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NUREG-1800, Rev. 2

# **Standard Review Plan for Review of License Renewal Applications for Nuclear Power Plants**

Final Report

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NUREG-1800, Rev. 2

# **Standard Review Plan for Review of License Renewal Applications for Nuclear Power Plants**

Final Report

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## **A.1 AGING MANAGEMENT REVIEW - GENERIC (BRANCH TECHNICAL POSITION RLSB-1)**

### **A.1.1 Background**

Pursuant to 10 CFR 54.21(a)(3), a license renewal applicant is required to demonstrate that the effects of aging on structures and components subject to an Aging Management Review (AMR) are adequately managed so their intended functions will be maintained consistent with the CLB for the period of extended operation. The purpose of this Branch Technical Position (RLSB-1) is to address the aging management demonstration that has not been addressed specifically in Chapters 3 and 4 of this Standard Review Plan.

The license renewal process is not intended to demonstrate absolute assurance that structures and components will not fail, but rather that there is reasonable assurance that they will perform such that the intended functions are maintained consistent with the current licensing basis (CLB) during the period of extended operation.

There are generally four types of aging management programs (AMPS): prevention, mitigation, condition monitoring, and performance monitoring. Prevention programs preclude the effects of aging. For example, coating programs prevent external corrosion of a tank. Mitigation programs attempt to slow the effects of aging. For example, water chemistry programs mitigate internal corrosion of piping. Condition monitoring programs inspect for the presence and extent of aging effects. Examples are the visual examination of concrete structures for cracking and the ultrasonic examination of pipe wall for flow-accelerated corrosion (FAC)-induced wall thinning. Performance monitoring programs test the ability of a structure or component to perform its intended function(s). For example, the ability of the tubes on heat exchangers to transfer heat is tested. More than one type of AMP may be implemented to ensure that aging effects are managed. For example, in managing internal corrosion of piping, a mitigation program (water chemistry) may be used to minimize susceptibility to corrosion. However, it may also be necessary to have a condition monitoring program (ultrasonic inspection) to verify that corrosion is indeed insignificant.

### **A.1.2 Branch Technical Position**

#### **A.1.2.1 Applicable Aging Effects**

1. The determination of applicable aging effects is based on degradation mechanisms that have occurred and those that potentially could cause structure and component degradation. The materials, environment, stresses, service conditions, operating experience, and other relevant information should be considered in identifying applicable aging effects. The effects of aging on the intended function(s) of structures and components also should be considered.
2. Relevant aging information may be contained in, but is not limited to, the following documents: plant-specific maintenance and inspection records; plant-specific site deviation or issue reports; plant-specific NRC and Institute of Nuclear Power Operations (INPO) inspection reports; plant-specific licensee self-assessment reports; plant-specific and other licensee event reports (LERs); NRC, INPO, and vendor generic communications; GSIs/unresolved safety issues (USIs); NUREG reports; and Electric Power Research Institute (EPRI) reports.

3. If operating experience or other information indicates that a certain aging effect may be applicable and an applicant determines that it is not applicable to its specific plant, the reviewer may question the absence of this aging effect unless the applicant has provided the basis for this determination in its license renewal application. However, in questioning the absence of the aging effect, a reference and/or basis which aided the applicant in addressing the question should be provided. For example, the question could cite a previous application review, NRC generic communications, engineering judgment, relevant research information, or other industry experience as the basis for the question. Simply citing that the aging effect is listed in the GALL Report is not a sufficient basis. For example, the aging effect is applicable to a PWR component, but the applicant's plant is a BWR and does not have such a component. In this example, using the GALL Report merely as a checklist is not relevant.
4. An aging effect may not have been identified in the GALL Report, if it arises out of industry experience after the issuance of the GALL Report. The reviewer should ensure that the applicant has evaluated the latest industry experience to identify all applicable aging effects.
5. An aging effect should be identified as applicable for license renewal even if there is a prevention or mitigation program associated with that aging effect. For example, water chemistry, a coating, or use of cathodic protection could prevent or mitigate corrosion, but corrosion should be identified as applicable for license renewal, and the AMR should consider the adequacy of the AMP referencing water chemistry, coating, or cathodic protection.
6. Specific identification of aging mechanisms is not a requirement; however, it is an option to identify specific aging mechanisms and the associated aging effects in the integrated plant assessment (IPA).
7. The applicable aging effects to be considered for license renewal include those that could result from normal plant operation, including plant/system operating transients and plant shutdown. Specific aging effects from abnormal events need not be postulated for license renewal. However, if an abnormal event has occurred at a particular plant, its contribution to the aging effects on structures and components for license renewal should be considered for that plant. For example, if a resin intrusion has occurred in the reactor coolant system at a particular plant, the contribution of this resin intrusion event to aging should be considered for that plant.

Design basis events (DBEs) are abnormal events; they include design basis pipe break, loss of coolant accident (LOCA), and safe shutdown earthquake (SSE). Potential aging effects resulting from DBEs are addressed, as appropriate, as part of the plant's CLB. There are other abnormal events which should be considered on a case-by-case basis. For example, abuse due to human activity is an abnormal event; aging effects from such abuse need not be postulated for license renewal. When a safety-significant piece of equipment is accidentally damaged by a licensee, the licensee is required to take immediate corrective action under existing procedures (see 10 CFR Part 50 Appendix B) to ensure functionality of the equipment. The equipment degradation is not due to aging; corrective action is not necessary solely for the period of extended operation. However, leakage from bolted connections should not be considered as abnormal events. Although bolted connections are not supposed to leak, experience shows that leaks do

occur, and the leakage could cause corrosion. Thus, the aging effects from leakage of bolted connections should be evaluated for license renewal.

An aging effect due to an abnormal event does not preclude that aging effect from occurring during normal operation for the period of extended operation. For example, a certain PWR licensee observed clad cracking in its pressurizer, and attributed that to an abnormal dry out of the pressurizer. Although dry out of a pressurizer is an abnormal event, the potential for clad cracking in the pressurizer during normal operation should be evaluated for license renewal. This is because the pressurizer is subject to extensive thermal fluctuations and water level changes during plant operation, which may result in clad cracking given sufficient operating time. The abnormal dry out of the pressurizer at that certain plant may have merely accelerated the rate of the aging effect.

#### **A.1.2.2 Aging Management Program for License Renewal**

1. An acceptable AMP should consist of the 10 elements described in Table A.1-1, as appropriate (Ref. 1). These program elements/attributes are discussed further in Position A.1.2.3 below.
2. All programs and activities that are credited for managing a certain aging effect for a specific structure or component should be described. These AMPs/activities may be evaluated together for the 10 elements described in Table A.1-1, as appropriate.
3. The risk significance of a structure or component could be considered in evaluating the robustness of an AMP. Probabilistic arguments may be used to develop an approach for aging management adequacy. However, use of probabilistic arguments alone is not an acceptable basis for concluding that, for those structures and components subject to an AMR, the effects of aging will be adequately managed in the period of extended operation. Thus, risk significance may be considered in developing the details of an AMP for the structure or component for license renewal, but may not be used to conclude that no AMP is necessary for license renewal.

#### **A.1.2.3 Aging Management Program Elements**

##### **A.1.2.3.1 Scope of Program**

The specific program necessary for license renewal should be identified. The scope of the program should include the specific structures and components, the aging of which the program manages.

##### **A.1.2.3.2 Preventive Actions**

1. The activities for prevention and mitigation programs should be described. These actions should mitigate or prevent aging degradation.
2. Some condition or performance monitoring programs do not rely on preventive actions and thus, this information need not be provided.
3. In some cases, condition or performance monitoring programs may also rely on preventive actions. The specific prevention activities should be specified.

#### **A.1.2.3.3 Parameters Monitored or Inspected**

1. This program element should identify the aging effects that the program manages and should provide a link between the parameter or parameters that will be monitored and how the monitoring of these parameters will ensure adequate aging management.
2. For a condition monitoring program, the parameter monitored or inspected should be capable of detecting the presence and extent of aging effects. Some examples are measurements of wall thickness and detection and sizing of cracks.
3. For a performance monitoring program, a link should be established between the degradation of the particular structure or component-intended function(s) and the parameter(s) being monitored. An example of linking the degradation of a passive component-intended function with the performance being monitored is linking the fouling of heat exchanger tubes with the heat transfer-intended function. This could be monitored by periodic heat balances. Since this example deals only with one intended function of the tubes (heat transfer), additional programs may be necessary to manage other intended function(s) of the tubes, such as pressure boundary. Thus, a performance monitoring program must ensure that the structure and components are capable of performing their intended functions by using a combination of performance monitoring and evaluation (if outside acceptable limits of acceptance criteria) that demonstrate that a change in performance characteristic is a result of an age-related degradation mechanism.
4. For prevention or mitigation programs, the parameters monitored should be the specific parameters being controlled to achieve prevention or mitigation of aging effects. An example is the coolant oxygen level that is being controlled in a water chemistry program to mitigate pipe cracking.

#### **A.1.2.3.4 Detection of Aging Effects**

1. Detection of aging effects should occur before there is a loss of the structure- and component-intended function(s). The parameters to be monitored or inspected should be appropriate to ensure that the structure- and component-intended function(s) will be adequately maintained for license renewal under all CLB design conditions. Thus, the discussion for the "detection of aging effects" program element should address (a) how the program element would be capable of detecting or identifying the occurrence of age-related degradation or an aging effect prior to a loss of structure and component (SC)-intended function or (b) for preventive/mitigative programs, how the program would be capable of preventing or mitigating their occurrence prior to a loss of a SC-intended function. The discussion should provide information that links the parameters to be monitored or inspected to the aging effects being managed.
2. Nuclear power plants are licensed based on redundancy, diversity, and defense-in-depth principles. A degraded or failed component reduces the reliability of the system, challenges safety systems, and contributes to plant risk. Thus, the effects of aging on a structure or component should be managed to ensure its availability to perform its intended function(s) as designed when called upon. In this way, all system level-intended function(s), including redundancy, diversity, and defense-in-depth consistent with the plant's CLB, would be maintained for license renewal. A program based solely



on detecting structure and component failure should not be considered as an effective AMP for license renewal.

3. This program element describes “when,” “where,” and “how” program data are collected (i.e., all aspects of activities to collect data as part of the program).
4. For condition monitoring programs, the method or technique (such as visual, volumetric, or surface inspection), frequency, and timing of new, one-time inspections may be linked to plant-specific or industrywide operating experience. The discussion should provide justification, including codes and standards referenced, that the technique and frequency are adequate to detect the aging effects before a loss of SC-intended function. A program based solely on detecting SC failures is not considered an effective AMP.

For a condition monitoring program, when sampling is used to represent a larger population of SCs, applicants should provide the basis for the inspection population and sample size. The inspection population should be based on such aspects of the SCs as a similarity of materials of construction, fabrication, procurement, design, installation, operating environment, or aging effects. The sample size should be based on such aspects of the SCs as the specific aging effect, location, existing technical information, system and structure design, materials of construction, service environment, or previous failure history. The samples should be biased toward locations most susceptible to the specific aging effect of concern in the period of extended operation. Provisions on expanding the sample size when degradation is detected in the initial sample should also be included.

5. For a performance monitoring program, the “detection of aging effects” program element should discuss and establish the monitoring methods that will be used for performance monitoring. In addition, the “detection of aging effects” program element should also establish and justify the frequency that will be used to implement these performance monitoring activities.
6. For a prevention or mitigation program, the “detection of aging effects” program element should discuss and establish the monitoring methods that the program will use to monitor for the preventive or mitigative parameters that the program controls and should justify the frequency of performing these monitoring activities.

#### **A.1.2.3.5 Monitoring and Trending**

1. Monitoring and trending activities should be described, and they should provide a prediction of the extent of degradation and thus effect timely corrective or mitigative actions. Plant-specific and/or industrywide operating experience may be considered in evaluating the appropriateness of the technique and frequency.
2. This program element describes “how” the data collected are evaluated and may also include trending for a forward look. This includes an evaluation of the results against the acceptance criteria and a prediction regarding the rate of degradation in order to confirm that timing of the next scheduled inspection will occur before a loss of SC-intended function. Although aging indicators may be quantitative or qualitative, aging indicators should be quantified, to the extent possible, to allow trending. The parameter or indicator trended should be described. The methodology for analyzing the inspection or test results against the acceptance criteria should be described. Trending is a comparison of

the current monitoring results with previous monitoring results in order to make predictions for the future.

#### **A.1.2.3.6 Acceptance Criteria**

1. The quantitative or qualitative acceptance criteria of the program and its basis should be described. The acceptance criteria, against which the need for corrective actions are evaluated, should ensure that the structure- and component-intended function(s) are maintained consistent with all CLB design conditions during the period of extended operation. The program should include a methodology for analyzing the results against applicable acceptance criteria.

For example, carbon steel pipe wall thinning may occur under certain conditions due to FAC. An AMP for FAC may consist of periodically measuring the pipe wall thickness and comparing that to a specific minimum wall acceptance criterion. Corrective action is taken, such as piping replacement, before deadweight, seismic, and other loads, and this acceptance criterion must be appropriate to ensure that the thinned piping would be able to carry these CLB design loads. This acceptance criterion should provide for timely corrective action before loss of intended function under these CLB design loads.

2. Acceptance criteria could be specific numerical values, or could consist of a discussion of the process for calculating specific numerical values of conditional acceptance criteria to ensure that the structure- and component-intended function(s) will be maintained under all CLB design conditions. Information from available references may be cited.
3. It is not necessary to justify any acceptance criteria taken directly from the design basis information that is included in either the final safety analysis report (FSAR), plant Technical Specifications, or other codes and standards incorporated by reference into NRC regulations; they are a part of the CLB. Nor is it necessary to justify the acceptance criteria that have been established in either NRC-accepted or NRC-endorsed methodology, such as those that may be given in NRC-approved or NRC-endorsed topical reports or NRC-endorsed codes and standards; the acceptance criteria referenced in these types of documents have been subject to an NRC review process and have been approved or endorsed for their application to an NRC-approved or NRC-endorsed evaluation methodology. Also, it is not necessary to discuss CLB design loads if the acceptance criteria do not permit degradation because a structure and component without degradation should continue to function as originally designed. Acceptance criteria, which do permit degradation, are based on maintaining the intended function under all CLB design loads.

#### **A.1.2.3.7 Corrective Actions**

1. Actions to be taken when the acceptance criteria are not met should be described in appropriate detail or referenced to source documents. Corrective actions, including root cause determination and prevention of recurrence, should be timely.
2. If corrective actions permit analysis without repair or replacement, the analysis should ensure that the structure- and component-intended function(s) are maintained consistent with the CLB.

3. For safety-related components, an applicant's 10 CFR Part 50, Appendix B, Quality Assurance Program, is an acceptable means to confirm that the corrective actions are done in a manner consistent with the condition monitoring program, preventive program, mitigative program, or performance monitoring program that is credited for aging management. For example, for a plant-specific condition monitoring program that is based on ASME Section XI requirements, the implementation of the Appendix B program should ensure that any corrective actions are performed in accordance with applicable Code requirements or NRC-approved Code cases.

#### **A.1.2.3.8 Confirmation Process**

1. The confirmation process should be described. The process ensures that preventive actions are adequate and that appropriate corrective actions have been completed and are effective.
2. The effectiveness of prevention and mitigation programs should be verified periodically. For example, in managing internal corrosion of piping, a mitigation program (water chemistry) may be used to minimize susceptibility to corrosion. However, it also may be necessary to have a condition monitoring program (ultrasonic inspection) to verify that corrosion is indeed insignificant.
3. When corrective actions are necessary, there should be follow-up activities to confirm that the corrective actions have been completed, a root cause determination was performed, and recurrence will be prevented.

#### **A.1.2.3.9 Administrative Controls**

1. The administrative controls of the program should be described. Administrative controls provide a formal review and approval process.
2. Any AMPs to be relied on for license renewal should have regulatory and administrative controls. That is the basis for 10 CFR 54.21(d) to require that the FSAR supplement include a summary description of the programs and activities for managing the effects of aging for license renewal. Thus, any informal programs relied on to manage aging for license renewal must be administratively controlled and included in the FSAR supplement.

#### **A.1.2.3.10 Operating Experience**

1. Consideration of future plant-specific and industry operating experience relating to aging management programs should be discussed. Reviews of operating experience by the applicant in the future may identify areas where aging management programs should be enhanced or new programs developed. An applicant should commit to a future review of plant-specific and industry operating experience to confirm the effectiveness of its aging management programs or indicate a need to develop new aging management programs. This information should provide objective evidence to support the conclusion that the effects of aging will be managed adequately so that the structure and component intended function(s) will be maintained during the period of extended operation.
2. Operating experience with existing programs should be discussed. The operating experience of AMPs that are existing programs, including past corrective actions

resulting in program enhancements or additional programs, should be considered. A past failure would not necessarily invalidate an AMP because the feedback from operating experience should have resulted in appropriate program enhancements or new programs. This information can show where an existing program has succeeded and where it has failed (if at all) in intercepting aging degradation in a timely manner. This information should provide objective evidence to support the conclusion that the effects of aging will be managed adequately so that the structure- and component-intended function(s) will be maintained during the period of extended operation.

3. For new AMPs that have yet to be implemented at an applicant's facility, the programs have not yet generated any operating experience (OE). However, there may be other relevant plant-specific OE at the plant or generic OE in the industry that is relevant to the AMP's program elements even though the OE was not identified as a result of the implementation of the new program. Thus, for new programs, an applicant may need to consider the impact of relevant OE that results from the past implementation of its existing AMPs that are existing programs and the impact of relevant generic OE on developing the program elements. Therefore, operating experience applicable to new programs should be discussed. Additionally, an applicant should commit to a review of future plant-specific and industry operating experience for new programs to confirm their effectiveness.

### **A.1.3 References**

1. NEI 95-10, "Industry Guideline for Implementing the Requirements of 10 CFR Part 54 – The License Renewal Rule," Nuclear Energy Institute, Revision 6.

**Table A.1-1 Elements of an Aging Management Program for License Renewal**

<b>Element</b>	<b>Description</b>
1. Scope of Program	Scope of program includes the specific structures and components subject to an AMR for license renewal.
2. Preventive Actions	Preventive actions should prevent or mitigate aging degradation.
3. Parameters Monitored or Inspected	Parameters monitored or inspected should be linked to the degradation of the particular structure or component-intended function(s).
4. Detection of Aging Effects	Detection of aging effects should occur before there is a loss of structure or component-intended function(s). This includes aspects such as method or technique (i.e., visual, volumetric, surface inspection), frequency, sample size, data collection, and timing of new/one-time inspections to ensure timely detection of aging effects.
5. Monitoring and Trending	Monitoring and trending should provide predictability of the extent of degradation, and timely corrective or mitigative actions.
6. Acceptance Criteria	Acceptance criteria, against which the need for corrective action will be evaluated, should ensure that the structure or component-intended function(s) are maintained under all CLB design conditions during the period of extended operation.
7. Corrective Actions	Corrective actions, including root cause determination and prevention of recurrence, should be timely.
8. Confirmation Process	Confirmation process should ensure that preventive actions are adequate and that appropriate corrective actions have been completed and are effective.
9. Administrative Controls	Administrative controls should provide a formal review and approval process.
10. Operating Experience	If the AMP is an existing program, operating experience of the AMP, including past corrective actions resulting in program enhancements or additional programs, should provide objective evidence to support the conclusion that the effects of aging will be managed adequately so that the structure- and component-intended function(s) will be maintained during the period of extended operation.