March 20, 2006

Mr. Christopher M. Crane
President and Chief Nuclear Officer
Exelon Nuclear
Exelon Generation Company, LLC
Quad Cities Nuclear Power Station
4300 Winfield Road
Warrenville, IL 60555

SUBJECT: QUAD CITIES NUCLEAR POWER STATION, UNITS 1 AND 2
NRC SPECIAL INSPECTION REPORT 05000254/2006009; 05000265/2006009

Dear Mr. Crane:

On February 7, 2006, the U. S. Nuclear Regulatory Commission (NRC) completed a Special Team Inspection at your Quad Cities Nuclear Power Station, Units 1 and 2. The enclosed report documents the inspection findings which were discussed with Mr. Tulon and other members of your staff on February 7, 2006.

In December 2005, station personnel determined that an intermittent 125 Vdc ground was present on the 3D electromatic relief valve (ERV) actuator circuitry on Unit 2. In response to this issue, an at-power drywell entry was conducted on December 30. During this entry it was identified that several of the actuator components were significantly degraded. As a result, Unit 2 was shut down on December 31, 2005, to allow inspections of the remaining ERV actuators.

Varying levels of degradation were identified on the remaining Unit 2 ERV actuators and subsequently, Unit 1 was shut down on January 6, 2006, for inspection. During this outage several Unit 1 ERV actuators were also found degraded. Details of the ERV actuator damage, potential root cause, and planned repairs were discussed with the NRC staff during conference calls on December 31, 2005, and January 1, 6, 7, and 8, 2006. Among the outcomes of these discussions was a decision to quarantine the actuators removed from Unit 1 and conduct an NRC Special Inspection to assess your efforts to identify the cause of the ERV actuator degradation and extent of condition.

Following the criteria specified in Management Directive 8.3 (Part I, Criterion (e & g)) and Inspection Procedure 71153, a Special Inspection was initiated in accordance with Inspection Procedure 93812 and Regional Procedure RP-1219. The Special Inspection officially commenced on January 9, 2006, with some inspection activities occurring during the weekend of January 7, 2006.

Based on the results of this inspection, the NRC identified three findings of very low significance, all of which involved violations of NRC requirements. However, because these violations were of very low safety significance and because the issues were entered into the

licensee's corrective action program, the NRC is treating these findings as Non-Cited Violations in accordance with Section VI.A.1 of the NRC's Enforcement Policy.

The NRC staff considers the discovery of the degraded Unit 2 ERV actuators on December 30, 2005, fortuitous. That conclusion was made because absent indications of the intermittent ground, the ERV actuators would likely have degraded further, potentially resulting in the unavailability of a safety system for both units or the inadvertent opening of an ERV. The discovery of degraded ERV actuators and the issues identified in this report highlight the necessity of expeditiously resolving the problems associated with increased vibration prior to operating either unit at the Quad Cities Nuclear Power Station at Extended Power Uprate power levels.

If you contest the subject or severity of a Non-Cited Violation, you should provide a response within 30 days of the date of this inspection report, with the basis for your denial, to the U.S. Nuclear Regulatory Commission, ATTN: Document Control Desk, Washington, D.C. 20555-0001; with a copy to the Regional Administrator, U.S. Nuclear Regulatory Commission - Region III, 2443 Warrenville Road, Suite 210, Lisle, IL 60532-4352; the Director, Office of Enforcement, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555-0001; and the Resident Inspector Office at the Quad Cities Nuclear Power Plant.

In accordance with 10 CFR 2.390 of the NRC's "Rules of Practice," a copy of this letter and its enclosure will be available electronically for public inspection in the NRC Public Document Room or from the Publicly Available Records (PARS) component of the NRC's document system (ADAMS),accessible from the NRC Web site at http://www.nrc.gov/reading-rm/adams.html (the Public Electronic Reading Room).

Sincerely,

/RA by S. West Acting for/

Mark A. Satorius, Director
Division of Reactor Projects

Docket Nos. 50-254; 50-265; 72-053
License Nos. DPR-29; DPR-30

Enclosure: Inspection Report 05000254/2006009; 05000265/2006009
w/Attachments: 1. Supplemental Information
2. Charter for Special Inspection

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U. S. NUCLEAR REGULATORY COMMISSION

REGION III

Docket Nos.:	50-254, 50-265
License Nos.:	DPR-29, DPR-30
Report No.:	05000254/2006009; 05000265/2006009
Licensee:	Exelon Nuclear
Facility:	Quad Cities Nuclear Power Station, Units 1 and 2
Location:	Cordova, Illinois
Dates:	January 9, 2006, through February 7, 2006
Inspectors:	J. Jacobson, Senior Inspector, Team Lead K. Stoedter, Senior Resident Inspector M. Kurth, Resident Inspector C. Hammer, Mechanical Engineer, NRR
Approved by:	M. Ring, Chief Branch 1 Division of Reactor Projects

SUMMARY OF FINDINGS

IR 05000254/2006009, 05000265/2006009; 1/9/2006 - 2/7/2006; Quad Cities Nuclear Power Station, Units 1 & 2; Special Inspection for Vibration Induced ERV Failures.

This Special Inspection examined the facts regarding the discovery of degraded electromatic relief valve (ERV) actuators on both units at the Quad Cities Station. In December 2005, the licensee identified an intermittent 125 Vdc ground on the 3D ERV actuator circuitry on Unit 2. In response to this issue, an at-power drywell entry was conducted on December 30, 2005. As a result of this entry it was identified that several of the actuator components were significantly degraded. As a result, Unit 2 was shut down on December 31 to allow inspections of the remaining ERV actuators. Varying levels of apparent vibration induced degradation were identified on the remaining Unit 2 ERV actuators and subsequently, Unit 1 was shut down on January 6, 2006, for inspection. During this outage several Unit 1 ERV actuators were also found degraded. A Special Inspection Team was initiated and consisted of Region III and resident inspectors with technical support from the Office of Nuclear Reactor Regulation (NRR) staff. The inspection assessed the licensee's efforts to identify the cause of the ERV degradation and extent of condition. Three Green findings associated with three Non-Cited Violations (NCV) were identified. The significance of most findings is indicated by their color (Green, White, Yellow, Red) using Inspection Manual Chapter (IMC) 0609, "Significance Determination Process" (SDP). Findings for which the SDP does not apply may be "Green" or be assigned a severity level after NRC management review. The NRC's program for overseeing the safe operation of commercial nuclear power reactors is described in NUREG-1649, "Reactor Oversight Process," Revision 3, dated July 2000.

A. Inspector-Identified and Self-Revealed Findings

Cornerstone: Initiating Events

Green. The inspectors identified a finding of very low safety significance and a Non-Cited Violation of 10 CFR 50, Appendix B, Criterion XVI on January 17, 2006, for failure to conduct effective walkdowns during the Unit 2 and Unit 1 outages that occurred on December 30, 2005, and January 7, 2006, respectively. This resulted in the licensee's failure to identify components and systems degraded by increased steam line vibration at EPU power levels. Specifically, during the Unit 2 outage commencing on January 13, a severely degraded snubber (bent extension tube and nearly worn through spherical bearing and attachment pin) on the Unit 2 3D ERV discharge piping was found. In addition, broken tack welds were discovered on both ends of the 3D and 3E ERVs and on one end of the 3C ERV pilot valve/actuator support. Several additional deficiencies of lesser significance were identified during the January 15 Unit 1 outage. Based on the degradation mode and extent of the Unit 2 3D ERV snubber end connection damage and Unit 2 3D, 3C, and 3E ERV turnbuckle tack weld cracks, it was determined that the degraded conditions existed prior to the Unit 2 and Unit 1 outages on December 30, 2005, and January 7, 2006, respectively.

This finding was determined to be more than minor because, if left uncorrected, the finding would become a significant safety concern. Specifically, the degraded components would continue to degrade and, if not identified and corrected, could

eventually result in component or system failure. This finding was of very low safety significance because the degraded items identified did not result in a loss of safety function of any system. The inspectors determined that this finding also affected the cross cutting area of problem identification and resolution because the licensee had performed multiple drywell walkdowns in an effort to assess the main steam line vibration impacts, but had failed to identify the degraded equipment discussed above. The licensee conducted additional focused walkdowns during the January 13, 2006, Unit 2 outage and the Unit 1 outage which began on January 15, 2006, and initiated Issue Report 451822 to document the issue and determine corrective actions to be taken. (Section 40A3.7)

Cornerstone: Mitigating Systems

- Green. The inspectors identified a finding of very low safety significance and a Non-Cited Violation of 10 CFR 50, Appendix B, Criterion III on January 15, 2006, for failure to adequately implement design control measures to ensure that the ERV assemblies were suitable for Extended Power Uprate (EPU) operations. This resulted in the licensee's failure to identify that the ERV pilot valve/actuator supports (turnbuckles) would degrade at EPU power levels. Following the January 13, 2006, Unit 2 shutdown, the licensee reported broken turnbuckle tack welds on both ends of the 3D and 3E ERVs and on one end of the 3C ERV. Inspection of the threaded portions of the 3D turnbuckle indicated significant degradation from thread fretting and thread fracture.

  This finding was determined to be more than minor because if left uncorrected, the ERV turnbuckles would continue to degrade, potentially fail, and result in an inoperable ERV or inadvertent opening of the ERV due to a pilot line failure. This finding was of very low safety significance because although the Unit 2 3D ERV turnbuckle was degraded and considered to be a design deficiency, the degradation/deficiency did not result in an ERV loss of function. The inspectors concluded that this finding also affected the cross cutting area of problem identification and resolution because the licensee had performed several evaluations regarding the acceptability of equipment operation at EPU power levels and had failed to identify the ERV turnbuckle as a high stress, and potential failure, location. Corrective actions for this issue included inspecting the remaining turnbuckle tack welds, scheduling an inspection of the Unit 2 3E ERV turnbuckle during the March 2006 refueling outage, performing additional extent of condition reviews to identify other EPU vulnerable components, and addressing the organizational issues which contributed to the failure to identify the turnbuckle as a potential high stress location. (Section 40A3.3)

- Green. The inspectors identified a finding of very low safety significance and a Non-Cited Violation of 10 CFR 50, Appendix B, Criterion V on January 10, 2006, for failure to implement procedures appropriate to the circumstance for previous inspection and disassembly of the Unit 1 3D ERV actuator. The licensee had not identified that the ERV actuator disassembly and inspection procedures failed to include the inspection of all critical components subject to wear or loosening. This resulted in the licensee's

failure to adequately inspect the ERV pivot bolts for tightness or wear. In addition to significant wear identified on the Unit 1 3D ERV pivot bolts, one of the Unit 1 3E ERV pivot bolts was found backed out and the Unit 2 3D ERV was missing one of the two pivot bolts.

This finding was determined to be more than minor because, if left uncorrected, the ERV pivot bolts would continue to degrade or loosen and could result in the failure of an ERV to actuate when required. This finding was of very low safety significance because although the results of a subsequent pivot bolt inspection indicated that some of the bolts were degraded, missing, or loose, the degradation in these instances did not result in an actual loss of system function. Corrective actions for this issue included revising the appropriate maintenance procedures, inspecting the Unit 2 pivot bolts, and installing new pivot bolts where needed. (Section 40A3.4)

REPORT DETAILS

Background and Overview

Each unit at Quad Cities Station contains four electromatic relief valves (ERVs). The ERVs are designed to prevent overpressurization of the reactor vessel during specific transients and to rapidly relieve reactor pressure to allow the low pressure emergency core cooling systems to function when required. Each ERV actuator consists of a solenoid actuated plunger and pilot valve. To open an ERV, electrical current is supplied to the solenoid. The magnetic field created by the energized solenoid causes the actuator plunger to move vertically downward until it contacts the pilot valve lever arm. As the pilot valve lever arm is forced down by the actuator plunger, the pilot valve opens which vents the chamber below the main valve disc through the pilot valve. The resultant pressure imbalance produces a force which moves the main valve disc and permits steam to escape through the valve outlet piping.

In December 2001, the Nuclear Regulatory Commission (NRC) approved a 17.8 percent power uprate for Quad Cities Station, Units 1 and 2. The licensee performed activities associated with implementing the NRC approved extended power uprate (EPU) in 2002. In November 2003, radiation protection technicians identified that the Unit 1 3B ERV pilot valve vent line was sheared at the pilot valve assembly. Subsequent inspections of the remaining 3B ERV actuator components identified significant degradation of the solenoid plunger springs, posts, and bushings. The licensee concluded that the root cause of the pilot vent valve line shear was a lack of standard procedural instructions to identify, evaluate, and resolve issues concerning cold spring when installing small bore piping. Specifically, the licensee determined that the pilot vent line failure resulted from fatigue cracking due to a combination of installation and operational stresses. Once the pilot valve vent line sheared, the licensee believed that the ERV actuator vibrated so severely that certain actuator components significantly degraded. Corrective actions for this issue consisted of repairing the degraded actuator, designing and installing a modification to upgrade the solenoid plunger posts and bushings, and operating Unit 1 at pre-EPU power levels until the actuator modifications were installed (Unit 2 was not required to be operated at pre-EPU power levels because at the time of this event, Unit 2 utilized power operated relief valves instead of ERVs.)

Between November 2003 and March 2004, the licensee conducted multiple tests to determine which ERV actuator components needed to be upgraded. Based upon the test results, the licensee concluded that the actuator posts and bushings should be made from Inconel rather than stainless steel in order to prevent the actuator degradation seen in November 2003. In March 2004, the licensee replaced the Unit 2 power operated relief valves with ERVs. As part of this replacement, the licensee also installed the upgraded ERV actuator posts and bushings. The corresponding Unit 1 ERV upgraded actuator components were installed in March 2005.

From early-2004 to mid-2005, Quad Cities Units 1 and 2 were operated at pre-EPU power levels due to ongoing concerns regarding the steam dryer. Following the completion of steam dryer replacement activities, Quad Cities Units 1 and 2 returned to EPU power levels in August 2005 and June 2005 respectively.

In December 2005, licensee personnel determined that an intermittent 125 Vdc ground was present on the 3D ERV actuator circuitry on Unit 2. In response to this issue, the licensee performed an at-power drywell entry on December 30 to determine if the circuitry could be repaired online. Individuals in the drywell identified that several of the ERV actuator components were significantly degraded. As a result, the licensee shut down Unit 2 to allow inspections of the remaining ERV actuators.

Varying levels of degradation were identified on the remaining Unit 2 ERV actuators. Due to the amount of degradation identified, the licensee reduced Unit 1 reactor power to pre-EPU levels pending an inspection of the Unit 1 actuators. During a January 6, 2006, Unit 1 outage the licensee identified that several Unit 1 ERV actuators were also degraded. Details of the ERV actuator damage, potential root cause, and planned repairs were discussed with the NRC staff during conference calls on December 31, 2005, and January 1, 6, 7, and 8, 2006. Among the outcomes of these discussions was a decision to conduct a Special Inspection to assess the licensee's efforts to identify the cause of the ERV actuator degradation, the possible extent of condition, and the potential applicability to Dresden Station. The Special Inspection Team consisted of NRC Region III personnel who coordinated and led the team activities, and a member of the Office of Nuclear Reactor Regulation's Division of Engineering who provided specialized technical assistance regarding relief valves.

4. OTHER ACTIVITIES

4OA3 Event Followup

.1 Sequence of Events (93812)

a. Inspection Scope

The inspectors interviewed licensee personnel, observed actual plant activities, reviewed operator logs and previous corrective action documents to develop the following sequence of events for the ERV actuator degradation discovered on both units.

Date	Event Description
5/2005	The licensee conducted the Unit 2 steam dryer replacement outage. As part of this outage, the licensee inspected all of the Unit 2 ERV actuators. No degradation of the upgraded posts or bushings was identified.
6/2005	The licensee returned Unit 2 to EPU power levels.
8/2005	The licensee returned Unit 1 to EPU power levels.
11/27/2005	Unit 2 operations personnel identified an intermittent Level II ground on the 125 Vdc system. The licensee was unable to locate and isolate the ground due to the intermittent nature.

12/5/2005	Unit 2 operations personnel noticed that the 3D ERV showed dual indication. Alternate indications were used to verify that the 3D ERV was closed. The licensee initiated Operability Evaluation 430555 to document that the dual indication issue had no impact on the ability of the 3D ERV to perform its safety function. Subsequent troubleshooting identified that the 3D ERV open light limit switch had failed.
12/19/2005	Unit 2 operations personnel identified that the ground condition was becoming worse. Specifically, the ground increased to a Level III ground and the ground alarm was received more frequently. Due to the increased alarm frequency and ground level, the licensee re-instituted troubleshooting efforts to locate and isolate the ground.
12/20/2005	The troubleshooting efforts revealed that the 125 Vdc ground was located on the Unit 2, 3D ERV. Unit 2 operations personnel also identified that the numeric indication provided on the 3D ERV acoustic monitor was fluctuating from 0.03 to 0.06 units. Normal readings were approximately 0.00 to 0.01 units.
12/21/2005 1:52 a.m.	Unit 2 operations personnel declared the 3D ERV inoperable and entered a 14 day limiting condition for operation due to the ground.
12/21-22/2005	The licensee continued efforts to specifically locate and isolate the 3D ERV ground.
12/22/2005 3:25 a.m.	Maintenance personnel determined that the ground was on the 3D ERV solenoid actuator circuitry.
12/22-26/2005	The licensee isolated the Unit 2 3D ERV solenoid actuator by removing fuses and de-energizing the solenoid circuitry. The licensee continued efforts to determine whether the ground was located on circuitry inside or outside of the Unit 2 drywell. The licensee also began efforts to assess whether the 3D ERV could be determined to be operable.
12/26/2005 1:12 a.m.	Unit 2 control room personnel began receiving a sequence of events recorder alarm associated with the 3D ERV being open. A non-licensed operator also reported that the Unit 2 ground recorder had seen a +60 unit spike and then returned to normal levels. The control room personnel checked other indications to verify the 3D ERV remained closed. The sequence of events alarm was received a second time approximately 6 hours later.
12/27/2005 6:06 p.m.	Troubleshooting efforts determined that the ground was located inside the Unit 2 drywell.

12/27-29/2005	Licensee personnel prepared for an at-power, drywell entry of Unit 2 in an attempt to further locate and repair the cause of the ground.
12/30/2005 7:00 a.m.	Operations personnel reduced Unit 2 reactor power to 24 percent for the at-power drywell entry. Maintenance personnel entered the drywell and discovered that the 3D ERV actuator was severely degraded and unable to be repaired online. Based upon this information, licensee management directed that Unit 2 be placed in a shut down condition.
12/30/2005	The licensee conducted visual inspections of the three remaining Unit 2 ERV actuators. These actuators were also degraded. Based upon the condition of the Unit 2 ERV actuators, operations personnel lowered Unit 1 reactor power to pre-EPU power levels. The licensee concluded that the Unit 1 ERVs remained operable since no indications were available which indicated that the Unit 1 ERVs may be degraded.
12/31/2005	Unit 2 operations personnel attempted to stroke the three remaining Unit 2 ERV actuators by energizing the actuator solenoid. Each of the remaining ERV actuators stroked satisfactorily.
12/31/2005	The licensee replaced all four of the Unit 2 ERV actuators with rebuilt actuators. The licensee also chartered a multi-person root cause team to investigate the cause of the actuator degradation.
01/01/2006	Operations personnel returned Unit 2 to power. Licensee management directed that Unit 2 reactor power be maintained at pre-EPU power levels pending completion of the ERV actuator root cause and the implementation of corrective actions.
01/01-06/2006	The licensee prepared for a planned Unit 1 outage to inspect the ERV actuators.
01/07/2006	Operations personnel shut down Unit 1 for the ERV actuator inspections. Upon reaching cold shutdown, operations personnel attempted to demonstrate operability of the ERV actuators by stroking each actuator three times. The Unit 1 3C and 3E actuators were successfully stroked three times. The Unit 1 3B ERV actuator failed to stroke on the first attempt. However, the remaining two attempts were both successful. The 3D ERV actuator failed to stroke during any of the three attempts. Various levels of degradation were found on the ERV actuators. Based upon the amount of degradation, the licensee installed four new ERV actuators on Unit 1.

01/08/2006	Operations personnel returned Unit 1 to power. Licensee management directed that Unit 1 power level be restricted to pre-EPU power levels pending the completion of the ERV actuator root cause and the implementation of corrective actions.
01/10/2006	Members of the NRC's Special Inspection Team (SIT) observed licensee personnel disassembling and inspecting the Unit 1 ERV actuators removed on January 7, 2006. During this observation, the inspectors identified that the actuator pivot pins were not routinely inspected for wear or degradation (see Section 4OA3.4 of this report). The licensee initiated an operability evaluation to assess whether the Unit 2 ERV actuators could be considered operable, but degraded, due to the potentially worn pivot pins. The licensee was not required to assess the Unit 1 pivot pin condition since these actuators were new when they were installed.
01/12/2006	SIT members identified an additional operability issue regarding the structural integrity of the ERV turnbuckle tack welds and possible degradation of the turnbuckle threads (see Section 4OA3.3 of this report for additional details).
01/13/2006	The licensee approved the operability evaluation for the Unit 2 ERV actuator pivot pin issue, however, a decision was made to shut down Unit 2 to perform additional ERV actuator inspections.
01/14/2006	Upon reaching cold shutdown, the licensee attempted to stroke each Unit 2 ERV actuator three times. During this testing, the 3D ERV failed to function. The other valves functioned appropriately. During a conference call between the licensee and the NRC, the NRC questioned the licensee regarding the need to complete extensive walkdowns of the main steam piping and supports in order to identify any additional vibration related degradation. The licensee stated that the walkdowns had been completed.
01/15/2006	The licensee removed the Unit 2 3D ERV actuator for further inspection. During the inspection, the licensee discovered considerable interference between the actuator plunger legs and the solenoid body. Based upon this newly identified failure mode, the licensee removed the remaining Unit 2 ERV actuators for inspection and repair. The licensee also declared all of the Unit 1 ERV actuators inoperable which resulted in an additional Unit 1 shut down. The licensee informed the NRC that several of the Unit 2 ERV turnbuckle tack welds were found broken.

	Unit 1 entered cold shutdown. Each of the Unit 1 ERV actuators was successfully stroked three times.
01/15-19/2006	The licensee repaired and reinstalled the Unit 1 and Unit 2 ERV actuators.
01/17/2006	The licensee identified a severely degraded snubber associated with the Unit 2 3D ERV discharge piping. This discovery prompted the licensee to perform more detailed inspections of main steam line piping and supports. Minor vibratory damage was identified on several other components.
01/18/2006	NRC inspectors walked down portions of the Unit 2 main steam line piping. Additional minor vibratory damage was identified.
01/19/2006	The licensee returned Unit 1 and Unit 2 to pre-EPU power levels following the ERV actuator repairs.

.2 Effectiveness of Licensee's Root Cause Efforts (93812)

a. Inspection Scope

The inspectors reviewed licensee actions to identify and address the root cause of the ERV actuator degradation issue. As part of this review, the inspectors observed maintenance personnel disassembling and inspecting the Unit 1 and 2 ERV actuators to determine the extent of the damage. The inspectors also viewed pictures of the Unit 2 ERV actuators which were taken during the December 30, 2005 outage. These observations aided in determining whether maintenance work practices may have contributed to the actuator degradation. In addition, the inspectors held multiple discussions with members of the licensee's root cause team to monitor the team's efforts and reviewed the licensee's ERV actuator vibration test program.

This inspection represented the completion of one maintenance effectiveness (71111.12) inspection sample and one annual problem identification and resolution (71153) inspection sample.

b. Findings

Observation of Maintenance Activities

The inspectors witnessed the initial inspection of the Unit 1 3D ERV in the plant shop facility which involved attempts to manually push the solenoid actuator to the actuated position. However, the actuator only traveled about 1/4 inch when pushed. During earlier testing in the installed position in the drywell, the actuator also did not stroke with electrical power. On disassembly, it was found that the return springs had worn significant grooves into the guide posts. Further, one of the springs had worn thin at the upper end where it mates with a bushing and had wedged into the annulus between the

post and bushing. The top coil of the other spring had broken from the lower part of the spring and was wedged between the post and bushing. This intrusion of the spring into the post/bushing interface effectively prevented the actuator from stroking. Severe grooving of the guide posts was also noted on Unit 1 3B ERV and on Unit 2 3D ERV.

On the Unit 1 3D ERV there were also two limit switch mounting bolts missing, one missing on each of the two switches, with the remaining bolts still in position. Other Unit 1 and 2 actuators were also found with loose or missing switch mounting bolts. On disassembly of the Unit 1 3D ERV tilting plate mechanism which activates a set of contacts and energizes an additional solenoid coil when the ERV is stroked, inspection identified that the pivot bolts showed significant wear. One of the pivot bolts on Unit 1 3E ERV was found backed out and on Unit 2, the 3D ERV was missing one of the two pivot bolts. Loose and worn pivot bolts are documented in Section 4OA3.4 of this report.

On Unit 1 3C ERV, the inspectors witnessed a series of four tests with the actuator plunger roller bolt positioned in its as-found position in the drywell, which was with the nut completely missing and the bolt length withdrawn approximately 2/3 outside of the roller. The actuator had not been actuated in its installed position in the drywell because of its degraded condition. The actuator was stroked successfully four times with the bolt in various positions. On disassembly of the Unit 1 3D actuator plunger roller bolt and nut, the break-loose torque was found to be only 5 foot-pounds, much less than needed for a good mechanical connection of a bolt of this size (approximately ½ inch).

During the week of January 15, 2006, following the shutdown of Unit 2 on January 13, the inspectors witnessed additional testing of the Unit 2 ERVs. The licensee found a variety of degraded conditions, including the wearing of the actuator spring into the bottom of its bushing, a degradation which occurred over only a 2-week period, and the cracking of the actuator internal angle iron riveted to the solenoid laminate. Also noted was a notch worn into the brass arms of the plunger on the 3D actuator. This notch provided sufficient interference with the solenoid body such that this actuator failed to function when stroked from the control room. This condition appeared to be aggravated by the recently specified torque value used to assemble the plunger roller bolt and nut.

Disassembly and inspection of the actuators was performed in accordance with Work Order 00879655, “Inspect and Rebuild ERV Solenoid Actuators,” dated January 7, 2006, which included input from the root cause team. The inspectors observed careful disassembly in accordance with the procedure and good documentation of the inspections.

Review of Previous ERV Vibration Testing

As a result of vibration induced degradation identified during Q1F51 in November 2003 on the Unit 1 ERVs, the licensee developed a testing plan to determine the ERV vibration response and to recommend modifications to improve resistance to vibration degradation. A series of vibration tests on a shaker table were conducted in February 2004. The testing consisted of: (1) a resonance search to determine the natural frequencies of the ERV assembly configurations; (2) determining the effect of installing various structural supports and/or modifications to minimize or eliminate the

vibrational damage; and (3) establishing, if possible, ERV component wear rates. The NRC inspectors identified the following deficiencies:

1) Due to limitations at the testing facility, the vibrational testing was limited to one-directional motion. This differed with the three-dimensional movement that the ERV assembly was exposed to during plant operation;

2) The correlation between the in-plant at power operational time period and the shaker table time period was suspect. Licensee testing concluded that exposing an ERV actuator to approximately 4 hours of shaker table testing equated to 5 months operation at EPU power levels. This was based on the relationship of a known wear rate of a guide post bushing that was in use at EPU power operations to a shaker table tested guide post bushing that demonstrated a similar wear pattern. No further shaker table testing was performed to reaffirm the testing results. In addition, no further as found comparisons were made between ERV components found in a degraded condition from EPU operations with ERV components vibrated during shaker table testing. For example, during Q1F51, an ERV was found to have a damaged shorting link and another ERV was found to have a worn trip plate pivot point, yet, these degraded conditions were not assessed during the shaker table testing.

3) When the excitation frequencies of the ERV actuator were identified, the ERV valve and pilot valve were removed from the shaker table and only the ERV actuator was mounted to the shaker table for endurance testing. This testing method did not consider the interaction of the ERV main body, the cantilevered pilot/actuator support (turnbuckle assembly), and the actuator assembly.

In general, the shaker table testing narrowly focused on determining the excitation modes of the ERV actuator and then testing at these frequencies to recreate a known wear rate in an ERV component. The inspectors noted that no attempts were made to reaffirm the testing results and that no additional components were assessed to determine wear rates to qualify that the testing duration was representative of ERV operation at EPU power for a given time period. Based on the results of this testing, the ERV actuators were modified and tested on the shaker table with (harder) guide posts and bushings made of Inconel-750. Using previous testing assumptions, the shaker table testing was conducted for approximately 20 hours at varying frequencies that was considered to equate to 12 months of EPU operation. The licensee identified minimal wear and extrapolated those results to conclude that the ERV actuator could function for at least one full cycle (24 months) at EPU operations. After testing was completed the licensee modified and updated the ERV actuators to include Inconel-750 guide rods and guide rod bushings.

On December 30, 2005, the licensee inspected the Unit 2 ERV actuator conditions and observed, in some cases, severe wear on the guide rods and guide rod springs, loose fasteners, a degraded pivot plate condition, worn actuator pivot plate screws, and limit switches in a degraded condition. As evidenced by the degraded condition of the Unit 2 ERVs that were operated for approximately 6 months at EPU power, the inspectors concluded that the licensee's ERV test program was not effective.

Review of Root Cause Team Activities

The inspectors were unable to fully assess the effectiveness of the licensee's root cause efforts due to the fact that the licensee's root cause evaluation was still ongoing at the end of the inspection. Preliminary indications were that the ERV actuators degraded because they were not qualified for the increased steam line vibration levels experienced at EPU power levels. This degradation resulted in some ERVs not being operable. As a result, the inspectors considered the effectiveness of the licensee's root cause efforts to be unresolved pending a review of the licensee's root cause report and a final determination of ERV unavailability **(URI 05000254/2006009-01; 05000265/2006009-01)**.

.3 Review of Testing and Analyses for Other EPU Vulnerable Components (93812)

a. Inspection Scope

The inspectors interviewed engineering personnel and reviewed corrective action documents, test results, and engineering evaluations for components potentially susceptible to vibration degradation other than the ERV actuators. This review was performed to determine whether previous testing and analyses adequately ensured that those components would remain operable for an entire operating cycle at EPU power levels. During the inspection, the inspectors identified a vulnerability which had not been evaluated by the licensee.

b. Findings

Target Rock Valves

A 2004 Target Rock valve bellows cap degradation issue had been attributed to insufficient spring tolerance specifications in conjunction with the use of a bellows cap material that did not have sufficient hardness. The licensee concluded that increased main steam line vibrations at EPU power levels contributed to the Target Rock degradation, however, vibration was not the root cause.

Plant data indicated that the predominant EPU vibration levels occurred between 150 and 160 Hertz; however, shaker table test results showed that the maximum Target Rock valve bellows cap response occurred in the 20 to 100 Hertz range. Based upon this information and operating experience from Dresden Station, which documented similar bellows cap degradation issues prior to EPU implementation, the licensee's root cause efforts focused on the straightness of the bellows cap spring as the primary contributor to degradation. The licensee confirmed their assumptions by performing multiple shaker table tests utilizing at least 12 springs of varying straightness. During each of these tests, testing personnel were unable to reproduce the degradation identified on the Quad Cities Unit 2 Target Rock valve bellows cap. However, these springs were significantly straighter than the spring removed from the Unit 2 Target Rock valve. Additional tests were then performed using the previously installed Unit 2 Target Rock valve spring. The results of these tests closely resembled the degradation found on the Quad Cities Unit 2 Target Rock bellows cap.

Corrective actions for this issue consisted of installing hardened bellows caps on the valves for each unit and replacing the bellows cap springs. The licensee also communicated the Quad Cities specific bellows cap spring straightness specifications to the vendor to ensure that future springs were manufactured in accordance with the straightness requirements. Based upon the above information, the inspectors concluded that the licensee's corrective actions appeared appropriate.

Limitorque Actuator Components and NAMCO Limit Switches

In 2005, the licensee informed the NRC that previously identified degradation of a Unit 1 high pressure coolant injection Limitorque actuator limit switch and NAMCO limit switches installed on the main steam isolation valves were not caused by increased steam line vibration at EPU power levels. The inspectors assessed the testing and analyses used to draw this conclusion to ensure that the conclusion remained valid.

The inspectors reviewed the testing inputs and determined that the inputs were developed based upon actual Quad Cities data. In each case, the inputs used bounded actual plant vibration and acoustic conditions. The inspectors also reviewed the licensee's test duration determination and concluded that the durations appeared to accurately simulate plant operation for an entire cycle at EPU conditions. The test results showed that there was no apparent connection between operating at EPU conditions and the previously identified degradation of the Limitorque limit switch and the NAMCO limit switches. The test results were further supported by visual inspections of the above components performed in 2005. Specifically, no indications of wear or degradation were identified during the visual inspections.

The licensee also provided the inspectors with several pieces of industry operating experience which reflected that multiple NAMCO limit switch issues have been identified over the last 5 years. These issues appeared to be caused by heat related degradation of the limit switch lubricant due to the proximity of the limit switch to the main steam isolation valve bonnet. The inspectors discussed the lubricant degradation with the main steam system engineer and were informed that drywell temperatures had not significantly increased following EPU implementation. In addition, the system engineer stated that periodic burnishing of the limit switch contacts had improved NAMCO limit switch performance. The licensee planned to continue the periodic contact burnishing while considering additional corrective actions such as installing a different type switch, relocating the NAMCO switches, or providing the switches with supplemental cooling. Based on the information discussed in the above paragraphs, the inspectors determined that the licensee's conclusion remained valid.

Pilot Valve/Actuator Assembly Support

Introduction: A Green NCV was identified for the failure to comply with 10 CFR Part 50, Appendix B, Criterion III, Design Control for ensuring that the ERV turnbuckle connections were suitable for operation at EPU power. As a result, the licensee had not identified that the ERV pilot valve/actuator support was susceptible to degradation due to the increased vibration experienced during operation at EPU power levels.

Description: During the process of reviewing the vibration related degradation of the Unit 1 3D ERV actuator, the inspectors identified a potential vulnerability associated with the supporting member of the pilot valve/actuator assembly (also known as the turnbuckle). Through a review of licensee documents and drawings, the inspectors determined that the pilot valve/actuator assembly weighed in excess of 100 lbs. and was supported and attached to the main valve via a threaded turnbuckle. Threaded turnbuckle couplings were welded to the main valve and pilot valve respectively. The turnbuckle was tack welded to the threaded couplings at both ends to prevent rotation of the turnbuckle. The inspectors observed a spare ERV assembly in the plant storage area and found the tack welds to be of substantial size (approximately .75 inch in length) and clearly visible. The threaded portion of the turnbuckle section was machined down to a smaller diameter with little radius in the transition corner. The inspectors were concerned that stress risers in this connection may be challenged by known vibratory accelerations at EPU power levels. The inspectors questioned engineering personnel to determine whether a stress analysis had been previously performed for the turnbuckle. Engineering personnel stated that they had not performed a stress analysis for the turnbuckle connection because they had not recognized the connection as a potential high stress location. This raised concerns regarding the structural integrity of the connection due to possible overstress, thread fretting, and fatigue.

Subsequent to the inspection team identifying this concern, Unit 2 was shut down on January 13, 2006, to inspect the ERV actuators. Following the shut down, the licensee reported broken turnbuckle tack welds on both ends of the 3D and 3E ERVs and on one end of the 3C ERV. Calculation QC-31-301, “Stress Evaluation of the ERV Turnbuckle,” was completed on January 18, 2006, to evaluate this connection utilizing measured acceleration values previously obtained at EPU power levels. This calculation demonstrated that the endurance limit would be exceeded for the range of stress concentration factors evaluated at the tack weld location, predicting fatigue cracking. The 3D ERV turnbuckle connection was destructively removed from the valve for inspection of the threaded portions. Visual examination indicated significant degradation from thread fretting and thread fracture.

Analysis: The inspectors determined that the licensee’s failure to adequately implement design control measures to ensure that the ERV assembly was suitable for EPU operations was a performance deficiency because it resulted in the licensee’s failure to identify that the ERV turnbuckle would degrade at EPU power levels. This finding was determined to be more than minor because if left uncorrected, the ERV turnbuckles would continue to degrade, potentially fail, and result in an inoperable ERV or inadvertent opening of the ERV due to a pilot line failure. The inspectors concluded that this finding also affected the cross cutting area of problem identification and resolution because the licensee had performed several evaluations regarding the acceptability of equipment operation at EPU power levels and had failed to identify the ERV turnbuckle as a high stress, and potential failure, location. This finding was evaluated using the Significance Determination Process and was determined to be a finding of very low safety significance because, although the Unit 2 3D ERV turnbuckle was degraded and considered to be a design deficiency, the degradation/deficiency did not result in an ERV loss of function.

Enforcement: 10 CFR Part 50, Appendix B, Criterion III, Design Control, states, in part, measures shall be established for the selection and review for suitability of applications of equipment essential to the safety-related functions of structures, systems, and components. Contrary to the above, as of January 2006, measures had not been established to ensure that the ERV turnbuckle connections were suitable for application as part of the automatic depressurization system during plant operations at EPU power levels. Because this failure to comply with 10 CFR Part 50, Appendix B, Criterion III, is of very low safety significance and has been entered into the licensee's corrective action program as Issue Reports 443035 and 448773, this violation is being treated as an NCV, consistent with Section VI.A of the NRC Enforcement Policy **(NCV 05000254/2006009-02; 05000265/2006009-02)**. Corrective actions for this issue included inspecting the remaining turnbuckle tack welds, scheduling an inspection of the Unit 2 3E ERV turnbuckle during the March 2006 refueling outage, performing additional extent of condition reviews to identify other EPU vulnerable components, and addressing the organizational issues which contributed to the failure to identify the turnbuckle as a potential high stress location.

.4 Review of Maintenance Work Practices (93812)

a. Inspection Scope

The licensee's maintenance procedures for the ERVs were reviewed to determine any actions or inactions that may have contributed to the degradation of the ERVs. The licensee provided several versions of the maintenance procedures including a 2004 version and the most recent version which was in effect prior to the Unit 2 shutdown on December 30. Additions to the procedure, which were being implemented in January 2006 as a result of the recent ERV degradation and extensive disassembly information, were also provided. In addition, the inspectors observed the disassembly and inspection of several ERVs as discussed in Section 4OA3.2.b of this report.

b. Findings

Introduction: A Green NCV was identified for the failure to comply with 10 CFR Part 50, Appendix B, Criterion V, Instructions, Procedures, and Drawings. As a result, the licensee had not identified that the ERV actuator disassembly and inspection procedures failed to include the inspection of all critical components subject to wear or loosening.

Description: On January 10, 2006, the inspectors observed the disassembly of the Unit 1 3D ERV. Upon disassembly, the pivot bolts for the tilting plate mechanism were found to have significant wear. The actuator tilting plate mechanism was used to activate a set of contacts and energize an additional solenoid coil when the ERV was stroked. If the pivot bolts failed, the contacts potentially would not activate, resulting in solenoid coil overheat and failure. In addition to the degraded pivot bolts on the Unit 1 3D ERV, one of the Unit 1 3E ERV pivot bolts was found backed out and the Unit 2 3D ERV was missing one of the two pivot bolts. Inspector's review of Procedure QCEMS 0250-13 and results of licensee interviews with maintenance staff identified that

there was no step to remove and inspect the pivot bolts and maintenance staff did not routinely wrench check the pivot bolts for tightness.

Analysis: The inspectors determined that the licensee's failure to implement procedures appropriate to the circumstance for previous inspection and disassembly of the ERV actuators was a performance deficiency because it resulted in not inspecting the ERV pivot bolts for tightness or wear. This finding was determined to be more than minor because if left uncorrected, the ERV pivot bolts would continue to degrade or loosen and could result in the failure of an ERV to actuate when required. This finding was evaluated using the Significance Determination Process and was determined to be a finding of very low safety significance because, although the results of a subsequent pivot bolt inspection indicated that some of the bolts were degraded, missing, or loose, the degradation in these instances did not result in an actual loss of system function.

Enforcement: 10 CFR Part 50, Appendix B, Criterion V, Instructions, Procedures, and Drawings, states, in part, that activities affecting quality shall be prescribed by documented instructions, procedures, and drawings appropriate to the circumstance. Contrary to the above, prior to January 10, 2006, procedures associated with the disassembly and inspection of the ERV actuators were not appropriate to the circumstance. Specifically, the procedures failed to include instructions to remove and inspect the pivot bolts as part of the disassembly and inspection. Because this failure to comply with 10 CFR Part 50, Appendix B, Criterion V, is of very low safety significance and has been entered into the licensee's corrective action program as Issue Reports 437638 and 440773, this violation is being treated as an NCV, consistent with Section VI.A of the NRC Enforcement Policy **(NCV 05000254/2006009-03; 05000265/2006009-03)**. Corrective actions for this issue included revising the appropriate maintenance procedures, inspecting the Unit 2 pivot bolts, and installing new pivot bolts where needed.

.5 Review of Licensee's Response to Initial Unit 2 ERV Indications and Associated Operability Evaluations

a. Inspection Scope

As stated in Section 4OA3.1 of this report, licensee personnel had several indications that the Unit 2 3D ERV was degrading. Those indications included:

- The presence of a 125 Vdc ground which was determined to be on the ERV actuation circuitry;
- The position indication changed from full closed to dual;
- The acoustic monitor readings appeared to be fluctuating from normal; and
- The sequence of events recorder alarm associated with the Unit 2, 3D ERV being open was received.

The inspectors observed control room indications associated with the 3D ERV to determine if the indications were changing significantly with time. The inspectors also attended meetings, observed troubleshooting activities in the field, held discussions with

licensee personnel, and verified that the initial issues associated with the Unit 2 3D ERV appeared to be addressed in a timely manner.

The inspectors also evaluated the technical adequacy of the operability evaluations listed below to ensure that Technical Specification operability was properly justified and the subject component or system remained available such that no unrecognized increase in risk occurred. The inspectors reviewed the Updated Final Safety Analysis Report to verify that the system or component remained available to perform its intended function. In addition, the inspectors reviewed compensatory measures implemented by the licensee to verify that the measures worked as stated and the measures were adequately controlled.

- Operability Evaluation 430555, Relief Valve 2-0203-3D Position Indication Shows Both Open and Closed;
- Operability Evaluation 437638, Electromatic Relief Valves 1-0203-3B/3C/3D/3E and 2-0203-3B/3C/3D/3E, Revision 1;
- Operability Evaluation 437638, Electromatic Relief Valves 1-0203-3B/3C/3D/3E and 2-0203-3B/3C/3D/3E, Revision 2; and
- Operability Evaluation 437638, Electromatic Relief Valves 1-0203-3B/3C/3D/3E and 2-0203-3B/3C/3D/3E, Revision 3.

The inspection represented the completion of four inspection samples as described in Inspection Procedure 71111.15.

b. Findings

Based upon the information available at the time the evaluations were completed, the inspectors determined that the conclusions stated in the operability evaluations were reasonable. However, the conclusion drawn in Operability Evaluation 430555 was determined to be incorrect following the licensee's discovery that the Unit 2 3D ERV was significantly degraded and would not have functioned if called upon.

The inspectors also noted weaknesses in the thoroughness and quality of the licensee's operability evaluations. For example, more than one of the evaluations utilized engineering judgement which was not adequately supported. The inspectors discussed this issue with engineering management. One of the evaluations failed to discuss the potential vibration impacts that could have been experienced by the 3D ERV (and caused the dual indication) due to manipulating a reactor core isolation cooling (RCIC) system valve attached to the same steam line as the 3D ERV. The inspectors discussed this with engineering personnel and were informed that the potential impacts from manipulating the RCIC valve were considered negligible. However, the consideration of the potential for RCIC valve manipulation involvement and the basis for concluding the impact was negligible were not documented. Lastly, at least one of the operability evaluation conclusions was based upon oral information from an outside source which had not been reviewed by the station prior to being used in the operability evaluation. On January 31, 2006, licensee management initiated Issue Report 447979 to document the operability evaluation deficiencies. Corrective actions included scheduling a human performance review board to determine whether organizational issues had contributed to the overall operability evaluation issues.

.6 Review of Historical ERV Operating Experience

a. Inspection Scope

The inspectors reviewed corrective action documents associated with the ERVs and held discussions with engineering and root cause personnel to evaluate whether previous ERV issues were similar to the failures experienced in 2003 and 2005. This review also helped the inspectors to determine whether the 2003 and 2005 failures were solely attributable to EPU implementation or caused by other failure mechanisms.

b. Findings

Historical information showed that the licensee had experienced multiple ERV degradation problems due to long-standing main steam line vibration issues. From the early 1970's to the mid-1990's each of the Quad Cities units had ERVs installed as part of the main steam system. During this time, the licensee experienced approximately 36 ERV failures. As part of the current root cause effort, a team member reviewed each of these failures. The team member concluded that vibration contributed to 24 of the 36 ERV failures. Of the 24 vibration related failures, 14 were associated with the main valve, 7 were associated with the pilot valve, and 3 were related to the actuator solenoid.

Several corrective actions were performed to address the ERV performance concerns. In the mid-1990's the Unit 2 ERVs were replaced with power operated relief valves (PORVs) to improve system performance. The licensee also improved Unit 1 ERV performance by enhancing the maintenance procedures and the preventive maintenance program. Over time, problems associated with the PORVs due to the inability to differentiate PORV pilot valve leakage from main seat leakage were experienced. This resulted in an April 2003 ALERT due to an inadvertent PORV opening while Unit 2 was operating at 98 percent power. Based upon this information, the licensee replaced the Unit 2 PORVs with ERVs in March 2004.

While some vibration related ERV problems existed prior to EPU, the inspectors concluded that the ERV actuator degradation and failures experienced in 2003 and 2005 were caused by increased steam line vibration due to EPU implementation.

.7 Extent of Condition Review

a. Inspection Scope

Quad Cities Extent of Condition Review

The licensee formed a task force to evaluate the potential extent of condition and, along with the root cause effort discussed previously, this activity was ongoing at the conclusion of this inspection. With respect to extent of condition efforts completed at the time of this inspection, the inspectors held discussions with licensee management, engineering personnel, and members of the root cause team to gain insights into the

areas being evaluated as part of the extent of condition review. Additionally, the inspectors assessed the effectiveness of the licensee's walkdowns of components and systems that could be adversely impacted by steam line vibration at EPU power levels and reviewed the licensee's determination of applicability to Dresden.

b. Findings

Description: During the December 30, 2005, Unit 2 shutdown and the January 7, 2006, Unit 1 shutdown, site engineering personnel conducted walkdowns in the drywell to identify component and system degradation that may have been caused by main steam line vibrations at EPU power levels. The walkdowns included general observations of support hangars, spring cans, pipe supports, insulation, small bore piping, installed accelerometers, and other general observations. No discrepancies were noted.

During this Special Inspection the inspectors noted that the walkdowns did not appear to be extensive and were general in nature. The inspectors identified that no specific guidance was followed to conduct an effective, focused walkdown. The inspectors were concerned that the walkdowns lacked focus to identify potential vibration related issues.

During the above unit shutdowns, the licensee stated that thorough walkdowns were conducted and considered complete. Therefore, the licensee was confident, at that time, that further focused walkdowns were not warranted. This position was reiterated following the initial walkdowns for the Unit 2 shutdown which occurred on January 13, 2006. However a few days later, a maintenance mechanic, while working on an unrelated work task, noted a severely degraded snubber (bent extension tube and nearly worn through spherical bearing and attachment pin) on the Unit 2 3D ERV discharge piping. In addition, broken tack welds were discovered on both ends of the 3D and 3E and on one end of the 3C ERV turnbuckles (discussed in 4OA3.3 of this report). As a result of the identified degraded snubber and broken tack welds, the inspectors determined that the previous walkdowns were ineffective in identifying the full extent of vibration related degradation. Based on the degradation mode and extent of the Unit 2 3D ERV snubber end connection damage and Unit 2 3D, 3C, and 3E ERV turnbuckle tack weld cracks, it was determined that the degraded conditions existed prior to the Unit 2 and Unit 1 outages on December 30, 2005, and January 7, 2006, respectively. The inspectors and the licensee concluded that additional, focused walkdowns were warranted.

Additional walkdowns were conducted during the Unit 2 outage and during the Unit 1 outage which began on January 15, 2006. During these walkdowns the licensee identified varying levels of vibration degradation on components which included such items as missing or loose pipe clamps, dislodged flexible conduit, missing snubber cotter pins, loose support hangars, and a broken weld for a support frame for a safety relief valve leak-off line. The degraded conditions were identified on components for various safety-related and nonsafety-related systems. Further, the NRC inspectors conducted a detailed walkdown of the Unit 2 drywell and identified additional items that included worn snubber pins, a misaligned shaft on a spring can, and several small spring cans with bent rods. The identified items were assessed and degraded conditions were either repaired or considered minor items (i.e., loose insulation piece) that were acceptable to be corrected at a later date.

Analysis: The inspectors determined that the failure to conduct effective drywell walkdowns during the Unit 2 and Unit 1 outages that occurred on December 30, 2005, and January 7, 2006, respectively, to identify components and systems degraded by increased steam line vibration at EPU power levels was more than minor because, if left uncorrected, the finding would become a significant safety concern. Specifically, the degraded components would continue to degrade and, if not identified and corrected, could eventually result in component or system failure. The inspectors also determined that this finding affected the cross cutting area of problem identification and resolution because the licensee had performed multiple drywell walkdowns in an effort to assess the main steam line vibration impacts but had failed to identify the degraded equipment discussed above. The inspectors concluded that this finding should be assessed using the Significance Determination Process since it was associated with the operability, availability, reliability, or function of mitigating systems equipment. The inspectors completed the phase 1 analysis and determined that the finding was of very low safety significance (Green). Although degraded items were found through additional focused walkdowns, it was determined that the broken tack welds identified on the ERV turnbuckles and the degraded Unit 2 3D ERV snubber did not result in a loss of safety function of the system.

Enforcement: 10 CFR Part 50, Appendix B, Criterion XVI, "Corrective Actions," requires, in part, that measures shall be established to assure that conditions adverse to quality are promptly identified and corrected. Contrary to the above, as of January 7, 2006, the licensee failed to establish measures to conduct focused walkdowns of systems, structures, and components, to assure that conditions adverse to quality (i.e., vibration degradation) were promptly identified and corrected. Specifically, the drywell walkdowns performed during the Unit 2 and Unit 1 outages that occurred on December 30, 2005, and January 7, 2006, were not focused on the problem at hand (excessive steam line vibration) and failed to promptly identify and correct conditions adverse to quality caused by steam line vibration experienced during operation at EPU power levels. As a result, a degraded Unit 2 3D ERV discharge piping snubber and degraded Unit 2 3D, 3C, and 3E ERV turnbuckles (broken tack welds) were not identified during the walkdowns. The violation was of very low safety significance (Green) because, although the degraded conditions existed, the conditions did not result in a loss of safety function **(NCV 05000254/2006004;NCV 05000265/2006004)**. The licensee conducted additional focused walkdowns during the Unit 2 outage and during the Unit 1 outage which began on January 15, 2006, and initiated Issue Report 451822 to document the issue and determine corrective actions to be taken.

Applicability of ERV Actuator Issues to Dresden Station

The licensee concluded that the current ERV issues at Quad Cities do not impact the operability of the ERVs at Dresden. The inspectors held discussions with engineering personnel regarding the vibration information obtained for Dresden Station. In addition, the inspectors reviewed previous vibration data measured for Dresden Unit 3. The inspectors found that the measured vibration levels at Dresden Unit 3 during EPU operation were an order of magnitude lower than those at Quad Cities. While ERV vibration data was not available for Dresden Unit 2, its configuration and prior inspection

results were consistent with Dresden Unit 3 which supports Unit 2's vibration levels being more in line with Dresden Unit 3 than Quad Cities. In addition, inspections of the actuators on both Dresden Units subsequent to at least one full cycle of operation at EPU power levels did not reveal degradation comparable to that found at Quad Cities.

4OA6 Exit Meeting

The team presented the inspection results to Mr. T. Tulon and members of his staff on February 7, 2006. The licensee acknowledged the results presented. No proprietary information is presented in this inspection report.

ATTACHMENT: SUPPLEMENTAL INFORMATION

SUPPLEMENTAL INFORMATION

KEY POINTS OF CONTACT

Licensee Personnel

T. Tulon, Site Vice President
R. Gideon, Plant Manager
W. Beck, Regulatory Assurance Manager
S. Boline, Deputy Engineering Director
D. Craddick, Maintenance Manager
S. Darin, System Engineering Manager
S. Eldridge, Corporate Engineer
T. Fuhs, Regulatory Assurance
R. Hall, Root Cause Team Leader
D. Moore, Nuclear Oversight Manager
K. Moser, Engineering Director
V. Neels, Chemistry Manager
K. Ohr, Radiation Protection Manager
T. Scott, Shift Operations Superintendent
R. Swart, Main Steam System Engineer

NRC Personnel

M. Ring, Branch Chief, Region III
M. Banerjee, Project Manager, NRR

LIST OF ITEMS OPENED, CLOSED, AND DISCUSSED

Opened

05000254/2006009-01 05000265/2006009-01	URI	Evaluate Root Cause Report and ERV Operability (Paragraph 4OA3.2)
05000254/2006009-02 05000265/2006009-02	NCV	Failure to Apply Design Control Measures to Ensure ERV Pilot Valve / Actuator Support Was Adequate for EPU Operation (Paragraph 4OA3.3)
05000254/2006009-03 05000265/2006009-03	NCV	Inadequate Maintenance Procedure to Inspect ERV Actuators (Paragraph 4OA3.4)
05000254/2006009-04 05000265/2006009-04	NCV	Failure to Identify Degraded Unit 2 Snubber and Broken Welds on Pilot Valve / Actuator Support (Paragraph 4OA3.7)

Closed

05000254/2006009-02 05000265/2006009-02	NCV	Failure to Apply Design Control Measures to Ensure ERV Pilot Valve / Actuator Support Was Adequate for EPU Operation (Paragraph 4OA3.3)
05000254/2006009-03 05000265/2006009-03	NCV	Inadequate Maintenance Procedure to Inspect ERV Actuators (Paragraph 4OA3.4)
05000254/2006009-04 05000265/2006009-04	NCV	Failure to Identify Degraded Unit 2 Snubber and Broken Welds on Pilot Valve / Actuator Support (Paragraph 4OA3.7)

Discussed

None.

LIST OF DOCUMENTS REVIEWED

The following is a list of documents reviewed during the inspection. Inclusion on this list does not imply that the NRC inspectors reviewed the documents in their entirety but rather that selected sections or portions of the documents were evaluated as part of the overall inspection effort. Inclusion of a document on this list does not imply NRC acceptance of the document or any part of it, unless this is stated in the body of the inspection report.

Issue Reports

IR 154275; Quad Cities Unit 2 Manual Scram Due to Inadvertent 3B PORV Opening and Elevated Torus Temperature; dated April 16, 2003
IR 160437; 3C ERV Pilot Solenoid; dated May 25, 2003
IR 160467; 3C ERV Pilot Valve Independently Cycles When Operated; dated May 25, 2003
IR 163249; Unit 1 Electromatic Relief Valve Experiences 125 VDC Level 1 Ground and Higher Than Expected Solenoid Coil Resistence; dated June 14, 2003
IR 186979; Unit 1, 1-0203-3B Electromatic Relief Valve Solenoid Actuator and Pilot Vent Line Failure due to Pipe Cold Spring; dated December 12, 2003
IR 187788; 3D ERV Shows Excessive Wear; dated November 22, 2003
IR 194877; Follow-up Actions from EPU Vibrations Assessment; dated January 13, 2004
IR 215874; Target Rock SRV As Found Lift Pressure High; April 20, 2004
IR 430555; ERV 2-0203-3D Shows Dual Position Indication; dated December 5, 2005
IR 435227; U-2 125V Battery Ground Level III; dated December 19, 2005
IR 435573; 3D ERV Acoustic Monitor Elevated Threshold; dated December 20, 2005
IR 435795; 125V Ground in Auto Blowdown Main Feed; dated December 20, 2005
IR 435857; U2 125 VDC Ground Returned to Level III Criteria; dated December 21, 2005
IR 435858; U2 D ERV Declared Inop/Unplanned 14 Day LCO; dated December 21, 2005
IR 436239; Damaged Terminal Board in 2-2202-5 Panel (for U-2 3D ERV); dated December 22, 2005
IR 436449; Paragon Shows GRN Risk Instead of YLW with ERV Unavailable; dated December 22, 2005
IR 436739; Annunciator SER CRT “Elec Relief Valve Open VLV 2-203-3D,” dated December 26, 2005
IR 437638; 2-0203-3D ERV Inspection; dated December 30, 2005
IR 437938; Documentation Improvements for Unit One ERV Decisions; dated December 31, 2005
IR 437951; Documentation of Follow-Up Inspections on 2-0203-3A/B/C/D; dated December 31, 2005
IR 439429; ERV Actuator for 1-0203-3D Refurbishment Discrepancy; dated January 6, 2006
IR 439798; U-1 ERV Indications; dated January 7, 2006
IR 439831; Degradation Identified on Unit 1 ERV Solenoids in Q1F55; dated January 7, 2006
IR 439878; Wear on the ERV Solenoid Bracket Adjusting Screw; dated January 8, 2006
IR 439990; 3D ERV Indicates Elevated Tailpipe Temps; dated January 9, 2006
IR 440324; Perform Stroke Testing on Removed U1 3C ERV Actuator; dated January 9, 2006
IR 440773; U1 3D ERV Actuator Shows Tilt Pivot Plate Bolt Wear; dated January 10, 2006
IR 440844; Missing G.E. Work Order 99256993-01; dated January 11, 2006
IR 441077; (Dresden) QC U1 ERV Actuator Shows Tilt Pivot Plate Bolt Wear; dated January 11, 2006

IR 441462; ERV Actuators not Refurbished per EC343933 Requirements; dated January 12, 2006
IR 441633; Repair/Replace U-2 3B ERV Actuator During Forced Outage; dated January 12, 2006
IR 441638; Repair/Replace U-2 3C ERV Actuator During Forced Outage; dated January 12, 2006
IR 441643; Repair/Replace U-2 3D ERV Actuator During Forced Outage; dated January 12, 2006
IR 441646; Repair/Replace U-2 3E ERV Actuator During Forced Outage; dated January 12, 2006
IR 441800; Discrepancies Found During Review of ERV Work Order History; dated January 13, 2006
IR 441819; Heat Balance Core Flow Deviation; dated January 13, 2006
IR 442070; Replace Pivot Plate Screws Cannibalized from Spare ERV SOVs; dated January 13, 2006
IR 442172; PSU - U2 3D Relief Valve Failed to Open; dated January 14, 2006
IR 442208; 3E ERV Welds Deficient; dated January 14, 2006
IR 442213; 3B ERV Welds Deficient; dated January 14, 2006
IR 442214; 3D ERV Welds Deficient; dated January 14, 2006
IR 442217; 3C ERV Welds Deficient; dated January 14, 2006
IR 442272; A Spare ERV Assembly Turnbuckle to be Cut and Tested; dated January 14, 2006
IR 442285; As Found Condition of ERV 2-0203-3D Actuator; dated January 15, 2006
IR 442311; ERV Turnbuckle Tack Welds Found Cracked; dated January 15, 2006
IR 442325; Junction Box Near 3C ERV is not Securely Fastened; dated January 15, 2006
IR 442335; Inspect or Repair U-1 3B ERV Actuator During Forced Outage; dated January 15, 2006
IR 442336; Inspect or Repair U-1 3C ERV Actuator During Forced Outage; dated January 15, 2006
IR 442337; Inspect or Repair U-1 3D ERV Actuator During Forced Outage; dated January 15, 2006
IR 442338; Inspect or Repair U-1 3E ERV Actuator During Forced Outage; dated January 15, 2006
IR 442379; Incorrect Spare ERV Selected for Turnbuckle Inspection; dated January 15, 2006
IR 442468; ERV Actuator Rivets not Compressed; dated January 16, 2006
IR 442546; Install TMOD for EC 344897 REV 6; dated January 16, 2006
IR 442566; Misaligned Discharge Piping on Unit 2 3D ERV; dated January 16, 2006
IR 442580; 3D ERV Pilot Valve Operating Lever Bushings were “Ovalized”; dated January 16, 2006
IR 442727; System Engineer Reports that the 1E ERV is not Fully Open; dated January 17, 2006
IR 442768; Inspection Results of U1 ERV 3D Pilot Operating Lever; dated January 17, 2006
IR 442823; PSU - Leak Off Line Sheared on U-1 4D Safety Valve; dated January 17, 2006
IR 442917; PSU - Loose Bolting Associated with MSL C Pipe Support; dated January 17, 2006
IR 442930; PSU - Cotter Pin Missing on Snubber TS 1-27; dated January 17, 2006
IR 442940; Small Bore Leak Off Line Broke at Threaded Connection; dated January 17, 2006
IR 442942; Rigid Strut ISI# 1307-102 is Bound; dated January 17, 2006
IR 442944; Small Bore Pipe Support Found Damaged; dated January 17, 2006
IR 442949; Locking Nuts not Set Tightly on Support; dated January 17, 2006
IR 443002; Snubber 2-67 1/4 Inch Short of MIN Setting; dated January 18, 2006

IR 443030; 3/4 Inch SS Line U Bolt Missing Attachment Nut and Jam Nut; dated January 18, 2006
IR 443035; Removed U2 3D ERV Turnbuckle Inspection Results; dated January 18, 2006
IR 443044; Minor Degradation of U2 Target Rock PS Flex Conduit; dated January 18, 2006
IR 443045; Minor Degradation of U2 Target Rock PS Flex Conduit; dated January 18, 2006
IR 443046; Minor Degradation of U2 Target Rock PS Flex Conduit; dated January 18, 2006
IR 443053; Cotter Pin Broken; dated January 18, 2006
IR 443317; Pipe Support Constant Can Found Outside Range; dated January 18, 2006
IR 443325; Contingency - Repair Main Steam Line Constant Supports; dated January 18, 2006
IR 443410; Spring Can Found to be Bottomed Out; dated January 18, 2006
IR 443413; NRC Found Bent Treaded Rod on Spring Can; dated January 18, 2006
IR 443434; Wear Noted on Load Pin on Target Rock Valve; dated January 18, 2006
IR 443436; Wear Noted on Snubber Load Pin; dated January 18, 2006
IR 443444; NRC Found Bent Threaded Rod on Spring Can; dated January 18, 2006
IR 443447; NRC Found Safety Valve Cap not Secured; dated January 18, 2006
IR 443448; Spring Can Rod in Contact with Can; dated January 18, 2006
IR 451822; Management Decision on Plant Walkdowns Needs Review; dated February 9, 2006

Procedures

ER-AA-2030, Attachment 4; System Walkdown Standards; Revision 4
LS-AA-105; Operability Evaluations; Revision 10
QCEMS 0250-13; Dresser Electromatic Solenoid Actuator EQ Surveillance, Various Revisions
QCOP 6900-19; Documenting 125/250 VDC Grounds; Revision 8
QOP 6900-01; 125 Volt DC Ground Detection Unit 2; Revision 36
QCEMS 0250-13 TIC 1361; Dresser Electromatic Solenoid Actuator Installation, Replacement, Inspection, and EQ Surveillance; dated January 6, 2006
QCEMS 0250-13; Dresser Electromatic Solenoid Actuator Installation, Replacement, Inspection, and EQ Surveillance; Revision 15
Dresser Manual 333; Instructions for Installation and Maintenance, Electromatic Relief Valve; Revision 0

Work Orders

WO 638286-01; Perform Visual and Liquid Penetrant Examination of ERV Leakoff Lines; dated November 15, 2003
WO 639258-01; Perform Visual and Liquid Penetrant Examination of ERV Leakoff Lines; dated November 15, 2003
WO 776224-01; Contingency to Investigate/Repair Ground of Unit 2 125 VDC System; dated December 21, 2005
WO 990154172; Inspect Spare ERV Actuator Removed from Unit 1 3B ERV; dated June 20, 2000
WO 879655-07; Inspect & Rebuild ERV Solenoid Actuators; dated January 7, 2006
Magnetic Particle Examination of Turnbuckle & Boss Data Sheet; dated January 15, 2006

Engineering Changes

Engineering Change 346515; Evaluation of Quad Cities Unit 1 Main Steam Line Vibrations at Extended Power Uprate Levels; Revision 3

Engineering Change 357589; Final Disposition of Vibration Data for Quad Cities MSL Components Unit 1 and 2; Revision 0
Engineering Change 350693; Vibration Evaluation of 3-Stage Target Rock First Stage Pilot Valve; Revision 0
Engineering Change 355702; Evaluation of Quad Cities Unit 2 Main Steam Line Vibrations at EPU Power Levels; Revision 0
Engineering Change 355773; Evaluation of Quad Cities Unit 1 Main Steam Line Vibrations at EPU Power Levels; Revision 0
Engineering Change 358944; ERV Guide Post Beveled Washer Modification; Revision 0
Engineering Change 343933 000; Replace the Current PORVs with ERVs; dated September 22, 2004
Engineering Change 358832; Evaluation of Quad Cities 2 ERV Failure Applicability to Dresden Units 2 and 3; Revision 1
Engineering Change 347763 001; Remove Actuator Tieback Supports on Unit 1 ERVs and Upgrade Actuators and Drain Line Flanges; dated April 27, 2005
Engineering Change 358821; ERV Rebuild Recommendations - Use of Loctite on Actuator Screws; dated January 7, 2006

Other Documents

Calculation QC-31-301; Evaluation of the ERV Turnbuckle; dated January 18, 2006
Control Room Logs; dated December 30, 2005
Technical Specifications
Updated Final Safety Analysis Report
Technical Assessment of Whether Unit 1 Target Rock Safety Relief Valve Should Be Inspected in January 2006 Outage; dated January 11, 2006
Presentation Slides on Main Steam Isolation Valve Limit Switch Degradation; dated December 2005
Results from Vibration-Related Extent of Condition Walkdowns and Evaluation of Cause Commonality; dated January 18, 2006
Quad Cities Unit 2 ERV Vibration Data; dated January 17, 2006
EPU Extent of Condition Review Recommendations; dated January 17, 2006
Quad Cities Unit 1 Generator Gross Generation and Reactor Thermal Power Data; dated January 13, 2006
Quad Cities Unit 2 Generator Gross Generation and Reactor Thermal Power Data; dated January 13, 2006
Observations and Measurements of ERV Assemblies from Unit 1; dated January 12 & 18, 2006
Observations and Measurements of ERV Assemblies from Unit 2; dated January 11 & 18, 2006
GENE 0000-0030-6847; Exelon Nuclear Quad Cities Nuclear Power Station Target Rock 3-Stage SRV Pilot Valve Assembly Vibration Aging Test Requirements; dated July 8, 2004
GENE-0000-0034-7073-00; Quad Cities Unit 2 Target Rock 3-Stage Pilot Operated Main Steam Safety Valve Design Modification; dated November 20, 2004
Main Steam Isolation Valve Failure Data; dated January 13, 2006
Quad Cities ERV Performance Review Post Q1R18 and Q2R17; dated January 9, 2006
Letter from James G. Trettin to Robert Holbrook; Cancellation of Modification M04-1-93-012; dated February 9, 1998
Licensee Event Report 50-265/77-31; Unit 2 Main Steam Electromatic Relief Valve 2-203-3E Failed to Open During Testing; dated November 21, 1977

Licensee Event Report 50-254/78-04; Unit 1 Main Steam Electromatic Relief Valve 1-203-3E Failed to Open During Testing; dated March 3, 1978
Dresser Industries Engineering Report SV-321; dated 12-19-1990
Email from Roland Huffman, Dresser; Recommendations for Application of Loctite to ERVs to Provide Resistance to Vibration; dated January 5, 2006
Exelon Operability Evaluation 437638-02; Quad Cities Units 1 and 2 ERVs; Revision 2
Magnetic Particle (dry) Examination of Turnbuckle & Boss Data Sheet; dated January 15, 2006
Magnetic Particle (wet) Examination of Turnbuckle & Boss Data Sheet; dated January 16, 2006
Structural Integrity Associates, Inc.; Subject - Quad Cities Unit 1 Main Steam Vibration Assessment; dated January 15, 2004
Commonwealth Edison Company document; Subject - Environmental Qualification of the Dresser Electromatic Relief Valve Solenoid Actuator; Revision 4

LIST OF ACRONYMS USED

EPU	Extended Power Uprate
ERV	Electromatic Relief Valve
NCV	Non-Cited Violation
PORV	Power Operated Relief Valve
RCIC	Reactor Core Isolation Cooling
SIT	Special Inspection Team
URI	Unresolved Item
Vdc	Volts direct current

January 9, 2006

MEMORANDUM TO: John Jacobson, Senior Reactor Engineer
Division of Reactor Safety

FROM: Mark A. Satorius, Director ***/RA by Steve West Acting for/***
Division of Reactor Projects

SUBJECT: SPECIAL INSPECTION CHARTER TO REVIEW UNEXPECTED ELECTROMATIC RELIEF VALVE DEGRADATION AT QUAD CITIES GENERATING STATION ON JANUARY 9, 2006

In mid-December 2005, the licensee for Quad Cities Station Unit 2 determined that a 125 VDC ground was present on the 3D electromatic relief valve (ERV) solenoid circuit. On December 30, 2005, the licensee entered the Unit 2 drywell at power and discovered that the 3D ERV actuator was severely degraded such that the valve would not have operated if called upon. This valve is one of four valves used for automatic depressurization. The licensee shut down Unit 2 and conducted inspections of the three remaining ERV actuators. The other three actuators also showed signs of degradation but were considered operable. The initial cause of the actuator degradation is thought to be flow induced vibration from extended power uprate (EPU) power levels. Immediate corrective actions included replacing all four of the Unit 2 ERV actuators, reducing Unit 1 power to pre-EPU levels, and scheduling a Unit 1 outage to allow inspection of the ERV actuators. An immediate shut down of Unit 1 was not pursued since the licensee had no indications that the Unit 1 ERV actuators were degraded and power was lowered to pre-EPU levels. Unit 2 returned to power on January 1, 2006, and continues to operate at pre-EPU power levels.

On January 6, 2006, the licensee shut down Unit 1 to inspect the ERV actuators. Again, all four valves experienced some amount of wear and degradation. During as-found testing of the actuators, the licensee determined that one of the valves (the 3D) failed to actuate. In addition, two of the other actuators (the 3B and 3C) may not have worked when called upon. The remaining actuator stroked satisfactorily. All four of the actuators were replaced. Unit 1 returned to power on January 8, 2006. Unit 1 will remain at pre-EPU power levels until the licensee can demonstrate the ability of the ERV actuators to operate at EPU power levels without experiencing degradation.

Based on the criteria specified in Management Directive 8.3 (Part I, Criterion (e & g)) and Inspection Procedure 71153, a Special Inspection was initiated in accordance with Inspection Procedure 93812 and Regional Procedure RP-1219. The Special Inspection will commence on January 9, 2006, and be led by John Jacobson, however some inspection activities began during the weekend of January 7, 2006. In addition to Mr. Jacobson, the team will consist of Karla Stoedter, DRP, Senior Resident Inspector - Quad Cities (part time), Charles Hammer, NRR, Relief Valve Specialist, and Michael Kurth, DRP, Resident Inspector - Quad Cities.

The special inspection will evaluate the facts, circumstances, and licensee actions surrounding the actuator degradation. Elements of this inspection should include a review of the licensee's disassembly and inspection of the Unit 1 ERV actuators, a review of the licensee's efforts to determine the root cause of the actuator degradation, and a review of previously identified EPU-vulnerable components that the licensee had considered acceptable for operation at EPU power levels. A charter was developed and is attached. An entrance meeting will be conducted on Monday, January 9, 2006.

Attachment: As stated

cc w/att: M. Ring, DRP
J. Jacobson, DRS
C. Hammer, NRR
M. Kurth, DRP
C. Pederson, DRS, Division Director
J. Caldwell, Regional Administrator, Region III
G. Grant, Deputy Regional Administrator, Region III
P. Habighorst, Region III EDO Coordinator
C. Haney, NRR, Director DORL

QUAD CITIES INSPECTION (SI) CHARTER

This Special Inspection is chartered to assess the circumstances surrounding the unexpected degradation of multiple electromatic relief valve actuators at Quad Cities Station, Units 1 and 2. The inspection should include a review of the licensee's disassembly and inspection of the Unit 1 ERV actuators, a review of the licensee's efforts to determine the root cause of the actuator degradation, and a review of previously identified EPU-vulnerable components that the licensee had considered acceptable for operation at EPU power levels. Additionally, any relationship to the 2003 Unit 1 ERV actuator degradation issue should be evaluated. The 2003 issue was similar in that an ERV actuator was found severely degraded. In addition, the corrective actions developed to address the 2003 ERV actuator issue should have prevented additional degradation from occurring. The Special Inspection will be conducted in accordance with Inspection Procedure 93812, "Special Inspection," and will include, but not be limited to, the following items:

1. Establish a sequence of events regarding the degradation of the ERV actuators for both units.

2. Monitor the licensee's efforts to determine the root cause of the 2005 and 2006 ERV actuator degradation.

3. Evaluate the adequacy of the licensee's previous testing and analysis used to conclude that other EPU-vulnerable components were acceptable for operation at EPU power levels. This evaluation should include, but not be limited to, the safety valves, the Target Rock valves, Limitorque actuators, and NAMCO limit switches.

4. Assess the adequacy of the licensee's maintenance work practices related to the assembly, installation, and testing of ERV actuators.

5. Evaluate the licensee's response to previously identified suspect indications associated with the 3D ERV on Unit 2 and any associated operability documents.

6. Evaluate the licensee's historical operating experience associated with ERV actuators.

7. Assess the licensee's efforts to determine the extent of condition and potential generic consequences including potential applicability to Units 2 and 3 at Dresden.