How Did the United States Get to the Point of Renewing Nuclear Power Plant Operating Licenses to 80 Years?

Allen Hiser
Division of New and Renewed Licenses
Office of Nuclear Reactor Regulation

IAEA Fifth International Conference on Nuclear Power Plant Life Management
Vienna, Austria

November 28, 2022

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

NRC PLiM Presentations

- Lessons Learned for License Renewal from 40 to 60 to 80 years
- Keynote Speech KS-6: Assuring Safety for Subsequent License Renewal
- Session 6-3: Applying the United States License Renewal Approach to an International Environment
- Session 6-4: Regulatory Research on the Aging Management of Structures, Systems and Components in Nuclear Power Plants Supporting License Renewal
- Harvesting of Aged Materials from Operating and Decommissioning Nuclear Power Plants

Topics

- License Renewal Approach
- Guidance Documents
  - Purpose
  - Development
  - Evolution from 40 to 60 to 80
- Summary

License Renewal Approach

- License Renewal – Part 54 of Title 10 of the U.S. *Code of Federal Regulations* (10 CFR Part 54)
- Standards for approval – "reasonable assurance that the activities authorized by the renewed license will continue to be conducted in accordance with the current licensing basis"
  - Managing the effects of aging during the period of extended operation on the functionality of in-scope long-lived, passive structures and components
  - Time-limited Aging Analyses (TLAAs)
  - Satisfy requirements for environmental review

License Renewal Principles

- The ongoing regulatory process is adequate to ensure the safety of operating plants
- The same plant operating rules (plant current licensing basis) apply during the renewal term
  - Requires additional actions for aging management of passive, long-lived plant structures and components for license renewal

License Renewal History

- Initial applications in 1998
- Early identification that adequate existing programs are frequently used for license renewal
- Questions on how to most effectively credit existing programs – industry wanted to exclude from review
- Desire to make license renewal application reviews
  - Consistent
  - Efficient
  - Based on rigorous technical review
  - Streamlined
- NRC was evaluating existing programs generically to determine their adequacy and when the programs should be augmented for license renewal

Commission Decision in 1999

- Proceed with the Generic Aging Lessons Learned (GALL) Report, the Standard Review Plan (SRP), and Regulatory Guide
  - Build on lessons learned from the initial applications and staff experience from review of license renewal applications
  - Identify when existing programs are adequate and when they should be augmented
- Ensure that regulatory guidance is clear and understandable to stakeholders so that the license renewal process is stable and predictable for future applicants.
- Seek stakeholders' participation in the development of guidance
  - Workshops
  - Public meetings to discuss comment resolution
- Update guidance, as appropriate, to capture the additional lessons learned and improve the license renewal process.

Generic Aging Lessons Learned (GALL) Report

- Provides assessments for aging management review (AMR), including identification of materials, environments and aging effects that require management
- Identifies acceptable Aging Management Programs (AMPs) – plant-specific alternatives may be proposed
- Defines terms
  - Structures and components
  - Materials
  - Environments
  - Aging effects
  - Significant aging mechanisms
- Identifies “Further Evaluations” (in SRP-LR) when adequacy of generic approach needs plant-specific review
- GALL Report is NOT a “scoping and screening document” – scoping and screened based on a plant-specific evaluation

Standard Review Plan for License Renewal (SRP-LR)

- Guidance for NRC staff review of
  - Scoping and Screening
  - AMR
  - TLAAs
    - e.g., metal fatigue, reactor pressure vessel (RPV) neutron embrittlement, environmental qualification
  - Updated Final Safety Analyses Report (UFSAR) supplement description of AMPs
  - UFSAR supplement description of TLAAs
  - Defines 10-element contents for plant-specific AMPs
- Purposes
  - Ensures the quality and consistency of staff reviewers
  - Presents a well-defined base from which to evaluate applicant programs and activities

Benefits of GALL Report & SRP-LR

- GALL Report is a key technical document for license renewal
  - Documents NRC expectations to ensure a stable regulatory process
- GALL Report improves effectiveness and efficiency of NRC staff review
  - Applicants typically claim 80% or more consistency
  - Helps focus NRC resources by not re-reviewing aging evaluations that have been found adequate generically – including findings of “no aging effects”

Regulatory Guide 1.188

- "Standard Format and Content for Applications to Renew Nuclear Power Plant Operating Licenses"

- Endorses Nuclear Energy Institute (NEI) guidance NEI 95-10
  - "Industry Guideline For Implementing the Requirements of 10 CFR Part 54 –The License Renewal Rule"
  - Standard format of license renewal application
  - Guidance for:
    - Scoping and screening
    - Identifying aging effects
    - Developing AMPs
    - Evaluating TLAAs

GALL Report and SRP-LR Versions

- GALL Report (NUREG-1801) and SRP-LR (NUREG-1800)
  - Revision 0 – issued July 2001
  - Revision 1 – issued September 2005
  - Revision 2 – issued December 2010
  - Interim changes made using Interim Staff Guidance – License Renewal (LR-ISG) process
    - 10 LR-ISGs apply to Revision 2
- GALL-SLR and SRP-SLR (NUREG-2191 & 2192)
  - Issued July 2017

Initial GALL Report & SRP-LR (Rev. 0)

- Based on extensive NRC research results, industry technical reports, plant operating experience, and NRC staff license renewal application review experience
  - NUREG-1568, License Renewal Demonstration Program: NRC Observations and Lessons Learned, 27 pp, Sept. 1996.
  - NUREG-1557, Summary of Technical Information and Agreements from Nuclear Management and Resources Council Industry Reports Addressing License Renewal, C. Regan, S. Lee, O.K. Chopra, D. C. Ma, and W. J. Shack, 188pp. October 1996.
  - NUREG/CR-6490, Volumes 1 and 2, Nuclear Power Plant Generic Aging Lessons Learned (GALL), Vol.1-448pp, Vol.2-439pp -448pp, December 1996.
  - NUMARC and Owners' Group / Vendor Reports on Major Components
  - Generic Communications
  - Previous Safety Evaluation Reports (SERs)
- Approved by the Commission

Revision 1

- Initiated in 2002
- Following issuance of 26 renewed licenses
- Component consolidations, reformatting, correction of errors
- Incorporates:
  - Approved LR-ISGs
  - Operating experience
  - Information from relevant generic communications
  - Lessons learned from applications and staff evaluations
- Public meetings with NEI
- Issued 2005

Revision 1 Changes

- Focus on improvements to AMR items to consolidate and make them less prescriptive
- AMP revisions
- New chapter on definitions to standardize terms for structures/components, materials, environments, aging effects, degradation mechanisms
- Additional documents
  - NUREG-1833: Technical Bases for Revision to the License Renewal Guidance Documents
  - NUREG-1832: Analysis of Public Comments on the Revised License Renewal Guidance Documents

Revision 2

- Began 2009
- Interaction with external stakeholders
  - NEI suggested changes (2009)
  - Public workshops (January and May 2010)
  - Formal external stakeholder comments (2010)
  - Buried pipe public meetings (2010)
- Objectives / source of changes
  - Capture operating experience gained since 2005
  - Integrate license renewal precedents since 2005
  - Account for changes in the NRC regulatory framework since 2005
  - Consider proposed changes identified by the nuclear industry
  - Incorporate content from license renewal ISGs
  - Account for changes in industry codes and standards since 2005

Revision 2 Changes

- Focus on AMP content
- Update AMPs for recent operating experience and reference documents
  - Domestic and foreign operating experience reviews (2004-2009)
  - To reflect precedents from recent license renewal applications and safety evaluation reports (SERs)
  - Capture ISG-LRs issued since Revision 1
- Consolidated GALL Report into a single volume
- Revised SRP-LR 10-Element Template for AMPs and updated AMPs for consistency with template
- NUREG-1950: Disposition of Public Comments and Technical Bases for Changes in the License Renewal Guidance Documents NUREG-1801 and NUREG-1800

Technical Issue Concerns for Operation to 80 years

- Identification of potential new aging phenomena – locations, forms, severity
  - Known mechanisms that could become more active – incubation times, activation energies, late blooming phases
  - New phenomena
- Approaches for identifying potential aging phenomena
  - Workshops with industry and international colleagues
  - Expanded Materials Degradation Assessment (EMDA)
  - Results from 1st renewal AMPs
    - Both “one-time” and periodic programs
  - Relevant domestic and international operating experience
- For operations to 80 years, operating experience cannot be relied on when oldest plants are just over 40 years old

Development of SLR Guidance

- Technical sources used for SLR guidance
  - EMDA
  - AMP effectiveness audits
  - Relevant domestic and international operating experience
  - External stakeholder, staff comments
- Internal expert panel process
  - Database of issues and comments
  - Public meetings
- Basis for changes
  - Expected aging differences for operations beyond 60 years
  - Lessons learned from GALL Report and SRP Revision 2 implementation
  - Improve efficiency and effectiveness in applications and NRC review
  - New operating experience since GALL Report and SRP Revision 2
  - Gaps and errors in GALL Report and SRP Revision 2

AMPs Effectiveness Audits

- Review both one-time and periodic AMPs
- Assess findings – unanticipated or expected degradation found, or confirm no degradation
- Accessibility issues, adequacy of methods
- Trending information (mainly existing programs)
- Three plants: 1 BWR and 2 PWRs
- Bottom line – Evaluate the effectiveness of AMPs and enable an assessment of the need for new or enhanced AMPs to address subsequent renewal

Subsequent License Renewal Guidance

- New TLAA AMP on Neutron Fluence Monitoring
- New AMP on High Voltage Insulators
- AMP XI.E3 on Inaccessible Cables divided into 3 AMPs (medium-voltage power, I&C cables, low-voltage power)
- Over 1000 new AMR line items
- Separate documents on “Technical Basis” and “Resolution of Public Comments”
- Technical issues
  - Reactor pressure vessel neutron embrittlement at high fluence
  - Irradiation-assisted stress corrosion cracking of reactor internals
  - Concrete and containment degradation
  - Electrical cable qualification, condition monitoring and assessment

Use of GALL Report in License Renewal Applications

- Pre-GALL
  - 8 units
- GALL Report Revision 0
  - 40 units
- GALL Report Revision 1
  - 27 units
- GALL Report Revision 2
  - 22 units (4 planned, 2 unplanned)
- GALL-SLR Report
  - 3 planned applications

Summary

- License renewal is a mature program – almost 20 years
- Use of guidance documents has been a key part of an efficient, consistent and predictable license renewal process
- Incremental changes are made through the LR-ISG process
- Document revisions have focused on incorporating LR-ISGs, new operating experience, lessons learned from application reviews, changes to NRC regulations and codes and standards
- Revision 2 + LR-ISGs is the final guidance for 40-60 year license renewal
- Guidance for subsequent license renewal (80 years) has been issued
  - Some technical issues require additional information or plant-specific determination