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PWROG

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**PWROG-EPRI-NRC Meeting to Discuss Future Changes to
MRP-227, Rev. 2 and WCAP-17096-NP-A, Rev. 3**

September 18, 2024





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Agenda

- Introductions
- Discuss extending the 10-year re-inspection interval for MRP-227, Rev. 2 Primary and Expansion Components from 10 to 12 years
- Changes to WCAP-17096-NP - A, Rev. 3
- Discuss an approach to incorporate reference revisions to MRP-227, Rev. 2 and WCAP-17096-NP-A, Rev. 3 without revising the entire documents



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Extension of the MRP-227, Rev. 2 Reinspection Interval from 10 Years to 12 Years

Interval Extension: Background

- ASME BPVC Section XI provides inspection requirements on a 10-year interval
 - Covers many components including the reactor vessel and reactor vessel internals
 - Permits an extension of the 10-year interval up to 1 year (e.g., IWA-2430.c.1)
- Code Case N-921 developed a basis for extending the Section XI 10-year interval to a 12-year interval for components including the RV
- MRP-227, Rev. 2 inspection requirements generally require a 10-year inspection interval
 - Creates a timing issue for plants implementing 12-year intervals under Code Case N-921 because the core barrel must be removed for both the MRP-227, Rev. 2 and ASME Section XI inspections
 - MRP-227, Rev. 2 is a separate program that was not covered by Code Case N-921
- The PWROG is currently developing a technical justification for extending the 10-year interval to 12-year inspection intervals for the MRP-227, Rev. 2 examination requirements
 - The justification will not impact MRP-227, Rev. 2 which is currently being reviewed by the Staff
 - Will not apply to Westinghouse baffle-former bolts which have separate re-inspection interval requirements

Interval Extension: Code Case N-921 Approach

- Code Case N-921 was approved for use in Regulatory Guide 1.147, Revision 21 (March 2024)
 - Included a few conditions, such as requiring the ISI program code of record to be the 2017 Edition or a later Edition, implementing it at the beginning of ISI interval, and some exclusions
 - Plants intend to implement the extended ISI interval (e.g., ML21314A447)
- Technical basis for Code Case N-921
 - Hardship: Section XI breaks the intervals into 3 periods → plants on 10-year intervals and 24-month cycles have a one-cycle period, placing a burden during that outage
 - Augmented ISI programs:
 - VT-2 examinations for Class 1 leakage tests are performed every outage, regardless of interval length
 - The examinations are focused on specific degradation mechanisms to address the relevant OE
 - OE:
 - Only a few issues have been identified in tens of thousands of hours of operation
 - Flaws that have occurred have resulted in leakage before a break has occurred
 - PRA evaluation:
 - Performed an evaluation of eliminating an inspection period worth of risk-informed examinations
 - Showed that each unit still met the Regulatory Guide 1.174 “Change in Risk” acceptance criteria
 - Included conservatism, since the 10-12 year extension is for a much shorter period

Interval Extension: Technical Basis

- Most of the MRP-227, Rev. 2 components have a 10-year re-inspection interval
 - The 10-year interval is implemented based on Conditions 5 and 6 in the NRC SE for MRP-227, Rev. 0 (ML11308A770)
 - Consistent with the ASME Section XI ISI interval
- The inspection of multiple MRP-227 components require removing the core barrel (e.g., core barrel, thermal shield flexures, clevis insert bolts, core stabilizing lug bolts, etc.)
- The approach for MRP-227 components is similar to that developed for Code Case N-921
 - Hardship: Misalignment of the 10-year MRP-227, Rev. 0 and 12-year Section XI intervals will result in removing the core barrel twice
 - OE:
 - The MRP-227 inspection results generally been positive (i.e., identification of very few relevant indications)
 - MRP-227 inspection results are reported biennially, see ML14135A383, ML16144A789, ML18204A161, ML20229A000, ML2273A155
 - Components where degradation has been identified have been addressed by supplemental requirements (e.g., TS flexures – TB-19-5; core barrel welds – MRP 2023-005 R1, MRP 2024-008; etc.)
 - PRA:
 - Considering the incremental core damage risk
 - The failure of many components create no direct risk to core damage (e.g., TS flexures, baffle-edge bolts, instrument guide tubes, etc.)
 - Other components (e.g., core barrel welds) can be evaluated using a combination of probabilistic arguments (such as from OE) and deterministic evaluations (e.g., flaw tolerance)

Interval Extension: Request for NRC Approval and Implementation

- The PWROG plans to submit the technical justification for a 12-year inspection interval to the NRC for review and approval in Q1 2025
 - Due to the ongoing review, the alternative 12-year interval will not be included in MRP-227, Revision 2-A
 - The change will be incorporated in MRP-227, Revision 3
 - NRC review and approval will allow plants to implement the 12-year interval before MRP-227, Revision 3-A is approved
 - The changes to WCAP-17096-NP-A, Rev. 3 only require the acceptance criteria to assume 12 years instead of 10 years (e.g., project crack growth for 12 years instead of 10 years)



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Changes to WCAP-17096-NP-A Rev. 3

WCAP-17096-NP-A, Rev. 3: Background

- The purpose of updating WCAP-17096-NP-A Rev. 3 is to:
 - Incorporate MRP-227 changes from Rev. 1-A to Rev. 2-A, which includes adding, removing, or updating the methodologies for components that were changed to address operation in SLR
 - Note that the PWROG and EPRI are discussing including the updates to MRP-227 Rev. 3 in the changes to WCAP-17096-NP-A, Rev. 3 and submitting the two reports for review and approval at the same time
 - Address Limitations and Conditions in the Safety Evaluation for WCAP-17096-NP-A, Rev. 3
 - Example: Condition 3 pertaining to the fracture toughness limits used in the linear elastic fracture mechanics methodologies for the flaw tolerance evaluations in PWR core barrels and core shrouds
 - Incorporate lessons learned and other improvements to the document since Rev. 3 of WCAP-17096-NP was submitted in July 2019
- Specific changes to WCAP-17096-NP-A, Rev. 3:
 - Component methodologies that will be removed and/or modified (including WCAP-17096-NP-A, Rev. 3 Limitation L-02)
 - Plan to address WCAP-17096-NP-A, Rev. 3 Condition C-03

Component Methodologies to be Added in the Changes to WCAP-17096-NP-A, Rev. 3

- Westinghouse Designs: No added components
- CE Designs:
 - CE-ID 6.4: Upper Internals Assembly – Fuel Alignment Plate (plants with welded core shrouds assembled in two vertical sections)
 - CE-ID 18: Core Shroud Assembly (Welded) – Core Shroud Tie Rods and Nuts
 - CE-ID 19: CEA Shroud Assemblies – CEA Shroud Bolts
 - All three are new components in MRP-227, Rev. 2
 - CE-ID 18 is based on OE; CE-ID 6.4 and CE-ID 19 were added for SLR operation due to increases in neutron fluence at those locations
- B&W Designs:
 - B15.2: Upper Grid Assembly: Upper grid fuel assembly support pad items: pad, Alloy X-750 dowels, cap screw, and their locking welds
 - B16 Core Barrel Assembly: Core barrel cylinder top flange circumferential weld HAZ

Component Methodologies to be Added in the Changes to WCAP-17096-NP-A, Rev. 3

- B&W Designs (continued):

- B17 Core Barrel Assembly: Core barrel top and bottom cylinders center circumferential weld regions
- B18 Lower Grid Assembly: Lower grid rib section
- B19 Core Barrel Assembly: Surveillance specimen holder tube (SSHT) bolts and their locking devices (60-80 years)
- B20 Core Barrel Assembly: Core barrel cylinder top flange circumferential weld regions
- B20.1 Plenum Cover Assembly: Plenum cover weldment ribs to each other welds
- B20.2 Core Support Shield Assembly: Core support shield cylinder top flange
- B21 Lower Grid Assembly: Alloy X-750 dowels-to-lower grid fuel assembly support pad welds
- Note: will reflect core barrel interim guidance that is currently in draft format

Component Methodologies to be Removed in the Changes to WCAP-17096-NP-A, Rev. 3

- Westinghouse designs:
 - W-ID 1: CRGT Assembly Guide Plates (Cards)
 - Moved to Existing components in MRP-227, Rev. 2
 - Acceptance criteria methodology documented separately in WCAP-17451-P, Rev. 2, "Reactor Internals Guide Tube Wear – Westinghouse Domestic Fleet Operational Projections"
- CE designs:
 - CE-ID 3.2: Core Shroud Assembly (Welded) – Ribs and Rings
 - Removed as an Expansion component in MRP-227, Rev. 2
 - The removal is based on the finite element analysis documented in MRP-230, Revision 3
- B&W designs:
 - B2.1 Vent Valve Assembly
 - Removed after review of ferrite content
 - B10.1 Core Barrel Assembly
 - Moved from Expansion to Primary in MRP-227, Rev. 2
 - B14 Lower Grid Assembly
 - Removed as only applicable to TMI-1

Component Methodologies to be Modified in the Changes to WCAP-17096-NP-A, Rev. 3

- CE and Westinghouse: core support barrel/core barrel methodologies
 - Editorial updates to be consistent with the latest core barrel inspection interim guidance
 - MRP 2023-005R1 (WEC/CE), MRP 2024-004 (WEC), MRP 2024-008 (WEC/CE), TBD (B&W)
 - Address fracture toughness Condition 3 in WCAP-17096-NP-A, Rev. 3 (more detail in subsequent slides)
 - WCAP-17096-NP-A, Rev. 3 requires to: “Ensure that the ΔK resulting from flow induced vibration (FIV) is below the threshold for fatigue crack growth.”
 - This requirement is presenting challenges to the allowable flaw lengths for core barrels
 - Westinghouse is proposing an alternative approach to allow for a quantifiable amount of crack growth due to FIV
 - The amount of crack growth would be discussed in the changes to WCAP-17096-NP-A, Rev. 3, but would be sufficiently small to allow for management of the flaw for the remainder of the inspection interval
 - The amount of crack growth would be calculated through fatigue crack growth methods consistent with those for other cyclic loadings currently included in WCAP-17096 WCAP-17096-NP-A, Rev. 3

Component Methodologies to be Modified in WCAP-17096-NP-A, Rev. 3

- Westinghouse Baffle-Former Assembly and Edge Bolts

- Limitation L-02 in the NRC SE for WCAP-17096-NP-A Rev. 3 states:

“The scope of WCAP-17096-NP, Revision 3, is limited in that it does not include any acceptance and data analysis criteria for evaluating component distortion or void swelling, or for managing changes in dimension due to distortion or void swelling in the PWR “Primary” or “Expansion” category components that are within the scope of WCAP-17096-NP, Revision 3. If distortion or changes in dimension due to void swelling is detected in an RVI component, a licensee using this TR will need to address distortion or changes in dimension due to void swelling on a component-specific basis per the acceptance criteria and corrective program element bases of its PWR Vessel Internals Programs and its 10 CFR Part 50, Appendix B program.”

- Westinghouse will resolve Limitation L-02 by supplementing the failure modes and effects analysis FMEA, which is the current approved methodology, with a methodology to disposition the potential aging effects.
 - The FMEA is a valuable tool as it provides direction to potential impacts if relevant indications are identified
 - The supplemental methodology will be added in addition to the FMEA to provide an NRC approved method for accepting relevant indications

Component Methodologies to be Modified in WCAP-17096-NP-A, Rev. 3

- B&W designs:

- Acceptance Criteria Methodology for B&W Core Barrel Welds: NEI 03-08 “Needed” guidance has been issued for the CE and Westinghouse CB welds in MRP 2023-005, which requires inspection at both sides of the UFW location. However, no acceptance criteria methodology is defined for the equivalent location in the B&W core barrel. Therefore, this scope will include the development of a flaw tolerance methodology for the B&W core barrel welds. This methodology can be adapted from existing flaw tolerance methodologies at similar locations
- Add additional detail for several B&W methodologies as discussed in RAI 12: The acceptance criteria methodologies used to disposition the degradation will be based upon those from the original design basis. An expert panel process will be used to determine the appropriate details to be included.
 - A.1.1 Core Clamping Items, A.1.2 Control Rod Guide Tube Spacer Castings, A.1.3 Vent Valve Assembly Vent Valve Retaining Rings, A.1.7 Lower Core Barrel Bolts and Locking Devices, A.1.9 Baffle Plates, A.1.10 Locking Devices and Locking Welds of Baffle-to-Former and Internal Baffle-to-Baffle Bolts, A.1.11 Flow Distributor Bolts and Locking Devices, A.1.12 Guide Block Dowel Welds, A.1.13 Shock Pad Bolts and Locking Devices, A.1.14 Incore Monitoring Instrumentation Guide Tube Spiders and Welds, A.2.1 Upper Grid Fuel Assembly Support Pad Dowel Welds, A.2.3 Upper Thermal Shield Bolts and Locking Devices, A.2.4 Surveillance Specimen Holder Tube Studs/Nuts or Bolts and Locking Devices (DB-1 only), A.2.10 Lower Grid Fuel Assembly Support Pad Items, A.2.12 Dowel to Lower Grid Fuel Assembly Support Pad Dowel Welds, A.2.13 Lower Thermal Shield Bolts and Locking Devices
- Remove locking devices
 - B7.1/B7.2/B8 Core Barrel Assembly, B12 Flow Distributor Assembly, B7 Core Support Shield Assembly: Upper core barrel (UCB) bolts
 - Acceptance Criteria Methodology for B&W Core Barrel Top Flange Weld

WCAP-17096-NP-A, Rev. 3 Condition 3

- Condition C-03 in the NRC SE for WCAP-17096-NP-A, Rev. 3 states:

“Until such time that the EPRI or PWROG can resolve the EPRI BWRVIP Letter No. 2021-030 Part 21 issue on neutron fluence ranges associated with the specified lower bound fracture toughness values reported in an updated version of MRP-210 or MRP-211 (or alternate industry record), licensees will need to justify any lower bound fracture toughness values used as inputs in component-specific flaw tolerance analyses. The selection of the applicable lower bound fracture toughness value(s) should be reported and justified in a site-specific record and reconciled with any updated industry reports or records used to correlate lower bound fracture toughness value(s) and the most recent neutron fluence range(s) reported for the specified fracture toughness value(s).”

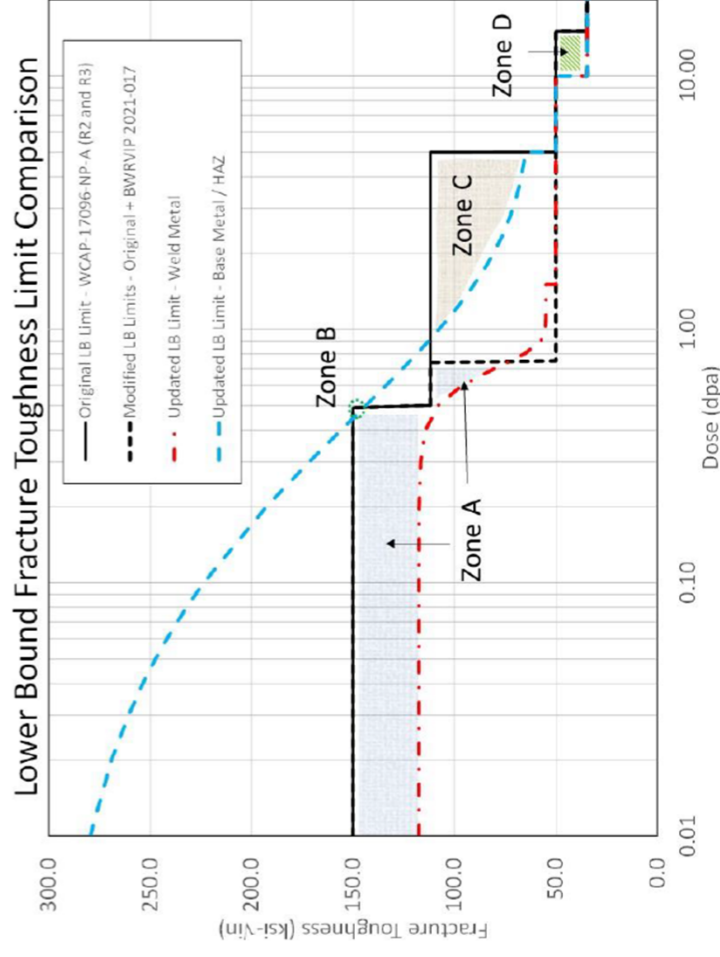
- BWRVIP 2021-030 (ML21084A164) discussed a potential non-conservatism in BWRVIP-100, Rev. 1-A (ML17076A228)
- The non-conservatism was in lower bound fracture toughness for irradiated austenitic stainless steel based on the latest testing results → the saturation toughness may be reached at a lower neutron dose
- WCAP-17096-NP, Rev. 3-A references BWRVIP-100, Rev. 1-A for irradiated fracture toughness
- The PWROG and EPRI MRP have addressed the non-conservatism, and will incorporate this in the changes to WCAP-17096-NP-A, Rev. 3 to address Condition 3

Resolution of Irradiated Fracture Toughness

- The PWROG issued interim guidance on the lower bound fracture toughness
 - Most of the underlying basis in the interim guidance was obtained from EPRI-sponsored evaluations of fracture toughness data:
 - EPRI and Westinghouse re-evaluated the available irradiated fracture toughness data
 - EPRI convened a new MRP-211 expert panel to review the fracture toughness analysis and conclusions
 - The MRP-211 expert panel provided recommendations for the bounding fracture toughness values to use with neutron dose and the analysis method to use depending on dose (i.e., limit load, EPFM, and LEFM) that was published in MRP 2023-011
 - The lower bound fracture toughness data was documented in the interim guidance in PWROG-24017-P, Rev. 0 that will be referenced and provided in the update to PWROG-17096-NP-A, Rev. 3
 - Showed that the updated lower bound limits for fracture toughness are generally conservative for a neutron dose > 0.75 dpa
- The revised lower bound values will be incorporated in the changes to PWROG-17096-NP-A, Rev. 3
- The technical basis for the lower bound fracture toughness addresses Condition 3 in the NRC SE for PWROG-17096-NP-A, Rev. 3 and the impact of the BWRVIP 2021-030 Part 21

Resolution of Irradiated Fracture Toughness

- The figure shows a comparison of:
 - The original LB Limits – WCAP-17096-NP_A, R2 & R3
 - The modified LB Limits – Original + BWRVIP 2021-017
 - The updated Limits – Weld, Base Metal/HAZ
- Four zones (A-D) where fracture toughness is reduced from the original limits
 - Zone A: Weld – 0 to 0.75 dpa
 - Zone B: Base metal / HAZ at 0.5 dpa
 - Zone C: Base metal / HAZ from 1 to 5 dpa
 - Zone D: Weld and base metal / HAZ from 10 to 15 dpa





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Incorporation of the Latest Guidance Documents

Incorporation of Guidance Documents: Background

- Currently MRP-227, Rev. 2 and WCAP-17096-NP-A, Rev. 3 include reference to industry guidance documents for managing thermal sleeve and guide card wear
 - Thermal sleeve wear is managed by PWROG-16003-P, Rev. 2
 - Guide card wear is managed by WCAP-17451-P, Rev. 2
- By including specific revisions of PWROG-16003-P and WCAP-17451-P in MRP-227 and WCAP-17096, licensees are limited in their ability to implement new revisions of these documents prior to the next revision of MRP-227 and/or WCAP-17096
 - Example: MRP-227 Rev. 1-A referenced WCAP-17451-P, Rev. 1, however WCAP-17451-P, Rev. 2 was approved in 2018 and licensees are unable to fully implement the benefits of WCAP-17451 Rev. 2 since MRP-227 Rev. 1-A references WCAP-17451 Rev. 1
 - Utilities are waiting for MRP-227 Rev. 2-A to be issued, which will result in a 6-7 year delay in being able to fully implement WCAP-17451 Rev. 2

Streamlining Incorporation of Guidance Documents

- Licensees are interested in options to allow for earlier implementation of the latest industry guidance in their aging management programs
 - Licensees would like to implement the latest revisions of PWROG-16003-P and WCAP-17451-P without revising MRP-227 and WCAP-17096
 - Since both thermal sleeve wear and guide card wear are Existing Components in MRP-227, Rev. 2, it is desired to reference PWROG-16003-P and WCAP-17451 without specifying a revision level in future updates to MRP-227 and WCAP-17096
 - Allows for management of the aging mechanisms to the latest revisions of the guidance documents