3.3.3 Conclusion

The staff concluded that the applicant provided sufficient information to demonstrate that the effects of aging for the of the auxiliary systems components, that are within the scope of license renewal and subject to an AMR, 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 applicable UFSAR supplement program summaries and concluded that they adequately describe the AMPs credited for managing aging of the auxiliary systems, as required by 10 CFR 54.21(d).

3.4 Aging Management of Steam and Power Conversion Systems

This section of the SER documents the staff's review of the applicant's AMR results for the steam and power conversion system components and component groups associated with the following systems:

- main steam system
- extraction steam system
- moisture separator reheater drains system and reheat steam system
- auxiliary boiler
- feedwater system
- heater drains and miscellaneous vents and drains
- condensate system
- turbine building sampling system
- main condenser gas removal system
- turbine electro-hydraulic control system
- turbine lube oil system
- stator cooling system
- hydrogen seal oil system

3.4.1 Summary of Technical Information in the Application

In LRA Section 3.4, the applicant provided AMR results for components. In LRA Table 3.4.1, "Summary of Aging Management Evaluations in Chapter VIII of NUREG-1801 for Steam and Power Conversion Systems," the applicant provided a summary comparison of its AMRs with the AMRs evaluated in the GALL Report for the steam and power conversion system components and component groups.

The applicant's AMRs incorporated applicable operating experience in the determination of AERMs. These reviews included evaluation of plant-specific and industry operating experience. The plant-specific evaluation included reviews of condition reports and discussions with appropriate site personnel to identify AERMs. The applicant's review of industry operating experience included a review of the GALL Report and operating experience issues identified since the issuance of the GALL Report.

3.4.2 Staff Evaluation

The staff reviewed LRA Section 3.4 to determine whether the applicant provided sufficient information to demonstrate that the effects of aging for the steam and power conversion system components that are within the scope of license renewal and subject to an AMR 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 performed an onsite audit of AMRs to confirm the applicant's claim that certain identified AMRs were consistent with the GALL Report. The staff did not repeat its review of the matters described in the GALL Report; however, the staff did verify that the material presented in the LRA was applicable and that the applicant had identified the appropriate GALL AMRs. The staff's evaluations of the AMPs are documented in SER Section 3.0.3. Details of the staff's audit evaluation are documented in the Audit and Review Report and are summarized in SER Section 3.4.2.1.

During the audit, the staff reviewed the AMRs that were consistent with the GALL Report and for which further evaluation is recommended. The staff confirmed that the applicant's further evaluations were consistent with the acceptance criteria in SRP-LR Section 3.4.2.2. The staff's audit evaluations are documented in the Audit and Review Report and are summarized in SER Section 3.4.2.2.

During the audit, the staff also conducted a technical review of the remaining AMRs that were not consistent with, or not addressed in, the GALL Report. The audit and technical review included evaluating (1) whether all plausible aging effects were identified, and (2) whether the aging effects listed were appropriate for the combination of materials and environments specified. The staff's audit evaluations are documented in the Audit and Review Report and are summarized in SER Section 3.4.2.3. The staff's evaluation of its technical review is also documented in SER Section 3.4.2.3.

Finally, in accordance with 10 CFR 54.21(d), the staff reviewed the AMP summary descriptions in the UFSAR supplement to ensure that they provided an adequate description of the programs credited with managing or monitoring aging for the steam and power conversion system components.

Table 3.4-1 below provides a summary of the staff's evaluation of components, aging effects/mechanisms, and AMPs listed in LRA Section 3.4, that are addressed in the GALL Report.

Table 3.4-1 Staff Evaluation for Steam and Power Conversion System Components in the GALL Report

Component Group	Aging Effect/ Mechanism	AMP in GALL Report	AMP in LRA	Staff Evaluation
Piping and fittings in main feedwater line, steam line and AFW piping (PWR only) (Item 3.4.1-01)	Cumulative fatigue damage			Not applicable, PWR only

Component Group	Aging Effect/ Mechanism	AMP in GALL Report	AMP in LRA	Staff Evaluation
Piping and fittings, valve bodies and bonnets, pump casings, tanks, tubes, tubesheets, channel head and shell (except main steam system) (Item 3.4.1-02)	Loss of material due to general (carbon steel only), pitting, and crevice corrosion	Water chemistry and one-time inspection	Water Chemistry Program (B.2.2), One-Time Inspection Program (B.2.15)	Consistent with GALL, which recommends further evaluation (See Section 3.4.2.2)
Auxiliary feedwater (AFW) piping (Item 3.4.1-03)	Loss of material due to general, pitting, and crevice corrosion, MIC, and biofouling	Plant specific		Not applicable, PWR only
Oil coolers in AFW system (lubricating oil side possibly contaminated with water (Item 3.4.1-04)	Loss of material due to general (carbon steel only), pitting, and crevice corrosion and MIC	Plant specific		Not applicable, PWR only
External surface of carbon steel components (Item 3.4.1-05)	Loss of material due to general corrosion	Plant specific	Systems Monitoring Program (B.2.29)	Consistent with GALL, which recommends further evaluation (See Section 3.4.2.2)
Carbon steel piping and valve bodies (Item 3.4.1-06)	Wall thinning due to flow-accelerated corrosion	Flow-accelerated corrosion	Flow-Accelerated Corrosion Program (B.2.5)	Consistent with GALL, which recommends no further evaluation (See Section 3.4.2.2)
Carbon steel piping and valve bodies in main steam system (Item 3.4.1-07)	Loss of material due to pitting and crevice corrosion	Water chemistry	Water Chemistry Program (B.2.2), One-Time Inspection Program (B.2.15)	Consistent with GALL, which recommends no further evaluation (See Section 3.4.2.2)
Closure bolting in high-pressure or high-temperature systems (Item 3.4.1-08)	Loss of material due to general corrosion; crack initiation and growth due to cyclic loading and/or SCC	Bolting integrity		Not applicable (See Section 3.4.2.2)
Heat exchangers and coolers/condensers serviced by open-cycle cooling water (Item 3.4.1-09)	Loss of material due to general (carbon steel only), pitting, and crevice corrosion, MIC, and biofouling; buildup of deposit due to biofouling	Open-cycle cooling water system		Not applicable (See Section 3.4.2.2)

Component Group	Aging Effect/ Mechanism	AMP in GALL Report	AMP in LRA	Staff Evaluation
Heat exchangers and coolers/condensers serviced by closed-cycle cooling water (Item 3.4.1-10)	Loss of material due to general (carbon steel only), pitting, and crevice corrosion	Closed-cycle cooling water system		Not applicable (See Section 3.4.2.2)
External surface of aboveground condensate storage tank (Item 3.4.1-11)	Loss of material due to general (carbon steel only), pitting, and crevice corrosion	Aboveground carbon steel tanks	Aboveground Carbon Steel Tanks Program (B.2.12)	Consistent with GALL, which recommends no further evaluation (See Section 3.4.2.2)
External surface of buried condensate storage tank and AFW piping (Item 3.4.1-12)	Loss of material due to general, pitting, and crevice corrosion and MIC	Buried piping and tanks surveillance or Buried piping and tanks inspection		Not applicable (See Section 3.4.2.2) Not applicable (See Section 3.4.2.2)
External surface of carbon steel components (Item 3.4.1-13)	Loss of material due to boric acid corrosion	Boric acid corrosion		Not applicable, PWR only

The staff's review of the BSEP component groups followed one of three approaches depending on the group's consistency with the GALL Report. Section 3.4.2.1 discusses the staff's review and documentation of the AMR results for components in the steam and power conversion system that the applicant indicated are consistent with the GALL Report and do not require further evaluation; SER Section 3.4.2.2 discusses the staff's review and documentation of the AMR results for components that the applicant indicated are consistent with the GALL Report and for which further evaluation is recommended; and SER Section 3.4.2.3 discusses the staff's review and documentation of the AMR results for components that the applicant indicated are not consistent with, or not addressed in, the GALL Report. The staff's review of AMPs that are credited to manage or monitor aging effects of the steam and power conversion system components is documented in SER Section 3.0.3.

3.4.2.1 AMR Results That Are Consistent with the GALL Report

Summary of Technical Information in the Application. In LRA Section 3.4.2.1, the applicant identified the materials, environments, and AERMs. The applicant identified the following programs that manage the aging effects related to the steam and power conversion system components:

- Flow-Accelerated Corrosion Program
- Water Chemistry Program
- One-Time Inspection Program
- Systems Monitoring Program
- Aboveground Carbon Steel Tanks Program
- Buried Piping and Tanks Inspection Program

- Selective Leaching of Materials Program

Staff Evaluation. In LRA Tables 3.4.2-1 through 3.4.2-7, the applicant provided a summary of AMRs for the steam and power conversion system components, and identified which AMRs it considered to be consistent with the GALL Report.

For component groups evaluated in the GALL Report for which the applicant has claimed consistency with the GALL Report, and for which the GALL Report does not recommend further evaluation, the staff performed an audit to determine whether the plant-specific components contained in these GALL Report component groups were bounded by the GALL Report evaluation.

The applicant provided a note for each AMR line item. The notes described how the information in the tables aligns with the information in the GALL Report. The staff audited those AMRs with Notes A through E, which indicate that the AMR is consistent with the GALL Report.

Note A indicates that the AMR line item is consistent with the GALL Report for component, material, environment, and aging effect. In addition, the AMP is consistent with the AMP identified in the GALL Report. The staff audited these line items to verify consistency with the GALL Report and the validity of the AMR for the site-specific conditions.

Note B indicates that the AMR line item is consistent with the GALL Report for component, material, environment, and aging effect. In addition, the AMP takes some exceptions to the AMP identified in the GALL Report. The staff audited these line items to verify consistency with the GALL Report. The staff verified that the identified exceptions to the GALL AMPs had been reviewed and accepted by the staff. The staff also determined whether the AMP identified by the applicant was consistent with the AMP identified in the GALL Report and whether the AMR was valid for the site-specific conditions.

Note C indicates that the component for the AMR line item is different from, but consistent with the GALL Report for material, environment, and aging effect. In addition, the AMP is consistent with the AMP identified by the GALL Report. This note indicates that the applicant was unable to find a listing of some system components in the GALL Report. However, the applicant identified a different component in the GALL Report that had the same material, environment, aging effect, and AMP as the component that was under review. The staff audited these line items to verify consistency with the GALL Report. The staff also determined whether the AMR line item of the different component was applicable to the component under review and whether the AMR was valid for the site-specific conditions.

Note D indicates that the component for the AMR line item is different from, but consistent with the GALL Report for material, environment, and aging effect. In addition, the AMP takes some exceptions to the AMP identified in the GALL Report. The staff audited these line items to verify consistency with the GALL Report. The staff verified whether the AMR line item of the different component was applicable to the component under review. The staff verified whether the identified exceptions to the GALL AMPs had been reviewed and accepted by the staff. The staff also determined whether the AMP identified by the applicant was consistent with the AMP identified in the GALL Report and whether the AMR was valid for the site-specific conditions.

Note E indicates that the AMR line item is consistent with the GALL Report for material, environment, and aging effect, but a different aging management program is credited. The staff audited these line items to verify consistency with the GALL Report. The staff also determined whether the identified AMP would manage the aging effect consistent with the AMP identified by the GALL Report and whether the AMR was valid for the site-specific conditions.

The staff conducted an audit of the information provided in the LRA, as documented in the Audit and Review Report. The staff did not repeat its review of the matters described in the GALL Report. However, the staff did verify that the material presented in the LRA was applicable and that the applicant had identified the appropriate GALL Report AMRs. The staff's evaluation is discussed below.

In LRA Section 3.4, the applicant provided the results of its AMRs for the steam and power conversion systems.

In LRA Tables 3.4.2-1 through 3.4.2-7, the applicant provided a summary of the applicant's AMRs results for components/commodities in the following systems: (1) main steam; (2) auxiliary boiler; (3) feedwater; (4) heater drains and miscellaneous vents and drains; (5) condensate; (6) turbine building sampling; and (7) main condenser gas removal.

The summary information for each component type included intended function; material; environment; aging effect requiring management; AMPs; the GALL Report Volume 2 item; cross reference to the LRA Table 3.4.1 (Table 1); and generic and plant-specific notes related to consistency with the GALL Report.

Also, the applicant identified for each component type in the LRA Table 3.4.1 those components that are consistent with the GALL Report for which no further evaluation is required, those that are consistent with the GALL Report for which further evaluation is recommended, and those that are not addressed in the GALL Report together with the basis for their exclusion.

For AMRs that the applicant stated are consistent with the GALL Report and for which no further evaluation is recommended, the staff conducted its audit to determine whether the applicant's references to the GALL Report in the LRA are acceptable.

The staff reviewed its assigned LRA line-items to determine that the applicant: (1) provided a brief description of the system, components, materials, and environment; (2) stated that the applicable aging effects have been reviewed and are evaluated in the GALL Report; and (3) identified those aging effects for the main steam, auxiliary boiler, feedwater, heater drains and miscellaneous vents and drains, condensate, turbine building sampling, and main condenser gas removal system components that are subject to an AMR.

3.4.2.1.1 Loss of Material for Closure Bolting in High Temperature and Pressure Systems

In the discussion section of LRA Table 3.4.1, item number 3.4.1-08, the applicant addressed aging management of closure bolting in the steam and power conversion system. The applicant stated that the Bolting Integrity Program is not applicable since this system does not use high-strength pressure boundary bolting. For non-Class 1 closure bolting, the applicant considers bolting to be a subcomponent of the associated component; therefore, bolting materials are not itemized as a separate component and the Bolting Integrity Program is not needed for aging management.

During the audit, the staff reviewed LRA Tables 3.4.2-1 through 3.4.2-7 and noted that the AMR line items for the steam and power conversion systems specify the Systems Monitoring Program for visual inspection of the external surfaces of components, including any bolting associated with the component, to identify general corrosion. However, this AMP does not address the crack initiation and growth aging effect for pressure-retaining bolting. the GALL Report recommends the GALL AMP XI.M18 (Bolting Integrity Program) to manage loss of material due to general corrosion, and crack initiation and growth due to cyclic loading and/or SCC for all closure bolting in high-pressure or high-temperature systems within the scope of license renewal. The GALL Report AMP does not exclude non-Class 1 bolting.

The staff reviewed the Bolting Integrity Program, and its evaluation is documented in the Audit and Review Report. It was noted that the BSEP Bolting Integrity Program is claimed to be consistent with GALL AMP XI.M18; however, it has several major exceptions. For non-Class 1 pressure-retaining bolting, the BSEP AMP excludes the ASME Section XI inservice inspection activities, along with monitoring and trending under the Systems Monitoring Program.

This discrepancy was identified as part of the staff's audit of the ESF systems. The staff requested that the applicant clarify how aging management of pressure-retaining bolting would be managed during the extended period of operation. In its response, the applicant committed to revise the Bolting Integrity Program to include those bolted connections outside of ASME Section XI boundaries (non-Class 1 pressure-retaining bolting) (see Commitment Item #3). In addition, the applicant committed to revise each applicable section of the LRA, including Section 3.4 on the steam and power conversion systems, to reflect this change in scope of the Bolting Integrity Program and address each of the aging effects identified in the GALL Report.

The staff determined that upon completion of the revisions noted above the Bolting Integrity Program will be consistent with the GALL Report for all pressure-retaining bolting. Structural bolting will not be addressed. Since BSEP treats bolting as a subcomponent of the pressure-retaining components, there are no separate AMRs for bolting in the steam and power conversion systems. However, the applicant's commitment to specify the Bolting Integrity Program to manage all of the aging effects identified in the GALL Report for components containing Class 1 and non-Class 1 pressure-retaining bolting will resolve the above mentioned discrepancy.

On the basis of its review, the staff found that the applicant appropriately addressed the aging mechanism, as recommended by the GALL Report.

3.4.2.1.2 Loss of Material and Buildup of Deposits for Heat Exchangers, Coolers, and Condensers Serviced by Open-Cycle Cooling Water

In the discussion of LRA Table 3.4.1, item number 3.4.1-09, the applicant addressed loss of material due to corrosion and buildup of deposits due to biofouling for heat exchangers, coolers, and condensers serviced by open-cycle cooling water. The GALL Report recommends the Open-Cycle Cooling Water System Program to manage these aging effects. However, the applicant stated that management of these aging effects is not applicable to BSEP since the main condensers' pressure boundary integrity is continuously confirmed through normal plant operation.

Therefore, the Open-Cycle Cooling Water System Program is not credited for managing aging effects/mechanisms for the main condensers.

As part of its AMR audit for the main condensers, the staff asked the applicant to justify its conclusion that no aging management program was required for these components. In response, the applicant stated that intended function, provide pressure-retaining boundary, was inappropriate for the main condenser and the LRA will be revised to reflect this.

On the basis of its review, the staff found that the applicant appropriately addressed the aging mechanism, as recommended by the GALL Report.

3.4.2.1.3 Loss of Material for Heat Exchangers, Coolers, and Condensers Serviced by Closed-Cycle Cooling Water

In the discussion section of LRA Table 3.4.1, item number 3.4.1-10, the applicant addressed loss of material due to corrosion for heat exchangers, coolers, and condensers that are serviced by closed-cycle cooling water. The applicant stated that item number 3.4.1-10 is not applicable to BSEP, since there are no heat exchangers and cooler/condensers serviced by closed-cycle cooling water. The staff agreed with the applicant's determination that the aging effects addressed by this item number are not applicable on the basis that the BSEP plant design eliminates any closed-cycle cooling water system components from the steam and power conversion systems.

3.4.2.1.4 Loss of Material for Piping and Fittings, and Valves in the Auxiliary Boiler System

In the discussion section of LRA Table 3.4.2-2, the applicant included AMR line items for piping and fittings, and valves in the auxiliary boiler system that are constructed of carbon steel and exposed to treated water. The One-Time Inspection Program is specified to manage loss of material due to crevice, general, and pitting corrosion for these components. GALL Report line item VIII.B2.1-a is referenced for the piping and fittings AMR, and VIII.B2.2-b is referenced for the valve AMR. However, both of the referenced GALL Report line items recommend GALL AMP XI.M2 to manage these aging effects.

The staff evaluated the applicant's use of the One-Time Inspection Program as an alternative to the Water Chemistry Program for managing the aging effects identified for the auxiliary boiler system. Through interviews with the applicant, the staff determined that although corrosion inhibitors are added to the water in the auxiliary boiler, the subject piping and valves are not under constant water chemistry control. The One-Time Inspection Program in GALL AMP XI.M32 states:

> There are cases where either (a) an aging effect is not expected to occur but there is insufficient data to completely rule it out, or (b) an aging effect is expected to progress very slowly. For these cases, there is to be confirmation that either the aging effect is indeed not occurring, or the aging effect is occurring very slowly as not to affect the component or structure intended function. A one-time inspection of the subject component or structure is an acceptable option for this verification. One-time inspection is to provide additional assurance that either aging is not occurring or the evidence of aging is so insignificant that an aging management program is not warranted.

The staff also reviewed BSEP operating procedures, as documented in the Audit and Review Report. Based on the review of these documents, the staff determined that the auxiliary steam system is operated infrequently; there may be locations that are isolated from the flow stream for extended periods or that are susceptible to the gradual accumulation and concentration of agents that promote certain aging effects. The One-Time Inspection Program provides inspections that either verify the absence of aging degradation or trigger additional actions that will assure that the intended function of affected components will be maintained during the period of extended operation.

The staff determined that, since the GALL Report identifies the One-Time Inspection Program as an acceptable method for verifying the lack of an aging effect, or a slowly progressing aging effect, this AMP is acceptable for managing the aging effects for the auxiliary boiler system components. On the basis of its review, the staff found that the applicant appropriately addressed the aging mechanism, as recommended by the GALL Report.

3.4.2.1.5 Loss of Material for the Main Condenser in the Condensate System

In the discussion section of LRA Table 3.4.2-5, the applicant presented its AMR results for the main condenser system. Under the table subheading "Main Condenser," the applicant claimed consistency with the GALL Report for aging management of the internal and external surfaces of the carbon steel condenser shell. Generic Note E is cited (component, material, environment consistent, different AMP). However, the applicant claimed that an AMP is not applicable, and referenced plant-specific Note 404. The staff noted that the applicant's use of Note E for these AMR entries is questionable, because no AMP is credited.

The applicant's justification for not specifying an AMP for these components is provided in plant-specific Note 404, which states that the integrity of the main condenser required to perform its post-accident intended function is continuously confirmed by normal plant operation; therefore, no traditional aging management program is required. The post-accident intended function of the main condensers is to provide a holdup volume and plateout surface for main steam isolation valve (MSIV) leakage. This intended function does not require the main condensers to be leak-tight, since the post-accident conditions in the main condensers are essentially atmospheric. Under post-accident conditions, there will be no challenge to the pressure boundary integrity of the main condensers. Since normal plant operation assures adequate main condenser pressure boundary integrity, the post-accident intended function to provide pressure boundary and holdup volume and plateout surface is assured.

During the audit, the staff evaluated the applicant's justification and noted that SRP-LR Section A.1.2.3.4 states that a program based solely on detecting structure and component failures is not considered an effective aging management program. The staff requested that the applicant justify why monitoring main condenser integrity during normal plant operation is adequate as the only aging management program for ensuring intended functions identified, which are provide pressure-retaining boundary (—1), and provide post-accident containment, holdup, and plateout of MSIV bypass leakage (—7).

As documented in the Audit and Review Report, the applicant stated that the main condensers were placed within the scope of license renewal due to application of the alternate source term requirement. The applicant inadvertently assigned the intended function pressure boundary (—1) to the main condensers and associated components. The intended function —7, which provides holdup and plateout of MSIV leakage, is the appropriate function for the main condensers in the alternate source term role; whereas, pressure boundary is not an appropriate intended function. LRA Tables 2.3.4-5 and 3.4.2-5 will be revised to show that the main condenser tubes, tube sheet, shell, and associated components have an intended function of —7 only. The applicant also will revise LRA Table 3.4.1 Item Numbers 3.4.1-05 and 3.4.1-09, and LRA Section 3.4.2.2.4 by removing reference to the pressure boundary function of the main condenser. Additionally, the applicant will revise plant-specific Note 404 to remove the discussion of the pressure boundary function of the main condenser, and it will read as follows:

> Aging management of the Main Condensers is not based on analysis of materials, environments and aging effects. Materials, environments, and aging effects were evaluated, however no traditional aging management program is require. The Main Condenser is required to perform a post-accident intended function of holdup and plateout of MSIV leakage (—7), and this function is continuously confirmed by normal plant operation. The —7 intended function does not require the Main Condensers to be leak-tight, with the post-accident conditions in the Main Condenser essentially atmospheric. In maintaining vacuum, the Main Condenser proves its integrity continuously as a vital component of continued plant operation. Normal plant operation continuously monitors the integrity of the Main Condenser which provides assurance that the Main Condenser would be able to perform a post-accident intended function of holdup and plateout of MSIV leakage.

Based on the applicant's statement that the only intended function for the main condensers is —7, to provide post-accident containment, holdup, and plateout of MSIV bypass leakage, the staff agreed with the applicant's determination that the main condenser does not have to be leak-tight, since the post-accident conditions in the main condenser are essentially atmospheric. During normal plant operations, condenser vacuum is continuously monitored, which verifies the integrity of the main condenser. If the integrity of the main condenser were to degrade to a point where a loss of vacuum occurred, this would require placing the plant in a mode where the —7 intended function would be obviated. Therefore, acceptable performance during normal plant operation provides adequate assurance that the main condenser can perform the holdup and plate-out post-accident function.

On the basis of its review, the staff found that the applicant appropriately addressed the aging mechanism, as recommended by the GALL Report.

Conclusion. The staff evaluated the applicant's claim of consistency with the GALL Report. The staff also reviewed information pertaining to the applicant's consideration of recent operating experience and proposals for managing associated aging effects. On the basis of its review, the staff concludes that the AMR results, which the applicant claimed to be consistent with the GALL Report, are consistent with the AMRs in the GALL Report. Therefore, the staff concluded that the applicant demonstrated that the effects of aging for these components will be adequately managed so that their 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).

3.4.2.2 AMR Results For Which Further Evaluation is Recommended By the GALL Report

Summary of Technical Information in the Application. In LRA Section 3.4.2.2, the applicant provided further evaluation of aging management as recommended by the GALL Report for the steam and power conversion system. The applicant provided information concerning how it will manage the following aging effects:

- cumulative fatigue damage
- loss of material due to general, pitting, and crevice corrosion
- local loss of material due to general, pitting, and crevice corrosion, MIC, and biofouling
- general corrosion
- loss of material due to general, pitting, and microbiologically influenced corrosion

Staff Evaluation. For component groups evaluated in the GALL Report for which the applicant has claimed consistency with the GALL Report, and for which the GALL Report recommends further evaluation, the staff audited the applicant's evaluation to determine whether it adequately addressed the issues that were further evaluated. In addition, the staff reviewed the applicant's further evaluations against the criteria contained in SRP-LR Section 3.4.2.2. Details of the staff's audit are documented in the staff's Audit and Review Report. The staff's evaluation of the aging effects is discussed in the following sections.

3.4.2.2.1 Cumulative Fatigue Damage

Cumulative fatigue is a TLAA, as defined in 10 CFR 54.3. TLAAs are required to be evaluated in accordance with 10 CFR 54.21(c)(1). The evaluation of this TLAA is addressed by staff in SER Section 4.3.

3.4.2.2.2 Loss of Material Due to General, Pitting, and Crevice Corrosion

The staff reviewed the LRA Section 3.4.2.2.2 against the criteria found in SRP-LR Section 3.4.2.2.2:

> The management of loss of material due to general, pitting, and crevice corrosion should be evaluated further for carbon steel piping and fittings, valve bodies and bonnets, pump casings, pump suction and discharge lines, tanks, tubesheets, channel heads, and shells except for main steam system components and for loss of material due to pitting and crevice corrosion for stainless steel tanks and heat exchanger/cooler tubes. The water chemistry program relies on monitoring and control of water chemistry based on the guidelines in EPRI guideline TR-102134 for secondary water chemistry to manage the effects of loss of material due to general, pitting, or crevice corrosion. However, corrosion may occur at locations of stagnant flow conditions. Therefore, the effectiveness of the chemistry control program should be verified to ensure that corrosion is not occurring. The GALL Report recommends further evaluation of programs to manage loss of material due to general, pitting, and crevice corrosion to verify the effectiveness of the water chemistry program. A one-time inspection of select components and susceptible locations is an acceptable method to ensure that corrosion is not occurring and that the component's intended function will be maintained during the period of extended operation.

In LRA Section 3.4.2.2.2, the applicant stated that loss of material for carbon and stainless steel components in steam and power conversion systems (except for main steam system components) is managed by the Water Chemistry Program. Also, to verify the efficacy of that program, a one-time inspection of selected components and susceptible locations will be performed.

The staff found that, based on the programs identified above, the applicant met the criteria of SRP-LR Section 3.4.2.2.2 for further evaluation. The staff found that the applicant demonstrated that the effects of aging will be adequately managed so that the intended functions will be maintained during the period of extended operation, as required by 10 CFR 54.21(a)(3).

3.4.2.2.3 Local Loss of Material Due to General, Pitting, and Crevice Corrosion, Microbiologically Influenced Corrosion, and Biofouling

Applicable to PWR auxiliary feedwater systems only.

3.4.2.2.4 General Corrosion

The staff reviewed LRA Section 3.4.2.2.4 against the criteria found in SRP-LR Section 3.4.2.2.4:

> Loss of material due to general corrosion could occur on the external surfaces of all carbon steel strictures and components, including closure boltings, exposed to operating temperature less that 212 °F. The GALL Report recommends further evaluation to ensure that this aging effect is adequately managed.

In LRA Section 3.4.2.2.4, the applicant stated that loss of material for steel components, including closure bolting, in steam and power conversion systems due to general corrosion on external surfaces that are exposed to operating temperatures less than 212°F, is managed by the plant-specific Systems Monitoring Program. Management of aging effects/mechanisms associated with the main condensers is not applicable as the pressure boundary integrity of the main condensers is continuously confirmed through normal plant operations.

The applicant stated that it will revise LRA Section 3.4.2.2.4 to eliminate the reference to the pressure boundary function of the main condensers since this function is inappropriate for these components. Also, the applicant stated that the Bolting Integrity Program will be revised to include non-Class 1 pressure-retaining bolting, and the applicable LRA sections will be revised to reflect the change in scope of the AMP and the aging effects identified in the GALL Report for pressure-retaining bolting.

The staff found that, based on the programs identified above, the applicant has met the criteria of SRP-LR Section 3.4.2.2.4 for further evaluation. The staff found that the applicant has demonstrated that the effects of aging will be adequately managed so that the intended functions will be maintained during the period of extended operation, as required by 10 CFR 54.21(a)(3).

3.4.2.2.5 Loss of Material Due to General, Pitting, and Microbiologically Influenced Corrosion

PWR Auxiliary Feedwater System Lube Oil Coolers (LRA Section 3.4.2.2.5.1). Applicable to PWR auxiliary feedwater systems only.

Buried Components (LRA Section 3.4.2.2.5.2). Not applicable at BSEP since auxiliary feedwater is a PWR system.

Conclusion. On the basis of its review, for component groups evaluated in the GALL Report for which the applicant has claimed consistency with the GALL Report, and for which the GALL Report recommends further evaluation, the staff determined that (1) those attributes or features for which the applicant claimed consistency with the GALL Report were indeed consistent, and (2) the applicant adequately addressed the issues that were further evaluated. The staff found 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).

3.4.2.3 Results That Are Not Consistent with or Not Addressed in the GALL Report

Summary of Technical Information in the Application. In LRA Tables 3.4.2-1 through 3.4.2-7, the staff reviewed additional details of the results of the AMRs for material, environment, aging effect requiring management, and AMP combinations that are not consistent with the GALL Report, or that are not addressed in the GALL Report.

In LRA Tables 3.4.2-1 through 3.4.2-7, the applicant indicated, via Notes F through J, that neither the identified component nor the material and environment combination is evaluated in the GALL Report, and it provided information concerning how the aging effect will be managed. Specifically, Note F indicated that the material for the AMR line-item component is not evaluated in the GALL Report. Note G indicated that the environment for the AMR line-item component and material is not evaluated in the GALL Report. Note H indicated that the aging effect for the AMR line-item component, material, and environment combination is not evaluated in the GALL Report. Note I indicated that the aging effect identified in the GALL Report for the line-item component, material, and environment combination is not applicable. Note J indicated that neither the component nor the material and environment combination for the line item is evaluated in the GALL Report.

Staff Evaluation. For component type, material, and environment combination that are not evaluated in the GALL Report, the staff reviewed the applicant's evaluation to determine whether the applicant had demonstrated that the effects of aging will be adequately managed so that the intended function(s) will be maintained consistent with the CLB during the period of extended operation. The staff's evaluation is discussed in the following sections.

3.4.2.3.1 Steam and Power Conversion Systems – Summary of Aging Management Evaluation – Main Steam (MS) System – Table 3.4.2-1

The staff reviewed LRA Table 3.4.2-1, which summarizes the results of AMR evaluations for the main steam system component groups.

In LRA Section 3.4.2.1.1, the applicant identified the materials, environments, and AERMs. The applicant identified the following programs that manage the AERMs for the main steam system components:

- Water Chemistry Program
- Flow-Accelerated Corrosion Program

In LRA Table 3.4.2-1, the applicant provided a summary of the AMRs for the system components and identified which AMRs it considered to be consistent with the GALL Report.

The technical staff reviewed the applicant's AMR of the main steam system component-material-environment-AERM combinations that are not addressed in the GALL Report. These combinations are identified by Notes F through J in LRA Table 3.4.2-1. The staff also reviewed those combinations in LRA Table 3.4.2-1, with Notes A through E, for which issues were identified. The staff determined that the applicant has identified all applicable AERMs and credited appropriate AMPs for managing them. The staff also reviewed the applicable UFSAR supplements for the AMPs to ensure that the program descriptions are adequate.

Aging Effects. LRA Table 2.3.4-1 lists individual system components within the scope of license renewal and subject to an AMR. The component types that do not rely on the GALL Report for aging management review are piping and fittings, and valves.

For these component types, the applicant identified the materials, environments, and AERMs, as specified below:

- Carbon steel components in treated water (includes steam)(internal) environments are subject to loss of material due to general corrosion.
- Stainless steel components in treated water (includes steam)(internal) environments are subject to cracking due to SCC, and loss of material due to crevice and pitting corrosion.
- Stainless steel and carbon steel components in indoor air (external) environments are not identified with any AERMs.

During its review, the staff determined that it needed additional information. The specific RAI and the applicant's response are discussed below.

In RAI 3.4-1, dated April 8, 2005, the staff stated that in LRA Tables 3.4.2-1 and 3.4.2-6, stainless steel piping and fitting (steam drains) and valves in treated water (includes steam)(internal) environments are subject to cracking due to SCC, and loss of material due to crevice and pitting corrosion. The Water Chemistry Program alone is credited to manage the aging effects. The staff considered this to be unacceptable, since, for the BWR plant components in the above identified environments, the AMP needs to be augmented by verifying the effectiveness of water chemistry control. Therefore, the staff requested that the applicant reassess the AMR for the components. In its response, by letter dated May 4, 2005, the applicant stated that stainless steel components represented by the Table 3.4.2-1 subject line items are NSR orifice plates and instrumentation components. Stainless steel components represented by the LRA Table 3.4.2-6 subject line items are NSR stainless steel tubing. The applicant stated that to verify the effectiveness of water chemistry control for these stainless steel components, the Water Chemistry Program will be augmented by using the One-Time Inspection Program. The staff found that the applicant's response adequately resolved the staff's concern related to the implementation of a verification program; therefore, RAI 3.4-1 is resolved.

On the basis of its review of the information provided in the LRA and the additional information included in the applicant's response to the above RAI, the staff found that the aging effects of the main steam system component types not addressed by the GALL Report are consistent with industry experience for these combinations of materials and environments. The staff did not identify any omitted aging effects. Therefore, the staff found that the applicant has identified the appropriate aging effects for the materials and environments associated with the components in the main steam system.

Aging Management Programs. After evaluating the applicant's identification of aging effects for each of the above components, the staff evaluated the AMPs to determine whether they are appropriate for managing the identified aging effects. The staff also determined that the UFSAR supplement contains an adequate description of the program.

LRA Table 3.4.2-1 identifies the following AMPs for managing the aging effects described above for the main steam system.

- Water Chemistry Program
- Flow-Accelerated Corrosion Program

SER Sections 3.0.3.2.1 and 3.0.3.2.2, respectively, present the staff's detailed review of these AMPs.

On the basis of its review of the information provided in the LRA, the staff found that the applicant has described appropriate AMPs for managing the aging effect of the main steam system component types not addressed by the GALL Report. In addition, the staff found the program descriptions in the UFSAR supplement acceptable.

3.4.2.3.2 Steam and Power Conversion Systems – Summary of Aging Management Evaluation – Auxiliary Boiler – Table 3.4.2-2

The staff reviewed LRA Table 3.4.2-2, which summarizes the results of AMR evaluations for the auxiliary boiler component groups.

In LRA Section 3.4.2.1.2, the applicant identified the materials, environments, and AERMs. The applicant identified the following programs that manage the AERM for the auxiliary boiler system components:

- One-Time Inspection Program
- Systems Monitoring Program

In LRA Table 3.4.2-2, the applicant provided a summary of the AMRs for the auxiliary boiler system components and identified which AMRs it considered to be consistent with the GALL Report.

The technical staff reviewed the applicant's AMR of the auxiliary boiler system component-material-environment-AERM combinations that are not addressed in the GALL Report. These combinations are identified by Notes F through J in LRA Table 3.4.2-2. The staff also reviewed those combinations in LRA Table 3.4.2-2, with Notes A through E, for which issues were identified. The staff determined that the applicant has identified all applicable AERMs and credited appropriate AMPs for managing them. The staff also reviewed the applicable UFSAR supplements for the AMPs to ensure that the program descriptions are adequate.

Aging Effects. LRA Table 2.3.4-2 lists individual system components within the scope of license renewal and subject to an AMR. The following component types do not rely on the GALL Report for an AMR: piping and fittings, and valves.

For this component type, the applicant identified the material, environment, and AERM, as specified below:

- Carbon steel components in treated water (includes steam)(internal) environments are subject to loss of material due to crevice, general, and pitting corrosion.

During its review, the staff determined that it needed additional information to complete its review. The specific RAI and the applicant's response are discussed below.

In RAI 3.4-2, dated April 8, 2005, the staff stated that In LRA Table 3.4.2-2, carbon steel piping and fittings (steam drains) and valves in treated water (includes steam)(internal) environments are subject to loss of material due to general, crevice, and pitting corrosion. The One-Time Inspection Program is credited as the only AMP to manage the aging effects. It should be noted that one-time inspections may be appropriate only for situations where material degradation is not expected or is expected to occur at a slow rate. One-time inspections can also be used to verify the effectiveness of an AMP in its management of aging effects. Therefore, the staff requested that the applicant provide justification for not using a periodic inspection program, supplemented by the One-Time Inspection Program, to manage the aging effects for the above carbon steel components. In its response, by letter dated May 4, 2005, the applicant stated that the components represented by LRA Table 3.4.2-2 subject line items are NSR auxiliary boiler system piping components and valves within scope for potential spatial interactions. The auxiliary boiler system is a unit-sharing system that provides steam to both Units 1 and 2 for HPCI and RCIC turbine testing prior to unit startup. The applicant stated that this auxiliary steam piping is only used infrequently for unit startup at the HPCI and RCIC turbines located in the reactor building. This piping is routed through the radwaste building tunnels into the reactor building. After the HPCI and RCIC turbines are tested during unit startup, the subject steam supply piping in the tunnels and reactor building are de-pressurized and isolated from the auxiliary boiler.

The applicant stated that the GALL XI.M32, One-Time Inspection AMP is appropriate for the subject auxiliary boiler piping components. The one-time inspection provides inspections that either verify that unacceptable degradation is not occurring or trigger additional actions that will assure that the intended function of affected components will be maintained during the period of extended operation. The applicant stated that the BSEP One-Time Inspection Program will verify that the expectation of potential aging effects occurring very slowly so as not to affect the component intended function during the period of extended operation is correct or will verify the extent of condition for subsequent corrective actions.

Based on the fact that the subject in-scope auxiliary boiler system piping components and valves are infrequently used and isolated from the auxiliary boiler after usage, with piping that is de-energized and drained or partially drained, the staff considered the applicant's response to be acceptable; the use of One-Time Inspection Program is appropriate for the subject auxiliary boiler piping components. Therefore, the staff's concern described in RAI 3.4-2 is resolved. SER Section 3.0.3.15 provides additional staff discussion on the One-Time Inspection Program.

On the basis of its review of the information provided in the LRA and the additional information included in the applicant's response to the above RAI, the staff found that the aging effects of the auxiliary boiler system component types not addressed by the GALL Report are consistent with industry experience for these combinations of materials and environments. The staff did not identify any omitted aging effects. Therefore, the staff found that the applicant has identified the appropriate aging effects for the materials and environments associated with the components in the auxiliary boiler system.

Aging Management Programs. After evaluating the applicant's identification of aging effects for each of the above components, the staff evaluated the AMPs to determine whether they are appropriate for managing the identified aging effects. The staff also determined that the UFSAR supplement contains an adequate description of the program.

LRA Table 3.4.2-2 identifies the following AMPs for managing the aging effects described above for the auxiliary boiler system.

- One-Time Inspection Program
- Systems Monitoring Program

SER Sections 3.0.3.2.11 and 3.0.3.3.2, respectively, present the staff's detailed review of these AMPs.

On the basis of its review of the information provided in the LRA, the staff found that the applicant described the appropriate AMPs for managing the aging effect of the auxiliary boiler system component types not addressed by the GALL Report. In addition, the staff found the program descriptions in the UFSAR supplement acceptable.

3.4.2.3.3 Steam and Power Conversion Systems – Summary of Aging Management Evaluation – Feedwater (FW) System – Table 3.4.2-3

The staff reviewed LRA Table 3.4.2-3, which summarizes the results of AMR evaluations for the feedwater system component groups.

In LRA Section 3.4.2.1.3, the applicant identified materials, environments, and AERMs. The applicant identified the following programs that manage the AERMs for the feedwater system components:

- Water Chemistry Program
- Flow-Accelerated Corrosion Program
- One-Time Inspection Program

In LRA Table 3.4.2-3, the applicant provided a summary of the AMRs for the feedwater system components and identified which AMRs it considered to be consistent with the GALL Report.

The technical staff reviewed the applicant's AMR of the feedwater system component-material-environment-AERM combinations that are not addressed in the GALL Report. These combinations are identified by Notes F through J in LRA Table 3.4.2-3. The staff also reviewed those combinations in LRA Table 3.4.2-3, with Notes A through E, for which issues were identified. The staff determined that the applicant has identified all applicable AERMs and credited appropriate AMPs for managing them. The staff also reviewed the applicable UFSAR supplements for the AMPs to ensure that the program descriptions are adequate.

Aging Effects. LRA Table 2.3.4-3 lists individual system components within the scope of license renewal and subject to an AMR. The following component types do not rely on the GALL Report for aging management review: piping and fittings, and valves.

For these component types, the applicant identified the materials, environments, and AERMs, as specified below:

- Stainless steel components in treated water (includes steam)(internal) environments are subject to cracking due to SCC, and loss of material due to crevice and pitting corrosion.
- Stainless steel and carbon steel components in indoor air (external) environments are not identified with any aging effects.

On the basis of its review of the information provided in the LRA, the staff found that the aging effects of the feedwater system component types not addressed by the GALL Report are consistent with industry experience for these combinations of materials and environments. The staff did not identify any omitted aging effects. Therefore, the staff found that the applicant has identified the appropriate aging effects for the materials and environments associated with the components in the feedwater system.

Aging Management Programs. After evaluating the applicant's identification of aging effects for each of the above components, the staff evaluated the AMPs to determine whether they are appropriate for managing the identified aging effects. The staff also determined that the UFSAR supplement contains an adequate description of the program.

LRA Table 3.4.2-3 identifies the following AMPs for managing the aging effects described above for the feedwater system.

- Water Chemistry Program
- Flow-Accelerated Corrosion Program
- One-Time Inspection Program

SER Sections 3.0.3.2.1, 3.0.3.2.2, and 3.0.3.2.11, respectively, present the staff's detailed review of these AMPs.

On the basis of its review of the information provided in the LRA, the staff found that the applicant has described appropriate AMPs for managing the aging effect of the feedwater system component types not addressed by the GALL Report. In addition, the staff found the program descriptions in the UFSAR supplement acceptable.

3.4.2.3.4 Steam and Power Conversion Systems – Summary of Aging Management Evaluation – Heater Drains (HD) and Miscellaneous Vents and Drains (MVD) – Table 3.4.2-4

The staff reviewed LRA Table 3.4.2-4, which summarizes the results of AMR evaluations for the HD and MVD component groups.

In LRA Section 3.4.2.1.4, the applicant identified materials, environments, and AERMs. The applicant identified the following programs that manage the AERMs for the HD and MVD system components:

- Water Chemistry Program
- Flow-Accelerated Corrosion Program
- One-Time Inspection Program
- Systems Monitoring Program

In LRA Table 3.4.2-4, the applicant provided a summary of the AMRs for the HD and MVD system components and identified which AMRs it considered to be consistent with the GALL Report.

The technical staff reviewed the applicant's AMR of the HD and MVD system component-material-environment-AERM combinations that are not addressed in the GALL Report. These combinations are identified by Notes F through J in LRA Table 3.4.2-4. The staff also reviewed those combinations in LRA Table 3.4.2-4, with Notes A through E, for which issues were identified. The staff determined that the applicant has identified all applicable AERMs and credited appropriate AMPs for managing them. The staff also reviewed the applicable UFSAR supplements for the AMPs to ensure that the program descriptions are adequate.

Aging Effects. LRA Table 2.3.4-4 lists individual system components within the scope of license renewal and subject to an AMR. The following component types do not rely on the GALL Report for AMR: piping and fittings, and valves.

For these component types, the applicant identified the materials, environments, and AERMs, as specified below:

- Carbon steel components in indoor air (internal) environments are subject to loss of material due to general corrosion.
- Stainless steel components in treated water (includes steam)(internal) environments are subject to cracking due to SCC, and loss of material due to crevice and pitting corrosion.
- Stainless steel and carbon steel components in indoor air (external) environments are not identified with any aging effects.

On the basis of its review of the information provided in the LRA, the staff found that the aging effects of the HD and MVD system component types not addressed by the GALL Report are consistent with industry experience for these combinations of materials and environments. The staff did not identify any omitted aging effects. Therefore, the staff found that the applicant has identified the appropriate aging effects for the materials and environments associated with the components in the HD and MVD system.

Aging Management Programs. After evaluating the applicant's identification of aging effects for each of the above components, the staff evaluated the AMPs to determine whether they are appropriate for managing the identified aging effects. The staff also determined that the UFSAR supplement contains an adequate description of the program.

LRA Table 3.4.2-4 identifies the following AMPs for managing the aging effects described above for the HD and MVD system.

- Water Chemistry Program
- Flow-Accelerated Corrosion Program
- One-Time Inspection Program
- Systems Monitoring Program

SER Sections 3.0.3.2.1, 3.0.3.3.2, 3.0.3.2.11, and 3.0.3.3.2, respectively, present the staff's detailed review of these AMPs.

On the basis of its review of the information provided in the LRA, the staff found that the applicant has described appropriate AMPs for managing the aging effect of the HD and MVD system component types not addressed by the GALL Report. In addition, the staff found the program descriptions in the UFSAR supplement acceptable.

3.4.2.3.5 Steam and Power Conversion Systems – Summary of Aging Management Evaluation – Condensate System – Table 3.4.2-5

The staff reviewed LRA Table 3.4.2-5, which summarizes the results of AMR evaluations for the condensate system component groups.

In LRA Section 3.4.2.1.5, the applicant identified the materials, environments, and AERMs. The applicant identified the following programs that manage the AERMs for the condensate system components:

- Water Chemistry Program
- Aboveground Carbon Steel Tanks Program
- One-Time Inspection Program
- Selective Leaching of Materials Program
- Buried Piping and Tanks Inspection Program
- Systems Monitoring Program

In LRA Table 3.4.2-5, the applicant provided a summary of the AMRs for the condensate system components and identified which AMRs it considered to be consistent with the GALL Report.

The technical staff reviewed the applicant's AMR of the condensate system component-material-environment-AERM combinations that are not addressed in the GALL Report. These combinations are identified by Notes F through J in LRA Table 3.4.2-5. The staff also reviewed those combinations in LRA Table 3.4.2-5, with Notes A through E, for which issues were identified. The staff determined that the applicant has identified all applicable AERMs and credited appropriate AMPs for managing them. The staff also reviewed the applicable UFSAR supplements for the AMPs to ensure that the program descriptions are adequate.

Aging Effects. LRA Table 2.3.4-5 lists individual system components within the scope of license renewal and subject to an AMR. The following component types do not rely on the GALL Report for AMR: piping and fittings, valves, tanks, tubes, tubesheets, and shells.

For these component types, the applicant identified the materials, environments, and AERMs, as specified below:

- Carbon steel components in treated water (internal) environments are subject to loss of material due to galvanic corrosion.
- Carbon steel components in indoor air (external) and outdoor air (external) environments are subject to loss of material due to general corrosion.
- Stainless steel components in treated water (internal) environments are subject to loss of material due to erosion.
- Stainless steel components in buried (external) environments are subject to loss of material due to crevice and pitting corrosion, and MIC.
- Stainless steel components in outdoor air (external) environments are subject to loss of material due to crevice and pitting corrosion.
- Grey cast iron components in treated water (internal) or outdoor air (external) environments are subject to loss of material due to selective leaching.
- Grey cast iron components in treated water (internal) environments are subject to loss of material due to galvanic, crevice, general, and pitting corrosion.
- Grey cast iron components in outdoor air (external) environments are subject to loss of material due to galvanic and general corrosion.
- Stainless steel and carbon steel components in indoor air (internal or external) environments are not identified with any aging effects.

During its review, the staff determined that it needed additional information to complete its review. The specific RAI and the applicant's response are discussed below.

In RAI 3.4-4, dated April 8, 2005, the staff stated that in LRA Table 3.4.2-5, titanium condensate coolers/condensers (tubes) in raw water environments are not identified with any aging effects. The same components in treated water (including steam)(external) environments are subject to loss of material due to crevice corrosion. Therefore, the staff requested that the applicant provide the basis for determining that no aging effects need to be identified for the titanium condensate coolers/condensers (tubes) in raw water environments. In its response, by letter dated May 4, 2005, the applicant stated that the BSEP mechanical tools for assessing aging effects are based on industry guidance, EPRI TR-1003056, "Non-Class 1 Mechanical Implementation Guideline and Mechanical Tools, Revision 3." The applicant stated that the subject titanium condensate coolers/condensers (tubes) in treated water environments are normally at a temperature greater than 160 °F. The titanium condensate coolers/condensers (tubes) in a raw water environments are normally at a temperature less than 160 °F. The applicant stated that, based on the referenced EPRI document, the BSEP mechanical tools identified that titanium in raw water at a temperature less than 160 °F does not exhibit aging effects, while titanium in treated water at a temperature of greater than 160 °F is potentially subject to aging effects. The staff considered the applicant's response incorporating general industry experience to be acceptable; therefore, RAI 3.4-4 is resolved.

On the basis of its review of the information provided in the LRA and the additional information included in the applicant's response to the above RAI, the staff found that the aging effects of the condensate system component types not addressed by the GALL Report are consistent with industry experience for these combinations of materials and environments. The staff did not identify any omitted aging effects. Therefore, the staff found that the applicant has identified the appropriate aging effects for the materials and environments associated with the components in the condensate system.

Aging Management Programs. After evaluating the applicant's identification of aging effects for each of the above components, the staff evaluated the AMPs to determine whether they are appropriate for managing the identified aging effects. The staff also determined that the UFSAR supplement contains an adequate description of the program.

LRA Table 3.4.2-5 identifies the following AMPs for managing the aging effects described above for the condensate system.

- Water Chemistry Program
- Aboveground Carbon Steel Tanks Program
- One-Time Inspection Program
- Selective Leaching of Materials Program
- Buried Piping and Tanks Inspection Program
- Systems Monitoring Program

SER Sections 3.0.3.2.1, 3.0.3.1.4, 3.0.3.2.11, 3.0.3.2.12, 3.0.3.2.13, and 3.0.3.3.2, respectively, present the staff's detailed review of these AMPs.

On the basis of its review of the information provided in the LRA, the staff found that the applicant has described appropriate AMPs for managing the aging effect of the condensate system component types not addressed by the GALL Report. In addition, the staff found the program descriptions in the UFSAR supplement acceptable.

3.4.2.3.6 Steam and Power Conversion Systems – Summary of Aging Management Evaluation – Turbine Building (TB) Sampling System – Table 3.4.2-6

The staff reviewed LRA Table 3.4.2-6, which summarizes the results of AMR evaluations for the turbine building sampling system component groups.

In LRA Section 3.4.2.1.6, the applicant identified the materials, environments, and AERMs. The applicant identified the Water Chemistry Program to manage the aging effects for the turbine building sampling system components.

In LRA Table 3.4.2-6, the applicant provided a summary of the AMRs for the turbine building sampling system components and identified which AMRs it considered to be consistent with the GALL Report.

The technical staff reviewed the applicant's AMR of the turbine building sampling system component-material-environment-AERM combinations that are not addressed in the GALL Report. These combinations are identified by Notes F through J in LRA Table 3.4.2-6. The staff also reviewed those combinations in LRA Table 3.4.2-6, with Notes A through E, for which issues were identified. The staff determined that the applicant has identified all applicable AERMs and credited appropriate AMPs for managing them. The staff also reviewed the applicable UFSAR supplements for the AMPs to ensure that the program descriptions are adequate.

Aging Effects. LRA Table 2.3.4-6 lists individual system components within the scope of license renewal and subject to an AMR. The following component types do not rely on the GALL Report for AMR: piping and fittings (steam drains).

For these component types, the applicant identified the materials, environments, and AERMs, as specified below:

- Stainless steel components in treated water (includes steam)(internal) environments are subject to cracking due to SCC, and loss of material due to crevice and pitting corrosion.
- Stainless steel components in indoor air (external) environments are not identified with any aging effects.

During its review, the staff determined that it needed additional information to complete its review. The specific RAI and the applicant's response are discussed below.

In LRA Table 3.4.2-6, stainless steel piping and fitting (steam drains) and valves in treated water (includes steam)(internal) environments are subject to cracking due to SCC, and loss of material due to crevice and pitting corrosion. The Water Chemistry Program alone is credited to manage the aging effects. The staff considered this to be unacceptable, since for the BWR plant components in the above identified environments, the AMP needs to be augmented by verifying the effectiveness of water chemistry control. In RAI 3.4-1, the staff requested the applicant to reassess the AMR for the components. SER Section 3.4.2.3.1 provides the staff's discussion of this RAI and its resolution by the applicant.

On the basis of its review of the information provided in the LRA and the additional information included in the applicant's response to the above RAI, the staff found that the aging effects of the turbine building sampling system component types not addressed by the GALL Report are consistent with industry experience for these combinations of materials and environments. The staff did not identify any omitted aging effects. Therefore, the staff found that the applicant has identified the appropriate aging effects for the materials and environments associated with the components in the turbine building sampling system.

Aging Management Programs. After evaluating the applicant's identification of aging effects for each of the above components, the staff evaluated the AMPs to determine whether they are appropriate for managing the identified aging effects. The staff also determined that the UFSAR supplement contains an adequate description of the program.

LRA Table 3.4.2-6 identifies the Water Chemistry Program and One-Time Inspection Program for managing the aging effects described above for the turbine building sampling system. SER Section 3.0.3.2.1 presents the staff's detailed review of this AMP.

On the basis of its review of the information provided in the LRA, the staff found that the applicant has described an appropriate AMP for managing the aging effects of the turbine building sampling system component types not addressed by the GALL Report. In addition, the staff found the program descriptions in the UFSAR supplement acceptable.

3.4.2.3.7 Steam and Power Conversion Systems – Summary of Aging Management Evaluation – Main Condenser Gas Removal System – Table 3.4.2-7

The staff reviewed LRA Table 3.4.2-7, which summarizes the results of AMR evaluations for the main condenser gas removal system component groups.

In LRA Section 3.4.2.1.7, the applicant identified the materials, environments, and AERMs. The applicant identified the following programs that manage the AERMs for the main condenser gas removal system components:

- Water Chemistry Program
- One-Time Inspection Program
- Systems Monitoring Program

In LRA Table 3.4.2-7, the applicant provided a summary of the AMRs for the main condenser gas removal system components and identified which AMRs it considered to be consistent with the GALL Report.

The technical staff reviewed the applicant's AMR of the main condenser gas removal system component-material-environment-AERM combinations that are not addressed in the GALL Report. The staff noted no such combinations, identified by Notes F through J, in LRA Table 3.4.2-7; therefore, no AERMs are identified. The staff also reviewed those combinations in LRA Table 3.4.2-7, with Notes A through E, for which issues were identified.

Aging Effects. LRA Table 2.3.4-7 lists individual system components within the scope of license renewal and subject to an AMR. Since there are no component types that are considered to not rely on the GALL Report for aging management review, there are no AERMs specified in the table.

Aging Management Programs.

After evaluating the applicant's identification of aging effects for each of the above components, the staff evaluated the AMPs to determine whether they are appropriate for managing the identified aging effects. The staff also determined that the UFSAR supplement contains an adequate description of the program.

LRA Table 3.4.2-7 identifies the following AMPs for managing the aging effects described above for the main condenser gas removal system.

- Water Chemistry Program
- One-Time Inspection Program
- Systems Monitoring Program

As indicated, these AMPs are credited to manage the aging effects of all three main condenser gas removal system component types contained in LRA Table 3.4.2-7. According to the system generic notes, all these component types are addressed by the GALL Report. SER Sections 3.0.3.2.1, 3.0.3.2.11, and 3.0.3.3.2, respectively, present the staff's detailed review of these AMPs.

Conclusion. On the basis of its review, the staff found that the applicant appropriately evaluated AMR results involving material, environment, AERMs, and AMP combinations not evaluated in the GALL Report. The staff found that the applicant 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).

3.4.3 Conclusion

The staff concluded that the applicant provided sufficient information to demonstrate that the effects of aging for the of the steam and power conversion system components, that are within the scope of license renewal and subject to an AMR, 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 applicable UFSAR supplement program summaries and concluded that they adequately describe the AMPs credited for managing aging of the steam and power conversion system, as required by 10 CFR 54.21(d).

3.5 Aging Management of Containments, Structures, and Component Supports

This section of the SER documents the staff's review of the applicant's AMR results for the containments, structures, and component supports components and component groups associated with the following systems:

- containment
- intake and discharge canals
- refueling system
- switchyard and transformer yard structures
- monorail hoists
- bridge cranes
- gantry cranes
- service water intake structure
- reactor building
- augmented off-gas building
- diesel generator building
- control building
- turbine building
- radwaste building
- water treatment building
- miscellaneous structures and out-buildings

3.5.1 Summary of Technical Information in the Application

In LRA Section 3.5, the applicant provided AMR results for components. In LRA Table 3.5.1, "Summary of Aging Management Evaluations in Chapters II and III of NUREG-1801 for Containments, Structures, and Component Supports," the applicant provided a summary comparison of its AMRs with the AMRs evaluated in the GALL Report for the containments, structures, and component supports components and component groups.

The applicant's AMRs incorporated applicable operating experience in the determination of AERMs. These reviews included evaluation of plant-specific and industry operating experience. The plant-specific evaluation included reviews of condition reports and discussions with appropriate site personnel to identify AERMs. The applicant's review of industry operating experience included a review of the GALL Report and operating experience issues identified since the issuance of the GALL Report.

3.5.2 Staff Evaluation

The staff reviewed LRA Section 3.5 to determine if the applicant provided sufficient information to demonstrate that the effects of aging for the containments, structures, and component supports components that are within the scope of license renewal and subject to an AMR 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 performed an onsite audit of AMRs to confirm the applicant's claim that certain identified AMRs were consistent with the GALL Report. The staff did not repeat its review of the matters described in the GALL Report; however, the staff did verify that the material presented in the LRA was applicable and that the applicant had identified the appropriate GALL AMRs. The staff's evaluations of the AMPs are documented in SER Section 3.0.3. Detail of the staff's audit evaluation are documented in the Audit and Review Report and are summarized in SER Section 3.5.2.2.1.

During the audit, the staff reviewed the AMRs that were consistent with the GALL Report and for which further evaluation is recommended. The staff confirmed that the applicant's further evaluations were consistent with the acceptance criteria in the GALL Report, Section 3.5.2.2. The staff's audit evaluations are documented in the Audit and Review Report and are summarized in SER Section 3.5.2.2.

During the audit, the staff also conducted a technical review of the remaining AMRs that were not consistent with, or not addressed in, the GALL Report. The audit and technical review included evaluating (1) whether all plausible aging effects were identified, and (2) whether the aging effects listed were appropriate for the combination of materials and environments specified. The staff's audit evaluations are documented in the Audit and Review Report and are summarized in SER Section 3.5.2.3. The staff's evaluation of its technical review is also documented in SER Section 3.5.2.3.

Finally, the staff reviewed the AMP summary descriptions in the UFSAR supplement to ensure that they provided an adequate description of the programs credited with managing or monitoring aging for the containments, structures, and component supports components.

Table 3.5-1, below, provides a summary of the staff's evaluation of components, aging effects/mechanisms, and AMPs listed in LRA Section 3.5, that are addressed in the GALL Report.

Table 3.5-1 Staff Evaluation for Containments, Structures, and Component Supports in the GALL Report

Component Group	Aging Effect/ Mechanism	AMP in GALL Report	AMP in LRA	Staff Evaluation
Common Components of All Types of PWR and BWR Containment				
Penetration sleeves, penetration bellows, and dissimilar metal welds (Item Number 3.5.1-01)	Cumulative fatigue damage (CLB fatigue analysis exists)	TLAA, evaluated in accordance with 10 CFR 54.21(c)	TLAA	This TLAA is evaluated in Section 4.3
Penetration sleeves, bellows, and dissimilar metal welds (Item Number 3.5.1-02)	Cracking due to cyclic loading, or crack initiation and growth due to SCC	Containment ISI and Containment leak rate test	ASME Section XI, Subsection IWE Program (B.2.18); 10 CFR Part 50, Appendix J Program (B.2.21)	Not consistent with GALL (See Section 3.5.2.2.1.7)
Penetration sleeves, penetration bellows, and dissimilar metal welds (Item Number 3.5.1-03)	Loss of material due to corrosion	Containment ISI and Containment leak rate test	ASME Section XI, Subsection IWE Program (B.2.18); 10 CFR Part 50, Appendix J Program (B.2.21)	Consistent with GALL, which recommends no further evaluation (See Section 3.5.2.1)
Personnel airlock and equipment hatch (Item Number 3.5.1-04)	Loss of material due to corrosion	Containment ISI and Containment leak rate test	ASME Section XI, Subsection IWE Program (B.2.18); 10 CFR Part 50, Appendix J Program (B.2.21)	Consistent with GALL, which recommends no further evaluation (See Section 3.5.2.1)
Personnel airlock and equipment hatch (Item Number 3.5.1-05)	Loss of leak tightness in closed position due to mechanical wear of locks, hinges and closure mechanism	Containment leak rate test and Plant Technical Specifications	10 CFR Part 50, Appendix J Program (B.2.21); BSEP Units 1 and 2 Technical Specifications for Containment Systems	Consistent with GALL, which recommends no further evaluation (See Section 3.5.2.1)
Seals, gaskets, and moisture barriers (Item Number 3.5.1-06)	Loss of sealant and leakage through containment due to deterioration of joint seals, gaskets, and moisture barriers	Containment ISI and Containment leak rate test	ASME Section XI, Subsection IWE Program (B.2.18); 10 CFR Part 50, Appendix J Program (B.2.21)	Consistent with GALL, which recommends no further evaluation (See Section 3.5.2.1)
PWR Concrete (Reinforced and Prestressed) and Steel Containment BWR Concrete (Mark II and III) and Steel (Mark I, II, and III) Containment				

Component Group	Aging Effect/ Mechanism	AMP in GALL Report	AMP in LRA	Staff Evaluation
Concrete elements: foundation, walls, dome (Item Number 3.5.1-07)	Aging of accessible and inaccessible concrete areas due to leaching of calcium hydroxide, aggressive chemical attack, and corrosion of embedded steel	Containment ISI	ASME Section XI, Subsection IWL Program (B.2.19)	Consistent with GALL, which recommends further evaluation (See Section 3.5.2.2.1)
Concrete elements: foundation (Item Number 3.5.1-08)	Cracks, distortion, and increases in component stress level due to settlement	Structures Monitoring	Structures Monitoring Program (B.2.23)	Consistent with GALL, which recommends no further evaluation (See Section 3.5.2.2.1)
Concrete elements: foundation (Item Number 3.5.1-09)	Reduction in foundation strength due to erosion of porous concrete subfoundation	Structures Monitoring	N/A	Not applicable (See Section 3.5.2.2.1.2)
Concrete elements: foundation, dome, and wall (Item 3.5.1-10)	Reduction of strength and modulus due to elevated temperature	Plant specific		Not consistent with GALL (See Section 3.5.2.2.1.3)
Prestressed containment: tendons and anchorage components (Item 3.5.1-11)	Loss of prestress due to relaxation, shrinkage, creep, and elevated temperature	TLAA, evaluated in accordance with 10 CFR 54.21(c)		Not Applicable (See Section 3.5.2.2.1.5)
Steel elements: liner plate, containment shell (Item 3.5.1-12)	Loss of material due to corrosion in accessible and inaccessible areas	Containment ISI and Containment leak rate test	ASME Section XI, Subsection IWE Program (B.2.18); 10 CFR Part 50, Appendix J Program (B.2.21)	Consistent with GALL, which recommends further evaluation (See Section 3.5.2.2.1)
Steel elements: vent header, drywell head, torus, downcomers, pool shell (Item 3.5.1-13)	Cumulative fatigue damage (CLB fatigue analysis exists)	TLAA, evaluated in accordance with 10 CFR 54.21(c)	TLAA	This TLAA is evaluated in Section 4.
Steel elements: protected by coating (Item3.5.1-14)	Loss of material due to corrosion in accessible areas only	Protective coating monitoring and maintenance	N/A	Not applicable

Component Group	Aging Effect/ Mechanism	AMP in GALL Report	AMP in LRA	Staff Evaluation
Prestressed containment: tendons and anchorage components (Item 3.5.1-15)	Loss of material due to corrosion of prestressing tendons and anchorage components	Containment ISI	N/A	Not applicable
Concrete elements: foundation, dome, and wall (Item 3.5.1-16)	Scaling, cracking, and spalling due to freeze-thaw; expansion and cracking due to reaction with aggregate	Containment ISI	ASME Section XI, Subsection IWL Program (B.2.19)	Consistent with GALL, which recommends no further evaluation (See Section 3.5.2.1.1)
Steel elements: vent line bellows, vent headers, downcomers (Item 3.5.1-17)	Cracking due to cyclic loads or Crack initiation and growth due to SCC	Containment ISI and Containment leak rate test	ASME Section XI, Subsection IWE Program (B.2.18); 10 CFR Part 50, Appendix J Program (B.2.21)	Not consistent with GALL (See Section 3.5.2.2.1.7)
Steel elements: Suppression chamber liner (Item 3.5.1-18)	Crack initiation and growth due to SCC	Containment ISI and Containment leak rate test		Not applicable
Steel elements: drywell head and downcomer pipes (Item 3.5.1-19)	Fretting and lock up due to wear	Containment ISI		Not applicable (See Section 3.5.2.1.2)
Class I Structures				
All Groups except Group 6: accessible interior/exterior concrete steel & components (Item 3.5.1-20)	All types of aging effects	Structures Monitoring	Structures Monitoring Program (B.2.23)	Consistent with GALL, which recommends no further evaluation (See Section 3.5.2.1)
Groups 1-3, 5, 7-9: inaccessible concrete components, such as exterior walls below grade and foundation (Item 3.5.1-21)	Aging of inaccessible concrete areas due to aggressive chemical attack, and corrosion of embedded steel	Plant specific	Structures Monitoring Program (B.2.23)	Consistent with GALL, which recommends further evaluation (See Section 3.5.2.2.2)
Group 6: all accessible/ inaccessible concrete, steel, and earthen components (Item 3.5.1-22)	All types of aging effects, including loss of material due to abrasion, cavitation, and corrosion	Inspection of Water-Control Structures or FERC/US Army Corp of Engineers dam inspection and maintenance	Structures Monitoring Program (B.2.23)	Not consistent with GALL (See Section 3.5.2.2.2)

Component Group	Aging Effect/ Mechanism	AMP in GALL Report	AMP in LRA	Staff Evaluation
Group 5: liners (Item Number 3.5.1-23)	Crack initiation and growth from SCC and loss of material due to crevice corrosion	Water Chemistry Program and Monitoring of spent fuel pool water level	Water Chemistry Program (B.2.2); Technical Specifications	Consistent with GALL, which recommends no further evaluation (See Section 3.5.2.1)
Groups 1-3, 5, 6: all masonry block walls (Item 3.5.1-24)	Cracking due to restraint, shrinkage, creep, and aggressive environment	Masonry Wall	Masonry Wall Program (B.2.22)	Consistent with GALL, which recommends no further evaluation (See Section 3.5.2.1)
Groups 1-3, 5, 7-9: foundation (Item 3.5.1-25)	Cracks, distortion, and increases in component stress level due to settlement	Structures Monitoring	Structures Monitoring Program (B.2.23)	Consistent with GALL, which recommends no further evaluation (See Section 3.5.2.1)
Groups 1-3, 5-9: foundation (Item 3.5.1-26)	Reduction in foundation strength due to erosion of porous concrete subfoundation	Structures Monitoring	N/A	Not applicable
Groups 1-5: concrete (Item 3.5.1-27)	Reduction of strength and modulus due to elevated temperature	Plant-specific		Not consistent with GALL (See Section 3.5.2.2.1.3)
Groups 7, 8: liners (Item 3.5.1-28)	Crack Initiation and growth due to SCC; Loss of material due to crevice corrosion	Plant-specific	N/A	Not applicable
Component Supports				
All Groups: support members: anchor bolts, concrete surrounding anchor bolts, welds, grout pad, bolted connections, etc. (Item 3.5.1-29)	Aging of component supports	Structures Monitoring	Structures Monitoring Program (B.2.23)	Consistent with GALL, which recommends no further evaluation (See Section 3.5.2.1)
Groups B1.1, B1.2, and B1.3: support members: anchor bolts, welds (Item 3.5.1-30)	Cumulative fatigue damage (CLB fatigue analysis exists)	TLAA, evaluated in accordance with 10 CFR 54.21(c)	N/A	Not applicable

Component Group	Aging Effect/ Mechanism	AMP in GALL Report	AMP in LRA	Staff Evaluation
All Groups: support members: anchor bolts, welds (Item 3.5.1-31)	Loss of material due to boric acid corrosion	Boric acid corrosion	N/A	Not applicable
Groups B1.1, B1.2, and B1.3: support members: anchor bolts, welds, spring hangers, guides, stops, and vibration isolators (Item 3.5.1-32)	Loss of material due to environmental corrosion; loss of mechanical function due to corrosion, distortion, dirt, overload, etc.	ISI	ASME Section XI, Subsection IWF Program (B.2.20)	Consistent with GALL, which recommends no further evaluation (See Section 3.5.2.1)
Group B1.1: high strength low-alloy bolts (Item 3.5.1-33)	Crack initiation and growth due to SCC	Bolting integrity	N/A	Not applicable

The staff's review of the BSEP component groups followed one of three approaches depending on the group's consistency with the GALL Report. SER Section 3.5.2.1 discusses the staff's review and documentation of the AMR results for components associated with containments, structures, and component supports that the applicant indicated are consistent with the GALL Report and do not require further evaluation; SER Section 3.5.2.2 discusses the staff's review and documentation of the AMR results for components that the applicant indicated are consistent with the GALL Report and for which further evaluation is recommended; and, Section 3.5.2.3 discusses the staff's review and documentation of the AMR results for components that the applicant indicated are not consistent with, or not addressed in, the GALL Report. The staff's review of AMPs that are credited to manage or monitor aging effects of the containment, structures, and component supports components is documented in SER Section 3.0.3.

3.5.2.1 AMR Results That Are Consistent with the GALL Report

Summary of Technical Information in the Application. In LRA Section 3.5.2.1, the applicant identified the materials, environments, and AERMs. The applicant identified the following programs that manage the aging effects related to the containments, structures, and component supports components:

- Structures Monitoring Program
- ASME Section XI, Subsection IWE Program
- ASME Section XI, Subsection IWL Program
- ASME Section XI, Subsection IWF Program
- 10 CFR Part 50, Appendix J Program
- Water Chemistry Program
- Inspection of Overhead Heavy Load and Light Load Handling Systems
- Masonry Wall Program
- Fire Protection Program
- Fuel Pool Girder Tendon Monitoring Program

Staff Evaluation. In LRA Tables 3.5.2-1 through 3.5.2-15, the applicant provided a summary of AMRs for the containments, structures, and component supports components, and identified which AMRs it considered to be consistent with the GALL Report.

For component groups evaluated in the GALL Report for which the applicant has claimed consistency with the GALL Report, and for which the GALL Report does not recommend further evaluation, the staff performed an audit to determine whether the plant-specific components contained in these GALL Report component groups were bounded by the GALL Report evaluation.

The applicant provided a note for each AMR line item. The notes described how the information in the tables aligns with the information in the GALL Report. The staff audited those AMRs with Notes A through E, which indicate that the AMR is consistent with the GALL Report.

Note A indicates that the AMR line item is consistent with the GALL Report for component, material, environment, and aging effect. In addition, the AMP is consistent with the AMP identified in the GALL Report. The staff audited these line items to verify consistency with the GALL Report and the validity of the AMR for the site-specific conditions.

Note B indicates that the AMR line item is consistent with the GALL Report for component, material, environment, and aging effect. In addition, the AMP takes some exceptions to the AMP identified in the GALL Report. The staff audited these line items to verify consistency with the GALL Report. The staff verified that the identified exceptions to the GALL AMPs had been reviewed and accepted by the staff. The staff also determined whether the AMP identified by the applicant was consistent with the AMP identified in the GALL Report and whether the AMR was valid for the site-specific conditions.

Note C indicates that the component for the AMR line item is different from, but consistent with the GALL Report for material, environment, and aging effect. In addition, the AMP is consistent with the AMP identified by the GALL Report. This note indicates that the applicant was unable to find a listing of some system components in the GALL Report. However, the applicant identified a different component in the GALL Report that had the same material, environment, aging effect, and AMP as the component that was under review. The staff audited these line items to verify consistency with the GALL Report. The staff also determined whether the AMR line item of the different component was applicable to the component under review and whether the AMR was valid for the site-specific conditions.

Note D indicates that the component for the AMR line item is different from, but consistent with the GALL Report for material, environment, and aging effect. In addition, the AMP takes some exceptions to the AMP identified in the GALL Report. The staff audited these line items to verify consistency with the GALL Report. The staff verified whether the AMR line item of the different component was applicable to the component under review. The staff verified whether the identified exceptions to the GALL AMPs had been reviewed and accepted by the staff. The staff also determined whether the AMP identified by the applicant was consistent with the AMP identified in the GALL Report and whether the AMR was valid for the site-specific conditions.

Note E indicates that the AMR line item is consistent with the GALL Report for material, environment, and aging effect, but a different aging management program is credited. The staff audited these line items to verify consistency with the GALL Report. The staff also determined whether the identified AMP would manage the aging effect consistent with the AMP identified by the GALL Report and whether the AMR was valid for the site-specific conditions.

The staff conducted an audit of the information provided in the LRA, as documented in the Audit and Review Report. The staff did not repeat its review of the matters described in the GALL Report. However, the staff did verify that the material presented in the LRA was applicable and that the applicant had identified the appropriate GALL Report AMRs. The staff's evaluation is discussed below.

In the LRA Section 3.5, the applicant provided the results of its AMRs for containments, structures, and component supports.

In LRA Tables 3.5.2-1 through 3.5.2-15, the applicant provided a summary of the AMR results for components/commodities in the (1) primary containment; (2) intake and discharge canals; (3) refueling system; (4) switchyard and transformer yard structures; (5) bridge cranes; (6) gantry cranes; (7) service water intake structure; (8) reactor building; (9) augmented off-gas building; (10) diesel generator building; (11) control building; (12) turbine building; (13) radwaste building; (14) water treatment building; and (15) miscellaneous structures and out-buildings.

Also, for each component type in LRA Table 3.5.1, the applicant identified those components that are consistent with the GALL Report, those that are consistent with the GALL Report in which further evaluation is recommended, and those that are not addressed in the GALL Report together with the basis for their exclusion.

For aging management evaluations that the applicant stated are consistent with the GALL Report, the staff conducted its audit to determine if the applicant's reference to the GALL Report in the LRA is acceptable.

The staff reviewed its assigned LRA line items to determine that the applicant : (1) provided a brief description of the system, components, materials, and environment; (2) stated that the applicable aging effects have been reviewed and are evaluated in the GALL Report; and (3) identified those aging effects for the primary containment, intake and discharge canals, refueling system, switchyard and transformer yard structures, bridge cranes, gantry cranes, service water intake structure, reactor building, augmented off-gas building, diesel generator building, control building, turbine building, radwaste building, water treatment building, and miscellaneous structures and out-buildings components that are subject to an AMR.

3.5.2.1.1 Loss of Material due to Wear and Corrosion for Rails in Load Handling Systems

LRA Tables 3.5.2-3, 3.5.2-5, and 3.5.2-6 each include an AMR line item for loss of material due to wear of rails in load handling systems. The AMRs reference GALL line item VII.B.2-a, Table 1 item 3.3.1-16, and generic Note A. The staff noted that GALL line item VII.B.2-a lists a specific grade of corrosion-resistant steel, ASTM A759 commonly used for crane rails. The applicant's AMRs identify the material as "carbon steel." During the audit, the staff noted that carbon steel would also be susceptible to loss of material due to corrosion. The staff asked the applicant to confirm that the crane rail material used at BSEP is grade A759 or equivalent. In its response the applicant confirmed that the crane rail material used at BSEP for the reactor building crane and the intake structure gantry crane meets the specifications for grade A759 crane rail steel. The crane rail material used for the refueling platform meets the specifications for ASTM A1, which is a corrosion-resistant steel commonly used in railroad applications and is considered equivalent to A-759. On this basis, the staff concluded that the crane rail materials used at BSEP are consistent with the material specified in the GALL Report.

The staff also noted that in LRA Table 3.5.2-6, the AMR line item for the rails of the intake structure gantry crane identifies the environment as "exposed to weather." GALL line item VII.B.2-a lists the environment as "air at 100 percent relative humidity and 49 °C (120 °F)," which is representative of design conditions inside containment. The staff also asked the applicant to provide its technical basis for concluding that the rails of the intake structure gantry crane in an "exposed to weather" environment are not susceptible to loss of material due to corrosion. In its response, the applicant stated that grade A759 crane rail steel has a long history of outdoor use without significant corrosion. In addition, BSEP's operating experience review has not identified corrosion as an issue for crane rails. The staff agreed with the applicant's assessment that corrosion is not a concern for A759 exposed to weather.

On the basis of its review, the staff found that the applicant appropriately addressed the aging mechanism, as recommended by the GALL Report.

3.5.2.1.2 Fretting and Lock Up Due to Wear for Drywell Head and Downcomer Pipes

LRA Table 3.5.1, Item 3.5.1-19, identifies steel elements: drywell head and downcomer pipes; fretting and lock-up due to wear as the aging effect/mechanism; and containment ISI as the AMP. In the discussion column for item 3.5.1-19 in LRA Table 3.5.1, the applicant stated:

> During normal operating conditions, the Primary Containment Drywell Head and Downcomers are not in contact with other components that could expose them to wear. However, during refueling operations, rubbing contact is possible during removal and reinstallation of the Drywell Head. Drywell Head movement is strictly controlled by procedure; therefore, loss of material due to wear is considered to be negligible.

The staff noted that there are no AMR entries in LRA Table 3.5.2-1 (containment) that reference LRA Table 3.5.1, item 3.5.1-19. During the audit, the staff asked the applicant to provide its AMR results for this component-aging effect combination, and to address whether the ASME Section XI, Subsection IWE Program is credited for aging management of fretting and lock-up due to wear.

In its response, the applicant stated that

> All items in Table 3.5.1 were addressed in the LRA and an explanation provided in the discussion section, regardless of whether the aging effect was considered applicable. The discussion associated with item 3.5.1-19 explains the effect is considered negligible and that is why it was not addressed within Table 3.5.2-1.
>
> Although the IWE program is not credited for management of "fretting and lock-up due to wear" for the subject components; it is credited for "Loss of Material", which effectively envelops wear. As such, management of the subject components by IWE is considered sufficient.

The staff agreed that the applicant's ASME Section XI, Subsection IWE Program will provide adequate aging management of fretting and lock-up due to wear for the drywell head and downcomer pipes, and determined that the applicant's response is acceptable.

On the basis of its review, the staff found that the applicant appropriately addressed the aging mechanism, as recommended by the GALL Report.

Conclusion. The staff evaluated the applicant's claim of consistency with the GALL Report. The staff also reviewed information pertaining to the applicant's consideration of recent operating experience and proposals for managing associated aging effects. On the basis of its review, the staff concluded that the AMR results, which the applicant claimed to be consistent with the GALL Report, are consistent with the AMRs in the GALL Report. Therefore, the staff concluded that the applicant has demonstrated that the effects of aging for these components will be adequately managed so that their 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).

3.5.2.2 AMR Results For Which Further Evaluation is Recommended By the GALL Report

Summary of Technical Information in the Application. In LRA Section 3.5.2.2, the applicant provided further evaluation of aging management as recommended by the GALL Report for the containments, structures, and component supports. The applicant provided information concerning how it will manage the following aging effects:

- PWR and BWR containments
- Class 1 structures
- component supports

Staff Evaluation. For component groups evaluated in the GALL Report for which the applicant has claimed consistency with the GALL Report, and for which the GALL Report recommends further evaluation, the staff audited the applicant's evaluation to determine whether it adequately addressed the issues that were further evaluated. In addition, the staff reviewed the applicant's further evaluations against the criteria contained in Section 3.5.2.2 of the SRP-LR. Details of the staff's audit are documented in the Audit and Review Report. The staff's evaluation of the aging effects is discussed in the following sections.

3.5.2.2.1 PWR and BWR Containments

Aging of Inaccessible Concrete. The staff reviewed LRA Section 3.5.2.2.1.1 against the criteria found in SRP-LR Section 3.5.2.2.1.1:

> Cracking, spalling, and increases in porosity and permeability due to leaching of calcium hydroxide and aggressive chemical attack; and cracking, spalling, loss of bond, and loss of material due to corrosion of embedded steel could occur in inaccessible areas of PWR concrete and steel containments; BWR Mark II concrete containments; and Mark III concrete and steel containments. The GALL Report recommends further evaluation of plant-specific programs to manage the aging effects for inaccessible areas if specific criteria defined in the GALL Report cannot be satisfied.

In LRA Section 3.5.2.2.1.1, the applicant stated that the aging mechanisms of leaching of calcium hydroxide, aggressive chemical attack, and corrosion of embedded steel are not significant for the concrete components of the primary containment structure. The BSEP primary containment is completely contained within the reactor building; therefore, it is not subject to aging effects associated with a below-grade, exterior environment. The primary containment concrete is not exposed to an aggressive environment and has been designed in accordance with ACI 318, with a low water/cement ratio and entrained air between 3 and 6 percent. Therefore, the aging mechanism of leaching of calcium hydroxide, which becomes significant only if the concrete is subject to flowing water, is not applicable. Also, aggressive chemical attack and corrosion of embedded steel are not applicable because the concrete is not exposed to aggressive chemicals.

The staff noted that the Mark I concrete containment design is unique. However, similar to Mark I steel containments, it is completely enclosed by the reactor building, and it is protected from the adverse environments that potentially cause age-related degradation of inaccessible concrete. The staff found that, based on the programs identified above, the applicant has met the criteria of SRP-LR Section 3.5.2.2.1 for further evaluation. The staff found that the applicant demonstrated that the effects of aging will be adequately managed so that the intended functions will be maintained during the period of extended operation, as required by 10 CFR 54.21(a)(3).

Cracking, Distortion, and Increase in Component Stress Level Due to Settlement; Reduction of Foundation Strength Due to Erosion of Porous Concrete Subfoundations, if Not Covered by Structures Monitoring Program. The staff reviewed LRA Section 3.5.2.2.1.2 against the criteria found in SRP-LR Section 3.5.2.2.1.2:

> Cracking, distortion, and increase in component stress level due to settlement could occur in PWR concrete and steel containments and BWR Mark II concrete containments and Mark III concrete and steel containments. Also, reduction of foundation strength due to erosion of porous concrete subfoundations could occur in all types of PWR and BWR containments. Some plants may rely on a de-watering system to lower the site ground water level. If the plant's CLB credits a de-watering system, the GALL Report recommends verification of the continued functionality of the de-watering system during the period of extended operation. The GALL Report recommends no further evaluation if this activity is included in the scope of the applicant's structures monitoring program.

In LRA Section 3.5.2.2.1.2, the applicant stated that settlement was monitored during construction of BSEP, and the predicted settlement values were found to be consistent with that actually experienced. Plant engineers monitor for the effects of differential settlement during inspections of structures under the Structures Monitoring Program. A review of plant operating history has not identified any settlement issues. BSEP structures do not have porous concrete subfoundations and do not employ a de-watering system. Furthermore, the primary containment concrete is not in contact with the soil or groundwater. Therefore, reduction of foundation strength due to erosion of porous concrete is not an applicable aging effect.

During the audit the staff determined the applicant's further evaluation to be acceptable, on the basis that the effects of differential settlement of BSEP structures is monitored during inspections under the Structures Monitoring Program; BSEP does not have porous concrete subfoundations; and does not employ a de-watering system.

On the basis of its review, the staff found that the applicant appropriately addressed the aging mechanism, as recommended by the GALL Report.

Reduction of Strength and Modulus of Concrete Structures Due to Elevated Temperature. The staff reviewed LRA Section 3.5.2.2.1.3 against the criteria found in SRP-LR Section 3.5.2.2.1.3:

> Reduction of strength and modulus of elasticity due to elevated temperatures could occur in PWR concrete and steel containments and BWR Mark II concrete containments and Mark III concrete and steel containments. The GALL Report recommends further evaluation if any portion of the concrete containment components exceeds specified temperature limits, i.e., general area temperature 66°C (150°F) and local area temperature 93°C (200°F).

In LRA Section 3.5.2.2.1.3, the applicant stated that elevated temperatures above the limits specified in the GALL Report are not applicable for concrete structures and components outside the primary containment. Inside the primary containment structure, the bulk average temperature is less than 150 °F; however, data for the confined, upper elevations of the primary containment have identified a maximum average temperature of 194 °F. Based on an evaluation of drywell temperatures, the contact temperature at the inside face of the concrete (drywell side) is approximately 175 °F and the contact temperature at the outside face of the concrete (reactor building side) is approximately 107 °F. Because the elevated temperatures are localized to the confined upper elevation of the drywell and the actual concrete temperatures are on a gradient through the drywell wall, the upper elevation of the drywell is considered a local rather than a general area. Therefore, the containment concrete elements are exposed to temperatures consistent with the guidance provided in the GALL Report, which defines elevated temperatures as greater than 150 °F general and 200 °F local; and the primary containment concrete is not subject to degradation due to elevated temperature.

During the audit, the staff requested that the applicant provide the detailed technical basis for this conclusion, including the results of heat transfer and thermal stress analyses, if available. In its response, the applicant stated:

> The BSEP containment bulk average temperature is maintained below 150 °F and is managed by Technical Specifications Section 3.6.1.4, which require the plant enter LCO actions if the drywell bulk average temperature exceeds 150 °F.
>
> The geometry of the BSEP drywell is such that the confined upper elevations will experience temperatures in excess of 150 °F. However the increased temperatures are only present in the very upper regions of the drywell; as such only the pressure boundary concrete walls, as discussed in GALL Chapter II, of the drywell are subject to the higher temperatures. Plant-specific note 536 was provided to explain this condition. The interior containment concrete addressed under GALL item III.A4.1-c is below the area of increased temperature and therefore not subject to the elevated temperatures, which is why plant specific note 513 is only associated with the interior concrete of GALL Chapter III.A4.
>
> A technical evaluation of the temperature gradient through the drywell wall determined interior concrete temperatures based on varying values of ambient drywell temperatures. Based on the results of that evaluation, using the maximum upper drywell ambient air temperature of 194 degrees F (based on local monitoring), the concrete surface

temperature is approximately 175 degrees F. The temperature gradient through the drywell wall was determined to be approximately 68 degrees F. Based on the temperature gradient of 68 degrees F and a drywell wall thickness of four feet, the internal concrete temperature would fall below 150 degrees F approximately 18 inches from the inside surface of the drywell wall. The concrete contact temperature of 175 degrees in the upper elevations is well below the "local" areas temperature limit of 200 degrees and drops off to a contact temperature of 150 degrees F within twenty feet of the upper elevations.

ACI 349 provides no basis for how local areas are defined and only provides the following statement for guidance: "such as around penetrations." The drywell concrete subject to temperatures in excess of 150°F is limited to less than half the wall thickness and is confined to the very upper elevations. The basis for "local" consideration is the fact that only a limited portion of the concrete cross-section is subject to temperatures over 150°, not the entire section, which is similar to the temperature gradient surrounding a penetration. As such, the very upper elevations of the drywell would effectively mimic a large penetration and would therefore be categorized as a local area.

However, the drywell concrete has been evaluated for the effects of increased temperature and was found to be acceptable. The evaluation considered drywell concrete temperature to be 185°F with a linear temperature gradient between the interior and exterior surfaces of approximately 70°F.

Summary of the evaluation results are as follows:

The states of stress in liner, rebar and concrete are well within allowable for the normal operating condition and are not significantly different for the design accident conditions.

Reductions in strength and modulus may occur at elevated temperature and can conservatively be accounted for by reduction factors on allowable stresses. The physical state of the concrete at 175°F to 185°F will not be significantly different from the ASME code limit 150°F.

There is no compromise of the containment's integrity under design accident conditions.

The staff reviewed the applicant's response and determined that any reduction in strength and modulus of concrete resulting from sustained temperatures between 150°F and 175°F in the localized area of concrete at the upper elevation of the drywell would be minimal and will not compromise the structural integrity of the containment structure under design accident conditions. The staff noted that the concrete area in question is inaccessible for inspection because it is behind the steel liner. Therefore, the applicant appropriately addressed this condition by analysis.

The staff further determined that, assuming complete loss of concrete strength in this localized area, the steel liner alone is capable of resisting the design accident pressure, although no credit is taken for it in the containment design. In addition, the capacity of the containment structure to resist seismic loading would be unaffected because the maximum seismic loads occur at the base of the containment structure and are minimum at the top.

Therefore, the staff concluded that the applicant's further evaluation of the elevated temperature condition at the upper elevation of containment is acceptable.

The staff noted that the applicant does not address penetrations through the containment and reactor building concrete for the main steam and feedwater lines in LRA Section 3.5.2.2.1.3. The concrete surrounding these penetrations needs to be maintained below 200 °F during normal operation to prevent long-term degradation. The staff requested that the applicant provide its AMR results for the concrete surrounding these and any other penetrations for hot piping; and, if insulation and/or a penetration cooling system is credited for maintaining acceptable temperatures, to provide the AMR results for these items.

The applicant stated that the concrete surrounding the subject penetrations is addressed under "Concrete above grade" in LRA table 3.5.2-1. The specific aging effect associated with elevated temperature is addressed by GALL item number II.B2.2.1-g, within the "Concrete above grade" group. The commodity "Insulation," within Table 3.5.2-1 is credited with maintaining the penetration temperatures below the local limits of 200 °F.

In its response, the applicant further stated that hot penetration temperatures, recorded on chart paper, were reviewed back to 1997. No penetration temperatures exceeded 200 °F, with the highest recorded temperature of 185 °F occurring between June 2003 and August 2003 on one of the main steam lines. As such, the insulation has proven effective in maintaining hot penetration temperatures below 200 °F.

The staff found that, based on the programs identified above, the applicant has met the criteria of SRP-LR Section 3.5.2.2.1.3 for further evaluation. The staff found that the applicant has demonstrated that the effects of aging will be adequately managed so that the intended functions will be maintained during the period of extended operation, as required by 10 CFR 54.21(a)(3).

Loss of Material Due to Corrosion in Inaccessible Areas of Steel Containment Shell or Liner Plate. The staff reviewed LRA Section 3.5.2.2.1.4 against the criteria found in SRP-LR Section 3.5.2.2.1.4:

> Loss of material due to corrosion could occur in inaccessible areas of the steel containment shell or the steel liner plate for all types of PWR and BWR containments. The GALL Report recommends further evaluation of plant-specific programs to manage this aging effect for inaccessible areas if specific criteria defined in the GALL Report cannot be satisfied.

In LRA Section 3.5.2.2.1.4, the applicant stated that loss of material due to corrosion in inaccessible areas (embedded containment steel shell or liner) is not significant because of the following:

- The primary containment concrete structure was designed to ACI 318 and was constructed in accordance with ACI 301. The low water-cement ratio and air entrainment between 3 and 6 percent provides a dense concrete with low permeability, which meets the intent of ACI 201.2R.
- The concrete is monitored by the Structures Monitoring Program to ensure that it is free of penetrating cracks that provide a path for water seepage to the surface of the containment liner.
- The moisture barrier, at the junction where the shell or liner becomes embedded, is subject to aging management activities in accordance with IWE requirements.

- The above moisture barrier at the drywell liner and concrete containment floor interface has been designed to direct water away from the drywell liner. The containment concrete floor is sloped away from the drywell liner for drainage purposes. Periodic inspections of the concrete floor surface condition performed in accordance with the Structures Monitoring Program will validate the continued absence of corrosion for the inaccessible portions of the drywell liner.

During the audit, the staff determined that the applicant satisfied the specific criteria defined in the GALL Report for preventing loss of material due to corrosion in inaccessible areas of the steel liner; however, the applicant did not address plant-specific operating experience in LRA Section 3.5.2.2.1.4. The staff requested that the applicant provide details of the plant-specific operating experience for this aging effect/mechanism. If loss of material due to corrosion has occurred, the staff asked the applicant to describe the corrective actions taken to prevent future occurrences, to describe any augmented inspection of the concrete floor and/or the moisture barrier that is currently conducted (e.g., inspection every outage), and to describe any augmented inspection that is credited for the period of extended operation.

In its response, the applicant stated that degradation of the drywell liner, at the intersection of the concrete floor and moisture barrier, was identified in 1993. The degradation was extensively evaluated and weld repairs were performed in several areas. To minimize recurring corrosion, this area of the liner was re-coated with an epoxy coating and an enhanced moisture seal was installed in the expansion joint between the liner plate and the concrete floor that redirects any water in the vicinity away from the liner. Since the revised moisture barrier has been installed, no liner degradation has been identified; minor separation of the moisture barrier to the liner has been identified and repaired.

The applicant further stated that the moisture barriers are inspected once each inspection period (i.e., three examinations in a ten-year period) via a general visual examination. The IWE inspection for the moisture barrier lists the following recordable conditions: wear, damage, erosion, tear, surface cracks, or other defects that may violate the leak-tight integrity; and moisture barrier separation at the interface to the liner and/or concrete. Specific instructions under acceptance criteria state: "Any condition that will permit intrusion of moisture against the inaccessible areas of the pressure-retaining surfaces of the metallic liner shall be repaired or replaced." Inspection of the moisture barrier will be continued within the IWE program during the period of extended operation.

The staff found that, based on the programs identified above, the applicant has met the criteria of SRP-LR Section 3.5.2.2.1.4 for further evaluation. The staff found that the applicant has demonstrated that the effects of aging will be adequately managed so that the intended functions will be maintained during the period of extended operation, as required by 10 CFR 54.21(a)(3).

<u>Loss of Prestress Due to Relaxation, Shrinkage, Creep, and Elevated Temperature</u>. In LRA Section 3.5.2.2.1.5, the applicant stated that the BSEP primary containment structure is constructed of reinforced concrete. There are no prestressed tendons associated with the primary containment structure design. Therefore, the aging effect, loss of prestress, is not applicable to the BSEP primary containment structure.

Cumulative Fatigue Damage. Cumulative fatigue is a TLAA, as defined in 10 CFR 54.3. TLAAs are required to be evaluated in accordance with 10 CFR 54.21(c))(1). The evaluation of this TLAA is addressed by staff in SER Section 4.6.

Cracking Due to Cyclic Loading and SCC. The staff reviewed LRA Section 3.5.2.2.1.7 against the criteria found in SRP-LR Section 3.5.2.2.1.7:

> Cracking of containment penetrations (including penetration sleeves, penetration bellows, and dissimilar metal welds) due to cyclic loading or SCC could occur in all types of PWR and BWR containments. Cracking could also occur in vent line bellows, vent headers and downcomers due to SCC for BWR containments. A visual VT-3 examination would not detect such cracks. The GALL Report recommends further evaluation of the inspection methods implemented to detect these aging effects.

In LRA Section 3.5.2.2.1.7, the applicant stated that the GALL Report discussion involves cracking due to cyclic loading and SCC of carbon steel, stainless steel, and dissimilar metal welds in containment penetration sleeves and bellows; and vent line bellows, vent headers, and downcomers. BSEP penetrations do not use expansion bellows, and penetration sleeves are fabricated from carbon steel. However, some penetrations incorporate stainless steel components, which require dissimilar metal welds. The vent line bellows are fabricated from stainless steel, and the vent header and downcomers are fabricated from carbon steel.

The applicant further stated that SCC is not an applicable aging effect for these components, because (1) carbon steel components are not susceptible to SCC, and (2) to be susceptible to SCC, stainless steel must be subject to both high temperature (>140 °F) and an aggressive chemical environment. Components fabricated from stainless steel are not subject to an aggressive chemical environment.

The applicant further stated that cracking of metal components owing to cyclic loads is a potential aging effect. However, the AMR, as supported by operating experience, concluded that cyclic loading from plant heatups and cooldowns, containment testing, and system vibration was very low or limited in numbers of cycles; therefore, additional methods of detecting postulated cracking were not warranted. The applicant also noted that the cyclic loading of the vent header and downcomers has been analyzed as a TLAA, and addressed in LRA Subsection 3.5.2.2.1.6.

The applicant further stated that, for the steel elements of containment that are part of the IWE pressure boundary; both the ASME Section XI, Subsection IWE Program and 10 CFR Part 50, Appendix J Program are used to monitor for degradation. However, the vent line bellows are inaccessible, and only the accessible surface areas of the assembly are subject to visual examination. A review of BSEP operating experience indicates that cracking has not been a concern for steel containment pressure boundary components.

The applicant concluded that, based on the above discussion, potential cracking of steel containment components is not expected, and use of the combination of the ASME Section XI, Subsection IWE Program and 10 CFR Part 50, Appendix J Program, as recommended by the GALL Report, will adequately assure the detection of cracking should it occur.

The staff agreed with the applicant's further evaluation, with one exception. The staff noted that specific Mark I bellows design(s) have experienced cracking, and that the cracking was not detected by Appendix J leak rate testing. The staff requested the applicant to describe the bellows design, compared to the design(s) that developed cracks that were undetectable by Appendix J leak rate testing; and provide the technical basis for the determination that Appendix J leak rate testing would be able to detect cracks in the inaccessible regions of the vent line bellows.

The applicant stated that the bellows degradation referenced for another plant in their SER (NUREG-1796) was identified while conducting Appendix J testing and was associated with a 2-ply bellows. The subject bellows were replaced with a single-ply bellows. The Brunswick Containment Inspection Program (OBNP-TR-002) addresses the vent line bellows within Appendix F, augmented areas, as follows:

> Occurrences with transgranular stress corrosion cracking (TGSCC) with two-ply containment bellows were also identified. The containment design at BNP employs a single-ply containment bellows. These containment bellows are located inside the Suppression Chamber and are insulated by a protective cover. Unlike the examples given in SECY-96-080, a failure caused by transgranular stress corrosion cracking of these bellows is minimal. The controlled atmosphere, the protective cover over the bellows, and the location of these bellows inside the Suppression Chamber does not provide the environment (e.g., high temperature, surfaces exposed to a chemical environment, etc.) which is known to initiate stress corrosion cracking. In addition, no leakage associated with these bellows has been identified during previous Type A tests. Thus, this type of degradation at BNP is not a concern.

The staff acknowledges that the applicant is correct in that the other plant's bellows cracking was detected by Appendix J testing. BSEP employs a single-ply containment bellows design. The environment is not conducive to SCC, and previous Appendix J, Type A tests have not identified any leakage associated with the bellows. On this basis, the staff concluded that Appendix J, Type A leak rate testing is sufficient to manage cracking in the inaccessible regions of vent line bellows, and determined that the applicant's further evaluation is acceptable.

The staff found that, based on the programs identified above, the applicant has met the criteria of SRP-LR Section 3.5.2.2.1.7 for further evaluation. The staff found that the applicant has demonstrated that the effects of aging will be adequately managed so that the intended functions will be maintained during the period of extended operation, as required by 10 CFR 54.21(a)(3).

3.5.2.2.2 Class 1 Structures

Aging of Structures Not Covered by Structures Monitoring Program. The staff reviewed LRA Section 3.5.2.2.2.1 against the criteria found in SRP-LR Section 3.5.2.2.2.1:

> The GALL Report recommends further evaluation of certain structure/aging effect combinations if they are not covered by the structures monitoring program. This includes (1) scaling, cracking, and spalling due to repeated freeze-thaw for Groups 1-3, 5, 7-9 structures; (2) scaling, cracking, spalling and increase in porosity and permeability due to leaching of calcium hydroxide and aggressive chemical attack for Groups 1-5, 7-9 structures; (3) expansion and cracking due to reaction with aggregates for Groups 1-5, 7-9 structures; (4) cracking, spalling, loss of bond, and

loss of material due to corrosion of embedded steel for Groups 1-5, 7-9 structures; (5) cracks, distortion, and increase in component stress level due to settlement for Groups 1-3, 5, 7-9 structures; (6) reduction of foundation strength due to erosion of porous concrete subfoundation for Groups 1-3, 5-9 structures; (7) loss of material due to corrosion of structural steel components for Groups 1-5, 7-8 structures; (8) loss of strength and modulus of concrete structures due to elevated temperatures for Groups 1-5; and (9) crack initiation and growth due to SCC and loss of material due to crevice corrosion of stainless steel liner for Groups 7 and 8 structures. Further evaluation is necessary only for structure/aging effect combinations not covered by the structures monitoring program. Technical details of the aging management issue are presented in SRP-LR Subsection 3.5.2.2.1.2 for items (5) and (6) and Subsection 3.5.2.2.1.3 for item (8).

In LRA Section 3.5.2.2.2.1, the applicant stated that aging effects associated with freeze/thaw; leaching of calcium hydroxide; reaction with aggregates; corrosion of embedded steel; and aggressive chemical attack of concrete are not applicable, as discussed in the plant-specific notes associated with LRA Tables 3.5.2-1 through 3.5.2-15. Nevertheless, the Structures Monitoring Program is credited for aging management of these effects/ mechanisms for the affected structures, in accordance with the current NRC position (ISG-03). Corrosion of structural steel components is addressed by the Structures Monitoring Program.

The applicant further stated that aging effects associated with GALL Report, Volume 2, item III.A4.2-b, involve Lubrite slide-bearing plates. The plates provide a low-friction barrier between the equipment and their support structures. A review of industry operating experience, and 20 years of service at BSEP, reveals no adverse experience data recorded for the Lubrite sliding surfaces for applications both inside and outside containment. Based on the low cycle service required, it was concluded the Lubrite bearing plates will continue to perform their intended function for the period of extended operation.

During the audit, the staff also requested the applicant to describe any inspections of Lubrite plates that are currently conducted under the IWF, Maintenance Rule, or any other existing program; whether these inspections will continue during the extended period of operation; and whether they are credited for license renewal aging management.

In its response, the applicant stated that, as addressed by previous applicants and agreed with by the staff, Lubrite resists deformation, has a low coefficient of friction, resists softening at elevated temperatures, absorbs grit and abrasive particles, is not susceptible to corrosion, tolerates high intensities of radiation, and will not score or mar. In addition, Lubrite products are solid, permanent, completely self-lubricating, and require no maintenance, as documented in NUREG-1759, "Safety Evaluation Report Related to the License Renewal of Turkey Point Nuclear Plant, Units 3 and 4." A search of industry operating experience found no reported instances of Lubrite plate degradation or failure to perform its intended function, and, after more than 20 years of service, there has been no adverse experience data recorded for Brunswick Lubrite plates. Therefore, it is concluded that Brunswick Lubrite plates will not require aging management to perform their intended functions for the period of extended operation.

The applicant further stated that there is no inspection criteria specific to Lubrite in either the IWF or Maintenance Rule inspection programs. The IWF and Maintenance Rule programs monitor components within their scope for corrosion, deformation, cracks, and damage, etc.; as such, any visual degradation of the component associated with Lubrite would be identified and evaluated. The IWF program is credited for license renewal and will be continued during the period of extended operation. Maintenance Rule inspections will be continued during the period of extended operation. The Structures Monitoring Program, which utilizes the same inspection procedure credited by Maintenance Rule, is credited for license renewal aging management during the period of extended operation for non-IWF supports.

The staff determined the applicant's further evaluation for Lubrite plates to be acceptable, on the basis that there is no industry or plant-specific history of degradation, and on the basis that the AMPs credited by BSEP for inspection of component supports would identify and evaluate any visual degradation of Lubrite, should it occur.

The staff found that, based on the programs identified above, the applicant has met the criteria of SRP-LR Section 3.5.2.2.2.1 for further evaluation. The staff found that the applicant demonstrated that the effects of aging will be adequately managed so that the intended functions will be maintained during the period of extended operation, as required by 10 CFR 54.21(a)(3).

Aging Management of Inaccessible Areas. The staff reviewed LRA Section 3.5.2.2.2.2 against the criteria in SRP-LR Section 3.5.2.2.2.2. LRA Section 3.5.2.2.2.2 states:

> Cracking, spalling, and increases in porosity and permeability due to aggressive chemical attack, and cracking, spalling, loss of bond, and loss of material due to corrosion of embedded steel could occur in below-grade inaccessible concrete areas. The GALL Report recommends further evaluation to manage these aging effects in inaccessible areas of Groups 1-3, 5, 7-9 structures, if specific criteria defined in the GALL Report cannot be satisfied.

In LRA Section 3.5.2.2.2.2, the applicant stated that the service water intake structure is the only structure with concrete elements subject to aggressive ground water. The structure is located adjacent to the intake canal; therefore, the environmental parameters of the intake water have been applied to the below-grade portions of the concrete. Groundwater monitoring is performed periodically to validate that the below-grade environment is not aggressive for in-scope structures other than the service water intake structure. Examination of representative samples of below-grade concrete, when excavated for any reason, will be included as part of the Structures Monitoring Program, which will be used to manage aging due to aggressive chemical attack and corrosion of embedded steel.

In its review of the applicant's Structures Monitoring Program, as documented in SER Section 3.0.3.2.17, the staff confirmed that the Structures Monitoring Program includes periodic inspection of the submerged portions of the service water intake structure; periodic groundwater monitoring to validate that the below-grade environment is not aggressive; and examination of representative samples of below-grade concrete when excavated for any reason. For below-grade, inaccessible concrete areas, the applicant meets the specific criteria recommended in the GALL Report. For the service water intake structure, the applicant has defined an aging management program that is consistent with the recommendations of GALL AMP XI.S7, "Inspection of Water Control Structures," and included it as part of the Structures Monitoring Program.

The staff found that, based on the programs identified above, the applicant has met the criteria of SRP-LR Section 3.5.2.2.2.2 for further evaluation. The staff found that the applicant has demonstrated that the effects of aging will be adequately managed so that the intended functions will be maintained during the period of extended operation, as required by 10 CFR 54.21(a)(3).

3.5.2.2.3 Component Supports

Aging of Supports Not Covered by Structures Monitoring Program. The staff reviewed LRA Section 3.5.2.2.3.1 against the criteria in SRP-LR Section 3.5.2.2.3.1, which states:

> The GALL Report recommends further evaluation of certain component support/aging effect combinations if they are not covered by the structures monitoring program. This includes (1) reduction in concrete anchor capacity due to degradation of the surrounding concrete, for Groups B1-B5 supports; (2) loss of material due to environmental corrosion, for Groups B2-B5 supports; and (3) reduction/loss of isolation function due to degradation of vibration isolation elements, for Group B4 supports. Further evaluation is necessary only for structure/aging effect combinations not covered by the structures monitoring program.

In LRA Section 3.5.2.2.3.1, the applicant stated that the GALL Report recommends further evaluation of certain component support/aging effect combinations if they are not covered by the Structures Monitoring Program. Degradation of these components/commodities at BSEP is managed by the Structures Monitoring Program.

The staff found that, based on the programs identified above, the applicant has met the criteria of SRP-LR Section 3.5.2.2.3 for further evaluation. The staff found that the applicant has demonstrated that the effects of aging will be adequately managed so that the intended functions will be maintained during the period of extended operation, as required by 10 CFR 54.21(a)(3).

Cumulative Fatigue Damage Due to Cyclic Loading. There are no fatigue analyses applicable to component supports in the CLB; therefore cumulative fatigue damage of component supports is not a TLAA as defined in 10 CFR 54.3.

Conclusion. On the basis of its review, for component groups evaluated in the GALL Report for which the applicant has claimed consistency with the GALL Report, and for which the GALL Report recommends further evaluation, the staff determined that (1) those attributes or features for which the applicant claimed consistency with the GALL Report were indeed consistent, and (2) the applicant adequately addressed the issues that were further evaluated. The staff found that the applicant 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).

3.5.2.3 AMR Results That Are Not Consistent with or Not Addressed in the GALL Report

Summary of Technical Information in the Application. In LRA Tables 3.5.2-1 through 3.5.2-15, the staff reviewed additional details of the results of the AMRs for material, environment, aging effect requiring management, and AMP combinations that are not consistent with the GALL Report, or that are not addressed in the GALL Report.

In LRA Tables 3.5.2-1 through 3.5.2-15, the applicant indicated, via Notes F through J, that neither the identified component nor the material and environment combination is evaluated in the GALL Report, and it provided information concerning how the aging effect will be managed. Specifically, Note F indicated that the material for the AMR line-item component is not evaluated in the GALL Report. Note G indicated that the environment for the AMR line-item component and material is not evaluated in the GALL Report. Note H indicated that the aging effect for the AMR line-item component, material, and environment combination is not evaluated in the GALL Report. Note I indicated that the aging effect identified in the GALL Report for the line-item component, material, and environment combination is not applicable. Note J indicated that neither the component nor the material and environment combination for the line item is evaluated in the GALL Report.

Staff Evaluation. For component type, material, and environment combinations that are not evaluated in the GALL Report, the staff reviewed the applicant's evaluation to determine whether the applicant had demonstrated that the effects of aging will be adequately managed so that the intended function(s) will be maintained consistent with the CLB during the period of extended operation. The staff's evaluation is discussed in the following sections.

3.5.2.3.1 Containments, Structures, and Component Support – Summary of Aging Management Evaluation – Primary Containment – Table 3.5.2-1

The staff reviewed LRA Table 3.5.2-1, which summarizes the results of AMR evaluations for the primary containment component groups.

Summary of Technical Information in the Application. In LRA Section 3.5.2.1.1, the applicant identified materials, environment, and AERMs. The applicant identified the following programs that manage the AERMs for the primary containment structures components:

- Structures Monitoring Program
- ASME Section XI Subsection IWE Program
- ASME Section XI Subsection IWL Program
- ASME Section XI Subsection IWF Program
- 10 CFR 50 Appendix J Program

In LRA Table 3.5.2-1, the applicant provided a summary of AMRs for the Primary Containment Structures components and identified which AMRs it considered to be consistent with the GALL Report. In LRA Table 3.5.2.-1, the applicant provided a summary of AMR results for primary containments.

Staff Evaluation. The staff's review of LRA Section 3.5 identified areas in which additional information was necessary to complete the review of the applicant's results. The applicant responded to the staff's RAIs as discussed below.

In RAI 3.5-1, dated April 8, 2005, the staff stated that the refueling bellows are manufactured from stainless steel, and they are protected from weather. The components protected from weather are not necessarily immune to loss of material. As the bellows are located between the refueling cavity and the drywell, they come in direct contact with water, and subjected to sustained moist condition. In similar situations, the stainless steel bellows of some ice-condenser and Mark 1 containments (see IN 92-20) have experienced degradation and cracking. Therefore, the staff requested that the applicant provide justification for not managing the aging of the bellows during the period of extended operation.

In its response, by letter dated May 4, 2005, the applicant stated that the refueling bellows are not containment pressure boundary components and are not subject to the frequency and severity of loading as would be experienced by containment pressure boundary penetration bellows described in IN 92-20, "Inadequate Local Leak Rate Testing." The refueling bellows provide an expansion boundary between the exterior drywell wall and the reactor building, inside the refueling cavity. The primary environment seen by the refueling bellows is warm, dry air, with short periods of immersion in demineralized water when the reactor refueling cavity is flooded. Following refueling, any residual demineralized water would evaporate quickly. The long-term environment, for material aging purposes, is protected from weather, with reactor building air on both sides of the bellows. Based on the subject environment and consistent with industry guidance, the stainless steel is not subject to degradation.

The staff concern related to the leakage of refueling bellows in BWR Mark 1 containments is related to corrosion of steel drywell from the inaccessible area of the shell. A review of the detail of the drywell bellows indicates that, because the Brunswick drywell is of reinforced concrete construction, any leakage from bellows will not affect the drywell liner plate. Therefore, based on the applicant's response, the staff's concern described in RAI 3.5-1 is resolved.

In RAI 3.5-2, dated April 8, 2005, the staff stated that the cable trays and conduits are either made of galvanized carbon steel, or stainless steel. The staff further noted that the potential for corrosion of stainless steel cable trays/conduits is remote, unless they are subjected to sustained high temperatures (> 140 °F) and the material yield strength is high (> 140 ksi). Loss of material due to galvanic corrosion is more likely for the cable trays/conduits if they are subjected to a humid environment and welded to non-galvanized carbon steel supports. Therefore, the staff requested that the applicant discuss why the BSEP cable trays and conduits and all components/commodities with Notes 521 and 529 from LRA Tables 3.5.2-1 through 3.5.2-15 need no aging management. As part of the justification, the applicant was requested to provide operating experience related to these components/commodities.

In its response, dated May 4, 2005, the applicant explained that only the upper elevations of the drywell are subject to temperatures between 140 °F and 200 °F, and no degradation of galvanized or stainless steel components have been identified within plant operating experience in this area. Based on industry guidance, loss of material by general corrosion is not an applicable aging effect for galvanized steel exposed to, or protected, from weather; unless the pH of precipitation is outside the range of 6 to 12, or temperatures are between 140 °F and 200 °F. Also, based on industry guidance, galvanized steel is not subject to galvanic corrosion because the zinc coating provides galvanic protection of the carbon steel base metal even under degraded conditions. Therefore, loss of material by galvanic corrosion is not an applicable aging effect for galvanized steel protected from or exposed to weather. Precipitation is not monitored at BSEP; however, groundwater is monitored for pH and the results show the pH is not outside the range of 6 to 12. Plant operating experience has not identified degradation of galvanized or stainless steel components where the ambient environment is not aggressive, which is consistent with the industry guidance discussed above. Based on review of typical cable tray and conduit support details and discussions with system and welding engineers, BSEP does not weld cable trays or conduits to non-galvanized carbon steel supports. Cable tray and conduit supports are typically fabricated from galvanized unistrut members and fittings. Furthermore, the applicant stated that

BSEP has identified loss of material as an applicable aging effect for cable trays and conduits and all galvanized and stainless in-scope civil components in the service water intake structure, based on the aggressive environment in that location and plant operating experience. See LRA plant-specific Note 544 for further information.

The applicant performed an AMR based on plant-specific and industry experience related to the cable trays and conduits made of galvanized carbon steel and stainless steel. The staff review of Note 544 indicated that the applicant appropriately designated aging management of cable trays and conduits made of galvanized carbon steel and stainless steel in the service water intake structure, where the environment has been found to degrade these components. Therefore, the staff found the applicant's approach in performing the AMR of these components adequate and acceptable. Therefore, the staff's concern described in RAI 3.5-2 is resolved.

In RAI 3.5-3, dated April 8, 2005, the staff stated that in context with GALL Report item II.B2.2.21-g, related to the concrete components subjected to elevated temperatures, the applicant provided an evaluation in Note 536 and in LRA Section 3.5.2.2.1.3. The staff did not agree with the applicant's interpretation that the upper portion of the drywell subjected to sustained temperatures of approximately 170 °F can be considered as "local area." However, the staff indicated that on a case-by-case basis, the staff has approved such temperatures without complex analysis, provided the concrete components and the load-bearing items attached to such concrete components are periodically monitored. In light of the above discussion. Therefore, the staff requested that the applicant justify why the items in LRA Table 3.5.2-1 with Notes 536 and 513 should not be subjected to aging management during the period of extended operation.

In its response dated May 4, 2005, the applicant explained that Note 536 is applicable to the containment pressure boundary concrete, and Note 513 is applicable to containment internal concrete and concrete outside the containment. The only BSEP concrete above the 150 °F temperature level is associated with the upper elevations of the containment pressure boundary concrete, as stated in Note 536. The containment pressure boundary concrete is subjected to aging management by both the ASME Section XI, Subsection IWL Program and the Structures Monitoring Program; as such, the concrete components are periodically monitored.

The staff found the applicant's response acceptable, as the applicant will manage the aging of concrete components inside the containment by its Structures Monitoring Program, and the primary containment reinforced concrete outside areas by ASME Code Section XI, Subsection IWL during the period of extended operation.

In RAI 3.5-4, dated April 8, 2005, the staff noted that based on the evaluation provided in LRA Section 3.5.2.2.1.3, a number of load resisting reinforced concrete structures within the drywell shell would likely be subjected to temperatures higher than the established threshold of 150 °F. The staff requested the applicant to provide a summary of the operating experience related to the reliability of the cooling ventilation system, if these structures were kept within the threshold temperature of 150 °F by a cooling system. Therefore, the staff requested that the applicant provide a summary of the results of the last inspections performed on (1) RPV pedestal supports, (2) the foundation and floor slabs, and (3) the sacrificial shield wall under the existing Structures Monitoring Program.

In its response, by letter dated May 4, 2005, the applicant stated that the containment bulk average temperature is managed under TS 3.6.1.4, which requires the plant enter LCO actions if the drywell temperature exceeds 150 °F. In response to the subsequent request, the applicant stated that the last two inspections performed under the existing Structures Monitoring Program, dated March 15, 2004, for Unit 1 and February 25, 2001, for Unit 2, identified no degradation associated with the RPV pedestal supports, the floor slabs, or the sacrificial shield wall. The only issues identified were coating deficiencies, which were referred to the Coating Inspection Program, and an improperly supported grating.

The staff believes that maintaining the bulk temperature in the containment, as required by TS 3.6.1.4, will ensure that the concrete material properties; that is, compressive strength and modulus of elasticity, will not be significantly affected. Even within the TS-established bulk temperature, cracking and spalling of concrete cannot be ruled out. The applicant will be inspecting these areas under its Structures Monitoring Program. Therefore, the staff's concern described in RAI 3.5-4 is resolved.

In RAI 3.5-5, dated April 8, 2005, the staff stated that item hot penetration insulation, in Table 3.5.2-1, has been screened out as having no aging effects, and did not require aging management (Note 540). As the inside sustained temperature of the containment is high (>140 °F), and the outside is subjected to the reactor building temperature, the concrete temperatures around these penetration is likely to be high. Therefore, the staff requested that the applicant discuss the plant-specific operating experience related to the effectiveness of the insulation in keeping the temperatures around these penetrations (in the containment concrete) below 200 °F.

In its response, by letter dated May 4, 2005, the applicant stated that hot penetration temperatures, recorded on chart paper, were reviewed back to 1997. No penetration temperatures exceeded 200 °F, with the highest recorded temperature of 185 °F occurring between June 2003, and August 2003, on one of the main steam lines. From these observations, the applicant infers that the insulation has proven effective in maintaining hot penetration temperatures below 200 °F.

In follow-up to RAI 3.5-5, the staff reiterated the following concern: As the insulation around hot penetrations could be affected by time-dependant aging, and the applicant does not plan to monitor its effectiveness, the applicant was requested to provide a schedule for monitoring the penetration or concrete temperature during the period of extended operation, as was done prior to submitting the LRA. In its supplemental response, by dated August 11, 2005, the applicant noted that the penetration insulation material is fabricated from hydrous calcium silicate, and added that, although not a requirement of the Structures Monitoring Program, hot penetration temperatures are periodically monitored by the primary containment system engineer and trended in the system notebook. The staff found the applicant's method of monitoring hot penetration temperatures adequate and acceptable, as it will signal significant departures from the threshold temperature, and prompt the applicant to take necessary actions. Therefore, the staff's concern described in the supplemental response to RAI 3.5-5 is resolved.

In RAI 3.5-6, dated April 8, 2005, the staff agreed with the applicant that in general, the sump stainless steel liner is not subject to aging management, so far as it meets the threshold criteria for stainless steel discussed in RAI 3.5-2. However, the staff observed that the thin sump liner needs to have some type of periodic inspection to assure that it has not bulged excessively between the anchors, and was not affected by the dissimilar weld details at penetrations and at the junctions of carbon steel components. Therefore, the staff requested that the applicant discuss the plant-specific as well as the industry experience related to the condition of the stainless steel sump liners, and to justify the AMR conclusion that no aging management is needed for stainless steel sump liners.

In its response, by letter dated May 4, 2005, the applicant emphasized that the subject sump is fabricated entirely of stainless steel; all attached piping is fabricated from stainless steel; and it does not contain any dissimilar welds. The sump is a very high radiation environment; as such, it is treated as an inaccessible area. The sump pump was modified in 2000 by replacing the submersible pump with a top-mount motor and cantilevered pump. No degradation was recorded during installation; however, the water level within the sump was maintained as high as possible for shielding purposes. Any observable degradation identified during periodic maintenance of the pumps, performed every refueling outage, will be evaluated through the normal work process. Furthermore, the applicant explained that the liner is considered inaccessible, and any degradation identified for similar stainless steel liners would be considered applicable to the sump liner and an evaluation performed in accordance with the BSEP corrective action process.

The staff considered the approach taken by the applicant in assessing the condition of the sump liner in this high-radiation area acceptable, as the industry-wide experience, in general, indicates that the stainless steel sump liner is not subjected to systematic degradation.

In RAI 3.5-7, dated April 8, 2005, the staff stated its concern regarding the different write-ups in LRA Table 3.5.2-1, item 3.5.1-02, and in component "penetrations" related to aging management of penetrations (including sleeves and bellows). In item 3.5.1-02, the applicant has credited the ASME XI, IWE, and 10 CFR 50, Appendix J Programs for aging management, and provided acceptable further evaluation in LRA Section 3.5.2.2.1.7. However, in LRA Table 3.5.2-1, the applicant asserted "no aging effects," and "no AMP." Note 542 reiterates the AMPs stated in item 3.5.1-02. Therefore, the staff requested that the applicant clarify this contradictory LRA requirements.

In its response, by letter dated May 4, 2005, the applicant indicated that the further evaluation information in LRA Section 3.5.2.2.1.7 addressed cracking in both items 3.5.1-02 and 3.5.1-17 components. Item 3.5.1-02 covers penetration sleeves, bellows, and dissimilar metal welds. Item 3.5.1-17 addresses steel elements; vent line bellows, vent headers, and downcomers. Therefore, LRA Section 3.5.2.2.1.7 is written to address all of the above components. With respect to the penetration components (i.e., 3.5.1-02), the aging management review determined that they had no aging effects involving cracking. For those line items on Table 3.5.2-1, generic Note I was used, and GALL Report, Volume 2 was referenced to indicate what specific aging effect was not applicable. The ASME Section XI, Subsection IWE and 10 CFR 50 Appendix J Programs are credited for steel components that form the pressure boundary of primary containment. Therefore, plant-specific Note 541 was used.

The staff found the applicant's clarification acceptable, as it succinctly separated the items such as penetration sleeves, bellows, and dissimilar metal welds, and vent line bellows, vent headers and downcomers. Therefore, the staff's concern described in RAI 3.5-8 is resolved.

In RAI 3.5-8, dated April 8, 2005, the staff stated its concern and skepticism regarding the industry position that, without providing acceptable technical justification, no aging management of Lubrite bearings is needed. Some of the aging effects/mechanism could be loss of mechanical function because of distortion, dirt accumulation, fatigue due to vibratory and cyclic thermal loads, and gradual degradation of the lubricant used, particularly, when subjected to sustained elevated temperatures and radiation (inside containment). The staff further noted that without systematic investigation of these factors, it would be difficult to accept a position that "no aging management of Lubrite bearings is needed (Note 524). Therefore, in the context of the above discussion, the staff requested that the applicant provide information that would justify that none of the conditions cited in the aging effects/mechanism above is possible where the Lubrite plates are used in BSEP.

In its response, by letter dated May 4, 2005, the applicant stated that as addressed by previous applicants, Lubrite resists deformation, has a low coefficient of friction, resists softening at elevated temperatures, absorbs grit and abrasive particles, is not susceptible to corrosion, tolerates high intensities of radiation, and will not score or mar. In addition, Lubrite products are solid, permanent, completely self-lubricating, and require no maintenance. As documented in NUREG-1759, "Safety Evaluation Report Related to the License Renewal of Turkey Point Nuclear Plant, Units 3 and 4," NRC staff has agreed that there are no known aging effects for Lubrite. A search of industry operating experience found no reported instances of Lubrite plates degrading or failing to perform their intended function; and, after more than 20 years of service, there has been no adverse experience data recorded for BSEP Lubrite plates. Lubrite plates at BSEP are typically located in a closed, clean environment, such as the drywell or reactor building, and are not subject to accumulation of dirt or debris. It is therefore concluded that the Lubrite plates will not require aging management to perform their intended functions for the period of extended operation.

In its supplemental response to RAI 3.5-8, by letter dated June 14, 2005, the applicant stated that the ASME Section XI, Subsection IWF and Structures Monitoring Program did not specifically address Lubrite; however, the inspection criteria for supports within the programs effectively enveloped misalignment and accumulation of debris.

The staff found that the applicant's position, that aging management of Lubrite supports are included as part of the examinations of ASME supports under its IWF program, and non-ASME supports are under its Structures Monitoring Program, is acceptable. Therefore, the staff's concern described in RAI 3.5-8 is resolved.

In RAI 3.5-9, dated April 8, 2005, the staff stated that in the LRA, the applicant did not specify the AERM or AMP for the embedded/encased carbon steel (LRA Tables 3.5.2-1, 3.5.2-4, and 3.5.2-7 through 3.5.2-15) and galvanized carbon steel (LRA Table 3.5.2-4) anchorages/embedments. In plant-specific Notes 518 and 519 for Tables 3.5.2-1 through 3,5,2-15, the applicant stated that the BSEP AMR methodology concluded that carbon/low-alloy steel and galvanized carbon/low-alloy steel, completely encased in concrete, are not subject to aging effects. The staff's concern is that the carbon/low-alloy steel and galvanized carbon/low-alloy steel are likely subject to corrosion and loss of material for conditions involving cracked concrete. Therefore, the staff requested that the applicant provide its justification for not considering aging effects for these structural elements.

In its response, by letter dated May 4, 2005, the applicant stated that the AMR results documented in the LRA (reflected in plant-specific Notes 518 and 519) involve steel components that are completely encased in concrete so that the protection from corrosion afforded by the highly alkaline environment is present. Therefore, no aging management is needed. For the case of cracked concrete, the applicant agreed with the staff that plant-specific Notes 518 and 519 are not applicable. The applicant further stated, in its response, that the condition of concrete in BSEP structures within the scope of license renewal will be monitored by the ASME Section XI, IWL and Structures Monitoring Programs that would detect the presence of cracking in the vicinity of embedded steel components. On the basis of the above discussion, the staff considered the applicant's response acceptable; therefore, RAI 3.5-9 is resolved.

In RAI 3.5-11, dated April 8, 2005, the staff stated that LRA Section 3.5.2.2.2.1, "Aging of Structures Not Covered by Structures Monitoring Program," states that aging effects associated with aggressive chemical attack on concrete, etc. are not applicable as discussed in the plant-specific notes associated with LRA Tables 3.5.2-1 through 3.5.2.15. In LRA Tables 3.5.2.2 through 3.5.2-15, the applicant, based on the plant-specific Notes 501 and 517, did not specify the AERM for Class I below-grade concrete structures (reactor building, augmented off-gas building, diesel generator building, control building, turbine building, radwaste building, and miscellaneous structures and out buildings). Note 501 states that although no aging effects have been identified, the specified GALL Report program will be assigned for management of this commodity, in accordance with the NRC's current position (ISG-03); and Note 517 states that groundwater monitoring is performed periodically to validate the assumption that the groundwater below-grade environment is not aggressive. In LRA Section 3.5.2.2.2.2, "Aging Management of Inaccessible Areas," the applicant stated that the service water intake structure is the only structure with concrete elements subject to aggressive groundwater. The structure is located adjacent to the intake canal; therefore, the environmental parameters of intake water have been applied to the below-grade portions of the concrete. Therefore, the staff requested that the applicant provide additional information to explain how the water chemistry is monitored, including past and current groundwater qualities (pH values and content of chlorides and sulfates), frequency of monitoring, specific monitoring program used, and future plan for groundwater monitoring.

In its response, by letter dated May 4, 2005, the applicant stated that the groundwater is currently being monitored by the implementing procedure 0E&RC-3250, Groundwater Monitoring Program, and the monitoring will be continued during the period of extended operation. The results of groundwater monitoring in the years of 2002 and 2004, as shown in the table below, indicate that pH values and content of chlorides and sulfates are below the GALL Report limits for aggressive groundwater (pH< 5.5, chloride > 500 ppm and sulfate >1500 ppm).

Parameter	GALL Criteria for Aggressive Environment	Well# ESS-1B		Well# ESS-2B		Well# ESS-3B		Well# ESS-13C		Manhole 2-MH-CB7	
		Date		Date		Date		Date		Date	
Year		02	04	02	04	02	04	02	04	02	04
pH	< 5.5	7.5	7.0	6.6	6.9	7.0	7.2	6.6	6.7	N/A	6.4
Chlorides	> 500 ppm	36	26	49	31	27	12	34	21	N/A	11
Sulfate	>1500 ppm	2	<5	66	48	50	10	18	<5	N/A	45

The applicant also stated that a one-time inspection was performed on Well No. ESS-3B for phosphate, and the result indicates that the groundwater phosphate level is at 0.12 ppm. In addition, the applicant stated that an enhancement to the Structures Monitoring Program implementing procedure EAR-NGGC-0351, "Condition Monitoring of Structures," will be performed prior to the period of extended operation that requires the structures system engineer to review the groundwater monitoring results against the applicable parameters for an aggressive below-grade environment. On the basis of the above discussion, the staff considers the applicant's response acceptable, except that the applicant did not specify the frequency of the future groundwater monitoring as requested in the RAI.

A review of the applicant's response to audit item AQ B.2.23-2, attached to its letter (BSEP-05-0041) dated March 14. 2005, indicates that the applicant plans to enhance its Structures Monitoring Program to specify an annual groundwater monitoring frequency for concrete structures. The staff found the frequency of ground water monitoring adequate and acceptable; therefore, RAI 3.5-11 is resolved.

3.5.2.3.2 Containments, Structures, and Component Support – Summary of Aging Management Evaluation – Intake and Discharge Canals – Table 3.5.2-2.

As described in SER Section 3.5.2.1, the staff reviewed LRA Table 3.5.2-2, which summarizes the results of AMR evaluations for the intake and discharge canals and no RAI was identified.

3.5.2.3.3 Containments, Structures, and Component Support – Summary of Aging Management Evaluation – Refueling System – Table 3.5.2-3

The staff reviewed LRA Table 3.5.2-3, which summarizes the results of AMR evaluations for the refueling system component groups.

The applicant plans to manage the aging of the line items fuel prep machines and auxiliary work platforms under its Structures Monitoring Program, and the staff found the applicant's aging management review of these items acceptable.

3.5.2.3.4 Containments, Structures, and Component Support – Summary of Aging Management Evaluation – Switchyard and Transformer Yard Structures – Table 3.5.2-4

The staff reviewed LRA Table 3.5.2-4, which summarizes the results of AMR evaluations for the switchyard and transformer yard structures component groups.

In RAI 3.5-10, dated April 8, 2005, the staff stated that in LRA Table 3.5.2-4, the applicant did not specify the AERM or AMP for the carbon steel piles that were driven in undisturbed soil. In Note 522 of LRA Table 3.5.2-4, the applicant stated that, based on NUREG-1557, steel piles driven in undisturbed soils have been unaffected by corrosion; and those driven in disturbed soil experience minor to moderate corrosion to a small area of metal. Therefore, no aging effects have been concluded for steel piles. However, it is the staff's understanding that the conclusion of NUREG-1557 (References 16 and 17 of the LRA) is based on less than 40-year data. There are other industry documents and design manuals which indicate that significant corrosion of steel piles has been identified, even when piles were driven in undisturbed soil. Therefore, the staff requested that the applicant provide additional information to justify the validity of its conclusion.

In its response, by letter dated May 4, 2005, the applicant stated, by referencing EPRI TR-103842, "Class I Structures License Renewal Industry Report," that in addition to the conclusion drawn in NUREG-1557, a study by Romanoff involved 43 steel piles driven to depths up to 136 feet into a wide variety of soil conditions. The time of exposure of this study varies from 7 to 50 years. The data indicate that the type and amount of corrosion observed on steel pilings driven into undisturbed natural soil, regardless of the soil characteristics and properties, is not sufficient to significantly affect the strength of pilings as load bearing structures. The data also indicate that undisturbed soils are so deficient in oxygen at levels a few feet below the ground surface or below the water table, that steel piles are not appreciably affected by corrosion, regardless of the soil type or the soil properties. Also, in its response to RAI 3.5-11 (discussed above) the applicant demonstrated that the water chemistry at the Brunswick site is not aggressive (pH, chlorides, and sulfates are within the limits of the GALL). On the basis of the above discussion, RAI 3.5-10 is resolved.

In addition to the line items anchorage/embedment, concrete below grade (which are discussed in SER Section 3.5.2.3.1), and carbon steel piping, the staff reviewed five line items (cable tray/conduit, electrical support, equipment support, siding, and structural steel) listed in this table, and found the applicant's AMR of these items acceptable.

3.5.2.3.7 Containments, Structures, and Component Support – Summary of Aging Management Evaluation – Service Water Intake Structure – Table 3.5.2-7

The staff reviewed LRA Table 3.5.2-7, which summarizes the results of AMR evaluations for the service water intake structure component groups.

Because of the harsh environment in the intake structure, except for the anchorage/embedments, the applicant plans to monitor the aging of concrete below grade, and another 14 line items (cable tray/conduit, concrete below grade, electrical enclosure, electrical support, equipment support, fire hose station, floor drains, instrument racks, instrument support, pipe support, roof-membrane/built-up, seals and gaskets, spray shield, and spray on coatings) under its Structures Monitoring Program. Therefore, the staff found the applicant's AMR acceptable.

3.5.2.3.8 Containments, Structures, and Component Support – Summary of Aging Management Evaluation – Reactor Building – Table 3.5.2-8

The staff reviewed LRA Table 3.5.2-8, which summarizes the results of AMR evaluations for the reactor building component groups.

In addition to the line items anchorage/embedment and concrete below grade (which are discussed in SER Section 3.5.2.3.11), the staff reviewed 21 line items such as, concrete curbs, damper mounting, electrical enclosure, electrical support, equipment support, fire barrier assembly, fire hose station, floor drains, HVAC support, instrument racks, instrument support, liner, pipe support, roof-membrane/built-up, seals and gaskets, siding, siding bearing plate, spent fuel storage rack, spray shield, spray on coatings, and tendons listed in the table, and found the applicant's aging management review of these items acceptable. The aging management of fuel pool girder tendons and the relevant TLAA for monitoring of prestressing force in the tendons are reviewed in SER Sections 3.0.3.3.5, and 4.7.2.

3.5.2.3.9 Containments, Structures, and Component Support – Summary of Aging Management Evaluation – Augmented Off-Gas Building – Table 3.5.2-9

The staff reviewed LRA Table 3.5.2-9, which summarizes the results of AMR evaluations for the augmented off-gas building component groups.

In addition to the line items anchorage/embedment and concrete below grade (which are discussed in SER Section 3.5.2.3.1), the staff reviewed eight line items (cable tray/conduit, doors, electrical enclosure, electrical support, equipment support, fire hose station, penetrations, and siding bearing plate) listed in the table, and found the applicant's aging management review of these items acceptable.

3.5.2.3.10 Containments, Structures, and Component Support – Summary of Aging Management Evaluation – Diesel Generator Building – Table 3.5.2-10

The staff reviewed LRA Table 3.5.2-10, which summarizes the results of AMR evaluations for the diesel generator building component groups.

In addition to the line items anchorage/embedment and concrete below grade (which are discussed in SER Section 3.5.2.3.1), the staff reviewed 14 line items (blow-out panel, cable tray/conduit, concrete curbs, damper mounting, electrical enclosure, electrical support, fire barrier assembly, fire hose station, floor drains, pipe support, roof-built-up, siding, spray shield, and spray on coatings) listed in the table, and found the applicant's AMR of these items acceptable.

3.5.2.3.11 Containments, Structures, and Component Support – Summary of Aging Management Evaluation – Control Building – Table 3.5.2-11

The staff reviewed LRA Table 3.5.2-11, which summarizes the results of AMR evaluations for the control building component groups.

In addition to the line items anchorage/embedment and concrete below grade, (which are discussed in SER Section 3.5.2.3.1), the staff reviewed 12 line items (cable tray/conduit, concrete above grade, control room ceiling, damper mounting, electrical enclosure, electrical support, fire barrier assembly, fire hose station, raised floor, seals and gaskets, roof-membrane/built-up, and spray on coatings) listed in the table, and found the applicant's AMR of these items acceptable.

3.5.2.3.12 Containments, Structures, and Component Support – Summary of Aging Management Evaluation – Turbine Building – Table 3.5.2-12

The staff reviewed LRA Table 3.5.2-12, which summarizes the results of AMR evaluations for the turbine building component groups.

In addition to the line items anchorage/embedment and concrete below grade (which are discussed in SER Section 3.5.2.3.1), the staff reviewed nine line items (cable tray/conduit, concrete above grade, concrete curbs, electrical enclosure, electrical support, fire barrier assembly, fire hose station, roof-membrane/built-up, and siding) listed in the table, and found the applicant's AMR of these items acceptable.

3.5.2.3.13 Containments, Structures, and Component Support – Summary of Aging Management Evaluation – Radwaste Building – Table 3.5.2-13

The staff reviewed LRA Table 3.5.2-13, which summarizes the results of AMR evaluations for the radwaste building component groups.

In addition to the line items anchorage/embedment and concrete below grade (which are discussed in SER Section 3.5.2.3.1), the staff reviewed six line items (cable tray/conduit, concrete above grade, doors, electrical enclosure, fire hose station, and roof-membrane/built-up) listed in the table, and found the applicant's AMR of these items acceptable.

3.5.2.3.14 Containments, Structures, and Component Support – Summary of Aging Management Evaluation – Water Treatment Building – Table 3.5.2-14

The staff reviewed LRA Table 3.5.2-14, which summarizes the results of AMR evaluations for the water treatment building component groups.

In addition to the line items anchorage/embedment and concrete below grade (which are discussed in SER Section 3.5.2.3.1), the staff reviewed eight line items (cable tray/conduit, concrete above grade, electrical enclosure, battery rack, electrical support, fire barrier assembly, siding, and structural steel) listed in the table, and found the applicant's AMR of these items acceptable.

3.5.2.3.15 Containments, Structures, and Component Support – Summary of Aging Management Evaluation – Miscellaneous Structures and Out-Buildings – Table 3.5.2-15

The staff reviewed LRA Table 3.5.2-15, which summarizes the results of AMR evaluations for the miscellaneous structures and out-buildings component groups.

In addition to the line items anchorage/embedment, concrete below grade, and piles (which are discussed in SER Section 3.5.2.3.1), the staff reviewed eight line items (cable tray/conduit, concrete BWR vent stack, concrete above grade, tank foundation, electrical support, instrument support, siding, and structural steel) listed in the table, and found the applicant's AMR of these items acceptable.

3.5.2.3.16 Conclusion on Subsections 3.5.2.3.2 to 3.5.2.3.15

On the basis of its review, the staff found that the applicant appropriately evaluated AMR results involving material, environment, AERMS, and AMP combinations that are not evaluated in the GALL Report. The staff found that the applicant 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).

3.5.3 Conclusion

The staff concluded that the applicant provided sufficient information to demonstrate that the effects of aging of the containments, structures, and component supports components, that are within the scope of license renewal and subject to an AMR, 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 applicable UFSAR supplement program summaries and concluded that they adequately describe the AMPs credited for managing aging of the containments, structures, and component supports, as required by 10 CFR 54.21(d).

3.6 Aging Management of Electrical and Instrumentation and Controls

This section of the SER documents the staff's review of the applicant's AMR results for the electrical and instrumentation and control (I&C) components and component groups associated with the following systems:

- non-EQ insulated cables and connections
- phase bus
- non-EQ electrical/I&C penetration assemblies
- high voltage insulators
- switchyard bus
- transmission conductors

3.6.1 Summary of Technical Information in the Application

In LRA Section 3.6, the applicant provided AMR results for electrical and I&C components. In LRA Table 3.6.1, "Summary of Aging Management Evaluations in Chapter VI of NUREG-1801 for Electrical Components," the applicant provided a summary comparison of its AMRs with the AMRs evaluated in the GALL Report for the electrical and I&C components and component groups.

The applicant's AMRs incorporated applicable operating experience in the determination of AERMs. These reviews included evaluation of plant-specific and industry operating experience. The plant-specific evaluation included reviews of condition reports and discussions with appropriate site personnel to identify AERMs. The applicant's review of industry operating experience included a review of the GALL Report and operating experience issues identified since the issuance of the GALL Report.

3.6.2 Staff Evaluation

The staff reviewed LRA Section 3.6 to determine if the applicant provided sufficient information to demonstrate that the effects of aging for the electrical and I&C components that are within the scope of license renewal and subject to an AMR 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 performed an onsite audit of AMRs to confirm the applicant's claim that certain identified AMRs were consistent with the GALL Report. The staff did not repeat its review of the matters described in the GALL Report; however, the staff did verify that the material presented in the LRA was applicable and that the applicant had identified the appropriate GALL AMRs. The staff's evaluations of the AMPs are documented in SER Section 3.0.3. Details of the staff's audit evaluation are documented in the Audit and Review Report and are summarized in SER Section 3.6.2.1.

During the audit, the staff reviewed the AMRs that were consistent with the GALL Report and for which further evaluation is recommended. The staff confirmed that the applicant's further evaluations were consistent with the acceptance criteria in SRP-LR Section 3.6.2.2. The staff's audit evaluations are documented in the Audit and Review Report and are summarized in SER Section 3.6.2.2.

The staff performed a technical review of the remaining AMRs that were not consistent with, or not addressed in, the GALL Report. The technical review included evaluating (1) whether all plausible aging effects were identified, and (2) whether the aging effects listed were appropriate for the combination of materials and environments specified. The staff's evaluation of its technical review is documented in SER Section 3.6.2.3.

Finally, the staff reviewed the AMP summary descriptions in the UFSAR supplement to ensure that they provided an adequate description of the programs credited with managing or monitoring aging for the electrical and I&C components.

Table 3.6-1, below, provides a summary of the staff's evaluation of components, aging effects/mechanisms, and AMPs listed in LRA Section 3.6, that are addressed in the GALL Report.

Table 3.6-1 Staff Evaluation for Electrical and Instrumentation and Controls in the GALL Report

Component Group	Aging Effect/ Mechanism	AMP in GALL Report	AMP in LRA	Staff Evaluation
Electrical equipment subject to 10 CFR 50.49 environmental qualification (EQ) requirements (Item 3.6.1-01)	Degradation due to various aging mechanisms	Environmental qualification of electric components	TLAA	This TLAA is evaluated in Section 4.4, Environmental Qualification of Electrical Equipment
Electrical cables and connections not subject to 10 CFR 50.49 EQ requirements (Item 3.6.1-02)	Embrittlement, cracking, melting, discoloration, swelling, or loss of dielectric strength leading to reduced insulation resistance (IR); electrical failure caused by thermal/ thermoxidative degradation of organics; radiolysis and photolysis [ultraviolet (UV) sensitive materials only] of organics; radiation-induced oxidation; moisture intrusion	Aging management program for electrical cables and connections not subject to 10 CFR 50.49 EQ requirements	Electrical Cables and Connections Not Subject to 10 CFR 50.49 Environmental Qualification Requirements Program (B.2.25)	Consistent with GALL, which recommends no further evaluation (See Section 3.6.2.1)

Component Group	Aging Effect/ Mechanism	AMP in GALL Report	AMP in LRA	Staff Evaluation
Electrical cables used in instrumentation circuits not subject to 10 CFR 50.49 EQ requirements that are sensitive to reduction in conductor insulation resistance (IR) (Item 3.6.1-03)	Embrittlement, cracking, melting, discoloration, swelling, or loss of dielectric strength leading to reduced IR; electrical failure caused by thermal/ thermoxidative degradation of organics; radiation-induced oxidation; moisture intrusion	Aging management program for electrical cables used in instrumentation circuits not subject to 10 CFR 50.49 EQ requirements	Electrical Cables Not Subject to 10 CFR 50.49 Environmental Qualification Requirements Used in Instrumentation Circuits Program (B.2.26)	Consistent with GALL, which recommends no further evaluation (See Section 3.6.2.1)
Inaccessible medium-voltage (2 kV to 15 kV) cables (e.g., installed in conduit or direct buried) not subject to 10 CFR 50.49 EQ requirements (Item 3.6.1-04)	Formation of water trees; localized damage leading to electrical failure (breakdown of insulation); water tress caused by moisture intrusion	Aging management program for inaccessible medium-voltage cables not subject to 10 CFR 50.49 EQ requirements	Inaccessible Medium-Voltage Cables Not Subject to 10 CFR 50.49 Environmental Qualification Requirements Program (B.2.27)	Consistent with GALL, which recommends no further evaluation (See Section 3.6.2.1)
Electrical connectors not subject to 10 CFR 50.49 EQ requirements that are exposed to borated water leakage (Item 3.6.1-05)	Corrosion of connector contact surfaces caused by intrusion of borated water	Boric acid corrosion		Not applicable, PWR only

The staff's review of the BSEP component groups followed one of several approaches. One approach, documented in SER Section 3.6.2.1, discusses the staff's review of the AMR results for components in the electrical and I&C component groups that the applicant indicated are consistent with the GALL Report and do not require further evaluation. Another approach, documented in SER Section 3.6.2.2, discusses the staff's review of the AMR results for components in the electrical and I&C systems that the applicant indicated are consistent with the GALL Report and for which further evaluation is recommended. A third approach, documented in SER Section 3.6.2.3, discusses the staff's review of the AMR results for components in the electrical and I&C component groups that the applicant indicated are not consistent with, or not addressed in, the GALL Report. The staff's review of AMPs credited to manage or monitor aging effects of the electrical and I&C components is documented in SER Section 3.0.3.

3.6.2.1 AMR Results That Are Consistent with the GALL Report, for Which Further Evaluation is Not Recommended

Summary of Technical Information in the Application. In LRA Section 3.6.2.1, the applicant identified the materials, environments, and AERMs. The applicant identified the following programs that manage the aging effects related to the electrical and I&C components:

- Electrical Cables and Connections Not Subject to 10 CFR 50.49 Environmental Qualification Requirements Program
- Electrical Cables Not Subject to 10 CFR 50.49 Environmental Qualification Requirements Used in Instrumentation Circuits Program
- Inaccessible Medium-voltage Cables Not Subject to 10 CFR 50.49 Environmental Qualification Requirements Program

Staff Evaluation. In LRA Table 3.6.2-1, the applicant provided a summary of AMRs for the electrical and I&C components, and identified which AMRs it considered to be consistent with the GALL Report.

For component groups evaluated in the GALL Report for which the applicant has claimed consistency with the GALL Report, and for which the GALL Report does not recommend further evaluation, the staff performed an audit to determine whether the plant-specific components contained in these GALL Report component groups were bounded by the GALL Report evaluation.

The applicant provided a note for each AMR line item. The notes described how the information in the tables aligns with the information in the GALL Report. The staff audited those AMRs with Notes A through E, which indicate that the AMR is consistent with the GALL Report.

Note A indicates that the AMR line item is consistent with the GALL Report for component, material, environment, and aging effect. In addition, the AMP is consistent with the AMP identified in the GALL Report. The staff audited these line items to verify consistency with the GALL Report and the validity of the AMR for the site-specific conditions.

Note B indicates that the AMR line item is consistent with the GALL Report for component, material, environment, and aging effect. In addition, the AMP takes some exceptions to the AMP identified in the GALL Report. The staff audited these line items to verify consistency with the GALL Report. The staff verified that the identified exceptions to the GALL AMPs had been reviewed and accepted by the staff. The staff also determined whether the AMP identified by the applicant was consistent with the AMP identified in the GALL Report and whether the AMR was valid for the site-specific conditions.

Note C indicates that the component for the AMR line item is different from, but consistent with the GALL Report for material, environment, and aging effect. In addition, the AMP is consistent with the AMP identified by the GALL Report. This note indicates that the applicant was unable to find a listing of some system components in the GALL Report. However, the applicant identified a different component in the GALL Report that had the same material, environment, aging effect, and AMP as the component that was under review. The staff audited these line items to verify consistency with the GALL Report. The staff also determined whether the AMR line item of the different component was applicable to the component under review and whether the AMR was valid for the site-specific conditions.

Note D indicates that the component for the AMR line item is different from, but consistent with the GALL Report for material, environment, and aging effect. In addition, the AMP takes some exceptions to the AMP identified in the GALL Report. The staff audited these line items to verify consistency with the GALL Report. The staff verified whether the AMR line item of the different component was applicable to the component under review. The staff verified whether the identified exceptions to the GALL AMPs had been reviewed and accepted by the staff. The staff also determined whether the AMP identified by the applicant was consistent with the AMP identified in the GALL Report and whether the AMR was valid for the site-specific conditions.

Note E indicates that the AMR line item is consistent with the GALL Report for material, environment, and aging effect, but a different aging management program is credited. The staff audited these line items to verify consistency with the GALL Report. The staff also determined whether the identified AMP would manage the aging effect consistent with the AMP identified by the GALL Report and whether the AMR was valid for the site-specific conditions.

The staff conducted an audit of the information provided in the LRA, as documented in the Audit and Review Report. The staff did not repeat its review of the matters described in the GALL Report. However, the staff did verify that the material presented in the LRA was applicable and that the applicant had identified the appropriate GALL Report AMRs. The staff's evaluation has been discussed in the Audit and Review Report.

Conclusion. The staff evaluated the applicant's claim of consistency with the GALL Report. The staff also has reviewed information pertaining to the applicant's consideration of recent operating experience and proposals for managing associated aging effects. On the basis of its review, the staff concludes that the AMR results, which the applicant claimed to be consistent with the GALL Report, are consistent with the AMRs in the GALL Report. Therefore, the staff concludes that the applicant has demonstrated that the effects of aging for these components will be adequately managed so that their 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).

3.6.2.2 AMR Results That Are Consistent with the GALL Report, for Which Further Evaluation is Recommended

Summary of Technical Information in the Application. In LRA Section 3.6.2.2, the applicant provided further evaluation of aging management as recommended by the GALL Report for the electrical components. The applicant stated that environmental qualification (EQ) is a TLAA, as defined in 10 CFR 54.3. Aging evaluations for EQ components that specify a qualified life of 40 years are considered to be TLAAs for license renewal.

Staff Evaluation. For component groups evaluated in the GALL Report for which the applicant has claimed consistency with the GALL Report, and for which the GALL Report recommends further evaluation, the staff audited the applicant's evaluation to determine whether it adequately addressed the issues that were further evaluated. In addition, the staff reviewed the applicant's further evaluations against the criteria contained in Section 3.6.2.2 of the SRP-LR.

3.6.2.2.1 Electrical Equipment Subject to Environmental Qualification

Environmental qualification is a TLAA as defined in 10 CFR 54.3. TLAAs are required to be evaluated in accordance with 10 CFR 54.21(c))(1). The staff reviewed the evaluation of this TLAA separately in SER Section 4.4, following the guidance in SRP-LR Section 4.4.

3.6.2.3 AMR Results That Are Not Consistent with or Not Addressed in the GALL Report

In LRA Table 3.6.2-1, the staff reviewed additional details of the results of the AMRs for material, environment, aging effect requiring management, and AMP combinations that are not consistent with the GALL Report, or that are not addressed in the GALL Report.

In LRA Table 3.6.2-1, the applicant indicated, via Notes F through J, that neither the identified component nor the material and environment combination is evaluated in the GALL Report and provided information concerning how the aging effect will be managed. Specifically, Note F indicated that the material for the AMR line-item component is not evaluated in the GALL Report. Note G indicated that the environment for the AMR line-item component and material is not evaluated in the GALL Report. Note H indicated that the aging effect for the AMR line-item component, material, and environment combination is not evaluated in the GALL Report. Note I indicated that the aging effect identified in the GALL Report for the line-item component, material, and environment combination is not applicable. Note J indicated that neither the component nor the material and environment combination for the line item is evaluated in the GALL Report.

For component type, material, and environment combination that are not evaluated in the GALL Report, the staff reviewed the applicant's evaluation to determine whether the applicant had demonstrated that the effects of aging will be adequately managed so that the intended function(s) will be maintained consistent with the CLB during the period of extended operation. The staff's evaluation is discussed in the following sections.

3.6.2.3.1 Phase Bus

Phase bus is used to connect two or more elements (electrical equipment such as switchgear and transformers) of an electrical circuit. Isolated phase bus is an electrical bus in which each phase conductor is enclosed by an individual metal housing separated from adjacent conductor housing by an air space. Non-segregated phase bus is an electrical bus constructed with all phase conductors in a common enclosure without barriers (only air space) between the phases.
See SER Section 3.0.3.3.4 for staff evaluation for Phase Bus Aging Management Program (B.2.31).

On the basis of its review, the staff found that this is a non-GALL program and that this program provides adequate management of the aging effects of the bus ducts. The staff also reviewed the UFSAR supplement for this AMP and found that it provides an adequate summary description of the program as required by 10 CFR 54.21(d).

3.6.2.3.2 Non-EQ Electrical/I&C Penetration Assemblies

The applicant stated that many electrical/I&C assemblies are included in the EQ program and, therefore, do not meet the criteria of 10 CFR 54.21(a)(1) and are not subject to an AMR. A small number of non-EQ electrical/I&C penetration assemblies are subject to an AMR. The materials of construction for the non-EQ electrical/I&C penetration assemblies are:

- XLPE, cross-linked polyolefin (XLPO), and SR internal conductor/pigtail insulation
- Dow Corning 185 Encapsulant
- Ceramic

The non-EQ electrical/I&C penetration assemblies are exposed to heat, radiation, and oxygen.

Aging Effects. The applicant stated that the non-EQ electrical/I&C penetration assemblies subject to AMR are Westinghouse Class E or Class D2 assemblies. The penetration assembly primary insulation materials are XLPE, XLPO, and SR (insulation). The AMR of these materials identified no AERMs based on an analysis of 60-year service limiting environments for the penetration locations in the lower drywell. Also, an aging analysis of the direct current (DC) 185 encapsulant determined that the material is acceptable for BSEP during 60-year service life inside the lower drywell. Therefore, the non-EQ electrical/I&C penetration assemblies have no AERMs for the period of extended operation.

Aging Management Programs. The applicant determined that no aging management activities are required for the extended period of operation for the organic insulating and encapsulant materials within the penetration assemblies. Therefore, no AMPs are required for the non-EQ electrical/I&C penetration assemblies. However, as a conservative measure, potential aging effects of penetration pigtail wiring insulation will be addressed by the Electrical Cables and Connections Not Subject to 10 CFR 50.49 EQ Requirements Program.

In LRA Section 3.6.2.1.3, the applicant stated that the penetration assembly primary insulation materials are XLPE, XLPO, and SR. The AMR of these materials identified no AERMs based on an analysis of 60-year service limiting environments for the penetration locations in the lower drywell. Also, an aging analysis of the Dow Corning 185 encapsulant determined that the material is acceptable for BSEP during 60-year service life inside the lower drywell.

In RAI 3.6.2.3-2, dated May 18, 2005, the staff requested that the applicant address why the metals and inorganic materials (such as cable fillers, epoxies, potting compounds, connector pins, plugs, and facial grommets) associated with non-EQ electrical/I&C penetration assemblies do not require an AMR.

In its response, by letter dated June 14, 2005, the applicant stated:

> Electrical penetration assemblies are used to pass electrical circuits through the containment drywell while maintaining drywell integrity. The intent of the electrical AMR of electrical penetration assemblies is to preserve the electrical continuity function of the penetration assemblies. The focus of this review is to evaluate the interaction between the organic insulating materials of the penetration assemblies and their operating environment. The organic insulating materials comprise the penetration primary insulation system of the assemblies. In addition to organic insulating materials, there are other materials (i.e., metals and inorganic materials) used in the construction of the penetration assembly. These include cable fillers, epoxies, potting compounds, connector pins, plugs, and facial grommets. Consistent with the findings from Department of Energy (DOE)/Sandia Aging Management Guideline (SAND 96-0344) these items have no significant effect on the normal aging process of the primary insulation system and do not adversely affect the electrical continuity function of the penetration assemblies. Therefore, no AMR of these materials is warranted. The civil/structural pressure boundary function of the penetration is tested by the Appendix J Program as shown in Table 3.5.2-1 of the LRA.

The staff found the applicant's response acceptable because the potential aging effects of penetration wiring insulation will be addressed by the Electrical Cables and Connections Not

Subject to 10 CFR 50.49 EQ Requirements Program and the leak test as required by Appendix J Program will test the boundary function of the non-EQ electrical and I&C penetrations. Therefore, the staff's concern described in RAI 3.6.2.3-2 is resolved.

On the basis of its review, the staff concluded that the applicant adequately identified the aging effects, and has an adequate AMP for managing the aging effects for containment electrical penetrations, such that there is reasonable assurance that the component intended functions will be maintained consistent with the CLB for the period of extended operation, as required by 10 CFR 54.21(a)(3).

3.6.2.3.3 High Voltage Insulators

High-voltage insulators are provided on the circuits used to supply power from the switchyard to plant buses during recovery from a station blackout (SBO). The function of high-voltage insulators is to insulate and support electrical conductors.

In LRA Section 3.6.2.1.4, the applicant lists the high-voltage insulators' materials of construction:

- porcelain
- metal (galvanized iron, galvanized steel)
- portland cement porcelain jointing material

The applicant stated that high-voltage insulator components are exposed to an outdoor environment (i.e., component used in transformer yard, switchyard). The applicant also stated that the high-voltage insulators have no AERMs. In Footnote 606 of LRA Table 3.6.2-1, Electrical and I&C Systems - Summary of Aging Management Evaluation - Electrical/I&C Components/Commodities, the applicant stated that surface contamination is not an applicable aging mechanism. The buildup of surface contamination is typically a slow, gradual process. BSEP is located in a rural area where airborne particle concentrations are comparatively low. Consequently, the rate of contamination buildup on the insulators is not significant. Any such contamination accumulation is washed away naturally, by rainwater. The glazed surface on high-voltage insulators aids in the removal of this contamination. In March 1993, the Unit 2 switchyard experienced a flashover of some high-voltage insulators. The incident was attributed to a severe winter storm with gale force winds that persisted in the area for a number of days. The incident was considered a highly unusual atmospheric event and was not attributed to actual aging of the insulators but rather to the storm itself. The storm was unusual because it contained high winds but little or no precipitation to wash away the salt spray on the insulators. An event like this had not occurred prior or subsequent to March 1993. As the March 1993 incident was event-driven, it is concluded that surface contamination is not an applicable stressor for the high-voltage insulators within the scope of this review when exposed to normal service conditions. Therefore, no aging management activities are required for the extended period of operation. This event resulted in the issuance of IN 93-95, "Storm-Related Loss of Offsite Power Events Due to Salt Buildup on Switchyard Insulators."

The applicant also stated that cracking is not an applicable aging mechanism. Cracking or breaking of porcelain insulators is typically caused by physical damage which is event-driven rather than an age-related mechanism. Mechanical wear is an aging effect for strain and suspension insulators if they are subject to significant movement. BSEP transmission conductors do not normally swing and when they do, because of strong winds, they dampen quickly once the wind has subsided. Loss of material due to wear has not been identified during routine inspections at BSEP. The applicant concluded that no aging management activities are required for this commodity group.

Aging Effects. Because there are no AERMs, the applicant stated that no AMPs are required for high-voltage insulators.

In RAI 3.6.2.3-3, dated May 18, 2005, the staff requested that the applicant provide the following information:

> Various airborne materials such as dust, salt and industrial effluent can contaminate insulator surfaces. A large buildup of contamination enables the conductor voltage to track along the surface more easily and can lead to insulator flash over. Surface contamination can be a problem in areas where there are greater concentration of airborne particles such as near facilities that discharge soot or near the sea coast where salt spray is prevalent. Industry operating experience identified the potential of loss of offsite power due to salt contamination of switchyard insulators at other plants beside BSEP. On March 17, 1993, Crystal River Unit 3 experienced a loss of the 230 kV switchyard (normal off-site power to safety-related busses) when a light rain caused arcing across salt-laden 230 kV insulators and opened breakers in switchyard. Since 1982, Pilgrim station has also experienced several loss of offsite power events when heavy ocean storms deposited salt on the 345 kV switchyard causing the insulator to arc to ground. In light of these industry operating experiences, provide an AMP to manage the aging effects of insulator or provide a justification of why an AMP is not necessary.

In its response, by letter dated June 14, 2005, the applicant stated:

> Surface contamination on BSEP high-voltage insulators is an applicable aging mechanism that requires management. A silicon-based coating has been applied to the 230KV porcelain insulators to prevent the buildup of surface contamination. As part of the PM Program AMP, the silicon-based coating on the switchyard insulators will be tested. This test consists of the application of a water mist to verify that water beads are present. An initial performance interval of once every refueling outage will be established for this inspection. Should test results warrant an additional coating of silicon, the first inspection following reapplication may be extended. Subsequent inspections after the initial inspection will occur every refueling outage. This test will become part of the PM Program described in Section A.1.1.32 of the LRA. The program description for the PM Program described in Section B.2.30 of the LRA is amended by this response as follows [see Commitment Item #24]:

System	PM Program Activity
230KV Switchyard System	Inspect high-voltage insulators for water beading on silicone coating and for age related degradation.

The staff found the applicant's response acceptable; therefore, the concern described in RAI 3.6.2.3-3 is resolved.

Aging Management Program. The applicant revised the PM Program described in LRA Section B.2.30 to include the inspection of high-voltage insulators to address the staff's concern about the potential for loss of offsite power due to salt contamination of switchyard insulators. The staff's evaluation of this AMP is in SER Section 3.0.3.3.3.

On the basis of its review, the staff concluded that the applicant adequately addressed the aging threat to high-voltage insulators and has an adequate program for management of the aging effects of high-voltage insulators.

3.6.2.3.4 Switchyard Bus

Switchyard bus provides a portion of the circuit supplying power from the switchyard to plant buses during recovery from an SBO. The function of switchyard bus is to provide electrical connections to specified sections of an electrical circuit to deliver voltage, current or signals.

Aging Effects. In LRA Section 3.6.2.1.5, the applicant lists aluminum and galvanized steel as the materials of construction for the switchyard bus components. The switchyard bus components are exposed to outdoor (switchyard) environment but have no AERMs. The applicant stated in Table 3.6.2-1, Footnote 607, that the connections' surface oxidation is not an applicable aging effect. All switchyard bus connections have welded and/or compression connections. For the service conditions encountered at BSEP, no aging effects have been identified that could cause a loss of intended function. Vibration is not an applicable aging mechanism since switchyard bus has no connections to moving or vibration equipment. Switchyard buses are connected to flexible conductors that do not normally vibrate and are supported by insulator mounted to static; structural components, such as concrete footing; and structural steel. This configuration provides reasonable assurance that switchyard bus will perform its intended function for the extended period of operation.

The applicant stated that connections' surface oxidation is not an applicable aging effect and that all switchyard bus connections have welded and/or compression connections. The staff questioned this assessment, because loss of material due to corrosion of connections due to surface oxidation is an aging effect of the high-voltage switchyard bus connections.

In RAI 3.6.2.3-4, dated May 18, 2005, the staff requested that the applicant provide a justification why aging effects due to corrosion are not significant to the high-voltage switchyard bus and connections.

In its response by letter dated June 14, 2005, the applicant stated:

> Loss of material due to the corrosion of connections due to surface oxidation is an applicable aging mechanism but is not significant enough to cause a loss of intended function. The components involved in switchyard connections are constructed from cast aluminum, galvanized steel and stainless steel. The switchyard bus is constructed of 5-inch, schedule 80, aluminum pipe. No organic materials are involved. Connections to the switchyard bus are welded. Conductor connections are generally of the compression bolted category. Components in the switchyard are exposed to precipitation. The components in the switchyard do not experience any appreciable aging effects in this environment, except for minor oxidation, which does not impact the ability of the switchyard bus to perform its intended function.

At BSEP, switchyard connection surfaces are coated with an anti-oxidant compound (i.e., a grease-type sealant) prior to tightening the connection to prevent the formation of oxides on the metal surface and to prevent moisture from entering the connection thus reducing the chances of corrosion. Based on operating experience, this method of installation has been shown to provide a corrosion resistant low electrical resistance connection. Therefore, it is concluded that general corrosion resulting in the oxidation of switchyard connection surface metals is not an AERM at BSEP.

The staff found the applicant's response addressed why general corrosion resulting in the oxidation of switchyard connection surface is not a significant AERM. Therefore, the staff's concern described in RAI 3.6.2.3-4 is resolved.

Aging Management Program. The applicant explained why aging effects of switchyard bus are not significant at BSEP and staff agreed that no AMP for switchyard bus was required.

On the basis of its review, the staff concluded that the applicant adequately addressed the aging threat to switchyard bus and that no AMP was required.

3.6.2.3.5 Transmission Conductors

Transmission conductors provide a portion of the circuits used to supply power from the switchyard to plant buses during recovery from an SBO. The function of transmission conductors is to provide electrical connection to specified sections of an electrical circuit to deliver voltage, current or signals.

Aging Effects. In LRA Section 3.6.2.1.6, the applicant indicated that the transmission conductors are aluminum conductor steel reinforced (ACSR). The material of construction for the transmission conductor components are aluminum and steel. The transmission conductors are exposed to an outdoor (i.e., components are used in the transformer yard or switchyard) environment. The applicant stated that the transmission conductors have no AERMs. In LRA Table 3.6.2-1, Footnote 608, the applicant stated that loss of conductor strength due to corrosion of ACSR transmission conductor is a very slow process. This process is even slower in rural areas, with generally less suspended particles and SO_2 concentration in the air, than in urban areas. BSEP is located in a rural area where airborne particle concentrations are comparatively low. Consequently, this is not considered a significant contributor to the aging of BSEP transmission conductors. Transmission conductor vibration may be caused by wind loading. Wind loading is considered in the initial design and field installation of transmission conductors and high-voltage insulators throughout the CP&L system. Compression connections to transmission conductors are equipped with Belleville washers which provide vibration absorption and prevent loosening. Loss of material (wear) and fatigue that could be caused by transmission conductor vibration or sway are not considered applicable aging effects that warrant aging management. The applicant concluded that no aging management activities are required for this commodity group.

In RAI 3.6.2.3-5, dated May 18, 2005, the staff stated that the most prevalent mechanism contributing to loss of high-voltage transmission conductor strength is corrosion, which includes corrosion of steel core and aluminum strand pitting. The applicant stated that loss of conductor strength due to corrosion of ACSR transmission conductor is a very slow process; however, the applicant failed to provide the technical basis for this conclusion. Therefore, the staff requested that the applicant provide a technical basis for why loss of conductor strength due to corrosion of ACSR transmission conductor is not significant.

In its response, by letter dated June 14, 2005, the applicant stated:

> Loss of transmission conductor strength due to corrosion is an applicable aging effect, but ample design margin ensures that it is not significant enough to cause a loss of intended function. BSEP transmission conductors are Type ACSR (i.e., aluminum conductor steel reinforced). They are constructed of strand aluminum conductors wound around a steel core. No organic materials are involved. The most prevalent mechanism contributing to loss of conductor strength of an ACSR transmission conductor is corrosion, which includes corrosion of the steel core and aluminum strand pitting. For ACSR transmission conductors, degradation begins as a loss of zinc from the galvanized steel core wires. Corrosion rates depend largely on air quality, which includes suspended particle chemistry, SO2 concentration in air, precipitation, fog chemistry, and meteorological conditions. Corrosion of ACSR transmission conductors is a very slow process that is even slower for rural areas with generally fewer suspended particles and lower SO2 concentrations in the air than urban areas. BSEP is located in a rural area where airborne particle concentrations are comparatively low. Consequently, this is not considered a significant contributor to this aging mechanism.
>
> There is a set percentage of composite conductor strength established at which a transmission conductor is replaced. The National Electrical Safety Code (NESC) requires that tension on installed conductors be a maximum of 60% of the ultimate conductor strength. The NESC also sets the maximum tension a conductor must be designed to withstand under heavy load requirements, which includes consideration of ice, wind, and temperature. Tests performed by Ontario Hydroelectric showed a 30% loss of composite conductor strength of an 80-year-old transmission conductor due to corrosion. Assuming a 30% loss of strength, there would still be significant margin between what is required by the NESC and actual conductor strength.
>
> These requirements were reviewed concerning the specific transmission conductors used at BSEP. BSEP is in the medium loading zone; therefore, the Ontario Hydroelectric heavy loading zone study is conservative. The BSEP transmission conductors with the smallest ultimate strength margin, i.e., 1272 MCM ACSR, will be used as an illustration. The ultimate strength of 1272 MCM ACSR is 34,100 lbs and the maximum heavy load tension of 1272 MCM ACSR is 3,000 lbs. The margin between the heavy load tension and the ultimate strength is 31,100 lbs.; therefore, there is a 91% ultimate strength margin (i.e., 31,100/34,100). The Ontario Hydroelectric study showed a 30% loss of composite conductor strength in an 80-year-old conductor. In the case of the 1272 MCM ACSR transmission conductors, a 30% loss of ultimate strength would mean that there would still be a 61% ultimate strength margin between what is required by the NESC and the actual conductor strength in an 80-year old conductor.
>
> The BSEP transmission conductors within the scope of License Renewal are short span lengths located entirely within the switchyard area. The spans are approximately 287 feet in length. Therefore, the tension exerted on these conductors is less than would be experienced in typical applications, which could be up to 1000 feet in length.

> The foregoing discussion illustrates that there is ample design margin in the transmission conductors at BSEP. Based on the conservatism in the ultimate strength margin, it is concluded that loss of conductor strength is not an AERM at BSEP.

The staff found the applicant's response adequately addressed why loss of conductor strength due to corrosion is not a significant AERM at BSEP. Therefore, the staff's concern described in RAI 3.6.2.3-6 is resolved.

Aging Management Program. The applicant clearly explained why loss of conductor strength due to corrosion of transmission conductors is not a significant AERM and the staff agreed that no AMP for transmission conductors is required.

On the basis of its review, the staff concluded that the applicant adequately addressed the aging threat to transmission conductors and that no AMP is required.

3.6.3 Conclusion

The staff concluded that the applicant provided sufficient information to demonstrate that the effects of aging for the electrical and I&C components, that are within the scope of license renewal and subject to an AMR, 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 applicable UFSAR supplement program summaries and concludes that they adequately describe the AMPs credited for managing aging of the electrical and I&C components, as required by 10 CFR 54.21(d).