MRP-227, REVISION 2, PRESSURIZED WATER REACTOR INTERNALS INSPECTION AND EVALUATIONS GUIDELINE

REQUESTS FOR ADDITIONAL INFORMATION (RAIS)
PROPRIETARY

Regulatory Basis: Part 54 of 10 CFR addresses the requirements for plant license renewal. The regulation at 10 CFR 54.21, "Administrative review of applications; hearings," requires that each application for license renewal contain an integrated plant assessment (IPA) and an evaluation of time limited aging analyses. The IPA shall identify and list those structures and components subject to an aging management review and demonstrate that the effects of aging (i.e., cracking, loss of material, loss of fracture toughness, dimensional changes, loss of preload) will be adequately managed so that their intended functions will be maintained consistent with the current licensing basis for the period of extended operation as required by 10 CFR 54.29, “Standards of Issuance of a Renewed License.”

Electric Power Research Institute (EPRI) Non-Proprietary Topical Report (TR) No. 3002020105, “Material Reliability Program: Pressurized Water Reactor Internals Inspection and Evaluation Guidelines (MRP-227, Revision 2)” (the “Subject TR;” Agencywide Documents Access and Management System (ADAMS) Accession No. ML22129A141) contains a discussion of the technical basis for the development of plant-specific aging management programs (AMPs) for reactor vessel internal (RVI) components in pressurized water reactor (PWR) vessels and provides inspection and evaluation guidelines for PWR applicants to use in their plant-specific AMPs. MRP-227, Revision 2, provides the basis for renewed license holders to develop plant-specific inspection plans to manage aging effects on RVI components, as described by their final safety analysis report commitment. The staff has the following questions (in the form of requests for addition additional information [RAIs]) on the updated inspection and evaluation (I&E) guidelines that were included in MRP-227, Revision 2 and submitted as the non-proprietary record in ADAMS Accession No. ML22129A141.

The general authority of the staff to review MRP-227, Revision 2 and issue RAIs (on behalf of the Commission) is established in Chapter 14, Section 161, Subsection c. of the Atomic Energy Act of 1954 (Section c. of 42 U.S.C. 2201, ADAMS Accession No. ML15364A497), which states the Commission may “*make such studies and investigations, obtain such information, and hold meeting or hearings as the Commission may deem necessary or proper to assist it in exercising any authority provided in this Act...*“ The staff applies the guidance in U.S. Nuclear Regulatory Commission (NRC) Office Instruction No. LIC-500, Revision 9, “Topical Report Process” (ADAMS Accession No. ML20247G279) as the basis for performing TR reviews.

Proprietary Marking: The staff’s request contains some proprietary materials from MRP-231 version background reports that were used to develop the component-specific screening results, inspection categorizations and I&E criteria for Babcock & Wilcox (B&W)-design PWR RVI components. The proprietary contents in RAI #10 are identified using a **[[yellow highlighted, bolded, double bracketed]]** text format. Consistent with the Commission proprietary withholding criteria in 10 CFR 2.390, the staff is protecting the identified proprietary material from public disclosure. For the redacted version, publicly available version of the RAI, the protected material will be deleted from the bolded brackets (i.e., designated by a blank **[[ ]]** bracketed format).

Enclosure 1

General Technical or Logistics Topics

RAI MRP-227-Gen-1 - Applicability of the Subject TR for PWR Reactor Units with Amended Operating Licenses that Allow Flexible (Non-Base Load) Plant Operations

Background and Issue: Appendix D of MRP-227, Revision provides EPRI MRP's statements regarding the applicability of the Subject TR for U.S. licensees that have been approved to implement flexible (non-base load) power operations of their PWR units. Previous criteria for flexible operations were given in MRP 2019-002 (ADAMS Accession No. ML19255E193). The staff notes that the information in Appendix D of the Subject TR appears to be extremely limited based on the following observations:

- EPRI MRP's flexible operation (FlexOp) impact assessment criteria defined in Appendix D of MRP-227, Revision 2, appear to be limited in that the criteria only apply to a 60-year service life; EPRI MRP did not perform corresponding studies and apply similar FlexOp impact assessment criteria for a 80-year service life. This issue applies to the RVI components in all operating PWR units regardless of the nuclear steam supply system vendor (i.e., Babcock or Wilcox Company [B&W], Combustion Engineering Company [CE], or Westinghouse Electric Company [Westinghouse or WEC]) used to fabricate the PWR RVI components.

- EPRI MRP's FlexOp impact assessment criteria defined in Appendix D of MRP-227, Revision 2 appear to be limited in that they do not apply to B&W units; EPRI MRP identifies that the potential impacts of flexible, non-base-load operations on the I&E criteria for B&W-design Primary and Expansion category components will need to be evaluated on a case by case basis for the five B&W-design PWR units that remain as operating reactors.

- In Appendix D of the Subject TR, EPRI MRP evaluated the following three FlexOp power change transients (assumed maximum power rate change 5 percent thermal power per minute) for potential impacts in the Chapter 4 and 5 I&E criteria for CE-design and WEC-design RVI components: (1) a 100 percent to 80 percent thermal power change, (2) a 100 percent to 70 percent thermal power change, and (3) a 100 percent to 30 percent thermal power change. For evaluated CE-design RVI components, EPRI MRP's FlexOp impact assessment criteria appear to be limited in that EPRI MRP does not include any supporting information or data for CE-design RVI components in the manner this was done for corresponding WEC-design RVI components in Table D-1, D-2 and D-3 of the Subject TR using information from either MRP-191, Revision1 or MRP-232, Revision 1 (for the 60-year analysis). In this regard, EPRI MRP states (without any supporting data) that CE-designed RVI components are "*substantially less susceptible to flexible operations that Westinghouse-design internals and would not be impacted by flexible operation as long the CE unit operations within it design cycles*." Yet the staff has observed that similar tables could have been developed for designated CE-design RVI components (i.e., in support of the above quoted and italicized statement) based on available data in MRP-191, Revision 1 or MRP-232, Revision 1 (if done for 60-year FlexOp impact assessments), or even in MRP-191, Revision 2 or MRP-232, Revision 2 (if EPRI MRP had decided to perform the FlexOp impact studies on an 80-year basis).

- EPRI MRP's FlexOp impact assessment criteria appear to be limited in that the scope of the 6-year FlexOp impact case studies provided in Appendix D do not cover: (1) flexible

operations from 100 percent rated power to less than 30 percent rated power, or (2) power changes that occur at a rate of change greater than 5 percent thermal power per minute.

- EPRI MRP's FlexOp impact assessment criteria defined in Appendix D of MRP-227, Revision 2 appear to be limited in that they do not establish whether FlexOps could potentially result in elevation of B&W-design, CE-design, and WEC-design "No Additional Measures" category components into either the Primary or Expansion category of the program (for both 60-year and 80-year service life assessments).

- The FlexOp impacts evaluated in Appendix D are focused to evaluate potential FlexOp impacts on RVI components whose inspection categorizations are based mainly on an evaluated fatigue mechanism. Yet the inspection categorizations for some components may be driven predominantly by time-dependent aging mechanisms other than fatigue (e.g. wear, or irradiation-enhanced stress relaxation/creep [ISR/IC] for bolted, keyed or spring loaded components). Thus, Appendix D appears to be limited in that it does not establish whether FlexOps could potentially impact the inspection categorizations of RVI components whose inspections categorizations derive from time-dependent mechanisms other than fatigue (e.g., wear, ISR/IC, irradiation-assisted stress corrosion cracking (IASCC), etc.).

The staff has also noted some potential quality issues with information provided in Appendix D of the Subject TR.[1]

RAI MRP-227-Gen-1

Request: Clarify whether the noted and bulleted observations above would constitute significant limitations on the use of MRP-227, Revision 2, Appendix D for B&W-design, CE-design, and WEC-design PWR RVI Primary and Expansion category components. Clarify whether flexible operations of B&W-design, CE-design, and WEC-design PWR units could potentially result in the elevation of designated No Additional Measures components into either the Primary or Expansion category of the program. Clarify why Appendix D does not need to address potential FlexOp impacts for RVI components whose final inspection categorizations are derived from aging mechanisms other than fatigue.

RAI MRP-227-Gen-2 - Use of American Society of Mechanical Engineering (ASME) Section XI VT-3 Visual Inspection Methods

Background and Issue: In Section 5.1.1 of the Subject TR, EPRI MRP addresses use of ASME Code Section XI VT-3 inspection methods for some PWR RVI component locations. Section 5.1.1 establishes that the ASME Section XI VT-3 visual inspection methods are appropriate for detection of the following types of component-specific surface conditions:

[1] For example, Table D-3 includes column entries for "*fatigue*" mechanism susceptibility rankings (i.e., "A" – low, "B" – moderate, or 'C" – high susceptibility rankings) as derived from MRP-191, Revision 1 60-year ranking information for the component types. However, the rankings for some listed components derive mainly from mechanisms other than fatigue (e.g., the cited Category "C" ranking for control rod guide tube [CRGT] guide cards/support cards are based mainly on guide card susceptibility to "wear"). Table 3-3 in MRP-227, Revision 2 lists the CRGT guide cards as Category "N" for fatigue.

- evidence of structural distortion or displacement of parts to the extent that component intended function may be impaired
- evidence of loose, missing, cracked, or fracture parts, bolting, or fasteners
- evidence of corrosion or erosion that reduces component section thickness by more than 5 percent of the defined nominal thickness for the component type
- wear of mating surfaces that may lead to loss of function
- structural degradation of interior attachments such that the original cross-section area is reduced by more than 5 percent

In comparison to these criteria, the 2019 Edition of ASME Code Section XI, Paragraph IWB-3520.2 contains an item "foreign materials or accumulation of corrosion products that could interfere with control rod motion or could result in blockage of coolant flow through fuel." However, this item is not listed as an additional surface condition (i.e., relevant condition type) in Section 5.1.1 of the Subject TR.

RAI MRP-227-Gen-2

Request: Justify why the relevant condition of "foreign materials or accumulation of corrosion products that could interfere with control rod motion or could result in blockage of coolant flow through fuel" is not listed as one of the relevant condition types for ASME Section XI VT-3 visual inspection methods discussed in Section 5.1.1 of the Subject TR.

RAI MRP-227-Gen-3 – deleted based on clarification call. Deleted RAIs are included in Enclosure 2

RAI MRP-227-Gen-4 - NRC Conditions Applying to EPRI Crack Growth Rate Report Source References, As Referenced in Chapter 6 of the Subject TR

Background and Issue: In Chapter 6 of the Subject TR, EPRI MRP references the following EPRI report (Chapter 8, Reference 38 in the Subject TR) as a potentially applicable EPRI source reference that may be used to establish bounding fluence-dependent crack growth rates (CGRs) for stainless steel materials

- Report No. 3002003103, "Models of Irradiation-Assisted Stress Corrosion Cracking of Austenitic Stainless Steels in Light-Water Reactor Environments: Volume 1: Disposition Curves Development," 2014.

Although the CGR methodology in EPRI Report No. has not yet been submitted or requested for staff review (and approval), EPRI has used the CGR modeling in EPRI Report No. 3002003103 as the basis for CGRs (of austenitic stainless steel materials) that were incorporated into ASME Code Case N-889, "Reference Stress Corrosion Crack Growth Rate Curves for Irradiated Stainless Steel in Light-Water Reactor Environments, Section XI, Division 1," as approved in Regulatory Guide (RG) 1.147, Revision 20 (ADAMS Accession No. ML21181A222). In RG 1.147, Revision 20, staff endorsed use of ASME Code Case N-889 with following conditions:

1) The code case must not be used for fluence levels greater than 20 dpa

2) For neutron fluences less than or equal to 0.75 dpa ($5x10^{20}$ n/cm^2), the CGR of Code Case N-889 must not be used unless they result in a higher CGR than the CGR calculated using the method of ASME Code Section XI, Non-Mandatory Appendix C, Article C-8520.

3) For cold-worked non-Molybdenum (Mo) bearing stainless-steel (SS) materials (including Type 304 and 347 SS), the irradiated yield stress model for cold-worked Mo-bearing SS materials must be used.

Yet Chapter 6 of the Subject TR does not identify that use of ASME Code Case N-889 and the associated CGR modeling in EPRI Report No. 3002003103 (as linked to use of the specified the Code Case) are subject to the stated conditions in Table 2 of RG 1.147, Revision 20.

RAI MRP-227-Gen-4

Request: Justify why the Chapter 6 discussions on stainless steel CGRs and CGR modeling do not include any guidance on how a licensee implementing the CRG modeling guidance in EPRI Report 3002003103 will need to address the three NRC conditions placed on this methodology, as defined in Table 2 of RG 1.147, Revision 20 for use of ASME Code N-889.

RAI MRP-227-Gen-5 - deleted based on clarification call. Deleted RAIs are included in Enclosure 2

B&W-Design Component-Specific Topics

RAI MRP-227-B&W-1 - Changes to Expansion-Link Criteria for B&W-Design Expansion Category Upper Thermal Shield (UTS) Bolts and Lower Thermal Shield (LTS) Bolt/Studs and Nuts

Background and Issue: In Tables 4-1 and 4-4 of the Subject TR, the EPRI MRP maintained the Item B7.1 UTS bolts and Item B8.1, LTS bolts/stud and nuts[2] as Expansion category bolts for the ultrasonic test (UT) inspections that would be performed based on the linked Primary Item B7 upper core barrel (UCB) bolts, Item B8, lower core barrel (LCB) bolts, and Item B12 flow distributor (FD) bolts. However, in Footnote 10 of Table 4-1 of the Subject TR, EPRI MRP qualifies the sample-expansion-link relationship between Primary category UCB, LCB, and FD bolts and Expansion category UTS bolts and LTS bolts/studs and nuts by including the following sample-*expansion* statement:

> "The Primary-Expansion relationship between the UCB, LCB, and FD bolts and the UTS and LTS bolts/studs is for stress corrosion cracking (SCC) only."

The staff previously addressed this type of reduced-scope *expansion*-link basis in the staff's issuance of RAI B2.1.7-1, Parts 1 and 2 on the pending Oconee Nuclear Station (ONS) subsequent license renewal application review (Refer to the issuance of RAI B2.1.7-1, Parts 1 and 2 in NRC ADAMS Accession No. ML22012A043). The staff has observed that issues identified in RAI B2.1.7-1 apply to the Table 4-1 Footnote 10 basis in the Subject TR due to the following reasoning:

1) For this type of sample-*expansion* basis to occur, a licensee of a B&W-designed PWR implementing the Subject TR and performing UT inspections of the Primary category UCB, LCB, and FD bolts would not only need to detect cracking in more than 10 percent of the population of UCB, LCB, or FD bolts (including previously failed or missing bolts) but would also need to perform some sort of confirmatory activity that would be capable of verifying that the cause of cracking in the Primary bolting type had actually initiated by an SCC mechanism. Yet the current criteria for bolt sample-*expansion* related to cracking in the Tables 5-1, 5-2, and 5-3 of the Subject TR is still based solely on detection of relevant indications of cracking independent of cause of cracking; and, specifically, for the case of potential *sample-expansion* to the UTS bolts and LTS bolts/studs, the EPRI MRP has yet to define and justify exactly what type of additional confirmatory activity would need to be performed under Items B7, B8, and B12 of Table 5-1 in the Subject TR to verify that the actual cause of cracking detected in the UCB, LCB, and FD bolting types was initiated by an SCC aging mechanism.

2) To date, the industry has yet to establish any type of UT inspection method that is capable generating UT monitoring equipment signals capable of distinguishing between relevant flaw indications initiated by SCC (or by irradiation-assisted stress corrosion cracking [IASCC]) from relevant crack-like conditions that may be initiated by a component-specific fatigue or cyclic loading mechanism (or by component overload).

[2] In the Subject TR, the applicable Expansion Item B8.1 LTS bolting types are specified as LTS bolts for the Arkansas Nuclear One, Unit 1 (ANO-1) plant and the Davis Besse (DB) unit, and as LTS studs and nuts for the three Oconee Nuclear Station units (ONS-1, ONS-2 and ONS-3).

RAI MRP-227-B&W-1

Request: Justify the Footnote 10 basis for restricting sample-*expansion* to the UTS bolts and LTS bolts/studs (presuming that cracking is first detected in more than 10 percent of the population of Primary UCB, LCB or FD bolt types) based only on confirmation that cracking detected in the Primary bolting type had initiated by SCC. As part of this basis, clarify whether the current state of UT technology in the industry is capable of generating UT signals that can distinguish crack-like indications induced by an SCC mechanism from crack-like indications induced by fatigue, cyclic loading, or component overload mechanisms. If the current Table 4-1 Footnote 10 basis is to be maintained in the Subject TR, justify why Items B7, B8, and B12 in Table 5-1 of the Subject TR would not need to be amended accordingly to define and justify the type of supplemental confirmation activities that would need to be performed for verification that relevant crack-like indications detected in the UCB, LCB, or FD bolt population had actually initiated by SCC.

RAI MRP-227-B&W-2 - Screening and Inspection Categorizations and I&E Criteria for B&W-Design Core Barrel Assembly Components - Fatigue Screening

Background and Issue for Part a.: In Table 3-1 of MRP-227, Revision 2 (the Subject TR), EPRI MRP establishes the following core barrel (CB) assembly components as Primary components predominantly on the susceptibility screening study and results for the assessed fatigue mechanism: (a) CB top and bottom cylinders, (b) CB top flange and bottom flange, (c) CB top flange-to-top cylinder circumferential seam weld, (d) CB top cylinder-to-bottom cylinder circumferential seam weld, (e) CB top cylinder and bottom cylinder axial seam welds, and (f) CB bottom cylinder-to-bottom flange circumferential seam weld. However, the tabular line item entries for the CB components include Notes 2 and 5 which states:

> Note 2 – "*Fatigue is permitted to be addressed by analysis in lieu of inspection*"

> Note 5 - "*The component was categorized as Primary (P) (core barrel cylinder items) ... for fatigue, but the examination coverage only applies to the . . . core barrel top flange, top flange weld, and top cylinder based on the justification in MRP-231."*

The Table 3-1 Note 2 language would allow disposition by fatigue analysis instead of inspection. Yet for the first renewed current licensing bases (FR-CLB) of the five remainging B&W PWR units in operation (i.e., ONS Units 1, 2, and 3, Arkansas Nuclear One, Unit 1, and Davis Besse Units 1), the FR-CLB for the units did not include any fatigue-related time limited aging analyses (TLAAs) that related to CB assembly base metal or weld components. Specifically, the staff has confirmed that that the only low cycle fatigue analysis (i.e., ASME Section III design cumulative usage factor analyses) that could serve as an existing as a TLAA for an RVI component type was that for some replacement RVI bolts made from Alloy X-750 materials (i.e., confirmed as being applicable at least to the ONS and Davis Besse units). Although the staff confirmed that the CLB did include a BAW-10051 flow-induced vibration (FIV) analysis (TLAA) for the RVI components, the FIV analysis in BAW-10051 for RVI components surrounding the core focused in part on assessing FIV impacts on the thermal shield structure and not the CB assembly in the units. Thus, the staff is not aware of any fatigue-related TLAA that for the CLB of the five units could be credited for disposition of the CB top and bottom flanges, top and bottom cylinders, and associated flange and cylinder seam welds that by analysis.

The Table 3-1 Note 5 language clearly indicates that, although the B&W-design CB top and bottom cylinder vertical seam welds, CB top-cylindert- bottom cylinder circumferential seam weld, bottom flange ,and bottom cylinder-to-bottom flange circumferential weld are Primary category comopnents, they will not be subject to any Primary category inspections during the subsequent period of extended operation. The staff has a logistics issue with this type of basis in that EPRI MRP has never before designated a specified RVI component as a Primary category component and then qualified the Primary categorization basis by not subjecting the specified Primary component to scheduled Primary category inspections. Instead, under the MRP-227 general methodology (including Revision 2), the Primary category components are the RVI components that are expected to be lead indicators of aging and are to be subject to Primary component inspections; it is the general MRP-227 methodology for Expansion components that permits sample-*expansion* to Expansion category components to be done by inspection or alternatively by component-specific analysis or repair/replacements activities. Yet the staff may comprehend why these CB asssembly bottom flange and bottom flange weld components may not need to be subject to aging management inspections, particularly if the component types are either predominantly or totally inaccessible to inspection. Thus, if fatigue is the aging mechanism that will drive the inspection category of the CB bottom flange and bottom cylinder-to-bottom flange circumferential seam weld, the staff has to question why EPRI MRP is not either: (1) defining and specifying the specific I&E criteria in Chapter 4, Table 4-1 and Chapter 5, Table 5-1 of the Subject TR for these components (if they are Primary category components), or else (2) alternatively establishing the B&W-design CB assembly bottom flange and CB assembly bottom cylinder-to-bottom flange circumferential seam weld as Expansion category components in appropriate line items of Tables 3-1, 4-1, 4-4 and 5-1 of the Subject TR, and then establishing the Primary-to-Expansion component links and applicable Expansion criteria for CB assembly bottom flange and bottom cylinder-to-bottom flange circumferential seam weld (including the possibility of sample-*expansion* by analysis) in appropriate adjustments of the Chapter 4 and 5 tabular criteria in the report (particularly, if these components are inaccessible to inspection).

RAI MRP-227-B&W-2

Request.: In relation Table 3-1 Note 2, justify why the Primary CB assembly components (including flanges, cylinders, and seam weld components) would not be subject to Primary category inspections if they were confirmed as being partially accessible to the applicable inspection techniques (Note; Part c. of this RAI addresses potential accessiblity considertions of the components). As part of the response, justify why Table 3-1 of the Subject TR designates the B&W-design CB assembly bottom flange and bottom cylinder-to-bottom flange circumferential weld as Primary category components, when according to Table 3-1, Note 5 the components will not be subject to any Primary category inspections when Tables 4-1 and 5-1 of the Subject TR fail to include any Primary category I&E criteria for the CB assembly bottom flange and associated bottom cylinder-to-bottom flange weld.

RAI MRP-227-B&W-3 - Screening and Inspection Categorizations and Inspection and Evaluation Criteria for B&W-Design CB Assembly Components - Screening of SCC, IASCC, and Irradiation Embrittlement (IE) Mechanisms

Background and Issue: In Table 3-1 of MRP-227, Revision 2 (the Subject TR), EPRI MRP establishes identifies a categorization of “P/N” for the assessed SCC, IASCC, or IE mechanisms

in the line items for the CB assembly CB top and bottom cylinders,[3] top flange, and top flange-to-top cylinder circumferential seam weld. However, the tabular line item entries for the CB components include either Note 6 and 7 which states:

> Note 6 – *"Primary (P) is applicable to plants that have had weld repairs performed in their top flange circumferential weld after the stress relief treatment. For plants that have not had weld repairs performed in their top flange circumferential weld after the stress relief treatment, No Additional Measures (N) is applicable."*
>
> Note 7 - *"Primary (P) is applicable to plants that have had weld repairs performed in their center circumferential weld after the stress relief treatment. For plants that have not had weld repairs performed in their center circumferential weld after the stress relief treatment, No Additional Measures (N) is applicable."*

The staff observes that under the Note 6 and 7 bases, EPRI MRP now allows initial weld design stress relief practices to be used as a basis for placing the specified B&W-design CB assembly base metal or weld component type into the No Additional Measures (NAM) category of the program, unless the component was weld repaired after the original weld design stress relief treatment.

The staff has the following logistical, technical, and safety-based issues with EPRI's position to use original weld design stress relief practices a basis for placing B&W-design CB assembly welds into the NAM category for B&W plant-specific RVI management programs that will be implemented during subsequent license renewal (SLR) periods:

- From a logistics perspective, EPRI MRP does not use original weld design stress relief practices as a basis for placing corresponding WEC- or CE-design CB assembly welds into the NAM category for the guidance in the Subject TR that applies to WEC-design or CE-design RVI management programs.

- From a logistics perspective, EPRI MRP did not use weld stress relief practices as a basis for placing B&W-design CB assembly weld types into the NAM category for the prior 60-year screening assessment of welds in either MRP-222-A or MRP-227, Revision 1-A; from a logistics perspective, EPRI MRP always categorized B&W-design CB assembly welds at least at the Expansion category level for B&W RVI management programs that would be implemented during 40 – 60 year initial license renewal (ILR) periods (Refer to Item B10.1 in Table 4-4 of MRP-227, Revision 1-A).

- From a technical perspective, the staff does not have any technical evidence to draw a conclusion that the minimized weld residual stress levels afforded by implementation of original weld design stress relief practices would still be maintained after irradiating the weld materials for prolonged, cumulative periods with the reactor at critical power levels through the expiration of an 80-year SLR period. Since prolonged irradiation of the weld materials may have the potential to change the microstructure of the welds, the staff does

[3] The CB cylinders (including vertical and circumferential seam welds) were within the scope of B&W-design RVI components that were designated by EPRI MRP as inaccessible, Expansion category components per applicant/licensee action item (A/LAI) #6, as issued in the staff's December 16, 2022, safety evaluation (SE) for MRP-227, Revision 0/MRP-227-A. EPRI MRP's position on designating these CB assembly components as inaccessible, Expansion category components was maintained in the MRP-227, Revision 1-A report.

not have sufficient confidence that the minimized weld residual stress levels afforded by original weld design stress practices would still be maintained after irradiating the same weld materials through the end of an 80-year SLR period.

- In Framatome's prior response to RAI 4-1 on the original MRP-227, Revision 0 review (i.e., on behalf of EPRI MRP in MRP 2010-066; refer to ADAMS Accession No. ML103160381), Framatome identified that B&W-design CB assemblies serve an important emergency function of properly orienting emergency reactor coolant through the reactor core and minimizing emergency reactor coolant flow bypass during a postulated loss of coolant accident event in B&W-designed PWRs. From a safety perspective, the staff considers this to be too significant of a safety function to allow for potential placement of B&W-design CB assembly welds into the NAM category of the program based solely of application of original weld design stress relief practices (i.e., does apply to repaired welds) during initial, pre-irradiated weld fabrication.

RAI MRP-227-B&W-3

Request: Justify the basis for allowing original weld design stress relief practices to be used as a basis for placing these types these types of CB assembly welds in the NAM category (i.e., if the welds are not subject to weld repair after implementation of stress relief). Alternatively, amend the Subject TR accordinlgy to define at least the most highly irradiated and partially accessible CB assembly weld component as the Primary weld for SCC/IASSC/IE of the CB assembly and to designate all other CB assembly flange or cylinder weld types as either Primary or Expanion category welds for the program (including appropriate Primary-to-Expansion sample-*expansion* considerations based on unit redundancy at the B&W-design sites of interest) based on all assessed mechanism.

RAI MRP-227-B&W-4 - Screening and Inspection Categorizations and Inspection and Evaluation Criteria for B&W-Design Core Barrel Assembly Components - Significant Changes to Component Accessibility Criteria for Assessed CB Assembly Components

Background and Issues: In the Subject TR, EPRI MRP has changed up the inaccessiblity claim for B&W-design CB assembly components (including CB assembly welds) by designated some of the CB assembly welds as Primary welds for Table 4-1 in the Subject TR, including: (1) New Primary Item B16, CB cylinder top flange circumferential weld HAZ, (2) New Primary Item B17, CB top and bottom cylinder center circumferential weld regions, and (3) New Primary Item B20. CB cylinder top flange circumferntial weld regions. In these new Primary Items, EPRI MRP identified that the Primary CB welds will be periodically inspected using either EVT-1 visual, UT, or eddy current testing (ECT) inspection techniques. This implies that some of the CB assembly welds are partially accessible to inspection, which is a change from the total inaccessibility claim being made for B&W-design CB assembly weld components in both MRP-227-A (under the past Applicant/Licensee Action Item [A/LAI] #6 topic) and MRP-227, Revision 1-A.

This creates a significant logistics issue for the review for B&W-design CB assembly welds in the Subject TR because, in the staff's prior reviews of MRP-227, Revision 0 and MRP-227, Revision 1, the staff was never afforded the opportunity to address minimum weld inspection coverage criteria for partially accessible B&W-design CB assembly welds due to the EPRI MRP's prior basis that all of the CB assembly seam welds were entirely inaccessible to inspection (Refer to Item B10.1 in Table 4-4 of MRP-227, Revision 1-A). Specifically, in

Item B10.1 of Table 4-4 in MRP-227, Revision 1-A, EPRI MRP formerly established that if sample-*expansion* was triggered by the results of Primary inspections performed on the RVI baffle plates, sample-*expansion* to the CB cylinder and associated cylinder seam welds would be accomplished by component-specific analysis or component-specific replacement activities. Based on the EPRI MRP's claims of total inaccessibility, the staff-approved these Expansion Item B10.1 expansion-link criteria for what were presumed as totally inaccessible CB assembly cylinder and cylinder weld components in the staff's April 25, 2019, safety evaluation for MRP-227, Revision 1/Revision 1-A.

In contrast, based the staff's corresponding reviews for Westinghouse-design and CE-design CB assembly welds during the prior MRP-277, Revision 0 and MRP-227, Revision 1 report reviews, EPRI MRP established minimum weld inspection coverage criteria for taking inspection credit of applicable WEC-design and CE-design CB assembly weld types as partially accessible welds for inspection. Under the MRP-227-A basis, this was set at a minimum coverage criterion of 75 percent of the total weld length for partially accessible WEC-design or CE-design CB assembly welds of interest; in MRP-227, Revision 1-A, the staff-approved a reduction of the minimum coverage criterion down to 50 percent of the total weld length for the partially accessible WEC-design or CE-design CB assembly welds of interest.

RAI MRP-227-B&W-4

Request: Given that the Subject TR is now designating some B&W-design CB assembly seam welds as partially accessible Primary category welds for inspection, define the minimum weld coverage criterion (i.e., in terms of minimum total weld length achieved by inspection) that will be used for taking inspection credit of the inspected, B&W-design Primary category CB assembly welds or even for B&W-design CB assembly weld that may be designated as partially accessible Expansion category welds. Justify the basis for the minimum weld coverage criterion that is selected for taking inspection credit of the partially accessible weld types. Additionally, for each of the B&W-design CB assembly welds defined in Table 3-1 of the Subject TR (i.e., for B&W-design CB top flange-to-top cylinder circumferential seam weld, CB top cylinder-to-bottome cylinder center circumferential seam weld, CB top and bottom cylinder vertical seam welds, and CB bottom cylinder-to-bottom flange circumferential seam weld), provide the anticipated degree of access (i.e., 0 percent up to 100 percent of the defined total weld length) that would be achieved by the inspection equipment if each of the EVT-1, UT or ECT inspection methods was applied to the specified weld type.

RAI MRP-227-B&W-4 - Expansion-Link Changes For MRP-227, Rev. 2, Table 4-1, Item B10 Baffle Plates and Item B10.2 Former Plate Relationships

Background and Issue: In Appendix F, Part 1, of MRP-227, Revision 2, EPRI MRP states that Tables 4-1, 4-4 and 5-1 (including notes) in MRP-227, Revision 2 were updated according MRP-231, Revision 4; this does not assist the staff in its review because it does not identify all of changes that are being made to Table 4-1, 4-4, and 5-1 in MRP-227, Revision 2 from the prior versions of those tables in MRP-227, Revision 1-A. In Tables 4-1 of the Subject TR, the staff has noted that EPRI MRP includes two different Primary B10 line items for the baffle plates: (a) a Primary B10 line item for the 40 – 60 year time period where the item sample-*expands* only to the Item B10.3 Expansion category lower grid rib sections, and (b) a Primary B10 line item for the 60 – 80 year time period where the item only sample-*expands* to the Item B10.2 former plates. In contrast, the prior 40 – 60 year B10 item in Table 4-1 of MRP-227, Revision 1-A sample-expanded to three types of Expansion category components:

(a) the Table 4-4 Item B10.1 Expansion CB cylinder (including vertical and circumferential seam welds), (b) the Table 4-4 Item B10.2 Expansion category former plates, and (c) the Table 4-4 Item B10.3 Expansion category lower grid rib sections.

In the updated 40 – 60 year version and the new 60 – 80 year version of Item B10, "Baffle Plates," in Table 4-1 of the Subject TR, EPRI removes the Item B10.1 Expansion category CB and CB seam welds as a cited Expansion category component class for Item B10 due to EPRI MRP's decision to update and disjoint the aging management criteria for the CB top and bottom flanges, top and bottom cylinders, and associated vertical and circumferential seam welds from being linked to aging management criteria in the Subject TR for the baffle plates. In the 60 – 80 year version of Item B10, EPRI no longer lists the lower grid rib sections as a cited Expansion category component class for the Item B10 baffle plates because the EPRI MRP has conservatively elevated the lower grid rib sections to a Primary category component class for the MRP-227-based program that will be implemented during the 60 – 80 year SLR period.

However, the basis for removal of the Item B10.2 "former plates" from the scope of the updated 40 – 60-year version of Item B10 is less evident. Specifically, the last staff-approved 40 – 60 year aging mechanism screening ranking assessments for the former plates were established in Table 3-1 of MRP-227, Revision 1-A, as supported by the proprietary technical screening result bases in Sections 2.1.3.1 and 2.1.4 of EPRI MRP Proprietary Report MRP-231, Revision 3 (non-public) for the proprietary assessments of the **[[** **]]** aging mechanisms. Thus, in MRP-227, Revision 1-A, the former plates were left as inaccessible, Expansion category plates for the Primary category baffle plates based on the following MRP-231, Revision 3, Section 2.7 proprietary screening result bases: (1) **[** **]**, (2) **[** **]]**, and (3) **[** **]**. For the corresponding assessments in Sections 2.1.3.1 and 2.1.3.4 of Proprietary MRP-231, Revision 4, the staff perceives that the EPRI MRP is working off of prior assessments for **[[** **]]** in MRP-231, Revision 3, with a bit of additional screening justifications in MRP-231, Revision 4. But Section 2.7 of MRP-231, Revision 4, does not provide the **[** **]** of the former plates in the manner that this categorization basis was provided for the former plates in Section 2.7 of MRP-231, Revision 3. Yet, the removal of the former plates as Expansion category components for the 40 – 60-year version of Item B10 in Table 4-1 of MRP-227, Revision 2 appears to now be resulting in a **[** **]]**.

RAI MRP-227-B&W-5

Request: Justify the basis for removing the Item B10.2 former plates as cited Expansion category components for the 40 – 60 year-version of Item B10, "Baffle Plates," in Table 4-1 of the Subject TR. As part of this, provide the proprietary **[** **]]** of the former plates.

RAI MRP-227-B&W-6 - Aging Management of B&W-Design Baffle-to-Baffle Bolts, Core Barrel-to-Former Bolts, and Associated Bolt Locking Devices (Complex Technical Topic; Prior A/LAI #6 Expansion Category Components)

Background and Issue: In Expansion Item B9.1 of Table 4-4 of the Subject TR, the EPRI MRP establishes that B&W-design core barrel-to-former (CB-F) bolts and baffle-to-baffle (BB) bolts are Expansion category components for the Primary Item B9 baffle-to-former (BF) bolts in the program. For aging management of the CB-F and BB bolts in the Subject TR, the applicant maintains its previous position that the industry has yet to develop a qualified industry inspection method for the internal BB bolts and that the CB-F bolts and external BB bolts are inaccessible to UT inspection methods.

Under this type of basis, if sample-*expansion* to the internal and external BB bolts and CB-F is triggered by the results of Primary UT inspections of the BF bolts, sample-*expansion* is accomplished by performance of a component-specific analysis of the internal and external BB bolts, or alternatively by component-specific repair/replacement activities. The internal and external BB bolts, the CB-F bolts, and the locking devices for the CB-F bolts and external BB bolts were among the CB assembly and baffle-former assembly components that were within the scope of Applicant/Licensee Action Item (A/LAI) #6, as issued in the staff's December 16, 2011, safety evaluation for MRP-227 Revision 0/MRP-227-A; thus, the sample-*expansion* basis in the Subject TR for these components is a carry-over from the aging management criteria for internal and external BB bolts in Table 4-4 of the MRP-227-A and of MRP-227, Revision 1-A reports, where the bolt and bolt locking device accessibility considerations and inspection method capabilities for internal B&W-design BB bolts were considered as far back as the time when MRP-227, Revision 0 was submitted for staff review in January of 2009. As a result, the staff notes that MRP-227, Revision 2 methodology is propagating the prior I&E informational gap for development of a qualified inspection method for B&W-design internal BB bolts.

Thus, presuming that the internal BB bolts are at least partially accessible to inspection, the persistent lack of qualified inspection method for the internal BB bolts suggests that an alternative closure approach may be necessary to adequately close issue.

In addition, in the Subject TR, EPRI MRP identifies that some of the prior CB assembly welds (refer to the topic of RAI #8, Part c.) that were previously identified as being inaccessible components in prior A/LAI #6 topic are partially accessible to inspection. Given the change in accessible considerations for these CB assembly weld types, the staff also has to consider whether the prior claim of inaccessibility for the external BB bolt and CB-F bolt populations (and the populations of CB-F bolt and external BB bolt locking devices) is accurate, as the these bolting types and bolt locking devices were within the scope of the past A/LAI #6 issue and claimed as being totally inaccessible to inspection.

RAI MRP-227-B&W-6

Request:

a. Provide the basis why the industry has not yet defined and developed a qualified inspection method for B&W-design internal BB bolts, or alternatively, why a qualified inspection method does not need to be defined, developed, and credited for aging management of B&W internal BB bolts in the future (e.g. an alternative acceptable basis for these components

than a qualified inspection method). Based on this response, clarify whether the alternate bases for *expanding* (i.e., if *expansion* is triggered, expansion by analysis or component replacement activities) to the internal BB bolts in Item B9 of Table 4-1 of MRP-227, Revision 1-A remains expansion basis for the managing the internal BB bolts during the 60 – 80 year SLR period per Item B9 in Table 4-1 of the Subject TR.

b. For the CB-F bolts and external BB bolts, and the locking devices of the CB-F bolts and external BB bolts, clarify whether the populations of the specified component types are totally inaccessible to inspection or only a portion of component populations are inaccessible to inspection. If it is the latter case and it is confirmed that only a portion of the component type population is inaccessible to inspection, provide the basis why the Expansion criteria for the specified B&W-design Expansion category component type is not being based on crediting and justifying a specified qualified inspection method for the percentage of the bolts or bolt locking devices that are accessible to inspection.[4]

[4] For inspection credit of redundant bolting populations, the minimum population of inspected bolts for inspection credit is currently set at a minimum 75 percent population of the bolts, as indicated in Section 3.3.1 of the staff's December 16, 2011, safety evaluation (ADAMS Accession No. ML11308A770) for MRP-227, Revision 0/Revision A.

CE-Design Specific Topics

RAI MRP-227-CE-1 - Inspection and Evaluation Criteria for CE-Design Core Support Barrel (CSB) Assembly Flexure Welds and Upper Internals Assembly (UIA) Fuel Alignment Plates

Background and Issue: In the screening-based line item for the CSB flexures welds in Table 3-2 of the Subject TR, EPRI MRP identifies that the Final Group's inspection category for the flexure welds is "P, E", as based on an inspection category ranking of "P, E" for the assessed SCC and fatigue mechanisms. The actual inspection category for CSB flexure weld depends on performance of an 80-year screening analysis for the assessed fatigue mechanism, where the CSB flexure weld is designated as a Primary category weld and will be subject to periodic EVT-1 visual inspections if the welds screens in for fatigue per C7 in Table 4-2 of the Subject TR. However, in MRP-227, Revision 2, the CSB flexure weld is no longer subject to SCC screening because the flexure weld screened in for SCC and is age-managed as an Expansion component for the Primary CSB upper flange weld (UFW) per Item C5 in Table 4-2 of the Subject TR and Item C5.5 in Table 4-5 of the Subject TR. However, it is not established in Item C5 of Table 4-2 whether the CSB flexure weld would still be an Item C5.5 Expansion category component for the Primary Item C5 CSB UFW in Table 4-2 of the Subject TR, if the CSB flexure weld screened in for fatigue and was identified as an Primary category weld for the program per Item C7 in Table 4-2 of the Subject TR.

Similarly, in the screening-based line item for the UIA fuel alignment plate in Table 3-2 of the Subject TR, EPRI MRP identifies that the Final Group's inspection category of the fuel alignment plate is "P, E", as based on an inspection category ranking of "P. E" for the assessed fatigue and IE mechanisms. The actual inspection category for UIA fuel alignment plate depends on performance of an 80-year screening analysis for the assessed fatigue mechanism, where the fuel alignment plate is identified as designated Primary category plate if the plate screens in for fatigue per Item C10 in Table 4-2 of the Subject TR. If the UIA fuel alignment plate does not screen in for fatigue, the plate type is established as an Expansion category plate for the CSB middle girth weld (MGW) per Item C6 Table 4-2 of the Subject TR and per Item C6.4 in Table 4-5 of the Subject TR. However, it is not established in Item C6 of Table 4-2 whether the UIA fuel alignment plate would still be an Item C6.4 Expansion category plate for the Primary Item C6 CSB MGW in Table 4-2 of the Subject TR, if the UIA fuel alignment plate screened in for fatigue and was identified as a Primary category plate for the program per Item C10 in Table 4-2 of the Subject TR.

RAI MRP-227-CE-1

Request: Clarify whether the Primary inspections of the CSB UFW per Item C5 in Table 4-2 of the Subject TR will sample-*expand* to the Expansion Item C5.5 CSB flexure weld if the CSB flexure weld screens in for fatigue (i.e., for the 80-year fatigue screening assessment) and is categorized as a Primary Item C7 category weld in Table 4-2 of the Subject TR (and will be subject to the EVT-1 inspection). Similarly, clarify whether the Primary inspections of the CSB MGW per Item C6 in Table 4-2 of the Subject TR will sample-*expand* to the Expansion Item C6.4 UIA fuel alignment plate if the fuel alignment plate screens in for fatigue (i.e., for the 80-year fatigue screening assessment) and is categorized as a Primary Item C10 category plate in Table 4-2 of the Subject TR (and will be subject to the EVT-1 inspection).

RAI MRP-227-CE-2 - Inspection and Evaluation Criteria for CE-Design Control Element Assembly (CEA) Shroud Bolts (Applicable to All CE Units With a Lower Core Support Plate)

Background and Issue: Table 4-2 in the Subject TR includes new line Item C19 for the CE-design PWR units that include CEA shroud bolts. In this item, EPRI designates the CEA shroud bolts as Primary category components for the 60 – 80 Year SLR period (the bolts are NAM components for 40 – 60 Year ILR periods), without any linked Expansion category components. Item C19 includes the following "Examination Method/Frequency" column entry basis for the CEA shroud bolts:

> If screening for IASCC cannot be satisfied by plant-specific or generic evaluation, volumetric (UT) examination within two refueling outages of subsequent license renewal. The plant-specific or generic analysis must also demonstrate that wear and fatigue are either adequately managed or that the plant falls below screening thresholds. Subsequent examinations are at a 10-year interval.

The inspection frequency and frequency basis are worded to ensure that the 80-year screening evaluation/analysis (if performed for the SLR period) accounts for screening assessments of the IASCC, wear, and fatigue aging mechanisms. Yet in Table 3-2 of MRP-227, Revision 2, EPRI MRP indicates that the CEA shroud bolts are Primary (i.e., Category "P") for the IASCC, fatigue, IE, and irradiation-enhanced stress relaxation or creep (ISR/IC) aging mechanisms. This is supported by both the proprietary safety-based and economic-based technical assessments for the CEA shroud bolts in MRP-232, Revision 2.

To screen out of the UT inspection need, the screening assessment would have to be performed on a component-specific, unit-specific, or supplemental generic analysis basis, as the generic 80-year proprietary technical assessment for the CEA bolts was already performed in MRP-232, Revision 2; and the proprietary generic analysis used to develop the component-specific screening basis in MRP-227, Revision 2 resulted in "*screening-in*" of the bolts for the IASCC, fatigue, IE, and ISR/IC mechanisms (as confirmed and designated in Table 3-2 of MRP-227, Revision 2 as Category "P" mechanisms). To be capable of avoiding the Primary UT inspection necessity during the SLR period, the supplemental screening evaluation/analysis would have to ensure that the CEA shroud bolts would screen out for all four of the aging mechanisms that the bolts had been identified as Category "P" in Table 3-2 of the Subject TR (i.e., IASCC, fatigue, IE, and ISR/IC mechanisms). Yet of these four mechanisms, the screening statements in the "Examination Method/ Frequency" column entry of Item C19 only accounts for screening of the IASCC and fatigue mechanisms. The screening statements in Item C19 also state that screening of wear in the CEA shroud bolts needs to be done; yet in comparison, the CEA shroud bolts screen in as Category "N" for "wear" in Table 3-2 of the Subject TR.

RAI MRP-227-CE-2

Request: Justify why the screening evaluation/analysis necessity in Item C19 of Table 4-2 does not apply the screening analysis to all four of the aging mechanisms that the CEA shroud bolts screened in as Category "P" in Table 3-2 or MRP-227, Revision 2 (i.e., apply the screening analysis/evaluation necessity to all four of the IASCC, fatigue, IE, and ISR/IC mechanisms). Is there a reason why Item C19 is also applying the screening evaluation/analysis necessity to the aging mechanism of wear (i.e., wear is Category "N" in Table 3-2 of the Subject TR)? And if

screening of wear is needed as one of the aging mechanisms assessed (by screening) for the UT inspection necessity determination, why is wear identified as Category "N" in Table 3-2 of the Subject TR? If the screening analysis can be performed using a "generic" type of analysis, does the statement reference of a generic analysis apply to a supplemental generic analysis other than the proprietary generic analysis that was already performed and applied to the CEA shroud bolts in MRP-232, Revision 2?

RAI MRP-227-CE-3 - "Reference" Column Entry Information for Item C20 ICI Thimble Tubes -Lower in Table 4-8 of the Subject TR

Background and Issue: Table 4-8 of the Subject TR includes a new component-specific Item C20 for the incore instrumentation (ICI) thimble tubes, which applies to all operating CE-design PWRs that are designed with top-mounted ICI. The new Item C20 references that a plant-specific program exists for these types of tubes and states that the examination method is set "by the plant-specific programs but may require updates for SLR operation." The staff has reviewed the supporting proprietary information in Section 4.1.7 of MRP-232, Revision 2 and has observed that the MRP-232, Revision 2 background report does not provide sufficient supporting documentation as to the type of inspection and evaluation protocols will be implemented as part of these CE-design ICI thimble tube-specific Existing Programs. Thus, the staff is unable to determine which type of *existing* plant-specific program applies to the top-mounted ICI thimble tubes or which type of inspection or alternative aging management activities will be applied to the top-mounted ICI thimble tubes, as evaluated for potential SLR impacts on the inspection method or the inspection frequency or acceptance criteria (or alternate aging management activities) that apply to the Existing Program method.

RAI MRP-227-CE-3

Request: Clarify whether there is any specific industry document or record that establishes the plant-specific Existing Program for the top-mounted ICI thimble tubes, and if so, whether the industry record or document identifies the inspection method and inspection frequency (or alternate aging management basis) that will be applied to the top-mounted ICI thimble tubes during the SLR period. If there is an applicable industry record or document for the top-mounted ICI thimble tubes, clarify the type of inspection or evaluation criteria (or alternate aging management criteria) that "*may require updates for SLR operation*," and whether the applicable industry source document or record of reference has been submitted to the NRC for inclusion in ADAMS (i.e., for informational objectives only).

Westinghouse-Design Specific Topics

RAI MRP-227-WEC-1 - Inspection Categorization Results for Westinghouse-Design Conduit Seal Assembly Components

Background and Issue: In Table 3-3 of the Subject TR, the conduit seal assembly components are identified as NAM category components inclusive of plant operations through a 80-year SLR period. The conduit seal assembly components were not included for 60-year ILR period screening in Table 3-2 of MRP-227, Revision 1-A.

In Section 4.2.8 of MRP-232, Revision 2, EPRI MRP states the conduit seal assembly [[ ]]. EPRI MRP provides its proprietary inspection categorization bases for the conduit seal assembly tubes, bodies, tubesheets, and tubesheet welds in Section 4.2.8 of MRP-232, Revision 2. In Section 4.2.8 of MRP-232, Revision 2, EPRI MRP identifies that the [[ ]]. In Section 4.2.8 of MRP-232, Revision 2 EPRI MRP also makes the following statements regarding the structural integrity of conduit seal assemblies:

[[ ]]

In Section 4.2.8.2 of MRP-232, Revision 2, EPRI MRP states that the conduit seal assembly tubes, bodies, tubesheets and tubesheet welds [ ]. From the staff's understanding, the [ ]], which are outside the scope of the MRP-227 methodology and would rely on detection of a component failure (i.e., detection of system reactor coolant pressure boundary leakage) as an adequate AMPs categorization protocol. In the proprietary basis, EPRI states that there has been relevant operating experience with [[ ]]. Yet in Section A.1.2.3.4 of NUREG-2192 (SRP-SLR, ADAMS Accession No. ML16247A402), Appendix A-1, the staff establishes its aging management position that a "*program based solely on detecting structure and component failure should not*

be considered as an effective AMP for SLR;" this prohibits waiting for [ ]. Thus, EPRI MRP's basis for using [ ]] of the program do not appear to be appropriate when considered in context with the staff's stated position on aging management protocols that rely on detection of component failures (as established in Section A.1.2.3.4 of NUREG-2192, Appendix A-1).

RAI MRP-227-WEC-1

Request: Justify why the Westinghouse-design conduit seal assembly tubes, bodies, tubesheets, and tubesheet weld are not being categorized as Primary components for the program, as based on; (1) screening in of these components for [ ]], (2) the [ ]] of the components, and (3) the past operating experience of [ ]] in the referenced conduit seal assembly components.

RAI MRP-227-WEC-2 - Inspection Categorization Results for WEC-Design CB Outlet Nozzles and Safety Injection Nozzles

Background and Issue: In Table 3-3 of the Subject TR, the CB outlet nozzles and safety injection (SI) nozzle interfaces are identified as NAM category components inclusive of plant operations through a 80-year SLR period. In Table 3-3 of MRP-227, Revision 1-A, the CB outlet nozzles were identified as Item Expansion category components for 60-year ILR period screening.

In Sections 4.2.2.6 and 5.1.2.2 of Proprietary Report No. MRP-232, Revision 2, EPRI MRP identifies that aging management of [ ]]. If this is the case, it is not evident why the updated component-specific assessments in Table 3-3 of MRP-227, Revision 2, would not categorize the Westinghouse-design CB outlet nozzles and SI nozzles as Existing Program components in Table 3-3 based on the mechanism of [ ]] and why Table 4-9 of MRP -227, Revision 2 does not include additional Existing Program line items for the CB outlet nozzle and SI nozzles, as linked to the management of [ ]] in the nozzle types.

RAI MRP-227-WEC-2

Request: Provide the basis why Table 3-3 in MRP-227, Revision 2 does not identify Westinghouse-design CB outlet nozzles and SI nozzles as Existing Program components for the version of the PWR Vessel Internals Program that will be implemented during 40 – 80 year service periods. Justify why Table 4-9 in MRP-227, Revision 2 does not include any applicable Existing Program based line items for Westinghouse-design CB outlet nozzle and SI nozzles.

RAI MRP-227-WEC-3 - Referencing of WCAP-17451 Versions for Aging Management of Westinghouse-Design Control Rod Guide Tube (CRGT) Guide Plates (Guide Cards)

Background and Issue: The EPRI MRP cites two different versions of Proprietary Report No. WCAP-17451 as the basis for managing loss of material due to wear in the CRGT guide cards: (1) WCAP-17451-P, Revision 1 in MRP-227, Revision 2 (i.e., Reference 37 in Chapter 8 of the Subject TR), and (2) WCAP-17451-P Revision 2 in MRP-232, Revision 2 (Reference 26 in the referenced Proprietary MRP-232, Revision 2 report).

RAI MRP-227-WEC-3

Request: Reconcile the difference between the version of WCAP-17451-P (i.e., Revision 1) being referenced in MRP-227, Revision 2, for management of wear in the CRGT guide cards from the version of WCAP-17451-P (i.e., Revision 2) being referenced for the CRGT guide cards in Proprietary Report No. MRP-232, Revision 2.

RAI MRP-227-WEC-4 - deleted based on clarification call. Deleted RAIs are included in Enclosure 2

MRP-227, Rev. 2, Appendix C, Alternate Aging Management Strategies

RAI MRP-227-App C-1 - deleted based on clarification call. Deleted RAIs are included in Enclosure 2

RAI MRP-227-App C-1 - Alternate Aging Management Strategies for B&W-Design RVI Components

Background and Issue: The methods in the "Impacts of Primary-Expansion Component Relationships," "Continued Management of Aging Degradation Mechanisms," and "Incorporation of Relevant Operating Experience" Sections in Appendix C provide a general nexus of EPRI MRP perspectives on the technical and regulatory matters that should considered if considering alternative MRP-227, Revision 2, Section 7.3 aging management strategies. The technical review matters considered for alternate strategies are discussed as a general concept regardless of the NSSS designer and vendor for a particular PWR RVI component. On Page C-1, EPRI MRP states that "…Alternate aging management considerations associated with B&W-designed plants are addressed outside of this guidance on a unit-specific basis…" But if alternate strategies are needed for RVI component types in comparable WEC-design or CE-design PWR units, the alternate strategies would also need to be developed on a unit-specific or component-specific alternate basis. Thus, it is not evident why the B&W-design RVI components are being singled out from the criteria in the "Impacts of Primary-Expansion Component Relationships," "Continued Management of Aging Degradation Mechanisms," and "Incorporation of Relevant Operating Experience" Sections in Appendix C solely on the fact that the alternate strategy for B&W component would be done on unit-specific basis.

RAI MRP-227-App C-1

Request: Justify why the alternate strategy criteria defined and discussed in the "Impacts of Primary-Expansion Component Relationships," "Continued Management of Aging Degradation Mechanisms," and "Incorporation of Relevant Operating Experience" Sections of Appendix C are being singled out from being applicable to the alternative strategy review process for B&W-design components, even if the alternate strategy review process will be performed on a unit-specific basis.

RAI MRP-227-App C-3 - Staff Review of Proposed Alternate Aging Management Strategies for PWR RVI Components

Background and Issue: Page C-1 states that "…As any particular alternate approach becomes more popular, the industry could consider creating generic evaluations and justifications for that case through the PWROG or other industry group. However, the wide variability in plant designs and potential proactive approaches makes it likely that case- and plant-specific evaluations and justifications will constitute most cases…"

Page C-2 states that "…The plant should also evaluate any potential impacts to downstream program implementation documentation and licensing submittals and commitments…"

Per the reference in Section 7.3 of MRP-227, Revision 2, the criteria for implementing alternate inspection strategies in Appendix C of the Subject TR applies to any defined RVI Primary, Expansion or Existing Program component in the applicable Category in Chapter 4 or 5 of the Subject TR; this is regardless of the NSSS-designer of the RVI component type. However, the

selected alternate aging management strategy may or may not be an NRC staff-approved process. This creates a regulatory logistics issue if the alternate strategy is not a staff-approved strategy, as the standard type of aging management strategy for the specified RVI component type defined in the Chapter 4 and 5 tables of the Subject TR would presumably be staff-approved in the upcoming safety evaluation for the report.

RAI MRP-227-App C-3

Request: Clarify whether a given selected, alternate aging management strategy and the criteria for implementing an alternate aging management strategy will need to be the subject of a staff review and approval process prior to implementation of the alternate strategy. If not, justify why the selected alternate aging management strategy would not require NRC staff approval prior to implementation.

RAI MRP-227-App C-4 - Operating Experience Reviews for Potential Impacts on Proposed Alternate Aging Management Strategies for PWR RVI Components

Background and Issue: Page C-6 states that "…it is recommended that the update to the AMPs for an alternate approach include a thorough review of operating experience and that the utility consider consultation with the original equipment manufacturer for additional operating experience and lessons learned…It is recommended that the operating experience review and AMPs update be conducted prior to implementing an alternate aging management approach, if possible…"

The staff noted that both statements point to recommending actions instead of requiring actions. However, the "Corrective Actions," "Confirmation Process", and "Administrative Controls" program elements of GALL-SLR AMP XI.M16A, "PWR Vessel Internals," would call for the operating experience reviews (i.e., for potential impact on the proposed alternative aging management strategy) as part of the 10 CFR Part 50, Appendix B, NEI 03-08, and MRP-227 Chapter 7 implementations processes; thus, it is not evident why the operating experience reviews are being suggested as recommended activities.

RAI MRP-227-App C-4

Request: Justify why the referenced "operating experience" review (i.e., as performed for assessing potential impacts on the proposed alternate aging management strategy) would not need to be performed in accordance with the program element criteria of the "Corrective Actions," "Confirmation Process", and "Administrative Controls" program elements the applicant's or licensee's PWR Vessel Internals Program, which invoke the 10 CFR Part 50, Appendix B, NEI 03-08, and MRP-227 Chapter 7 implementations processes.

MRP-227, REVISION 2, PRESSURIZED WATER REACTOR INTERNALS INSPECTION AND EVALUATIONS GUIDELINE

REQUESTS FOR ADDITIONAL INFORMATION (RAIS) DELETED AFTER CLARIFICATION CALL

RAI MRP-227-Gen-3 - Industry Open Item on Lower Bound Fracture Toughness Values As Related to Fracture Toughness Report Source References in Chapter 6 of the Subject TR

Background and Issue: In Chapter 6 of the Subject TR, EPRI MRP references the following EPRI reports as potentially applicable EPRI source references for establishing the fracture toughness acceptance criteria values that are needed for performance of component-specific flaw or fracture toughness analyses:

- Report No. 3002008388, "BWRVIP [Boiling Water Reactor Vessel Internals Program]-100, Revision 1-A: BWR [boiling water reactor] Vessel and Internals Project, Updated Assessment of the Fracture Toughness of Irradiated Stainless Steel for BWR Core Shrouds," February 2017 (Proprietary/Non-Public)

- Report No. 1016106, "Material Reliability Program: Fracture Toughness Evaluation of Highly Irradiated PWR Stainless Steel Internal Components (MRP-210)," December 2007 (Proprietary/Non-Public)

- Report No. 3002010270, "Materials Reliability Program: Age-Related Material Properties, Degradation Mechanisms, Models, and Basis Data – State of Knowledge (MRP-211, Revision 1)," October 2017 (Proprietary/Non-Public)

The lower bound fracture toughness acceptance criteria values referenced in MRP-211, Revision 1 for irradiated stainless-steel materials are based on those referenced for irradiated stainless-steel materials in BWRVIP-100, Revision 1-A. Yet, in MRP 2021-030, "Potential Non-Conservatism in EPRI Report, BWRVIP-100, Revision 1-A, 3002008388 and Impacted BWRVIP Reports" (dated March 22, 2021; ADAMS Accession No. ML21084A164), EPRI MRP reported "a potential non-conservatism in ... BWRVIP ... guidance on fracture toughness values for evaluation of irradiated of irradiated stainless steel reactor internals components."

In MRP 2021-030, EPRI states that the potential "non-conservatism" issue was issued as a "10 CFR Part 21 Transfer of Information Notice" to participating EPRI members.[5] The fracture toughness evaluation discussions in Chapter 6 of the Subject TR (as referenced to the guidelines in the MRP-211, Revision 1 and BWRVIP-100, Revision 1-A reports) do not address the potential non-conservatism related issue raised in the MRP 2021-030 letter or how a licensee implementing the MRP-227, Revision 2 methodology would need to address this potential non-conservatism (on reported lower bound fracture toughness acceptance criteria

[5] The notice dated February 19, 2021 and is entitled "10 CFR Part 21 – Transfer of Information Notice – Potential Non-Conservatism in EPRI Software, BWRVIP-235, 1018251." The BWRVIP-235 software was used for the fracture toughness values reported in BWRVIP-100, Revision 1-A.

values) if licensee was using BWRVIP-100 Revision 1-A or MRP-211, Revision 1 as the source of the lower bound fracture toughness acceptance criteria values.

Additionally, there is a typographical error in the Chapter 8, Reference 26 for the BWRVIP-100, Revision 1-A report, which cites the year of issuance of the report as 2016; yet BWRVIP-100, Revision 1-A (as submitted) identifies the time of issuance as February 2017. The Year 2016 reference is actually for the prior BWRVIP-100-A report. Thus, Reference 26 needs to be corrected to cite the Final Issuance date of BWRVIP-100, Revision 1-A as February 2017.

RAI MRP-227-Gen-5 - Chapter 6 Reference for Use of WCAP-17096-NP-A, Revision 2

Background and Issue: In Chapter 6 of the Subject R, EPRI MRP states that the guidance in NRC-approved non-proprietary report WCAP-17096-NP-A, Revision 2 (Reference 33 in the Subject TR; ADAMS Accession No. ML16279A320) may be used as an acceptable methodology for evaluating examination results that do not meet EPRI MRP examination acceptance criteria defined in the Chapter 5 tables of the Subject TR. The staff has some definite logistics issues with the referencing of WCAP-17096-NP-A, Revision 2 in MRP-227, Revision 2 because:

(1) the past scope of WCAP-17096-NP-A, Revision 2 only applied to the scope of those B&W-, CE- or WEC-designed PWR RVI components that were identified as Primary or Expansion components as of the status of Primary category components defined in Tables 4-1, 4-2, and 4-3 of MRP-227-A report or as Expansion category components in Tables 4-4, 4-5, or 4-6 of MRP-227-A,

(2) it is Pressurized Water Reactor Owners Group (PWROG) Non-Proprietary Report No. WCAP-17096, Revision 3 that applies to the scope of components designated as Primary or Expansion category components in Tables 4-1 through 4-6 of the MRP-227, Revision 1-A report and the NRC has yet to issue its Final Safety Evaluation Report in approval of the methods and guidelines in WCAP-17096, Revision 3, and

(3) the PWROG has yet to develop or submit any subsequent version of WCAP-17096 that applies to the status of B&W, CE, and Westinghouse components that are firmly designated as Primary category components in Tables 4-1, 4-2, and 4-3 of Subject TR or as Expansion category components in Tables 4-4, 4-5, or 4-6 of the Subject TR.

Based on the logistics issues summarized above, staff observes that WCAP-17096-NP-A, Revision 2 could only be used as an applicable acceptance criteria and data analysis criteria report of reference in MRP-227, Revision 2 if it was confirmed (on a component-specific basis) that:

(1) a specified component designated as a Primary or Expansion category component in the applicable Chapter 4 and 5 tables of the Subject TR was actually identified as a Primary or Expansion category component type in MRP-227-A,[6]

(2) the specified component identified as a Primary or Expansion category component in the Chapter 4 and 5 tables of the Subject TR had the same inspection categorization

[6] Or alternatively, for basis of the component type in MRP-227, Revision 1-A if the staff-approved component inspection categorization and I&E criteria for the component type in MRP-227, Revision 1-A were identical those approved for the component type in MRP-227-A.

(i.e., Primary or Expansion category) as that previously defined for the component type in MRP-227-A,[2] and, the I&E criteria defined for the Primary or Expansion category component type in the applicable Chapter 4 and 5 tables of the Subject TR are identical to I&E criteria previously defined for the component type in the Chapter 4 and 5 tables of the MRP-227-A report.[2]

RAI MRP-227-Gen-5

Request: Justify the basis for referencing use of WCAP-17096-NP-A, Revision 2 in Chapter 6 of the Subject TR, given that the scope of this WCAP report does not apply to the status of all components defined as Primary and Expansion category components in the Subject TR.

RAI MRP-227-WEC-4 - Inspection Categories for Westinghouse-Design Upper Core Plate Components

Background and Issue: In Tables 4-3 and 4-6 of the Subject TR, EPRI MRP cites the Item W4.1 upper core plate (UCP) as one of the linked Expansion category components for the Primary Item W4 CB assembly lower girth weld (LGW). However, in Items W15 and W19 of MRP-227, Revision 2, Table 4-9, EPRI MRP identifies that the UCP alignment pins and UCP inserts are ASME Section XI-based Existing Program components for the program. Thus, the staff needs to consider whether the UCP itself is an ASME Section XI, Table IWB-2500-1, Examination Category B-N-3 core support structure component and whether (instead) the UCP should be identified in Table 4-9 as an ASME Section XI-based Existing Program component for the program.

RAI MRP-227-WEC-4

Request: Justify the basis why the UCP is currently identified and cited as an Item W4.1 Expansion category component for the Primary Item W4 CB LGW and why the UCP is not cited and included as one of the cited ASME Section XI-based Existing Program components referenced in Table 4-9 of the Subject TR.

RAI MRP-227-App C-1 - Use of Neutron Noise Monitoring as an Alternate Aging Management Strategy

Background and Issue: EPRI MRP discusses alternate aging management strategies in In MRP-227, Revision 2, Appendix C, “Options for Alternative Aging Management Approaches for Westinghouse and CE Designs.” In Appendix C, EPRI MRP references use of “*neutron noise monitoring*” as an potential alternative, remote aging management strategy. However, “*neutron noise monitoring*” is not referenced as an acceptable aging management technique in MRP-228, Revision 4. Yet the staff acknowledges that it previously included aging management program element criteria for implementing “*neutron noise monitoring*” programs in AMP Chapter XI.M15, “Neutron Noise Monitoring,” of NUREG-1801, Revision 0, “Generic Aging Lessons Learned (GALL) Report.” The “*neutron noise monitoring*” program that was previously credited in AMP XI.M15 of GALL, Revision 0, was limited only as a condition monitoring program for detecting loss of axial preload (loss of axial restraint) in bolted CB/CSB upper support flanges of PWR-designed units.

However, the staff removed AMP XI.M15 from the scope of NUREG-1801, Revision 1 (Generic Aging Lessons Learned [GALL] Report, Revision 1) at the request of the industry licensees and

organizational stakeholder when the staff performed its first GALL report revision review. In supporting the referenced GALL report content change, the industry members rationalized the removal of AMP XI.M15 on the fact that no industry licensee was crediting a "*neutron noise monitoring*" program as an applicable AMP for its license renewal application. Thus, EPRI MRP appears to be re-introducing "*neutron noise monitoring*" as an acceptable alternative management strategy for PWR RVI components in spite of the deletion of GALL AMP XI.M15, "Neutron Noise Monitoring," from the scope of the defined AMPs in GALL Revision 1 or in subsequent GALL or GALL-SLR report versions.

RAI MRP-227-App C-1

Request: Justify the basis for re-introducing "*neutron noise monitoring*" as an alternate aging management strategy for licensees owning PWR units, given the deletion of GALL AMP XI.M15, "Neutron Noise Monitoring," from the scope of GALL, Revision 1 and from inclusion in subsequent versions of the GALL or GALL-SLR reports. As part of the response, clarify the specific types of RVI components that may be managed by alternate "*neutron noise monitoring*" activities (i.e., as defined alternate performance monitoring activities). Additionally, clarify whether EPRI MRP is calling for AMP XI.M15, "Neutron Noise Monitoring," to be reintroduced as a potential AMP for PWR units in the current GALL-SLR update process that is currently being performed in parallel with the current MRP-227, Revision 2 review. If so, clarify whether the prior program element criteria in GALL AMP XI.M15, "Neutron Noise Monitoring," will need to be adjusted to accommodate the possibility of applying "*neutron noise monitoring"* activities to PWR RVI components other than PWR CB upper flange bolting.