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10 CFR 2.201

SVP-06-076

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U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, D.C. 20555-001

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

Subject: Reply to a Notice of Violation; EA-06-112

Reference: Letter from J. L. Caldwell (U. S. NRC) to C. M. Crane (Exelon Generation Company, LLC), "Final Significance Determination for a White Finding and Notice of Violation (NRC Inspection Report No. 05000254/2006014) Quad Cities Nuclear Power Station Unit 1," dated June 29, 2006

The referenced letter provided Exelon Generation Company, LLC (EGC) with a Notice of Violation (NOV) of 10 CFR 50, Appendix B, Criterion III, "Design Control," for Quad Cities Nuclear Power Station (QCNPS) Unit 1. The NOV is related to QCNPS's failure to establish measures to ensure the electromatic relief valve design remained suitable for operation in an extended power uprate environment. In accordance with 10 CFR 2.201, "Notice of violation," this letter provides EGC's written statement and explanation in reply to this NOV. The NOV requires this reply to be submitted within 30 days of the date of the referenced letter.

The attachment to this letter provides the reason for the violation, the corrective actions taken and their results, the corrective actions remaining to be taken, and when full compliance will be achieved. As stated in the attachment, QCNPS is in full compliance. The attached NOV response contains no new regulatory commitments.

If you have any questions concerning this letter, please contact Mr. Wally Beck at (309) 227-2800.

Respectfully,

Timothy J. Tulon
Site Vice President
Quad Cities Nuclear Power Station

Attachment: Reply to a Notice of Violation; EA-06-112

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

IE01

NOTICE OF VIOLATION EA-06-112:

"Title 10 CFR 50, Appendix B, Criterion III, Design Control, requires, in part, that measures be established for the selection and review for suitability of application of materials, parts, equipment, and processes that are essential to the safety-related functions of the structures, systems, and components.

Contrary to the above, the licensee failed to establish measures to ensure that the application of the electromatic relief valve (ERV) actuators (which are essential to perform the safety-related reactor vessel depressurization and reactor overpressure protection functions) was reviewed and remained suitable for operation prior to implementing an extended power uprate (EPU) for Unit 1 in November 2002. This resulted in multiple ERVs becoming inoperable and unavailable due to being subjected to significantly higher vibration levels during Unit 1 operation at EPU power levels.

This violation is associated with a White Significance Determination Process finding."

REPLY:

Background

On January 7, 2006, Quad Cities Nuclear Power Station (QCNPS) Unit 1 was shut down to perform inspections to determine if the Main Steam Line (MSL) ERV actuators were degraded as a result of the vibration levels experienced at EPU conditions. The actuator inspections were required to determine extent-of-condition following an inspection of the QCNPS Unit 2 ERV actuators approximately one week earlier. This Unit 2 inspection identified an inoperable ERV due to vibration-induced wear.

The Unit 1 inspections determined that the 3B, 3C and 3D ERVs were inoperable based on unsuccessful actuation tests and visual evidence of wear. As an interim measure, the Unit 1 and Unit 2 ERV actuators were upgraded to include material improvements and refined manufacturing tolerances. Both units were administratively limited to pre-EPU power levels. This event was reported to the NRC in Licensee Event Report (LER) 265/05-002 (Reference 1).

In Reference 2, Exelon Generation Company, LLC (EGC) committed to continue operating QCNPS at pre-EPU power levels until a root cause evaluation was completed, necessary corrective actions were implemented, and a meeting was held with the NRC to discuss these actions.

Reason for the Violation

On March 16, 2006, EGC met with the NRC to discuss the results of the root cause evaluation and to outline the modifications and other corrective actions planned to reduce MSL vibration and improve ERV actuator performance (References 3 and 4). As reported during the meeting, a multi-discipline team, comprised of expertise internal and external to EGC, performed the root cause evaluation. The scope of the evaluation was sufficient to identify the causes surrounding the ERV failure and wear mechanisms and included a review of maintenance practices, operating experience, and previous corrective actions. Management and organizational contributing factors were also evaluated. The NRC conducted a Special Inspection in January 2006 to assess our efforts in identifying and correcting the cause of the ERV actuator

degradation. The NRC inspectors determined the root cause evaluation to be self-critical and appropriately focused on the technical and organizational aspects that contributed to the ERV actuator failures (Reference 5).

The primary root cause of the ERV actuator failures was a failure to correct the long-standing source of MSL vibrations. Historically, MSL vibrations have been evaluated and addressed at the component level; however, a holistic strategy to reduce the source of MSL vibration was not developed. While addressing MSL vibration at the component level was relatively effective prior to EPU operation, the higher power levels associated with EPU exacerbated the impact of MSL vibrations. A contributing cause was a failure to recognize the design limitations of the ERV actuator design at EPU conditions. As discussed in more detail below, a design change (i.e., Acoustic Side Branch (ASB) modification) was implemented on both Unit 1 and Unit 2 to address the source of the MSL vibrations, and new, enhanced ERV actuators were installed on both units, which are considerably more tolerant of MSL vibration.

Corrective Steps Taken and Results Achieved

ASB Modification

EPU operation at QCNPS began in 2002 (17% power uprate). The higher EPU power level increased the steam velocity in the MSLs, which contributed to higher MSL vibration loads. Testing confirmed the source of the vibrations to be from the effects of steam flow past the inlet standpipes to the four ERVs and eight MSL safety valves. Analysis of power ascension test data led to the conclusion that strong acoustic vibration in the 140Hz to 160Hz range accounted for the majority of the main steam vibrations. The ASB modification changes the inlet configuration associated with the eight safety valves and four ERVs. The modified inlet configuration was designed to reduce the acoustic coupling between the forcing function (i.e., vortex shedding at the valve inlet) and the acoustic frequency of the valve inlet volume at EPU conditions.

Prior to installation, a rigorous test plan was developed to confirm the expected ASB performance. The test plan included:

- Scale model testing to demonstrate the expected frequency shift and amplitude reduction,
- Full scale testing to validate acoustic characteristics, and
- Shaker table testing to confirm vibration endurance.

Following installation on each unit, a comprehensive startup plan was implemented to validate ASB performance. The startup plan was designed to verify that plant and equipment performance remained within established acceptance criteria (Reference 6). Acceptance criteria were provided at specified test plateaus to ensure vibration conditions were acceptable. Data was collected using installed strain gauges and accelerometers located on the MSLs and vibration-sensitive components (additional instrumentation was installed on both Unit 1 and Unit 2 to facilitate testing).

The test results confirm that the ASB modification is performing as designed. Acoustic vibration levels in the range of interest (i.e., 140Hz to 160Hz) have been significantly reduced. The EPU acoustic vibration loads as measured by installed strain gauges and accelerometers located on

vibration sensitive equipment have been reduced to levels that are equivalent to (or below) those experienced at the original licensed thermal power level. The Unit 1 and Unit 2 test results were shared with the NRC following completion of the test plan - the Unit 2 startup test report was provided in Reference 7.

Modified ERV Actuator

As discussed during the March 16, 2006, meeting with the NRC, EGC evaluated several ERV actuator replacement options. An ERV design by General Electric was selected and was installed in Units 1 and 2. The design results in improved vibration resistance by providing:

- Stellite guides and guideposts,
- Stainless steel pivot pins,
- New spring configuration (non-buckling spring arrangement),
- Improved vibration isolation, and
- Specified component tolerances.

In addition, actuator rigidity has been improved through the addition of an upper angle bracket to fix the guide post alignment.

Prior to installation, the new ERV actuator performance was validated through qualification testing. The new ERV actuator's vibration endurance was demonstrated through shaker table testing at acceleration levels that bound plant conditions at full EPU power prior to ASB installation. Additional margin was realized due to the ASB modification, which successfully reduced main steam line vibration, including the vibration loads on the ERV actuators. (*Reference 6 provided additional information regarding the ASB and ERV qualification testing* and associated startup test acceptance criteria.)

All four ERV actuators are replaced with rebuilt/refurbished actuators during scheduled refueling outages. Following removal from the plant, the actuators receive an inspection of critical components to identify conditions that could impact performance, including unusual wear.

Corrective Steps That Will be Taken to Avoid Further Violations

Installation of the ASBs has effectively reduced MSL vibration and associated loads to levels consistent with pre-EPU operation. In addition, an enhanced ERV actuator design has been installed that is considerably more resistant to vibration, ensuring long-term operability. These combined actions will prevent further violations related to the subject finding - a failure to establish measures to ensure that the application of the ERV actuators remained suitable for operation prior to implementing EPU for Unit 1 in November 2002. Therefore, EGC considers both QCNPS units to be in full compliance.

Date When Full Compliance Will Be Achieved

As noted above, EGC considers both QCNPS units to be in full compliance.

ORGANIZATIONAL EFFECTIVENESS AND LESSONS LEARNED:

As noted during the March 16, 2006, meeting with the NRC, the root cause evaluation included a review of additional causal factors related to management effectiveness during the EPU upgrade and initial MSL vibration evaluations. Corporate personnel trained in human performance performed a supplementary organizational assessment. Examples of issues identified include:

- A systematic approach was not always used to evaluate decisions related to EPU,
- Their was over-reliance on contractor products and expertise and, in some cases, their approach and methodology was less than adequate, and
- Collective and historical conditions were not always clearly recognized.

The organizational contributors related to the EPU upgrade/MSL vibration evaluations, taken in aggregate, demonstrate a weakness in managing information, over-reliance on contractor-performed analysis, and a failure to apply a systematic approach to decision making for complex, high-risk situations. The actions resulting from this assessment are to revise key decision making procedures to add the necessary rigor and documentation to ensure proper evaluation of complex engineering decisions and to provide training to Engineering on these requirements. These actions are currently scheduled for completion by the end of 2006.

Additionally, the root cause evaluation identified other lessons learned. These lessons learned have been or will be incorporated into QCNPS and EGC procedures and processes. These include:

- Revision to the ERV actuator rebuild and inspection procedures to identify critical actuator parts and address preventative maintenance weaknesses;
- Integration of the piping system walkdowns, including MSL, feedwater and condensate, into the QCNPS preventive maintenance program; and
- Revision of the design review process to include upfront challenges to analysis and assumptions.

References:

1. Letter from T. J. Tulon (Exelon Generation Company, LLC) to U. S. NRC, "Licensee Event Report 265/05-002, Main Steam Relief Valve Actuator Degradation," dated February 28, 2006
2. Letter from K. R. Jury (Exelon Generation Company, LLC) to U. S. NRC, "Commitments and Plans Related to Extended Power Uprate Operation," dated January 26, 2006
3. Exelon Slides from Public Meeting, (ADAMS Accession Number: ML060820120), dated March 16, 2006
4. Letter from M. A. Ring (U. S. NRC) to Exelon Generation Company, LLC, "Summary of March 16, 2006, Public Meeting to Discuss Electromatic Relief Valve Inspection Scope for the Quad Cities Unit 2 Refueling Outage," dated March 22, 2006
5. Letter from M. A. Satorius (U. S. NRC) to C. M. Crane (Exelon Generation Company, LLC), "Quad Cities Nuclear Power Station, Units 1 and 2; NRC Inspection Report 05000254/2006012; 05000265/2006012; Preliminary White Finding," dated May 30, 2006

6. Letter from P. R. Simpson (Exelon Generation Company, LLC) to U. S. NRC, "Additional Information Regarding Quad Cities Unit 2 Steam Dryer Inspection, Start-up and Power Ascension Plan," dated April 27, 2006
7. Letter from P. R. Simpson (Exelon Generation Company, LLC) to U. S. NRC, "Quad Cities Unit 2 Startup and Power Ascension Testing Following Installation of Acoustic Side Branch Modifications," dated May 3, 2006