CALLAWAY PLANT UNIT 1
LICENSE RENEWAL APPLICATION

RESPONSES TO REQUEST FOR ADDITIONAL INFORMATION (RAI) SETS #29 AND #27 (RAI B2.1.6-4b)

RAI SET # 29 RESPONSES

**RAI B2.1.6-4d**

Background:

*Generic Background Information-* The Nuclear Regulatory Commission's (NRC's) position regarding implementation of recommended inspection and evaluation (I&E) criteria from the MRP-227-A report as part of a plant-specific aging management program (AMP) for reactor vessel internal (RVI) components is given in NRC Regulatory Issue Summary (RIS) No. 2011-07, "License Renewal Submittal Information for Pressurized Water Reactor Internals Aging Management," dated July 21, 2011. The RIS recommends that the review of the I&E bases for Category D pressurized-water reactor (PWR) facilities be assessed as part of the review of the applicant's AMP for its RVI components, including the bases for resolving any applicant/licensee action items (A/LAIs) on the MRP-227-A I&E methodology that are applicable to the design of the RVI components at the facility. These A/LAIs are identified in the NRC's revised safety evaluation (SE, Rev. 1, dated December 16, 2011) on the MRP-227-A I&E methodology. According to RIS No. 2011-07, Callaway Plant, Unit 1 (Callaway) is categorized as a Category D facility, which applies to PWR applicants that either will be submitting a license renewal application (LRA) that is based on the recommended criteria in NUREG 1801, "Generic Aging Lessons Learned (GALL) Report," Revision 2, or currently have GALL Report Revision 2 based LRAs pending an NRC review.

*Plant-Specific Background Information-* The staff's understanding is that the current licensed core power level for Callaway is set at 3565 MWt, as approved in the NRC's license amendment and safety evaluation of March 30, 1988, which was issued on the 4.5 percent stretch power uprate request for Callaway (ADAMS Accession No. ML021650524).

In A/LAI No. 1, the staff requested that applicants with a PWR design provide a demonstration that the bases and assumptions for the I&E methodology in Topical Report MRP-227-A are applicable and bounding for the design of the RVI components at the applicant's plant. The applicant responded to the request in A/LAI No. 1 in the applicant's response to RAI B2.1.6-4a which was provided in Ameren Letter No. ULNRC-05950, dated January 24, 2013.

In its January 24, 2013, response letter to RAI B2.1.6-4a, the applicant provided the following LRA commitment (as given in Commitment No.4 in LRA UFSAR Supplement Table A4-1) as the basis for resolving the request in A/LAI No. 1:

> Each applicant/licensee is responsible for assessing its plant's design and operating history and demonstrating that the approved version of MRP-227 is applicable to the facility. Each applicant/licensee shall refer, in particular, to the assumptions regarding plant design and operating history made in the FMECA and functionality analyses for reactors of their design (i.e., Westinghouse, CE, or B&W) which support MRP-227 and describe the process used for determining plant-specific differences in the design of their RVI components or plant operating conditions, which result in different component inspection categories. The applicant/licensee shall submit this evaluation for NRC review and approval as part of its application to implement the approved version of MRP-227.

Issue:

Since Callaway is a RIS 2011-07 Category D plant, the resolution of A/LAI No. 1 needs to be resolved as part of the staff's review of the Callaway LRA and PWR Vessel Internals Program.

Request:

(a) Clarify whether the design of RVI components at Callaway includes any non-welded or bolted austenitic stainless steel components whose design stresses are greater than 30 ksi and whose materials were cold worked to 20 percent or greater cold-work levels. If so, justify why the current I&E bases in MRP-227-A report are sufficient to provide for management of cracking or other applicable aging effects in these non-welded components. Otherwise, clarify and justify how the MRP-227-A report I&E bases for these RVI components will be adjusted as part of the applicant's response to the NRC's request in A/LAI No. 2.

(b) Clarify whether Ameren Missouri has ever utilized an atypical fuel design or fuel management protocols that could make the assumptions in MRP-227-A on core design, core loading, and core leakage patterns non-representative for the Callaway RVI design, including those that might have been approved for the facility under the NRC's process for reviewing power uprate/power change license amendment requests. If so, justify why the current I&E bases in MRP-227-A report are sufficient to provide for management of cracking and other applicable aging effects in the plant's RVI components based on the actual fuel loading patterns and fuel power conditions that are approved in the current licensing basis. Otherwise, clarify and justify how the MRP-227-A report I&E bases for these RVI components will be adjusted as part of the applicant's response to the NRC's request in A/LAI No. 2.

**Callaway Response**

(a) The response to RAI B2.1.6-4d part (a) will be submitted at a later date.

(b) MRP-227-A assumed that the degradation rate of the reactor internals would decrease during the second 30 years of operation. This requires the use of low leakage reactor cores during this period, and thus precludes the use of out-in core loading patterns. EPRI letter MRP 2013-025, Attachment 1, provides criteria for Combustion Engineering and Westinghouse PWRs with regard to radial boundary limitations, upper axial boundary limitations, and lower axial boundary limitations which, if met, ensure that the assumptions of MRP-227-A are met. As stated in MRP 2013-025, these criteria apply to operation going forward; i.e., during the second 30 years of operation.

To meet the radial boundary limitations, the following limits must be met:

Heat generation figure of merit, $F \leq 68$ Watts/cm$^3$
Average core power density < 124 Watts/cm$^3$

To meet the upper axial boundary limitations, it is only necessary that the average core power density be less than 124 watts/cm$^3$ and the distance between the top of the active fuel and the upper core plate be greater than 12.2 inches. The lower axial boundary criteria of MRP-227-A, Section 2.4, criteria, are satisfied by meeting the requirements stated above for average core power density, heat generation figure of merit, and the distance from the active fuel to the upper core plate. Thus, for the lower axial boundary criteria it is only necessary to meet the radial boundary and upper axial boundary limitations.

Historically, in-out core loading patterns have been used in all Callaway reload fuel cycles.

The average core power density has been 111.7 watts/$cm^3$ since Cycle 3, when reactor power was uprated, and was 106.9 watts/$cm^3$ prior to the uprating. Thus, the average core power density has always been met at Callaway.

With regard to the heat generation figure of merit, all reload fuel cycles except fuel cycles 2 and 13 met the limit of 68 watts/$cm^3$. The duration of fuel cycle 2, which ran from April, 1986 to September, 1987, was 1.15 effective full power years. The duration of fuel cycle 13, which ran from November, 2002 to April, 2004, was 1.26 effective full power years. Although the heat generation figure of merit exceeded 68 watts/$cm^3$ for these two fuel cycles in the first 20 years of operation, it did not exceed this value in the next 10 years of operation, and is not expected to exceed it in the second 30 years of operation. Since these two fuel cycles occurred in the first 20 years of operation, they do not invalidate the requirement to not use out-in loading patterns in the second 30 years of operation. In addition, the relatively short duration of these two fuel cycles in the first 30 years of operation are offset by many more years of operation where the heat generation figure of merit was below the limit.

The upper axial boundary criteria have always been met at Callaway. As discussed above, the average core power density is less than 124 watts/$cm^3$. The distance from the active fuel to the upper core plate has varied due to changes in fuel design. However, this distance has always been greater than 12.2 inches, which meets the limit set by MRP 2013-025.

To ensure that these limits are met in future core designs, Callaway will continue to use in-out core loading patterns in all future fuel cycles. The core design procedure will be modified to include for each core loading pattern a review for the following parameters:

- Active fuel – upper core plate distance > 12.2 inches
- Average core power density < 124 watts/$cm^3$
- Heat generation figure of merit, $F \leq 68$ watts/$cm^3$

LRA Table A4-1 item 43 has been added as shown in Amendment 29 in Enclosure 2 to revise the core design procedure to include the core design parameters noted above.

**<u>Corresponding Amendment Changes</u>**

Refer to the Enclosure 2 Summary Table "Amendment 29, LRA Changes" for a description of LRA changes with this response.

**RAI 3.3.2-2**

Background:

By letter dated August 29, 2013, the LRA was amended to include submerged carbon steel and stainless steel closure bolting associated with pumps in the essential service water, service water, fire protection, emergency diesel engine fuel oil storage and transfer, oily waste, and floor and equipment drain systems. The bolting is managed for loss of material and loss of preload.

- The Open-Cycle Cooling Water System Program is proposed to manage loss of material of the submerged closure bolting exposed to raw water in the essential service water system. LRA Section B2.1.10 states that routine inspections and maintenance ensure that corrosion is managed.

- The Fuel Oil Chemistry and One-Time Inspection programs are proposed to manage loss of material of the submerged closure bolting exposed to fuel oil in the emergency diesel engine fuel oil storage and transfer system. LRA Section B2.1.16 states that fuel oil chemistry is maintained to reduce contaminants and visual inspections are performed on the internal surfaces of the emergency fuel oil system storage tanks and day tanks during periodic draining. In addition, a one-time inspection is performed to confirm the effectiveness of the Fuel Oil Chemistry Program.

- The External Surfaces Monitoring of Mechanical Components Program is proposed to manage loss of material of the submerged closure bolting exposed to either raw water or waste water in the remaining systems. LRA Section B2.1.21 states that surfaces that are not readily visible during plant operations and refueling outages are inspected when they are made accessible and at intervals that would ensure the components' intended functions are maintained. Accessible surfaces are visually inspected at least every refueling outage.

- The Bolting Integrity Program is proposed to manage loss of preload of all submerged bolting exposed to raw water, fuel oil, or waste water. LRA Section B2.1.8 states that inspection activities for bolting in a submerged environment are performed in conjunction with associated component maintenance activities.

The GALL Report recommends that loss of material and loss of preload of pressure-retaining closure bolting be managed with GALL Report AMP XI.M18, "Bolting Integrity". GALL Report AMP XI.M18 includes preventive measures to minimize loss of preload, such as proper torqueing of bolts and checking for uniformity of gasket compression. AMP XI.M18 also recommends periodic inspections (at least once per refueling cycle) of closure bolting for signs of leakage to ensure the detection of age-related degradation due to loss of material and loss of preload. GALL Report AMP XI.M1 "ASME Section XI Inservice Inspection, Subsections IWB, IWC, and IWD," supplements AMP XI.M18 with ASME Code inspections of closure bolting, as appropriate.

Issue:

It is not clear to the staff that the submerged closure bolting will be inspected with effective techniques or with sufficient frequency such that loss of material and loss of preload can be detected prior to loss of intended function. Given the difficulty of detecting leakage of submerged bolted connections, it is not clear what parameters will be monitored to detect loss of material and loss of preload. In addition, while GALL Report AMP XI.M18 recommends inspections at least once per refueling cycle, the proposed AMPs do not state minimum inspection frequencies for submerged bolting.

Request:

For the submerged closure bolting associated with pumps in the essential service water, service water, fire protection, emergency diesel engine fuel oil storage and transfer, oily waste, and floor and equipment drain systems:

(a) State the parameters that will be inspected and how the inspection of these parameters will be capable of detecting both loss of material and loss of preload. Clarify whether inspections will be performed in the submerged environment or when the associated pumps are removed from the submerged environment.

(b) State the minimum inspection frequencies and the justification for those frequencies. If inspections are to be performed during maintenance, include information such as historical maintenance intervals and planned preventive maintenance activities. If inspection intervals are based on an evaluation (as discussed in the External Surfaces Monitoring of Mechanical Components Program description), state the inputs into the evaluation, considering that inspections of comparable accessible components with the same material and environment may not be available.

**Callaway Response**

(a.) Parameters Inspected

Essential Service Water (ESW) Pump Closure Bolting:
Submerged closure bolting of the ESW pumps will be visually inspected for degradation when they are made accessible during dewatering of the ESW intake bays for structures monitoring inspections. Dewatering of the ESW pump house intake bays is performed on a four refueling outage frequency (six years). There have been no documented failures of the submerged ESW pump closure bolts in the last ten years. A visual inspection of a representative sample of submerged ESW pump closure bolts at least every six years provides reasonable assurance that significant degradation can be identified prior to loss of intended function. The ESW pumps are tested at least quarterly, and removed from service and repaired or refurbished when trending of pump parameters, such as pressure, flow and vibration indicate that repair or refurbishment is necessary.

The representative sample for ESW pump submerged closure bolting will be 20% of the population with a maximum of 25, during each six year interval. The inspection focuses on the bounding or lead components most susceptible to aging due to time in service and severity of operating conditions. Adverse bolting indications observed during inspections are entered into the plant corrective action program.

Emergency Diesel Engine Fuel Oil Storage Tanks (FOSTs) Transfer Pump Closure Bolting
Submerged closure bolting of the FOST transfer pumps will be visually inspected for degradation when they are made accessible during the disassembly and inspection of the FOST transfer pumps. Disassembly and inspection of the FOST transfer pumps is performed on a ten year frequency. There have been no documented failures of the submerged FOST transfer pump closure bolts in the last ten years. In addition, significant degradation of the FOST transfer pump submerged closure bolting is not expected due to the effectiveness of the Fuel Oil Chemistry program with maintaining and controlling a non-aggressive fuel oil environment. A visual inspection of a representative sample of submerged FOST transfer pump closure bolts at least every ten years during the periodic disassembly and inspection of the FOST transfer pumps provides reasonable assurance that significant degradation can be identified prior to loss of intended function. The FOST transfer pumps are periodically tested and removed from service and repaired or refurbished when trending of pump parameters, such as pressure and flow indicate that repair or refurbishment is necessary.

The representative sample for FOST transfer pump submerged closure bolting will be 20% of the population with a maximum of 25, during each ten year interval. The inspection focuses on the bounding or lead components most susceptible to aging due to time in service and severity of operating conditions. Adverse bolting indications observed during inspections are entered into the plant corrective action program.

Service Water Pump Closure Bolting
Each Service Water pump is replaced nominally every six years with a refurbished pump. Because the pumps are periodically replaced every six years with a refurbished pump, they are not subject to aging management requirements.

Waste Water and Raw Water Pump Closure Bolting:
Submerged pump closure bolting in the oily waste system and the floor and equipment drainage system as well as submerged pump closure bolting for the raw water valve pit pumps in the fire protection system will be visually inspected for degradation when they are made accessible during pump maintenance activities. The submerged closure bolting for waste water and raw water pumps will be inspected on a four refueling outage frequency (six years) if an opportunistic inspection has not been performed. There have been no documented failures of the submerged closure bolting for waste water and raw water pumps in the last ten years. A visual inspection of a representative sample of normally submerged pump bolts at least every six years provides reasonable assurance that significant degradation can be identified prior to loss of intended function. The waste water sumps and fire protection valve pits are monitored during operator rounds to confirm that waste water sumps or raw water valve pits are being drained. Waste water and raw water pumps are removed from service and repaired or refurbished when waste water sumps or the fire protection valve pits are not being drained.

The representative sample for waste water or raw water pump submerged closure bolting will be 20% of the population with a maximum of 25, during each six year interval. The inspection focuses on the bounding or lead components most susceptible to aging due to time in service and severity of operating conditions. Adverse bolting indications observed during inspections are entered into the plant corrective action program.

Loss of Preload:
To prevent loss of preload for submerged bolting in submerged components, preventive actions consistent with NUREG-1801 Section XI.M18, “Bolting Integrity” include proper selection of bolting material, the use of appropriate lubricants and sealants in accordance with the guidelines of EPRI NP-5769, EPRI TR-104213, and NUREG-1339, consideration of yield strength when procuring bolting material, proper torqueing of bolts, checking for uniformity of gasket compression after assembly, and application of an appropriate preload based on guidance in EPRI documents, manufacturers recommendations, or engineering evaluation.

Operating experience (OE) shows that the Bolting Integrity program (B2.1.8) has been effective in managing loss of material and loss of preload of bolted connections. Therefore, continued implementation of the program with the identified enhancements provides reasonable assurance that the effects of aging will be managed so that components crediting this program can perform their intended functions consistent with the current licensing basis during the period of extended operation.

(b) Minimum Inspection Frequency and Associated Justification

Minimum inspection frequencies and associated justifications are identified in RAI response part (a).

LRA Table 2.3.3-5 and Table 3.3.2-5 have been revised as shown in Amendment 29 in Enclosure 2 to identify that the service water pumps do not require aging management. LRA Appendix A1.8, LRA Table A4-1 item 5, and Appendix B2.1.8 have been revised as shown in Amendment 29 in Enclosure 2 to provide periodic inspections of the in-scope submerged closure bolting by the Bolting Integrity program (B2.1.8). The periodic inspection of the in-scope submerged closure bolting by the Bolting Integrity program (B2.1.8) will be initiated prior to the period of extended operation. In addition, the aging evaluation of submerged closure bolting has been revised for the affected systems as noted in LRA Chapter 3:

- Table 3.3-1, Auxiliary Systems
- Table 3.3.2-4, Essential Service Water System.
- Table 3.3.2-20, Fire Protection System
- Table 3.3.2-21, Emergency Diesel Engine Fuel Oil Storage and Transfer System
- Table 3.3.2-26, Oily Waste System
- Table 3.3.2-27, Floor and Equipment Drainage System
- Table 3.4-1, Steam and Power Conversion System

**Corresponding Amendment Changes**

Refer to the Enclosure 2 Summary Table "Amendment 29, LRA Changes” for a description of LRA changes with this response.

RESPONSES TO REQUEST FOR ADDITIONAL INFORMATION (RAI) SETS #29 AND #27 (RAI B2.1.6-4b)

RAI Set # 27 (RAI B2.1.6-4b) Response

## RAI B2.1.6-4b

Background:

By letter dated October 24, 2012 (Ameren Letter No. ULNRC-05920, as docketed in ADAMS ML12299A249), the applicant responded to RAI B2.1.6-4. In its response, the applicant stated that Applicant/License Action Item No. 7 (A/LAI No. 7) from Electric Power Research Institute (EPRI) Technical Report (TR) No. 1022863, "Materials Reliability Program: Pressurized Water Reactor Internals Inspection and Evaluation Guidelines (MRP-227-A)," is not applicable to the design of the Callaway Plant (Callaway) reactor vessel internal (RVI) components because the lower support column bodies at the facility were not fabricated from cast austenitic stainless steel (CASS) materials. The reference document for all applicable A/LAIs in the MRP-227-A report is given in the NRC's revised safety evaluation on the MRP-227-A report, dated December 16, 2011 (ADAMS ML11308A770).

Issue:

The staff agrees that A/LAI No. 7 of MRP-227-A report would not be applicable to the design of the lower core support column bodies if they are not made from CASS materials. However, the scope of A/LAI No. 7 also applies to any component made from a CASS, martensitic stainless steel, or precipitation hardened, martensitic stainless steel material that was not considered and evaluated in the development of the MRP-227-A report (i.e., not considered or evaluated in either MRP-227-A or the supporting MRP background documents). Updated Final Safety Analysis Report (UFSAR) Table 5.2-4 identifies that the Callaway RVI design includes RVI components made from SA-351 CF8 or CF8A CASS materials. To resolve the request in A/LAI No.7, the staff needs clarification regarding RVI components in the plant design that were made from these types of CASS materials and whether the applicable CASS components were considered in the development and component category disposition bases in MRP-227-A.

Request:

Based on the design basis information in UFSAR Table 5.2-4, identify those RVI components that are specifically fabricated from CF8 or CF8A CASS materials. For those RVI components that are made from these materials, clarify whether the components were considered in the development of the MRP-227-A recommendations for management of thermal aging embrittlement and neutron irradiation embrittlement effects and dispositioned in accordance with applicable component category recommendations for the components in the MRP-227-A report. If it is determined that any RVI CASS component was not considered in the development of MRP-227-A and appropriately dispositioned in the report, clarify and justify how the pressurized-water reactor (PWR) Vessel Internals Program will be adjusted under A/LAI No. 2 to manage loss of fracture toughness in the components as a result of potential neutron irradiation embrittlement and thermal aging embrittlement mechanisms; consistent with the position in A/LAI No.7, if the basis for aging management (as applicable) will be by implementation of a component-specific evaluation, submit the evaluation for NRC review and approval as an enclosure to your RAI response.

## Callaway Response

Callaway reactor vessel internals (RVI) components and materials are consistent with the typical generic Westinghouse PWR internals components identified on MRP-191 Table 4-4. No additional components were identified for Callaway by the comparison to MRP-191 Table 4-4.

Callaway has two RVI CASS component groups: bottom mounted instrument (BMI) column cruciforms and one offset instrument column cruciform bolted to the underside of the lower core plate which was evaluated with the BMI column cruciforms. MRP-227-A functionality assessments placed the BMI column cruciforms into the no additional measure functional group.

In the case of material differences, there would be no effect on the aging management strategies. The following CASS components identified by MRP-191, Table 4-4 are fabricated with stainless steel, other than CF8 or CF8A material, at Callaway:

- Control Rod Guide Tube Assemblies: Intermediate and Lower Flanges
- Upper Internals Assembly Upper Support Column Assemblies Column Bases
- Lower Internals Lower Support Column Bodies
- Lower Internals Lower Support

None of the remaining CASS components identified by MRP-191 Table 4-4 are applicable to Callaway.

Therefore, aging management of thermal aging embrittlement and neutron embrittlement effects of CASS components is not required. RVI component and material identification and their consistency with MRP-191 Table 4-4 has been confirmed by Westinghouse.

## Corresponding Amendment Changes

No changes to the License Renewal Application (LRA) are needed as a result of this response.

# Amendment 29, LRA Changes

## Enclosure 2 Summary Table

| Affected LRA Section | LRA As-Submitted Page Number(s) |
|---|---|
| Table 2.3.3-5 | 2.3-36 |
| Table 3.3-1 | 3.3-52, 3.3-58, 3.3-60, 3.3-67, 3.3-69, and 3.3-81 |
| Table 3.3.2-4 | 3.3-94 and 3.3-99 |
| Table 3.3.2-5 | 3.3-100, 3.3-101, and 3.3-104 |
| Table 3.3.2-20 | 3.3-204 and 3.3-216 |
| Table 3.3.2-21 | 3.3-217 and 3.3-221 |
| Table 3.3.2-26 | 3.3-258 and 3.3-262 |
| Table 3.3.2-27 | 3.3-263 and 3.3-270 |
| Table 3.4-1 | 3.4-24 |
| Section A1.8 | A-5 and A-6 |
| Table A4-1, item 5 | A-37 |
| Table A4-1, item 43 | A-49 |
| Section B2.1.8 | B-34 through B-37 |

**Callaway Plant**
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**Amendment 29**

**Changes made to delete pumps because they are periodically replaced with a refurbished pump.**

**Table 2.3.3-5 (Pages 2.3-36) is revised as follows (deleted text shown in strikethrough):**

*Table 2.3.3-5 Service Water System*

| Component Type | Intended Function |
|---|---|
| Closure Bolting | Leakage Boundary (spatial)<br>Pressure Boundary<br>Structural Integrity (attached) |
| Piping | Leakage Boundary (spatial)<br>Pressure Boundary<br>Structural Integrity (attached) |
| ~~Pump~~ | ~~Pressure Boundary~~ |
| Strainer | Pressure Boundary |
| Thermowell | Pressure Boundary |
| Tubing | Pressure Boundary |
| Valve | Leakage Boundary (spatial)<br>Pressure Boundary<br>Structural Integrity (attached) |

**Callaway Plant**
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**Changes made to discussion column as a result of aging management changes to submerged pumps and associated closure bolting.**

**Table 3.3-1, Summary of Aging Management Programs in Chapter VII of NUREG-1801 for Auxiliary Systems, (Pages 3.3-52, 3.3-58, 3.3-60, 3.3-67, 3.3-69, and 3.3-81) is revised as follows (new text underlined and deleted text shown in strikethrough):**

*Table 3.3-1 Summary of Aging Management Programs in Chapter VII of NUREG-1801 for Auxiliary Systems*

| Item Number | Component Type | Aging Effect / Mechanism | Aging Management Program | Further Evaluation Recommended | Discussion |
|---|---|---|---|---|---|
| 3.3.1.040 | Stainless steel Piping, piping components, and piping elements exposed to Raw water | Loss of material due to pitting and crevice corrosion; fouling that leads to corrosion | Open-Cycle Cooling Water System (B2.1.10) | No | Consistent with NUREG-1801 for all components except that a different aging management program is credited for the following. The aging of ~~internal component surfaces~~ submerged bolting exposed to the raw water environment of the ~~chemical and volume control system,~~ essential service water system ~~and drains in the control building HVAC system~~ is managed by ~~Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components (B2.1.22)~~ Bolting Integrity (B2.1.8). |

*Table 3.3-1 Summary of Aging Management Programs in Chapter VII of NUREG-1801 for Auxiliary Systems*

| Item Number | Component Type | Aging Effect / Mechanism | Aging Management Program | Further Evaluation Recommended | Discussion |
|---|---|---|---|---|---|
| 3.3.1.064 | Steel, Copper alloy Piping, piping components, and piping elements exposed to Raw water | Loss of material due to general, pitting, crevice, and microbiologically-influenced corrosion, fouling that leads to corrosion; flow blockage due to fouling | Fire Water System (B2.1.14) | No | Consistent with NUREG-1801 for all components except that a different aging management program is credited for the following. The aging of submerged pumps ~~and associated bolting~~ exposed to the raw water environment of the fire protection system is managed by External Surfaces Monitoring of Mechanical Components (B2.1.21). |
| 3.3.1.071 | Stainless steel, Aluminum Piping, piping components, and piping elements exposed to Fuel oil | Loss of material due to pitting, crevice, and microbiologically-influenced corrosion | Fuel Oil Chemistry (B2.1.16) and One-Time Inspection (B2.1.18) | No | Consistent with NUREG-1801 for all components except that a different aging management program is credited for the following. The aging of submerged bolting exposed to a fuel oil environment is managed by Bolting Integrity (B2.1.8). |
| 3.3.1.091 | Steel Piping, piping components, and piping elements; tanks exposed to Waste Water | Loss of material due to general, pitting, crevice, and microbiologically-influenced corrosion | Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components (B2.1.23) | No | Consistent with NUREG-1801 with aging management program exceptions. ~~for all components except that a different aging management program is credited for the following: The aging of external component surfaces exposed to the waste water environment of the oily waste system is managed by External Surfaces Monitoring of Mechanical Components (B2.1.21)~~ The aging |

*Table 3.3-1 Summary of Aging Management Programs in Chapter VII of NUREG-1801 for Auxiliary Systems*

| Item Number | Component Type | Aging Effect / Mechanism | Aging Management Program | Further Evaluation Recommended | Discussion |
|---|---|---|---|---|---|
| | | | | | management program(s) with exceptions to NUREG-1801 include: Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components (B2.1.23) |
| 3.3.1.095 | Copper alloy, Stainless steel, Nickel alloy, Steel Piping, piping components, and piping elements, Heat exchanger components, Piping, piping components, and piping elements; tanks exposed to Waste water, Condensation (Internal) | Loss of material due to pitting, crevice, and microbiologically-influenced corrosion | Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components (B2.1.23) | No | Consistent with NUREG-1801 with aging management program exceptions. for all components except that a different aging management program is credited for the following: The aging of external component surfaces exposed to the waste water environment of the oily waste system is managed by External Surfaces Monitoring of Mechanical Components (B2.1.21) The aging management program(s) with exceptions to NUREG-1801 include: Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components (B2.1.23) |

*Table 3.3-1 Summary of Aging Management Programs in Chapter VII of NUREG-1801 for Auxiliary Systems*

| Item Number | Component Type | Aging Effect / Mechanism | Aging Management Program | Further Evaluation Recommended | Discussion |
|---|---|---|---|---|---|
| 3.3.1.134 | Steel, stainless steel, or copper alloy piping, piping components, and piping elements, and heat exchanger components exposed to a raw water environment (for nonsafety-related components not covered by NRC GL 89-13) | Loss of material due to general (steel and copper alloy only), pitting, crevice, and microbiologically influenced corrosion, fouling that leads to corrosion | Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components (B2.1.23) | No | Consistent with NUREG-1801 ~~for material, environment, and aging effect, but a different aging management program External Surfaces Monitoring of Mechanical Components (B2.1.23) is credited for the submerged service water pumps because the material and environment combinations are the same for the internal and external surfaces.~~ <u>with aging management program exceptions. The aging management program(s) with exceptions to NUREG-1801 include: Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components (B2.1.23)</u> |
| 3.3.1.135 | Steel or stainless steel pump casings submerged in a waste water (internal and external) environment | Loss of material due to general (steel only), pitting, crevice, and microbiologically influenced corrosion | External Surfaces Monitoring of Mechanical Components (B2.1.21) | No | Consistent with NUREG-1801 <u>for all components except that a different aging management program is credited for the following. The aging of submerged bolting exposed to a waste water environment is managed by Bolting Integrity (B2.1.8).</u> |

# Callaway Plant
# License Renewal Application
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**Changes made to revise the aging management program for loss of material in submerged closure bolting.**

**Table 3.3.2-4 (Pages 3.3-94 and 3.3-99) is revised as follows (new text underlined and deleted text shown in strikethrough):**

*Table 3.3.2-4 Auxiliary Systems – Summary of Aging Management Evaluation – Essential Service Water System*

| Component Type | Intended Function | Material | Environment | Aging Effect Requiring Management | Aging Management Program | NUREG-1801 Item | Table 1 Item | Notes |
|---|---|---|---|---|---|---|---|---|
| Closure Bolting | PB | Stainless Steel | Raw Water (Ext) | Loss of material | ~~Open-Cycle Cooling Water System (B2.1.10)~~ Bolting Integrity (B2.1.8) | VII.C1.A-54 | 3.3.1.040 | ~~C~~ E, 6 |

Notes for Table 3.3.2-4:

Plant Specific Notes:

1 External Surfaces Monitoring of Mechanical Components program (B2.1.21) is used instead of Open Cycle Cooling Water program (B2.1.10) to manage the aging of the external surfaces of nonsafety-related components exposed to raw water.

2 HDPE components in a plant indoor air environment are not exposed to an aggressive chemical environment that would concentrate contaminants and degrade HDPE chemical and mechanical properties. HDPE is not exposed to ozone, ionizing radiation or a UV source (sunlight or fluorescent light) that would result in aging. Operating temperatures do not exceed 140°F. HDPE components in a plant indoor air environment have no aging effects requiring aging management.

3 This TLAA is applicable to the high-density polyethylene (HDPE) piping. Section 4.7.7 describes the evaluation of this TLAA for the replacement ESW piping.

4 Open-Cycle Cooling Water System program (B2.1.10) is used instead of Flow-Accelerated Corrosion program (B2.1.7) to manage wall thinning due to erosion of carbon steel piping exposed to raw water.

5. The Open-Cycle Cooling Water System program (B2.1.10) is used to monitor for recurring internal corrosion in the ESW system. See Further Evaluation 3.3.2.2.8.

6. The Bolting Integrity program (B2.1.8) is used instead of Open-Cycle Cooling Water program (B2.1.10) to manage loss of material in submerged closure bolting.

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**Changes made to delete pumps and associated submerged closure bolting because they are periodically replaced with a refurbished pump.**

**Table 3.3.2-5 (Pages 3.3-100, 3.3-101, 3.3-104)** is revised as follows (**deleted text shown in strikethrough):**

*Table 3.3.2-5 Auxiliary Systems – Summary of Aging Management Evaluation – Service Water System*

| Component Type | Intended Function | Material | Environment | Aging Effect Requiring Management | Aging Management Program | NUREG-1801 Item | Table 1 Item | Notes |
|---|---|---|---|---|---|---|---|---|
| ~~Closure Bolting~~ | ~~PB~~ | ~~Carbon Steel~~ | ~~Raw Water (Ext)~~ | ~~Loss of material~~ | ~~External Surfaces Monitoring of Mechanical Components (B2.1.21)~~ | ~~VII.C1.AP-194~~ | ~~3.3.1.037~~ | ~~E, 2~~ |
| ~~Closure Bolting~~ | ~~PB~~ | ~~Carbon Steel~~ | ~~Raw Water (Ext)~~ | ~~Loss of preload~~ | ~~Bolting Integrity (B2.1.8)~~ | ~~VII.I.AP-264~~ | ~~3.3.1.015~~ | ~~A~~ |
| ~~Pump~~ | ~~PB~~ | ~~Cast Iron (Gray Cast Iron)~~ | ~~Plant Indoor Air (Ext)~~ | ~~Loss of material~~ | ~~External Surfaces Monitoring of Mechanical Components (B2.1.21)~~ | ~~VII.I.A-77~~ | ~~3.3.1.078~~ | ~~A~~ |
| ~~Pump~~ | ~~PB~~ | ~~Cast Iron (Gray Cast Iron)~~ | ~~Raw Water (Ext)~~ | ~~Loss of material~~ | ~~Selective Leaching (B2.1.19)~~ | ~~VII.C1.A-51~~ | ~~3.3.1.072~~ | ~~B~~ |
| ~~Pump~~ | ~~PB~~ | ~~Cast Iron (Gray Cast Iron)~~ | ~~Raw Water (Ext)~~ | ~~Loss of material~~ | ~~External Surfaces Monitoring of Mechanical Components (B2.1.21)~~ | ~~VII.C1.A-408a~~ | ~~3.3.1.134~~ | ~~E, 3~~ |
| ~~Pump~~ | ~~PB~~ | ~~Cast Iron (Gray Cast Iron)~~ | ~~Raw Water (Int)~~ | ~~Loss of material~~ | ~~Selective Leaching (B2.1.19)~~ | ~~VII.C1.A-51~~ | ~~3.3.1.072~~ | ~~B~~ |
| ~~Pump~~ | ~~PB~~ | ~~Cast Iron (Gray Cast Iron)~~ | ~~Raw Water (Int)~~ | ~~Loss of material~~ | ~~External Surfaces Monitoring of Mechanical Components (B2.1.21)~~ | ~~VII.C1.A-408a~~ | ~~3.3.1.134~~ | ~~E, 3~~ |

Notes for Table 3.3.2-5:

Standard Notes:

A Consistent with NUREG-1801 item for component, material, environment, and aging effect. AMP is consistent with NUREG-1801 AMP.

B Consistent with NUREG-1801 item for component, material, environment, and aging effect. AMP takes some exceptions to NUREG-1801 AMP.

E Consistent with NUREG-1801 for material, environment, and aging effect, but a different aging management program is credited or NUREG-1801 identifies a plant-specific aging management program.

Plant Specific Notes:

1 NUREG-1801, Section XI.M20, *Open-Cycle Cooling Water System* is for water which cools safety-related components and rejects heat to the ultimate heat sink. Since the service water system rejects heat to the circulating water system and is nonsafety-related, the Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components program (B2.1.23) is credited.

~~2 External Surfaces Monitoring of Mechanical Components program (B2.1.21) is used instead of Open-Cycle Cooling Water program (B2.1.10) to manage the aging of the external surfaces of nonsafety-related components exposed to raw water.~~

~~3 Since the internal and external environments for this component are the same, the External Surfaces Monitoring of Mechanical Components (B2.1.21) is credited to manage the aging of the internal surfaces of this component.~~

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**Changes made to revise the aging management program for loss of material in submerged closure bolting.**

**Table 3.3.2-20 (Page 3.3-204 and 3.3-216) is revised as follows (new text underlined and deleted text shown in strikethrough):**

*Table 3.3.2-20 Auxiliary Systems – Summary of Aging Management Evaluation – Fire Protection System*

| Component Type | Intended Function | Material | Environment | Aging Effect Requiring Management | Aging Management Program | NUREG-1801 Item | Table 1 Item | Notes |
|---|---|---|---|---|---|---|---|---|
| Closure Bolting | PB | Carbon Steel | Raw Water (Ext) | Loss of material | ~~External Surfaces Monitoring of Mechanical Components (B2.1.21)~~ Bolting Integrity (B2.1.8) | ~~VII.G.A-33~~ VIII.G.SP-136 | ~~3.3.1.064~~ 3.4.1.038 | ~~E, 3~~ E, 5 |

Notes for Table 3.3.2-20:

Plant Specific Notes:

1 The fire water storage tanks rest on a sand cushion surrounded by a reinforced concrete ring beam.

2 PVC in a wastewater environment is unaffected by water, concentrated alkalies, nonoxidizing acids, oils, ozone, or humidity changes. PVC in a waste water environment is not exposed to direct sunlight or ionizing radiation. Therefore PVC in a wastewater environment has no aging effect.

3 The external surface of these components will be managed by the External Surfaces Monitoring of Mechanical Components program (B2.1.21).

4 The Fire Water System (B2.1.14) program is used to manage components in the fire water system.

5. The Bolting Integrity program (B2.1.8) is used instead of the Internal Surfaces in Miscellaneous Piping and Ducting Components program (B2.1.23) to manage loss of material in submerged closure bolting.

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**Changes made to revise the aging management program for loss of material in submerged closure bolting.**

**Table 3.3.2-21 (Page 3.3-217 and 3.3-221) is revised as follows (new text underlined and deleted text shown in strikethrough):**

*Table 3.3.2-21 Auxiliary Systems – Summary of Aging Management Evaluation – Emergency Diesel Engine Fuel Oil Storage and Transfer System*

| Component Type | Intended Function | Material | Environment | Aging Effect Requiring Management | Aging Management Program | NUREG-1801 Item | Table 1 Item | Notes |
|---|---|---|---|---|---|---|---|---|
| Closure Bolting | PB | Stainless Steel | Fuel Oil (Ext) | Loss of material | ~~Fuel Oil Chemistry (B2.1.16) and One-Time Inspection (B2.1.18)~~ <u>Bolting Integrity (B2.1.8)</u> | VII.H1.AP-136 | 3.3.1.071 | ~~C~~ <u>E, 3</u> |

<u>Notes for Table 3.3.2-21:</u>

<u>Standard Notes:</u>
A Consistent with NUREG-1801 item for component, material, environment, and aging effect. AMP is consistent with NUREG-1801 AMP.
B Consistent with NUREG-1801 item for component, material, environment, and aging effect. AMP takes some exceptions to NUREG-1801 AMP.
C Component is different, but consistent with NUREG-1801 item for material, environment, and aging effect. AMP is consistent with NUREG-1801 AMP.
D Component is different, but consistent with NUREG-1801 item for material, environment, and aging effect. AMP takes some exceptions to NUREG-1801 AMP.
<u>E Consistent with NUREG-1801 for material, environment, and aging effect, but a different aging management program is credited or NUREG-1801 identifies a plant-specific aging management program.</u>
G Environment not in NUREG-1801 for this component and material.

<u>Plant Specific Notes:</u>
1. Loss of preload for underground bolting is managed by the Bolting Integrity program (B2.1.8).
2. The internal surface of this tank is coated, and the aging effect includes flow blockage due to degradation of the coating. Inspections of the internal surface of the tank performed under the Fuel Oil Chemistry program (B2.1.16) include inspections of the coating.
3. <u>The Bolting Integrity program (B2.1.8) is used instead of the Fuel Oil Chemistry program (B2.1.16) and the One-Time Inspection program (B2.1.18) to manage loss of material in closure bolting submerged in fuel oil.</u>

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**Changes made to revise the aging management program for loss of material in submerged closure bolting.**

**Table 3.3.2-26 (Pages 3.3-258 and 3.3-262) is revised as follows (new text underlined and deleted text shown in strikethrough):**

*Table 3.3.2-26 Auxiliary Systems – Summary of Aging Management Evaluation – Oily Waste System*

| Component Type | Intended Function | Material | Environment | Aging Effect Requiring Management | Aging Management Program | NUREG-1801 Item | Table 1 Item | Notes |
|---|---|---|---|---|---|---|---|---|
| Closure Bolting | LBS, PB | Carbon Steel | Waste Water (Ext) | Loss of material | ~~External Surfaces Monitoring of Mechanical Components (B2.1.21)~~<br>Bolting Integrity (B2.1.8) | ~~VII.E5.AP-281~~<br>VII.E5.A-410 | ~~3.3.1.091~~<br>3.3.1.135 | ~~E, 1~~<br>E, 2 |
| Closure Bolting | LBS, PB | Carbon Steel | Waste Water (Ext) | Loss of preload | Bolting Integrity (B2.1.8) | None | None | ~~G, 2~~<br>G,1 |
| Closure Bolting | LBS | Stainless Steel | Waste Water (Ext) | Loss of material | ~~External Surfaces Monitoring of Mechanical Components (B2.1.21)~~<br>Bolting Integrity (B2.1.8) | ~~VII.E5.AP-278~~<br>VII.E5.A-411 | ~~3.3.1.095~~<br>3.3.1.135 | ~~E, 1~~<br>E, 2 |
| Closure Bolting | LBS | Stainless Steel | Waste Water (Ext) | Loss of preload | Bolting Integrity (B2.1.8) | None | None | ~~G, 2~~<br>G,1 |

Notes for Table 3.3.2-26:

Plant Specific Notes:

~~1 The External Surfaces Monitoring of Mechanical Components program (B2.1.21) is credited since the component's external surface is exposed to waste water.~~

~~2~~1 Loss of preload for submerged bolting associated with submerged pumps is managed by the Bolting Integrity program (B2.1.8).

2. The Bolting Integrity program (B2.1.8) is used instead of the External Surfaces Monitoring of Mechanical Components program (B2.1.21) to manage loss of material in submerged closure bolting.

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**Changes made to revise the aging management program for loss of material in submerged closure bolting.**

**Table 3.3.2-27 (Pages 3.3-263 and 3.3-270) is revised as follows (new text underlined and deleted text shown in strikethrough):**

*Table 3.3.2-27 Auxiliary Systems – Summary of Aging Management Evaluation – Floor and Equipment Drainage System*

| Component Type | Intended Function | Material | Environment | Aging Effect Requiring Management | Aging Management Program | NUREG-1801 Item | Table 1 Item | Notes |
|---|---|---|---|---|---|---|---|---|
| Closure Bolting | LBS, SIA | Stainless Steel | Waste Water (Ext) | Loss of material | ~~External Surfaces Monitoring of Mechanical Components (B2.1.21)~~ Bolting Integrity (B2.1.8) | ~~VII.E5.AP-278~~ VII.E5.A-411 | ~~3.3.1.095~~ 3.3.1.135 | ~~E, 2~~ E, 3 |
| Closure Bolting | LBS, SIA | Stainless Steel | Waste Water (Ext) | Loss of preload | Bolting Integrity (B2.1.8) | None | None | ~~G, 3~~ G, 2 |

Notes for Table 3.3.2-27:

Plant Specific Notes:

1 Components associated with the reactor coolant pump oil collection system do not normally contain lubricating oil. Any oil or water that is found during operator visual inspections is documented and reviewed. If there is an accumulation of liquid, it is removed and discarded during the outage inspection. The Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components program (B2.1.23) inspects the piping, valves and tank for loss of material to maintain these components' intended function.

~~2. The External Surfaces Monitoring of Mechanical Components program (B2.1.21) is credited since the component's external surface is exposed to waste water.~~

~~3~~2 Loss of preload for submerged bolting associated with submerged pumps is managed by the Bolting Integrity program (B2.1.8).

3. The Bolting Integrity program (B2.1.8) is used instead of the External Surfaces Monitoring of Mechanical Components program (B2.1.21) to manage loss of material in submerged closure bolting.

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**Changes made to discussion column as a result of aging management changes to submerged closure bolting.**

**Table 3.4-1, Summary of Aging Management Programs in Chapter VIII of NUREG-1801 for Steam and Power Conversion System, (Page 3.4-24) is revised as follows (deleted text shown in strikethrough and new text shown underlined):**

*Table 3.4-1 Summary of Aging Management Programs in Chapter VIII of NUREG-1801 for Steam and Power Conversion System*

| Item Number | Component Type | Aging Effect / Mechanism | Aging Management Program | Further Evaluation Recommended | Discussion |
|---|---|---|---|---|---|
| 3.4.1.038 | Steel Piping, piping components, and piping elements exposed to Raw water | Loss of material due to general, pitting, crevice, galvanic, and microbiologically-influenced corrosion; fouling that leads to corrosion | Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components (B2.1.23) | No | Consistent with NUREG-1801 ~~with aging management program exceptions. The aging management program(s) with exceptions to NUREG-1801 include: Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components (B2.1.23).~~ <u>for all components except that a different aging management program is credited for the following. The aging of submerged bolting exposed to the raw water environment of the fire protection system is managed by Bolting Integrity (B2.1.8).</u> |

# A1.8 BOLTING INTEGRITY

The Bolting Integrity program manages cracking, loss of material and loss of preload for pressure retaining bolting. The program includes periodic inspection of closure bolting for pressure-retaining components consistent with recommendations as delineated in NUREG-1339, *Resolution of Generic Safety Issue 29: Bolting Degradation or Failure in Nuclear Power Plants* and EPRI NP-5769, *Degradation and Failure of Bolting in Nuclear Power Plants*, Volume 1 and 2 with the exceptions noted in NUREG-1339. The Bolting Integrity program also includes activities for preload control, material selection and control, and use of lubricants/sealants as delineated in EPRI TR-104213, *Bolted Joint Maintenance and Application Guide.*

The ASME Section XI Inservice Inspection, Subsections IWB, IWC and IWD program supplements the Bolting Integrity program by providing the requirements for inservice inspection of ASME Class 1, 2, and 3 safety-related pressure retaining bolting. The integrity of non-ASME Class 1, 2, 3 system and component bolted joints is evaluated by detection of visible leakage during maintenance or routine observation such as system walkdowns.

A sample of submerged bolting in raw water and waste water environments is visually inspected every four refueling outages (six years) during maintenance activities. A sample of submerged bolting on the fuel oil storage tank transfer pumps is visually inspected every 10 years during maintenance activities. The sample for submerged bolting will be 20% of the population with a maximum of 25 for each environment. The inspection of submerged bolting focuses on the bounding or lead components most susceptible to aging due to time in service and severity of operating conditions.

Safety-related and nonsafety-related structural bolting is managed by the following programs:

(a) ASME Section XI, Subsection IWE program (A1.26) provides the requirements for inspection of structural bolting.

(b) ASME Section XI, Subsection IWF program (A1.28) provides the requirements for inservice inspection of safety-related component support bolting.

(c) Structures Monitoring program (A1.31) monitors the condition of structures and structural supports that are within the scope of license renewal.

(d) RG 1.127, Inspection of Water-Control Structures Associated with Nuclear Power Plants program (A1.32) provides the requirements for inspection of water control structures associated with emergency cooling water systems.

(e) Inspection of Overhead Heavy Load and Light Load (Related to Refueling) Handling Systems program (A1.12) provides the requirements for inspection of handling systems within the scope of license renewal.

Reactor pressure vessel head closure studs are managed by the Reactor Head Closure Stud Bolting program (A1.3).

Inspection activities for bolting in buried and underground applications is performed in conjunction with inspection activities for the Buried and Underground Piping and Tanks (A1.25) program due to the restricted accessibility to these locations.

**Appendix A**
**Final Safety Analysis Report Supplement**

*Table A4-1 License Renewal Commitments*

| Item # | Commitment | LRA Section | Implementation Schedule |
|---|---|---|---|
| 5 | Enhance the Bolting Integrity program procedures to:<br>• reference NUREG-1339 and EPRI NP-5769 to meet the NUREG-1801 recommendations. (Completed LRA Amendment 1)<br>• include bolting in the list of items to be inspected during walkdowns. (Completed LRA Amendment 15)<br>• include a visual inspection of a sample of submerged bolting in raw water and waste water environments every four refueling outages (six years) during maintenance activities. A sample of submerged bolting on the fuel oil storage tank transfer pumps will be visually inspected every 10 years during maintenance activities. The sample for submerged bolting will be 20% of the population with a maximum of 25 for each environment. The inspection of submerged bolting will focus on the bounding or lead components most susceptible to aging due to time in service and severity of operating conditions. | B2.1.8 | ~~Completed~~ Completed no later than six months prior to the PEO. Inspections and testing to be completed no later than six months prior to the PEO or the end of the last refueling outage prior to the PEO, whichever occurs later. |

*Table A4-1 License Renewal Commitments*

| Item # | Commitment | LRA Section | Implementation Schedule |
|---|---|---|---|
| 43 | The core design procedure will be modified to include a review for the following core design parameters to ensure that these limits are met in future core designs:<br>• Active fuel – upper core plate distance > 12.2 inches<br>• Average core power density < 124 watts/$cm^3$<br>• Heat generation figure of merit, F ≤ 68 watts/$cm^3$ | B2.1.6 | Completed before December 19, 2014 (prior to 30 years of service on the reactor vessel internals) |

## B2.1.8 Bolting Integrity

### Program Description

The Bolting Integrity program manages cracking, loss of material and loss of preload for pressure retaining bolting. The program includes preload control, selection of bolting material, use of lubricants/sealants, and performance of periodic inspections for indication of aging effects.

The general practices that are established in this program are consistent with the recommendations, as delineated in NUREG-1339, *Resolution of Generic Safety Issue 29: Bolting Degradation or Failure in Nuclear Power Plants*, and EPRI NP-5769, *Degradation and Failure of Bolting in Nuclear Power Plants*, Volume 1 and 2 with the exception noted in NUREG-1339 for safety-related bolting. In addition to the inspection activities noted above, the Bolting Integrity program includes activities for preload control, material selection and control, and use of lubricants/sealants as delineated in EPRI TR-104213, *Bolted Joint Maintenance and Applications Guide*.

ASME Section XI Inservice Inspection, Subsections IWB, IWC and IWD program (B2.1.1) supplements the Bolting Integrity program to manage cracking, loss of preload, and loss of material by providing the requirements for inservice inspection of ASME Class 1, 2, and 3 safety-related pressure retaining bolting. Examinations are currently performed in accordance with the ASME Section XI, 1998 Edition with the 2000 Addenda, per the ISI program plan. As required by 10 CFR 50.55a(g)(4)(ii), the Callaway ISI Program is updated during each successive 120-month inspection interval to comply with the requirements of the latest edition of the Code specified twelve months before the start of the inspection interval. Callaway will use the ASME Code Edition consistent with the provisions of 10 CFR 50.55a during the period of extended operation. The extent and schedule of the inspections is in accordance with IWB-2500-1, IWC-2500-1 and IWD-2500-1 and assures that detection of leakage or fastener degradation occurs prior to loss of system or component intended functions. Bolting associated with Class 1 vessel, valve and pump flanged joints receive visual (VT-1) inspection. For other pressure retaining bolting, routine observations identify any leakage before the leakage becomes excessive.

~~Inspection activities for bolting in a submerged environment are performed in conjunction with associated component maintenance activities. Inspection activities for bolting in buried and underground applications is performed in conjunction with inspection activities for the Buried and Underground Piping and Tanks (B2.1.25) program due to the restricted accessibility to these locations.~~

A sample of submerged bolting in raw water and waste water environments is visually inspected every four refueling outages (six years) during maintenance activities. A sample of submerged bolting on the fuel oil storage tank transfer pumps is visually inspected every 10 years during maintenance activities. The sample for submerged bolting will be 20% of the population with a maximum of 25 for each environment. The inspection of submerged bolting focuses on the bounding or lead components most susceptible to aging due to time in service and severity of operating conditions.

The integrity of non-ASME Class 1, 2, 3 system and component bolted joints is evaluated by detection of visible leakage during maintenance or routine observation such as system walkdowns. Inspection activities for non-ASME Class 1, 2, or 3 bolting in a submerged environment are performed in conjunction with associated component maintenance activities.

The Corrective Action Program is used to document and manage those locations where leakage was identified during routine observations including engineering walkdowns and equipment maintenance activities. Based on the severity of the leak and the potential to impact plant operations, nuclear or industrial safety, a leak may be repaired immediately, scheduled for repair, or monitored for change. If the leak rate changes (increases, decreases or stops), the monitoring frequency is re-evaluated and may be revised.

High strength bolts (actual yield strength ≥150 ksi) are not used on pressure retaining bolted joints within the scope of the Bolting Integrity program.

Procurement controls and installation practices, defined in plant procedures, include preventive measures to ensure that only approved lubricants, sealants, and proper torque are applied.

Safety-related and nonsafety-related structural bolting is managed by the following programs:

(a) ASME Section XI, Subsection IWE program (B2.1.26) provides the requirements for inspection of structural bolting.

(b) ASME Section XI, Subsection IWF program (B2.1.28) provides the requirements for inservice inspection of safety-related component support bolting.

(c) Structures Monitoring program (B2.1.31) monitors the condition of structures and structural supports that are within the scope of license renewal.

(d) RG 1.127, Inspection of Water-Control Structures Associated with Nuclear Power Plants program (B2.1.32) provides the requirements for inspection of water control structures associated with emergency cooling water systems.

(e) Inspection of Overhead Heavy Load and Light Load (Related to Refueling) Handling Systems program (B2.1.12) provides the requirements for inspection of handling systems within the scope of license renewal.

Reactor pressure vessel head closure studs are not included in the Bolting Integrity program. The Reactor Head Closure Stud Bolting program (B2.1.3) provides the requirements for inspection of the reactor vessel head closure studs.

Inspection activities for bolting in buried and underground applications is performed in conjunction with inspection activities for the Buried and Underground Piping and Tanks (B2.1.25) program due to the restricted accessibility to these locations.

**NUREG-1801 Consistency**

The Bolting Integrity program is an existing program that following enhancement, will be ~~is~~ consistent with NUREG-1801, Section XI.M18, *Bolting Integrity*.

**Exceptions to NUREG-1801**

None

**Enhancements**

~~None~~
Prior to the period of extended operation, the following enhancements will be implemented in the following program elements:

*Scope (Element 1) and Parameters Monitored or Inspected (Element 3)*

Procedures will be revised to include a visual inspection of a sample of submerged bolting in raw water and waste water environments every four refueling outages (six years) during maintenance activities. A sample of submerged bolting on the fuel oil storage tank transfer pumps will be visually inspected every 10 years during maintenance activities. The sample for submerged bolting will be 20% of the population with a maximum of 25 for each environment. The inspection of submerged bolting will focus on the bounding or lead components most susceptible to aging due to time in service and severity of operating conditions.

**Operating Experience**

The following discussion of operating experience provides objective evidence that the Bolting Integrity program will be effective in ensuring that intended functions are maintained consistent with the current licensing basis for the period of extended operation.

1. The Bolting Integrity program incorporates the applicable industry experience on bolting issues into the program. Actions taken include confirmatory testing/analysis or inspections. Also included are the addition of procedures of inspection, material procurement and verification processes.

2. A review of plant operating experience identified issues with corrosion, missing or loose bolts, inadequate thread engagement, and improper bolt applications. Identified concerns were corrected or evaluated to be accepted as-is. No generic bolting failure issues or trends have been identified. There is no documented case of cracking of pressure retaining bolting due to stress corrosion cracking. .

The operating experience of the Bolting Integrity program shows that the program effectively monitors and trends the aging effects of cracking, loss of material, and loss of preload on pressure retaining bolting and takes appropriate corrective action prior to loss of intended function. Occurrences that would be identified under the Bolting Integrity program will be evaluated to ensure there is no significant impact to safe operation of the plant and corrective actions will be taken to prevent recurrence. Guidance for re-evaluation, repair, or replacement is provided for locations where aging is found. There is confidence that the continued implementation of the Bolting Integrity program will effectively identify aging prior to loss of intended function.

**Conclusion**

The continued implementation of the Bolting Integrity program, following enhancement, provides reasonable assurance that aging effects will be managed such that the systems and components within the scope of this program will continue to perform their intended functions consistent with the current licensing basis for the period of extended operation.