Safety Evaluation Report

Related to the License Renewal of Beaver Valley Power Station, Units 1 and 2

Supplement 1

Docket Nos. 50-334 and 50-412

FirstEnergy Nuclear Operating Company

U.S. Nuclear Regulatory Commission

Office of Nuclear Reactor Regulation

October 2009

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ABSTRACT

This document is a supplemental safety evaluation report (SSER) for the technical review of the Beaver Valley Power Station (BVPS), Units 1 and 2, license renewal application (LRA) as filed by FirstEnergy Nuclear Operating Company (FENOC or the applicant). By letter dated August 27, 2007, FENOC submitted its application to the United States (US) Nuclear Regulatory Commission (NRC) for renewal of the BVPS, Units 1 and 2, operating licenses (Facility Operating License Numbers DPR-66 and NPF-73, respectively) for a period of 20 years beyond the current operating license. The NRC staff issued a safety evaluation report (SER), dated June 8, 2009, which summarizes the results of its safety review of the renewal application for compliance with the requirements of Title 10, Part 54, of the *Code of Federal Regulations*, (10 CFR Part 54), "Requirements for Renewal of Operating Licenses for Nuclear Power Plants." This SSER only provides changes to the June 2009 SER.

This SSER documents the NRC staff's evaluation of information provided by the applicant on supplemental volumetric examinations of the BVPS, Units 1 and 2 containment liners. The applicant provided additional information regarding examinations of the Units 1 and 2 containment liners as a result of discussion during the Advisory Committee of Reactor Safeguards meeting held in July 2009 and by letters dated July 28, 2009, September 2, 2009, September 4, 2009, September 8, 2009, and September 14, 2009.

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ABBREVIATIONS

ACRS	Advisory Committee on Reactor Safeguards
AMP	aging management program
ASME	American Society of Mechanical Engineers
BVPS	Beaver Valley Power Station
CFR	Code of Federal Regulations
FENOC	FirstEnergy Nuclear Operating Company
LRA	license renewal application
NRC	Nuclear Regulatory Commission
RAI	request for additional information
SC	structures and components
SER	safety evaluation report
SSER	supplemental safety evaluation report
US	United States
UFSAR	updated final safety analysis report

SECTION 1

INTRODUCTION AND GENERAL DISCUSSION

1.1 Introduction

This document is a supplemental safety evaluation report (SSER) on the license renewal application (LRA) for Beaver Valley Power Station (BVPS), Units 1 and 2, as filed by FirstEnergy Nuclear Operating Company (FENOC or the applicant). By letter dated August 27, 2007, FENOC submitted its application to the U.S. Nuclear Regulatory Commission (NRC) for renewal of the BVPS operating licenses for an additional 20 years. The NRC staff (the staff) issued a safety evaluation report (SER), dated June 8, 2009, which summarizes the results of its safety review of the renewal application for compliance with the requirements of Title 10, Part 54, of the *Code of Federal Regulations*, (10 CFR Part 54), "Requirements for Renewal of Operating Licenses for Nuclear Power Plants." This SSER supplements portions of Sections 1 and 3, and Appendices A and B of the June 2009 SER.

In letters dated July 28, 2009, September 2, 2009, September 4, 2009, September 8, 2009, and September 14, 2009, the applicant provided revisions to commitments related to the aging management program for the BVPS Units 1 and 2 containment liners, associated with FENOC's renewal application. These letters were a result of discussions between the NRC and the applicant during teleconferences held between July 24, 2009, and September 3, 2009, concerning the applicant's planned examinations of the containment liners of Units 1 and 2.

1.6 Summary of Proposed License Conditions

The staff has added a proposed license condition that requires the applicant to continue containment liner volumetric examinations under the following conditions:

a) If degradation (greater than 10 percent of the nominal thickness not attributable to fabrication/erection practices) is identified in the non-random areas examined using ultrasonic testing (UT), UT examinations shall be performed at additional non-random areas, to be selected based on this operating experience. Should additional degradation be identified, additional non-random areas shall be UT examined until no further degradation (greater than 10 percent of the nominal thickness) is identified. All areas with degradation shall be reexamined over at least the next three successive inspection periods to ensure that progression of the degradation is not occurring.

b) If degradation (greater than 10 percent of the nominal thickness not attributable to fabrication/erection practices) is identified in the random samples examined using UT, UT examinations shall be performed on additional random samples, to ensure a 95 percent confidence that 95 percent of the unexamined accessible containment liner is not degraded. If additional degradation is identified, the sample size for UT examinations shall be further expanded until the statistical sampling has achieved the 95 percent confidence goal described previously. All areas with degradation shall be reexamined over at least the next three successive inspection periods to ensure that progression of the degradation is not occurring.

SECTION 2

STRUCTURES SYSTEMS AND COMPONENTS

The staff does not have any changes or update to this section of the original SER (ML091600216).

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SECTION 3

AGING MANAGEMENT REVIEW RESULTS

3.0.3 Aging Management Programs

3.0.3.2 AMPs Consistent with the GALL Report with Exceptions or Enhancements

3.0.3.2.2 ASME Code Section XI, Subsection IWE Program

Summary of Technical Information in the Application. In LRA Section B.2.3, the applicant described the existing ASME Code Section XI, Subsection IWE Program as consistent, with an exception, with GALL AMP XI.S1 "ASME Code Section XI, Subsection IWE." This program is implemented through plant procedures, which provide for ISI of Class MC and metallic liners of Class CC components.

Section 50.55a of 10 CFR specifies the use of the examination requirements in the ASME Code, Section XI, Subsection IWE, for steel liners of concrete containments and other containment components. The applicant stated that it has implemented ASME Code Section XI, Subsection IWE, 1992 Edition with the 1992 Addenda, and will use the ASME Code edition consistent with the provisions of 10 CFR 50.55a, during the period of extended operation.

Staff Evaluation. In the LRA, the applicant stated that ASME Code Section XI, Subsection IWE is an existing program that is consistent, with exception, with GALL AMP XI.S1.

During the audit, the staff interviewed the applicant's technical staff and audited the applicant's ASME Code Section XI, Subsection IWE Program onsite basis documents to confirm the applicant's claim of consistency with GALL AMP XI.S1. In addition, the staff reviewed the exception and its justification to determine whether the AMP, with the exception, remains adequate to manage the aging effects for which it is credited.

The applicant's ASME Code Section XI, Subsection IWE Program takes exception to the scope of program, parameters monitored or inspected, detection of aging effect, monitoring and trending, acceptance criteria, and corrective action program elements in that it did not use the ASME Code Section XI, Subsection IWE, 2001 edition, with the 2002 through 2003 Addenda. In the LRA, the applicant stated that its use of the ASME Code 1992 edition through the 1992 Addenda complies with 10 CFR 50.55a which requires use of the Code in effect 12 months prior to the start of the inspection interval. The applicant further committed that it will use the ASME Code edition consistent with the provisions of 10 CFR 50.55a during the period of extended operation. The staff issued generic RAI B.2-2, by letter dated June 5, 2008, requesting that the applicant clarify which edition of the ASME Code Section XI will be credited for those AMPs that credit the ASME Code Section XI, during the period of extended operation. The staff's review of RAI B.2-2 is documented in SER Section 3.0.3.2.1.

The staff reviewed the exception described in LRA Section B.2.3 and additional information provided by the applicant in its response to RAI B.2-2 dated July 21, 2008. The staff finds that

the exception to the use of the ASME Code Section XI, Subsection IWE, 1992 Edition with 1992 Addenda is within the limitations and modifications required by 10 CFR 50.55a. The applicant's assurance of the use of subsequent editions and addenda of ASME Code Section XI, Subsection IWE, as required by 10 CFR 50.55a ensures that the applicant's IWE program will be consistent with GALL AMP XI.S1 during the period of extended operation. Based on its review, the staff finds the applicant's exceptions to the use of the IWE program acceptable.

Operating Experience. The staff also reviewed the operating experience, including samples of condition reports, and interviewed the applicant's technical staff to confirm that the plant-specific operating experience did not reveal any degradation not bounded by industry experience. However, during its review audit, the staff noted that a temporary construction opening was created in 2006 for the Unit 1 SG and reactor head replacements. Inspections during RFO 17 (2006) revealed degradation from the inaccessible side of the steel liner, for which the applicant could not identify a root-cause from observations in field or from lab analysis. To ensure the essential leak-tight condition of the containment, the staff identified three issues where additional clarifications and justifications were needed to complete the review.

In RAI B.2.3-1, dated May 8, 2008, that staff requested that the applicant provide information related to the minimum required thickness of the liner; discuss the possibility and severity of similar corrosion at other locations, including Unit 2 containment; and justify whether the corrosion is active. Furthermore, the staff requested the applicant discuss the use of the GALL Report which recommends further evaluation of plant-specific programs to manage this aging effect for inaccessible areas, if corrosion is significant.

In its response to RAI B.2.3-1, dated June 16, 2008, the applicant stated:

> Analyses and evaluations of the Unit 1 containment liner corrosion in 2006 were performed for FENOC by several vendors that specialize in these types of analyses and by the FirstEnergy Beta Laboratory.
>
> The Shaw Group, Inc., evaluated the condition of the Unit 1 containment liner regarding the extent of the degradation and effects on intended function following the discovery of the containment liner corrosion in 2006. 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.
>
> In the Shaw Group's report, design basis calculations originally developed for the BVPS Unit 1 containment liner were used to demonstrate that the degraded conditions found on the liner did not adversely affect its mechanical/structural function as a leak-tight membrane. The thickness of the remaining sound metal was determined to be adequate to maintain the design safety function of the liner. In addition, the capacity of the concrete containment structure to withstand Design Basis Accident loadings was not adversely affected.

Of the three areas of corrosion identified, two were replaced with new plate material. The third area showed minimal wall loss at the deepest pit, and was left in place for further monitoring. In addition to initial "baseline" ultrasonic thickness measurements in accordance with Table IWE-2500-1, examination category E-C, it was recommended that the third area of degradation be mapped on the inside of the containment liner for future UT examinations. It was recommended that this area be examined for the next three inspection periods. If no change in liner thickness was detected after three inspection periods, it was determined that the area would require no additional inspections. Further engineering evaluation was recommended if the thickness changed. FENOC has scheduled additional UT examinations as recommended by The Shaw Group, Inc., for the three inspection periods following the 2006 RFO when the degradation was discovered.

A material analysis was performed by the FirstEnergy Beta Laboratory on the corroded steel liner areas and sample pieces of concrete to aid in determining a cause of the corrosion. The following conclusions were drawn concerning the corrosion activities:

- The corrosion was general pitting corrosion (wastage) with no evidence of stress corrosion or microbiological attack. The metallographic work performed by Beta Labs found the pitting to be rounded in nature with no crack like projections. The examination of the corrosion product trapped in the deep pits identified no unusual levels of elements that were not expected to be present. No preferential corrosion attack was observed on the sample piece with the weld or on the welds around the Nelson studs welded to the liner plate. Some crevice corrosion was observed in the cross section of the studs where the flash weld could trap contaminates.

- The corrosion occurred after welding and construction of the liner plate since the corrosion pitting was even across the weld, the heat affected zone (HAZ) and both edges of the weld where weld prep would have occurred. No preferential corrosion occurred at the weld or HAZ.

- The necessary elements for corrosion (oxygen and water) were present throughout the construction phase of Unit 1, from the fabrication and erection of the liner plate through the completion of concrete pours for the top of the containment structure. During this timeframe, water, in the form of the wetting methodology used during the concrete pour sequences and weather (rain and snow), could accumulate in areas between the liner plate and the concrete structure. Corrosion activities are likely to have initiated during this construction period.

- Access to these necessary elements for corrosion activity became significantly limited once the concrete structure was completed. Exposure to water sources all but ceased, and the concrete/steel interface was no longer exposed to the atmosphere for re-oxygenation.

- The corrosion process consumes oxygen, and, once it is depleted, corrosion can not be sustained at a high rate due to the limited supply of oxygen between the concrete and the liner plate following fabrication.

- No corrosive agents or corrosion catalysts, such as chlorides, could be identified on or in the steel liner plate. Additionally, no corrosion agents were found in the pitted areas of the liner plate or in the concrete materials tested in concentrations that would be of concern. However, it must be considered that such materials may have existed in local areas and were removed during the water hydrolazing process that was used to remove the exterior containment concrete.

- Approximately 1% of the observable liner plate (portion removed for the construction opening) contained corroded areas and a much smaller percentage of the rebar surface area had evidence of corrosion. So, it is reasonable to assume that the concrete did not contain corrosive agents, and that corrosion elements (water and oxygen) were not present in abundant amounts. This finding would support the general conclusion that no general corrosion is active in the area between the liner plate and the concrete.

- The corrosion is localized for reasons that can not be determined with certainty. However, small breaks in the mill scale surface or other surface imperfections can provide the initiation sites for pitting (oxygen cell corrosion) during the time of construction when oxygen and water were known to be present.

- The concrete did contain small void areas at the concrete/steel interface. These voids would most likely have filled with water during the construction phase. During the post-construction life of the liner, these locations could also serve as an accumulation point for any moisture that enters the concrete structure. However, the area of the containment liner where the concrete was found to have small voids at the steel/concrete interface had no corrosion activity.

- Foreign material has been identified by other power plants that removed the liner plate from the inside of containment leaving the concrete in place. The foreign debris was identifiable in these instances since the corrosion product was available for analysis. At BVPS, little or no corrosion product remained following the water hydrolazing, so no conclusions could be drawn regarding the source of the corrosion.

A vendor materials specialist was commissioned to perform a corrosion assessment of the corroded steel liner, and stated that the primary source of passivation of the steel used in fabrication of the containment liner, studs and rebar is the concrete itself. The passivity of the steel depends upon the quality of the concrete in contact with the steel and the intimate contact of the steel to the concrete. The vendor concluded that, where the containment steel liner, studs

and rebar are in contact with the concrete cover, the containment steel liner at BVPS Unit 1 would be in a passivated state and not subject to oxygen concentration cell corrosion. The visual inspection of the removed cutout and rebar identified that the majority (over 99%) of the surfaces in contact with the concrete were passive to an oxygen concentration cell corrosion mechanism.

Based on its review, the staff finds the applicant's response to RAI B.2.3-1 acceptable because the applicant has adequately explained that corrosion of the liner plate or rebar materials from the concrete side of the liner plate is passive because there is no active mechanism for corrosion. The staff determined that the Shaw Group's evaluation of the Unit 1 containment liner confirmed that the degraded conditions found on the liner did not adversely affect its mechanical and/or structural function as a leak-tight membrane. Therefore, the staff's concern described in RAI B.2.3-1 is resolved.

In LRA Section B.2.3, the applicant stated that following RFO 17 (2006) for Unit 1, test procedures for the evaluation of the containment liner plates were modified at both units. The staff determined that additional information was required to complete its review.

In RAI B.2.3-2, dated May 8, 2008, the staff requested that the applicant identify which test procedures or part of the procedures were modified and compare them with previous procedures, as well as those required by ASME Code Section XI, Subsection IWE. The applicant was also asked to explain whether the modified test procedures help detect similar containment liner degradation on the side that is in contact with the concrete and; if not, how the applicant will ensure that similar degradation, if any, is detected.

In its response to RAI B.2.3-2, dated June 16, 2008, the applicant explained that the procedures for Units 1 and 2 were modified to include two additional requirements in the containment inspection procedures, resulting from the liner corrosion found in 2006: (1) 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 (2) 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 condition (*i.e*., depth, size, shape, orientation). The applicant further stated 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 addressed.

Based on its review, the staff finds the applicant's response to RAI B.2.3-2 acceptable because the applicant described the modifications of the containment inspection procedures that will identify additional areas of corrosion (if any). These procedures will be incorporated as part of the ASME Code XI, Subsection IWE examinations. Therefore, the staff's concerns described in RAI B.2.3-2 are resolved.

The staff reviewed the applicant's ASME Code Section XI, Subsection IWE Program. GALL AMP XI.S1 states that ASME Code Section XI paragraph IWE-1240 requires augmented examinations of containment surface areas that are subject to degradation. The staff determined that additional information was required to complete the review.

In RAI B.2.3-3, dated May 8, 2008, the staff requested that the applicant historically explain what inspection findings under the BVPS ISI – IWE Program, including the 2006 findings of the liner degradation on the side in contact with concrete, have led to the need for augmented inspections.

In its response to RAI B.2.3-3, dated June 16, 2008, the applicant stated that Units 1 and 2 do not meet the criteria for ASME Code augmented examinations as defined in ASME Code XI, IWE-1240. There are no augmented examinations being performed on examination surface areas at Units 1 or 2 as defined in ASME Code Section XI, Subsection IWE-1240. However, the applicant further explained that two of the three degraded areas were removed and replaced with new plate material in 2006, following the discovery of corrosion on the concrete side of the liner plate. The third area was found acceptable from examination and laboratory analysis and was left in place. As part of the corrective actions from the discovery, this third area is monitored with additional examinations. FENOC has scheduled additional UT examinations for the three inspection periods following RFO 17 (2006), when the degradation was discovered. So far, these additional UT examiniations have identified no degradation.

Based on its review, the staff finds the applicant's response to RAI B.2.3-3 acceptable because the applicant has verified that Units 1 and 2 do not meet the criteria for ASME Code augmented examinations as defined in ASME Code Section XI, IWE-1240. Two of the three unacceptable degraded areas were removed and replaced with new plate material following the discovery of the corrosion on the concrete side of the liner plate during RFO 17 (2006), and the third area will have been examined for three inspection period following RFO 17. Therefore, the staff's concerns described in RAI B.2.3-3 are resolved.

On April 23, 2009, during a Unit 1 IWE inspection, a paint blister was discovered on the containment liner. Further investigation revealed through-wall corrosion of the containment liner. In response to this operating experience, by letter dated May 7, 2009, the staff issued RAI B.2.3-4, RAI B.2.3-5, and RAI B.2.5-1, requesting the applicant to explain how the recent plant-specific operating experience, as well as the 2006 degradation, would be incorporated into the ASME Section XI, Subsection IWE and Subsection IWL AMPs, and if the Subsection IWE AMP has been enhanced by the applicant.

In its response to RAIs B.2.3-5 and B.2.5-1, dated June 1, 2009, the applicant stated that in April 2009 during performance of an ASME Subsection IWE containment liner plate examination a through wall hole with dimensions of 1 inch by 3/8 inch was discovered. Wood debris was found within the concrete adjacent to the hole. Laboratory analysis concluded that the wood debris most likely promoted corrosion. The wood debris was removed. No structural rebar was exposed during this process. The concrete behind the through wall liner plate flaw was repaired, and the affected area of the liner plate was replaced and pressure tested to ensure leak tightness.

The staff review of the reactor operating experience records indicate that through-wall corrosion of the liner plate similar to that found in the BVPS containment has been previously detected in both PWR and BWR containments. Plants with previously detected through-wall corrosion include Brunswick Units 2 (ambient pressure containment), D. C. Cook Unit 2 (ambient pressure containment), and North Anna Unit 2 (sub-atmospheric containment). BVPS, Units 1 and 2 containments were originally designed as sub-atmospheric but were converted to atmospheric

containments in 2006. The root cause of the through-wall corrosion at Brunswick Unit 2, D.C. Cook Unit 2, and North Anna Unit 2 plants was found to be construction imperfections and foreign material trapped in the concrete against the liner. Therefore, the staff believes that the occurrence of through wall corrosion at Beaver Valley is likely due to a foreign object (wood debris) trapped in the concrete against the liner, especially since the wood debris had a pH value 3.7 and a moisture content of 13 percent. The additional visual and volumetric examinations that the applicant plans to perform, as described below, may provide additional insight about the potential corrosion mechanism. In addition, the corrective actions carried out by the applicant, also described below, have restored the liner's ability to perform its intended function as a leak tight barrier.

The applicant also stated in its response to RAI B.2.3-4 dated June 1, 2009, that a plant-specific program to manage aging of the containment liner or enhancement to the ASME Subsections IWE and IWL is not necessary due to discovery of the through-wall hole in April 2009. However, the containment liner plate inspection procedures for both Units 1 and 2 were modified following the identification of degradation in 2006 to include the following acceptance criteria for the containment liner plate:

1. When paint or coatings are to be removed for further inspection, the paint or coatings shall be visually examined by a qualified VT-3 inspector prior to removal.

2. If the visual examination detects surface flaws on the liner or suspect areas on the liner plate that could potentially impact leak tightness or structural integrity of the liner, then surface or volumetric examinations shall be performed to characterize the condition (i.e., depth, size, shape, orientation).

In addition, in the June 1, 2009, response to RAIs B.2.3-4 and B.2.3-5, the applicant stated that the corrective actions for the degradation found in April 2009 include visual examination of 100 percent of the accessible containment liner plate area of Unit 1 during 1R20 refueling outage in October/November 2010 and Unit 2 refueling outage 2R14 in October/November 2009. A volumetric examination of the small area of the Unit 1 liner plate replaced to remove the defect discovered in April 2009 is also planned for the 1R20 refueling outage. Furthermore, in the June 1, 2009, letter, the applicant also committed to perform supplemental volumetric examinations of randomly selected 75 (one square foot) locations at both Units 1 and 2. If no degradation is found at these 75 sample locations in each unit, it will provide a 95 percent confidence that 95 percent of the containment liner plate is not degraded (using the methodology of EPRI TR-107514). These corrective actions are not characterized as ASME Section XI, Subsection IWE augmented examinations but rather as "supplemental volumetric examinations."

During teleconferences held from July 24 through September 3, 2009, the staff requested the applicant to clarify the supplementary volumetric examination commitments described in the letter dated June 1, 2009. In subsequent letters dated July 28, 2009, September 2, 2009, September 4, 2009, September 8, 2009, and September 14, 2009, the applicant modified and expanded its previous commitments that will evaluate the condition of the containment liners at Beaver Valley Units 1 and 2. These commitments are in addition to the visual examination of 100 percent of the accessible containment liner plate area that the applicant plans to perform in Unit 1 during 1R20 refueling outage in October/November 2010 and in Unit 2 during refueling outage 2R14 in October/November 2009 as a part of the corrective action program. The new commitments are to perform:

1. A supplemental volumetric examination (UT) of a minimum of 75 (one-foot square) locations of the accessible portions of the containment liner plate of both Unit 1 and 2 selected randomly, with completion of Unit 1 examinations over the next three refueling outages beginning in October 2010. The Unit 2 examinations will be completed prior to entering the period of extended operation. If there are any failures in the first set of samples (minimum of 75), additional samples will be randomly selected such that, upon completion of the random sampling plan, there is sufficient data to demonstrate with a 95 percent confidence that 95 percent of the accessible portion of the containment liner is not experiencing localized pitting corrosion of concern with greater than 10 percent loss of material. Any degradation discovered will be addressed in the corrective action process.

2. A supplemental volumetric examination of a minimum of eight areas located in the accessible areas of liner plate. Site specific and industry operating experience will be used to determine locations that are susceptible to localized pitting corrosion. The specific areas to be considered for selection include:

    a. areas that have been repainted more than once

    b. areas with irregular contour

    c. an area 5 feet below the 2006 steam generator replacement construction opening (Unit 1 only)

    d. the area covering the final grade level where the concrete containment is exposed to environment

    e. an area adjacent to where the through-wall degradation of the liner was discovered in April 2009 (Unit 1 only)

    The Unit 1 examination will commence on-line, within the current fuel cycle and will be completed prior to the end of the 1R20 refueling outage, not to exceed December 31, 2010. The Unit 2 examinations will be completed prior to entering the period of extended operation. Any degradation discovered will be addressed in the corrective action process.

The following table provides the relevant past operating experience, as well as proposed future actions.

Unit	Date	Activity
1	May 2006	Found three small areas of degraded liner plate. Two areas removed and replaced. Third area found acceptable. Successful integrated leakage rate test (ILRT) after repair.
2	May 2008	Successful integrated leakage rate test (ILRT)
1	April 2009	IWE inspection found a 3/8 inch x 1 inch hole in liner plate which was removed and replaced.
2	October 2009	Complete 100 percent visual examination of liner plate
1	October 2010	Complete 100 percent visual examination of liner plate. Perform UT examination of the liner plate area replaced during April 2009.
1	December 2010	Complete volumetric examination of 8 or more areas of liner plate, focused on areas most likely to experience degradation based on past operating experience.
2	April 2011	Scheduled IWE program visual examination of liner plate
1	April 2012	Scheduled IWE program visual examination of liner plate
1	January 2016	Complete volumetric examination of a minimum of 75 one-foot square areas of liner plate, selected randomly, during the next three refueling outages beginning in October 2010.
2	May 2027	Complete volumetric examination of a minimum of 75 one-foot square areas of liner plate, selected randomly, prior to the start of period of extended operation.
2	May 2027	Complete volumetric examination of 8 or more areas of liner plate, focused on areas most likely to experience degradation based on past operating experience.

The supplemental volumetric inspections will identify the minimum liner thickness and document any degradation patterns by scanning the entire one-foot square sample area. In its letter dated September 4, 2009, the applicant clarified that the purpose of the volumetric examinations of the minimum of 75 random samples is to ensure with a 95 percent confidence that 95 percent of the accessible ultrasonically untested portion of the containment liner is not experiencing degradation due to corrosion with greater than 10 percent loss of material. Liner plate thinning attributed to degradation on the inside surface of the liner will be managed in accordance with the existing ASME Subsection IWE aging management program.

The applicant's acceptance criteria for the volumetric examinations of the concrete to liner interface defines a statistical sample failure as a random location with greater than 10 percent loss of material, unless through engineering evaluation it is attributed to fabrication/erection practices. Samples with greater than 10 percent loss of liner material would be re-examined during subsequent outages until dispositioned.

Indications of liner plate loss of thickness of less than 10 percent that can be attributed to corrosion will be entered into the corrective action program and tracked as a point of interest during subsequent outages until dispositioned.

The applicant has committed to evaluate appropriate/applicable statistical methodologies to gain additional insight into potential liner corrosion. Data gathered will be used to determine the general state of the liner.

For all of the planned supplemental volumetric examinations, adverse findings will be addressed by the applicant's corrective action program as described above.

The staff has determined that the random sampling plan, which includes the initial examinations of a minimum of 75 one-foot square locations and any needed scope expansion locations of the accessible portions of the containment liner, will result in 95 percent confidence that 95 percent of the accessible portion of the containment liner is not experiencing corrosion with greater than 10 percent loss of material (95/95 confidence). This approach is used routinely in the nuclear industry for investigation of degradation in different commodities and is considered to be a high confidence level from a statistical standpoint. Degradation in the liner plate found during April 2009 where the corrective actions have been taken is not a part of the random inspection plan, and is not required to be considered to determine the sample size for a new random plan.

The random volumetric examinations will commence by the end of the Unit 1 Refueling Outage in 2010 and will be completed over the next three refueling outages prior to the period of extended operation in January 2016. The Unit 2 examinations will commence by the end of the Unit 2 refueling outage in 2011 and will be completed prior to the period of extended operation. Any degradation discovered that does not meet the volumetric examination acceptance criteria, as noted above, will result in examination of additional randomly selected samples, as necessary to meet the 95/95 confidence criterion described above. In addition, the applicant will evaluate applicable statistical methodologies to characterize the general state of the containment liner plate. The staff finds the selection of the initial random sample of a minimum of 75 locations and the inclusion of additional random samples, in case one or more of the initial sample fails the examination acceptance criteria, conforms to the guidance provided in Section 4 of EPRI report TR-107514 and NUREG 1475. In any case, the applicant will perform sufficient random sampling to ensure 95 percent confidence that 95 percent of the accessible portion of the containment liner is not experiencing localized pitting corrosion of concern with greater than 10 percent loss of material.

The staff notes that the supplemental volumetric examination of a minimum of eight non-randomly selected areas will focus on those locations that the applicant believes are most likely to experience degradation based on prior experience. These non- random volumetric examinations will provide additional confidence that the liner plate is performing its intended function as a leak tight membrane. The applicant has committed to commence these examinations on-line prior to beginning of Unit 1 refueling outage in 2010 and to complete them no later than December 31, 2010. The staff believes that this non-random selection of volumetric examination at a minimum of eight areas will supplement the results of examinations at randomly selected locations and will provide an early indication of loss of containment liner plate integrity and leak tightness. Adverse findings from the examinations will be addressed in the corrective action process as described above, and will involve additional examinations, assessments, and repairs, as necessary. In addition, the applicant will provide NRC a summary report of the results from the volumetric examinations for each unit after completion of each phase of testing.

Based on its review, the staff finds the applicant's responses to RAIs B.2.3-4, B.2.3-5, B.2.5-1, and clarifications in their July 28, 2009, September 2, 2009, September 4, 2009, September 8, 2009, and September 14, 2009, letters, acceptable because the applicant's aging management program incorporates the recent plant-specific operating experience. The modified procedures, along with the 100 percent visual examination of the liner plate during the next outage and the supplemental volumetric examinations of a minimum of 75 random samples and a minimum of 8 non-random areas 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 LRA. The applicant's commitment to perform volumetric examination of the minimum of 8 non-random areas in Unit 1 on-line by December 2010 will confirm if corrosion at the liner concrete interface is present at the most likely locations. Completing volumetric examinations for Unit 2 before the period of extended operation is acceptable since liner plate degradation has only been identified in Unit 1. The staff had included a proposed license condition, which ensures for continued containment liner volumetric examinations as necessary, which is discussed in SER Section 1.6, "Summary of Proposed License Conditions."

In response to RAI B.2.3-5 dated June 1, 2009, the applicant stated that the aging management program was not enhanced to achieve GALL consistency as described in NUREG-1801. The procedures were modified, as discussed above, to identify additional actions in the event that suspect surfaces are identified by the IWE visual inspection. The applicant further stated that UT examinations were performed on the area of degradation discovered during the 2006 steam generator replacement outage which was left in place. The applicant explained that these examinations were corrective actions related to the degradation and are not considered IWE augmented examinations since the degradation was discovered outside of the scheduled IWE examinations. The applicant also stated that the through-wall degradation discovered in April 2009 during an IWE examination does not require augmented examinations because the degraded area was replaced. The corrective actions from the 2009 degradation include 100 percent visual examination of the accessible liner during the next outage, a volumetric inspection of the replaced area, and supplemental volumetric examination. These corrective actions are not characterized by the applicant as IWE augmented examinations.

Based on its review of the applicant's response to RAI B.2.3-5, the staff finds the response acceptable because it explains how the corrective actions were implemented and why the degraded areas do not fall under the IWE Examination Category E-C (augmented examination). The 2006 degradation was not discovered during an IWE examination and the corrective actions are not tracked under the IWE AMP, while the 2009 degradation does not require IWE augmented examinations per IWE-2420 because the area was replaced. The staff's concerns described in RAI B.2.3-5 are resolved.

The staff confirmed that the "operating experience" program element satisfies the criterion defined in the GALL Report and in SRP-LR Section A.1.2.3.10. The staff finds the program element acceptable.

UFSAR Supplement. The applicant provided the UFSAR supplement for the ASME Code Section XI, Subsection IWE Program in LRA Section A.1.3. The staff reviewed this Section and determines that the information in the UFSAR supplement is an adequate summary description of the program, as required by 10 CFR 54.21(d).

Conclusion. The staff reviewed the information in LRA Section B.2.3 and additional information provided by the applicant in letters dated June 16, 2008, June 1, 2009, July 28, 2009, September 2, 2009, September 4, 2009, September 8, 2009, and September 14, 2009. The staff finds that those attributes of the applicant's ASME Code Section XI, Subsection IWE Program for which the applicant claimed consistency with the GALL Report are consistent with the GALL Report. In addition, the staff reviewed the applicant's exception and justification and

determines that the AMP, with the exception, and the additional commitments for the liner visual and volumetric inspection is adequate to manage the aging effects for which the LRA credits it.

Based on its review, the staff concludes that the applicant has demonstrated that the effects of aging will be adequately managed so that the intended functions will be maintained consistent with the CLB for the period of extended operation, as required by 10 CFR 54.21(a)(3).
The staff also reviewed the UFSAR supplement for this AMP and concludes that it provides an adequate summary description of the program, as required by 10 CFR 54.21(d).

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SECTION 4

TIME LIMITED AGING ANALYSIS

The staff does not have any changes or update to this section of the original SER (ML091600216).

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SECTION 5

REVIEW BY THE ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

The staff has provided the Advisory Committee on Reactor Safeguards with a copy of this Supplemental Safety Evaluation Report.

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SECTION 6

CONCLUSION

The staff does not have any changes or update to this section of the original SER (ML091600216).

APPENDIX A

BVPS UNITS 1 AND 2 LICENSE RENEWAL COMMITMENTS

During the review of the Beaver Valley Power Station, Units 1 and 2 (BVPS) license renewal application (LRA) by the staff of the United States (US) Nuclear Regulatory Commission (NRC) (the staff), FirstEnergy Nuclear Operating Company (the applicant) made commitments related to aging management programs (AMPs) to manage the aging effects of structures and components (SCs) both prior to and during the period of extended operation. The following tables list a revised commitment 32 for Unit 1 and a revised commitment 33 for Unit 2, as well as new commitments 33, 34 and 35 for Unit 1 and new commitments 34, 35 and 36 for Unit 2.

BVPS UNIT 1 LICENSE RENEWAL COMMITMENTS

Item Number	Commitment	Implementation Schedule	Source	Related LRA Section No./ Comments
32	Supplemental volumetric examinations will be performed on the Unit 1 containment liner prior to the period of extended operation. A minimum of seventy-five (one foot square) randomly selected (as described in FENOC Letter L-09-205) sample locations will be examined (as described in FENOC Letter L-09-243). If degradation is identified, it will be addressed through the corrective action program (as described in FENOC Letter L-09-243).	Unit 1 inspections for the initial sample lot of a minimum of 75 random ultrasonic examinations will be completed in the next three refueling outages, beginning with the Unit 1 refueling outage in 2010. The random sample plan will be completed by January 29, 2016	FENOC Letter L-09-205, FENOC Letter L-09-242, and FENOC Letter L-09-243	None
33	Supplemental volumetric examinations will be performed on the Unit 1 containment liner. A minimum of 8 non-randomly selected locations will be examined, focusing on areas most likely to experience degradation based on past operating experience (as described in FENOC Letter L-09-242). If degradation is identified, it will be addressed through the corrective action program.	Examinations will commence on-line, prior to the beginning of the Unit 1 Refueling outage in 2010. Examinations will be completed by December 31, 2010	FENOC Letter L-09-205, FENOC Letter L-09-242, and FENOC Letter L-09-245	None
34	A summary of results for each phase of volumetric testing (described in Unit 1 Commitments No. 32 and No. 33) will be documented in a letter to the NRC.	January 29, 2016	FENOC Letter L-09-242 and FENOC Letter L-09-245	None
35	FENOC will evaluate if an appropriate/applicable statistical method exists to gain additional insight into potential liner degradation. Data gathered will be evaluated and used to determine the general state of the liner.	January 29, 2016	FENOC Letter L-09-242 and FENOC Letter L-09-243	None-

BVPS UNIT 2 LICENSE RENEWAL COMMITMENTS

Item Number	Commitment	Implementation Schedule	Source	Related LRA Section No./ Comments
33	Supplemental volumetric examinations will be performed on the Unit 2 containment liner prior to the period of extended operation. A minimum of seventy-five (one foot square) randomly selected (as described in FENOC Letter L-09-205) sample locations will be examined (as described in FENOC Letter L-09-243). If degradation is identified, it will be addressed through the corrective action program (as described in FENOC Letter L-09-243).	Examinations will commence by the end of the Unit 2 refueling outage in 2011. The random sample plan will be completed by May 27, 2027	FENOC Letter L-09-205, FENOC Letter L-09-243, and FENOC Letter L-09-244.	None
34	Supplemental volumetric examinations will be performed on the Unit 2 containment liner. A minimum of 8 non-randomly selected locations will be examined, focusing on areas most likely to experience degradation based on past operating experience (as described in FENOC Letter L-09-242). If degradation is identified, it will be addressed through the corrective action program.	May 27, 2027	FENOC Letter L-09-205, FENOC Letter L-09-242, and FENOC Letter L-09-245	None
35	A summary of results for each phase of volumetric testing (described in Unit 2 Commitments No. 33 and No. 34) will be documented in a letter to the NRC.	May 27, 2027	FENOC Letter L-09-242 and FENOC Letter L-09-245	None

Item Number	Commitment	Implementation Schedule	Source	Related LRA Section No./ Comments
36	FENOC will evaluate if an appropriate/applicable statistical method exists to gain additional insight into potential liner degradation. Data gathered will be evaluated and used to determine the general state of the liner.	May 27, 2027	FENOC Letter L-09-242 and FENOC Letter L-09-243	None

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APPENDIX B

CHRONOLOGY

This appendix lists chronologically the routine licensing correspondence between the staff of the United States (US) Nuclear Regulatory Commission (NRC or the staff) and FirstEnergy Nuclear Operating Company (FENOC). This appendix also lists other correspondence on the staff's review of the Beaver Valley Power Station (BVPS), Units 1 and 2, license renewal application (LRA) (under Docket Nos. 50-334 and 50-412).

Date	Accession No.	Subject
June 4, 2009	ML091390631	ACRS Meeting with the U.S. Nuclear Regulatory Commission, - June 4, 2009, Slides
June 8, 2009	ML091550506	Safety Evaluation Report Related to the License Renewal of Beaver Valley Power Station, Units 1 and 2
June 17, 2009	ML091550750	G20090309/LTR-09-0234/EDATS: SECY-2009-0259 - Theodore Robinson Ltr re: Beaver Valley Power Station, Units 1 and 2, Safety Evaluation Report
June 8, 2009	ML091560200	Press Release-09-105: NRC Issues Final Safety Evaluation Report for Beaver Valley Nuclear Power Plant License Renewal
June 8, 2009	ML091590247	Press Release-09-105: NRC Issues Final Safety Evaluation Report for Beaver Valley Nuclear Power Plant License Renewal
June 8, 2009	ML091600216	Safety Evaluation Report Related to the License Renewal of Beaver Valley Power Station, Units 1 and 2
July 1, 2009	ML091910134	Citizen Power Ltr. re: Reply to June 17 Letter to Ted Robinson in Connection with Liner Degradation Problems at Beaver Valley Nuclear Station
July 14, 2009	ML091960450	FENOC Report on Containment Liner, Part 2
July 7, 2009	ML091900719	Concerns Regarding the Containment Liner at Beaver Valley Power Station, Units 1 & 2
July 15, 2009	ML091960496	Beaver Valley, Unit 1, Cover Letter for FENOC Report
July 15, 2009	ML091960519	FENOC Report on Containment Liner, Part 3

Date	Accession No.	Subject
July 15, 2009	ML091960562	FENOC Report on Containment Liner, Part 4
July 15, 2009	ML091960569	FENOC Report on Containment Liner, Part 5
July 28, 2009	ML092110117	Beaver Valley, Units 1 & 2 - Supplemental Information for the Review of License Renewal Application and License Renewal Application Amendment No. 39
August 6, 2009	ML092180038	Docketing of NRC Teleconference Notes Pertaining to the License Renewal of the Beaver Valley Power Station, Units 1 and 2
August 6, 2009	ML092180378	Transcript of NRC License Renewal Teleconference Held on July 16, 2009
August 10, 2009	ML092190384	Letter to Citizens Power dated August 10, 2009, Response to July 7, 2009, Regarding Concerns with Containment Liners at Beaver Valley Units 1 & 2, and Belief Proposed Inspection Techniques are Insufficient Given Discovery of Corrosion Went Through-Wall
August 11, 2009	ML092180206	Docketing of NRC Teleconference Notes Pertaining to the License Renewal of the Beaver Valley Power Station, Units 1 and 2
August 11, 2009	ML092180214	Docketing of NRC Telephone Conference Notes Pertaining to the License Renewal of the Beaver Valley Power Station, Units 1 and 2
August 12, 2009	ML092180557	Conference Call - Containment Liner Corrosion - Friday, July 24, 2009 11:30 a.m
September 2, 2009	ML092510168	Beaver Valley, Units 1 & 2 - Supplemental Information for the Review of License Renewal Application and License Renewal Application Amendment No. 40
September 4, 2009	ML092530241	Beaver Valley, Units 1 & 2 - Supplemental Information for the Review of License Renewal Application and License Renewal Application Amendment No. 41
September 8, 2009	ML092510226	Docketing of U.S Nuclear Regulatory Commission Teleconference Notes Pertaining to the License Renewal of the Beaver Valley Power Station, Units 1 and 2
September 8, 2009	ML092510254	Transcript of U.S. Nuclear Regulatory Commission Teleconference held on August 26, 2009

Date	Accession No.	Subject
September 8, 2009	ML092510260	Docketing of U.S. Nuclear Regualtyory Commission Teleconference Notes Pertaining to the License Renewal of the Beaver Valley Power Station, Units 1 and 2
September 8, 2009	ML092530242	Beaver Valley, Units 1 & 2 - Supplemental Information for the Review of License Renewal Application and License Renewal Application Amendment No. 42
September 9, 2009	ML092520067	Docketing of U.S. Nuclear Regulatory Commission Teleconference Notes Pertaining to the License Renewal of the Beaver Valley Power Station, Units 1 and 2
September 9, 2009	ML092520166	Docketing of U.S. Nuclear Regulatory Commission Teleconference Notes Pertaining to the License Renewal of the Beaver Valley Power Station, Units 1 and 2 (Enclosure)
September 14, 2009	ML092590047	Beaver Valley, Units 1 and 2 – Supplemental Information for the Review of License Renewal Application and License Renewal Application Ammendment 43