TLAA Considerations for Life Beyond 60 years

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Agenda

- LB60 TLAA Considerations
- Definition of TLAA
- TLAA Dispositions
- Significant TLAA Dispositions

LB60 TLAA Considerations

- Existing process is adequate
- Analysis will remain valid or be projected to the end of the period
- NUREG-1801 Aging Management Programs will manage aging so that the intended function is maintained consistent with the CLB
- Some plant specific mitigation programs, inspection programs or modifications may be required

Definition of TLAA

TLAAs as defined in 10 CFR 54.3 are those calculations & analyses that:

1. *Involve systems, structures, and components within the scope of license renewal*
2. *Consider the effects of aging;*
3. *Involve time-limited assumptions defined by the current operating term, for example, 40 years;*
4. *Were determined to be relevant by the licensee in making a safety determination*
5. *Involve conclusions or provide the basis for conclusions related to the capability of the system, structure, or component to perform its intended function(s), as delineated in 10 CFR 54.4(b);*
6. *Are contained or incorporated by reference in the CLB.*

TLAA Dispositions

Pursuant to 10 CFR 54.21(c)(1)(i) - (iii), an applicant must demonstrate one of the following:

(i) The analyses remain valid for the period of extended operation;

(ii) The analyses have been projected to the end of the extended period of operation; or

(iii) The effects of aging on the intended function(s) will be adequately managed for the period of extended operation.

Significant TLAA Considerations

- Reactor Vessel Neutron Embrittlement Analysis
- Metal Fatigue
- Environmental Qualification of Electrical Equipment
- Concrete Containment Tendon Prestress Analysis
- Containment Liner Plate, Metal Containments, and Penetrations Fatigue Analysis
- Plant Specific TLAAs (e.g. Cranes, LBB, etc.)

Reactor Vessel Neutron Embrittlement Analysis - USE

- Charpy upper-shelf energy (USE) of no less than 68 J (50 ft-lb) throughout the life of the reactor vessel, unless otherwise approved by the NRC
  - USE analysis or equivalent margins analysis (EMA) remains valid during the PEO because the projected ¼T neutron fluence is bounded by the fluence assumed in the existing analysis.
  - NRC RG 1.99 Rev. 2 used to project USE to the end of the PEO or ASME Code Section XI Appendix K used for the purpose of performing an equivalent margins analysis

Reactor Vessel Neutron Embrittlement Analysis - PTS

- Projected clad-to-base metal interface neutron fluence at the end of the PEO is reviewed to verify that it is bound by the fluence assumed in the existing PTS analysis, or
- Revised PTS analysis based on the projected neutron fluence at the end of the PEO
  - Delta RTNDT is determined with chemistry factor from the tables in 10 CFR 50.61, or
  - Delta RTNDT is determined with two or more sets of surveillance data

Reactor Vessel Neutron Embrittlement Analysis - PTS

- Flux reduction program implemented in accordance with §50.61(b)(3), and an identification of the viable options that exist for managing the aging effect
  - Core management plans (e.g., operation with a low leakage core design and/or integral burnable neutron absorbers) including limiting material projected fluence value, projected RTPTS value, and date PTS screening criteria exceeded
  - Aging management plans (i.e. vessel material surveillance program)
  - Options considered for "resolving" the PTS issue
    - Plant modifications (e.g., heating of ECCS injection water)
    - detailed safety analyses (e.g., using Regulatory Guide 1.154)
    - More advanced material property evaluation (e.g., use of Master Curve technology)
    - The potential for RPV thermal annealing in accordance with §50.66

Metal Fatigue

- Typical metal fatigue analysis or flaw growth/tolerance evaluations include:
  - CUF calculations for ASME Code Class 1 components designed to ASME Section III requirements or other Codes
  - Implicit fatigue-based maximum allowable stress calculations for piping components designed to USAS ANSI B31.1 or ASME Code Class 2 and 3 components designed to ASME III design requirements
  - Environmental fatigue calculations for ASME Code Class 1 reactor coolant pressure boundary components
  - Potential fatigue assessments for BWR vessel internals (applicable applicant action items identified in BWRVIP reports)
  - Potential fatigue-based flaw growth analyses or fatigue-based fracture mechanics analyses,

Metal Fatigue – Class 1 Component Dispositions

- Potential dispositions for CUF calculations of ASME Code Class 1 components include:
  - Valid for PEO: number of accumulated cycles for the design basis transients would not be exceeded
  - Analysis projected to the end of the PEO and results verified to remain less than or equal to a CUF value of one
  - Metal fatigue of the reactor coolant system components is managed consistent with aging management program requirements of NUREG-1801

Metal Fatigue – Aging Management

- Program monitors and tracks the number of critical thermal and pressure transients for selected components
- Program includes fatigue calculations that consider the effects of reactor water environment for a set of sample reactor coolant systems components
- Program monitors fatigue usage on an as-needed basis if an allowable cycle limit is approached:
    - Use of projected cycles and/or
    - Use of actual transient severity
- Program uses action limits and corrective actions to prevent the usage factor from exceeding the design code limit

Metal Fatigue – Class 2 & 3 Component Dispositions

- Valid for PEO: maximum allowable stress range values valid because number of full range thermal cycles would not be exceeded
- Maximum allowable stress range values are re-evaluated based on the projected number of assumed full thermal range transient cycles above a value of 7000
- Aging management consistent with aging management program requirements of NUREG-1801

BWRVIP Fatigue Assessments

- Address applicable BWRVIP action items for potential fatigue assessments of:
  - Core Spray Internals (BWRVIP-18-A)
  - Standby liquid control system/core plate △P (BWRVIP-27-A)
  - Lower Plenum (BWRVIP-47-A)
  - Reactor Pressure Vessel (BWRVIP-74-A)

Environmental Qualification of Electrical Equipment

- Components within the scope of 10 CFR 50.49 are managed consistent with aging management program requirements of NUREG-1801
  - Replacement or refurbishment of components not qualified for the current license term prior to the end of qualified life
  - Reanalysis to extend the qualification of components under 10 CFR 50.49(e) is performed on a routine basis and includes the following attributes:
    - Analytical methods,
    - Data collection and reduction methods,
    - Underlying assumptions,
    - Acceptance criteria, and
    - Corrective actions

Concrete Containment Tendon Prestress Analysis Dispositions

- Valid for PEO: existing prestressing force evaluation remains valid because losses of the prestressing force are less than the predicted losses (recent inspection trend lines)
- Aging Management consistent with aging management program requirements of NUREG-1801
  - Containment tendon prestressing forces monitored consistent with ASME Section XI Subsection IWL
  - Predicted lower limit (PLL), minimum required value (MRV) and trend lines developed for PEO
  - NRC RG 1.35-1 and NRC IN 99-10 guidance used
  - Systematic retensioning of tendons or containment reanalysis required to keep the trend line above the PLL

Containment Liner Plate, Metal Containments, and Penetrations Fatigue Analysis

- Examples of containment TLAAs
  - Fatigue of liner plates or metal containments based on assumed number of loading cycles
  - Stainless steel bellows assemblies (high energy piping penetrations and fuel transfer tubes)
  - BWR containment suppression chamber and vent system
- Dispositions are consistent with other fatigue analysis TLAAs

Plant Specific TLAAs

- Examples of plant specific TLAAs:
  - Fatigue analysis of cranes designed to CMAA specification 70 (1975)
  - Leak before break analysis
  - Metal corrosion analysis
  - In-service flaw growth analysis that demonstrate structure stability for 40 years
- Dispositions are consistent with 10 CFR 54.21(c)(1)(i) - (iii)

TLAA Options for LB60

- Analysis will remain valid for the period or be projected to the end of the period
- Aging Management Programs will manage aging consistent with the CLB:
  - Fatigue Monitoring
  - Concrete Containment Tendon Prestress
  - Environmental Qualification of Electrical Components
- Other mitigation programs, inspection programs or replacement options