Constellation Energy



Challenges for License Renewal Application Beyond 60 Years

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Agenda

- Examples of Technical Issues for Reapplication Beyond 60 Years
- Technologies Needed to Facilitate More Non-Intrusive Aging Management Inspections or Examinations
- Summary

Technical Issues for Reapplication Beyond 60 Years

Dominant Examples:

- Time-Limited Aging Analyses (TLAAs)
  - Reactor Vessel Embrittlement
  - Environmental Qualification (EQ) Analyses
  - Class I Piping Fatigue Analyses
  - Plant-Specific Time Limited Aging Analyses (TLAAs)
- Electrical Cable Degradation
- Concrete Prolonged Exposure to Elevated Temperatures

Reactor Vessel Embrittlement TLAA

- Current regulatory requirements and analytical methodologies will require refinement of current methodologies or the development of other options for some plants to be able to operate beyond 60 years, such as:
  - New more accurate analysis techniques that allow for less conservatism yet retain operational safety assurances
  - Cost-effective technology development for in-place annealing
  - Cost-effective fabrication and replacement methodologies for vessel replacement
  - Development of other technologies for RV embrittlement evaluation/disposition

EQ Analyses TLAA

- For EQ components that are not analyzed to last for 80 years:
  - More refined analyses may project required 80 year life
    - Current analyses re-performed with less conservative assumptions
    - Installation of equipment for ongoing measurement of environmental conditions for more accurate input data for analyses
    - New more accurate analytical methodologies developed
  - Replacement of components may be required
    - Like replacements may no longer be available
  - Development of other technologies for EQ equipment evaluation/disposition

Class I Piping Fatigue Analyses TLAA

- Fatigue analyses, particularly for environmentally-assisted fatigue (EAF) scenarios, will have to be re-performed to re-project cumulative usage factors (CUFs) for 60 to 80 years
- For components with reanalyzed CUFs >1.0:
  - More refined analyses may be able to result in CUFs <1.0
  - An AMP may have to be established for periodic inspections of the relevant components for the applicable aging effects
  - Replacement of these components may be considered or required
  - Development of other technologies for fatigue evaluation/disposition

Plant Specific TLAAs

- Each plant has plant-specific TLAAs that will require reanalyses to determine satisfactory re-projection of analyzed life to 80 years of operation or:
  - Refined analyses may be able to be performed for satisfactory projection
  - An AMP may have to be established for periodic inspections of the relevant components for the applicable aging effects
  - Replacement of applicable components may be required
    - Like replacements may no longer be available
  - Development of other technologies for selective TLAA evaluations/dispositions

Plant Specific TLAAs

- Examples of plant-specific TLAAs
  - Reactor Coolant Pump (RCP) motor flywheel bore keyway fatigue (PWRs)
  - Concrete containment tendon pre-stress (PWRs)
  - Containment liner stress (Common)
  - Plant crane load cycles (Common)
  - High energy line break (Common)
  - Torus corrosion allowance (BWRs)
  - Control Rod Drive (CRD) stub tube flaw analyses (BWRs)

Electrical Cable Degradation

- Many plants utilized the exact same cables for EQ and non-EQ applications – EQ analyses may show that cable life beyond 60 years is an issue
- To better assess cable degradation:
  - Use of more refined analysis techniques or better input data for existing analyses
  - On-going monitoring of space environments for better environmental data input to analyses
  - Use of on-line cable operating parameter measuring technologies to monitor for cable performance degradation
  - Development of other technologies for cable degradation evaluation/disposition
  - Last resort of replacement of cables

Concrete Prolonged Exposure to Elevated Temperatures

- Some plants may have portions of concrete structures that are subject to prolonged exposure to elevated temperatures (particularly inside containment or main steam piping rooms)
  - Actual degradation of concrete is not known or necessarily measurable
  - Actual environmental conditions not accurately known due to the lack of the presence of equipment for ongoing environmental monitoring
  - Extent of such degradation is largely unknown
  - Development of technologies for concrete degradation evaluation/disposition

Examples of Needed Aging Management Technologies

- NDE methodology for determination of location and quantification of extent of selective leaching of piping/components
  - Graphitization (Gray Cast Iron)
  - De-Zincification (Cu Alloys with Zn Content ≥15%)
- NDE methodology for determination of presence of degradation in buried components without excavation (guided wave technology)
- NDE methodology for detection of flaws in Cast Austenitic Stainless Steel (CASS)
- NDE methodology for determination of the presence of cracks in high strength structural bolting embedded in concrete

Summary

- The decision for reapplying for a renewed license to operate a plant in the 2nd period of extended operation (PEO) of 60 to 80 years will depend on the amount of money that has to be spent to address and resolve all of the technical issues that are applicable to that plant, dominant examples of which have been discussed in this presentation.
- Within 2 years, several of the plants with approved licenses for their 1st PEO will be eligible to apply for their 2nd PEO – R&D to address the dominant technical issues is needed now!