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Materials Reliability Program MRP-227-A PWR Reactor Internals Aging Management

Glenn Gardner

Dominion Resources

Kyle Amberge

EPRI

NRC / EPRI Materials Technology Exchange Meeting

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PWR Reactor Internals Implementation Status

- MRP-227-A guideline developed by MRP with NRC staff comments and SE incorporated
- Integrated into NEI 03-08 Materials Initiative
- Utility owner implementation of MRP-227-A
  - Proceeding effectively
  - Large quantities of items inspected
- Scope well coordinated with ASME XI ISI program

Results to Date

- Initial full inspections at W and B&W and partial CE NSSS designs have not identified any major issues of concern
- Current results are with uncertainty of mechanisms
- Issues of greatest concern not seen
  - SCC of austenitic welded components not observed
    - Cracking currently limited to high strength bolting
  - IASCC of welds not observed, indications limited to bolts
  - Macroscopic effect of void swelling not observed

By the Numbers*

- ~6** units completed MRP inspections
- 959 W guide tube flange welds inspected
- 3664 inches of irradiated welds inspected (approx.)
- 4551 inches of non-irradiated welds inspected (approx.)
- 2226 CASS items inspected
- 9024 baffle bolts inspected
- 1306 B&W high strength bolts inspected
- 108 B&W baffle plates inspected

* All numbers approximate. Includes reported inspections through Spring 2014; additional data may affect results slightly

** Varies by reactor design and type of inspection

By the Numbers*

- Zero Guide Tube Flange weld indications
- Zero irradiated weld indications
- Zero non-irradiated weld indications
- Zero CASS VT-3 indications
- 95 baffle bolt indications (1.1% of total)
- 20 B&W high strength bolt indications (1.5% of total)

* All numbers approximate. Includes reported inspections through Spring 2014; additional data may affect results slightly

Trends and Observations

- No observed austenitic SS stress corrosion cracking
- Irradiation Assisted SCC is extremely limited
  - Currently limited to bolts
  - High barrier to initiation in PWR environment
  - Explained in part by irradiation stress relaxation

Trends and Observations

- No macroscopic effects of void swelling
  - No distortions, cracking, or excessive bolting failure
- High-strength nickel alloy clevis insert bolting failures
  - However, not in safety function load path
- Guide card wear will require monitoring
  - MRP Interim guidance MRP-2014-006 issued recently based on specific PWROG work WCAP-17451-P, Rev. 1

Trends and Observations

- Sampling approach to inspections very successful
  - Spectrum of plant designs, materials, heats
  - Transition to more focused sampling for guide cards
- Efficiency could be increased, and is being pursued
- Integrated fleet management strategies are possible

MRP-227-A Experience Summary

- Exam results show few instances of service-induced degradation flaws, as expected
- Overall uncertainty of aging mechanism activity reduced
- Implementation by owners is thorough, but exams are difficult, as well as resource and dose intensive
- Some adjustments and efficiencies are needed, as expected with a ‘living’ program
- Joint MRP/PWROG team working to stream-line efforts of plant-specific implementation plans based on MRP-227

Industry Near Term Inspection Plans

Anticipated near term schedule of inspections

- Fall 2014 – 1 Westinghouse Design
- Spring 2015 – 1 CE Design
- Fall 2015 – 3 Westinghouse Designs
- Several more in 2016-2018 time frame

Continuing Industry Wide Activities

- Joint MRP/PWROG reactor internals core team is coordinating work activities
  - Broad spectrum of expertise
- On-going MRP Activities
  - Irradiated materials testing
  - Development of CASS screening with BWRVIP
  - MRP-227 Revision 1 under way
- PWROG Structural Assessments
  - Clevis insert bolting for commercial asset management
  - Lower core support column function and margin

Revision to Reactor Internals I&E Guideline

Planning / Schedule for MRP-227, Rev. 1

1. Initial draft for industry core team review ~ 10 weeks
2. Leadership team review and incorporate comments ~ 10 weeks
3. NEI 03-08 Actions Reviews and Sr. Exec. Reviews ~ 6 weeks
4. Face-to-Face planning meeting with NRC reviewers Interim
5. Consolidate comments and submit to EPRI publication ~Jan.2015

PWR RVI: Topic of Interest: CASS Internals and MRP-227-A A/LAI # 7

Westinghouse designs, CASS lower support columns

- NRC staff reviewers provided plant-specific RAIs related to CASS lower support columns and functionality when degraded condition(s) are identified.
- In 12/3/2013 closed meeting, as follow-up to 11/19/2013 public meeting, Westinghouse provided NRC staff with design- and fabrication-related information on CASS lower support columns and likelihood / consequence of failures.

…subsequent to closed meeting, Westinghouse provided technical-basis document to staff for use in generic consideration of RAIs related to CASS LSC. *(Ref. proprietary LTR-NRC-14-7,1/30/2014, ADAMs ML14063A070)*

PWR RVI: Topic of Interest: Plant-Specific RAIs related to CASS internals

Utility submittals for MRP-227-A A/LAI # 7

- On 2/18/2014 public meeting, MRP and BWRVIP met with NRC staff to understand plant-specific RAIs related to CASS components and thermal and irradiation embrittlement

  …staff concerns revolved around use of perceived non-conservative values for CASS chemical compositions (FN), and fluences for onset of irradiation embrittlement (e.g., Grimes letter versus MRP-175). Ref. ML14115A440

- NRC staff reviewers noted CASS database is RCS piping
- MRP noted that Reactor Internals made from CASS is intentionally different (lower FN) than RCS (valve bodies, pump casings, piping)
- MRP / BWRVIP CASS working group established technical position for handling of CASS reactor internals
  - Unified position submitted as RAI responses to BWRVIP-234, 5/2014
  - Next Steps ?

PWR RVI: Topics of Interest:

Cold Work of Stainless Steels

- NRC staff reviewers provided plant-specific RAIs related to >20% cold work (CW) of stainless steel.
- MRP and OEM prepared RAI response template provided to licensees via MRP-2013-025
  - Criteria defined by MRP.
  - Resource intensive effort with no cases of CW found yet.

Reporting of Reactor Internals Inspections

- Program Owners use Reactor Internals Utility Reporting Template as per EPRI MRP-2012-013, dated 3/20/2012

- EPRI MRP provided internals inspection results to NRC staff in EPRI letter MRP-2014-009, consistent with MRP-227-A 'Needed' requirement for reporting results
  - Submitted to NRC on May 12, 2014 (ML14135A383, 84, 85)

- MRP-227-A results will be submitted to NRC biennially.

Summary of MRP-227-A Implementation

- Utility owner implementation of MRP-227-A is effective
- Large quantities of items inspected with no major issues
- Current results match expectations
- MRP looking for efficiency gains and improvements in MRP-227 Rev. 1 for reactor internals aging management
- MRP-227-A will remain a ‘living program’

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