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## **2020 Materials Programs Technical Information Exchange PWROG Materials Committee Update**

Tim Wells – PWROG MSC Chair (SNOC)



## **PWR Owners Group MSC Agenda**

- **PWROG MSC Key Focus Areas with NRC Interaction in 2020**
- **Other Key PWROG MSC Programs in 2020/2021**
- **PWROG MSC NEI 03-08 Guidance Documents**
- **Thermal Sleeve and Driveline, Thermal Shield Flexure, and Guide Card Updates**
- **2020/2021 PWROG MSC Meeting Dates**
- **MSC PWROG Core/Planning Team Organization and Key Contacts**



## **PWROG MSC Key Focus Areas with NRC Interaction in 2020<sup>(1/5)</sup>**

### **Demonstrate Appendix G Margins for PWR RPV Nozzles and Beltline**

- The purpose of this completed program was to demonstrate that the RPV nozzle corner pressure-temperature (P-T) limit curves are bounded by the licensed traditional P-T limit curves for the US PWRs
  - PWROG-15109-NP-A, "PWR Pressure Vessel Nozzle Appendix G Evaluation" approved topical report was issued to the NRC and the PWROG in January 2020 under OG-20-24
  - Verification letter received and issued to the PWROG under OG-20-131

### **Transitioning RV Integrity to Direct Fracture Toughness**

- The purpose of this ongoing program is to develop an acceptable method for any licensee to use irradiated fracture toughness data to improve or demonstrate margin in P-T curves
  - Concept presented to NRC in March 2016. Plan to submit the topical report in mid 2020 for NRC review and approval
  - Ready to hold pre-submittal meeting (preferably in-person)



## **PWROG MSC Key Focus Areas with NRC Interaction in 2020<sup>(2/5)</sup>**

### **WCAP-17096-NP-A Interim Guidance and Document Update**

- The purpose of this ongoing program is to update WCAP-17096-NP to be consistent with MRP-227, Rev. 1, include recent interim guidance and operating experience as appropriate. The TR also emphasizes the intended goal is to develop methodologies that will remain applicable to initial and subsequent license renewal.
  - WCAP-17096-NP, Revision 3, “Reactor Internals Acceptance Criteria Methodology and Data Requirements,” was submitted to the NRC in July 2019 under OG-19-164
  - The TR was accepted for the accelerated review process and a fee waiver was granted
  - Draft SE scheduled for July 15, 2020



## **PWROG MSC Key Focus Areas with NRC Interaction in 2020<sup>(3/5)</sup>**

### **Prepare a TR Associated with the Changes to the NRC-Approved Methodology in WCAP-15029 for Acceptable Bolting Pattern Analyses (ABPA)**

- The purpose of this ongoing program is to prepare a topical report (TR) that will discuss the changes to the NRC approved methodology contained in WCAP-15029-P-A. The TR provides justification for the changes that have been incorporated in plant specific Acceptable Bolting Pattern Analyses (ABPA) so that the ABPAs can be incorporated into the design and licensing basis via a 50.59, based on the NRC approval of the changes to the methodology.
  - PWROG-18034-P/NP, “Updates to the Methodology in WCAP-15029-P-A, Rev. 1, ‘Westinghouse Methodology for Evaluating the Acceptability of Baffle Former–Barrel Bolting Distributions Under Faulted Load Conditions’” was submitted to the NRC for review in October 2018
    - ✓ Draft RAIs received and responded to
    - ✓ Draft and Final SE received
    - ✓ Working to issue A version of topical report in late July 2020



## PWROG MSC Key Focus Areas with NRC Interaction in 2020<sup>(4/5)</sup>

### SLR Activities

- **Recently completed PWROG MSC programs supporting SLR activities**
  - PWROG-17090-NP-A, Revision 0, “Generic Rotterdam Forging and Weld Initial Upper-Shelf Energy Determination”
    - The purpose of this completed program was to develop generic USE values intended to be used for Rotterdam welds and forgings
    - Approved topical report was issued to the NRC and the PWROG in January 2020 under OG-20-25
    - Verification letter received and issued to the PWROG under OG-20-130
  - PWROG-17011-NP, Rev 1, “Update for Subsequent License Renewal: WCAP-14535A, “Topical Report on Reactor Coolant Pump Flywheel Inspection Elimination” and WCAP-15666-A, “Extension of Reactor Coolant Pump Motor Flywheel Examination”
    - The purpose of this completed program was to update the subject reports to confirm that the analyses remain valid for SLR up to 80 years of operation
    - Approved topical report was issued to the NRC and the PWROG in November 2019 under OG-19-237
    - Verification letter received and issued to the PWROG under OG-20-83



## **PWROG MSC Key Focus Areas with NRC Interaction in 2020<sup>(5/5)</sup>**

### **SLR Activities – Cont'd**

- PWROG-17031-NP, Revision 1, “Update for Subsequent License Renewal: WCAP-15338-A, “A Review of Cracking Associated with Weld Deposited Cladding in Operating PWR Plants”
  - The purpose of this completed program was to update the subject reports to confirm that the analysis remains valid for SLR up to 80 years of operation
  - Approved topical report was issued to the NRC and the PWROG in May 2020 under OG-20-144
  - Verification letter pending
- PWROG-17033-P (& NP), Revision 1, “Update for Subsequent License Renewal: WCAP-13045, “Compliance to ASME Code Case N-481 of the Primary Loop Pump Casings of Westinghouse Type Nuclear Steam Supply Systems”
  - The purpose of this completed program was to update the subject reports to confirm that the analysis remains valid for SLR up to 80 years of operation
  - Approved topical report was issued to the NRC and the PWROG in November 2019 under OG-19-246
  - Verification letter received and issued to the PWROG under OG-20-82



## Other Key PWROG MSC Programs in 2020<sup>(1/3)</sup>

### Scale and Impact of Uncertainty in Fluence Determinations for Reactor Vessel Internals

- The purpose of this recently approved program revision is to;
  - Use the sensitivity studies completed under revision 0 of the program for the fluence input parameters to determine the range of the fast neutron fluence on the reactor vessel internals and,
  - The uncertainties associated with the fast neutron fluence will then be used to determine the impact on the downstream screening on RVI components

### Clevis Insert Bolts Relative Asset Management Risk Assessment

- The purpose of this recently completed program was to evaluate the relative asset management risk associated with operating with degraded clevis insert bolts considering design differences
  - This program provided a tool that supports informed decision making that is not explicitly tied to industry guidance or a regulatory requirement
  - Final PWROG-19023-P, Revision 0 “Clevis Insert Bolts Relative Asset Management Risk Assessment” was issued to the PWROG in November 2019 under OG-19-250



## Other Key PWROG MSC Programs in 2020<sup>(2/3)</sup>

### Clevis Insert / Radial Key Wear Assessment (Revisions 0 and 1)

- The purpose of the work completed under revision 0 was to perform a technical assessment of lower radial key (LRK)/clevis insert wear in the industry
  - The work provided an assessment of the current state of wear in the lower radial support systems (LRSS) of operating nuclear power plants, and identified specific trends that allowed for the grouping or ranking of plants based on susceptibility
  - Final PWROG-19003-P/NP, Revision 0 “Clevis Insert/Radial Key Wear Assessment”, was issued to the PWROG in November 2019 under OG-19-209
- Under revision 1 of the program, the work documented in PWROG-19003-P will be used to perform a generic safety assessment, with the intent of establishing a technical basis for safe operation with wear-related degradation of clevis inserts and radial keys
  - A draft report to the MSC participants for review and comment is expected to be issued in early 2021

## Other Key PWROG MSC Programs in 2020<sup>(3/3)</sup>

### Risk-Informed Asset Management for Baffle-former Bolts

- The purpose of the recently completed program was to develop a quantitative risk-informed asset management plan for baffle-former bolts (BFB) to minimize the need for replacement campaigns and outage extensions
- The key features of this BFB asset management approach are as follows:
  - Flexible framework to evaluate observation of clustering and un-inspectable baffle bolts
  - Rapid same-shift turnaround allowed just-in-time decision-making on replacement campaign
  - Justification for 10 years of continued operation without replacement
  - Reduced bolt replacement contingency plan costs
- Final PWROG-20005-P, Revision 0, “Probabilistic Structural Analysis Framework for Baffle-to-Former Bolts” was issued to the PWROG in April 2020 under OG-20-105
- The project was immediately implemented as part of the Ginna Baffle Bolt Inspection in April 2020. The successful analysis justified that baffle bolt replacements are not required at Ginna per a 10-year re-inspection interval.

## PWROG MSC NEI 03-08 Guidance Documents<sup>(1/2)</sup>

Doc Number	Rev	Document Title	Date	Implementation Level	Comments
Documents Incorporated Within (i.e., issued prior to the initiative) or Under the Materials Initiative (i.e., issued since the initiative)					
WCAP-12639-P	0	Westinghouse Owners Group Pressurizer Surge Line Thermal Stratification Generic Detailed Analysis Program MUHP-1091 Summary Report	Jun 2008	Mandatory	OG-08-203, 4/8/2003
WCAP-17451-P	2	Guidance: Reactor Internals Guide Tube Wear-Westinghouse Domestic Fleet Operational Projections (WCAP-17451-P, Revision 2)	November 2018	Needed	OG-18-276, 11/9/2018
WCAP-14950	0	Mitigation and Evaluation of Pressurizer Insurge/Outsurge Transients	Jun 2008	Needed	OG-08-203, 4/8/2003
51-5003700-01	1	CRDM Life Extension Action Plan	Jan 2006	Needed	OG-10-119, 3/29/2010
WCAP-16180-NP	0	Operability Assessment for Combustion Engineering Plants with Hypothetical Circumferential Flaw Indications in Pressurizer Heater Sleeves	Dec 2003	Mandatory	WOG-03-643, 12/23/2003
WCAP-15988-NP	2	Generic Guidance for an Effective Boric Acid Inspection Program for Pressurized Water Reactors	Dec 2013	Mandatory	OG-12-247, 6/20/12
WCAP-16423-NP	0	Standard Process and Methods for Calculating RCS Leak Rate for Pressurized Water Reactors	Dec 2008	Needed	OG-08-400, 11/19/2008

**2020 Materials Programs Technical Information Exchange**

## PWROG MSC NEI 03-08 Guidance Documents<sup>(2/2)</sup>

Doc Number	Rev	Document Title	Date	Implementation Level	Comments
Documents Incorporated Within (i.e., issued prior to the initiative) or Under the Materials Initiative (i.e., issued since the initiative)					
WCAP-16465-NP	0	Standard RCS Leakage Action Levels and Response Guidelines for Pressurized Water Reactors	Dec 2008	Needed	OG-08-400, 11/19/2008
WCAP-16913-P	1	Operability Assessment and Plant Applicability Evaluation for Pressurizer Heater Sleeve Leakage in Westinghouse Designed Pressurizers	Jan 2010	Needed	OG-09-140, 4/6/2009
51-5030027-01	1	Evaluation of RV Internals Bolting for the B&WOG (Note the "needed recommendations" for inspection of the high- strength bolt location is now superseded by MRP-227-A)	May 2005	Needed	OG-09-158, 4/17/2009
OG-12-330	0	Generic Guidance for Valves that have Seal Encapsulation Devices	Aug 2012	Needed	OG-12-330, 8/16/2012
PWROG-16003-P	2	Evaluation of Potential Thermal Sleeve Flange Wear	May 2019	Needed	OG-19-101, 05/13/2019, Non-Proprietary Appendix incorporates the MRP 2018-027 inspection guidance as "Needed"
OG-20-113	-	NEI 03-08 Needed and Good Practice Guidance: Thermal Sleeve Cross-Sectional Failure – Westinghouse Nuclear Safety Advisory Letter NSAL-20-1	July 2020	Needed	OG-20-113, 4/13/2020

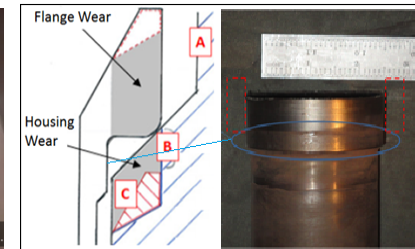
# Brief Review of Thermal Sleeve and Driveline Related Degradation Focus Group

- Purpose of Focus Group:
  - Understand the technical issues associated with recent thermal sleeve and drive line inspections and operating experiences
  - Coordinate industry activities to resolve the issues relative to potential degradation of thermal sleeves and driveline related components and its impact on plant operation (coordinating with EPRI/MRP)
- The focus group was specifically established to ensure that the utilities have guidance and tools needed to manage currently known degradation issues and to get ahead of potential degradation caused by related mechanisms
- Expectation is to have the focus group function independently for approximately 1 year and reassess continued need for the focus group at that time

CRDM Latch Wear



TS Flange Wear



TS Flange Cracking



TS OD Wear



TS ID Wear



## OE from Recent Thermal Sleeve and Driveline Inspections<sup>(1/3)</sup>

- **Flange Wear:**

- NEI 03-08 “Needed” Guidance in PWROG-16003-P, Rev. 2 (with reference to NSAL-18-1)
- Of the plants listed in Table 1 of NSAL-18-1 as having the greatest susceptibility to flange wear 23 of 36 total (16 of 24 in the U.S.) have completed inspections per the NEI 03-08 “Needed” Guidance. The remaining have either not yet reached 20 EFPY on their RVCH or are shutting down.
- Wear rates remain bounded by the 0.04 in/EFPY wear rate identified in NSAL-18-1
- Second round of inspections completed at one plant – shows possible evidence non-linear (accelerating) wear rate, similar trend has been reported by EDF for highly worn sleeves

## OE from Recent Thermal Sleeve and Driveline Inspections<sup>(2/3)</sup>

- **OD / ID Wear:**

- No NEI 03-08 Guidance for this wear mechanism. Managed by plants per recommendations of TB-07-2
- 3 plants have completed OD/ID wear inspections since May 2019
- The following trends continue:
  - Innermost locations tend to be more limiting due to ID wear
  - Outer rodded locations show a mix of ID wear and OD wear, but overall these locations have not been limiting
  - Unrodded locations show greater wear rates than rodded locations
- Three plants have reported signs of light to moderate grooved wear on the ID of the sleeve which may be indicative of wear occurring during extended times with rods inserted at flow conditions

- **Thermal Sleeve Cracking:**

- NEI 03-08 “Needed” and “Good Practice” Guidance in OG-20-113 (with reference to NSAL-20-1)
- No US plants have conducted thermal sleeve cracking inspections at this time. Guidance recently became effective as of July 1, 2020.

## OE from Recent Thermal Sleeve and Driveline Inspections<sup>(3/3)</sup>

- **Latch Assembly Gripper Wear Inspections:**

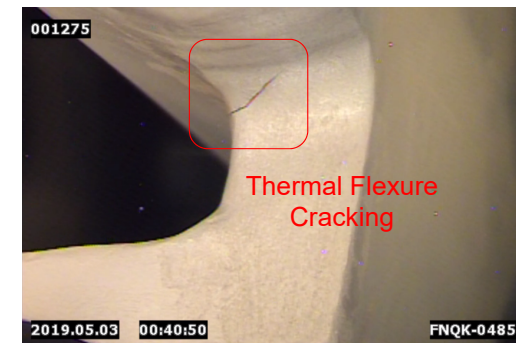
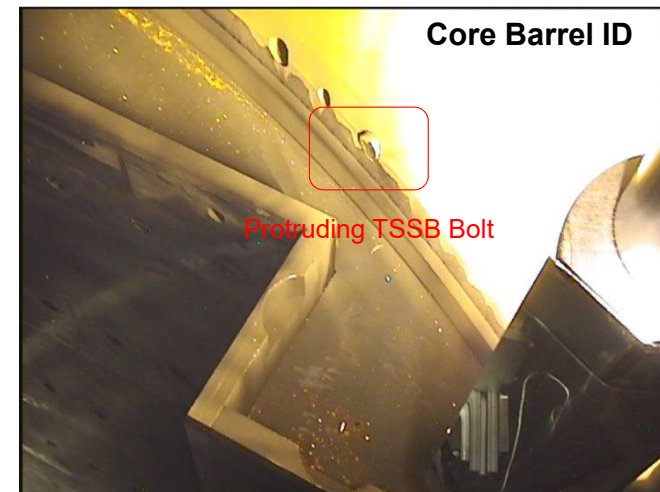
- Two plants (same utility) have completed latch assembly stationary gripper wear inspections
  - One of the two plants experienced mid-cycle rod drops
  - Both plants show similar trend of significant stationary gripper wear at the centermost location (H-08)
  - Other locations, mainly concentrated to the central locations, show signs of gripper wear, but to a lesser degree
  - Both plants processed an exigent LAR to remove the control rods at H-08 from service
- Westinghouse Infogram being developed to communicate this issue to the industry, planned for late July 2020
- Issue is not a safety concern but could have significant asset management impact
- Flow-induced vibration in plants with higher upper head bypass flow (T-cold heads) is likely a contributor
- Limited data at this time to draw correlations with thermal sleeve wear, but trends from these plants and similar likely causes suggest this is a possibility

# Thermal Sleeve and Driveline Related Degradation Current Work, Potential Gaps and Actions

- PWROG program (MSC-1788) has been developed to:
  - Perform metallurgical examination to support a further understanding of cause of thermal sleeve cracking and to support development of crack acceptance criteria
  - Develop refined lowering criteria used in determining timing for cracking inspections
- Current gaps:
  - Ultimate source/cause of control rod drive shaft (CRDS) dropping remain unknown
  - Correlations between thermal sleeve wear, CRDM latch assembly wear, and guide card wear remain unknown
- Current actions:
  - Westinghouse Issue communication (WEC Infogram) on Latch Assembly Wear
  - Send out survey requesting information on rod drop trace experiences, collect data from RCWG survey on plant plans in response to TVA OE and review OE databases
  - Determine what are the next steps related to thermal sleeve and latch assembly gripper wear

## Brief Review of Thermal Shield Focus Group

- Purpose of Focus Group:
  - Understand the technical issues associated with recent thermal shield inspections and operating experiences
  - Coordinate an agreed upon industry approach to resolving issues (coordinating with EPRI/MRP)
- The focus will be only dealing with issues related to degradation of thermal shields and supporting hardware (TSSB bolts, flexures, etc.)
- Expectation is to have the focus group function independently for approximately 1 year and reassess continued need for the focus group at that time

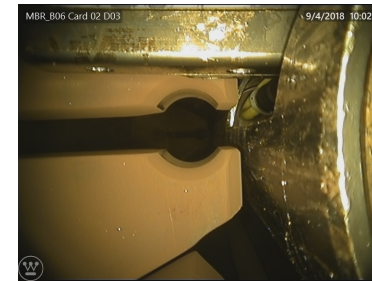


## Thermal Shield Current Work, Potential Gaps and Actions

- PWROG program (MSC-1789) has been developed to:
  - Provide a detailed safety assessment report for TSSB bolts to avoid outage impacts associated with unexpected degradation
  - Establish funding for future Thermal Shield Focus Group involvement
- Current gaps:
  - Ultimate source/cause of thermal shield TSSB bolts and flexure degradation remains unknown
  - Extent of interaction between thermal shield support degradation and other lower internal components remains incomplete
- Current actions:
  - PWROG to work with EPRI and PSEG to understand the logistics and cost of metallurgical examination of harvested flexures
  - Timing of next focus group meeting to be after Salem Unit 1 Fall 2020 inspection

## Guide Card Activities

- NRC has been notified that most of the changes that were made in revision 2 of WCAP-17451-P that were not covered in the Interim Guidance were related to the evaluation portion of the report and not necessarily the inspection timing / coverage requirements, which is the scope of MRP-227
  - The revised report was provided to the NRC for information only in September 2019 under OG-19-197 to support the submittal of WCAP-17096, next revision 3
  - If needed, a meeting with the NRC will be held to discuss the major updates in the report
- The evaluation, acceptance, and determination of re-inspection intervals are truly linked to WCAP-17096, which is with the NRC for review and approval
- Future plans include revising the report to take into account additional inspection data (domestic and international)—next revision estimated in 2022



Low Wear



High Wear

## Guide Card: Recent Inspections

Date	Guide Tube	RCCA Type	Wear Categorization (Aggressive/Moderate/Low)
Spring 2019	17x17AS	Ion nitride	Moderate
Spring 2019	15x15	Ion nitride	Low
Spring 2019	17x17 standard	Ion nitride	Low
Spring 2020	17x17AS	Chrome Plated	Moderate
Spring 2020	17x17 standard	Chrome Plated	Low

## Guide Card Recent OE

- Moderate wear was noticed at plants operating with 17x17 A/AS/AXLR guide tubes, confirming that these guide tubes are susceptible to guide card wear
- Plants with B4C absorber RCCAs seem to wear more aggressively on average in comparison to plants operating with Ag-In-Cd absorber RCCAs. Additional data is needed to confirm this trend
- Still in the process of evaluating the impact of ion nitride RCCAs on guide card wear, additional data is needed
- Aggressive continuous section wear was noticed at a 17x17 AS plant operating with chrome plated RCCAs. The plant also has moderate guide card wear. However, the continuous section wear at this plant was greater than previously observed at other plants.
- The recent OE is still bounded by the topical report

## Guide Card: Upcoming Inspections

Date	Guide Tube	RCCA Type
Fall 2020	17x17AS	Chrome Plated
Spring 2021	17x17 standard 17x17AS 16x16	Chrome Plated Chrome Plated Chrome Plated
Fall 2021	17x17AS 17x17 standard 17x17AS	Chrome Plated Ion Nitride Chrome Plated
Spring 2022	17x17 standard 17x17AS 17x17AS 17x17 standard	Ion Nitride Chrome Plated Chrome Plated Chrome Plated
Fall 2022	17x17 standard	Chrome Plated



# MSC PWROG Core/Planning Team Organization and Key Contacts

*Materials Committee  
Tim Wells, SNOC (Chair)*

*Open (Vice Chair)*

*Reactor Internals Industry Planning Team  
Heather Malikowski, Exelon*

*Reactor Vessel Integrity Core Team  
Chris Koehler, Xcel Energy*

*Pressure Boundary Core Team  
Open*

*Jim Molkenthin  
PWROG PMO*

*Ray Stewart  
Framatome*



## 2020/2021 PWROG MSC Meeting Dates

- August 24-27, 2020 PWROG Joint PWROG Meetings (via webinars)
- December 14-17, 2020 PWROG Joint PWROG Meetings
- April 26-29, 2021 PWROG Joint PWROG Meetings

**2020 Materials Programs Technical Information Exchange**



## Questions?

**The Materials Committee is established to provide a forum for the identification and resolution of materials issues including their development, modification and implementation to enhance the safe, efficient operation of PWR plants.**