

Fuel Performance and Cask Internals

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Meeting to provide Calvert Cliffs Nuclear Power Plant,
LLC, the opportunity to discuss request for
information responses regarding the Calvert Cliffs
ISFSI License Renewal with the NRC Staff

July 17, 2014



Introduction

- Current guidance in NUREG-1927 does not address cask/canister internals that are considered important to safety
 - Fuel performance for retrievability and cladding integrity functions
 - ISG-24 Final Guidance (ML14058B166)
- Staff is considering adding guidance to NUREG-1927 on this topic
- Aging management program (AMP) based on a surveillance demonstration program



AMP Element 1: Scope of the Program

NUREG-1927: The scope of the program should include the specific structures and components subject to an aging management review

- Components/Materials of Construction
 - Specify spent fuel maximum burnup
 - Specify cladding types and maximum cladding temperature
- Environment
 - Dry helium
- Aging effects for material/environment combinations
 - Fuel cladding breach
 - Assembly distortion
 - Residual moisture after drying
 - Changes in the hydride structure of the cladding



AMP Element 2: Preventive Actions

NUREG-1927: Preventive actions should mitigate or prevent the applicable aging effects

- Casks/Canisters dried per the accepted guidance in NUREG -1536, Standard Review Plan for Dry Cask Storage Systems
- Backfilled with helium cover gas
- Maximum cladding temperature is maintained below the recommended ISG-11 Rev 3 limits



AMP Element 3:

Parameters Monitored/ Inspected

NUREG-1927: Parameters monitored or inspected should be linked to the effects of aging on the intended functions of the particular structure and component

- Surveillance demonstration program meeting ISG-24:
 - Maximum cladding temperature
 - Inspection for the presence of fission gas in the cover gas
 - Inspection for presence of water vapor in the cover gas
 - Inspection for hydrogen to determine that any radiolysis of residual or bound water does not produce a flammable condition
 - Profilometry at the completion of the storage period to determine creep deformation
 - Gas puncturing at completion of storage to determine cladding stress for creep calculations
 - Cladding metallography at the completion of storage to determine condition of cladding hydrides



AMP Element 4: Detection of Aging Effects

NUREG-1927: Define method or technique, frequency, sample size, data collection, and timing to ensure timely detection of aging effects

- Surveillance demonstration program meeting ISG-24:
 - Calibrated thermocouple lances to measure the radial and axial temperature profile
 - Fission gas analysis technique for the cover gas with sensitivity to detect release of 1% of the fission gas produced in 1% of the cask rods with the lowest burnup in the demonstration
 - Residual moisture detection technique with sensitivity to detect the vapor pressure at the bottom of the demonstration system
 - Hydrogen detection technique with sensitivity to detect 2% hydrogen in the cover gas of the demonstration



AMP Element 5: Monitoring & Trending

NUREG-1927: Should provide for prediction of the extent of the effects of aging and timely corrective or mitigative actions

- As information/data from a fuel performance surveillance demonstration program becomes available, the licensee will monitor, evaluate, and trend the information via their Operating Experience Program and/or the Corrective Action Program to determine what actions should be taken to manage fuel and cladding performance, if any
- Similarly, the licensee will use its Operating Experience Program and/or Corrective Action Program to determine what actions should be taken if it receives information/data from other sources than the demonstration program on fuel performance



AMP Element 6: Acceptance Criteria

NUREG-1927: Acceptance criteria, against which the need for corrective action will be evaluated; should ensure that SSC functions are maintained

- ISG-24 acceptance criteria provide detailed guidance
- Cask internals and fuel performance criteria:
 - Temperature: spatial distribution and time history accurately determined - necessary since the behavior of the rods in the demonstration to the behavior expected of the rods in storage is temperature dependent.
 - Cladding Creep: total creep strain extrapolated to the total approved storage duration based on the best fit to the data, accounting for initial condition uncertainty shall be less than 1% - ISG-11 temperature limits are based on limiting creep to <1%



AMP Element 6: Acceptance Criteria

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- Cask internals and fuel performance criteria:
 - Hydrogen – maximum hydrogen content of the cover gas over the approved storage period shall be extrapolated from the gas measurements to be less than 5% - limit for precluding possible flammable mixture
 - Drying – The moisture content in the cask , accounting for measurement uncertainty, shall indicate no greater than one liter of residual water after the drying process is complete – Drying limit, in terms of residual moisture, in the SRP NUREG-1536
 - Fuel rod breach – fission gas analysis shall not indicate more than 1% of the fuel rod cladding breaches. – Recommended maximum number of cladding breaches during normal conditions of storage for containment analysis by ISG-5



AMP Element 7: Corrective Actions

NUREG-1927: Corrective actions, including root cause determination and prevention of recurrence, should be timely

- Licensee Corrective Action Program commensurate with 10 CFR 72 Subpart G, or 10 CFR 50 Appendix B
- Licensee Corrective Action Program to capture and evaluate surveillance demonstration program data, other information/data, and additional operating experience to initiate corrective and/or preventative actions:
 - Corrective actions to prevent reoccurrence
 - Extent of condition to other susceptible components
 - Timely corrective actions



AMP Elements 8: Confirmation Process

NUREG-1927: Confirmation process should ensure that preventive actions are adequate & appropriate corrective actions have been completed & are effective

- Licensee Quality Assurance Program consistent with 10 CFR 72 Subpart G, or 10 CFR 50 Appendix B
- What follow up action is going to be taken to determine whether preventative or corrective actions are a success
- Method to confirm any actions required are taken



AMP Elements 9: Administrative Controls

NUREG-1927: Administrative controls should provide a formal review and approval process

- Licensee Quality Assurance Program consistent with 10 CFR 72 Subpart G, or 10 CFR 50 Appendix B
- Training requirements for inspectors or personnel
- Records retention requirements
- Specified in the Demonstration Project Plan or alternate surveillance demonstration program meeting the ISG-24 guidance
- Frequency for updating AMP based on industry-wide operational experience



AMP Element 10: Operating Experience

NUREG-1927: Include past corrective actions; provide objective evidence to support a determination that the effects of aging will be adequately managed so that the SSC intended functions will be maintained during the period of extended operation

- Surrogate surveillance demonstration programs with storage conditions and fuel types similar to those in the dry storage system that satisfies the ISG-24 acceptance criteria is a viable method to obtain operating experience
- DOE Dry Cask Storage Demonstration Project is viable as a surrogate surveillance program for the industry
- Additional data/research to assess fuel performance



References

- NUREG-1927 – Standard Review Plan for Renewal of Spent Fuel Dry Cask Storage System Licenses and Certificates of Compliance
<http://pbadupws.nrc.gov/docs/ML1110/ML111020115.pdf>
- NUREG-1536, Rev 1 – Standard Review Plan for Spent Fuel Dry Storage Systems at a General License Facility
<http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr1536/r1/sr1536r1.pdf>
- ISG-5, Rev 1 – Confinement Evaluation
<http://www.nrc.gov/reading-rm/doc-collections/isg/isg-5R1.pdf>
- ISG-11, Rev 3 – Cladding Considerations for the Transportation and Storage of Spent Fuel
<http://www.nrc.gov/reading-rm/doc-collections/isg/isg-11R3.pdf>
- ISG-24 – The Use of a Demonstration Program as a Surveillance Tool for Confirmation of Integrity for Continued Storage of High Burnup Fuel Beyond 20 Years (ML14058B166)



Acronyms

- AMP – Aging Management Program
- CFR – Code of Federal Regulations
- DOE – U.S. Department of Energy
- ISG – Interim Staff Guidance
- SRP – Standard Review Plan