

## **POLICY ISSUE INFORMATION**

June 9, 2006

SECY-06-0136

FOR: The Commissioners

FROM: Luis A. Reyes  
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SUBJECT: STATUS REPORT ON POWER UPRATES

### PURPOSE:

This paper summarizes the power uprate program accomplishments and challenges since the last update in SECY-05-0098, dated June 2, 2005. This paper does not address any new commitments or resources.

### BACKGROUND:

The staff provides the Commission an annual update of significant power uprate activities in accordance with a staff requirements memorandum dated February 8, 2002 (SRM-M020129).

### DISCUSSION:

Since the last update, the staff has approved 4 plant-specific power uprates. The staff is currently reviewing 9 power uprates. Over the next 5 years, licensees are expected to submit an additional 23 power uprate applications. The enclosed status report provides detailed information on the power uprates approved since June 2, 2005, applications under review, applications expected in the future, accomplishments, operating experience, program performance and interactions with stakeholders.

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The staff is continuing to develop process improvements based on lessons learned from completed reviews and operating experience reviews. The process improvements include more detailed reviews of certain technical issues and some efficiency improvements. The technical issues include power uprate testing programs, flow-induced vibration issues, and reactor systems calculative techniques and methods. These more detailed reviews have resulted in an increase in the planned resources for an extended power uprate (EPU) review from 3,900 hours to 5,000 hours. These resources are budgeted through Fiscal Year 2008. Regarding efficiency improvements, the staff has implemented more rigorous acceptance reviews for power uprate applications and the staff will, on a pilot basis, conduct more extensive audits to improve the review efficiency. Details of the program accomplishments and improvements are described in the enclosure.

With the exception of the Vermont Yankee review, the 4 plant-specific power uprate reviews were completed within the established resource and timeliness goals. The Vermont Yankee review required additional time and resources to allow a thorough review of key technical issues associated with safe operation at the new power level. The review of the key technical issues discussed above took longer than expected for the staff and licensee to come to resolution on these issues. The review involved several rounds of RAIs and over 40 supplemental submittals by the licensee. Ultimately, license conditions were used to resolve the remaining key issues. To correct this in the future, the staff will utilize more and earlier management involvement in the decision-making process, including consideration of license conditions to resolve key issues earlier in the review process.

The staff formed a Special Inspection Team to evaluate the licensee's response to significant degradation of the electromatic relief valves at the Quad Cities units from EPU operation, and reviewed modifications at Quad Cities Unit 2 in spring 2006 to eliminate the source of flow-induced vibration and acoustic pressure pulses in the main steam lines during EPU operation. Additionally, the staff monitored the power ascension at Vermont Yankee following issuance of the EPU license amendment on March 2, 2006, and met with the vendors of ultrasonic flow meters used for measurement uncertainty recapture power uprates to discuss issues related to small differences in power level indications at some plants. The staff is evaluating the need to modify guidance to address the operating experience.

COORDINATION:

The Office of the General Counsel reviewed this report and has no legal objection.

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Enclosure: Power Uprate Program Status Report

**Power Uprate Program Status Report  
June 2006**

Power uprates are categorized based on the magnitude of the power increase and the methods used to achieve the increase. Measurement uncertainty recapture (MUR) power uprates result in power level increases that are less than 2 percent and are achieved by implementing enhanced techniques for calculating reactor power. Stretch power uprates (SPUs) typically result in power level increases that are up to 7 percent and generally do not involve major plant modifications. Extended power uprates (EPUs) result in power level increases that are greater than SPUs and usually require significant modifications to major plant equipment. The Nuclear Regulatory Commission has approved EPUs for increases as high as 20 percent.

Power Uprates Approved Since June 2005

Power uprates approved since June 2, 2005, have added an additional 608 megawatts thermal (MWt) or approximately 203 megawatts electric (MWe) to the Nation's electric generating capacity. This brings the total number of power uprates approved since 1977 to 109, resulting in a combined increase of about 13,858 MWt or 4,619 MWe to the Nation's electric generating capacity.

NO.	PLANT	% UPRATE	MWt	APPLICATION DATE	APPROVAL DATE	TYPE
1	Palo Verde 1	2.9	114	07/09/2004	11/16/2005	SPU
2	Palo Verde 3	2.9	114	07/09/2004	11/16/2005	SPU
3	Vermont Yankee	20	319	09/10/2003	03/02/2006	EPU
4	Seabrook	1.7	61	09/22/2005	05/22/2006	MUR

On March 2, 2006, the staff completed its review of the Vermont Yankee EPU application and approved the 20 percent power uprate. The licensee reached 120 percent of original licensed thermal power (the full EPU) on May 5, 2006, and successfully conducted a planned condensate pump trip test on May 8, 2006. Details on program performance versus established goals for these approved power uprates are presented later in this enclosure.

Power Uprate Applications Currently Under Staff Review

Power uprates currently under review could add an additional 2420 MWt or 807 MWe to the Nation's electric generating capacity if approved.

NO.	PLANT	% UPRATE	MWt	SUBMITTAL DATE	PROJECTED COMPLETION DATE	TYPE
1	Browns Ferry 2	15	494	06/25/2004	Spring 2007	EPU
2	Browns Ferry 3	15	494	06/25/2004	Spring 2007	EPU

NO.	PLANT	% UPRATE	MWt	SUBMITTAL DATE	PROJECTED COMPLETION DATE	TYPE
3	Browns Ferry 1	20	659	06/28/2004	Spring 2007	EPU
4	Beaver Valley 1	8	211	10/04/2004	07/18/2006	EPU
5	Beaver Valley 2	8	211	10/04/2004	07/18/2006	EPU
6	Calvert Cliffs 1	1.3	37	01/31/2005	12/31/2006	MUR
7	Calvert Cliffs 2	1.3	37	01/31/2005	12/31/2006	MUR
8	Fort Calhoun	1.5	22	03/31/2005	12/31/2006	MUR
9	Ginna	17	255	07/07/2005	08/23/2006	EPU

### Expected Power Uprate Applications

The following table describing intended future license amendment applications is the result of a survey of all licensees conducted in March 2006 and information obtained since the survey.

Fiscal Year	Power Uprates Expected	MUR Power Uprates	SPUs	EPUs	MWt	MWe
2006	4	1	0	3	1470	490
2007	6	5	1	0	431	144
2008	0	0	0	0	0	0
2009	10	2	3	5	1792	597
2010	2	2	0	0	76	25
2011	1	1	0	0	26	9
<b>TOTAL</b>	<b>23</b>	<b>11</b>	<b>4</b>	<b>8</b>	<b>3795</b>	<b>1265</b>

### Accomplishments Since June 2, 2005

- Approved four plant-specific power uprates: one MUR power uprate (Seabrook), two SPUs (Palo Verde Units 1 and 3) and an EPU (Vermont Yankee). An adjudicatory proceeding is currently in progress on the Vermont Yankee EPU; hearings are expected to be held in September-October 2006.
- Issued an acceptance review letter for the Ginna power uprate application.
- Monitored the installation of new steam dryers with an improved design at Quad Cities Units 1 and 2 in May 2005 and the return of those units to EPU operation.

- Performed additional reviews of, and conducted public meetings on, the Exelon Generating Company, LLC (Exelon) evaluations of the plant data obtained during EPU operation at Quad Cities to determine the causes of flow-induced vibration (FIV) issues.
- Reviewed Exelon's evaluation of the steam dryer cracking identified at Dresden Units 2 and 3 in November 2005 and subsequent repair of the steam dryers.
- Formed a Special Inspection Team led by Region III with NRR assistance in January 2006 to evaluate Exelon's response to significant degradation of the electromatic relief valves (ERVs) at Quad Cities Units 1 and 2 from EPU operation.
- Reviewed Exelon's response to the significant cracking identified in the steam dryer in Quad Cities Unit 2 during its spring 2006 refueling outage, which the licensee determined was caused by installation difficulties with the new dryer in May 2005.
- Reviewed the modifications performed by Exelon at Quad Cities Unit 2 in spring 2006 to eliminate the source of FIV and acoustic pressure pulses in the main steam lines to reduce vibration of main steam line components and pressure loading on the steam dryer during EPU operation.
- Monitored the power ascension at Vermont Yankee following issuance of the EPU license amendment on March 2, 2006, and reviewed plant data to evaluate pressure loading on the modified steam dryer and vibration of plant components during the power ascension process.
- Continued to hold discussions regarding FIV issues with General Electric Nuclear Energy and the Boiling Water Reactor Owners Group.
- Met with Westinghouse and Caldon, the vendors of ultrasonic flow meters used for MUR power uprates, to discuss issues related to small differences in power level indications at some plants.
- Presented information on the Vermont Yankee, Ginna, and Beaver Valley Units 1 and 2 EPU applications to the Advisory Committee on Reactor Safeguards (ACRS) and the ACRS Subcommittee on Power Uprates.
- Performed acceptance reviews of the EPU applications for Hope Creek and Susquehanna Units 1 and 2 and determined that the information provided was insufficient to demonstrate that the structural integrity of the steam dryers would be maintained during EPU operation.
- Briefed the Mexican regulator, the Japanese regulator, and a group of Young Swedish Nuclear Professionals on the Nuclear Regulator Commission's (NRC's) power uprate program.
- Presented information on NRC's power uprate program at regulatory information exchange meetings in Taiwan and Korea.
- Supported interviews by *World Watch* and the *Chicago Tribune* that included questions on NRC's power uprate program.
- Provided comprehensive power uprate review guidance in all aspects of power uprate reviews to NRC's plant project managers.
- Briefed the ACRS on the staff's proposed final version of Standard Review Plan Section 14.2.1, "Generic Guidelines for Extended Power Uprate Testing Programs."
- Responded to Congressional questions on power uprates.

#### Operating Experience Related to Power Uprates

There have been several FIV issues warranting staff attention. In May 2005, the licensee installed new steam dryers in Quad Cities Units 1 and 2 with an improved design to increase their structural capability for EPU operation. The steam dryer in Quad Cities Unit 2 was

instrumented with pressure, strain, and acceleration sensors to collect data during the power ascension and EPU operation to determine actual steam dryer loading and to validate an acoustic analysis method that uses main steam line strain gage data as input in calculating stress in the steam dryer during plant operation. The staff monitored the return to EPU operation of the Quad Cities units following replacement of the steam dryers. The staff has been reviewing the data collected at the Quad Cities units and the startup test reports prepared by the licensee and has conducted several public meetings with the licensee to discuss the steam dryer loads at EPU conditions. The staff is currently reviewing the licensee's response to several remaining issues regarding the steam dryer stress analysis and its uncertainty assumptions submitted on December 22, 2005. During EPU operation at Quad Cities Units 1 and 2, the licensee discovered significant degradation of the ERVs at those units in late December 2005 and early January 2006. The licensee shut down the Quad Cities units to repair the ERVs and restarted the units with operation up to pre-EPU power levels. In response to the discovery of the ERV degradation, NRC sent a Special Inspection Team to Quad Cities in January 2006 where the staff found several weaknesses in the licensee's actions to ensure the capability of the ERVs for EPU conditions. The licensee's evaluation of the ERV degradation under EPU conditions determined that the degradation was due to the failure to address the source of the vibrations at the Quad Cities units over the last several years.

During the spring 2006 refueling outage at Quad Cities Unit 2, the licensee discovered a significant crack in the skirt region of the steam dryer. The licensee determined that the cracking was the result of fatigue failure during EPU operation due to overstressing of the skirt during installation difficulties in May 2005. The licensee also conducted modifications to the safety and relief valves branch lines from the main steam lines at Quad Cities Unit 2 to reduce the acoustic pressure fluctuations that are causing significant steam dryer loading and main steam line component vibration. Upon restart of Quad Cities Unit 2 in April 2006, the licensee found that the main steam line strain gage instrumentation indicated acoustic pressure fluctuations during a brief test period at EPU conditions to be below the levels measured at EPU conditions. The licensee shut down Quad Cities Unit 1 in May 2006 to install similar modifications in its steam lines and to inspect the steam dryer. The licensee found minimal indications on the Quad Cities Unit 1 steam dryer which confirmed the analysis of the steam dryer cracking found at Quad Cities Unit 2 earlier this year. As a result, the licensee returned Quad Cities Unit 2 to EPU operation. Following the steam line modifications in Quad Cities Unit 1, the licensee restarted that unit and returned it to EPU operation. The NRC staff will evaluate the Quad Cities plant data, analysis, and inspection results to determine whether any safety concerns exist with the long-term EPU operation of those units.

In previous years, the steam dryers at Dresden Units 2 and 3 were modified to increase their structural capability for EPU operation. These plants had operated for several years at the EPU levels with the modified steam dryers without significant damage. However, cracking was found in November 2005 in Unit 2 and later in Unit 3. The licensee repaired the cracks and installed additional modifications to the steam dryers in the Dresden units. The licensee plans to replace the dryers during the fall 2006 (Unit 3) and the fall 2007 (Unit 2).

In preparing a safety evaluation for the EPU license amendment request for Vermont Yankee, the staff reviewed the licensee's modifications and analysis of the Vermont Yankee steam dryer and the plans for monitoring plant instrumentation to assess steam dryer loads and FIV during power ascension and EPU operation. The staff accepted the licensee's analysis of potential adverse flow effects for EPU operation with specific license conditions and a regulatory

commitment for monitoring plant instrumentation during power ascension. In March 2006 following issuance of the EPU license amendment, the licensee initiated a slow and deliberate power ascension at Vermont Yankee. The plant reached administrative limits on main steam line strain gage measurements at 105 percent, 112.5 percent, and 117.5 percent of original licensed thermal power (OLTP). The licensee also reached an administrative limit at 117.5 percent of OLTP for moisture carryover efficiency of the steam dryer. The staff reviewed the plant data for each power ascension step and the licensee's analysis of the stress on the steam dryer and specific reassessments of the administrative limits. The staff also reviewed the plant data for vibration and the results from walkdown inspections conducted by the licensee during the power ascension hold points. The staff will continue to monitor steam dryer loads and FIV of plant components at Vermont Yankee.

The staff is applying the lessons learned from the review of the power uprate flow effects at Quad Cities and Dresden to other power uprate applications. For example, the staff determined that the initial EPU applications submitted by the Hope Creek and Susquehanna Units 1 and 2 licensees were insufficient to demonstrate that the steam dryers at those plants were capable of maintaining their structural integrity at the uprated power levels. The Hope Creek and Susquehanna Units 1 and 2 licensees are modifying their applications.

Another operating experience issue relates to abnormalities in ultrasonic flow meter (UFM) instrumentation. The staff is currently following industry evaluations of a problem at plants using a UFM of the type used for MUR power uprates. This problem has led to unexpected but small differences in power level indications at some plants. The staff is currently completing its evaluations of pending applications using the Westinghouse Crossflow system with the benefit of this operating experience.

#### Program Performance vs. Established Goals

The established performance goals are: 6 months and 960 staff-hours for reviewing MUR power uprate applications, 9 months and 1800 staff-hours for reviewing SPU applications, and 12 months and 3900 staff-hours for reviewing EPU applications.<sup>1</sup>

The staff will continue to ensure that the goal of protection of public health and safety is not compromised in order to meet these timeliness and resource expenditure goals. To that end, the staff believes it now needs to increase the resource goal for EPU applications to 5,000 hours to adequately review EPU applications in several areas, including power uprate testing programs, FIV issues, and reactor systems calculative techniques and methods. These resources are budgeted through Fiscal Year 2008. It should be noted that individual applications may require more or less review time depending on the nature of the technical issues; for example, the staff's review of the Vermont Yankee EPU involved about 11,000 hours of review (about 10 percent of the 11,000 hours was used in the staff's acceptance review), and 900 hours for a pilot engineering inspection that touched on several EPU issues.

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<sup>1</sup> These goals do not include the duration of and staff-hours for the staff's acceptance review, which the staff conducts upon receipt of the initial application.

The timeliness and resource expenditure goals assume that licensees' submittals are consistent with established guidelines, do not include other non-power-uprate related requests, do not involve new or unanticipated significant technical issues, and that licensees respond to requests for additional information (RAIs) within established schedules. When establishing the above goals for the Office of Nuclear Reactor Regulation (NRR) Operating Plan, the staff recognized that in some cases, licensees' plans for implementing power uprates exceed the timeliness goals described above. As a result, for the NRR Operating Plan, the staff can meet its timeliness goals by either completing the reviews according to the numerical goals or by completing the reviews in time to support licensees' proposed implementation schedules (also known as licensees' need dates), whichever is longer. This flexibility allows the staff to utilize its resources to better support other high-priority activities.

The staff met its timeliness and resource goals for its review of the Seabrook MUR power uprate as well as the Palo Verde Units 1 and 3 SPUs. The Seabrook MUR power uprate was approved on May 22, 2006 (which was the licensee's need date), and the staff charged about 900 hours for its review. The Palo Verde Units 1 and 3 SPU was approved on November 16, 2005 (which was prior to the licensee's need date of November 18, 2005), and the staff charged about 1200 hours for its review. For the Vermont Yankee EPU review, the staff took about 25 months and charged about 10,000 hours from the completion of NRC's acceptance review. The timeliness and resource goals were not met. The scheduled review of the Vermont Yankee EPU was extended largely due to incomplete submissions by the licensee, which required greater effort to allow a thorough review of key technical issues associated with safe operation at the new power level.

The review involved several rounds of RAIs and over 40 supplemental submittals by the licensee. Ultimately, license conditions were used to resolve the remaining key issues. To correct this in the future, the staff will utilize more and earlier management involvement in the decision-making process, including consideration of license conditions to resolve key issues earlier in the review process. In addition, the staff will conduct, on a pilot basis, more extensive audits at the plant and/or vendor sites to expedite resolution of RAIs.

For the ongoing EPU reviews of Browns Ferry Unit 1, Browns Ferry Units 2 and 3, and Beaver Valley Units 1 and 2, the staff expects to meet the timeliness goals of 12 months after the staff's acceptance review or the licensee's need date; however, these applications needed substantial supplementation to pass their acceptance reviews, which took over 9 months in each case. To correct this situation, the staff is now conducting more thorough and rigorous acceptance reviews of power uprate applications. Any significant area not addressed with sufficient completeness to allow the staff to proceed with its detailed technical review, may be treated as a basis for not accepting the application. This staff position was illustrated with the Hope Creek and Susquehanna Units 1 and 2 applications that were withdrawn by the licensees on February 10 and May 18, 2006, respectively, after the staff determined that the applications were insufficient to demonstrate that the structural integrity of the steam dryers would be maintained during EPU operation. In addition, the Susquehanna application did not adequately address several plant systems areas.

For the Ft. Calhoun and Calvert Cliffs Units 1 and 2 MUR power uprate reviews, the NRC staff issued acceptance letters on May 12 and March 18, 2005, respectively. However, these reviews did not meet the 6-month timeliness goal because subsequent to the issuance of the acceptance letters, the staff determined that the NRC-approved methodologies for feedwater



flow measurement were not being used by the licensees. (The staff based the 6-month timeliness goal for MUR power uprates on the use of NRC-approved methodologies.) The staff may also need to revisit the generic topical report associated with these reviews (i.e., the Westinghouse Crossflow system).

#### Interactions with Internal and External Stakeholders

The staff briefed the ACRS Subcommittee on Power Uprates and the ACRS Full Committee in November and December of 2005 for the Vermont Yankee EPU, and in March, April and May of 2006 for the Ginna and Beaver Valley Units 1 and 2 EPUs. Regarding the Vermont Yankee EPU, the ACRS had particular interest in the areas of containment overpressure credit, large transient tests, times available to perform critical operator actions, margin added to the safety limit minimum critical power ratio, and the steam dryer monitoring plan during power ascension. By letter dated January 4, 2006, the ACRS recommended approval of the Vermont Yankee EPU.

Regarding the Ginna and Beaver Valley Units 1 and 2 EPUs, the ACRS had particular interest in the areas of non-loss-of-coolant accident (non-LOCA) events, LOCAs, boron precipitation during long-term cooling following a LOCA, flow-induced vibration, flow accelerated corrosion, and probabilistic risk assessment. By letters dated May 22, 2006, the ACRS recommended approval of the Ginna and Beaver Valley Units 1 and 2 EPUs.

For EPU applications, a proposed No Significant Hazards Consideration (NSHC) determination will be issued as soon as the staff is able to make this proposed determination. This determination would most likely be made right after the staff determines that the application passes the acceptance review. The reason for noticing future EPU applications with proposed NSHC determinations is that there has now been enough experience with EPUs (the staff has approved 14 EPUs to date), such that the staff can now issue a proposed NSHC determination when noticing the application.

The staff briefed the Mexican regulator (April 2006), the Japanese regulator (October 2005), and a group of Young Swedish Nuclear Professionals (October 2005) on NRC's power uprate program. This briefing focused on the staff's process for reviewing power uprate applications.

The staff presented information on NRC's power uprate program at regulatory information exchange meetings in Taiwan and Korea in April 2006. These presentations focused on the staff's process for reviewing power uprate applications and some of the current technical issues with power uprates.