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10 CFR 50.73

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 265/2012-001-00, "Main Steam Isolation Valve Local Leak Rate Test Exceeds Technical Specifications Limit"

Enclosed is Licensee Event Report (LER) 265/2012-001-00, "Main Steam Isolation Valve Local Leak Rate Test Exceeds Technical Specifications Limit," 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,

Tim Hanley
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

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

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

LICENSEE EVENT REPORT (LER)

(See reverse 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 5

4. TITLE

Main Steam Isolation Valve Local Leak Rate Test Exceeds Technical Specifications 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	DOCKET NUMBER
									N/A	N/A
03	19	2012	2012	- 001 -	00	05	18	2012	N/A	N/A

9. OPERATING MODE: 4

10. POWER LEVEL: 000%

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

☐ 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)
☐ 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)
☐ 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

FACILITY NAME	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 19, 2012, at 0830 hours, with Unit 2 shutdown for refuel outage Q2R21, the as-found local leak rate tests (LLRT) for the four main steam lines (MSL) were performed following closure of the main steam isolation valves (MSIV). 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)). Recorded leakage was 54.50 scfh inboard, and 45.60 scfh outboard.

The total combined as-found min-path LLRT results for all MSIVs (49.12 scfh) did not exceed the TS Surveillance criteria limit allowed (86 scfh), verifying primary containment integrity during the past operating cycle. Therefore, the MSIVs were capable of performing their intended function prior to shutdown.

The valves were disassembled and inspected. No abnormal wear was noted on the valve internals since some wear on the plug and seat is expected. The plugs were replaced, the valve seats were repaired by skim cuts, and the valves were reassembled. The as-left leak rate tests were satisfactory.

The most likely cause for the higher than expected leakages has been determined to be a valve design that allows for minor seat ring wear to degrade the LLRT performance which may also result in misalignment between the plug and the seat ring.

Corrective actions included repairing the valves. Future corrective actions include pursuing a new plug and seat design, as well as improve trending methodology for predicting MSIV LLRT failures.

The safety significance of this event was minimal. Although this MSIV line/path leak rate exceeded the as-found TS limit, the combined MSIV path leak rate TS limit was not exceeded. This event is therefore, a past operation or condition which was prohibited by the plant Technical Specifications, and is therefore reportable per 10 CFR 50.73(a)(2)(i)(B).

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 Test Exceeds Technical Specifications Limit

A. CONDITION PRIOR TO EVENT

Unit: 2	Event Date: March 19, 2012	Event Time: 0830 hours
Reactor Mode: 4	Mode Name: Cold Shutdown	Power Level: 0%

B. DESCRIPTION OF EVENT

On March 19, 2012, at 0830 hours, with Unit 2 shutdown for refuel outage Q2R21, the as-found local leak rate tests (LLRT) for the four main steam [SB] lines (MSL) were performed following closure of the main steam isolation valves [ISV] (MSIV). The LLRT resulted in higher than anticipated leakage rates on MSIVs on three of the four MSLs.

The initial as-found LLRT on the "B" MSL inboard and outboard isolation valves exceeded the minimum pathway (min-path) criteria (smaller leakage in a line) of 34 standard cubic feet/hr (scfh) at 25 psig per Technical Specification (TS) Surveillance 3.6.1.3.10. The individual as-found test results recorded the inboard, 2-0203-1B valve leakage as 54.50 scfh, and outboard, 2-0203-2B valve leakage as 45.60 scfh.

The TS Surveillance 3.6.1.3.10 criteria of 86 scfh for all MSIVs combined min-path leakage limit (smaller leakage in each line when combined for all MSIVs) was not exceeded. The combined as-found min-path leakage was 49.12 scfh based on the smaller leakage MSIVs on the remaining three MSLs having experienced minimal leakage (2-2023-2A was 0.20 scfh, 2-2023-2C was 0.02 scfh, and 2-2023-1D was 3.30 scfh). This verified that primary containment [NH] integrity was maintained for the main steam system during the past operating cycle. Therefore, the MSIVs were capable of performing their intended function prior to shutdown.

The failed "B" MSL inboard and outboard isolation valves were disassembled and inspected. No abnormal wear was noted on the valve internals, however, some wear on the plug and seat is expected. The inboard isolation valve 2-0203-1B had passed the LLRT each outage since its last failure in Q2R16, and the outboard isolation valve 2-0203-2B had passed the LLRT each outage since its last failure in Q2R17. The 2-0203-1B isolation valve had been stroked over the previous eight years, and the 2-0203-2B over the previous 10 years for surveillances and preventative maintenance activities. The multiple strokes experienced by the valve create wear on the fine edge of the seat ring and plug which acts as the sealing interface that provides the isolation function. Also, steam flowing over the seat typically causes additional wear on the seat face, typically from the 1000 to 1400 positions along the seat ring. All wear noted during the inspection was typical for valves that had been in service for over eight years.

The valve plugs were replaced. The valve seats were repaired by skim cuts, and the valves were then reassembled. The as-left leakage rate test results satisfactorily returned the valves to within the TS Surveillance limits prior to startup from Q2R21.

NARRATIVE

All valves that would have exceeded the as-left (max-path) leakage limits of TS Surveillance 3.6.1.3.10 for plant operation were also repaired and successfully leak tested prior to startup from Q2R21. These additionally repaired/retested valves were MSIVs 2-2023-1A and the 2-2023-2D.

Given the impact that the 2-0203-2B MSIV as-found leakage exceeded the TS limit for min-path leakage in its MSL, 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.

C. CAUSE OF EVENT

Based on the subsequent investigation, it was determined that the apparent cause of the abnormal leakage is a non-optimal valve design that allows the plug to become misaligned with the seat ring during closure, therefore causing wear. Inspections performed following the failed leak rate tests noted that wear was observed on the seating surface that correlated to the valve plug dragging across the seat edge and wearing the seating surface prematurely. The "Y" pattern globe valve [ISV] is designed with the valve plug entering the seat at an angle. This configuration allows the plug to drag along the liner and across the seat face as the valve closes. The design results in the premature wear as well as contributing to plug misalignment during seating. This less than optimal guidance of the plug is a known issue that has caused previous failures due to seat wear. It is suspected these design characteristics could also cause the valve plug to not fully self align during closure resulting in a leak path due to the misalignment.

A contributing factor to this issue is trending methods of LLRT results used to predict MSIV performance are limited. Guidance is given in station procedures to document any single increase in leakage greater than six scfh on MSIVs with poor historic LLRT performance. A work order is initiated to repair the valve during the following refuel outage when the valve is anticipated to degrade further. This process considers the TS Surveillance limits, past valve performance, and current test results. Based on test results, and a review of performance during Q2R19, a work order was written and planned for implementation during Q2R20 for MSIV 2-0203-1B. However, based on LLRT performance during Q2R20, the planned work on the 2-0203-1B MSIV was deferred to Q2R21. Subsequently, actual LLRT performance of the 2-0203-1B as measured during the recent Q2R21 refuel outage, was worse than projected by trend analysis completed during Q2R20; this contributed to the results where both "B" MSL MSIVs did not meet their LLRT limits during Q2R21.

A second contributing factor is that a valve modification recommended by a previous evaluation completed in 2008 that addressed similar MSIV failures at Quad Cities has not yet been implemented. The proposed modification is intended to improve valve performance by modifying the MSIV valve plug, however, remains open pending completion of plug fabrication and testing. Testing includes incorporation of the modification into a mock MSIV. Progress has been limited since the work includes detailed design work with input from the vendor, decontaminating the mock MSIV, machining the mock valve to match the valve design, and performing initial testing. Acceptance testing remains to be performed.

Since the "B" MSL isolation valves failed their LLRT due to wear on the valve seats, the extent of condition of this event is limited to seat wear on containment isolation valves. Since the LLRT program effectively monitors all applicable containment isolation valves 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 valves, the corrective actions identified from the apparent cause adequately address this issue.

D. SAFETY ANALYSIS

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.

The safety significance of this condition was low. One MSIV leakage path ("B" MSL) exceeded the allowed limit for leakage as specified by TS 3.6.1.3.10 for the as-found min path. The combined leakage of all main steam lines was 49.12 scfh at 25 psig, and this leakage was within the TS Surveillance 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 overall total Q2R21 primary containment as-found leakage was 201.45 scfh (calculated at 43.9 psig current accident pressure). The TS allowable limit (0.6La) for overall Unit 2 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 201.45 scfh was well within the allowed leakage limit of 823.79 scfh. Therefore, the safety significance of the "B" MSL leakage contribution to the overall primary containment leakage was minimal.

This condition has been compared to Updated Final Safety Analysis Report (UFSAR) 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, would result in only a 19% increase in overall containment leakage (201.45 scfh increase to 354.45 scfh), which is still well below the 0.6La (823.79 scfh) overall TS containment leakage criteria.

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 "B" MSIV line/path leak rate exceeded the as-found TS limit, the combined MSIV min-path leak rate TS limit was not exceeded, and overall containment leakage was maintained within limits.

NARRATIVE

E. CORRECTIVE ACTIONS

Actions Taken:

1. The valves were disassembled, inspected, repaired, and satisfactorily retested.

Actions to be Completed:

1. Finalize design and testing on an improved design to the MSIV plug and seat to achieve more reliable valve performance.
2. Based on the testing results of the improved design, determine a strategy for implementation.
3. Improve MSIV trending methods to better predict MSIV valve performance to avoid LLRT failures. This will include development of a process to track MSIV strokes/cycles prior to returning to service.

F. PREVIOUS OCCURRENCES

The station events database, LERs, EPIX, and NPRDS were reviewed for similar events at Quad Cities Nuclear Power Station. This event was the initial as-found LLRT on the "B" MSL inboard and outboard isolation valves exceeded the minimum pathway criteria (smaller leakage in a line) of the TS Surveillance (34 scfh).

- Station Events Database – Previous LLRT failure investigations have been performed at Quad Cities [Root Cause 36958 (2000 LER), Equipment Apparent Cause Evaluation 130565 (2002), 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, over the past 10 years 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 planned to be upgraded to improve the guidance of the plug (radius nose plug design). Mock-up testing is planed to demonstrate the feasibility of the nose-guided concept, along with seat angles and valve clearances. This design issue was identified as a chronic problem in 2004, and the resulting actions, although still open, are further addressed in this LER.
- LERs - A review of LERs at Quad Cities Nuclear Power Station over the past 10 years did not identify any events that were associated with failures of MSIV paths during LLRTs.

G. COMPONENT FAILURE DATA

The MSIVs (inboard, 2-0203-1B valve, and outboard, 2-0203-2B valve) are manufactured by Crane Nuclear, Inc.; model 20-inch "Y"-Pattern Globe Valve. This event has been reported to EPIX as Failure Report No. 1146.