

**4rd NRC – AERB Nuclear Safety Projects Meeting  
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## **License Renewal – Materials Issues**



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## United States Nuclear Regulatory Commission

### Materials Issues for License Renewal

- Nickel-Alloy Program Issues – Management of cracking in ASME Code Class 1 components fabricated from nickel-alloy materials
- PWR Vessel Internals Program Issues – Management of aging associated with PWR reactor vessel (RV) Internal Components
- BWR RV and RV Internals Issues – Management of aging associated with BWR RVs and RV Internal Components
- BWR Austenitic Stainless Steel and Nickel Alloy Piping



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### Aging Management of Cracking in Nickel-Alloys

- Industry experience demonstrates that cracking is an applicable aging effect for ASME Code Class 1 nickel-alloy (Inconel) base metal and weld components as a result of primary water stress corrosion cracking (PWSCC)
- Three AMPs are credited with the management of PWSCC in ASME Code Class 1 nickel-alloy components :
  - Inservice (ISI) Programs – requirements of Section XI of the American Boiler and Pressure Vessel Code for ASME Code Class 1 components
  - Water Chemistry Programs
  - Nickel-Alloy Management Programs – augmented inspection programs for nickel-alloy components



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### Nickel-Alloy Management Programs

- Augmented inspections of upper RV head penetration nozzles and upper RV heads for all PWR applications will need to continue to comply with augmented inspection requirements of NRC Order EA-03-009 or any subsequent requirements that supersede requirements of the Order.
- Augmented inspections of lower RV head penetration nozzles and pressurizer penetration nozzles and steam space piping connections, including any associated nickel-alloy welds:
  - either need to be consistent with commitments made in an applicant's responses to Bulletins 2003-02 and 2004-01
  - or if undeveloped, need to follow recommendations of the EPRI MRP's industry initiatives on PWSCC of nickel-alloy components (Refer to Slide 5)



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### Nickel-Alloy Management Programs

- Some applicants have proposed to defer the specific details of their augmented inspection programs for nickel-alloy components until after the EPRI MRP has completed its industry initiative studies on this topic.
- If this alternative process is proposed, the NRC staff seeks the following threefold commitment from license renewal applicants:
  - a commitment to continue the applicant's participation in the EPRI MRP's studies on nickel-alloy cracking
  - a commitment to continue to implement the EPRI MRP's recommendations on nickel-alloy cracking, as applicable to the applicant's design of its PWR facility
  - a commitment to submit to the NRC, for review and approval, the inspection plan for the nickel-alloy components at least 24 months prior to the extended term



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### Aging Management of PWR Vessel Internals

- The following aging effects may be applicable to PWR reactor vessel (RV) internal components:
  - cracking – the mechanisms include stress corrosion, irradiation assisted stress corrosion cracking, or fatigue
  - loss of fracture toughness properties – the mechanisms include neutron embrittlement, void swelling, and thermal aging for cast austenitic stainless steel materials (CASS),
  - loss of preload in bolted, keyed, fastened, or pinned connections (stress relaxation)
  - changes in dimension (void swelling)
  - loss of material (wear)



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### Aging Management of PWR Vessel Internals

- RV Internals of PWR-designed facilities are typically fabricated from either austenitic stainless steels (including CASS), nickel-based alloys, or high strength stainless steels.
- Applicants for license renewal of PWR facilities may use one of two means of managing age-related degradation of their RV internal components:
  - Define both the scope of the PWR Vessel Internals Program and the specific examination methods, frequencies, and qualifications that will be implemented to manage the applicable aging effects for a given RV internal component
  - As an alternative process, defer defining the details of the PWR Vessel Internals Program until after the EPRI MRP has completed its studies on age-related degradation of PWR RV internal components



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### Aging Management of PWR Vessel Internals

- If this alternative process is proposed, the NRC staff seeks the following threefold commitment from license renewal applicants:
  - a commitment to continue the applicant's participation in the EPRI MRP's studies on age-related degradation of PWR RV internal components
  - a commitment to continue to implement the EPRI MRP's recommendations on management of aging in PWR RV internal components, as applicable to the applicant's design of its PWR facility
  - a commitment to submit to the NRC, for review and approval, the inspection plan for the applicant's PWR RV internal components at least 24 months prior to the extended term





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### Aging Management of BWR Vessels and Vessel Internals

- U.S. and international utilities formed the BWR Vessels and Internals Project (BWRVIP) in 1994 to proactively address materials-related degradation of BWR RV and RV internal components.
- The BWRVIP develops guidelines for inspection and repair of BWR RV and RV internal components, which augment the existing inspection and repair requirements mandated by Section XI of the ASME Boiler and Pressure Vessel Code. These BWRVIP guidelines are reviewed and approved by the NRC.
- New BWRVIP guidelines are proposed and existing BWRVIP guidelines are revised based on BWR operating experience.



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### Aging Management of BWR Vessels and Vessel Internals

- Applicants for license renewal of BWR facilities typically state that they will implement the recommended programs and activities in the BWRVIP guidelines as their bases for managing aging in their BWR RV internals.
- Current BWR materials issues that may impact future license renewal applications include:
  - Impact of irradiation assisted stress corrosion cracking on structural integrity of top guides in BWR facilities
  - Development of an integrated RV materials surveillance program that will monitor the impact of neutron irradiation on the BWR RV materials through 60 years of licensed operation.



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# Aging Management of BWR Austenitic Stainless Steel Piping

- Continuation of existing aging management program
- Delineated in NUREG-0313, Rev 2 and NRC GL 88-01; GALL program
- Applies to all austenitic and nickel alloy BWR piping containing reactor coolant, " 4 inches, " 200<sup>0</sup> F
- Requires augmented inspection based on one of 7 IGSCC categories
- Staff approved BWRVIP-75 allows modification of inspection scope based on improved water chemistry