

Appendix C: Safety Review: The Tiered Approach

The Tiered Approach considers several characteristics of each of the technical areas of a license renewal (LR) application to determine the appropriate level of review. The level of review refers to the depth to which the U.S. Nuclear Regulatory Commission (NRC) staff verifies the information in the application, examines operating experience, and reviews engineering analyses, plant procedures, inspection results, and other documentation. These activities support the technical assessment and finding on the adequacy of the proposed aging management programs (AMPs) and time-limited aging analyses (TLAAs) to manage the effects of aging.

The Tiered Approach borrows existing concepts that have proven successful in NRC licensing activities:

- The adoption of a level-of-review framework is similar to that used for new and advanced reactor risk-informed reviews and topical report reviews, as described in Office of Nuclear Reactor Regulation (NRR) Office Instruction LIC-500, “Topical Report Process,” dated January 27, 2022 (Agencywide Documents Access and Management Program Accession No. ML20247G279). Individual portions of LR applications vary by complexity and risk, and it is appropriate to tailor the level of review to reflect those characteristics.
- The process to leverage risk insights in combination with traditional engineering factors to guide the review follows the general framework described in NRR Office Instruction LIC-206, “Integrated Risk-Informed Decision-Making for Licensing Reviews” dated June 6, 2019 (ML19031C861).
- The crediting of previously approved programs is consistent with the traditional successful application of NUREG-1801, “Generic Aging Lessons Learned (GALL) Report,” as continued for subsequent license renewal (SLR) with NUREG-2191, “Generic Aging Lessons Learned for Subsequent License Renewal (GALL-SLR) Report,” which describe programs that are considered generically acceptable to manage the effects of aging, such that the staff’s review can focus on unique plant configurations, operating experience, or program features.

Table C-1, “Tiers of Review,” summarizes the general expectations for the level of review for each of the three tiers, as well as the factors that will be considered by the NRC staff in assigning a review area to a particular tier.

The tiers will be assigned in a modified LIC-206 process, as introduced above and depicted in figure C-1. An integrated panel review will first establish a generic tiering determination for each technical area, independent of an application. This will be based on multi-plant probabilistic risk assessment (PRA) information and general characteristics of operating plant programs that are cited in the GALL and GALL-SLR Reports. For each plant, the review staff will either use the generic tier guidelines to perform their review or adjust the tier based on plant-specific considerations. The crediting of previous reviews is a special case, for which a gap analysis is an additional major driver of focusing review resources.

Table C-1 Tiers of Review

Standard (High)	Modified (Medium)	Confirmation (Low)
Documentation Review		
<ul style="list-style-type: none"> • Application • Operating experience • AMP and TLAA basis documents • Engineering analyses • Implementing procedures • Inspection and test results • Corrective actions 	<ul style="list-style-type: none"> • Application • Operating experience • AMP and TLAA basis documents <p><i>[Discretion to review key details in other plant documents]</i></p>	<ul style="list-style-type: none"> • Application • Operating experience <p><i>[Confirm sample of key details in basis documents]</i></p> <p>*For previously approved AMPs, a focus on gaps and new information</p>
AMP or TLAA Tiering Consideration Factors		
High risk/safety significant SSCs	Medium risk/safety significant SSCs	Low risk/safety significant SSCs
Limited or no reference to widely accepted standards	GALL-SLR recommends significant augmentation of industry standards	Mature plant programs with high degree of standardization
No or minimal NRC oversight/visibility	Moderate NRC oversight/visibility	Robust NRC oversight/visibility
No prior reviews	Relies on some aspects of previous reviews	Fully leverages previous reviews (initial license reviews or fleetwide programs)
Plant-specific AMPs or a high number/significance of exceptions to GALL-SLR	Limited GALL-SLR inconsistencies	Full GALL-SLR consistency
Recent, novel, or reoccurring operating experience of degradation	Operating experience shows average trends	Absence of unexpected operating experience of degradation; or shows positive trends
TLAAs dispositioned with calculations: 10 CFR 54.21(c)(1)(i or ii)	TLAAs dispositioned with an AMP: 10 CFR 54.21(c)(1)(iii)	

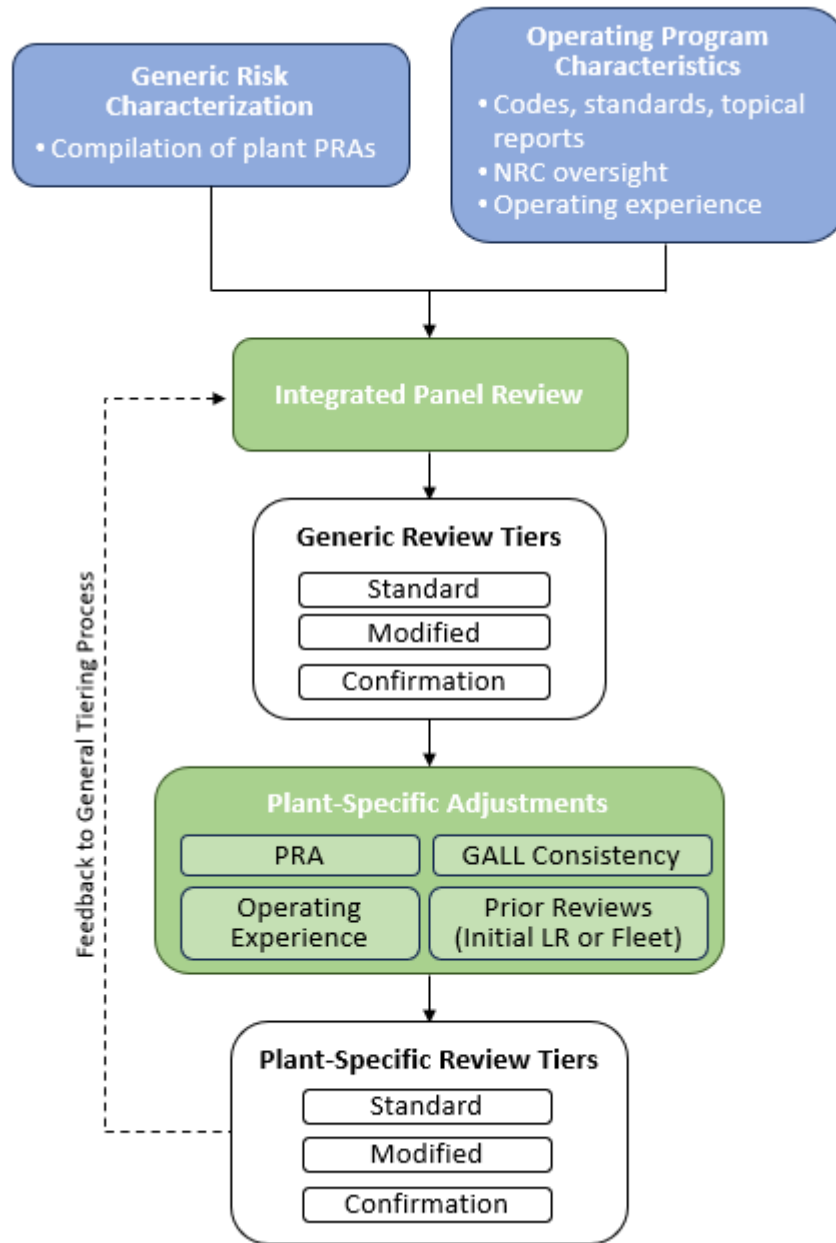


Figure C-1 Tiering process

Incorporating Risk Insights

Scope of Staff Review – Risk Insight for Passive Components

The NRC's LR rule is commonly described as a deterministic rule. The scope of structures, systems, and components (SSCs) that must be addressed in a LR application is explicitly defined in Title 10 of the *Code of Federal Regulations* (10 CFR) 54.4(a). Similarly, the subset of the in-scope structures and components (SCs) subject to an aging management review is explicitly defined in 10 CFR 54.21(a)(1), reflecting only those SCs that are screened-in as passive and long-lived. Per 10 CFR 54.21(a)(3), the applicant's integrated plant assessment (IPA) must demonstrate that the effects of aging will be adequately managed for the period of extended operation for "**each** [emphasis added] structure and component" identified in 10 CFR 54.21(a)(1).

The deterministic nature of the NRC's LR rule was the result of extensive discussions on the potential role of PRAs. The Statements of Consideration (SOC) for the original 1991 rule (Volume 56 of the *Federal Register* (FR), page 64943 (56 FR 64943)) concluded:

[A]t the present time, probabilistic assessments can be a useful adjunct to deterministic methods **to help draw attention to specific vulnerabilities and to help guard against significant oversights** [emphasis added] in the screening process. In view of the PRA limitations discussed, probabilistic assessment alone is not an acceptable basis for the exclusion of SSCs to be evaluated as part of an IPA. It may be useful to identify additional SSCs to be evaluated as part of the IPA.

The noted PRA limitations included the fact the PRA models historically have not provided a means to predict the probability of the age-related failure of passive, long-lived components. This is due to the past, relatively high reliability of most passive components, which has been bolstered by robust inspection practices (e.g., the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code requirements):

The Commission considers that at the present time appropriate **aging data and models have not been developed for many SSCs for inclusion in the PRAs** [emphasis added] and uniform criteria do not exist for evaluating the PRA results.... In view of the PRA limitations discussed, probabilistic assessment alone is not an acceptable basis for the exclusion of SSCs to be evaluated as part of an IPA.

When a component is cited in a PRA as being risk-significant, it is most often the component's active function that contributes to the calculated risk (e.g., opening of a control valve), as opposed to the passive function addressed by LR (e.g., the valve body that serves as the pressure boundary). Because of these limitations, and the deterministic nature of the LR rule, the use of risk insights to inform the scope of the renewal review (i.e., to not review some SSCs in scope of the rule) would likely require rulemaking.

Level of Staff Review – Enhancing the Current Risk-Informed Approach

Despite the above-noted limitations, PRAs have provided practical insights on the significance of systems and components that are useful in focusing review resources. Starting with the first SLR application, the NRC staff has been leveraging risk information to guide the level of

documentation review in audits of AMPs and TLAAs. At the submission of each SLR application, applicants have made available risk information for NRC consideration. This information has included the top 10 to 15 risk-significant events and systems and, in some instances, component importance in each of the significant systems. The NRC assesses this risk information, as well as plant risk information maintained by the Office of Nuclear Regulatory Research's Division of Risk Assessment, to inform the level of documentation review in the audit.

Action:

As part of the Tiered Approach, the NRC staff will enhance the current review process to further leverage risk insights to create a clear, comprehensive, and predictable methodology to determine the level of review. Specifically, the staff will:

1. Use an integrated panel review team to perform generic level-of-review determinations for each of the GALL-SLR Report AMPs and TLAAs, based on an evaluation of the combined risk information from the SLR applications evaluated to date and the degree to which operating plant programs can be leveraged (as described in the next section).
2. Revise internal staff guidance to include new guidance for the technical reviewer to perform plant-specific adjustments to the generic review tiers assigned in Item 1, based on plant-specific risk information.
3. Revise internal staff guidance to explicitly define the review approach (e.g., level of documentation review) for AMPs and TLAAs assigned to a plant-specific review tier, as noted in table C-1.

Leveraging Operating Programs

Many of the recommended AMPs in the GALL-SLR Report credit existing plant programs and activities that have long supported plant operations. These existing programs often rely on well-established and accepted industry standards that, in some instances, are subject to periodic NRC oversight or are otherwise of high awareness to the NRC staff. In such cases, a reduced level of review is appropriate.

When the initial version of the GALL Report was being developed, the NRC staff had extensive discussions with the Nuclear Energy Institute on the degree to which the staff could find those existing programs to be acceptable without further description by the applicant or review by the staff. In SECY-99-148, "Credit for Existing Programs for License Renewal," dated June 3, 1999 (ML12339A671), the staff described options for crediting existing programs. By staff requirements memorandum dated August 27, 1999 (ML003751930), the Commission approved the staff's recommendation to focus the staff review guidance on areas where existing programs should be augmented for LR.

In conducting its review of an applicant's proposal to credit existing operating programs, as augmented by the GALL-SLR Report, the NRC staff:

- Verifies that important aspects of the applicant's proposed program are consistent with the generically acceptable program recommended in the GALL-SLR Report.
- Evaluates the adequacy of any unique features of the applicant's program – where the applicant identifies a need to enhance its current program or to take an exception to the NRC recommendation.

- Reviews operating experience to verify that the existing program is “working” and that it will continue to be effective in the period of extended operation.

The NRC staff’s internal staff guidance discusses how to review AMPs and TLAAs that credit operating programs, but that guidance has largely relied on the technical reviewer’s engineering judgement on the appropriate level of review for the above steps.

To start the preparations for the Tiered Approach, the NRC staff has conducted training on the NRC oversight process; specifically, where it provides opportunities to verify the implementation and effectiveness of existing operating programs and TLAAs, such that the level of review in the renewal review may be reduced.

Action:

As part of the Tiered Approach, the NRC staff will enhance the current review process to more fully leverage operating programs to determine the appropriate level of review. This will primarily rely on (1) documenting key features of operating programs cited by the GALL-SLR Report AMPs (e.g., referenced codes and standards, NRC inspection procedures), and (2) providing more explicit expectations for reducing the level of review in those cases where an AMP or TLAAs relies on a mature, existing plant program or activity that is captured in NRC oversight. Specifically, the staff will:

- Use an integrated panel review team to perform generic level-of-review determinations to assign each of the GALL-SLR Report AMPs and TLAAs to a specific generic review tier, in a manner that fully leverages operating programs and risk characteristics.
- Revise internal guidance to include new guidance for technical reviewers to perform plant-specific adjustments to the generic review tiers, based on plant-specific operating program characteristics.
- Revise internal staff guidance to explicitly define the review approach (e.g., level of documentation review) for AMPs and TLAAs assigned to a plant-specific review tier, as noted in table C-1.

Leveraging Previous Reviews

As stated above, LR reviews have always credited programs that the NRC staff has previously found to be generically acceptable, as defined in the GALL and GALL-SLR Reports. The staff then primarily focuses its review on plant-specific considerations that may warrant augmentation, such as operating experience or unique plant configurations.

This framework can be extended to leverage approved approaches from prior renewal reviews, such as an AMP from the initial renewal of the same reactor site or a previously approved AMP from elsewhere in a utility’s reactor fleet, provided that the staff makes a technical determination that the prior, leveraged review remains valid and applicable to the current licensing basis of the facility for which the staff seeks to rely on a prior review. Staff reviews then can focus on site-specific considerations and any advances in recommended aging management approaches that have occurred since the prior review (e.g., updates to industry standards, guidance revisions due to recent operating experience).

In some cases, LR applicants have presented prior approvals as a basis for their proposed AMPs and TLAAs; however, the current development of the Tiered Approach provides an

opportunity to enhance the review framework to support a greater, and more efficient, use of this concept. Successful implementation will benefit from guidance to explain how the technical determination that the prior review remains valid for the current licensing basis of the facility seeking initial LR or SLR and can be leveraged in the current review, as well as clear expectations on how details from prior approvals and any gaps are presented in the LR application.

Action:

As part of the Tiered Approach, the NRC staff will enhance the current review process to provide a more complete framework for leveraging prior approvals. Specifically, the staff will:

- Revise internal guidance to include explicit guidance for technical reviewers to determine that the prior review remains valid for the current review prior to crediting prior approvals, with a focus on (1) any gaps from the previously approved AMP or TLAA, and (2) any needed augmentation due to plant-specific considerations and enhancements to recommended practices since the prior approval.
- Engage with industry to establish expectations on the content of a LR application to support the leveraging of prior approvals most efficiently, including details on prior approvals and any gaps relative to those earlier approvals.

Leveraging NRC/Industry Operating Experience with Aging Management

Since the first U.S. nuclear power plant entered its initial period of extended operation in 2009, the industry and the NRC have been gaining valuable insights into effective LR activities. Therefore, the SLR review provides the opportunity to recognize successful plant aging management practices and, as appropriate, adjust the level of review in those technical areas.

It is similarly important to recognize the uncertainties that exist in long-term materials aging. The maintenance activities and aging management approaches successfully used in the past are not necessarily appropriate for the future. As frequently represented in the “bathtub” curve in figure C-2, occurrences of component failures typically change with time. When an SSC is first placed into operation, there is generally an initial period during which some materials may degrade by unknown or unexpected mechanisms. Failure probabilities during this “burn-in” period generally decrease as degradation mechanisms are better understood and corrected. Failure probabilities then become relatively constant and are primarily influenced by random failures. As the SSC ages, however, long-term issues related to materials degradation may emerge and failure probabilities rise again.

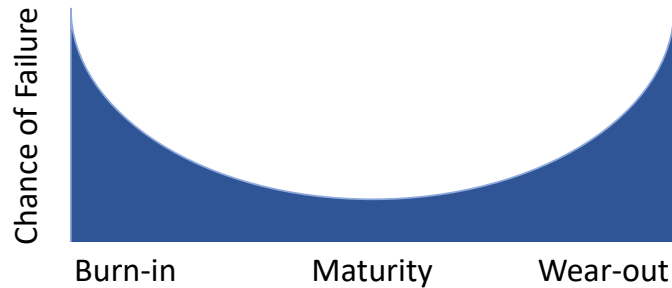


Figure C-2 Bathtub curve

This consideration is reflected in the SOC for the original 1991 rule (56 FR 64943), when the NRC discussed its basis for establishing a 20-year limit on the period of extended operation, stating:

The Commission believes that sufficient technical understanding of age-related degradation exists to enable nuclear power plant licensees to develop activities for ensuring safe operation of their plants for an additional 20 years beyond expiration of existing licenses. However, ***a 20-year limit on extended operation will, in the Commission's judgment, provide a useful opportunity to validate and reassess, if necessary, the current understanding of age-related degradation effects*** [emphasis added].

Plant-Specific Operating Experience

In the safety review, the NRC staff reviews plant-specific operating experience to verify that the applicant has adequately tailored its AMPs and TLAAs to address that experience. Information from the operating experience review can show where an existing program has succeeded and where it may not have been fully effective in identifying and addressing degradation in a timely manner.

Over time, the process to review plant-specific operating experience has been refined. For initial LRs, the NRC staff typically conducted independent searches of licensee records, including corrective actions, system health reports, inspection results, and other sources of operating experience information. For SLRs (and the most recent initial LRs), the staff has focused on the methodology that the applicant uses to identify and evaluate the operating experience used to inform the development of the AMPs. The staff reviews operating experience self-identified by the applicant, but may also request that the applicant provide detail on additional operating experience and, on a case-by-case basis, can request independent searches similar to how the staff's review was conducted for initial LRs.

For initial LRs, regional inspectors also have had responsibilities for reviewing plant-specific operating experience during the LR review process. Regional inspectors follow guidance in Inspection Procedure (IP) 71002, "License Renewal Inspection," performing inspections to verify the accuracy of information in the LR application, including operating experience. This inspection is not conducted during the SLR application review because during the first period of extended operation, which is when the application is under review, licensees are subject to IP 71003, "Post-Approval Site Inspection for License Renewal." IP 71003 also applies to the

subsequent period of extended operation.

Generic Operating Experience

Generic operating experience across the industry should be considered on an ongoing basis and, as appropriate, addressed by LR applicants. Consistent communication and awareness of generic operating experience contributes to a more efficient review process, with applicants proactively addressing concerns that similar plants may have experienced.

The NRC staff has frequently used the NRC's generic communication process to raise awareness of emergent age-related issues to ensure that licensees have the necessary information to evaluate the need for corrective actions at their sites (e.g., Information Notice 2020-04, "Operating Experience Related to Failure of Buried Fire Protection Main Yard Piping" dated December 17, 2020 (ML20223A333)). Also, as will be discussed in more detail below, the staff regularly enhances the GALL-SLR Report and issues Interim Staff Guidance to ensure that the aging management activities recommended therein reflect the latest operating experience.

Additionally, the NRC staff continues to collaborate with international counterparts to leverage international best practices and operating experience. For example, the staff holds leadership positions and actively participates in the International Atomic Energy Agency International Generic Aging Lessons Learned (IGALL) program, which shares worldwide best practices for managing the effects of aging degradation. Although the staff has always leveraged IGALL working group meetings to share operating experience, IGALL practices were recently modified to formally incorporate an operating experience agenda item for each meeting. Participants will bring significant operating experience from their country to each meeting to share and invite feedback.

The NRC staff's review of operating experience remains one of the most important aspects of a LR review, and the findings guide the appropriate level of review for a specific technical area. For well-established plant programs, positive operating experience trends, or an absence of unexpected degradation, the level of review can be scoped appropriately. For less mature plant programs, adverse trends, or recent or reoccurring issues, the level of review would require more resources.

Action:

As part of the Tiered Approach, the NRC staff will enhance the current operating experience review process to provide additional staff guidance for leveraging operating experience when determining the appropriate level of review for each technical area. Specifically, the staff will:

- Incorporate operating experience in the integrated panel review determinations for the generic level-of-review tiers of each of the GALL-SLR Report AMPs and TLAAs.
- Revise internal guidance to include new guidance for technical reviewers to adjust the generic review tiers, based on plant-specific operating experience.

Consistency with NRC Guidance Documents

As discussed above, the GALL-SLR Report discusses how existing plant programs should be augmented for license renewal. This guidance minimizes the need to review common technical issues on a plant-specific basis and contributes to a more appropriate level of the NRC staff's

technical review. As stated in NUREG-2192, “Standard Review Plan for Review of Subsequent License Renewal Applications for Nuclear Power Plants” (SRP-SLR):

If the applicant has provided the information necessary to adopt the finding of program acceptability as described and evaluated in the GALL-SLR Report, the reviewer should find acceptable the applicant’s reference to the GALL-SLR Report in its [subsequent license renewal application]. In making this determination, the reviewer confirms that the applicant has provided a brief description of the system, components, materials, and environment. The reviewer also confirms that the applicable aging effects have been addressed based on the staff’s review of industry and plant-specific [operating experience].

Reference to approved topical reports is one means by which the use of the GALL-SLR Report can streamline the NRC staff’s technical review. Topical reports allow for a single staff review of a safety-related topic that applies to multiple nuclear power plants. For example, a technical area that often requires a significant level of review is pressurized water reactor vessel internals. After the staff completes its current review of Materials Reliability Program (MRP)-227, Revision 2, “Pressurized Water Reactor Internals Inspection and Evaluations Guideline” dated February 23, 2022 (ML22055B041), (and if found to be acceptable), plants can use the guidelines therein to support SLR out to 80 years. The staff is similarly reviewing the Boiling Water Reactor Vessel and Internals Project (BWRVIP)-315, “Reactor Internals Aging Management Evaluation for Extended Operations,” dated October 22, 2019 (ML19297G277), which addresses the management of age-related degradation of BWR reactor internals for operating periods exceeding 60 years. If approved by the NRC, these two topical reports would limit the number of hours necessary for SLR reviews.

Since its initial issuance in 2001, the GALL Report has been regularly enhanced to account for plant operating experience, lessons learned, knowledge gains through research, and the issuance of new and updated industry consensus standards and technical reports. These enhancements enable the guidance to be informed by knowledge gains and best industry practices. In July 2023, the NRC staff issued, for public comment, draft updates of the GALL-SLR Report and the SRP-SLR. The NRC staff is currently evaluating public comments and expects to issue the final guidance documents in early 2025.