Exelon Generation.

April 29, 2015

10 CFR 50.73

SVP-15-031

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

Quad Cities Nuclear Power Station, Unit 1
Renewed Facility Operating License No. DPR-29
NRC Docket No. 50-254

Subject: Licensee Event Report 254/2015-003-00, "Main Steam Isolation Valve Local Leak Rates Exceed Technical Specifications Limits"

Enclosed is Licensee Event Report (LER) 254/2015-003-00, "Main Steam Isolation Valve Local Leak Rates Exceed Technical Specifications Limits," for Quad Cities Nuclear Power Station, Unit 1.

This report is submitted in accordance with the requirements of 10 CFR 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,

K for

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

IE22
NRR

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 1	05000254	1 OF 5

4. TITLE

Main Steam Isolation Valve Local Leak Rates Exceed Technical Specifications 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: N/A	DOCKET NUMBER: N/A
03	02	2015	2015 -	003	- 00	04	29	2015	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)(i)(C)	☐ 50.73(a)(2)(vii)
	☐ 20.2201(d)	☐ 20.2203(a)(3)(ii)	☐ 50.73(a)(2)(ii)(A)	☐ 50.73(a)(2)(viii)(A)
	☐ 20.2203(a)(1)	☐ 20.2203(a)(4)	☐ 50.73(a)(2)(ii)(B)	☐ 50.73(a)(2)(viii)(B)
	☐ 20.2203(a)(2)(i)	☐ 50.36(c)(1)(i)(A)	☐ 50.73(a)(2)(iii)	☐ 50.73(a)(2)(ix)(A)
10. POWER LEVEL	☐ 20.2203(a)(2)(ii)	☐ 50.36(c)(1)(ii)(A)	☐ 50.73(a)(2)(iv)(A)	☐ 50.73(a)(2)(x)
	☐ 20.2203(a)(2)(iii)	☐ 50.36(c)(2)	☐ 50.73(a)(2)(v)(A)	☐ 73.71(a)(4)
000	☐ 20.2203(a)(2)(iv)	☐ 50.46(a)(3)(ii)	☐ 50.73(a)(2)(v)(B)	☐ 73.71(a)(5)
	☐ 20.2203(a)(2)(v)	☐ 50.73(a)(2)(i)(A)	☐ 50.73(a)(2)(v)(C)	☐ OTHER
	☐ 20.2203(a)(2)(vi)	☒ 50.73(a)(2)(i)(B)	☐ 50.73(a)(2)(v)(D)	Specify in Abstract below or in NRC Form 366A

12. LICENSEE CONTACT FOR THIS LER

LICENSEE CONTACT	TELEPHONE NUMBER *(Include Area Code)*
Tom Petersen – Regulatory Assurance	(309) 227-2825

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 2, 2015, at 2359 hours, with Unit 1 shutdown for refuel outage Q1R23, 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 "D" MSL MSIVs exceeded the minimum pathway criteria (smaller leakage in a line) of the Technical Specifications (TS), 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 TS.

The leaking valves were disassembled and inspected. Although some seat ring wear is a normal occurrence in these valves, the excessive leakage was associated with wear due to the high friction that develops between the plug and the seat as initial contact occurs on valve closure, followed by the sliding action as the plug centers itself in the seat, which is inherent with the "Y"-style globe valve.

The most likely cause for the higher than expected leakages has been determined to be a valve design that is susceptible to localized seat wear during valve closure. The plug tends to drag across the sharp edge of the seat ring, and over time, if the closure strokes allow the plug to drag along the same contact point then wear will occur on the sharp edge of the seat ring.

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.

The safety significance of this event was minimal. The total primary containment leakage of 283.59 scfh was well within the allowed leakage limit of 823.79 scfh (0.6La). However, since the "D" MSL MSIV as-found leakage exceeded the TS limit, and the combined total leakage of all main steam lines 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.

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 one MSIV exceeding the individual Technical Specification limit and the total MSIV leakage exceeding the Technical Specifications Limit.

A. CONDITION PRIOR TO EVENT

Unit: 1	Event Date: March 2, 2015	Event Time: 2359 hours
Reactor Mode: 4	Mode Name: Cold Shutdown	Power Level: 0%

B. DESCRIPTION OF EVENT

On March 2, 2015, at 2359 hours, with Unit 1 shutdown for refuel outage Q1R23, 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). One MSIV leakage path ("D" MSL, inboard valve 1-0203-1D), 64.3 scfh 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 (smaller leakage in a line) criteria of 34 scfh at 25 psig. In addition, the combined total leakage of all main steam lines, 92.26 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., smaller leakage in each line when combined for all MSIVs).

Following the completion of the individual as-found results, each MSL was flushed to determine if foreign material could be contributing to the higher leakage across the plug to seat interfaces. On March 4, 2015, 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 1-0203-1A, 1-0203-1C, and 1-0203-1D MSIVs, while the 1-0203-1B and 1-0203-2D MSIVs continued to show significant seat leakage. Based on the post flush results the 1-0203-1B and 1-0203-2D were added to the Q1R23 outage scope for inspection and repair as necessary. The 1-0203-1C was also added to the Q1R23 outage scope for inspection and repair as necessary due to inconsistent leakage rates from previous LLRTs.

Each of these valves were disassembled and inspected, and seat wear associated with 1-0203-1B, 1-0203-1C, and 1-0203-2D was identified during Q1R23. The 1-0203-1B and 1-0203-2D were subsequently repaired and satisfactorily retested. During inspection, the 1-0203-1C was also identified with significant clearance between the lower liner and the valve bore, therefore the oversized bore and degraded wave spring associated with 1-0203-1C were also repaired during Q1R23, and the valve was subsequently satisfactorily retested.

Given the impact that the 1-0203-1D MSIV as-found leakage exceeded the TS limit for min-path leakage in its MSL, and the combined total leakage of all main steam lines exceeded the TS limit for min-path leakage for all MSIVs, this

1. FACILITY NAME	2. DOCKET	6. LER NUMBER			3. PAGE
		YEAR	SEQUENTIAL NUMBER	REV NO.	
Quad Cities Nuclear Power Station Unit 1	05000254	2015	- 003 -	00	3 OF 5

NARRATIVE

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.

C. CAUSE OF EVENT

Based on the subsequent investigation, it was determined that the apparent cause of the excessive leakage is the MSIV design is susceptible to localized seat wear 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, and over time, if the closure strokes allow the plug to drag along the same contact point then wear will occur on the sharp edge of the seat ring. During Q1R23, the 1-0203-1B, 1-0203-1C, and 1-0203-2D MSIVs were observed with locations on each of the seat rings where some wear to the seat ring edge had occurred. This less than optimal design of the valve plug is a known issue that has caused previous failures due to seat wear.

This apparent cause was previously known from LER 265/2012-001-00, but its corrective actions to modify the MSIV valve plug have not yet been fully implemented.

In addition, since the post flush data from Q1R23 continued to show a pattern of uncertainty with the MSIV 1-0203-1C leak rates and inconsistent leakage rates were also identified in previous LLRTs, the MSIV 1-0203-1C was inspected and significant clearance was identified between the lower liner and the valve bore. Therefore, contributing to the failure of the combined total min-path leakage rate, it was identified that previous corrective maintenance on MSIV 1-0203-1C was determined to have failed to correct an oversized valve bore condition. The oversized bore and degraded wave spring associated with 1-0203-1C were subsequently repaired during Q1R23.

Since the MSIV 1-0203-1D failed its LLRT, and all MSIVs combined min-path leakage rate also failed, and the failures were due to wear on the valve seats, the extent of condition of this event is limited to seat wear on MSIVs. Since the MSIV LLRT program monitors all MSIVs for seat leakage, this extent of condition is addressed.

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. 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 airspring-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 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.

1. FACILITY NAME	2. DOCKET	6. LER NUMBER			3. PAGE
		YEAR	SEQUENTIAL NUMBER	REV NO.	
Quad Cities Nuclear Power Station Unit 1	05000254	2015	- 003 -	00	4 OF 5

NARRATIVE

Safety Impact

One MSIV leakage path ("D" MSL), 64.3 scfh at 25 psig, exceeded the allowed limit for leakage as specified by TS SR 3.6.1.3.10 criteria for the as-found min path criteria of 34 scfh at 25 psig. In addition, the combined leakage of all main steam lines, 92.26 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., smaller leakage in each line when combined for all MSIVs). The combined leakage of all main steam lines was 147.90 scfh (calculated at 43.9 psig current accident pressure).

The safety significance of this condition was minimal. The overall total Q1R23 primary containment as-found leakage (MSIVs plus all other leak pathways) was 283.59 scfh (calculated at 43.9 psig current accident pressure). The TS allowable limit (0.6La) for overall Unit 1 primary containment leakage is 823.79 scfh (at 43.9 psig, max path limit, allowed as-left), where La is 1372.99 scfh at 43.9 psig. The total primary containment leakage of 283.59 scfh was well within the allowed leakage limit of 823.79 scfh. Therefore, the safety significance of the "D" MSL 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 (111.41 scfh at 43.9 psig), would result in only a 2.9% increase in overall containment leakage (283.59 scfh increase to 291.93 scfh), which is still well below the 0.6La (823.79 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 "D" 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 since the total as found was 283.59 scfh at 43.9 psig, which is within 0.6 La (823.79 scfh) for overall Unit 1 primary containment leakage.

E. CORRECTIVE ACTIONS

Immediate:

1. Flushed all MSIVs.
2. The seat wear associated with 1-0203-1B, 1-0203-1C, and 1-0203-2D was repaired during Q1R23. Each of these valves were disassembled, inspected, repaired, and satisfactorily retested.
3. The oversized bore and degraded wave spring associated with 1-0203-1C were repaired during Q1R23.

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 the "Main Steam Isolation Valve Overhaul" which allows installation of the new design during subsequent MSIV overhauls, and will achieve more reliable valve

1. FACILITY NAME	2. DOCKET	6. LER NUMBER			3. PAGE
		YEAR	SEQUENTIAL NUMBER	REV NO.	
Quad Cities Nuclear Power Station Unit 1	05000254	2015	- 003	- 00	5 OF 5

NARRATIVE

performance. The new design has already been installed on each Unit but is currently limited to one MSIV installation on each Unit until experience shows the design is effective.

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., smaller leakage in each line when combined for all MSIVs) of the TS Surveillance (86 scfh); and the initial as-found LLRT on the "D" MSL inboard and outboard isolation valves exceeded the minimum pathway criteria (smaller 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 as a chronic problem 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 (smaller 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.

G. COMPONENT FAILURE DATA

Failed Equipment: MSIVs (inboard - 1-0203-1B, 1-0203-1C, 1-0203-1D; and outboard - 1-0203-2D)
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. 315862.