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NUREG-1929, Vol. 1

Safety Evaluation Report

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

Docket Nos. 50-334 and 50-412

FirstEnergy Nuclear Operating Company

Office of Nuclear Reactor Regulation

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ABSTRACT

This safety evaluation report (SER) documents the technical review of the Beaver Valley Power Station (BVPS), Units 1 and 2, license renewal application (LRA) by the United States (US) Nuclear Regulatory Commission (NRC) staff (the staff). By letter dated August 27, 2007, FirstEnergy Nuclear Operating Company (FENOC or the applicant) submitted the LRA in accordance with Title 10, Part 54, of the *Code of Federal Regulations*, "Requirements for Renewal of Operating Licenses for Nuclear Power Plants." FENOC requests renewal of the 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 expirations at midnight January 29, 2016, for Unit 1, and at midnight May 27, 2027, for Unit 2.

BVPS is located approximately 17 miles west of McCandless, PA. The NRC issued the construction permits for Unit 1 on June 26, 1970, and on May 3, 1974, for Unit 2. The NRC issued the operating licenses for Unit 1 on July 2, 1976, and on August 14, 1987, for Unit 2. Units 1 and 2 are of a dry subatmospheric pressurized water reactor design. Westinghouse Electric supplied the nuclear steam supply system and Stone and Webster originally designed and constructed the balance of the plant. The licensed power output of each unit is 2900 megawatt thermal with a gross electrical output of approximately 972 megawatt electric.

This SER presents the status of the staff's review of information submitted through June 04, 2009, the cutoff date for consideration in the SER. Section 6.0 provides the staff's final conclusion on the review of the BVPS LRA.

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The staff confirms that the "operating experience" program element satisfies the recommendation in the GALL report and the guidance in SRP-LR Section A.1.2.3.10. The staff finds this program element acceptable.

UFSAR Supplement. The staff reviewed this Section and determines that the information in the UFSAR supplement provides an adequate description of the program as required by 10 CFR 54.21(d). The staff also verified that applicant has committed (Commitment No. 16 in UFSAR Supplement Table A.5-1) to implement its new Metal Enclosed Bus Program.

Conclusion. Based on its review, the staff finds that the applicant's Metal Enclosed Bus Program acceptable because it is consistent with the GALL report and the plant is bounded by the conditions set forth in the GALL Report for this AMP. The staff concludes that the applicant has demonstrated that the effects of aging will be adequately managed so that the intended function(s) 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)

3.0.3.1.15 Metal Fatigue of Reactor Coolant Pressure Boundary Program

Summary of Technical Information in the Application. In LRA Section B.2.27, the applicant described the existing Metal Fatigue of Reactor Coolant Pressure Boundary Program as consistent with GALL AMP X.M1, "Metal Fatigue of Reactor Coolant Pressure Boundary."

The applicant stated that the Metal Fatigue of Reactor Coolant Pressure Boundary Program is a TLAA that uses preventive measures to mitigate fatigue cracking caused by anticipated cyclic strains in metal components of the RCPB. The preventive measures monitor and track critical thermal and pressure transients for RCS components to prevent them from exceeding fatigue design limits. Critical transients are the subset of the design transients likely to approach or exceed the number of design cycles during the sixty-year operating life of the units. These critical transients include plant heatup, plant cooldown, reactor trip from full power (Unit 1), inadvertent auxiliary spray, safety injection activation (Unit 1), and RCS cold over-pressurization. The program also monitors supplemental transients like the pressurizer insurge transient, selected chemical and volume control system (CVCS) transients, auxiliary feedwater (AFW) injections, and RHR actuation (Unit 2). Before these transients exceed the fatigue design limit, the program triggers preventive or corrective actions or both.

In addition, the applicant also stated that the program evaluates environmental effects in accordance with the guidance in NUREG/CR-6260, "Application of NUREG/CR-5999 Interim Fatigue Curves for Selected Nuclear Power Plant Components," and EPRI Technical Report Materials Reliability Program (MRP)-47, "Guidelines for Addressing Fatigue Environmental Effects in a License Renewal Application." The program evaluates selected components using material-specific guidance found in NUREG/CR-6583, "Effects of LWR Coolant Environments on Fatigue Design Curves of Carbon and Low Alloy Steels," and in NUREG/CR-5704,"Effects of LWR Coolant Environments on Fatigue Design Curves of Austenitic Stainless Steels."

Staff Evaluation. During its audit and review, the staff reviewed the applicant's claim of consistency with the GALL Report.

Specifically, the staff reviewed the "scope of program" "preventative/mitigative actions," "parameters monitored/inspected," "detection of aging effects," "monitoring and trending," "acceptance criteria" and "operating experience" program elements of the applicant's Fatigue of Reactor Coolant Pressure Boundary Program against the staff's recommended criteria for these programs that are provided in the corresponding program elements of GALL AMP X.M1. The staff performed its review of the "corrective actions," "confirmatory actions," and "administrative controls" program elements as part of the staff's review of the applicant's Quality Assurance Program.

The staff's evaluation of the Quality Assurance Program is provided in SER Section 3.0.4.

The staff reviewed the technical information in LRA Section B.2.27 and the applicant's onsite documentation supporting the applicant's conclusion that the program elements are consistent with the elements in the GALL Report. The staff also interviewed the applicant's technical staff to verify the description of the LRA and its supplementing documents.

The staff determined that the applicant's Metal Fatigue of Reactor Coolant Pressure Boundary Program is based, in part, on a cycle counting process that is performed for the design basis transients that have been defined for the Units 1 and 2 facilities in LRA Table 4.3-2. The staff noted that the cycle counting is required for these transients in accordance with the applicant's Technical Specification (TS) 5.5.3, which reads as follows:

> 5.5.3 Component Cyclic or Transient Limit
>
> This program provides controls to track the UFSAR Table 4.1-10 (Unit 1) and UFSAR Table 3.9N-1 (Unit 2), cyclic and transient occurrences to ensure that components are maintained within the design limits.

The staff noted that this TS requirement provided the applicant's basis for the cycle counting that is part of the "monitoring and trending" program element aspect of the applicant's program. However, in comparing other aspects of the applicant's program elements to the -program element criteria in GALL AMP X.M1, the staff found that LRA Section B.2.27 did not provide sufficient detail for the staff to determine whether the "Metal Fatigue of Reactor Coolant Pressure Boundary Program" is adequate for the period of extended operation. The staff therefore issued to the applicant a number of RAIs on the Metal Fatigue of Reactor Coolant Pressure Boundary Program.

The staff noted that the applicant defines the term "critical transients" and provides the lists of the transients for each unit in the LRA Table 4.3-2. The staff issued an RAI for its clarification and review.

In RAI B.2.27-1, dated May 28, 2008, the staff requested that the applicant provide a list of the critical design basis transients that could impact the cumulative usage factor (CUF) assessments for the applicant and to justify its basis for selecting these transients as the critical ones for the CUF calculation.

In its response to RAI B.2.27-1, dated July 11, 2007, the applicant identified the critical transients, which include plant heat up and cool down, reactor trip from full power (Unit 1 only), inadvertent auxiliary spray, safety injection activation (Unit 1 only) and RCS cold over pressurization, that will be monitored by Metal Fatigue of Reactor Coolant Pressure Boundary Program. The applicant further identified supplemental transients, which include pressurizer insurge transient, selected CVCS transients, AFW injections and RHR actuation that will be monitored by Metal Fatigue of Reactor Coolant Pressure Boundary Program and stated that these critical and supplemental transients will be monitored and tracked in order to ensure that the fatigue design limit is not exceeded. The staff noted that as part of the response, the applicant provided a table of the critical and supplemental transients that are required for monitoring for Units 1 and 2, along with the basis of selection and the selection criteria of these transients. The staff further noted that the applicant selected these critical and supplemental transients because the projected cycles for these transients are expected to approach the design cycles during the period of extended operation.

Based on its review, the staff finds the applicant's response to RAI B.2.27-1 acceptable because the applicant has provided the complete list of critical and supplemental transients that will be monitored by the Metal Fatigue of Reactor Coolant Pressure Boundary Program and has included an appropriate basis for selecting these transients to be monitored by the program during the period of extended operation. Therefore, the staff's concern described in RAI B.2.27-1 is resolved.

In LRA Section B.1.3, the applicant provided the following elements: (a) corrective actions, (b) confirmation process, and (c) administrative controls common to all AMPs. The staff issued an RAI in order to verify the specific activities for those elements under this program.

In RAI B.2.27-2, dated May 28, 2008, the staff requested that the applicant provide the information on the design transient cycle-based acceptance criterion that will be used to initiate corrective actions if the criterion is exceeded, and provide a discussion on what these follow-up corrective actions would entail if the acceptance criterion is exceeded and the process is incorporated into the plant-specific implementation procedure for the Metal Fatigue of Reactor Coolant Pressure Boundary Program.

In its response to RAI B.2.27-2, dated July 11, 2007, the applicant stated that, as part of the implementing procedure for the Metal Fatigue of Reactor Coolant Pressure Boundary Program, the number of accumulated cycle occurrences for the critical transients, including the supplemental transients, is updated on an annual basis to determine and identify any adverse trends, adverse conditions and deficient conditions. The applicant defined the terms "adverse trend," "adverse condition" and "deficient condition" as they apply to the implementing procedure for the Metal Fatigue of Reactor Coolant Pressure Boundary Program. The applicant clarified that the intent of its implementing procedure is to detect adverse trends and adverse conditions early on, so that the likelihood of a deficient condition can be prevented. The applicant further indicated that it will perform an evaluation to determine when a rigorous analysis or an alternate solution is needed. When an adverse trend or condition has occurred the deficient condition(s) will be addressed with the applicant's Corrective Actions Program.

Based on its review, the staff finds the applicant's response to RAI B.2.27-2 acceptable because the applicant clarified the triggering points associated with the implementing procedures of the Metal Fatigue of Reactor Coolant Pressure Boundary Program and the applicant's procedures initiate corrective actions prior to the loss of the components intended function. Therefore, the staff's concern described in RAI B.2.27-2 is resolved.

The staff noted that in LRA B.2.27, the applicant indicated that supplemental transients are identified by the Metal Fatigue of Reactor Coolant Pressure Boundary Program for monitoring. The staff required additional information in order to complete its review of this program.

In RAI B.2.27-7, dated May 28, 2008, the staff requested that the applicant provide additional information related to the supplemental transients identified by the program for monitoring. Specifically, the applicant was asked to (a) identify the major components affected by the transients and confirm that a related fatigue analysis has been updated; (b) justify consistency between supplemental transients and design transients, (c) explain the method used to monitor these transients, and indicate whether the number of design cycles for the supplemental transients will remain valid for the period of extended operation.

In its response to RAI B.2.27-7, dated July 11, 2007, the applicant clarified that all supplemental transients listed in the LRA are applicable to both Units 1 and 2. The applicant continued in its response by listing those components that are affected by each of the transients (pressurizer insurge/outsurge, selected CVCS, AFW injection and RHR activation). The staff noted that the applicable analyses for the components specified by the applicant have incorporated the corresponding transients affecting these components and do not require a revision, with the exception of the ASME Class 1 portion of the Unit 2 charging piping. The applicable analyses for the ASME Class 1 portion of the Unit 2 charging piping is part of the applicant's commitment (Commitment No. 1) to perform a re-analysis and to incorporate the revised design cycles of the selected CVCS transients.

The applicant stated that the AFW injection transient was incorporated into the original analysis for the Unit 2 reactor coolant pumps (RCPs), pressurizer and loop stop valves. However, Westinghouse did not identify this transient in the NSSS transients and; therefore, it was not a part of the original design basis. The applicant specifically added this transient for the SGs as part of the design basis for the extended power uprate. The staff noted that the RHR Activation for Unit 2 was part of the original design basis, and was considered a supplemental transient because the applicant expected that the cycles would exceed the design cycles. However based on its response to RAI B.2.27-4, the applicant no longer expects these cycles to exceed the design cycles.

The staff noted that in its response to RAI B.2.27-7, the applicant is capable of monitoring the pressurizer insurge/outsurge, selected CVCS and AFW injection transient with the use of the Plant Computer data archiving system. The staff further noted that with the use of the Plant Computer, the applicant is able to identify the pressurizer insurge/outsurge transient via the surge line thermocouple that will detect a delta-temperature and allocate it into a pre-existing band of delta-temperatures. The applicant explained that the selected CVCS transients are identified with the use of the Plant Computer by noting the valve positions and that the AFW injection transient can be identified by noting the operation and system flow rates of the AFW pumps during Plant Mode 1, 2 and 3. As discussed in the staff's evaluation of RAI B.2.27-4, RHR activation can be identified when the plant transitions between Mode 3 and Mode 4.

Based on its review, the staff finds that the applicant has provided sufficient detail pertaining to the supplemental transients identified by the applicant, the components affected by these transients and the method of monitoring and identification of these transients during the period of extended operation. The staff concludes that, based on its review, the adequate information provided by the applicant, and the fact that the applicant has committed to re-analyzing the Unit 2 charging piping to incorporate the revised design cycles, the applicant's response is acceptable. Therefore, the staff's concern described in RAI B.2.27-7 is resolved.

During the audit, the staff reviewed the onsite basis documents supporting the LRA and discussed its review with the applicant. The staff found that LR basis document (FMP Program Document LRBV-PED-X.M1) Table 6.0-1, element 10 stated that "The design transient assumed by original design analysis will be sufficient for 60 years operation." The staff noted this sentence is also stated in the operating experience Section of LRA Section B.2.27. However, the annotation (a) of LRA Table 4.3-1 states that the projected 60-year cycles of RHR system piping are expected to exceed the design cycles by 50 percent.

In RAI B.2.27-4, dated May 28, 2008, the staff requested that the applicant justify the discrepancy between the text in the LRA and onsite basis documents and the annotation (a) of LRA Table 4.3-1.

In its response to RAI B.2.27-4, dated July 11, 2007, the applicant stated that for the location with the annotation (a), RHR System Piping, the transient that is of concern is "Placing RHR in Service," which occurs at approximately 350°F during plant shutdown procedures. The applicant further stated that Westinghouse performed its initial counting of this transient assuming that it occurs every time the plant transitions from Mode 3 (Hot Shutdown) to Mode 4 (Cold Shutdown), which is documented in Westinghouse Commercial Power (WCAP)-16173-P. The staff verified in the applicant's UFSAR and TSs that RHR is placed into service when the plant cools down from 350° F to less than 200° F. The applicant noted that this method of counting is very dependent on an accurate account of the plant modes and the transition between Mode 3 and Mode 4.

The staff noted that the applicant had performed an evaluation, to obtain an accurate count from the plant mode history from Power Ascension Testing until October 15, 2003. The applicant's result from this recount was 31 events compared to Westinghouse's count of 85 events. The staff compared the results of the applicant's recount with LRA Table 4.3-2 and noted that Unit 2 has had 30 plant cooldown cycles.

Based on its review, the staff finds the applicant's response to RAI B.2.27-4 acceptable because the applicant performed an evaluation to determine an accurate count of the "Placing RHR in Service" transient and has demonstrated that its new count is reasonable, since the transient has occurred every time the plant experienced the transient "Plant Cooldown." Therefore, the staff's concern described in RAI B.2.27-4 is resolved.

In LRA Table 4.3-2, the applicant provided the design transients for the transient cycle projection. Plant program basis document ADM 2115 also provides those transients. The staff noted that the design transients were inconsistent with those in the latest associated piping design specification. The staff determined that additional information was required In order to confirm the consistency between the documents.

In RAI B.2.27-5, dated May 28, 2008, the staff requested that the applicant provide a comparison of the design transients in the LRA table and the basis document and the transients in the latest associated piping design specification documents for Unit 2. The staff also requested that the applicant justify any discrepancy between the LRA table and plant documents (ADM 2115 and design specification).

In its response to RAI B.2.27-5, dated July 11, 2007, the applicant confirmed that there are no discrepancies between LRA Table 4.3-2 and its plant documents, which include AMD 2115 and the design specifications.

Based on its review, the staff finds the applicant's response to RAI B.2.27-5 acceptable because the applicant has confirmed that there are no discrepancies between LRA Table 4.3-2 and its plant documents. Therefore, the staff's concern described in RAI B.2.27-5 is resolved.
The staff noted during its review of the applicant's basis document that the design transient, RHR actuation (activation), for Unit 1 does not require monitoring. The staff determined that additional information was required in order to complete its review.

In RAI B.2.27-9, dated May 28, 2008, the staff requested that the applicant justify the basis for not monitoring the Unit 1 design transient, RHR actuation, for the period of extended operation.

In its response to RAI B.2.27-9, dated July 11, 2007, the applicant stated that the RHR system tee for Unit 1 is a NUREG/CR-6260 location that has been evaluated for environmentally assisted fatigue. The applicant further stated that this location was originally designed to the American National Standards Institute (ANSI) B31.1 standard and re-evaluated under American Society of Mechanical Engineers (ASME) Code Section III to determine a CUF. The staff noted that the applicant has amended the LRA to include an enhancement to the Metal Fatigue of Reactor Coolant Pressure Boundary Program to require that the design transient, RHR Activation for Unit 1 be monitored. The applicant committed (Commitment Nos. 25 and 26 for Units 1 and 2, respectively) to monitor transients in which the 60-year projected cycles are used in environmentally assisted fatigue evaluations.

Based on its review, the staff finds the applicant's response to RAI B.2.27-9 acceptable because the applicant has amended the LRA and has committed (Commitment No.25) to monitor the RHR activation transient for Unit 1 with the Metal Fatigue of Reactor Coolant Pressure Boundary Program. Therefore, the staff's concern described in RAI B.2.27-9 is resolved.

During the onsite discussion, the applicant stated "the surge line to hot leg nozzle for Units 1 and 2, is included in a stress and fatigue model to be used in an on-line monitoring system. The staff determined that additional information was required in order to complete its review.

In RAI B.2.27-3, dated May 28, 2008, the staff requested that the applicant explain the purpose of the on-line monitoring system (WESTEMS) in the management of components subject to metal fatigue, including NUREG/CR-6260 components for the period of extended operation. The staff also requested that the applicant provide its benchmarking results for the WESTEMS software, using relevant transient data and proper 3-D modeling, and justify the use of this software to update the CUF calculation, using the monitored or projected transient data (cycles).

In its response to RAI B.2.27-3, dated July 11, 2007, the applicant stated that WESTEMS is used only in the analysis of the pressurizer lower shell and related components and the surge line to hot leg nozzle for both Units 1 and 2 and the pressurizer spray nozzle of Unit 1. The applicant further stated that the analysis for each location is different and continued to describe how WESTEMS is used for aging management for each of the locations listed above, as requested by the staff.

Westinghouse collaborated on the applicant's response by providing an explanation of the methods utilized by the WESTEMS software in performing the fatigue evaluations for the locations listed above. In addition, Westinghouse provided the applicant with its benchmarking results, accompanied by several graphs that compared the stress results generated from WESTEMS fatigue analysis software and those generated from the traditional finite element ANSYS analysis. The staff noted from the graphs provided by Westinghouse that the difference between the stress results generated by WESTEMS and ANSYS, was negligible.

Based on its review, the staff finds the applicant's response to RAI B.2.27-3 acceptable because the applicant has provided adequate information pertaining to the use of WESTEMS system at Units 1 and 2 and that there is a negligible difference between the stress results generated by WESTEMS and ANSYS. Therefore, the staff's concern described in RAI B.2.27-3 is resolved.

In LRA Section 4.3.2.2, the applicant indicated that the Metal Fatigue of Reactor Coolant Pressure Boundary Program monitors the transients associated with non-regenerative (letdown) heat exchanger, regenerative heat-exchanger, and RHR heat exchangers. However, LRA Section B.2.27 did not indicate that monitoring of the relevant transients will be provided by this AMP.

In RAI B.2.27-10, dated May 28, 2008, the staff requested that the applicant provide a list of the transients associated with the heat exchangers, identify which of these transients are monitored by the program, and explain what corrective actions are taken when the current analyses are not bounding for 60 years of operation.

In its response to RAI B.2.27-10, dated July 11, 2007, the applicant clarified that all auxiliary system heat exchangers, which include letdown heat exchanger, regenerative heat exchanger and RHR heat exchangers, for both Unit 1 and 2 are installed on the Class 2 part of the their respective systems and the primary side of these auxiliary heat exchangers were designed in accordance with ASME Code Section III, Class 2 requirements. The staff noted that since these heat exchangers were designed in accordance with ASME Code Section III, Class 2 rules, a fatigue analysis in accordance with the ASME Code Section III Class 1 requirements is not applicable. The staff further noted that the expected total number of thermal cycles for the heat exchangers in question will be less than the 7000 thermal cycles required by ASME Code Class 2 thermal analysis and: thus, monitoring or a fatigue re-analysis is not required. The applicant amended LRA Sections 4.3.2.2 and A.3.3.2.2 and associated sub-sections and added LRA Section A.2.3.2.2 to reflect the discussion above. The staff noted that since these heat exchangers are bounded by 7000 equivalent full-temperature cycles for 60 years of operation, they will no longer be dispositioned under 10 CFR 54.21(c)(1)(iii), where the Metal Fatigue of Reactor Coolant Pressure Boundary Program will be used for monitoring; rather, they will be dispositioned under 10 CFR 54.21(c)(1)(i), where by the TLAA remains valid for the period of extended operation.

Based on its review, the staff finds the applicant's response to RAI B.2.27-10 acceptable because the applicant has verified that the heat exchangers in question are designed under ASME Code Section III, Class 2 rules, and have been evaluated such that they will not exceed the 7000 equivalent full-temperature cycles and; thus, will not be monitored under the Metal

Fatigue of Reactor Coolant Pressure Boundary Program. Therefore, the staff's concern described in RAI B.2.27-10 is resolved.

Enhancements. Enhancement 1 - The staff noted in the LRA that the applicant did not identify its Metal Fatigue of Reactor Coolant Pressure Boundary Program as AMP that is consistent with GALL AMP X.M1, with enhancement. The staff determined that additional information was required to complete its review.

In RAI B.2.27-6, dated May 28, 2008, the staff requested that the applicant provide additional information on the components that are within the scope of the program, how the program monitors for the impact of thermal transients on the CUFs for critical locations, how the program is updated to perform periodic updates of the CUF calculations for ASME Code Class 1 components, and how the program accounts for environmentally assisted fatigue on the CUF values for critical ASME Code Class 1 locations in the RVs and RCS piping.

In its response to RAI B.2.27-6, dated July 11, 2007, the applicant amended LRA Section B.2.27 to provide the program elements of the Metal Fatigue of Reactor Coolant Pressure Boundary Program and to provide the following enhancement that will affect the "preventive actions," "parameters monitored/inspected," and "corrective actions" program element of the program:

> Add a requirement that fatigue will be managed for the NUREG/CR-6260 locations. This requirement will provide that management is accomplished by one or more of the following:
>
> (1) Further refinement of the fatigue analyses to lower the predicted CUFs to less than 1.0;
>
> (2) Management of fatigue at the affected locations by an inspection program that has been reviewed and approved by the NRC (e.g. periodic non-destructive examination of the affected locations at inspection intervals to be determined by a method acceptable to the NRC); or,
>
> (3) Repair or replacement of the affected locations.
>
> Add a requirement that provides for reanalysis, repair, or replacement of the Unit 2 steam generator secondary manway bolts and the steam generator tubes such that the design bases of these components are not exceeded for the period of extended operation.

The staff reviewed this enhancement, noting that with respect to the applicant's option to refine the CUF analyses to maintain the predicted CUFs to less than a design-basis CUF limit of 1.0, (a) the option is consistent with the staff's recommended "preventative actions" program element in GALL AMP X.M1; (b) the fatigue usage factor will be maintained below the design code limit, taking into account the effects of the reactor water environment; and (c) with the staff's recommended "detection of aging effects," program element in GALL AMP X.M1 will be used to perform periodic updates of the CUF calculations.

With respect to the applicant's options to either refine the fatigue analysis for impacted ASME Code Class 1 compacts or to repair or replace the impacted locations, the staff noted that the applicant's options are consistent with the staff's recommended "corrective actions" program element in GALL AMP X.M1. This GALL AMP states that acceptable corrective actions for these type of AMPs include either repair or replacement activities on the impacted locations or more rigorous analyses of the impacted components to demonstrate that the design-basis code limit of 1.0 for CUFs will not be exceeded during the extended period of operation. The staff further noted that, since this AMP is credited with acceptance of the TLAA on environmentally-assisted metal fatigue of AMSE Code Class 1 components, the applicant's option to manage the impact of environmentally-assisted metal fatigue, and to monitor for fatigue-induced cracking using an inspection-based program, was in accordance with the staff's criterion for accepting TLAAs pursuant to 10 CFR 54.21(c)(1)(iii), where by the effects of aging will be managed for the period of extended operation.

The staff verified that the applicant incorporated this enhancement as part of revised Commitment No. 25 in UFSAR Supplement Table A.4-1 for Unit 1 and revised Commitment No. 26 in UFSAR Supplement Table A.5-1 for Unit 2.

Based on its review, the staff finds that this aspect of the applicant's enhancement is acceptable. The staff also finds the applicant's response to RAI B.2.27-6 acceptable because the applicant has enhanced the Metal Fatigue of Reactor Coolant Pressure Boundary Program such that it is consistent with the recommendations provided in the program elements, "preventative actions", "detection of aging effects" and "corrective actions" of GALL AMP X.M1 or with the acceptance criterion in 10 CFR 54.21(c)(1)(iii). The staff further finds that the applicant has reflected this enhancement in the revised Commitment No. 25 in UFSAR Supplement Table A.4-1 for Unit 1 and No. 26 in UFSAR Supplement Table A.5-1 for Unit 2. Therefore, the staff's concern in RAI B.2.27-6 is resolved.

As part of the applicant's response to RAI 4.3-2, the staff noted that the applicant included, as part of this enhancement to the Unit 2 Metal Fatigue of Reactor Coolant Pressure Boundary Program, that the applicant will re-analyze, repair, or replace the Unit 2 SG secondary manway bolts and SG tubes for the period of extended operation. The staff verified that the applicant has incorporated this enhancement as part of revised Commitment No. 26 for Unit 2, as provided in UFSAR Supplement Table A.5-1. The staff also verified that this enhancement for the Unit 2 SG secondary manway bolts and SG tubes is consistent with the recommendations in the "corrective actions" program element of GALL AMP X.M1 which states that "acceptable corrective actions include repair of the component, replacement of the component, or a more rigorous analysis of the impacted component to demonstrate that the design code limit will not be exceeded during the extended period of operation."

Based on its review, the staff finds that this aspect of the applicant's enhancement is acceptable because it is consistent with the recommendations that are provided in the program elements of GALL AMP X.M1, as described above, and because the applicant has reflected this enhancement in revised Commitment No. 26 in UFSAR Supplement Table A.5-1 for Unit 2.

Enhancement 2 - The staff noted that in the LRA, the applicant did not identify its Metal Fatigue of Reactor Coolant Pressure Boundary Program as an AMP that is consistent with GALL AMP X.M1, with enhancement. In its audit of the license renewal basis document for the Metal Fatigue of Reactor Coolant Pressure Boundary Program, the staff noted that the applicant stated that the design basis transient monitoring for actuation of the Unit 1 RHR system was not required.

In RAI B.2.27-9, dated May 28, 2008, the staff requested that the applicant provide its basis for concluding that actuations of the BVPS Unit 1 RHR system did not require cycle counting when the new 60-year ASME Code Section III CUF analysis and environmentally-assisted fatigue analysis for the limiting Unit 1 RHR nozzle was impacted by this transient.

In its response to RAI B.2.27-9, dated July 11, 2008, the applicant amended LRA Section B.2.27 to incorporate this enhancement which affects the program element, "parameters monitored/inspected." The enhancement states the following:

> Add a requirement that provides for monitoring of the Unit I RHR Activation transient and establishes an administration limit of 600 cycles for the transient.
>
> Add a requirement to monitor Unit I and Unit 2 transients where the 60-year projected cycles are used in the environmental fatigue evaluations, and establish an administration limit that is equal to or less than the 60-year projected cycles number.

The applicant also stated that it had to perform a new 60-year ASME Code Section III-based CUF analysis and a new 60-year environmentally-assisted fatigue-based CUF analysis because the component was designed to ANSI B.31.1 design standards. The applicant also stated that, the new 60-year ASME code Section III-based and environmentally-assisted fatigue-based CUF calculations were based on the assumption of 600 cycles of RHR system actuations. The applicant stated that as a result of the new calculations, the Metal Fatigue of Reactor Coolant Pressure Boundary Program will be amended and enhanced to include (a) a new cycle monitoring requirement for the BVPS Unit 1 RHR actuation transient and (b) a new requirement to establish 600 cycles of RHR actuation as the cycle-based acceptance criterion for monitored RHR actuations at BVPS Unit 1.

The staff noted that as part of this enhancement, the applicant is adding a requirement to monitor the Unit 1 RHR activation transient where the 60-year projected cycles may approach the analyzed number of cycles during the period of extend operation. The staff further noted that for the remaining Unit 1 and 2 transients whose 60-year projection cycles were used in the fatigue evaluations of the NUREG/CR-6260 recommended locations, the applicant also will monitor with the Metal Fatigue of Reactor Coolant Pressure Boundary Program and will require that an administration limit be established that is equal to or less than the 60-year projected cycles number.

The applicant stated that these changes would be reflected in an amendment of the LRA. The staff verified that the applicant has amended LRA Section B.2.27. The staff also verified that the applicant has incorporated this enhancement to the Metal Fatigue of Reactor Coolant Pressure Boundary Program in its revision of Commitment No. 25 in UFSAR Supplement Table A.4-1 for Unit 1 and in its revision of Commitment No. 26 in UFSAR Supplement Table A.5-1 for Unit 2.

Based on its review, the staff finds the applicant's response to RAI B.2.27-9 acceptable because the applicant has (a) amended the LRA and has committed (Commitment No. 25) that the Unit 1 RHR activation transient will be monitored with the Metal Fatigue of Reactor Coolant Pressure

Boundary Program and (b) set an administration limit for the Unit 1 RHR activation transient so that corrective actions will be initiated prior to loss of the components intended functions. Therefore, the staff's concern described in RAI B.2.27-9 is resolved.

Operating Experience. In LRA Section B.2.27, the applicant stated that the Corrective Action Program documented concerns for the overall health of the transient/cycle counting program. Corrective actions identified a program owner, developed an administration program document and updated it to incorporate responsibilities, improved cycle counting, and established a process for engineering to evaluate plant data. Fatigue monitoring, to date, indicates that the number of design transient events assumed in the original design analysis will be sufficient for a 60-year operating period. The applicant also stated that the program has remained responsive to emerging issues and concerns, particularly the pressurizer surge and spray nozzle, hot leg surge nozzle, and surge line transients.

For example, the applicant stated that in 2002, a Westinghouse evaluation found that the Unit 2 letdown, charging, and excess letdown piping could exceed their design allowable cycle counts for several design transients; however, further evaluation of existing plant operations and the physical separation distance of the letdown and excess letdown piping indicated that no further evaluation of the piping was required for current operation or for the period of extended operation. A re-analysis of the charging piping was required to account for the appropriate transients for a 60-year plant life.

The applicant further stated that this responsiveness to emerging issues and continued program improvements prove that the program will remain effective in managing cumulative fatigue damage for passive components.

The staff reviewed the operating experience and selected condition reports associated with this AMP during the onsite audit, and interviewed the applicant's technical staff to confirm that the effects of aging will be managed adequately so that the system and component intended function(s) will be maintained during the period of extended operation. The staff noted that the LRA indicated a re-analysis of the charging piping was required to account for the appropriate transients for a 60-year plant life.

In RAI B.2.27-8, dated May 28, 2008, the staff requested that the applicant justify the basis for the applicant's determination that no further evaluation of the letdown or excess letdown piping was required and provide results from the re-analysis of the charging piping and its environmentally-assisted fatigue evaluation.

In its response to RAI B.2.27-8, dated July 11, 2007, the applicant provided an explanation of the transients that are of concern for the Class 1 portion of the Unit 2 charging, letdown and excess letdown systems and how they affect these systems. The applicant stated that the following three specific transients can affect the above mentioned systems: (1) isolation of letdown flow; (2) isolation of charging flow; and (3) placing excess letdown in service. The applicant further stated that based on the Westinghouse count provided in WCAP-16173-P, the 60-year projection for the Unit 2 charging, letdown and excess letdown transients would exceed the design limit during the period extended operation. As of October 15, 2003, Westinghouse identified there to be approximately 1,076 thermal cycles. This concern was addressed with the FENOC corrective actions program, at which time the applicant stated that follow-up investigations had indicated that the Westinghouse evaluation in WCAP-16173-P combined the three transients listed above as if they affected all the same components, which was conservative. The staff confirmed that these three transients do not affect the same components and the applicant provided an explanation of how each of the three transients affects the letdown piping and excess letdown piping.

Based on its review, the staff finds the applicant's response to RAI B.2.27-8 acceptable because the applicant has demonstrated that the charging, letdown and excess letdown transients do not affect the same components and; therefore, do not require further evaluation. The staff also finds that the applicant has provided reasonable detail as to how these transients affect the letdown and excess letdown piping. The staff further finds that the applicant has committed (Commitment No. 1) to perform a re-analysis for the applicable NUREG/CR-6260 locations, including the Unit 2 charging piping, and submit the results to staff, with a summary of how the analysis was performed, no later than October 15, 2008. Therefore, the staff's concern described in RAI B.2.27-8 is resolved.

By letter dated October 2, 2008 the applicant stated it, (a) has completed the re-analysis and provided the results and methodology which demonstrated that the CUF, including environmental factors for the NUREG/CR-6260 locations will remain below the code allowable limit of 1.0, except for the Units 1 and 2 pressurizer surge line to hot leg nozzle; (b) will manage the all NUREG/CR-6260 locations, including the Units 1 and 2 pressurizer surge line to hot leg nozzle, with the Metal Fatigue of Reactor Coolant Pressure Boundary Program; and (c) calculated the environmental correction life fatigue factor (*i.e.*, F_{en}) for stainless steels for those locations requiring re-analysis in accordance with NUREG/CR-5704.

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 this program element acceptable.

<u>UFSAR Supplement</u>. In LRA Section A.1.27, the applicant provided the UFSAR supplement summarizing the Metal Fatigue of Reactor Coolant Pressure Boundary Program. The staff reviewed the Section of the UFSAR Supplement and determines that it is an adequate summary description of the program, as required by 10 CFR 54.21(d).

The staff reviewed the UFSAR Supplement summary description that was provided in LRA Section A.1.27 for the Metal Fatigue of Reactor Coolant Pressure Boundary Program. The staff verified that the applicant has committed (Commitments No. 25 in LRA Table A.4-1 and No. 26 in LRA Table A.5-1) to implementing the enhancements prior to the period of extended operation.

<u>Conclusion</u>. Based on its review of the applicant's Metal Fatigue of Reactor Coolant Pressure Boundary Program, the staff finds all program elements, with the enhancements discussed above, consistent with the GALL Report. The staff concludes that the applicant has demonstrated that the effects of aging will be adequately managed so that the intended function(s) 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).