

**Power Uprate Program Status Report
May 2007**

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 of 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 of up to 7 percent and generally do not involve major plant modifications. Extended power uprates (EPU) result in greater power-level increases than SPUs and usually require significant modifications to major plant equipment. The U.S. Nuclear Regulatory Commission (NRC) has approved EPUs for increases as high as 20 percent.

Power Uprates Approved Since June 2006

Power uprates approved since June 9, 2006, have added an additional 842 megawatts thermal (MWt) or approximately 281 megawatts electric (MWe) to the Nation's electric generating capacity. This brings the total number of power uprates approved since 1977 to 113, resulting in a combined increase of about 14,700 MWt (4,900 MWe) to the Nation's electric generating capacity. Table 1 provides information on these approved power uprate applications; details on program performance versus established goals for these approved power uprates will be discussed later in this enclosure.

Table 1 - Power Uprates Approved Since June 2006

| No. | Plant | % Uprate | MWt | Application Date | Approval Date | Type |
|-----|-----------------|--------------|------------|------------------|---------------|------|
| 1 | GINNA | 16.8 | 255 | 07/07/2005 | 07/11/2006 | EPU |
| 2 | Beaver Valley 1 | 8 | 211 | 10/04/2004 | 07/19/2006 | EPU |
| 3 | Beaver Valley 2 | 8 | 211 | 10/04/2004 | 07/19/2006 | EPU |
| 4 | Browns Ferry 1 | 5 | 165 | 09/22/2006 | 03/06/2007 | SPU |
| | | Total | 842 | | | |

On March 6, 2007, the staff completed its review of the Browns Ferry Unit 1 SPU application and approved the 5-percent power uprate. Browns Ferry Unit 1 was shut down in 1985, and the licensee commenced restart of the unit in May 2007. The licensee had originally submitted applications for EPUs for each of the three Browns Ferry units; however, because of delays in providing the information necessary to support the review of the EPUs, the licensee subsequently requested a two-step approach for Browns Ferry Unit 1. This approach involved, as a first step, review and approval of a separate 5-percent SPU application to raise Unit 1 power to the same level and operating conditions as Units 2 and 3. (The NRC approved SPUs for Units 2 and 3 in 1998.) The second step is to submit the information needed to enable the staff to complete its review of the three Browns Ferry EPUs.

Power Uprate Applications Currently Under Staff Review

Power uprates currently under review could add an additional 3,091 MWt or 1,030 MWe to the Nation's electric generating capacity if approved, as noted in Table 2.

Table 2 - Power Uprate Applications Under Review

| No. | Plant | % Uprate | MWt | Submittal Date | Projected Completion Date | Type |
|-----|------------------|--------------|--------------|----------------|---------------------------|------|
| 1 | Browns Ferry 2 | 15 | 494 | 06/25/2004 | Fall 2007 | EPU |
| 2 | Browns Ferry 3 | 15 | 494 | 06/25/2004 | Fall 2007 | EPU |
| 3 | Browns Ferry 1 | 15 | 494 | 06/28/2004 | Fall 2007 | EPU |
| 4 | Calvert Cliffs 1 | 1.3 | 37 | 01/31/2005 | To Be Determined* | MUR |
| 5 | Calvert Cliffs 2 | 1.3 | 37 | 01/31/2005 | To Be Determined* | MUR |
| 6 | Fort Calhoun | 1.5 | 22 | 03/31/2005 | To Be Determined* | MUR |
| 7 | Hope Creek | 15 | 501 | 09/18/2006 | 10/18/2007 | EPU |
| 8 | Susquehanna 1 | 13 | 463 | 10/11/2006 | 01/05/2008 | EPU |
| 9 | Susquehanna 2 | 13 | 463 | 10/11/2006 | 01/05/2008 | EPU |
| 10 | Davis-Besse | 1.6 | 45 | 04/12/2007 | 10/31/2007 | MUR |
| 11 | Crystal River 3 | 1.6 | 41 | 04/25/2007 | 11/15/2007 | MUR |
| | | Total | 3,091 | | | |

* To be determined when the NRC completes its reevaluation of the Westinghouse Crossflow ultrasonic flow meter.

Expected Power Uprate Applications

Table 3 describes intended future power uprate applications based on a survey of all licensees conducted in April 2007.

Table 3 - Projected Future Power Uprate Applications

| Fiscal Year | Power Uprates Expected | MUR Power Uprates | SPUs | EPUs | MWt | MWe |
|--------------|------------------------|-------------------|----------|-----------|--------------|--------------|
| 2007 | 5 | 2 | 3 | 0 | 669 | 223 |
| 2008 | 4 | 3 | 0 | 1 | 323 | 108 |
| 2009 | 6 | 2 | 0 | 4 | 1258 | 419 |
| 2010 | 11 | 2 | 1 | 8 | 1752 | 584 |
| 2011 | 1 | 0 | 0 | 1 | 375 | 125 |
| TOTAL | 27 | 9 | 4 | 14 | 4,377 | 1,459 |

Accomplishments Since June 9, 2006

- Approved four plant-specific power uprates, specifically one SPU (Browns Ferry Unit 1) and three EPU (Ginna, and Beaver Valley Units 1 and 2).
- Issued acceptance review letters for the EPU applications for Hope Creek and Susquehanna Units 1 and 2.
- Met with the Boiling Water Reactor Owners Group (BWROG) and General Electric to discuss improvements to industry guidance on potential adverse flow effects from power uprates.
- Met with Exelon to discuss long-term EPU operation at Dresden Units 2 and 3 and Quad Cities Units 1 and 2.
- Completed its reevaluation of the Caldon Check and CheckPlus ultrasonic flow meters (UFMs) that are used for MUR power uprates, and concluded that the performance of the Caldon Check and CheckPlus UFMs is consistent with Caldon topical reports previously approved by the NRC.
- Presented information on the Browns Ferry Unit 1 SPU application to the Advisory Committee on Reactor Safeguards (ACRS) and the ACRS Subcommittee on Power Uprates.
- Issued the final version of NUREG-0800, "Standard Review Plan," (SRP) Section 14.2.1, "Generic Guidelines for Extended Power Uprate Testing Programs."
- Issued updated versions of SRP Section 3.9.2, "Dynamic Testing and Analysis of Systems, Components, and Equipment," SRP Section 3.9.5, "Reactor Pressure Vessel Internals," and Regulatory Guide 1.20, "Comprehensive Vibration Assessment Program for Reactor Internals During Preoperational and Initial Startup Testing," to provide additional guidance for NRC staff reviewers and the nuclear industry on the evaluation of potential adverse flow effects at operating plants considering power uprates.
- Provided power uprate information to support the 2007 Congressional Oversight Hearings.

Operating Experience Related to Power Uprates

Potential Adverse Flow Effects

At power uprate conditions, nuclear power plants can experience significant increases in steam flow velocities. Plant experience has shown that the higher main steam line flow can create an acoustic resonance in the steam lines as the flow passes over branch lines that can vary greatly from one plant to another depending on the main steam lines routing and steam dryer vintage and geometry. The acoustic resonance can create pressure waves that strike the steam dryer in boiling water reactors (BWRs) with sufficient force to cause the stress in the steam dryer to exceed the material fatigue limits. The acoustic resonance can also cause excessive vibration that may damage steam line components, such as relief valves and piping.

In response to nuclear plant operating experience, the NRC staff has been performing more detailed reviews and inspections of plant performance and power uprate license amendment requests with respect to adverse flow effects on plant structures, systems, and components. However, the recognition of acoustic resonance as causing adverse flow effects is relatively new to the nuclear power industry. The nuclear industry is working to achieve a full understanding of this issue. The NRC staff has received assistance in this highly complex field

from technical experts at Argonne National Laboratory, Pennsylvania State University, and McMaster University.

In response to the failure of the original steam dryers at Quad Cities Units 1 and 2 during EPU operation, the licensee installed new steam dryers with an improved design in those units in May 2005. The Quad Cities Unit 2 steam dryer included pressure sensors, strain gages, and accelerometers to monitor the loads on the steam dryer during restart to EPU conditions. The main steam lines on both units were also instrumented to monitor loads during power ascension to EPU conditions. Following the return to EPU operation in mid-2005, the licensee discovered significant unexpected degradation of the actuators for several electromatic relief valves (ERVs) in the main steam lines at Quad Cities Units 1 and 2 in late December 2005 and early January 2006. To reduce the acoustic-generated pressure fluctuations and vibrations in the main steam lines, the licensee performed modifications by installing acoustic side branches (ASBs) in the inlet lines of the ERVs and the main steam safety valves during outages in the spring 2006. Following the modifications, the licensee returned the Quad Cities units to EPU operation. In letters dated May 3 and August 2, 2006, the licensee submitted EPU startup reports for the Quad Cities units, indicating that the ASB modifications have eliminated the severe acoustic resonances in the main steam lines. As discussed in its EPU startup reports, the licensee determined that with the successful performance of the ASB modifications, the pressure fluctuations and vibrations in the Quad Cities main steam lines at full EPU operation will not exceed the levels that were present at original licensed thermal power conditions before the ASB modifications.

The original steam dryers in Dresden Units 2 and 3 were similar to the original Quad Cities steam dryers, but they were subsequently modified to increase their structural capability. The licensee initially operated the Dresden units at EPU conditions for several years without significant damage. However, after the discovery of steam dryer damage at Dresden in 2005 and 2006, the licensee initiated plans to replace the steam dryers in the Dresden units. The licensee replaced the Dresden Unit 3 steam dryer during the November 2006 refueling outage. The licensee will replace the Dresden Unit 2 steam dryer during the refueling outage scheduled in October 2007.

On March 22, 2007, the staff held a meeting with the licensee regarding long-term EPU operation at Quad Cities Units 1 and 2 and at Dresden Units 2 and 3. The staff did not identify any issues associated with continuing full EPU operation at any of these units. In a followup letter dated April 20, 2007, the licensee provided its EPU monitoring and inspection plans to document its ongoing corrective actions and commitments.

After its detailed review of the Vermont Yankee EPU license amendment request, the NRC staff determined that the licensee's analysis of potential adverse flow effects for EPU operation was acceptable, with specific license conditions and a regulatory commitment for monitoring plant instrumentation during power ascension. Following issuance of the EPU license amendment in March 2006, the NRC staff reviewed the licensee's analysis of plant data and the results of plant walkdowns during power ascension to EPU conditions at Vermont Yankee. Based on plant data, the licensee held the power ascension at specific levels to analyze the data as necessary before achieving EPU conditions. Vermont Yankee has been operating at EPU conditions since May 4, 2006. The licensee will conduct steam dryer inspections at Vermont Yankee during future refueling outages in accordance with its license conditions.

With regard to the EPU requests for Browns Ferry Units 1, 2, and 3, the NRC staff reviewed the steam dryer analysis submitted by the licensee in mid-2006. The licensee based its analysis on small-scale testing without specific data from the steam dryer or main steam lines at Browns Ferry. Given the predicted steam dryer loads, assumptions, and uncertainties, the staff informed the licensee that the analysis did not adequately demonstrate that the steam dryer would meet its fatigue stress limits during EPU operation. Subsequently, the licensee requested a separate 5-percent SPU in late 2006 for Browns Ferry Unit 1 to allow the collection of actual plant data for use in the steam dryer analysis. (Units 2 and 3 received their 5-percent SPUs in 1998.) The licensee also installed main steam line instrumentation in Browns Ferry Unit 2 in October 2006 and is currently analyzing the collected data. The NRC staff briefed ACRS on the 5-percent SPU request for Browns Ferry Unit 1 in January and February 2007. The staff approved the 5-percent SPU on March 6, 2007. The staff anticipates completing the EPU review for Browns Ferry after the licensee completes its analysis using the actual plant data.

With regard to the September 18, 2006, EPU license amendment request for Hope Creek, the staff was concerned that the calculated stresses for some steam dryer locations appeared to be unacceptable for EPU operation. In response, by letter dated October 10, 2006, the licensee provided an evaluation that concluded that, when conservatisms introduced in the load assumptions are considered and estimated, the allowable stress limits of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code are met. On October 18, 2006, the staff accepted the EPU license amendment request for its detailed technical review. The staff has prepared requests for additional information (RAIs) on the licensee's consideration of potential adverse flow effects, including the steam dryer analysis, and will interact with the licensee to resolve the RAIs.

With regard to the October 11, 2006, EPU license amendment requests for Susquehanna Units 1 and 2, the licensee's steam dryer analysis indicated that additional evaluation was needed for specific steam dryer components that were predicted not to meet the fatigue stress limits under EPU conditions. During a public meeting on November 6, 2006, the licensee indicated that it was conducting an evaluation to determine whether to modify the original steam dryer or to install a new steam dryer with an improved design. By letter dated December 4, 2006, the licensee notified the staff that it will replace the steam dryers in Susquehanna Units 1 and 2. By letter dated December 26, 2006, the licensee subsequently provided a description of the new steam dryers, the steam dryer stress analysis, and the plans for instrumenting one of the steam dryers. By letter dated January 5, 2007, the staff accepted the licensee's application and initiated its detailed evaluation, including the preparation of RAIs.

The BWROG is leading the industry response to potential adverse flow effects from power uprate operation. On November 8, 2006, the NRC staff held a public meeting with the BWROG and General Electric to discuss improvements to the BWROG guidance in NEDO-33159, Revision 0, "Extended Power Uprate (EPU) Lessons Learned and Recommendations," which focuses on potential adverse flow effects from power uprates. On May 11, 2005, the BWR Vessel and Internals Project (BWRVIP) submitted BWRVIP-139, "BWR Vessel and Internals Project, Steam Dryer Inspection and Flaw Evaluation Guidelines," which is currently under staff review. Additionally, the staff has been informed that the development of a generic steam dryer integrated evaluation methodology is planned.

The staff is applying lessons learned from operating experience and analysis of potential adverse flow effects in its review of power uprate requests for currently operating nuclear power plants and its review of design certification requests for new nuclear power plants. As part of this effort, the staff has updated SRP Sections 3.9.2 and 3.9.5 and Regulatory Guide 1.20 to provide additional guidance for NRC staff reviewers and the nuclear industry on the evaluation of potential adverse flow effects at operating plants considering power uprates and at new nuclear power plants.

Ultrasonic Flow Meter Instrumentation

Another operating experience issue relates to abnormalities in UFM instrumentation. The staff is currently reviewing 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.

Two vendors, Caldon and Westinghouse, currently supply UFM's to nuclear power plants. The staff is reevaluating the generic approvals previously granted for these UFM's. By letter to Caldon dated July 5, 2006, the staff's reevaluation concluded that the performance of the Caldon Check and CheckPlus UFM's is consistent with previous NRC reviews and therefore is acceptable. The staff's reevaluation of the Westinghouse Crossflow UFM is ongoing. The staff will consider issuing additional guidance for MUR power uprate applications when it completes its reevaluation of the Westinghouse Crossflow UFM.

Program Performance versus Established Goals

The established performance goals are: 6 months for reviewing MUR power uprate applications, 9 months for reviewing SPU applications, and 12 months for reviewing EPU applications.¹ The staff will continue to ensure that the goal of protecting public health and safety is not compromised to meet these timeliness goals. Individual applications may require more or less review time depending on the nature of the technical issues.

The timeliness 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 these 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 these timeliness goals. As a result, for the NRR Operating Plan, the staff can meet its timeliness goals either by completing the reviews according to the numerical goals or by completing the reviews in time to support the licensees' proposed implementation schedules (also known as licensees' need dates), whichever is longer. This flexibility enables the staff to use its resources to better support other high-priority activities.

The staff met its timeliness goals for its completed reviews of the Browns Ferry Unit 1 SPU as well as the EPUs for Ginna and Beaver Valley Units 1 and 2. The NRC approved the Browns

¹ These goals do not include the duration of the staff's acceptance review, which the staff conducts upon receipt of the initial application.

Ferry Unit 1 SPU on March 6, 2007, which was less than 5 months after the staff accepted the application. The Ginna EPU received approval on July 11, 2006, which was less than 11 months after the staff accepted the application. The NRC approved the EPU for Beaver Valley Units 1 and 2 on July 19, 2006, which was 12 months after the staff accepted the application.

For the ongoing EPU reviews of Browns Ferry Units 1, 2, and 3, the licensee was unable to provide its revised steam dryer analysis by the committed-to date of early April 2007; therefore, the staff will reestablish the review schedule when the licensee provides a revised schedule for submitting the steam dryer analysis. For the ongoing EPU reviews of Hope Creek and Susquehanna Units 1 and 2, as a result of the staff's rigorous acceptance reviews, the licensees expeditiously supplemented the initial applications with regard to steam dryers to pass the staff's acceptance reviews. The staff is now conducting its detailed technical reviews of the EPU for Hope Creek and Susquehanna Units 1 and 2.

Regarding the ongoing Hope Creek EPU review, the staff is looking for opportunities to improve the review process for new EPU applications with the use of audits. Hope Creek is the first new EPU application since last year's status report. Preliminary staff views on the Hope Creek application are that the staff needs to review the responses to the RAs before making a final decision on the number of audits to be conducted in some of the review areas, and audits will not be needed in the remainder of the review areas. In addition, the staff has determined that working-level public meetings would serve the same purpose as an audit. Therefore, the staff will consider audits and/or working-level public meetings to improve review efficiency. Regarding the EPU reviews for Susquehanna Units 1 and 2, the staff only recently accepted the application (January 2007) and also needs to progress further in that review before deciding whether audits or working-level public meetings will improve review efficiency of those EPUs.

For the MUR power uprate reviews for Ft. Calhoun and Calvert Cliffs Units 1 and 2, 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 an NRC-approved methodology for feedwater flow measurement may not be adequate based on recent operating experience. As mentioned previously, the staff is reevaluating the generic topical report associated with these reviews (i.e., the Westinghouse Crossflow system).