



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

September 16, 2009

The Honorable Gregory B. Jaczko  
Chairman  
U.S. Nuclear Regulatory Commission  
Washington, DC 20555-0001

**SUBJECT:     REPORT ON THE SAFETY ASPECTS OF THE LICENSE RENEWAL  
              APPLICATION FOR THE BEAVER VALLEY POWER STATION, UNITS 1 AND 2**

Dear Chairman Jaczko:

During the 565<sup>th</sup> meeting of the Advisory Committee on Reactor Safeguards, September 10-12, 2009, we completed our review of the license renewal application for the Beaver Valley Power Station (BVPS), Units 1 and 2, and the final Safety Evaluation Report (SER) prepared by the NRC staff. We also reviewed this matter during our 564<sup>th</sup> meeting on July 8-10, 2009, and completed a report. The issuance of the report was delayed pending review of new information submitted by the applicant, FirstEnergy Nuclear Operating Company (FENOC), and the associated Supplemental SER prepared by the staff. Our Plant License Renewal Subcommittee also reviewed this matter during its meeting on February 4, 2009. During these reviews, we had the benefit of discussions with representatives of the NRC staff and FENOC. We also had the benefit of the documents referenced. This report fulfills the requirement of 10 CFR 54.25 that the ACRS review and report on all license renewal applications.

### **CONCLUSIONS AND RECOMMENDATIONS**

1. The programs established and committed to by the applicant to manage age-related degradation, including planned supplemental visual and volumetric examinations of the containment liners, provide reasonable assurance that BVPS, Units 1 and 2, can be operated in accordance with its current licensing basis for the period of extended operation without undue risk to the health and safety of the public.
2. The impact of containment liner corrosion on the current licensing basis of the plant is being reviewed and will be resolved under the provisions of the applicant's current 10 CFR Part 50 operating licenses.
3. The FENOC application for renewal of the operating licenses of BVPS, Units 1 and 2, should be approved.

### **BACKGROUND AND DISCUSSION**

BVPS consists of two Westinghouse 3-loop pressurized water reactors with subatmospheric containments (originally operated at 10 psia, now at about ½ psi below atmospheric) and is located on the south bank of the Ohio River in the Borough of Shippingport in Beaver County, Pennsylvania, approximately 25 miles northwest of Pittsburgh. The current licensed power

rating of each of the BVPS units is 2,900 megawatts thermal with a gross electrical output of approximately 974 megawatts for Unit 1 and 969 megawatts for Unit 2. FENOC requested renewal of the BVPS, Units 1 and 2 operating licenses for 20 years beyond the current license terms, which expire on January 29, 2016 for Unit 1, and May 27, 2027 for Unit 2.

In the final SER, the staff documented its review of the license renewal application and other information submitted by the applicant or obtained from the staff audit and inspection at the plant site. The staff reviewed the completeness of the applicant's identification of the structures, systems, and components (SCCs) 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 time-limited aging analyses (TLAAs) requiring review.

In the BVPS license renewal application, FENOC identified the SSCs that fall within the scope of license renewal. For these SSCs, the applicant performed a comprehensive aging management review. The final SER identifies 35 commitments for Unit 1 and 36 for Unit 2, as well as three license conditions for both units.

The BVPS application either demonstrates consistency with the Generic Aging Lessons Learned (GALL) Report or documents deviations to the specified approaches in this Report. The application includes very few exceptions, being consistent with 92% of aging management review line items specified in the GALL Report. We reviewed the exceptions and agree with the staff that they are acceptable.

The staff conducted a license renewal audit and inspection at BVPS. The audit verified the appropriateness of the scoping and screening methodology, AMPs, aging management review, and TLAAs. The site inspection verified that the license renewal requirements are appropriately implemented. Based on the audit and inspection, the staff concluded in the final SER that the proposed activities will adequately manage the effects of aging of SSCs identified in the application and that the intended functions of these SSCs will be maintained during the period of extended operation. We agree with this conclusion.

During its site inspection, the staff observed water in manholes that contain medium-voltage cables that are important to safety. The applicant has agreed that, although the cables may be suitable for submerged service, they are not qualified for that service. They have made commitments to demonstrate, using an acceptable methodology, that the cables will continue to perform their intended function; or will implement measures to minimize cable exposure to significant moisture; or will replace the cables with cables qualified for submerged service.

The applicant identified the systems and components requiring TLAAs and reevaluated them for the period of extended operation. The staff concluded that the applicant has provided an adequate list of TLAAs. Further, the staff concluded that the applicant has met the requirements of the License Renewal Rule by demonstrating that the TLAAs will remain valid for the period of extended operation, or that the TLAAs have been projected to the end of the period of extended operation, or that the aging effects will be adequately managed for the period of extended operation.

Staff reviews of operating experience have identified liner corrosion as an issue challenging containment integrity. Two separate instances of corrosion attack were discovered at BVPS, Unit 1, one in 2006 and one in 2009. These discoveries raised questions as to whether corrosion between the liner and the concrete is no longer active or will continue as the plant ages.

The 2006 discovery occurred when a temporary construction opening was made for the replacement of the Unit 1 steam generators and reactor vessel head. Degradation was observed on the inaccessible side of the steel liner. Analyses and evaluations of the Unit 1 containment liner corrosion were performed for FENOC by several contractors, including FirstEnergy Beta Laboratory and Shaw Stone & Webster, Inc.

Shaw Stone & Webster, Inc., evaluated the condition of the Unit 1 containment liner regarding the extent of the degradation and effects on its intended function as a leak tight membrane. The evaluation included consideration of the impact of an additional 20 years of operation as a result of license renewal on the recurring Integrated Leak Rate Test loading.

It was concluded that the degradation was pitting corrosion with no evidence of stress corrosion or microbiological attack. The corrosion occurred after welding and construction of the liner plate because the corrosion pitting was even across the weld, the heat affected zone of the base material, and both edges of the weld. If the corrosion had occurred prior to construction, there would be uneven corrosion across these areas due to the weld preparation and the welding process.

Approximately 1% of the observable liner plate contained corroded areas and a much smaller percentage of the rebar surface area had evidence of corrosion. The analysis concluded that the concrete did not contain corrosive agents and that no general corrosion is active in the area between the liner plate and the concrete.

The staff finds that the applicant has adequately explained the observed corrosion of the liner plate and that there is no active mechanism for corrosion. The staff agrees that the degraded conditions found on the liner in 2006 did not adversely affect its mechanical and/or structural function as a leak-tight membrane.

Following the 2006 discovery, the containment inspection procedures for Units 1 and 2 were modified to include: when paint or coatings are removed for further inspection, the paint or coatings shall be visually examined by a qualified VT-3 inspector prior to removal; and if the visual examination detects surface flaws on the liner or suspect areas on the liner plate that could potentially impact the leak tightness or structural integrity of the liner, then surface or volumetric examinations shall be performed to characterize the degradation. Staff agrees that these additional examination requirements and the use of the FENOC Corrective Action Program provide reasonable assurance that potential corrosion on the concrete side of the containment liner plate will be identified and managed.

On April 23, 2009, during a Unit 1 IWE inspection, i.e., visual inspection of 100% of all accessible portions of the containment steel liner, a paint blister was discovered on the containment liner. Further investigation revealed a rectangular through-wall hole in the containment liner, approximately 1" x 3/8". Subsequently, ultrasonic measurements were taken

in the vicinity surrounding the defect to determine the extent of liner thinning. These measurements revealed indications of localized type corrosion. As a result, the applicant removed a 2 inch by 5 inch portion of the affected liner plate to further evaluate and characterize the condition.

Removal of the degraded liner section revealed a partially decomposed piece of wood embedded in the concrete containment wall, located at the interface with the steel liner plate directly behind the through-wall liner hole. Laboratory analysis indicated that the wood contained approximately 13% moisture and low pH of 3.7, i.e., mildly acidic. The applicant determined that such conditions were sufficient to promote the corrosion mechanism and cause the through-wall flaw in the liner over time, i.e., since construction in the early 1970s.

As a result of the 2009 event, visual examinations of 100% of the accessible liner area have been scheduled for the Unit 1 refueling outage in fall 2010 and the Unit 2 refueling outage in fall 2009. Ultrasonic testing (UT) of the repaired area is also scheduled for the refueling outage in fall 2010. In addition to the visual inspections, the applicant committed to perform supplemental volumetric examinations of liner plate at each unit. A minimum of 75 one-foot square locations will be selected randomly. In addition, a minimum of eight non-random locations will be selected on the basis of perceived greater likelihood of corrosion. Staff agrees that the applicant will examine broad areas for each of the non-random inspections and that they plan to track resolution of any problems identified in any of the inspections. At Unit 1, the non-random UT will begin in the current fuel cycle and are to be completed by December 2010. The random UT will be performed during the next three refueling outages, with all tests to be completed not later than the beginning of period extended operation. At Unit 2, the UT will be completed prior to entering the period of extended operation.

Staff finds that the modified procedures developed following the 2006 event, the additional 100% visual examinations of the liners during the next outages, and the supplemental volumetric examinations to be performed prior to entering the period of extended operation, provide reasonable assurance that the AMP is adequate to manage the aging effects for which it is credited in the license renewal application. The impact of this operating experience on the current operation of the plant is being reviewed and will be resolved under the provisions of the applicant's current 10 CFR Part 50 operating licenses.

We conclude that the proposed inspection programs and related commitments provide reasonable assurance that liner integrity will be adequately maintained during the period of extended operation. Our conclusion is supported by the following observations:

- The mechanism responsible for the through-wall liner penetration in Unit 1 is reasonably well understood. This defect was caused by a wood construction spacer that was not removed as required prior to concrete pour. Wood has the capability to absorb and retain water from the concrete or the atmosphere in the interface between the liner and the concrete. In addition, the testing of the wood revealed that it was acidic and contained 13% water. This acidity could have been the result of boric acid treatment of the wood (a common practice to prevent infestation at the time of construction). This combination of moisture and acidity is corrosive to carbon steel.

- The feature of the supplemental inspection program that addresses this potentially systematic construction error is the non-random UT. FENOC plans to inspect eight broad areas. Some of these will be selected on the basis that additional wood spacers may have been left in the interface between the concrete and the liner during construction. Examinations are intended to ensure that the phenomenon causing the most serious damage is indeed not systematic.
- In addition, 75 or more randomly selected one-foot-square areas will be examined by UT to evaluate the condition of a representative portion of the liner. This examination is intended to determine if unacceptable pitting corrosion is present. The applicant has selected a very stringent failure criterion of >10% localized wall thinning.
- When unit 2 was constructed, welded angle irons were used as spacers between the liner and the first row of re-bar, rather than wood. The absence of wooden spacers significantly reduces the likelihood that the same failure mechanism observed in Unit 1 will occur in Unit 2. Therefore, the supplemental inspection program for Unit 2 on a slower schedule is reasonable.
- The near term 100% visual inspection of all accessible liner surfaces will be valuable in identifying locations for additional UT examinations.
- Based on historical evidence, the opportunity still exists for corrosion caused by the presence of foreign materials. Organic materials such as wood or gloves have been found to be the cause of the same type of damage as that observed in Unit 1 in the containment liners of other plants.
- Inspection of the Unit 1 liner will be completed in time for corrective actions, if required, to be accomplished prior to entering the period of extended operation.

We agree with the staff that there are no issues related to the matters described in 10 CFR 54.29(a)(1) and (a)(2) that preclude renewal of the operating licenses for BVPS, Units 1 and 2. The programs established and committed to by FENOC, including planned supplemental visual and volumetric examinations of the containment liners, provide reasonable assurance that the BVPS, Units 1 and 2, can be operated in accordance with its current licensing basis for the period of extended operation without undue risk to the health and safety of the public.

The FENOC application for renewal of the operating licenses for BVPS, Units 1 and 2, should be approved.

Sincerely,

/RA/

Mario V. Bonaca  
Chairman

**REFERENCES**

1. Memorandum dated June 10, 2009 from David Wrona, Office of Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission, to Edwin M. Hackett, Executive Director, ACRS, transmitting the NRC Final Safety Evaluation Report for Beaver Valley Power Station, Units 1 and 2, License Renewal Application (ML091560099 and ML091600216)
2. Letter dated August 27, 2007, from Peter P. Sena III, FirstEnergy Nuclear Operating Company, to U.S. Nuclear Regulatory Commission, transmitting the Beaver Valley Power Station, Units 1 and 2 License Renewal Application (ML072430913)
3. Safety Evaluation Report Related to the License Renewal of Beaver Valley Power Station, Units 1 and 2, Supplement 1, dated September 2009 (ML092570014)
4. Letter dated July 28, 2009, from Peter P. Sena III, FirstEnergy Nuclear Operating Company, to U.S. Nuclear Regulatory Commission, transmitting Amendment 39, to the Beaver Valley Power Station, Units 1 and 2, License Renewal Application (ML092110117)
5. Letter dated September 2, 2009, from Peter P. Sena III, FirstEnergy Nuclear Operating Company, to U.S. Nuclear Regulatory Commission, transmitting Amendment 40, to the Beaver Valley Power Station, Units 1 and 2, License Renewal Application (ML092510168)
6. Letter dated September 4, 2009, from Peter P. Sena III, FirstEnergy Nuclear Operating Company, to U.S. Nuclear Regulatory Commission, transmitting Amendment 41, to the Beaver Valley Power Station, Units 1 and 2, License Renewal Application (ML092530241)
7. Letter dated September 8, 2009, from Peter P. Sena III, FirstEnergy Nuclear Operating Company, to U.S. Nuclear Regulatory Commission, transmitting Amendment 42, to the Beaver Valley Power Station, Units 1 and 2, License Renewal Application (ML092530242)
8. Letter dated August 27, 2007, from Peter P. Sena III, FirstEnergy Nuclear Operating Company, to U.S. Nuclear Regulatory Commission, transmitting the Beaver Valley Power Station, Units 1 and 2 License Renewal Application ( ML072430913)
9. Letter dated July 6, 2009, from John White, U.S. Nuclear Regulatory Commission, to Peter P. Sena III, FirstEnergy Nuclear Operating Company, transmitting the Beaver Valley Power Station License Renewal Inspection Report 05000334/2009006 (ML091870328)

10. Letter dated December 23, 2008, from Richard J. Conte, U.S. Nuclear Regulatory Commission, to Peter P. Sena III, FirstEnergy Nuclear Operating Company, transmitting the Beaver Valley Power Station, License Renewal Inspection Report 05000334/2008007 & 05000412/2008007 (ML083590068)
11. Letter dated November 5, 2008, from Kent Howard, U.S. Nuclear Regulatory Commission, to Peter P. Sena III, FirstEnergy Nuclear Operating Company, transmitting the Audit Summary Report Regarding the Beaver Valley Power Station, Units 1 and 2, License Renewal Application (ML082140838)
12. U.S. Nuclear Regulatory Commission, NUREG-1801, Volumes 1 & 2, Revision 1, "Generic Aging Lessons Learned Report," September 2005 (ML052700171).
13. Letter dated March 13, 2006, from D.E. Graves, Shaw Stone & Webster, Inc. to Robert Dulee, FENOC transmitting the Containment Liner Degradation Report (ML091960569)
14. Letter dated July 7, 2009, from Theodore S. Robinson, Esquire, Citizen Power to Dr. Dennis C. Bley, ACRS, Regarding the Beaver Valley Power Station Unit 1 Containment Liner (ML091900719)
15. Letter dated August 27, 2009, from Theodore S. Robinson, Esquire, Citizen Power to Edwin M. Hackett, Executive Director, ACRS, Regarding the Beaver Valley Power Station Unit 1 Containment Liner (ML092460728)

- The feature of the supplemental inspection program that addresses this potentially systematic construction error is the non-random UT. FENOC plans to inspect eight broad areas. Some of these will be selected on the basis that additional wood spacers may have been left in the interface between the concrete and the liner during construction. Examinations are intended to ensure that the phenomenon causing the most serious damage is indeed not systematic.
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Sincerely,  
 /RA/  
 Mario V. Bonaca  
 Chairman

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Letter to the Honorable Gregory B Jaczko, Chairman, NRC, from Mario V. Bonaca, Chairman, ACRS, dated September 16, 2009

SUBJECT: REPORT ON THE SAFETY ASPECTS OF THE LICENSE RENEWAL  
APPLICATION FOR THE BEAVER VALLEY POWER STATION, UNITS 1 AND 2

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