Aging Management and Subsequent License Renewal in the United States

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U.S.NRC
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Protecting People and the Environment

OUTLINE

- Aging Management – First 40 years
- License Renewal Approach
- Subsequent License Renewal
- Summary

WHAT IS AGING MANAGEMENT?

- Design, fabrication, construction, installation, testing and operation steps to:
  - Inhibit or preclude aging degradation (e.g., material selection and environmental control)
  - Identify degradation conditions in SSCs prior to a loss of intended function
  - Ensure effective corrective actions

HOW IS AGING MANAGED POST-START UP?

- First 40 years – Part 50
  - Regulation
  - NRC actions (orders, etc.)
  - Industry voluntary initiative
  - Emphasis on safety-related and RCS
- License Renewal – Part 54
  - Builds upon aging management activities implemented for first 40 years
  - Expands the scope of SSCs covered by aging management

FOR FIRST 40 YEARS (1/2)

- Requirements
  - 50.55a: ASME Code inspections
  - 50.65: Maintenance rule
  - 50.49 (EQ), 50.61 & 61(a) (PTS), Appendix G (fracture toughness requirements), Appendix H (RPV surveillance requirements) . . .
- NRC actions
  - Orders
    - Upper head CRDM nickel alloy penetrations
  - Generic Letter
    - GL-16-01, Monitoring of Neutron-Absorbing Materials in Spent Fuels Pools

FOR FIRST 40 YEARS (2/2)

- Industry voluntary initiatives
  - Reduces need for NRC to impose requirements
  - BWR Vessels and Internals Program
    - Vessel internals cracking, etc.
  - Materials Reliability Program
    - Baffle former bolts
  - Deviations subject to NRC notification

LICENSE RENEWAL RULE – 10 CFR PART 54

- A limited scope review based on "Regulatory Process Essential Elements"
- Rule provisions
  - Permits renewal for up to 20 years (e.g., 40 to 60 years)
  - Can apply 20 years before license expiration per 54.17(c)
  - Must apply at least 5 years before expiration per 2.109(b)
  - **A renewed license may be subsequently renewed per 54.31(d)**
  - No restrictions on number of subsequent renewals
- Focus is on demonstrating adequate management of the effects of aging for long-lived, passive structures and components important to plant safety
  - Other aspects of original license are not reconsidered
  - "A program based solely on detecting structure and component failures is not considered an effective aging management program"

LICENSE RENEWAL SAFETY PRINCIPLES

- Plant safety assured by regulatory process
  - Same plant operating rules for the renewal term
  - The plant's current licensing basis (CLB) to be maintained

- Requires additional actions for aging management of passive, long-lived plant structures and components for license renewal

REGULATORY PROCESS ESSENTIAL ELEMENTS

- Effective compliance with regulations
- On-site resident inspectors and specialized inspections
- Performance assessments of inspection findings
- Operating experience analysis and utilization
- Safety issue resolutions (generic and plant specific)
- Materials aging & degradation issues important to safety addressed by
  - Rule changes, generic communications, orders, voluntary actions

BASIS FOR RULE

- Statement of Considerations – 1991 Rule
  - 56 Federal Register 64943; December 13, 1991
- NUREG-1412
  - "Foundation for the Adequacy of the Licensing Bases – A Supplement to the Statement of Considerations for the Rule on Nuclear Power Plant License Renewal (10 CFR Part 54)"
  - ADAMS Accession No. ML080310668
- Statement of Considerations – 1995 Rule
  - 60 Federal Register 22461; May 8, 1995

SCOPE OF LICENSE RENEWAL

- Safety-related systems, structures, and components (SSCs)
  - Maintain integrity of the reactor coolant pressure boundary
  - Ensure capability to shut down and maintain safe shutdown
  - Prevent or mitigate offsite exposures comparable to 10 CFR Part 100
- Non-safety related SSCs whose failure could affect safety-related SSC functions
- SSCs relied upon for compliance with the Commission's regulations for:
  - Fire Protection (10 CFR 50.48)
  - Environmental qualification (10 CFR 50.49)
  - Pressurized thermal shock (10 CFR 50.61)
  - Anticipated transients without scram (10 CFR 50.62)
  - Station blackout (10 CFR 50.63)

SCOPING & SCREENING

- Process for determining which structures and components require an aging management review (AMR)
  - **Scoping** – Identify SSCs that are within scope
  - **Screening** – Include only those structures and components (SCs) that are passive and long-lived
    - Passive = perform an intended function without moving parts or without a change in configuration or properties
    - Long-lived = not subject to replacement based on a qualified life or specified time period
- Reliability and performance of active structures and components are covered by compliance with the Maintenance Rule (10 CFR 50.65)

SAFETY REVIEW

- Review adequacy of scoping and screening
- Assess adequacy of aging management review – have all relevant aging effects been identified and will they be effectively managed (using aging management programs)
- Adequacy of evaluation of time-limited aging analyses (TLAAs)
- Inspections on licensee implementation of the license renewal aging management programs

LICENSE RENEWAL GUIDANCE DOCUMENTS

- These documents are subject to change using the License Renewal-Interim Staff Guidance (ISG-LR) process

GALL-SLR REPORT

- Generic Aging Lessons Learned for Subsequent License Renewal (GALL-SLR) Report
  - NUREG-2191, issued 2017
  - Provides assessments for aging management review, including identification of materials, environments and aging effects that require management
  - Identifies acceptable Aging Management Programs (AMPs)
  - Defines terms (structures and components, materials, environments, aging effects, significant aging mechanisms)

SRP-SLR

- Standard Review Plan for Subsequent License Renewal (SRP-SLR)
  - NUREG-2192, issued 2017
  - Guidance for NRC staff review of
    - Scoping and Screening
    - Aging Management Review
    - Time-limited Aging Analyses (TLAAs)
      - e.g., metal fatigue, reactor pressure vessel (RPV) neutron embrittlement, environmental qualification
    - UFSAR supplement description of AMPs
    - UFSAR supplement description of TLAAs

STANDARDS FOR APPROVAL

A renewed license may be issued if the Commission finds that:

- Actions have been identified and have been or will be taken such that there is **reasonable assurance** that the activities authorized by the renewed license will continue to be conducted in accordance with the CLB. The actions are with respect to
  - managing the effects of aging during the period of extended operation on the functionality of structures and components
  - time-limited aging analyses
- Requirements for Environmental review have been satisfied
- Any consideration of Commission rules and regulations in adjudicatory proceedings has been resolved

SUBSEQUENT LICENSE RENEWAL (SLR)

- Operation from 60 to 80 years
- Regulatory framework and approval process is the same as license renewal
- Specific regulatory documents have been issued – GALL-SLR and SRP-SLR
- Certain issues up to plant-specific resolution
- Optimization of the review process
  - 18 month review (reduced from 22 months)
  - Increased use of in-office audits and web portals
  - Only final SER issued (previously included an “open items” SER)

CONCERNS FOR AGING

- Identification of potential new aging phenomena
  - Known mechanisms
  - New phenomena
- Approaches for identifying potential aging phenomena
  - Expanded materials degradation assessment
  - Results from 1st renewal aging management programs
  - Domestic and international operating experience
  - Research findings

NRC ACTIONS ON SUBSEQUENT RENEWAL

- Expert panel process to identify potential materials degradation issues for 80 years of operation
- Audits to assess results from implementation of AMPs at three plants with renewed licenses
- Public meetings with industry on technical issues, including operating experience and industry research activities
- NRC staff review of information and propose aging management approaches for 80 years of operation

BASIS FOR CHANGES TO DEVELOP GALL-SLR AMPS

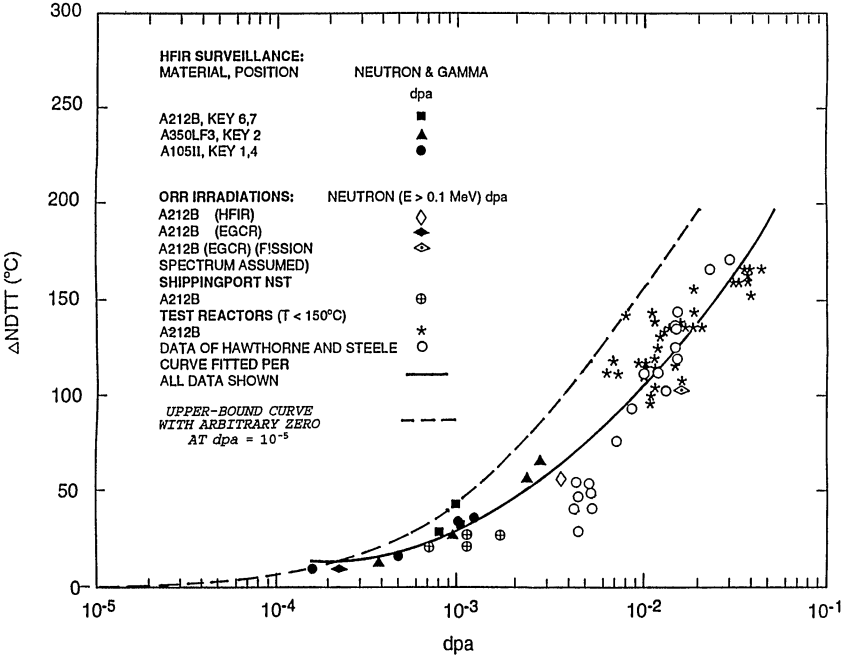
- To reflect expected aging differences for increased operating time from 60 to 80 years
- New plant operating experience since GALL Rev. 2
- Gaps identified in current guidance
- Improvements in efficiency and effectiveness of applications and NRC reviews
- Corrections to GALL Rev. 2 and SRP-LR Rev. 2
- Incorporate Interim Staff Guidance since GALL Rev. 2

SLR TECHNICAL ISSUES

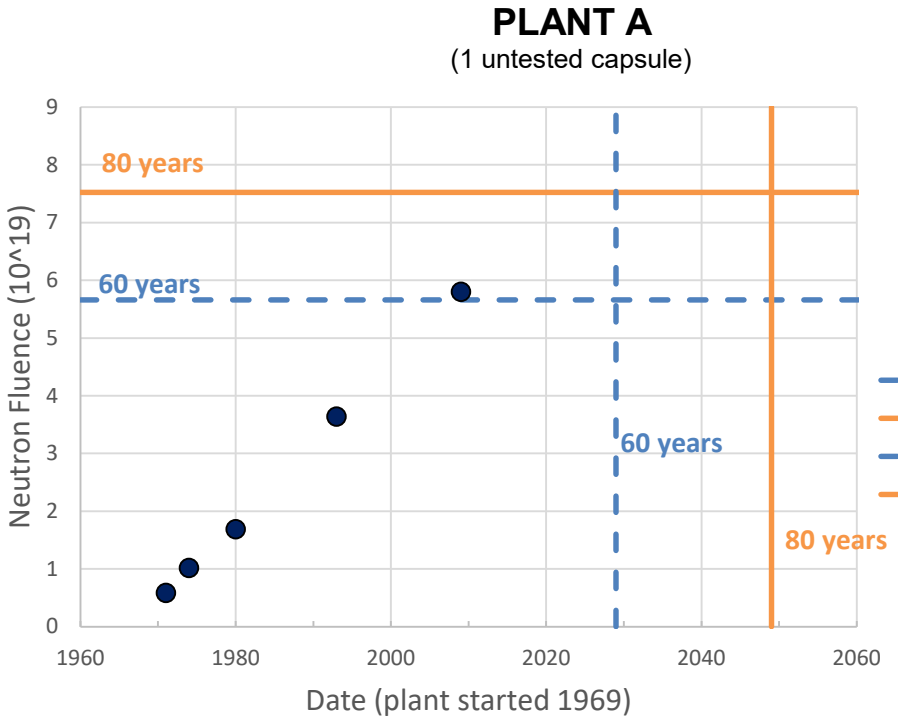
- **Reactor pressure vessel – neutron embrittlement**
  - Trends for high fluence levels
  - Surveillance programs
- **Reactor vessel internals - high fluence effects**
  - Irradiation-assisted stress corrosion cracking
  - Loss of fracture toughness
  - Void swelling
- Concrete and containment performance
  - Long-term radiation and high temperature exposure
  - Alkali-silica reaction (ASR)
- Electrical cables
  - Environmental qualification
  - In-service testing of cables
  - Long-term submersion of low and medium voltage cables

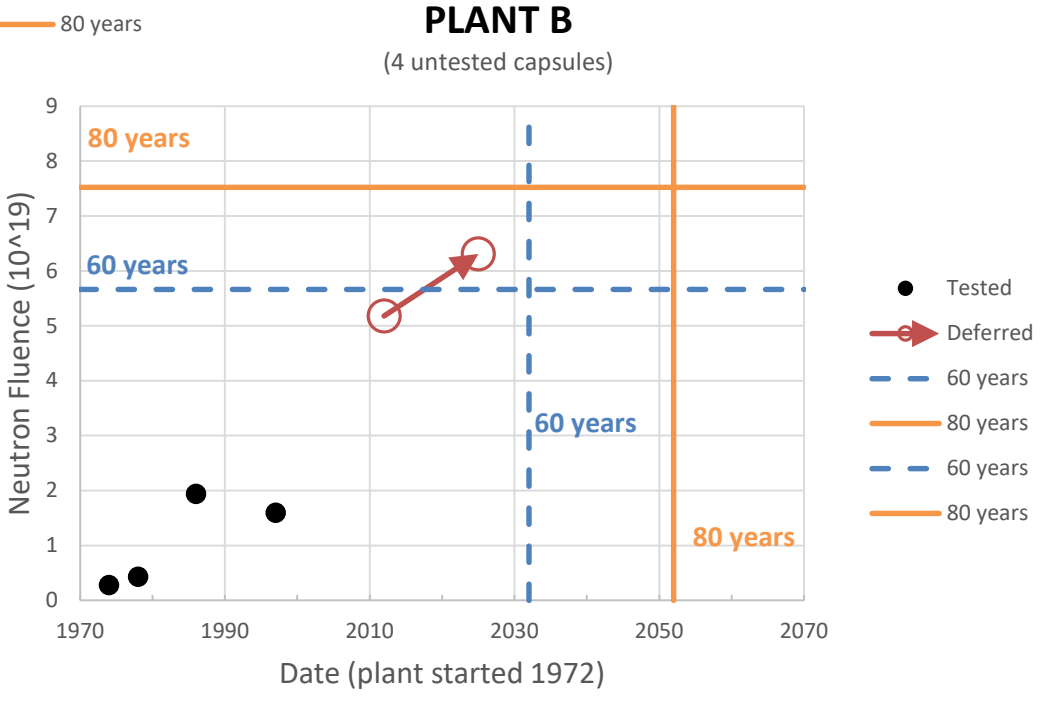
NEW TOPIC FROM SLR APPLICATIONS

- Neutron embrittlement for reactor pressure vessel support steel elements
  - First SLR applicants have no concrete “shielding” between the RPV and the support steel
  - Low temperature – 150°F
  - Copper 0.30 wt-%
  - NUREG-1509 analysis

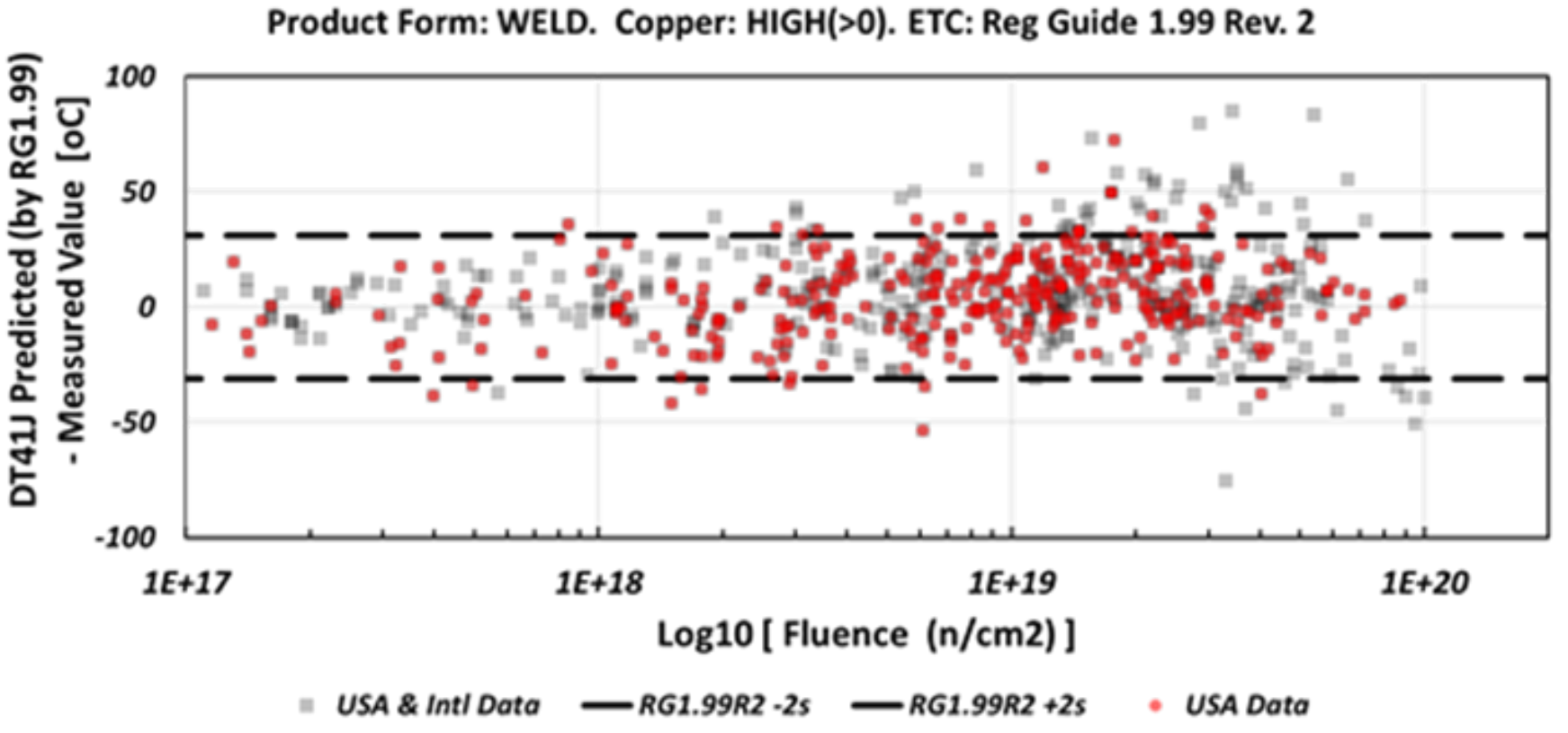


Reactor Vessel Material Surveillance AMP

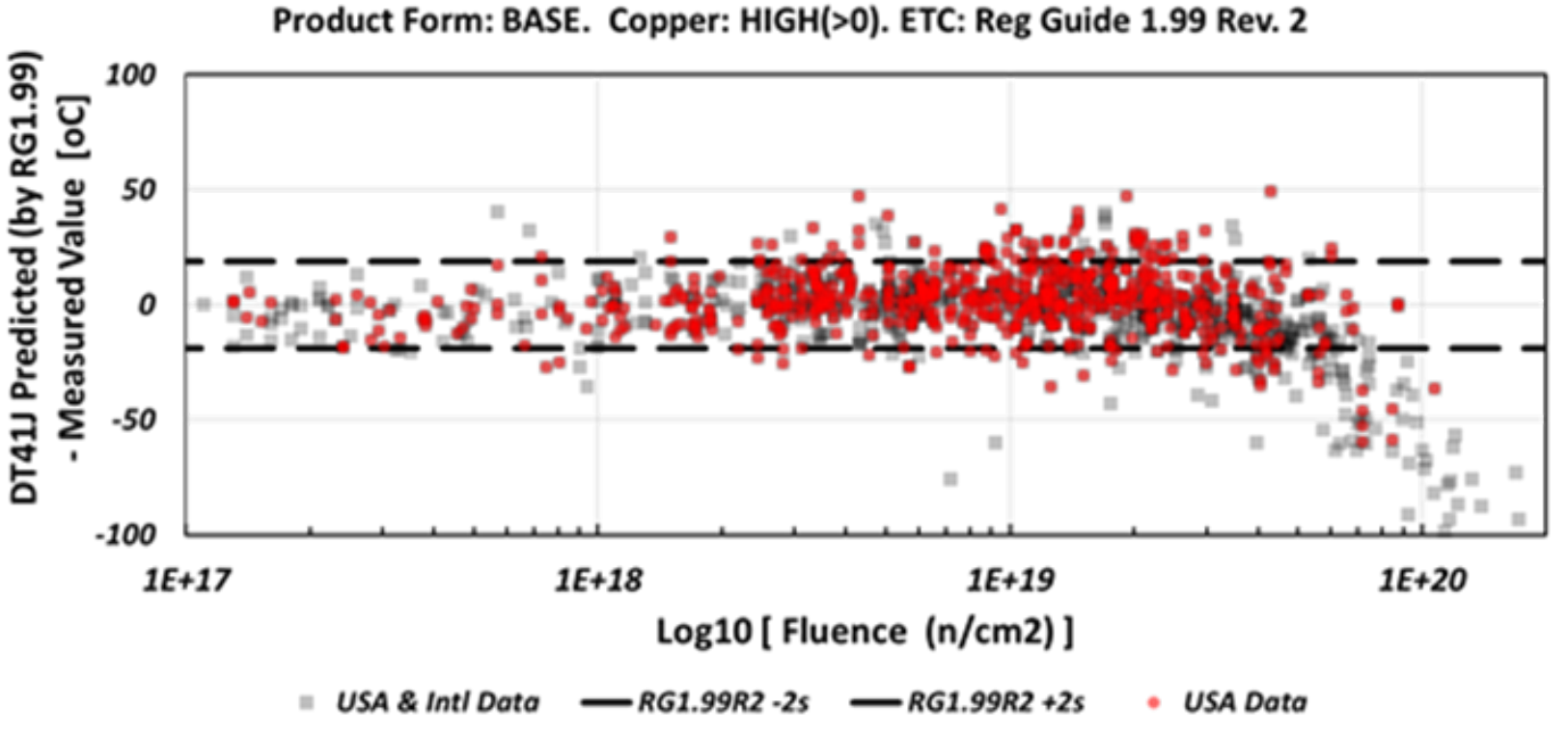




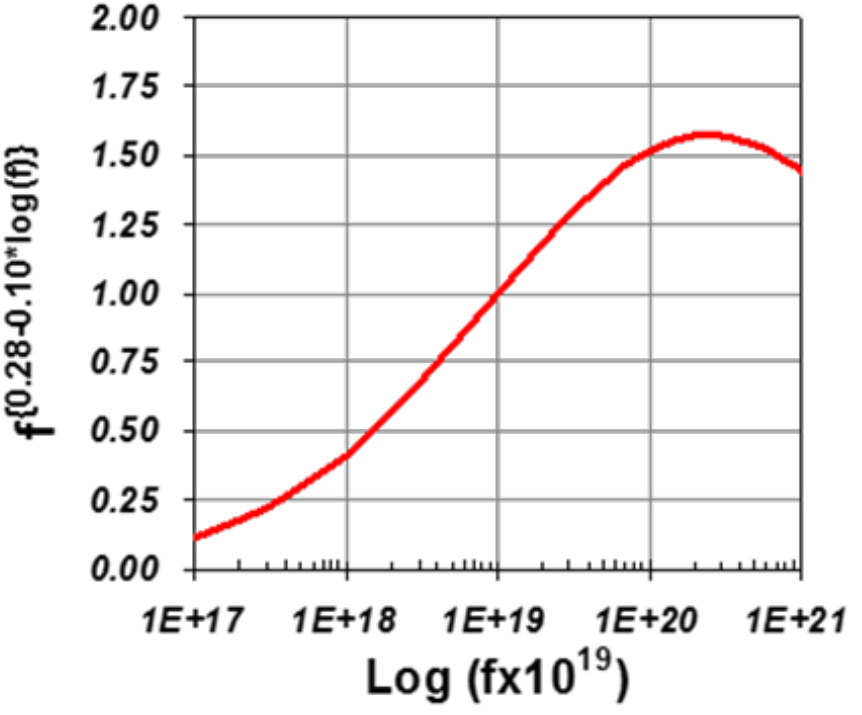
RESIDUALS FOR WELD MATERIALS



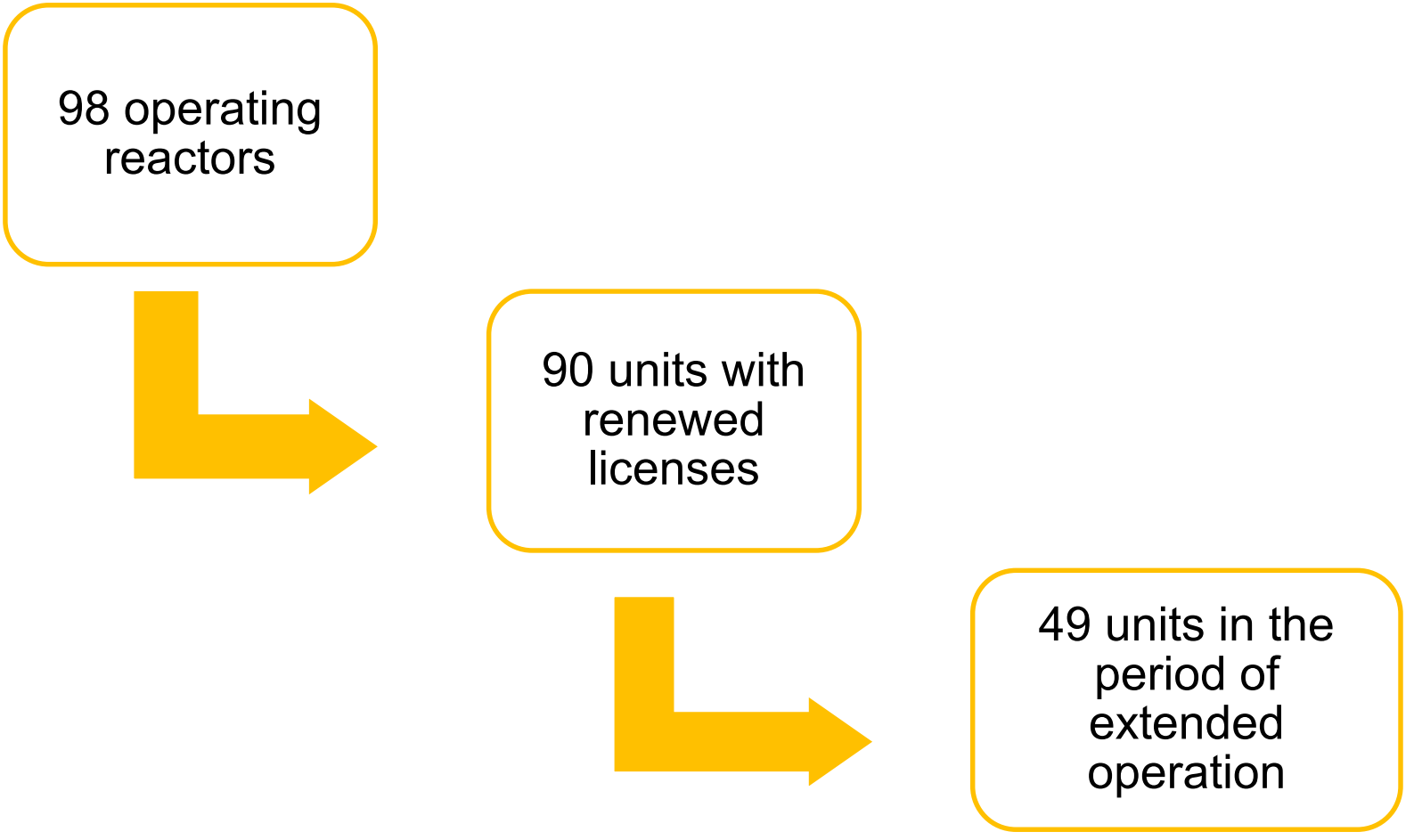
RESIDUALS FOR BASE MATERIALS



FLUENCE FACTOR RG 1.99, REV. 2



LICENSE RENEWAL STATUS



STATUS OF SLR

- Three SLR applications under review
  - Turkey Point, Units 3 and 4 (PWR) – accepted May 2018
  - Peach Bottom, Units 2 and 3 (BWR) – accepted September 2018
  - Surry, Units 1 and 2 (PWR) – accepted December 2018
  - [North Anna, Units 1 and 2 (PWR) – expected 2020]
- Application subject to acceptance review:
  - To determine if there is sufficient technical information in scope and depth to allow the NRC staff to complete its detailed technical review.
  - To identify whether the application has any readily apparent information insufficiencies in its characterization of the regulatory requirements or the licensing basis of the plant.

SUMMARY

- License renewal is a limited scope review
  - Supported by Regulatory Process Essential Elements
- Licenses have been renewed for over 90% of U.S. plants and reviews of remaining plants (except two) are ongoing or planned
- Licensees are responsible for demonstrating that aging is adequately managed for licensed operating period
- NRC ensures that plants will be operated with reasonable assurance of adequate protection of the public health and safety
- NRC is reviewing SLR applications for 3 sites (6 units)