



UNITED STATES  
NUCLEAR REGULATORY COMMISSION  
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS  
WASHINGTON, DC 20555 - 0001

ACRSR-2180

March 23, 2006

The Honorable Nils J. Diaz  
Chairman  
U.S. Nuclear Regulatory Commission  
Washington, DC 20555-0001

SUBJECT: REPORT ON THE SAFETY ASPECTS OF THE LICENSE RENEWAL  
APPLICATION FOR THE BROWNS FERRY NUCLEAR PLANT UNITS 1, 2,  
AND 3

Dear Chairman Diaz:

During the 530<sup>th</sup> meeting of the Advisory Committee on Reactor Safeguards, March 9-11, 2006, we completed our review of the license renewal application (LRA) for the Browns Ferry Nuclear Plant (BFN) Units 1, 2, and 3 and the associated final Safety Evaluation Report (SER) prepared by the NRC staff. On August 23, 2005, we visited the Browns Ferry site and reviewed activities under way for license renewal, power uprate, and restart. Our Plant Operations and Plant License Renewal Subcommittees also reviewed these matters on September 21, 2005. Our Plant License Renewal Subcommittee reviewed the LRA and SER with Open Items on October 5, 2005. We issued an interim letter on the safety aspects of this application on October 19, 2005. During our reviews, we had the benefit of discussions with representatives of the NRC staff, including Region II personnel, and the Tennessee Valley Authority (TVA). We also had the benefit of the documents referenced. This report fulfills the requirements of 10 CFR 54.25 that the ACRS review and report on all license renewal applications.

### CONCLUSIONS AND RECOMMENDATIONS

1. With the inclusion of the conditions in Recommendations 2 and 3, the application for license renewal for BFN Units 1, 2, and 3 should be approved.
2. The drywell refueling seals should be included within the scope of license renewal and be subjected to periodic inspections. Alternatively, as proposed by the staff, the drywell shells should be subjected to periodic volumetric inspections to detect external corrosion.
3. If the extended power uprate (EPU) is implemented before the period of extended operation, the staff should require that TVA evaluate the operating experience of Units 1, 2, and 3 at the uprated power level and then incorporate lessons learned into their aging management programs prior to entering the period of extended operation.

### DISCUSSION

TVA requested renewal of the BFN Units 1, 2, and 3 operating licenses for 20 years beyond their current operating terms, which expire on December 10, 2013, June 28, 2014, and July 2, 2016, respectively.

The BFN site is located in Limestone County, Alabama on the north shore of the Wheeler Reservoir. All three BFN units are General Electric boiling water reactors (BWR 4) with Mark 1 containments. Units 1 and 2 commenced operation in 1973 and 1974 respectively and were both shut down after the March 22, 1975 fire in Unit 1. Both units were returned to service in 1976, the same year Unit 3 commenced operation. All three units operated until 1985, when they were shut down to address management, technical, and regulatory issues. Units 2 and 3 were restarted in 1991 and 1995 respectively and have been in operation since then. Unit 1 has been shut down since 1985 and TVA plans to restart it in May 2007. The approximate duration of power operation of the three units is 10 years for Unit 1, 23 years for Unit 2, and 18 years for Unit 3. As part of an extensive restart program for Unit 1, components that have been in "layup" for the past 20 years will be either replaced or requalified. Layup is intended to provide a controlled environment to limit corrosion of plant components.

BFN Unit 1 is currently not identical to Units 2 and 3. TVA has committed to implement all of the physical and programmatic improvements to Unit 1 that have been made to Units 2 and 3. By the time of restart, the Unit 1 licensing basis will be identical to that of the other two units. The three units will have nearly identical components, materials, environments, operating procedures, and technical specifications. The Corrective Action Program applies to all three units, so that any condition identified in one unit will be reviewed for generic implications to the other units. The applicant states that, because all three units contain the same materials and have experienced the same conditions, the aging mechanisms during the layup and recovery periods are similar among the three units. Since the aging effects of the Unit 1 shutdown are similar to those experienced in Units 2 and 3, the applicant has used operating experience from the restart of Units 2 and 3 in the recovery of Unit 1. Based on these considerations, TVA has submitted a common license renewal application for all three units.

In part because it is not clear to what extent the layup experience of Units 2 and 3 parallels the experience of Unit 1, in our interim report we questioned the extent of applicability of Units 2 and 3 operating experience to the unique operating history of Unit 1. The SER states that a 1987 NRC inspection report identified several instances of deficient layup conditions during the early phase of the extended outage. This raises the possibility of potential latent effects that could result in accelerated aging once the plant restarts and operates at power. The applicant acknowledges this concern by stating on page B-4 of the LRA that "During the performance of the Aging Management Review activities, there was recognition that the operating experience of Unit 1 may not be the same as the operating experience on Units 2 and 3 due to the layup program implemented on Unit 1 during its extended outage."

In response to this concern, TVA added the Unit 1 Periodic Inspection Program to those aging management programs described in the LRA. Although this inspection program has not been fully defined, significant attributes of this program have been provided to the staff and are discussed in the final SER. This program requires periodic inspections of those components in layup that will not be replaced before restart. The scope of this program covers carbon steel, low-alloy steel, and stainless steel pipes and fittings from 25 plant systems. Samples are grouped by common material types and environments.

The applicant has agreed to use an inspection sampling size that would reflect a 95/95 confidence level that unacceptable degradation can be detected. Inspections will be performed at susceptible locations and in areas where degradation is not expected. Baseline inspections will be performed before restart. Additional inspections will be performed after Unit 1 is restarted and again within the first ten years of the period of extended operation. The inspection frequency will depend on the results of each inspection. The acceptance criteria are that the pipe wall remains above the minimum acceptable thickness until the next inspection

and no unacceptable weld cracks exist. We concur with the staff's conclusion that this program will adequately manage the aging effects for which it is credited.

In the original BFN LRA, the applicant requested renewed licenses at EPU conditions for all three units. In a letter dated January 7, 2005, TVA requested that the EPU and the LRA be separated. Even though the staff reviewed the LRA based on current licensed power levels for each unit, the final SER has several references to EPU conditions. The steam dryers are included in the scope of license renewal, but their aging management review will be performed as part of the safety evaluation of the EPU application. The time-limited aging analyses (TLAAs) associated with neutron embrittlement, reactor vessel fatigue, radiation degradation of drywell expansion gap foam, and stress relaxation of the core plate hold-down bolts were performed assuming EPU conditions.

In the final SER, the staff documents its review of the license renewal application and other information submitted by TVA and obtained through the audits and inspections conducted at the plant site. The staff reviewed the completeness of the applicant's identification of structures, systems, and components (SSCs) that are within the scope of license renewal; the integrated plant assessment process; the applicant's identification of the plausible aging mechanisms associated with passive, long-lived components; the adequacy of the applicant's aging management programs (AMPs); and the identification and assessment of TLAAs requiring review.

The BFN application either demonstrates consistency of aging management programs with the Generic Aging Lessons Learned (GALL) Report or documents deviations from the approaches specified in the GALL Report. The staff reviewed this application in accordance with NUREG-1800, the Standard Review Plan for Review of License Renewal Applications for Nuclear Power Plants.

The staff also performed inspections and an audit of AMPs and aging management reviews (AMRs). A recent inspection found that the applicant had made significant progress in developing the AMP implementation packages but identified errors in them. The applicant initiated a Problem Evaluation Report to identify the causes of the errors and determine corrective actions to prevent recurrence. Inspections performed before BFN enters the period of extended operation should verify that implemented corrective actions have been effective.

The audit of the AMPs and AMRs is documented in a report by the Brookhaven National Laboratory. The audit examined 28 AMPs and the associated AMRs and verified that the AMPs are consistent with the GALL Report or concluded that they would adequately manage aging during the period of extended operation. Several of the existing AMPs will be enhanced to include Unit 1 prior to the period of extended operation. Appendix F of the LRA describes TVA's plan to resolve the differences between the licensing bases of Unit 1 and Units 2 and 3 before Unit 1 restart. The staff's review of Appendix F did not identify any omissions or discrepancies.

The staff concluded that the scoping and screening processes implemented by the applicant have successfully identified SSCs within the scope of license renewal and subject to an AMR. With the inclusion in the scope of license renewal of those Unit 1 systems and components that were in layup and have not been replaced, we agree with this conclusion.

Open Item 2.4-3 in the SER concerns aging management of drywell shell corrosion. The staff was concerned that leakage through refueling seals at the top of the drywell could lead to corrosion of the drywell shell in a location that cannot be inspected. This aging effect has been

observed in several Mark I containments and is the subject of Generic Letter 87-05 and Information Notice 86-99 on the potential for corrosion of BWR Mark I steel drywells in the sandpocket region. The staff has concluded that the refueling seals should be within the scope of license renewal because they are nonsafety-related components whose failure can affect the integrity of the safety-related containment steel liner. We concur with this conclusion.

The applicant acknowledges that water was observed below the refueling seals at BFN Unit 3 during the 1998 refueling outage, but maintains that the refueling seals should not be within the scope of license renewal. As an alternative to the inclusion of the seals, the staff proposed that TVA periodically perform ultrasonic testing of the drywell shells as part of the containment inservice inspection program. Such an approach has been used by previous license renewal applicants, and we agree that it is an acceptable alternative. As an alternative to the staff's proposal, the applicant committed to perform a one-time confirmatory inspection of the Unit 1 drywell shell prior to restart and of the Units 2 and 3 shells prior to entering the period of extended operation. Based on this commitment, the staff closed out this open item. We do not agree with this resolution. One-time inspections are intended to confirm that an unexpected aging effect is not occurring or is occurring at such a slow rate that no further inspections are required. This aging effect has been observed in several Mark I containments, and we are aware of at least one instance of through-wall corrosion. One-time inspection of the shell does not provide assurance that leakage of the refueling seals after the one-time inspection is performed will not create an environment that could result in future drywell degradation. Unless the applicant can demonstrate that the resulting corrosion rate would not be sufficient to degrade the pressure retaining function during the period of extended operation, the refueling seals should be within the scope of license renewal and subject to periodic inspections, or the drywell shells should be subjected to periodic volumetric inspections.

During our March 9, 2006 meeting, we were told that the staff has reopened this item based on discussions with the applicant regarding drywell inspection results. Ultrasonic inspections performed in 1999, 2002, and 2004 identified a small inclusion in the drywell liner of Unit 1. The applicant will submit this information to the staff in writing. The staff plans to document its evaluation of this information in a supplemental SER. Based on our discussions with the applicant and staff, the resolution of this issue does not affect our recommendations regarding this LRA.

In our interim letter we noted that in the draft SER some restart inspections were referred to as "one-time" inspections. We suggested that, to avoid confusion, the term "one-time" inspection should be used only for license-renewal-related inspections. For clarification purposes, the final SER now provides definitions of one-time inspections, restart inspections, and Unit 1 periodic inspections. Section 3.7 of the final SER still refers to some restart inspections as one-time inspections. The final SER should be revised to be consistent with these definitions.

The applicant has identified systems and components requiring a TLAA and reevaluated them for 20 more years of operation. The SER concludes that the TLAA's are valid for the period of extended operation, the TLAA's are projected to the end of the period of extended operation, or that aging effects will be adequately managed for the period of extended operation. We concur with this assessment.

According to current plans, all three BFN units will be subjected to an EPU that will raise their power output to 3952 MWt prior to entering the period of extended operation. However, the LRA and the associated SER reflect operating experience only at the current power level. If the EPU is implemented before the period of extended operation, the staff should require that TVA evaluate the operating experience of Units 1, 2, and 3 at the uprated power level and then

incorporate lessons learned into their aging management programs prior to entering the period of extended operation. The EDO response to our interim letter stated that the staff's SER for the EPU would include a commitment to perform such an evaluation.

With the inclusion of commitments to perform periodic inspections of BFN Units 1, 2, and 3 drywell refueling seals or drywell shells and to perform an evaluation of operating experience at the EPU level and incorporate lessons learned into their aging management programs prior to entering the period of extended operation, the application for license renewal of Browns Ferry Units 1, 2, and 3 should be approved.

Sincerely,

/RA/

Graham B. Wallis  
Chairman

References:

1. U.S. Nuclear Regulatory Commission, "Safety Evaluation Report Related to the License Renewal of the Browns Ferry Nuclear Plant, Units 1, 2, and 3," January 2006.
2. U.S. Nuclear Regulatory Commission, "Safety Evaluation Report with Open Items Related to the License Renewal of the Browns Ferry Nuclear Plant, Units 1, 2, and 3," August 2005.
3. Tennessee Valley Authority, "Browns Ferry Nuclear Plant (BFN) - Units 1, 2, and 3 - Application for Renewed Operating Licenses," December 31, 2003.
4. Tennessee Valley Authority, "Browns Ferry Nuclear Plant (BFN) - Units 1, 2, and 3 - January 28, 2004 Meeting Follow-Up - Additional Information," February 19, 2004.
5. Brookhaven National Laboratory, "Audit and Review Report for Plant Aging Management Programs (AMPs) and Aging Management Reviews (AMRs), Browns Ferry Nuclear Plant Units 1, 2, and 3, Docket Nos.: 05000259, 05000260, 05000296," April 26, 2005.
6. U.S. Nuclear Regulatory Commission, "Browns Ferry Nuclear Plant - Inspection Report 05000259/2004012, 05000260/2004012, and 05000296/2004012," January 27, 2005.
7. U.S. Nuclear Regulatory Commission, "Browns Ferry Nuclear Plant - Inspection Report 05000259/2005013, 05000260/2005013, and 05000296/2005013," November 7, 2005.
8. Tennessee Valley Authority, "Browns Ferry Nuclear Plant (BFN) - Units 1, 2, and 3 License Renewal Application (LRA) - Annual Update (TAC Nos. MC1704, MC1705, and MC1706)," January 31, 2006.
9. Letter from William J. Shack, Acting Chairman, ACRS, to Luis A. Reyes, Executive Director for Operations, NRC, "Interim Report on the Safety Aspects of the License Renewal Application for the Browns Ferry Nuclear Plant, Units 1, 2, and 3," October 19, 2005.
10. Letter from Luis A. Reyes, Executive Director for Operations, NRC, to William J. Shack, Acting Chairman, ACRS, "Response to Advisory Committee on Reactor Safeguards - Interim Report on the Safety Aspects of the License Renewal Application for Browns Ferry Nuclear Plant, Units 1, 2, and 3," November 28, 2005.
11. Tennessee Valley Authority, "Browns Ferry Nuclear Plant (BFN) - Units 1, 2, and 3 - Summary of NRC Site Visit and Meeting Regarding Extended Power Uprate (EPU) and License Renewal Application (LRA)," January 7, 2005.
12. U.S. Nuclear Regulatory Commission, "10 CFR Parts 2, 50, 54, and 140, Nuclear Power Plant License Renewal," *Federal Register*, Vol. 54, No. 240, December 13, 1991, pp. 64943-64980.
13. U.S. Nuclear Regulatory Commission, "10 CFR Parts 2, 51, and 54, Nuclear Power Plant License Renewal; Revisions," *Federal Register*, Vol. 60, No. 88, May 8, 1995, pp. 22461-22495.

incorporate lessons learned into their aging management programs prior to entering the period of extended operation. The EDO response to our interim letter stated that the staff's SER for the EPU would include a commitment to perform such an evaluation.

With the inclusion of commitments to perform periodic inspections of BFN Units 1, 2, and 3 drywell refueling seals or drywell shells and to perform an evaluation of operating experience at the EPU level and incorporate lessons learned into their aging management programs prior to entering the period of extended operation, the application for license renewal of Browns Ferry Units 1, 2, and 3 should be approved.

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3. Tennessee Valley Authority, "Browns Ferry Nuclear Plant (BFN) - Units 1, 2, and 3 - Application for Renewed Operating Licenses," December 31, 2003.
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8. Tennessee Valley Authority, "Browns Ferry Nuclear Plant (BFN) - Units 1, 2, and 3 License Renewal Application (LRA) - Annual Update (TAC Nos. MC1704, MC1705, and MC1706)," January 31, 2006.
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