage in a line) of the Technical Specifications (TS), and the combined total leakage of all MSLs also exceeded the minimum pathway criteria (lesser leakage in each line when combined for all MSIVs) of the TS.

Corrective actions included flushing, disassembling, inspecting, repairing, and retesting the valves. Future corrective actions include installation of an improved spherical nose plug design to the MSIV plug and seat, and installation of an anti-rotation device to the MSIV pilot.

Valves 2-0203-2A and 2-0203-1C were disassembled and inspected. The most likely cause for the higher than expected leakages has been determined to be a valve design that is susceptible to a degraded main plug / seat interface during valve closure. A contributing cause was susceptible pilot plug / seat misalignment, due to pilot disc stem nut wear.

The safety significance of this event was minimal. The total primary containment leakage of 315.866 scfh was well within the allowed leakage limit of 1372.99 scfh (L_a). However, since the "A", "B", "C" and "D" MSL MSIV as-found leakage exceeded the TS limit, and the combined total leakage of all MSLs exceeded the TS limit, this report is submitted in accordance with the requirements of 10 CFR 50.73(a)(2)(i)(B), which requires the reporting of a past operation or condition which was prohibited by the plant Technical Specifications.

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

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LICENSEE EVENT REPORT (LER) CONTINUATION SHEET

1. FACILITY NAME	2. DOCKET NUMBER	3. LER NUMBER		
		YEAR	SEQUENTIAL NUMBER	REV NO.
Quad Cities Nuclear Power Station Unit 2	05000265	2016	- 001	- 00

NARRATIVE

PLANT AND SYSTEM IDENTIFICATION

General Electric - Boiling Water Reactor, 2957 Megawatts Thermal Rated Core Power

Energy Industry Identification System (EIIS) codes are identified in the text as [XX].

EVENT IDENTIFICATION

Main Steam Isolation Valve local leak rate testing resulted in two (2) MSIVs exceeding the individual Technical Specification limit and the combined minimum path MSIV leakage exceeding the Technical Specifications Limit.

A. CONDITION PRIOR TO EVENT

Unit: 2 Event Date: March 21, 2016 Event Time: 2200 hours
Reactor Mode: 4 Mode Name: Cold Shutdown Power Level: 0%

B. DESCRIPTION OF EVENT

On March 21, 2016, at 2200 hours, with Unit 2 shutdown for refuel outage Q2R23, the as-found local leak rate tests (LLRT) for the four (4) main steam [SB] lines (MSL) were performed following closure of the main steam isolation valves [ISV] (MSIV). Two (2) MSIV leakage paths; "A" MSL inboard valve 2-0203-1A (65.5 scfh) and "C" MSL outboard valve 2-0203-2C (45 scfh), when tested at ≥ 25 psig; exceeded the allowed limit for leakage as specified by Technical Specifications (TS) Surveillance Requirement (SR) 3.6.1.3.10 criteria for the as-found min path (lesser leakage in a line) criteria of 34 scfh at ≥ 25 psig. In addition, the combined total leakage of all MSLs, 118.8 scfh at ≥ 25 psig, exceeded the allowed limit for leakage as specified by TS SR 3.6.1.3.10 criteria of ≤ 86 scfh at ≥ 25 psig for all MSIVs combined minimum path leakage limit (i.e., lesser leakage in each line when combined for all MSIVs).

Following the completion of the individual as-found results, the "A", "B", and "D" MSLs were flushed. On March 22, 2016, following the flushing of the MSIVs and the subsequent re-draining of the test volumes, an additional LLRT was performed on each MSL. Post-flushing LLRTs resulted in successful leakage rates on the 2-0203-1A, 2-0203-1B, and 2-0203-2D MSIVs, while the 2-0203-2A MSIV continued to show significant seat leakage. The "C" MSL was not flushed due to the decision to repair valve 2-0203-1C. Valves 2-0203-2A and 2-0203-1C were originally scoped into Q2R23 based on results from the previous Unit 2 refuel outage (Q2R22).

Valves 2-0203-2A and 2-0203-1C were disassembled and inspected, and MSIV pilot and disc stem nut wear associated with the 2-0203-2A and 2-0203-1C MSIVs was identified as causing the seat leakage. Valves 2-0203-2A and 2-0203-1C were subsequently repaired and satisfactorily retested. Valve 2-0203-2C was not worked due to a successful combined as-left LLRT, following 2-0203-1C valve repair. The as-found leakage on valve 2-0203-1C masked 2-0203-2C as-found leakage and as such, repairs to valve 2-0203-2C were not required.

Given the impact that the "A" and "C" MSL isolation valves as-found leakage exceeded the TS limit for minimum path leakage in its MSL, and the combined total leakage of all MSLs exceeded the TS limit for min-path leakage for all MSIVs, this report is submitted in accordance with the requirements of 10 CFR 50.73(a)(2)(i)(B), which requires the reporting of a past operation or condition which was prohibited by the plant Technical Specifications.

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C. CAUSE OF EVENT

Subsequent investigation determined that the apparent cause of the leakage was due to the MSIV design being susceptible to degraded main plug/seat interface during valve closure; a non-optimal valve design. The MSIVs are 20-inch, Crane-Aloyco Y-Pattern globe valves [ISV] that utilize line contact between the valve plug and the seat ring to create a leak tight seal. The line contact is formed by mismatching the angles associated with the plug seat and the seat ring. The resulting line of contact occurs along a sharp edge associated with the seat ring. As the MSIVs are stroked closed, the plug tends to drag across the sharp edge of the seat ring, which creates a potential for a degraded main plug/seat interface. With respect to the MSIV pilots, there is a tight tolerance between the pilot plug and disc stem nut, which allows for proper alignment of the pilot plug and pilot seat. Should the disc stem nut start to wear, the pilot plug will start to shift. The gap created by the disc stem nut wear can allow the pilot to move freely, causing a potential for pilot plug/seat misalignment. When the MSIV pilot closes, without proper alignment with its seat, a potential leakage path develops. This was determined to be a contributing cause.

This apparent cause was previously identified (see LER 265/2012-001-00), and corrective actions to modify the MSIV valve plugs continue to be implemented.

Since MSIVs 2-0203-1A and 2-0203-2C failed their as-found LLRTs, and the combined minimum path leakage rate also failed; and the failures were due to a degraded main plug/seat interface and pilot disc stem nut wear, the extent of condition of this event is limited to these two failure mechanisms of the MSIVs.

The extent of cause is the MSIVs incorporate a non-optimal valve design that allows the plug to become misaligned with the seat ring during closure, and pilot disc stem nut wear. Since this cause is identified by failed or degraded LLRT results of susceptible MSIVs, the corrective actions identified from the apparent cause adequately address this issue.

D. SAFETY ANALYSIS

System Design

The design of the MSIVs is to prevent reactor coolant [AD] inventory loss and protect plant personnel in the event of steam line breakage outside the isolation valves, and to complete the containment boundary after a Loss of Coolant Accident (LOCA). The MSIVs are 20-inch air/spring-operated, balanced "Y"-type globe valves mounted inboard and outboard of the containment. The inboard valve air is supplied from the containment drywell pneumatic system. The outboard valve is supplied by the normal instrument air system. This valve combines a full port design with straight-line flow to provide a very good flow pattern. These valves use upstream pressure to aid in closure by tilting the actuator toward the upstream side of the valve.

For lines that extend the primary containment boundary, the boundary includes the piping to the last (i.e., outboard) isolation valve. A primary containment pathway must be capable of being isolated and as such is tested in accordance with the Primary Containment Leakage Rate Program. Penetration leak rate testing verifies the capability of the penetrations to maintain overall containment leakage (L_a) within the limits established by 10 CFR 50 Appendix J. Technical Specification 3.6.1.3 provides the operability requirements for primary containment isolation valves.

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Safety Impact

Two (2) MSIV leakage paths "A" MSL inboard valve 2-0203-1A (65.5 scfh) and "C" MSL outboard valve 2-0203-2C (45 scfh), exceeded the allowed limit for leakage as specified by TS SR 3.6.1.3.10 criteria for the as-found minimum path criteria of ≤ 34 scfh at ≥ 25 psig. In addition, the combined leakage of all MSLs, 118.8 scfh at ≥ 25 psig, exceeded the allowed limit for leakage as specified by TS SR 3.6.1.3.10 criteria of ≤ 86 scfh at ≥ 25 psig for all MSIVs combined min-path leakage limit (i.e., lesser leakage in each line when combined for all MSIVs). The combined leakage of all main steam lines was 190.436 scfh (calculated at 43.9 psig current accident pressure).

The safety significance of this condition was minimal. The overall Q2R23 primary containment as-found leakage (MSIVs plus all other leak pathways) was 315.866 scfh (calculated at 43.9 psig current accident pressure). The TS allowable limit (0.6 L_a) for overall Unit 2 primary containment leakage is 823.79 scfh (at 43.9 psig, combined max path limit, allowed as-left), where L_a is 1372.99 scfh at 43.9 psig. The total primary containment leakage of 315.866 scfh was well within the allowed leakage limit of 1372.99 scfh. Therefore, the safety significance of the "A" and "C" MSLs leakage contribution and the total combined MSL contribution to the overall primary containment leakage was minimal.

This condition has been compared to Updated Final Safety Analysis Report (UFSAR) Section 15.6.5.5.1 (Application of Alternative Source Term Methodology) assumptions, which includes a single failure of an inboard MSIV. Even if a single failure was considered during this condition, a single failure of the inboard MSIV in the line with the worst leakage outboard MSIV (158.70 scfh at 43.9 psig), would result in only a 17% increase in overall containment leakage (315.866 scfh increase to 369.59 scfh), which is still well below the L_a (1372.99 scfh) overall TS containment leakage criteria.

Risk Insights

Considering the impact of this condition on the Plant Probabilistic Risk Assessment (PRA), less than a 5% increase in risk would occur and would therefore have a negligible quantitative impact on the calculated Core Damage Frequency (CDF) and Large Early Release Frequency (LERF).

Since the MSIVs were not required to be operable or available at the time of discovery, this condition did not create any actual plant or safety consequences since the Unit was not in an accident or transient condition requiring use of MSL isolation during this period of time.

In conclusion, the safety significance of this event was minimal. Although this "A" and "C" MSIV line/path leak rate exceeded the as-found TS limit, and the combined MSIV min-path leak rate TS limit was exceeded, the overall containment leakage was maintained within limits. The total as-found leakage was 315.866 scfh at 43.9 psig, which is within L_a (1372.99 scfh) for overall Unit 2 primary containment leakage.

E. CORRECTIVE ACTIONS

Immediate:

1. Flushed "A", "B", and "D" MSL isolation Valves.
2. 2-0203-1A, 2-0203-1B, and 2-0203-2D maintenance flush LLRTs were satisfactory.
3. 2-0203-2A and 2-0203-1C were repaired during Q2R23. Each of these valves were disassembled, inspected, repaired, and satisfactorily retested.

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Follow-up:

1. The MSIV plugs have been re-designed to move the plug/seat ring contact interface away from the sharp edge on the seat ring. The new spherical plug modification design incorporates a spherical leading edge that also provides a wider band of contact with the seat ring and is more tolerant of minor misalignment that may occur during closure. This modification has been incorporated into procedure QCMM 0203-53 "Main Steam Isolation Valve Overhaul", which allows installation of the new design during subsequent MSIV overhauls, and will achieve more reliable valve performance. The new design has already been installed on each Unit (Valve 1-0203-1C on Unit 1 and Valves 2-0203-1C and 2-0203-1D on Unit 2) but the MSIV modification is currently limited until experience shows the design is effective.
2. Add anti-rotation device to MSIV pilot plug.

F. PREVIOUS OCCURRENCES

The station events database, LERs, and INPO Consolidated Event System (ICES) were reviewed for similar events at Quad Cities Nuclear Power Station. This event was the initial as-found combined LLRT of all main steam lines exceeded the combined min-path leakage limit (i.e., lesser leakage in each line when combined for all MSIVs) of the TS Surveillance (86 scfh); and the initial as-found LLRT on the "A" and "C" MSL inboard and outboard isolation valves exceeded the minimum pathway criteria (lesser leakage in a line) of the TS Surveillance (34 scfh). Based on the conditions of this event, causes, and associated corrective actions, the events listed below, although similar in topic, are not considered significant station experiences that would have directly contributed to preventing this event.

- Station Events Database – Previous LLRT failure investigations have been performed at Quad Cities [Root Cause 36958 (2000 LER), Equipment Apparent Cause Evaluation 130565 (2003), Common Cause Analysis 203885 (2004), and Apparent Cause Evaluation 747103 (2008)] that have concluded that ineffective guidance of the MSIV plug (an inherent design flaw) causes the seats to experience localized, accelerated wear as the plug drags across the sealing edge of the seat. There have been several cases where individual MSIVs have exceeded the acceptable leakage limits, however, between 2001 and 2012 the min-path leakage in these cases was within the TS values. Actions have been taken to minimize the number of valve strokes, modify seat and plug angles to improve the seating interface, and to eliminate closure of the MSIVs when MSL steam pressure is above 0 psig. To mitigate the overall design issue, the MSIV internals are currently being upgraded to improve the guidance of the plug (radius nose plug design). This design issue was identified in 2004 and 2012 (see 2012 LER below), and the resulting actions, although still in process of being implemented, are further addressed in this LER.
- LER 265/2012-001-00, 05/18/12, Main Steam Isolation Valve Local Leak Rate Testing Exceeds Technical Specifications Limits (03/19/12) - The initial as-found LLRT on the "B" MSL MSIVs exceeded the minimum pathway criteria (lesser leakage in a line) of the Technical Specification (TS) Surveillance (34 standard cubic feet/hour (scfh)). The apparent cause of the higher than expected leakage was determined to be a valve design that allowed for minor seat ring wear to degrade the LLRT performance which may also have resulted in misalignment between the plug and the seat ring. Corrective actions included repairing the valves. Future corrective actions included pursuing a new plug and seat design, as well as improved trending methodology for predicting MSIV LLRT failures. This 2012 design issue and the resulting actions, although still in process of being implemented, are further addressed in this LER.
- LER 254/2015-003-00, 04/29/15, Main Steam Isolation Valve Local Leak Rate Testing Exceeds Technical Specifications Limits (03/02/15) - The initial as-found LLRT on the "D" MSL MSIVs exceeded the minimum pathway criteria (lesser leakage in a line) of the Technical Specification (TS) Surveillance (34 standard cubic feet/hour (scfh)) and the combined total leakage of all MSLs also exceeded the minimum pathway criteria (smaller leakage in each line when combined for all MSIVs) of the Technical Specifications. The apparent cause of the higher than expected leakage was determined to be a valve design that allowed for minor seat ring wear to

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NARRATIVE

degrade the LLRT performance which may also have resulted in misalignment between the plug and the seat ring. Corrective actions included repairing the valves. Future corrective actions included pursuing a new plug and seat design, as well as improved trending methodology for predicting MSIV LLRT failures. This 2015 design issue and the resulting actions, although still in process of being implemented, are further addressed in this LER.

G. COMPONENT FAILURE DATA

Failed Equipment: MSIVs (inboard - 2-0302-1A, outboard - 2-0302-2A, inboard - 2-0302-1B, inboard - 2-0203-1C, outboard - 2-0203-2C, and outboard - 2-0203-2D)
Component Manufacturer: Crane Nuclear, Inc.
Component Model Number: Model 20-inch "Y"-Pattern Globe Valve
Component Part Number: N/A

This event has been reported to ICES as Failure Report No. 322335, Main Steam Isolation Valves Exceeded the Technical Specifications for As-found Local Leak Rate Testing.