

OPERATING EXPERIENCE RELATED TO POWER UPRATES

Damage of Steam Dryers and Other Plant Components at Quad Cities and Dresden

Exelon Generating Company, LLC (Exelon), has discovered cracks in the steam dryer on three separate occasions at Quad Cities Unit 2 since the unit has operated at EPU power levels. Exelon also found cracks in the steam dryers at Dresden Units 2 and 3 and Quad Cities Unit 1. Flow-induced vibration contributed to failures of feedwater sampling probes at Dresden Units 2 and 3 and inoperability of an electromatic relief valve at Quad Cities Unit 1. Loose parts in the reactor coolant system have been generated from pieces of cracked steam dryers and flow-induced vibration damaged feedwater probes. The staff has determined that these issues do not pose an immediate safety concern given the current operating conditions at Quad Cities and Dresden. However, steam dryers and other internal main steam and feedwater components must maintain structural integrity to avoid generating loose parts that could impact safety system or reactor plant operation.

Since 2002, steam dryer cracking and flow-induced vibration damage on components and supports for the main steam and feedwater lines have been observed at Dresden and Quad Cities following implementation of extended power uprates (EPUs). In June 2002, approximately 3 months following implementation of a 17.8-percent EPU, Quad Cities Unit 2 experienced an increase in the moisture content of the steam flowing to the turbine. In July 2002, the licensee shut down Quad Cities, Unit 2, for inspection and identified cracks in the steam dryer. The licensee repaired the steam dryer, and returned the unit to power operation at the EPU power level. The steam dryer is not a safety-related component, but is required to maintain its structural integrity. Approximately 10 months following restart of Quad Cities, Unit 2 from the outage to repair the steam dryer, the plant experienced a similar increase in the moisture content of the steam. The licensee shut down the plant for inspection of the steam dryer and identified cracks in several locations of the steam dryer.

On November 12, 2003, Quad Cities Unit 1 was shut down to perform inspections and repairs of the steam dryer. The unit had been operating at a reduced power level since November 3, 2003, due to indications of higher-than-normal moisture carryover in the reactor steam. On November 13, 2003, the steam dryer was found damaged during inspections following reactor disassembly. The damage occurred in the ½ inch-thick upper dryer hood cover plate. The cover plate had cracks approximately 51 inches in total length and a 6 inch by 9 inch portion of the plate broke off from the steam dryer. Exelon conducted extensive inspections in an effort to locate the lost steam dryer piece(s). The piece(s) were not recovered; however, Exelon has found indications on a recirculation pump impeller. Based on these indications, the material is most likely in the bottom of the reactor vessel. The licensee conducted a loose part analysis to determine potential effects on plant systems and concluded that it was safe to operate the plant with the loose part in the vessel. The staff reviewed the licensee's loose part analysis and agreed with the licensee. Repairs and modifications, similar to those completed on the Quad Cities Unit 2 steam dryer earlier in 2003, were also completed on Unit 1.

Also during the November 2003 Quad Cities Unit 1 outage, Exelon discovered that the pilot vent line on a main steam line electromatic relief valve was sheared off from the pilot assembly and the solenoid actuator for the valve was significantly damaged. Flow-induced vibration on the main steam line during EPU operating conditions contributed to this damage. Exelon replaced the damaged solenoid actuator and rewelded the pilot vent line to the pilot assembly on the relief valve prior to restarting the unit.

During the fall 2003 refueling outage at Dresden Unit 2, Exelon found cracking on the steam dryer, but it was not through-wall. There were no indications of higher-than-expected moisture carryover in the reactor steam at Dresden Unit 2 during the previous operating cycle. Repairs and modifications, similar to those performed on the dryers at Quad Cities Units 1 and 2, were completed on the steam dryer at Dresden Unit 2 during this recent refueling outage. Additionally, Exelon found three holes in a feedwater sparger and an isokinetic feedwater sampling probe in the sparger at Dresden Unit 2. Exelon believed that the probe apparently caused the damage to the sparger. Exelon determined that the probe failed due to mechanical, high-cycle fatigue induced by flow vibrations during the previous operating cycle. A feedwater sampling probe also failed at Dresden Unit 3 following EPU operation. This probe was never found. The staff issued Information Notice (IN) 2004-06, "Loss of Feedwater Isokinetic Sampling Probes at Dresden Units 2 and 3, on March 26, 2004, to inform licensees about this issue.

On February 24, 2004, Quad Cities Unit 2 was shut down for a scheduled refueling outage and for inspections of the steam dryer. After approximately 6 months of operation at EPU conditions, Exelon identified several new cracks on the steam dryer at Quad Cities Unit 2, including cracking on areas of the steam dryer that were modified to address previous problems identified with the steam dryer. Exelon repaired the steam dryer and developed a plan to attempt to identify the mechanism that has been causing unacceptable steam dryer loads and steam dryer cracking. On March 28, 2004, Exelon returned Quad Cities Unit 2 to operation at the pre-EPU power level and will hold the unit at this power level except to conduct testing at EPU conditions, for brief periods of time, to establish the steam dryer loads with respect to flow rates and to identify any operating limitations. Exelon has held Quad Cities 1 to pre-EPU power levels since returning the unit to operation following the November 2003 outage and plans to continue to operate the unit at pre-EPU levels until the results of the tests at Quad Cities 2 are evaluated. Based on longer EPU operation and less observed steam dryer damage at the Dresden units, in comparison to the Quad Cities units, Exelon believes that sufficient basis exists to continue to operate Dresden Units 2 and 3 at EPU power levels. Exelon plans to inspect the steam dryers at the Quad Cities and Dresden units at the next applicable refueling outages.

On April 2, 2004, Exelon committed to the Nuclear Regulatory Commission (NRC) to maintain both Quad Cities units at pre-EPU power levels, except for testing of the flow effects on the Quad Cities units. The NRC sent Exelon a commitment acknowledgment letter on April 20, 2004, documenting Exelon's commitments and the NRC's assessment of those commitments. In the April 20, 2004, letter, the NRC staff noted concerns with Exelon's plans to justify long-term EPU operation of the Quad Cities units and Exelon's summary basis for continued long-term EPU operation of the Dresden units. On May 12, 2004, Exelon provided an update to its commitments regarding EPU operation of the Quad Cities and Dresden units. In particular, Exelon will not exceed pre-EPU levels at the Quad Cities units until demonstrating

to the NRC staff that EPU operation is justified. Exelon also provided additional information for support of the continued EPU operation of the Dresden units.

The staff is closely monitoring industry's generic response to the failures. General Electric Nuclear Energy (GENE) issued Services Information Letter (SIL) No. 644, "BWR/3 Steam Dryer Failure," on August 21, 2002, to inform its customers of the first steam dryer failure and SIL No. 644, Supplement 1, "BWR Steam Dryer Integrity," on September 5, 2003, to inform its customers of the second steam dryer failure. Both of these documents provided recommendations for monitoring steam dryer performance to ensure that steam dryer degradation is promptly identified. The staff issued IN 2002-026, "Failure of Steam Dryer Cover Plate after a Recent Power Uprate," on September 11, 2002, to inform licensees of the first failure and Supplement 1 to IN 2002-026, "Additional Failure of Steam Dryer after a Recent Power Uprate," on July 21, 2003, to inform licensees of the second failure. On January 9, 2004, the staff issued Supplement 2 to IN 2002-026, "Additional Flow-Induced Vibration Failures after a Recent Power Uprate," to inform licensees of the failure of the steam dryer and other plant components at Quad Cities, Unit 1. In addition, the staff has provided comments to the Boiling Water Reactor Owners Group (BWROG) on the technical evaluation and recommendations contained in SIL No. 644.

The staff held meetings with the BWROG and GENE on February 3 and March 4, 2004, to discuss industry's actions related to resolution of BWR steam dryer integrity and other EPU concerns. On May 7, 2004, the BWROG provided the results from its EPU survey and the Institute of Nuclear Power Operations database review. The staff is considering its regulatory options based on the industry's response, including the ongoing activities noted above.

Abnormalities in Ultrasonic Flow Meter Instrumentation Readings

On August 28, 2003, Exelon informed the staff that it was reducing the operating power of Byron Units 1 and 2 by 32 megawatts thermal (MWe) and 22 MWe, respectively. The decision was made following analysis of feedwater flow data derived from the Westinghouse/AMAG "CROSSFLOW" ultrasonic flow meters (AMAG UFM) used at Byron and Braidwood. The AMAG UFM were used to adjust the feedwater flow rate indications from the venturi meters to compensate for possible venturi fouling during an operating cycle. Exelon reported that there were unexpected, small differences in power level indications while using the AMAG UFM. On September 1, 2003, the power at Braidwood Unit 2 was reduced due to problems with the AMAG UFM.

Westinghouse issued Technical Bulletin (TB) 03-6 on September 5, 2003, to inform its customers of the abnormalities experienced at the Byron and Braidwood plants. TB 03-6 also provided recommendations for plants to monitor their instrumentation to promptly identify any such abnormalities at their plants. Westinghouse issued a Nuclear Safety Advisory Letter (NSAL)-03-12 on December 5, 2003, describing this issue and providing recommendations to licensees using the AMAG system.

On February 6, 2004, a tracer test of the feedwater flow rates was conducted at Byron to obtain an accurate measure of the feedwater flow and compare this measurement with the AMAG UFM. The test results indicated that there were differences in flow measurements between the AMAG UFM reading and the tracer test results. On February 12, 2004, Westinghouse issued TB-04-4, which provided information regarding recent AMAG UFM system performance issues

including the results of the tracer test. Braidwood and Byron are no longer using the AMAG UFM system to measure feedwater flow.

The NRC staff met with Westinghouse on April 22, 2004, to discuss ongoing activities related to the AMAG UFM's. Westinghouse has implemented an action plan to perform scale model testing and obtain industry performance data. Additionally, the Westinghouse Owners Group (WOG) has notified the NRC that it is adopting the AMAG issue as an industry initiative. The WOG is soliciting industry support and will take over the Westinghouse action plan.

The staff continues to follow this issue for any implications for plants that have implemented MUR power uprates. There are 12 nuclear reactor units in the United States that have received staff approval for MUR power uprates based on the use of the AMAG UFM system.

An MUR power uprate for Fort Calhoun was authorized on January 16, 2004, which allowed an increase in the licensed thermal power limit to 1524 MWt. The licensee was subsequently informed by Westinghouse that potential instrument inaccuracies in the AMAG UFM would not allow implementation of the MUR power uprate at Fort Calhoun. As a result, on May 7, 2004, prior to implementation of the MUR power uprate, the licensee submitted an exigent license amendment request to return Fort Calhoun's licensed thermal power limit to 1500 MWt, the pre-MUR level. On May 14, 2004, the staff approved this license amendment request, returning the licensed maximum power level at Fort Calhoun to 1500 MWt.

Currently, the issues identified with the AMAG UFM's at Byron, Braidwood, and Fort Calhoun have not been shown to be a problem at nuclear units that have implemented MUR power uprates using the AMAG UFM system.