Long Term Operations of Nuclear Power Plants in the United States

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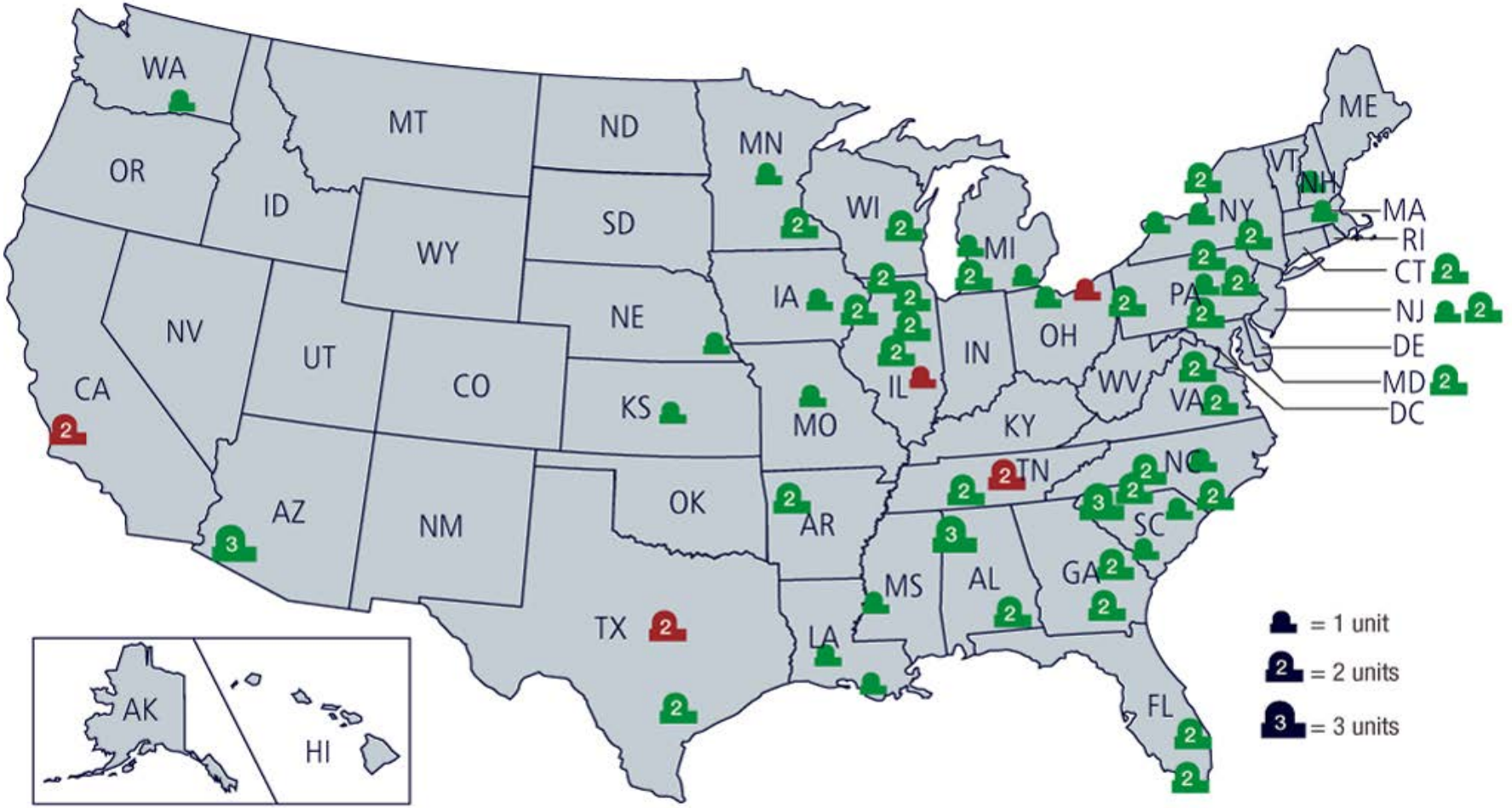
Key Points

1. Long Term Operations of NPP greater than 40 years is a reality in the United States
2. NPP are safely operated by implementation of the Current Licensing Basis (CLB) and Aging Management Programs
3. Operating NPP beyond 60 years is technically feasible
4. United States NPP owners are applying for licenses to operate beyond 60 years

US License Renewal Industry Status

- ✓ 94 units approved
- ✓ First unit operated beyond 40 years starting in 2009
- ✓ 48 units have operated beyond 40 years
- ✓ Overall Aging Management Programs have been effectively implemented
- ✓ Subsequent License Applications for 6 units to operate beyond 60 years are under NRC review

License Renewals Granted for Operating Nuclear Power Reactors



Licensed to Operate (98)

Original License (8) License Renewal Granted (90)

Note: The NRC has issued a total of 94 license renewals; four of these units have permanently shut down. Data are as of March 2019.

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

Data as of March 2019

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License Renewal Rule

- 10 CFR 54 – The License Renewal Rule
  - Safety Application – Part 54
  - Environmental Report – Part 51
- Application may not be submitted until the plant is within 20 years of license expiration
- New license can be extended 20 years beyond current license
- ***10 CFR 54.31 (d): a renewed license can subsequently be renewed***

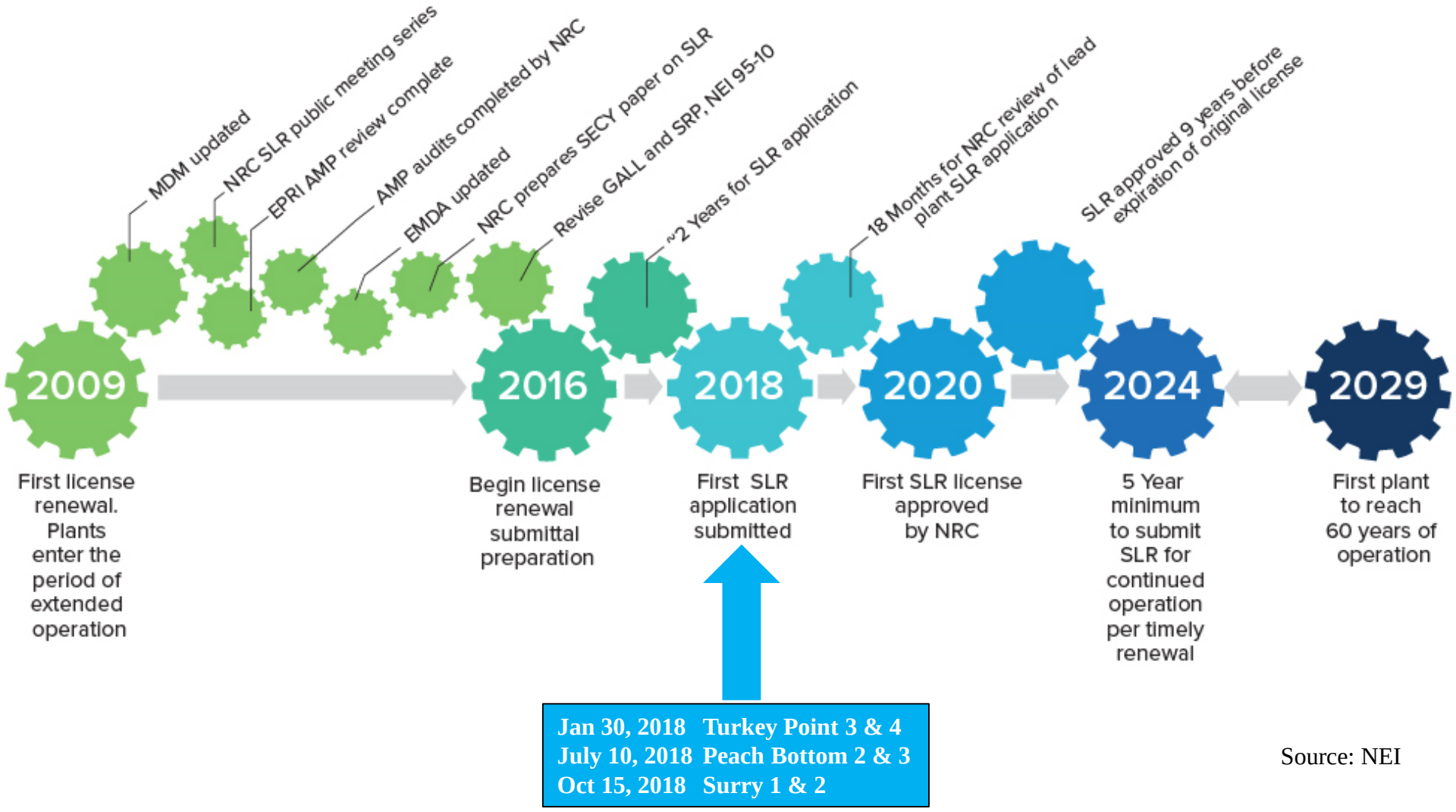
Existing rule is adequate and proven for Subsequent License Renewal

License Renewal Rule Principles

- The regulatory process is adequate to ensure that the current licensing basis provides an acceptable level of safety, with the possible exception of the detrimental effects of aging on certain systems, structures, and components, and

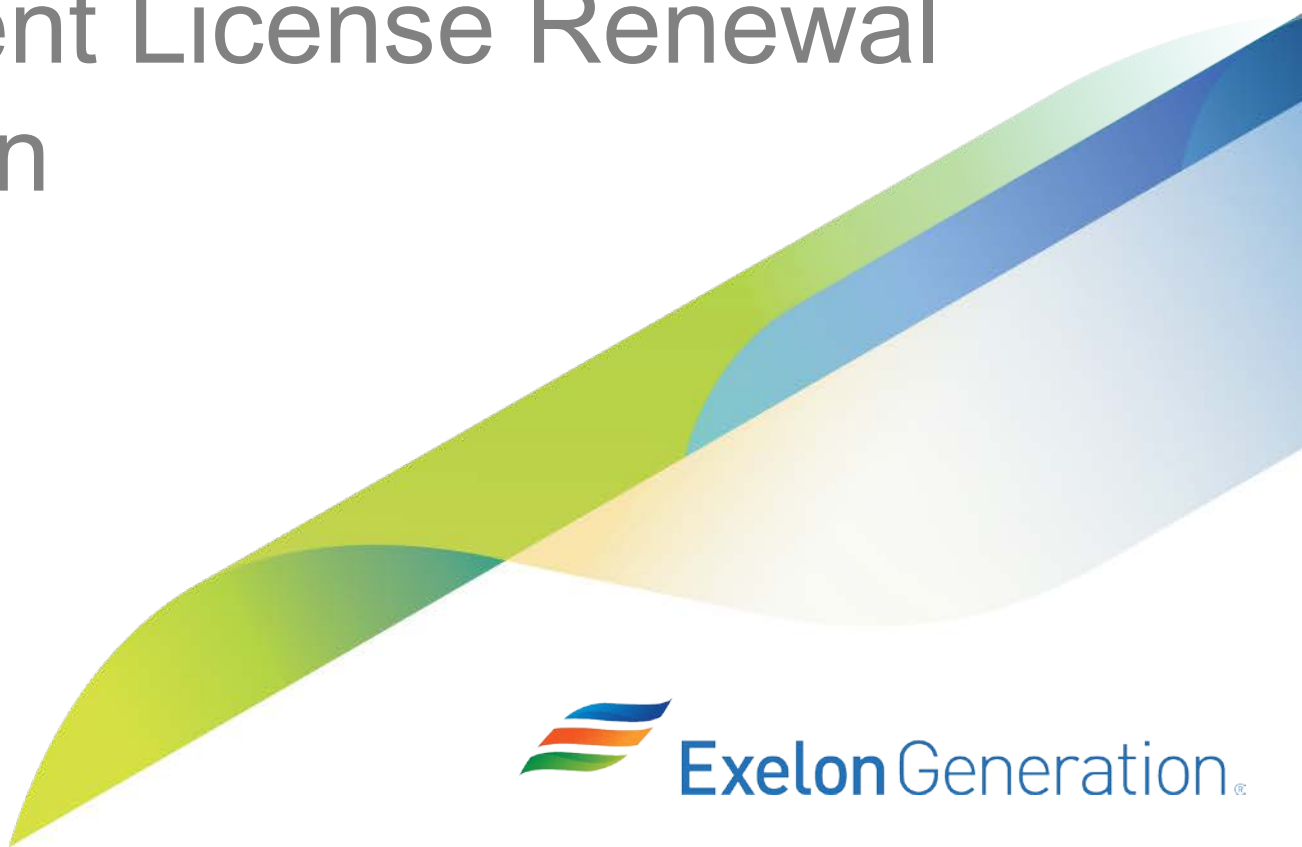
- Each plant's current licensing basis is required to be maintained during the renewal term.

Subsequent License Renewal Plan & Status



Source: NEI

Subsequent License Renewal Application



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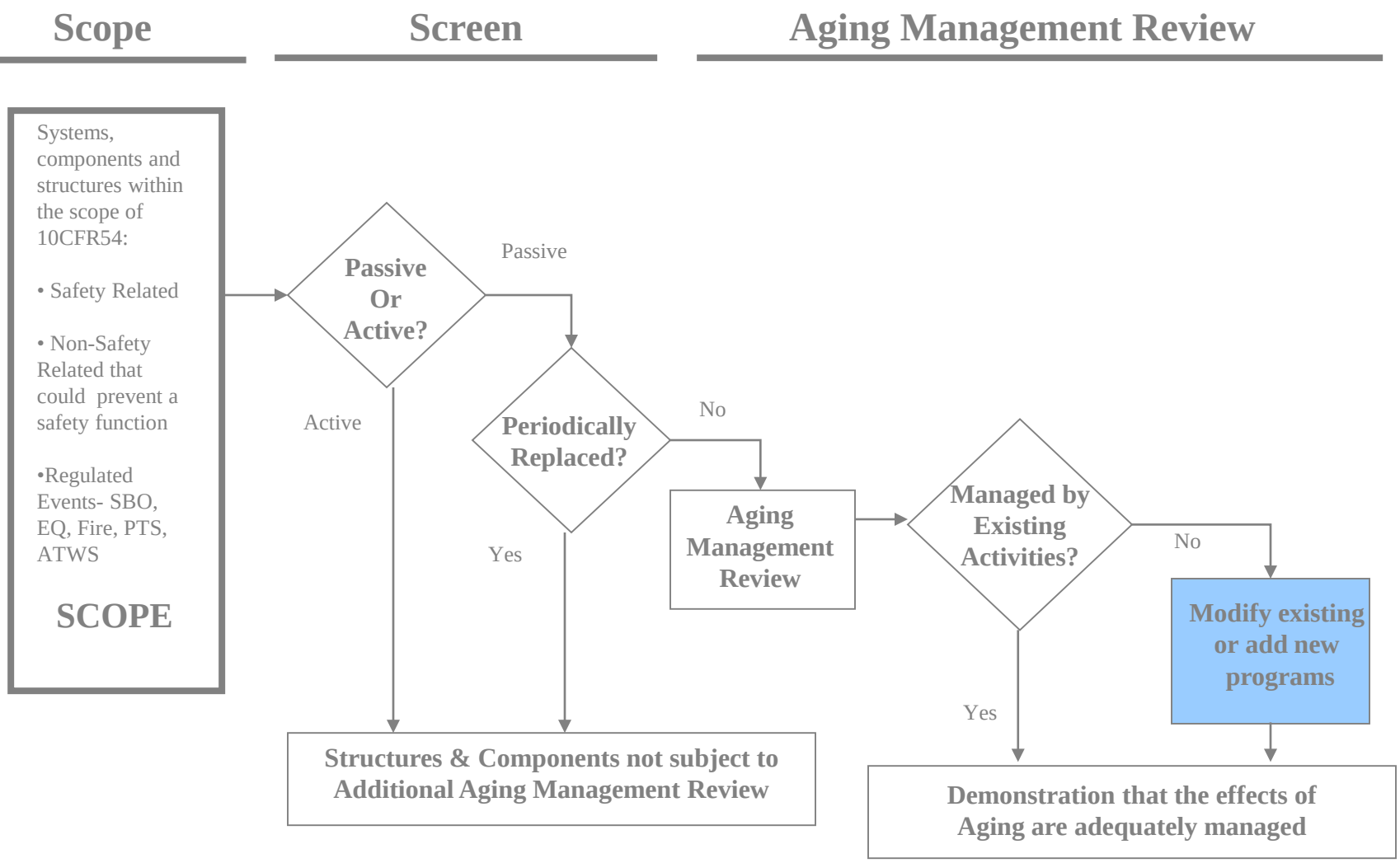
Peach Bottom Units 2 & 3

Station Overview

Peach Bottom	Unit 2	Unit 3
Initial License	8/08/1973	7/02/1974
5% Power Uprate to 3458 MW_t	1994	1995
First License Renewal Approval	2003	2003
EPU (15%) to 3951MW_t	2014	2014
MUR (1.65%) to 4016 MW_t	2017	2017
Current License Expiration	8/08/2033	7/02/2034
Anticipated SLR License Expiration	8/08/2053	7/02/2054

Part 54 Application Integrated Plant Assessment



SLR Application Development

- Based on NUREG-2191 GALL-SLR
- Scoping and Screening
  - ✓ Updated for plant modifications
  - ✓ Updated 10 CFR 54.4(a)(2) to NEI 17-01 Standards
- Aging Management Reviews
  - ✓ PB LR was pre-GALL, additional aging effects required assessment based on GALL-SLR
- Aging Management Programs (AMPs)
  - ✓ Total of 49 AMPs per GALL-SLR guidance
- Time-Limited Aging Analyses (TLAAs)
  - ✓ Existing TLAAs re-assessed
  - ✓ New TLAAs for SLR due to component repair/replacement
    - ✓ Jet Pump mechanical repairs
    - ✓ Unit 3 Core Spray piping in-vessel repair
    - ✓ New steam dryers
  - ✓ Total of 35 TLAA per GAL-SLR guidance

RPV Embrittlement

	SLRA Sections Addressing GALL-SLR Recommendations
Reactor pressure vessel neutron embrittlement at high fluence	3.1.2.2.3 Loss of Fracture Toughness Due to Neutron Irradiation Embrittlement 3.1.2.2.13 Loss of Fracture Toughness due to Neutron Irradiation or Thermal Aging Embrittlement 4.2 Reactor Vessel and Internals Neutron Embrittlement Analyses A.2.1.20 Reactor Vessel Material Surveillance A.3.1.2 Neutron Fluence Monitoring

- ✓ Fluence projections through SPEO (70 EFPY) were performed for neutron embrittlement analyses
- ✓ Analysis for USE, ART, P-T Limits, Axial/Circ Weld Failure Probability, and Reflood Thermal Shock for beltline materials have been satisfactorily evaluated using the 70 EFPY fluence projections
- ✓ PBAPS will manage fluence projections consistent with GALL-SLR Program X.M2, Neutron Fluence Monitoring Program
- ✓ PBAPS will manage embrittlement consistent with GALL-SLR Program XI.M31, Reactor Vessel Material Surveillance Program.
  - ✓ One capsule will be withdrawn from each Unit during SPEO at 60-62 EFPY

IASCC of Reactor Vessel Internals (RVI)

	SLRA Sections Addressing GALL-SLR Recommendations
IASCC of reactor internals and primary system components	3.1.2.2.12 Cracking Due to Irradiation-Assisted Stress Corrosion Cracking 4.2.1.2 Reactor Vessel Internals Neutron Fluence Analyses 4.2.14 First License Renewal Application Core Shroud IASCC and Embrittlement Analysis A.2.1.7 BWR Vessel Internals A.3.1.2 Neutron Fluence Monitoring

- ✓ IASCC is addressed in accordance with BWRVIP guidelines through:
  - ✓ periodic inspection using techniques capable of detecting cracking due to SCC
  - ✓ flaw tolerance guidance that considers the effect of neutron fluence on material properties and SCC growth rates.
- ✓ BWRVIP guidelines are adequate for use to determine the proper re-inspection interval and are not time dependent, rather are based on neutron fluence values.
- ✓ PBAPS Rx vessel internals have been assessed using governing BWRVIP inspection guidelines and existing program requirements were found acceptable
- ✓ PBAPS will manage RVI components and welds that are susceptible to IASCC consistent with GALL-SLR AMP XI.M9

Concrete and Containment Degradation

	SLRA Sections Addressing GALL-SLR Recommendations
Concrete and containment degradation	3.5.2.2.1 Pressurized Water Reactor and Boiling Water Reactor Containments 3.5.2.2.2 Safety-Related and Other Structures and Component Supports 4.6 Primary Containment Fatigue Analyses A.2.1.30 thru 36 (i.e., IWE, Structures Monitoring, Protective Coatings)

- ✓ Concrete overall is in good condition
  - ✓ ASR is not significant aging mechanism for PBAPS concrete structures
- ✓ PBAPS Containment is in good condition
  - ✓ The Sand Bed Region has been evaluated and demonstrated to be leakage free
  - ✓ Reactor Vessel Shield Wall gamma and neutron irradiation remains within acceptance limits through SPEO consistent with GALL-SLR
- ✓ PBAPS will manage concrete structures and containment consistent with GALL-SLR AMPs

Electrical Cable EQ and Condition Assessment

	SLRA Sections Addressing GALL-SLR Recommendations
Electrical cable qualification and condition assessment	3.6.2.2.1/4.4.1 Environmental Qualification of Electric Equipment 3.6.2.2.2 Reduced Insulation Resistance Due to Age Degradation of Cable Bus Arrangements .. 3.6.2.2.3 Loss of Material Due to Wind-Induced Abrasion, Loss of Conductor Strength Due to Corrosion, and Increased Resistance of Connection Due to Oxidation or Loss of Preload for Transmission Conductors, Switchyard Bus, and Connections A.2.1.37 through 43 (i.e., I&C, Medium and Low Voltage Cable Programs, MEB) A.3.1.3 3 Environmental Qualification of Electric Equipment

- Environmental Qualification of Electrical Equipment
  - ✓ EQ analysis has been updated through SPEO
  - ✓ CLB design ambient room temperature and accident profiles are utilized for environmental qualification analysis of electrical equipment.
  - ✓ All passive equipment evaluated for greater than 80 life
  - ✓ Program is consistent with GALL-SLR
- ✓ Electrical cable condition assessment
  - ✓ Added programs to be consistent with GALL-SLR

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Questions?

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